LAPPEENRANTA-LAHTI UNIVERSITY OF TECHNOLOGY LUT
LUT School of Energy Systems
LUT Mechanical Engineering

Olorunmuyiwa Igunnuoda

PRODUCT STRUCTURE UNIFICATION IN MODERNIZATION PROJECTS

20.06.2022

Examiners: Professor Juha Varis
Ari-Pekka Tiusanen

ABSTRACT

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Product structure unification in modernization projects

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Helping customers improve productivity and capacity through modernization of their existing machinery is a business model many companies are now embracing. This model comes with its own challenges. For some, modernization creates another structure in PDM system which then results in two structures for one machine. This study is aimed at finding a way two or more product structures can be unified in PDM system, so that there won't be need to keep two product structures for one machine after modernization projects.

Background information about the topic was gathered through interviews, semi-structured interviews and review of various related literatures. That information birthed the idea of unifying product structure through revision. Making revision to the machine delivered earlier to the customer by adding the necessary modernization parts and removing unnecessary parts will ensure that the machine at customer site has only one structure. A modernization simulation was carried out to test the efficacy of using revision to unify product structure and the result shows that the challenge of having to keep track of two structures in PDM system can indeed be solved by revision.

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Olorunmuyiwa Igunnuoda

Olorunmuyiwa Igunnuoda

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LIST OF ABBREVIATIONS

BOM	Bill of Material
CAD	Computer Aided Design
ERP	Enterprise resource planning
ETO	Engineer to Order
LVL	Laminated veneer lumber
PDM	Product Data Management
PLM	Product Lifecycle Management

1 INTRODUCTION

In this chapter, an introduction about the company as well as information about the background to this work will be presented in brief. The aim and objective of this work will also be presented, followed by a description of how this research work will be carried out. The last segment of this chapter will present the structure of this report.

1.1 Raute Oy

This research work is carried out for Raute Oy. Raute is a technology and service company that serves the wood product industry, and their main customers are companies that produce wood products such as veneers, plywood, laminated veneer lumber (LVL), and sawn timber. Raute as a global market leader account for about 15 – 20 % of the market share in the plywood industry, and over half of the world's LVL are produced by machines supplied by Raute.

Raute offers solutions that cover the entire production process of plywood and LVL such as log handling, turning, drying, veneer processing, plywood stacking and pressing, board handling and repair, LVL stacking and pressing, handling and sorting. Raute offers their customers lifecycle service support from early investment planning phase of a factory-to-factory audits, modernizations and competence development.

Raute Oy was founded in 1908. It is headquartered in Nastola, Finland, and it operates in 10 different countries. Its production facilities are located in Nastola and Kajaani, both in Finland, Vancouver in Canada, Shanghai and Pullman in China, and Washington D.C. in the USA. Raute has over 800 personnel with a turnover of about 142 million euros as of 2021.

1.2 Background

Technologies are improving almost every day in order to meet the challenges of this modern world. However, it is not feasible to keep investing in new technologies or machineries in order to keep up with these technological advancements. That is why modernization of existing machineries is seen as a viable alternative. Raute as a technological giant understands this, and they help their customers all over the world to improve efficiency, capacity and productivity through modernization of existing machineries.

For many big companies, after-sales modernization is seen as a way to gain competitive advantage in the face of intensified market competition. However, carrying out modernization projects does come with its own challenges; one of those challenges from Raute’s perspective is how to effectively manage the product structure. The production line, which is at customer sites (earlier purchased by customers) has its own equipment, spare parts structure, as well as related documentations. When modernization projects are carried out, new equipment, spare part and documents are made, which then result into two different model structures and documents, that is, the one at customer site, and the new one from modernization project. Keeping and maintaining those two structures and documentations for one production line in Raute’s product data management (PDM) system is quite challenging; hence, the need to look for a way to unify the product structure.

1.3 Aim and objective

The objective of this study is to find a way Raute Oy can conduct future modernization projects such that the result will be a unified model structure, unified spare part structure, as well as unified documentation in Raute’s PDM system. Figure 1 describes the aim and objectives of the research work. This study will also make sure that the results sync perfectly with Raute’s enterprise resource planning (ERP) system.

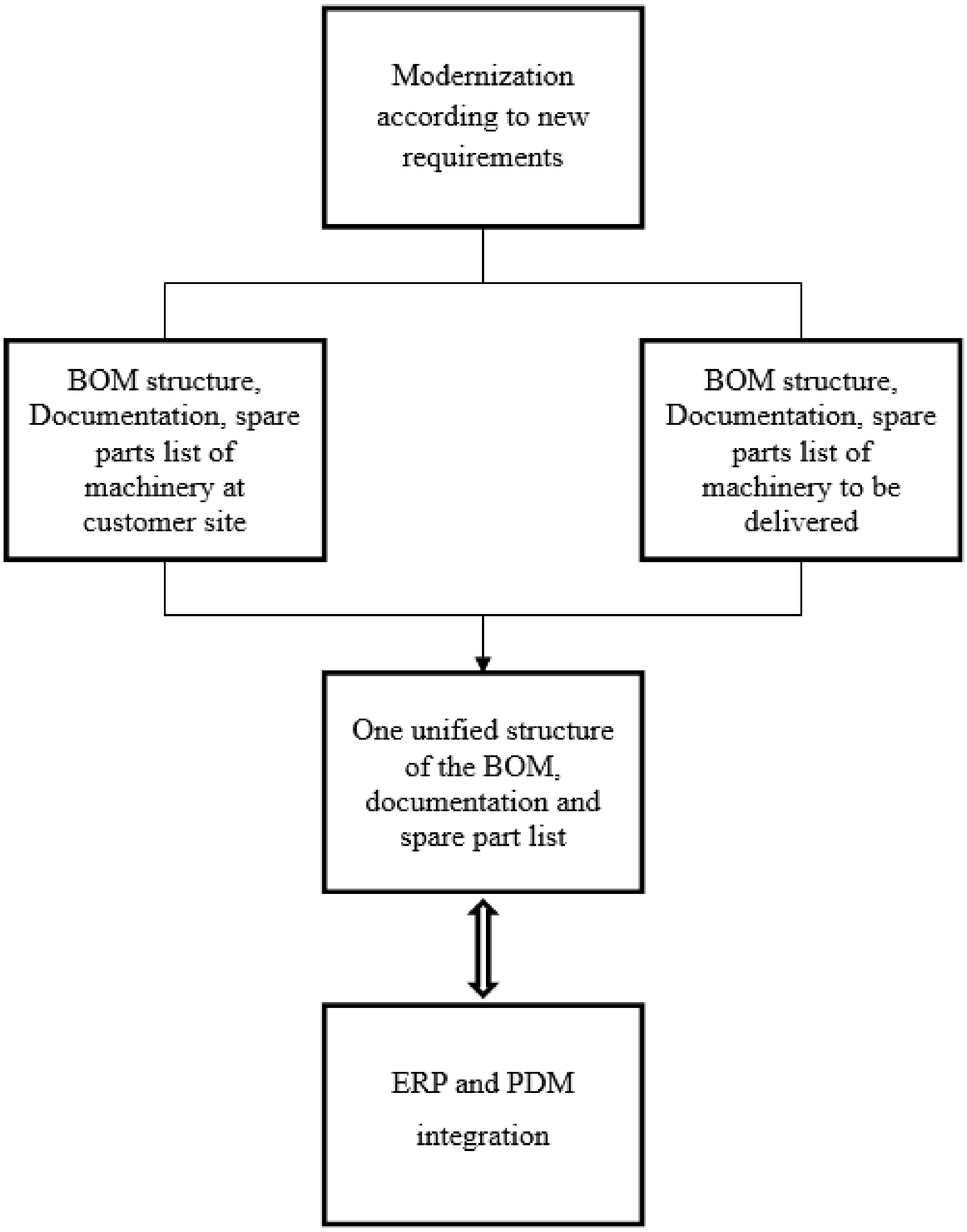


Figure 1. Aim and Objective of the thesis.

The research questions to which this study aims at finding answers to are:

RQ1. How can different product structures be unified in a PDM system?

RQ2. What are the key challenges that will arise in other systems that are linked to the PDM system when the structures are unified and how can the challenges be rectified?

1.4 Research methods

The type of research that will be employed for this work will be based on qualitative research. Qualitative research involves the collection of non-numerical data, as well as analysis of the data in order to gain in-depth knowledge into a particular problem of interest.

The data for this thesis will be gathered through semi-structured interviews, expert interviews, analysis and review of literatures, observation and experience of the author in working with Raute’s systems. The semi-structured interview will be conducted with experts from Raute Oy and Etteplan Finland Oy.

As regards the literature, which is wider than many research areas according to Crnkovic, Asklund & Dahlqvist (2003), and relatively new in terms of academic research area (Kropsu-Vehkaperä et al. 2009) the main source of the literature would be from scientific publications and articles, manuals from PDM/PLM manufacturers and books.

The inputs to this thesis work are through a combination of several actors as displayed in figure 2.

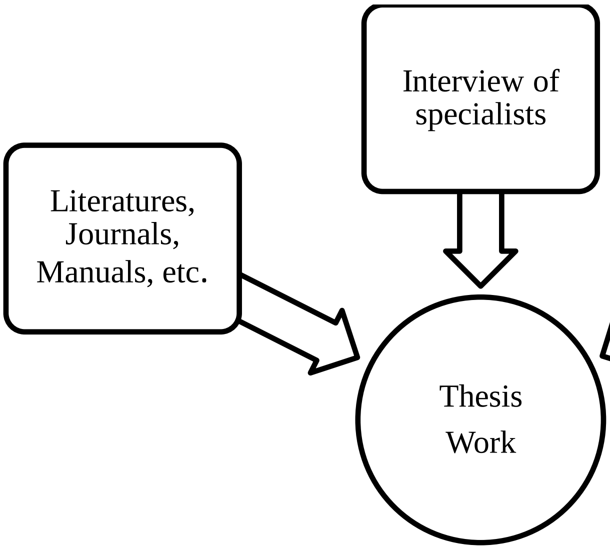


Figure 2. Thesis execution.

1.5 Structure of the thesis

This master's thesis is structured into 6 chapters. The first chapter provides a brief background and supporting information about this thesis work. The second chapter details on related theories to this thesis work, as well as discussion of relevant literatures in relation to PDM and product structure management and configuration. Chapter 3 focuses on strategic information gathering through interviews and study of various product lines, machines, their structures, how they work, and other related information. A breakdown and analysis of the machine used in this research work is presented in chapter 4. Idea and proposed solution are reported in chapter 5. Application of the solution as well as testing of the solution are documented also in chapter 5. The final chapter of this report, which is chapter 6, presents the summary of the results as well as the conclusion.

2 THEORETICAL BACKGROUND

This chapter presents the theoretical background to this research work. This chapter will help provide a general understanding of the literatures related to this study. This chapter will cover topics like product data, product data management (PDM) with its functions, and benefits, as well as product structure.

2.1 What is a product?

The definition of a product is countless. Every individual will no doubt have something to say about what a product means to them; that is to tell how numerous the definitions of a product could be. Few of the countless definitions are given here: A product is referred to as anything that can be built or manufactured. (Crnkovic et al., 2003). The Finnish standards association SFS defines a product as *"*an output of an organisation that can be produced without any transaction taking place between the organisation and the consumer*."* (SFS-EN ISO 9000).

(Kotler et al., 2006) defined a product as any physical object, services or ideas put up in the market for consumption or use. "Product is defined as hardware, software, services or some combination of these elements. Product also contains documents any of earlier defined cases. Product is understood as a portfolio item and not an individual serial-numbered item*."* (Kropsu-Vehkaperä, 2012).

A product is something of great importance to the customers as well as to the company. To the customers, a product satisfies their needs, and to the organisation; the product is the primary reason for their existence. Examples of common products are computers, phones, wristwatches, clothes, cars, and so on. A product can also be something abstract like rendering of services like fixing a car, advice from the doctor, and so on and so forth.

2.2 Product data

To have a good understanding of what product data is, it is imperative to break it down a little by defining what a product is, and what a data is. Some definitions of a product have been provided earlier; what then is data? Merriam-webster dictionary defined data as "information in digital form that can be transmitted or processed" Having provided the definition of a product and data, the idea of what a product data is becomes clearer.

What is product data? Product data is the data of a product. Since data is information from our definition, we can say product data is simply the information about a product. (Sääksvuori & Immonen, 2005) defined product data as any form of information related to a product. It includes all data or information related to a product and processes used to imagine, design, produce use, and dispose a product. (Stark, 2011). Examples of product data are listed below. (Stark, 2011; Huhtala, et al. 2003)

- Part number and description
- CAD documents
- BOM
- standards
- Drawings
- Test data
- Simulation results
- Vendor data
- User manuals
- Specification
- Patent report
- Customer requirements
- Verification report
- Product configurations
- Change data
- Engineering drawings
- Design specification
- Process plans

- Failure report
- NC program
- Data sheet and so on.

Various authors and researchers have categorised product data in different ways. Saaksvuori & Immonen categorised product data into three broad categories namely: Specification data, life cycle data and Metadata.

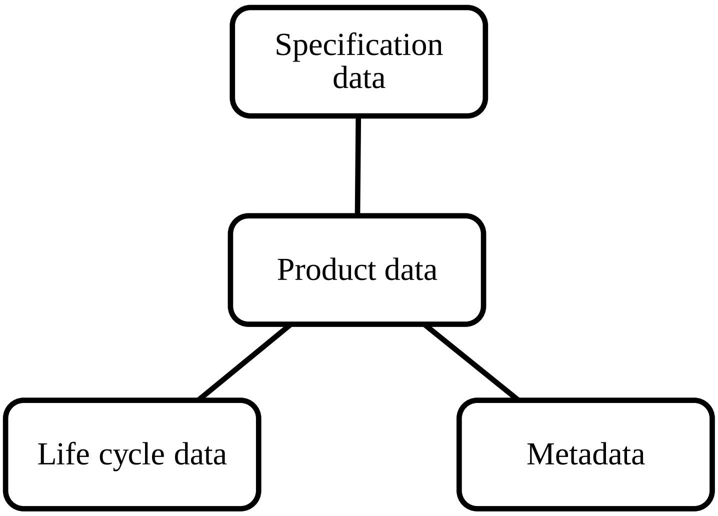


Figure 3. Product data according to Saaksvuori and Immonen

Specification data includes data about the physical and functional properties of a product. Life cycle data involves data about a product at each stage of its entire lifecycle. Data about ideation or conceptualisation, design, manufacture, use, recycling and disposal of the product are typical examples of lifecycle data. (Sääksvuori & Immonen 2005) Metadata is "Information about information" or "data about data" for the purpose of managing data (Kropsu-Vehkaperä, 2012; Stark, 2011; Sääkvuori & Immonen 2005). The data in question which metadata provides information about are typically large volume of data, it makes the usage and accessibility to those data easier. Product metadata may include product owner, location, status, name etc. (Stark 2011). Technical data, business data and administrative data are the three categorisations of product data according to Eskellinen.

2.3 Product data management

With individual customers having different requirement specifications, with engineering and manufacturing companies striving to gain competitive advantage in the market by offering highly configurable and customized products, the number of products as well as product data are increasing as a result of that. Managing these ever-increasing product data was becoming challenging and cumbersome; hence, it necessitated the invention of PDM.

PDM is primarily a tool aimed at managing product data effectively. (Saaksvuori & Immonen, 2005; Stark 2011). Siemens, a market leader in PDM and PLM systems referred to PDM as "the use of software to manage product data and process related information in a single, central system" The need for PDM systems has increased over the years as a result of continuous growth in product complexity, need for better data management, process improvement need and shorter product life cycle. (Peltonen, 2000; Svensson & Malmqvist, 2000)

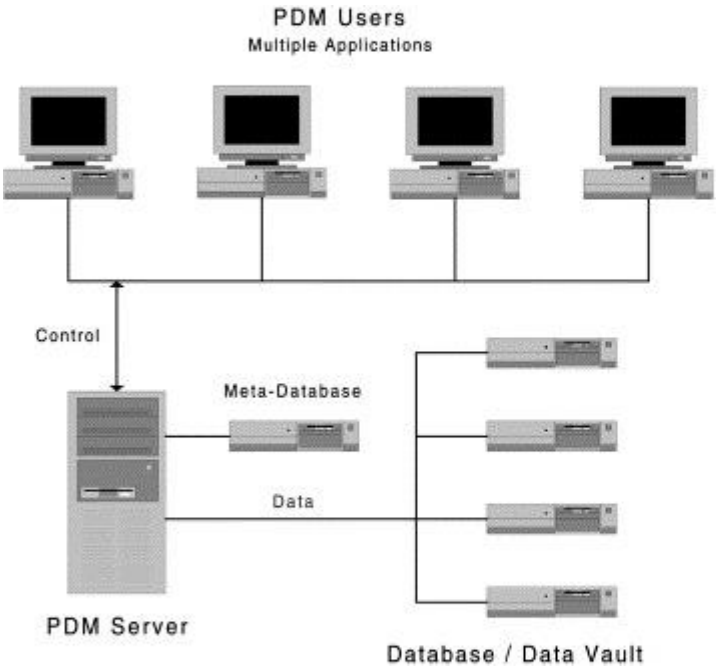


Figure 4. A typical PDM system. (Tony & William, 2001)

2.4 Basic functions of PDM

Literature from Crnkovic et al. 2003 and Philpotts, 1996 have it that the functionality of PDM system can be categorized broadly into two functions namely: Utility function and user function. The utility function simplifies the use of the system by supporting the user function, as well as keeping the complexities of the whole system away from the users. (Crnkovic et al. 2003; Philpotts, 1996). In this thesis, only the user function will be addressed.

The user functions are:

- Data vault and document management
- Workflow and process management
- Product structure management
- Classification management
- Program management

Data vault and document management

Data vaults provide secure storage, easy retrieval and distribution of product data in an efficient way. It is a warehouse for data. Users who have access to the vault can check-in and check-out a product to update or make changes to product information. Such changes can be seen and tracked by other users, which implies that up-to-date information is available to all users. An example of a data vault is shown in figure 5 below.

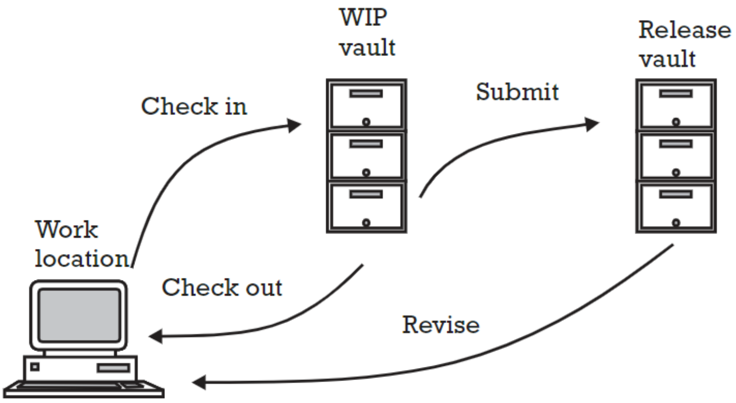


Figure 5. Example of data vault usage. Crnkovic et al. 2003

Workflow and process management

Workflow or process management tracks and control design and modifications made to a product. It manages what happens when a user makes changes to data; it also controls the process that manages how changes are proposed, reviewed, approved and in-cooperated into product data. The primary goal of this function is to ensure that users get the correct and latest version of what they are looking for.

Product structure management

The product structure management function in PDM makes it possible to create and manage bill of material, part lists and product configurations. This function also links product definition data such as drawings, specifications and support documents to part and product structure. The concept of product structure is explained later in this chapter.

Classification management

This function makes it possible to classify or group similar or standard parts, processes and other design information by common attributes. When they are grouped by attributes, it makes data retrieval easier, reduces the need for redesign, and encourages the re-use of part designs.

Program management

The program management function provides work breakdown structures and allows resource scheduling, coordination between projects and project tracking. This function provides a convenient way of tracking the progress of a project; this is possible when linked with other project management systems.

2.5 Benefits of PDM

Different companies have varied reasons for implementing PDM application; as a result, they all derive different benefits from it. Some general benefits are presented here.

With data stored in a centralised system, access to such data becomes easier, readily available and controllable. Easy access and availability to such data will ensure that engineers and designers spend more time on product development tasks and not on information search or retrieval. Data control or access control will also ensure that only authorised persons have access to certain product information.

The benefits of PDM are not in any way limited to the engineering department alone; it benefits the entire business as other departments like marketing, sales, purchasing, production and so on, can also perform their tasks more easily with PDM.

PDM has been acknowledged my many, such as (Helms, 2002; Gascoigne,1995) as an enabler for concurrent engineering. This will help in the development of better products through multidisciplinary collaboration and increased productivity.

Some benefits that can be derived from using PDM system are listed below (Stark 2011)

- Centralize the control of data
- Eliminate redundant data
- Enable better product development
- Improve access to data
- Reduce cost
- Improve supplier management
- Improve data management
- Reduce time to market
- Reduce the number of IT applications
- Replace legacy PDM application

2.6 Software's used in PDM system

The PDM market today boasts of a relatively huge amount of PDM systems, with individual companies offering varieties of packages to customers. These varieties make it possible for customers to choose based on their requirements, needs and budget. For example, Solidworks PDM package offers three different PDM solutions namely: Solidworks PDM standard, Solidworks PDM professional and Solidworks manage.

Some to the common PDM products used with CAD software's and their manufacturers are shown in *Table 1* below. (Tony & William, 2001)

Table 1. Examples of common PDM systems.

Company name	**PDM product name**
PTC (Parametric technology cooperation)	Windchill
Unigraphics solution	Information manager (iMAN)
IBM Corp.	ENOVIA pm
Autodesk	Autodesk Vault
Siemens	Teamcenter
Dassault systems	SolidWorks PDM
Sherpa Corp.	Sherpa Works
Metaphase Technology	Metaphase enterprise

2.7 Product structure

For products that are made of different components, there is a hierarchical product breakdown which describes how each component are put together to make subassemblies, and how the subassemblies are put together to form the final product. (Peltonen, 2000) This hierarchical arrangement of the different components of a product is referred to as product structure.

Product structure describes how parts or components, and subassemblies are linked to one another in the main assembly. (Sääksvuori & Immonen, 2005). For every product made by a manufacturer, it must have a product structure, this structure will for example tell which material and component will be bought or manufactured and in what quantity. Figure 6 shows a product structure of a pump.

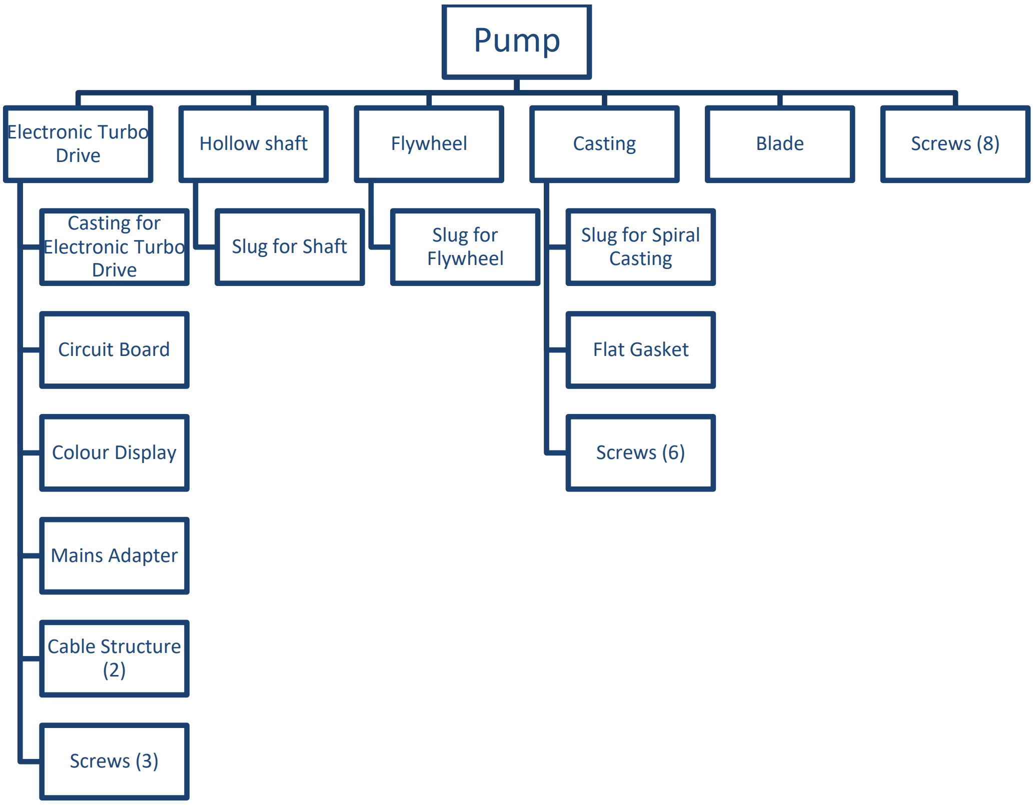


Figure 6. Product structure of a pump SAP-AG 2006 sited in Premaratne Samaranayakea and Tritos Laosirihongthong

(Sääksvuori & Immonen, 2005) described product structure as the "*Heart of a PLM/PDM system*" they further expatiated by saying "product structure provides the foundation for some of the basic functions of PLM/PDM system".

The concept of product structure is perceived in different ways by different departments or stakeholders according to different authors. (Svensson & Malmqvist, 2000) submitted that product structure can be viewed from the angle of design, manufacturing, purchasing, forecast, spare part/service and sales. (Sääksvuori & Immonen, 2005) in their book said that product structure can be viewed in terms of definition, design, sales manufacturing and service. It is fair to say that each organisation can define whichever way they view product structure based on different departments they have.

3 PRELIMINARY STUDY

In this chapter, some of Raute's product will be dissected so as to have a better understanding of the challenges at hand. This chapter will introduce the product and where it can be used in a production line, as well as discuss the types, functions, modules, product structure and other machines or equipment used in connection with it.

3.1 Overview of a product line

The product that will be used for this study is called a stacker. To have a better understanding of what a stacker is and what it does, it is imperative to present an overview of the product lines in which the stacker can be used.

Veneer production lines where a stacker can be used are:

- Veneer peeling line
- Veneer drying line

It is worth mentioning that no two production lines are the same as they are most often a result of engineer-to-order (ETO). ETO is simply a customer-driven manufacturing or production approach in which products are customised and delivered according to the wants of individual customers.

Veneer peeling line

The main machines that make up a peeling line are:

- Log feeder
- Veneer lathe
- Visual analyser
- Clipper
- Veneer stacker
- Conveyor(s)

Figure 7 shows one of Raute's peeling lines.

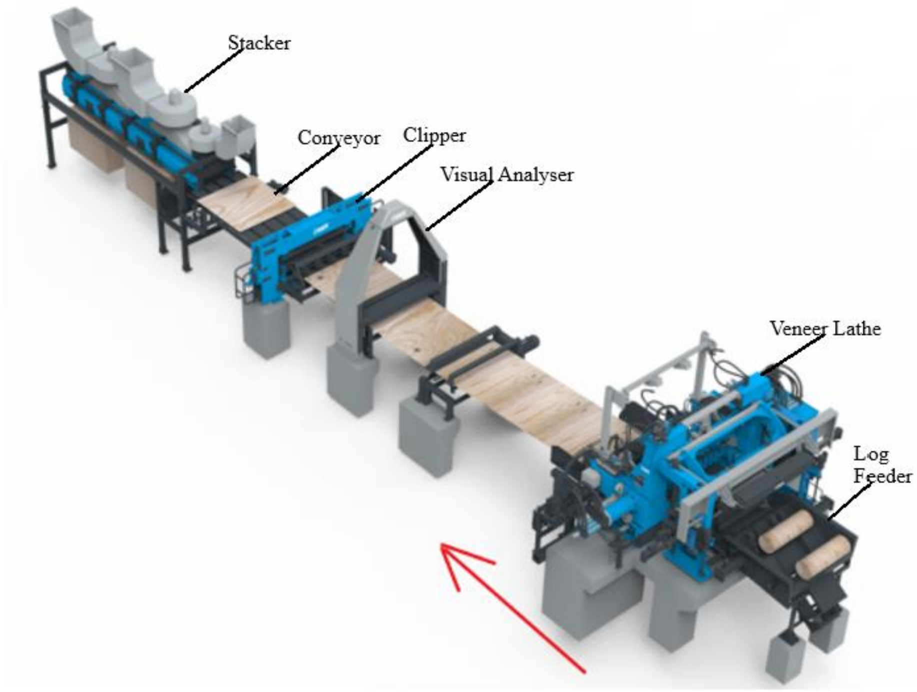


Figure 7. Veneer peeling line.

Veneer peeling is one of the stages in plywood production process. Before the commencement of the peeling process, logs of wood are first cut to size and then debarked. The debarked logs are then fed from the debarking machine into the veneer lathe through the log feeder. The lathe then peels the debarked log of wood into a continuous roll of wood. The continuous roll is then cut into length by a clipper. The cut length is then stacked up together and conveyed or transported to where they will be processed further.

Veneer drying line

The main machines that make up a peeling line are:

- Infeed roller
- Veneer dryer
- Outfeed roller
- Visual analyser
- Veneer stacker
- Conveyor(s)

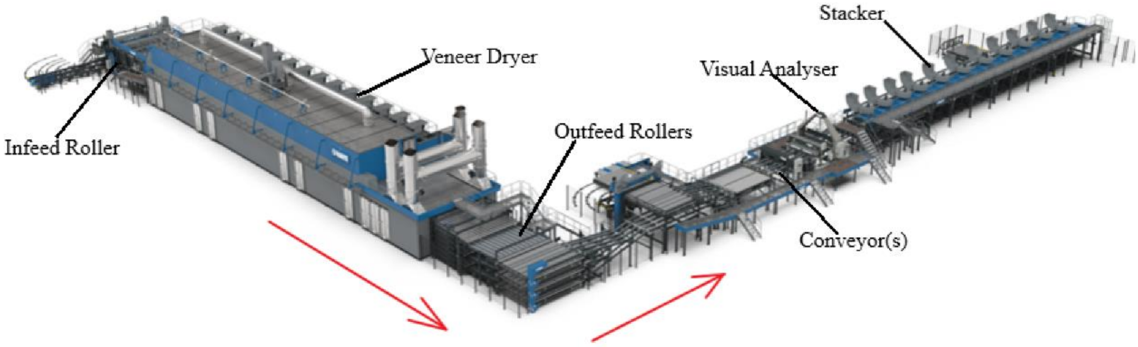


Figure 8. Veneer drying line.

As the name suggests, a veneer drying line is where drying of the veneers takes place. Veneer drying process is a very important process in veneer production. It ensures the production of high-quality and optimally dried veneers. Veneer sheets produced in the peeling process can be dried by feeding them into the veneer dryer through the infeed rollers. The dryer then dries the veneer sheets by removing water and reducing the moisture content in it. The dried veneer sheets are then cooled down and moved out of the dryer through the outfeed rollers. They are then conveyed by the conveyor to the stackers, where they will be stacked.

3.2 Veneer stacker

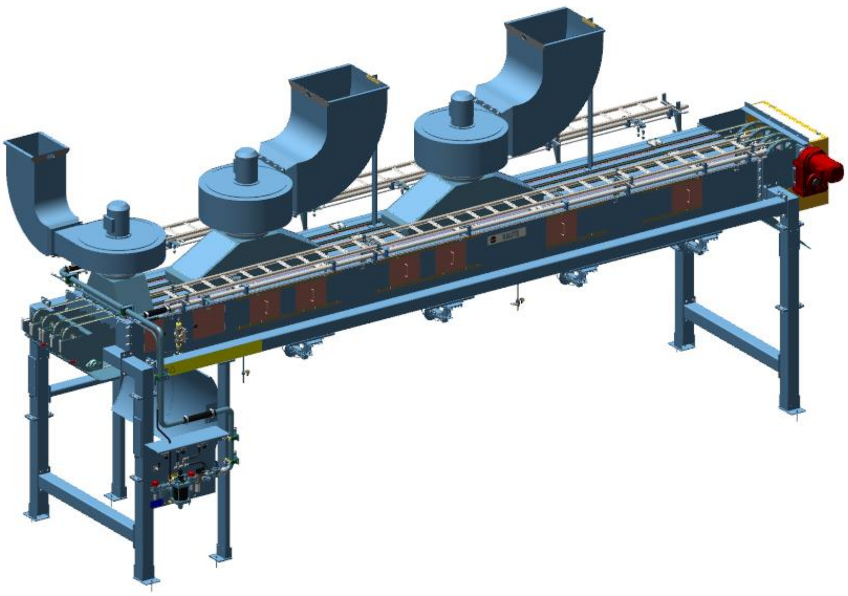


Figure 9. One of Raute's stackers.

Veneer stacker simply stack or pile up veneer sheets to make handling easier. In the past, stacking was done by manual labour where two or more workers lay the clipped veneer on top of each other. That is however not so efficient, time consuming and relatively expensive in terms of labour costs. These challenges are what birthed the automation of the stacking process.

The veneer stacker is an indispensable machine in any modern plywood production setup. It is an automated machine that stacks up veneer at high speed. The veneer stacker sorts the veneer based on its sizes. When veneers are sorted according to sizes, it promotes efficient processing and handling.

Veneer stacker are also capable of sorting veneers based on moisture content. Sorting veneer based on moisture content is of immense importance to the quality of the veneer produced. After the veneers have been stacked up, the next process is to dry the veneers. How will the drying time be decided when the moisture content in the veneers is not the same? Drying veneers with different moisture content at the same time in a veneer dryer will result in some veneers being overdried and some veneers not dry, which at the end of the day will result in bad quality veneers. To avoid bad veneer quality as a result of uneven dryness, veneer stacker is used to sort veneers based on moisture content, so that veneers with the same moisture content will be dried with the optimum and most suitable drying parameters. This simple explanation explains one of functions and importance of a veneer stacker. A veneer stacker is also capable of separating the bad veneer from the good ones.

Veneer stackers can generally be categorised into two main types namely:

1. Green veneer stacker
2. Dry veneer stacker

The green veneer stacker is basically used in veneer peeling lines where the peeled veneers have some moisture content in them. The dry veneer stacker, on the other hand, is used in veneer drying lines. They are typically used to stack veneers that have been dried by the veneer dryer in the veneer drying line. In terms of structure and functionality, there is no major difference between the two stackers.

3.3 How does a stacker work?

The veneers are conveyed from the clippers to the stacker. Just as the veneers get to the stacker, they are sucked by the suction blower in the suction box to the clogged belt. The suction ensures that the veneers remain attached to the clogged belt as long as necessary while the clogged belt rolls the veneer to the desired position in the stacker bin. Figure 10 below shows how the veneer is sucked into the clogged belt.

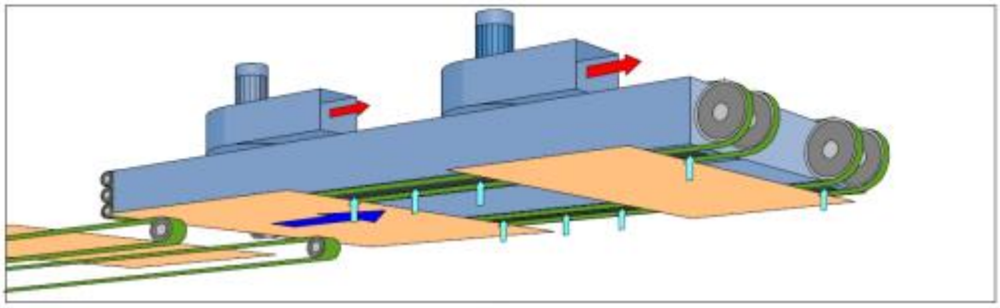


Figure 10. Veneer suction by suction box. (Raute)

When the veneer gets to the desired stacker bin position, it is knocked off the belt by a kicker arm. As the process continues, the stacker bin gets filled up as shown in figure 11 below.

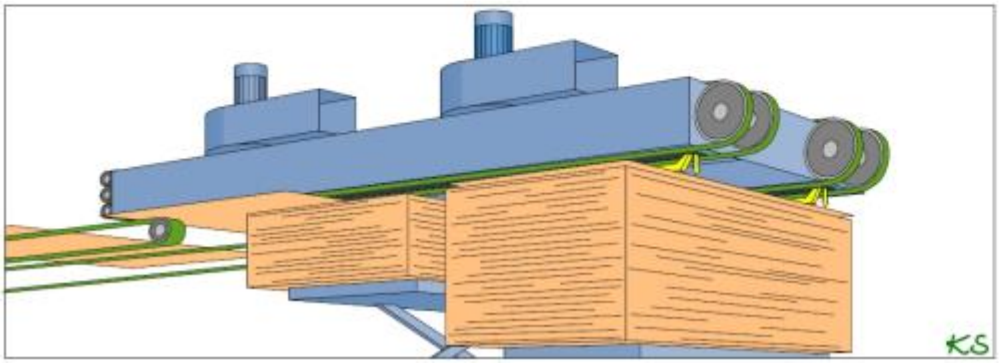


Figure 11. Veneer stacking in bins. (Raute)

3.4 Product structure of a stacker

No two stackers are the same; therefore, the structure of two stackers will also never be the same. The figure below shows a typical product structure of a stacker with two modules.

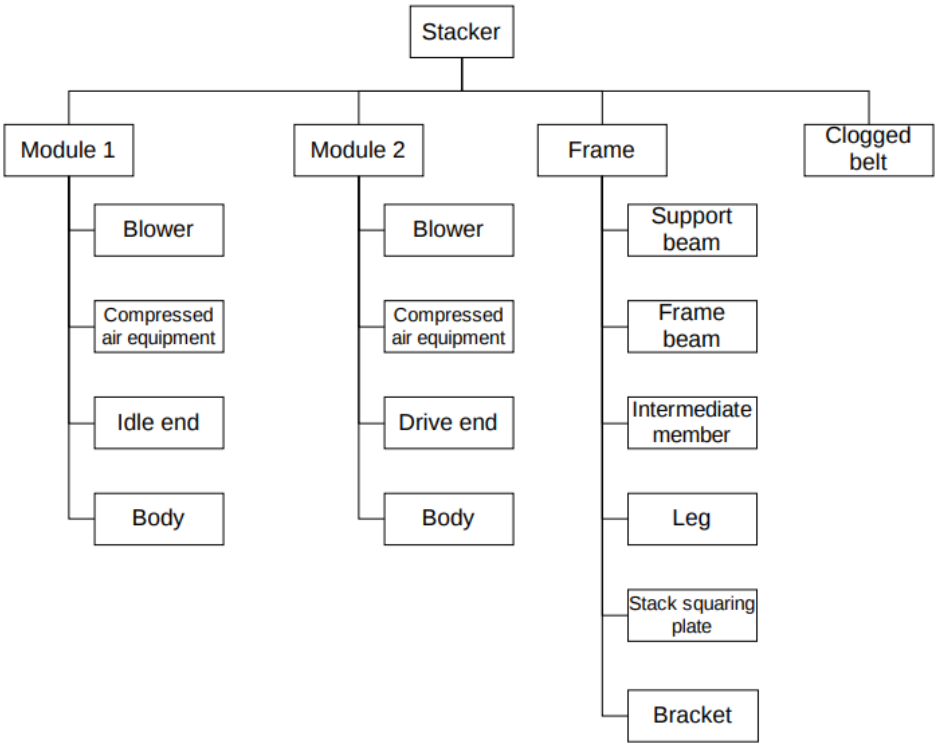


Figure 12. Product structure of a two-module stacker.

3.5 Stacker modules

The module is basically the heart of the stacker. Just as an engine is to a car, so is the module or modules is/are to a veneer stacker. There can be a couple of modules in a stacker depending on the wants and needs of the customer. The number of modules in a stacker can range from one to four, and even more in some cases. The structure of a module is presented in figure 13.

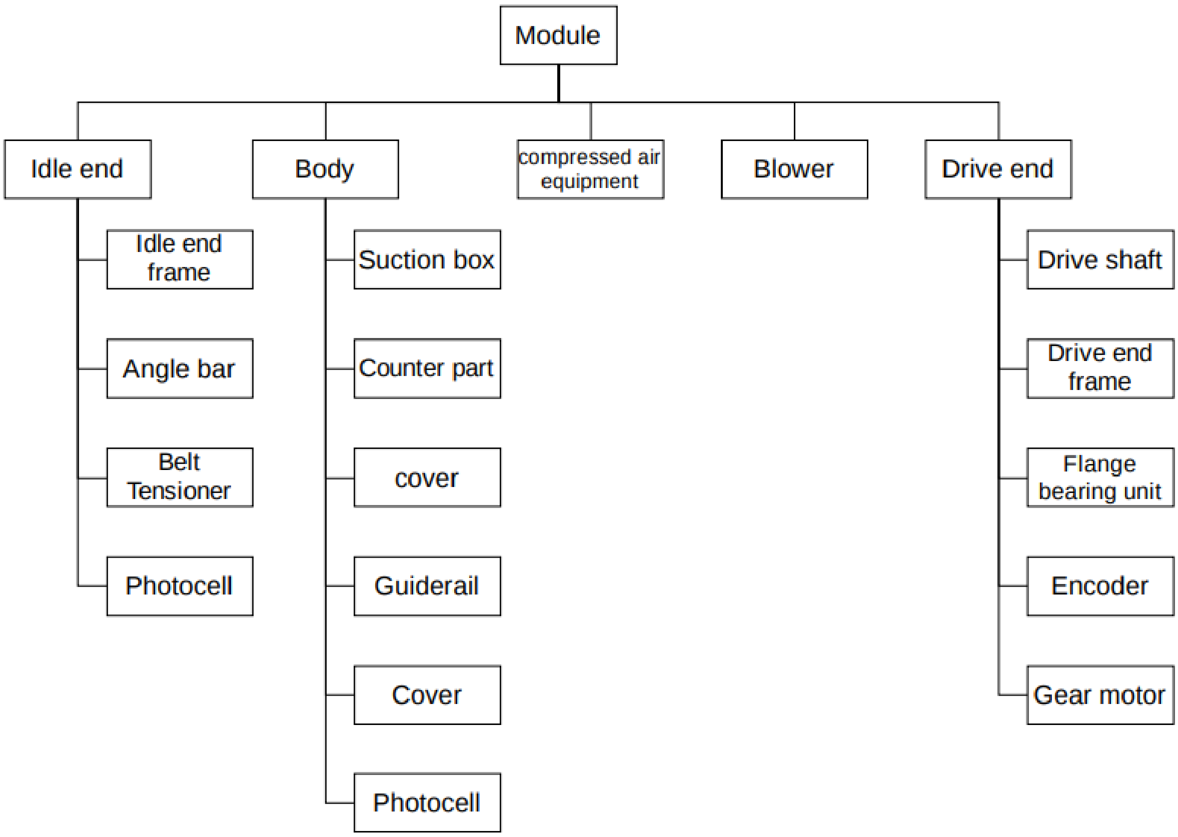


Figure 13. Structure of a module

The module whose structure is presented above is used in stackers that require only one module. This module has both the idle end and the drive end in the same module unit. The stacker shown earlier in figure 9 is an example of a stacker with one module.

For stackers with two modules, one of the modules houses the drive end, and for this research work, it will be referred to as the drive module. At the other end is the module that houses the idle end, and for this research work, it will be referred to as the idle module. An example of the structure of such stacker was presented in figure 12 earlier. An example of a two-module stacker is shown in figure 14.

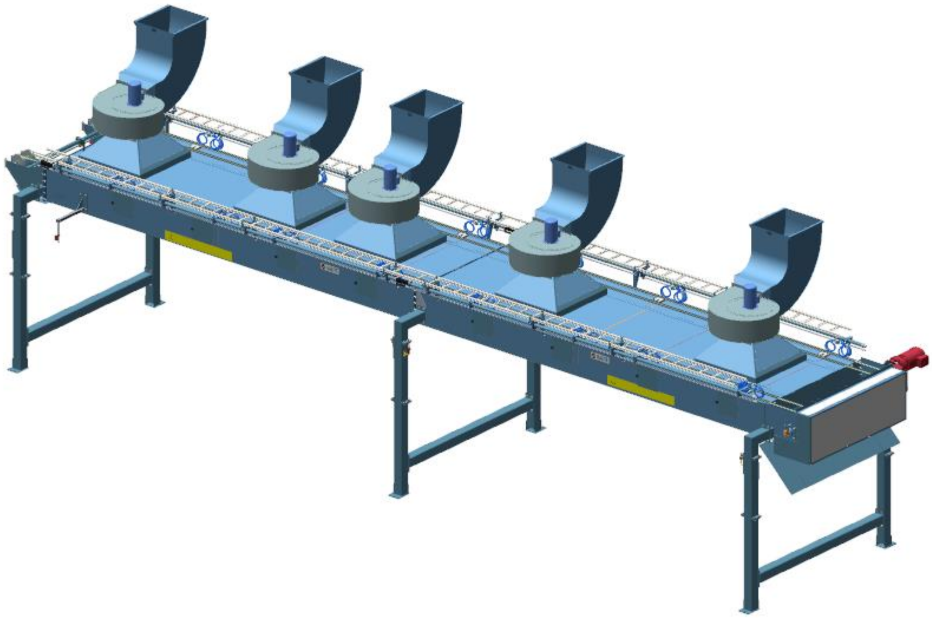


Figure 14. Example of a stacker with two modules.

For a three or more module stackers, the drive module is at one end, and the idle module is at the other end. In between the drive module and the idle module is the third module which for this research work will be referred to as intermediate module. For a four-module stacker, two intermediate modules are in between the drive module and the idle module. For a six-module stacker, four intermediate modules are placed in-between the drive module and the idle module.

3.6 Stacker bins

Stacker bins can simply be a compartment or a platform where veneers are stored or piled up before being transported or conveyed for further processing. Most veneers are binned on a scissors jack platform, which uses a sensor and a mirror control technology to ensure that the distance of the topmost veneer is constant to a reference point, so, as the veneers are stacked, the platform is lowered to ensure the distance remains the same.

The veneers need to be properly arranged in the bin, and to ensure this, a leveller which is also known as a stack squaring device is always attached to the stacker bin. The leveller is a pneumatically operated reciprocating device that ensures that veneer piles are well arranged in the stacker bins. When the veneer is knocked off to the stacker bin, the leveller makes a forward stroke. This forward stroke ensures that the edges of all the veneers piled up are on the same plane. Figure 15 below shows a picture of veneers stacked up in a stacker bin.

Figure 15. Veneers in stacker bins. (Raute)

4 ANALYSIS OF STACKERS

Further analysis of the stacker is what this chapter will address. This chapter will break the stacker down bit by bit and also point out the critical and non-critical parts for modernization projects.

The designs and structures of Raute’s stackers have changed over the years because of the need to keep improving the product and to stay as a dominant force to reckon with in the global market. As a result of this, there are different sets of stackers to deal with. For this analysis, veneer stackers have been categorised into two main categories namely new generation stackers and the old generation stackers. The term old and new used in this context is relative, and more light will be shed on it later in this chapter.

4.1 New generation stackers

Stackers that fall into this category are basically the ones delivered to customers not so long ago. It is a bit hard to give an exact year of delivery because, as mentioned earlier, the design and structure of stackers keep changing. They are of modularised design and the modules are jointed together by bolts and nuts. They are of improved design in terms of functionality and efficiency when compared to the old generation stackers. A modular break-down of the stacker is provided in figure 16 below.

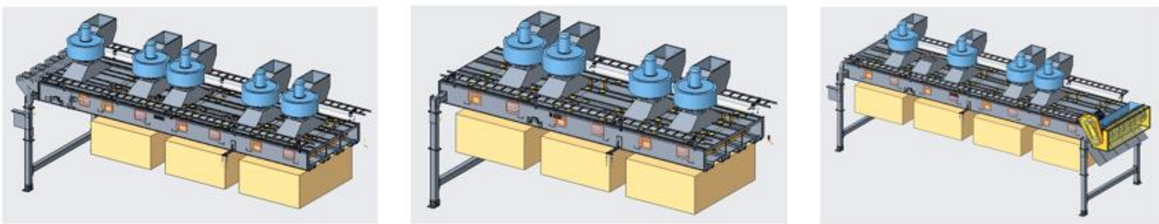


Figure 16. Modular breakdown of a stacker.

This design reduces the amount of welding on site, and it also makes future modernization of the stacker easier. The assembly of the three modules shown in figure 16 above is presented in figure 17.

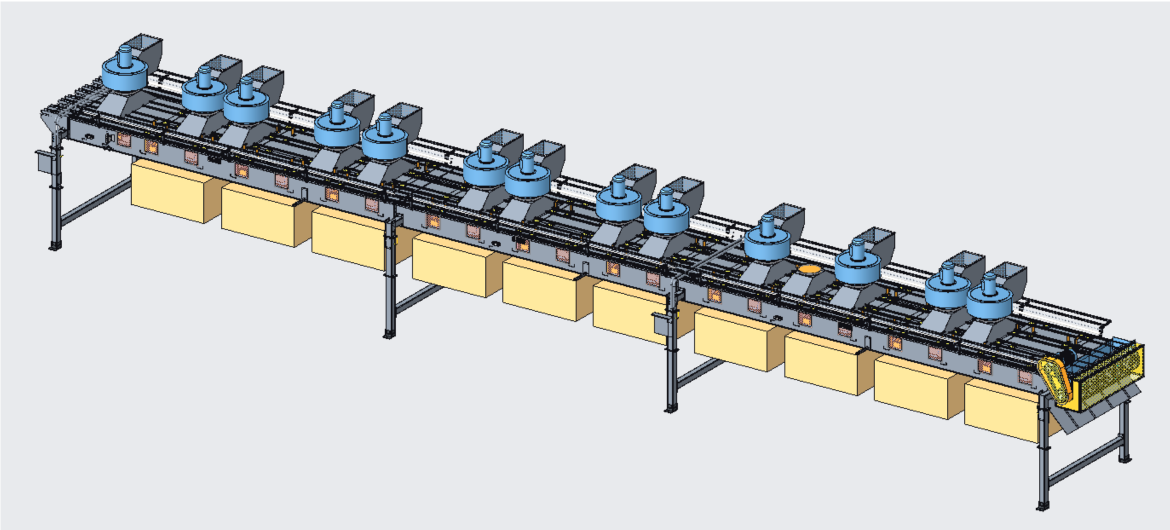


Figure 17. Assembly of modules shown in figure 16.

The need to modernize these kinds of stackers is not so urgent at the moment. However, this thesis will take into consideration how stackers like this can be modernised whenever the need arises, with the same solution that will be suggested. For this reason, the main focus for this analysis will be based on the old generation stackers.

4.2 Old generation stackers

Stackers that fall into this category are the ones that have been delivered to customers over some 20 years ago or thereabout, and the primary purpose of this research work is to address the challenges of these kinds of stackers when the need for modernization arises. The old generation stackers are also designed in modules just like the new generation stackers. The major difference here is that the modules are sturdier and are welded together at the customer site during installation. Another difference can be found in the structure of the modules.

In the analysis of this stacker, a top-down approach will be employed. The analysis will start from the main assembly to the least sub-assembly or part that needs to be analysed. The main assembly that will be used for this assembly is shown in figure 18. This same assembly will be employed in the next chapter to test the proposed solution.

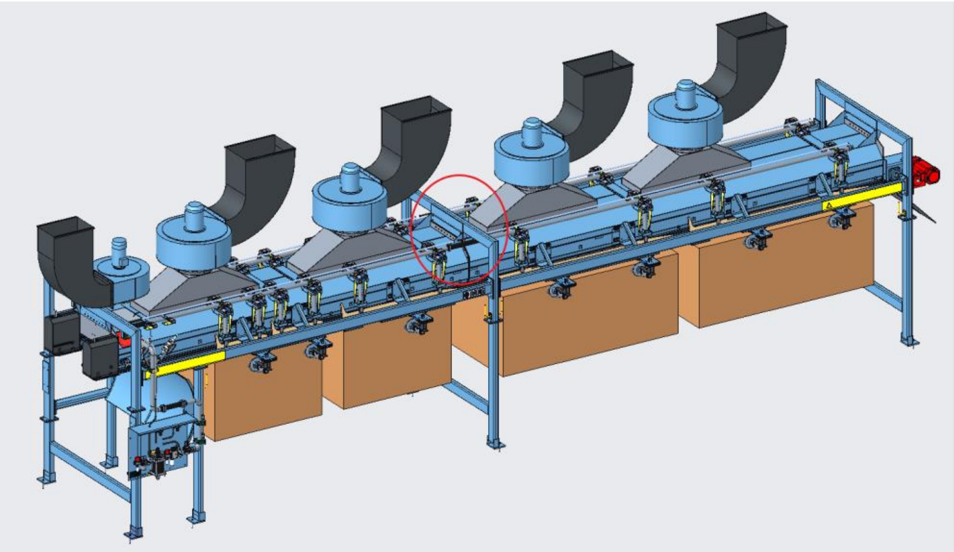


Figure 18. Model used for this project

The BOM for the above main assembly is shown in figure 19 below.

Item	Code	Quality	Form, Dimensions, Type, Standards	Amount	kg
15	2004728	KORISTEKILPI 350X100X3		2	0
14	2021094	HAMMASHIHNA	32AT10NT+PUR62/17X11 L=28512	4	10
13	2023041	HIHNANPAISTOMUOTTI		1	0
12	H007573	PINKAN TASAAJA		14	35
11	H056235	PAINEILMAKAAVIO		1	0
10	H056251	SYOTTOPUTKET		1	177
9	H056278	RUNKOPALKIT		1	2048
8	H056293	OSAT KÄYTTÖPÄÄ		1	400
7	H056294	VANERI	VANERILEVY s=9 1800x900	1	9
6	H056339	IMULAATIKKO		1	3896
5	H056341	VALMISTAJAN KONEKILPI, EN	EN	1	0
4	R365053	PAIKOITUS VALOKENNO OIKEA		1	0
3	R365055	PAIKOITUS VALOKENNO VASEN		1	0
2	R932986	VAROITUSKILPI	ALUMIINI, KELTAMUSTA s=2	4	1
1	R963234	HIHNANKIRISTIN		2	132

Figure 19. Project BOM

The BOM shown above will be subdivided into two groups, namely.

- Fixed parts
- Variable parts

Fixed parts

These parts are parts that remain the same no matter the magnitude or nature of the modernization that will be carried out on the stacker. They are basically parts or subassemblies that will be used the way they are.

For this stacker, the fixed pars are:

- Item 1 – Hihnankiristin (Belt tensioner)
- Item 2 – Varoituskilpi (Warning plate)
- Item 3 – Paikotus valokenno vasen (Location photocell left)
- Item 4 – Paikotus valokenno oikea (Location photocell right)
- Item 5 – Valmistajan konekilpi (Manufacturer's machine plate)
- Item 7 – Vaneri (Veneer)
- Item 8 – Osat käyttopää (Drive)
- Item 10 – Syöttöputket (Feed pipes)
- Item 12 – Pinkan tasaaja (Stack squaring plates)
- Item 13 – Hihnanpaistomuotti
- Item 15 – Koristekilpi (Name plate)

Figure 20 below shows the picture of items 1,3,4, 8, 10 and 12.

Figure 20. Some fixed parts

And figure 21 below shows items 2, 5 and 15.

Figure 21. Items 2, 5 and 15.

Variable parts

Variable parts are parts that are most likely to change whenever a stacker will be modernized. They are parts or subassemblies that will directly or indirectly be affected as a result of the change the modernization will bring. Those parts are:

- Item 6 – Imulaatikko (Suction box)
- Item 9 – Runkopalkit (Frame)
- Item 11 – Paineilmakaavio (Pneumatic Diagram)
- Item 14 – Hammashihna (Clogged belt)

The change that will happen to item 14 (Clogged belt) is basically a change in length. A longer belt will be used to replace the older one since it is impossible to join to the length of the existing belt. Similarly, item 14, which is the pneumatic diagram, will have to be redrawn or edited. These two aforementioned items require no or very little analysis since they are not so complicated.

Item 9, which is the frame, is shown in figure 22 below. The frame is welded together as in the case of the old generation stacker and bolted together in the case of the new ones. For any modernization project, the frame will have to be disassembled and another frame added to it.

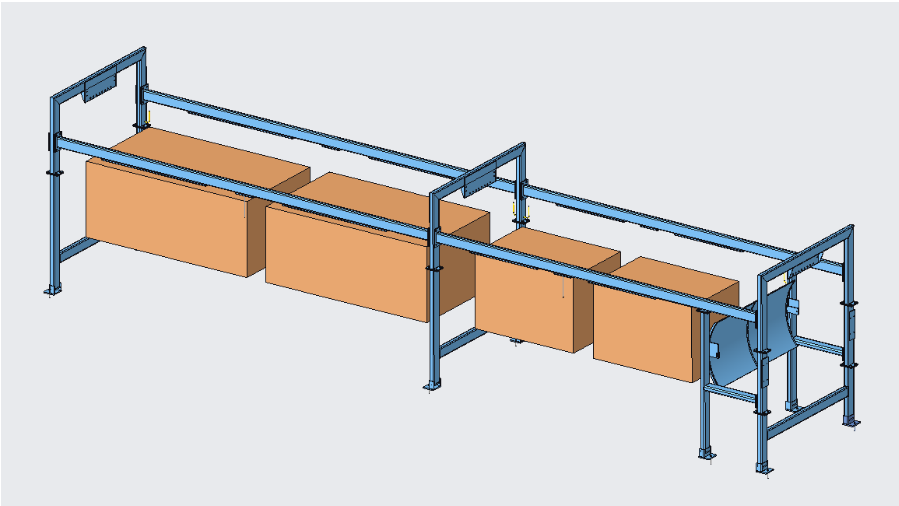


Figure 22. Stacker frame before modernization.

The analysis of the stacker will be concentrated on item 6 (suction box) since it contains almost all the functional parts of the stacker. The suction box is shown in figure 23.

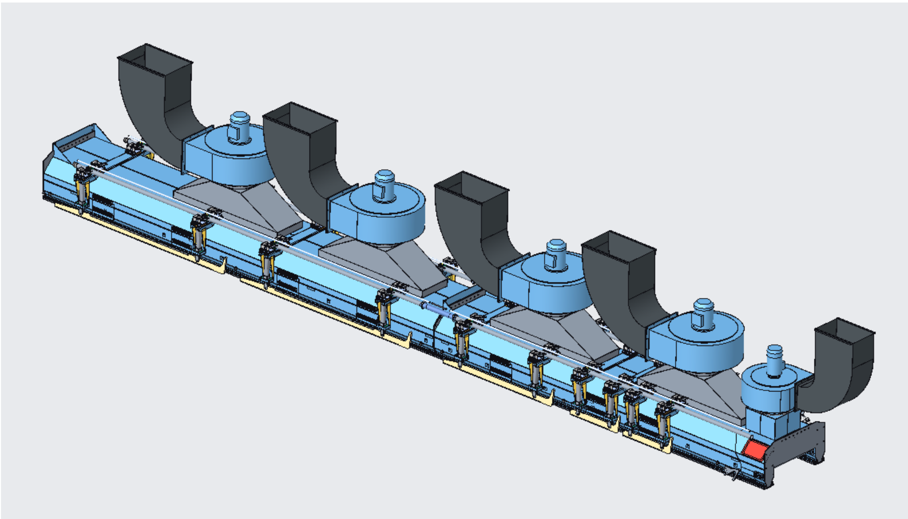


Figure 23. Suction box.

The suction box shown above has two modules with 4 big blowers and a small blower. The modules to which the blowers will be attached is shown below. They are welded together as shown in figure 24 below.

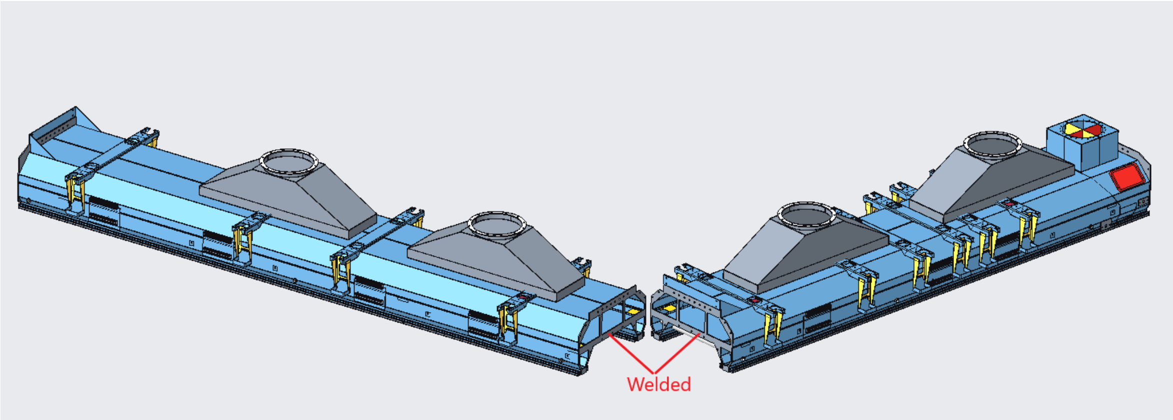


Figure 24. Box module unto which blowers are mounted.

The suction boxes are designed in a modularised way which makes this analysis as well as modernization project much easier. The modernization will not in any way affect the working elements in the modules, so, there is no point digging deeper into it. However, some elements that make up the modules will be presented.

In these modules are the kicker arm shown in figure 25 below. It is this part that knocks off the veneer sheet that has been sucked to the belt.

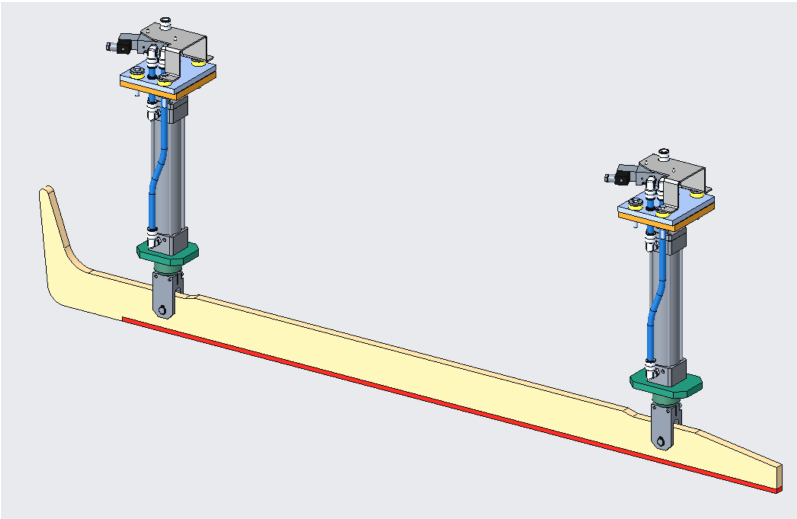


Figure 25. Kicker arm

The part shown in figure 26 below is the cylinder fastener. It is welded to the module. it is onto this part the kicker arm will be fastened.

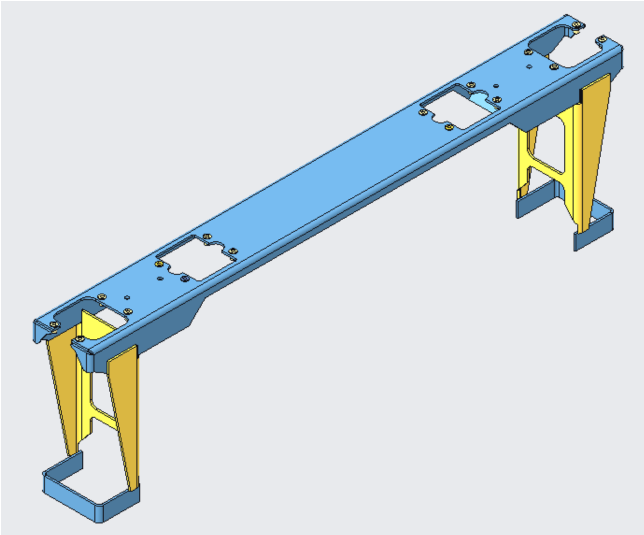


Figure 26. Cylinder fastener.

The kicker arm, the cylinder fastener and the module in its entirety will not be affected by modernization.

5 MODERNIZATION IDEA AND ITS APPLICATION

This chapter will present the ideas that came to mind after a series of interviews and thorough background study about the problem. The merits and downsides of each idea will be presented, as well as the justification for the proposed solution. Testing of the proposed solution and its results will also be included in this chapter.

It is worth mentioning again as a reminder that the problem this thesis work is aimed at solving is a multi-layered one. It is so because the result as expected, should address the problem of unifying the product structure in the PDM system, it should work or sync effortlessly with Raute’s other systems like the ERP system for example. It should work in a way that only the required raw materials needed for the modernization project will be transferred to the ERP system. It sounds straight forward, but in Raute’s system or environment it is a bit complicated.

Putting all other factors into consideration, the ideas are:

- Use of shrink-wrap
- Revision

5.1 Use of shrink-wrap

The term shrink-wrap in CAD means creating a lightweight model from a very big and complex assembly. It makes opening, sending, and handling of the complex CAD model easier. For CAD programs like Creo and Inventor, it is called shrink-wrap, while other CAD programs have different terms for it, even though the idea is the same.

The idea here is to make a copy of the stacker at customer site; edit it so as to make room for the new module that will be added, make a shrink-wrap from that edited copy, then add the new module.

This idea solves the problem from the ERP angle because only the structure of the new module will be published into the ERP system; hence, only the published structure will be purchased. From visualisation perspective, this idea will also show how the new module will be installed and how the modified stacker will look like after modernization. However, this idea does not in any way unify the structures in the PDM system. As a result of this, this idea was jettisoned.

5.2 Revision

In engineering, any modification or change made to a drawing after it has been released is termed a revision. Revision could be by adding, replacing, or even deleting a part or information in the drawing. Records of all the changes that will be made to a drawing throughout its life cycle must be properly documented in the revision block. The revision block will show information such as date of revision, summary of the revision made, revision number, and name of the person who made the revision.

As mentioned in an earlier chapter, the modernization of a stacker most times is basically increasing the length and the number of bins in the stacker. When the length is increased, the number of modules and the number of bins will as well increase. The idea here is to make revision to the stacker that was first delivered to the customer. The revision will be made such that the length of the stacker will be increased so as to accommodate a new module. By revising the stacker at customer site, the structure in the PDM system will automatically remain as one, as there will be no need to have two different structures as it is the case at the moment.

How about the ERP system? One way to address that will be by either filtering out the parts or subassembly that are in the old stacker and will not be purchased, or by designing the new module as a single unit. That single unit will then be published in the ERP system. Both ideas will be tried and tested, and the most suitable will be adopted.

5.3 Application of the idea in PDM

To apply this idea and see how it works in the PDM system, a real-life modernization project will be simulated. To do so, the old stacker presented in chapter 3 will be used. The start model will be selected, the typical requirement specification for modernization will be defined and applied to the old stacker. This will help have a first-hand information about the challenges that might arise as a result of the modernization.

Be it a delivery project or a modernization project, one key and early important step to take is to select the start model. Start model is basically a model that will be tailored or customised to what a customer wants. The two possible models that can be used as a start model in this case are:

- Master model
- Project model

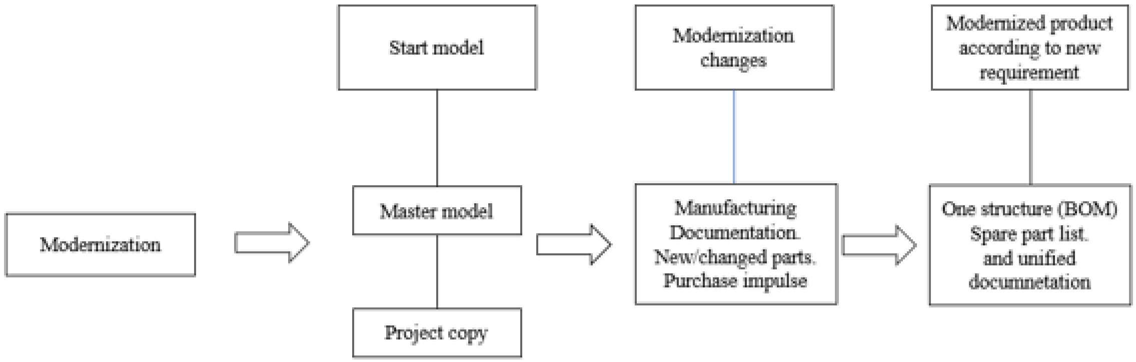


Figure 27. Modernization process chat.

Master model

A master model is basically the direct result of research and development (R&D). Whenever the R&D team comes up with a solution, the 3-D model of that solution is referred to as the master model. It is from that model various customizations will be made for different customer demands.

The master model 20 years ago is not the master model now owing to the fact that times have changed, and there is a need to keep improving on one’s product in order to stay relevant in this ever-dynamic global market. It is also not wise to keep the master models of different generations of products knowing fully well that customers would prefer the latest and improved product. With this simple analogy, it is easy to conclude that the master model cannot be used in this simulation as our start model; neither will it be recommended for any future modernization.

Project model.

This is the model that was delivered to the customer in the first place. It is the best model to use as the start model because it would be easier to work with since the structure, idea and concept of what is to be designed is similar to it. One set back here would be that some of the parts will be obsolete in terms of the lifecycle used in Raute's PDM and ERP systems.

For this simulation, the start copy will be made from the model that the customer has at their site. For future modernizations, it would be suggested that the start copy should be made from the model at customer site.

The modernization requirements are given below:

- Add a new module of certain length X
- Number of bins = 2
- The bins should stack veneer lengths of x ft and y ft
- And many more not listed here

Once the start model is decided, the next point of action is to identify the parts that need to change or be revised. From the analysis in chapter 4, the parts that will change in the case of this stacker were identified already, and they are item 6,9,11 and item 14.

The third point of action is to make the necessary revisions to all the identified parts. The revisions should be made in such a way that enough rooms are created in the old stacker so as to accommodate the new one, taking into consideration the functionality of the whole stacker

Item 6 – Suction box

The revision required here will be to increase the distance between the face of the two modules from 0 to 6034 mm as shown in figure 28. From the practical point of view, this would mean that the weld that was used to join the two modules together when they were first delivered to the customer would be grinded with a grinding machine so as to separate them and make room for the incoming module.

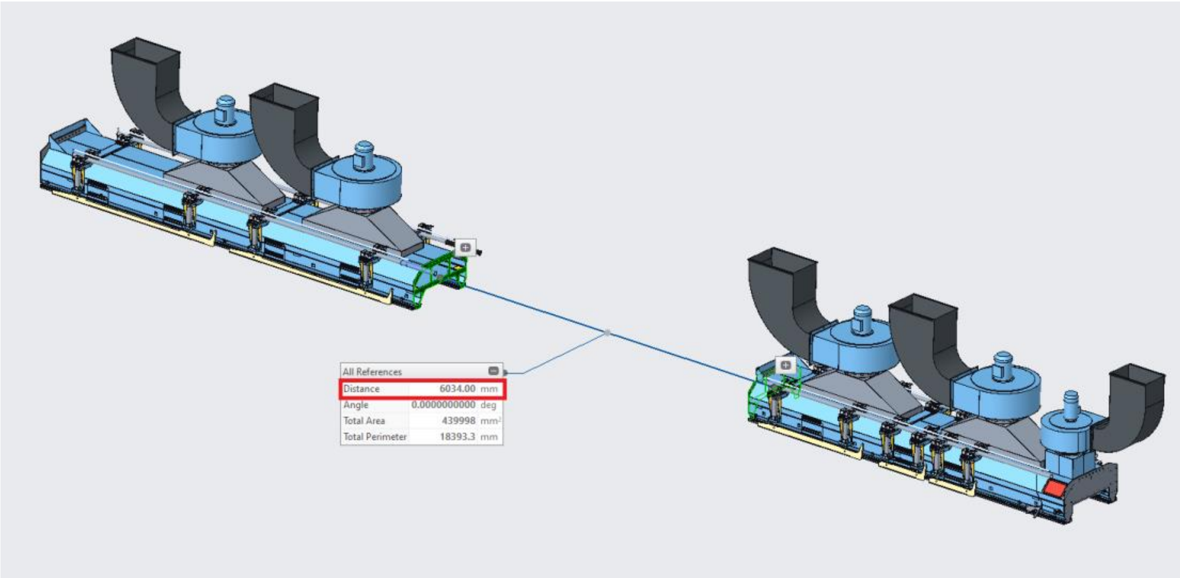


Figure 28. Suction box revision

Will this revision require adding or removing a part? Will this revision require a change in the ERP system? The answer is NO! Therefore, the revision will only reflect in the PDM system.

Item 9 - Frame

The revision for the frame is similar to that of the suction box. A space for the new frame will be created as shown in figure 29 below.

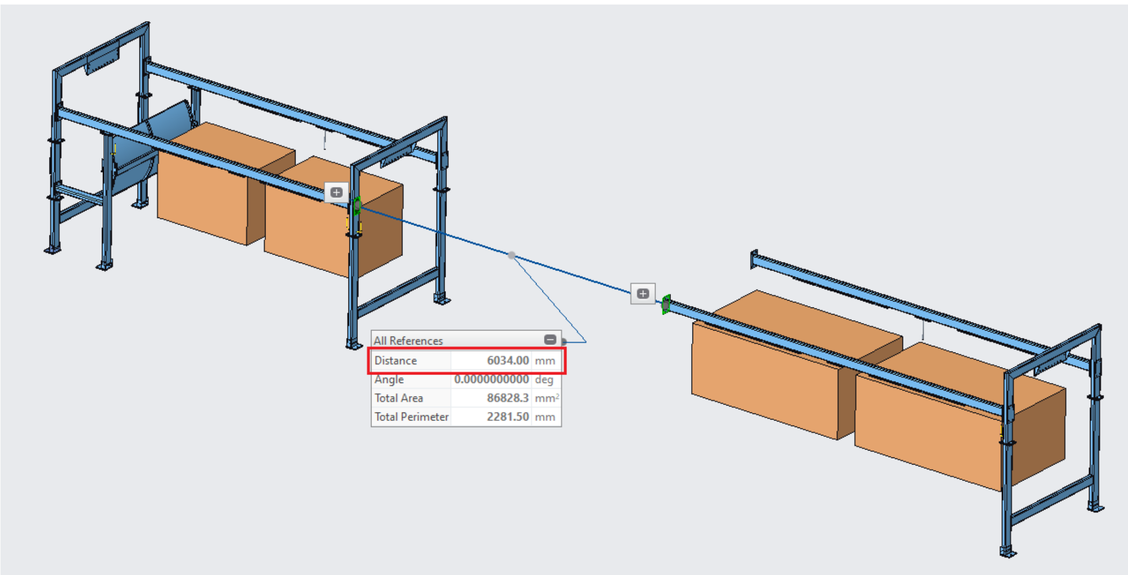


Figure 29. Frame revision

This will also require grinding of the welded joints in order to separate the frame as shown. This revision, just like the suction box has no effect on the ERP system.

Item 11 - Pneumatic drawings

This is just a drawing that shows how all pneumatic components are arranged. This drawing will have to be edited or redrawn to reflect the additional pneumatic components that will be added to the main assembly.

Item 14 - Clogged belt

The revision for the clogged belt will take place in the main assembly. It would require replacing the old, clogged belt with a totally new one. This is necessary because the change in length of the overall stacker would require a longer clogged belt. Figure 30 shows the dimensions of the belt before and after revision in an assembled state. The total length of the belt is 28512 mm before revision, and 40580 mm after revision. This revision will require that a new belt be purchased and hence, the change needs to be reported in the ERP system.

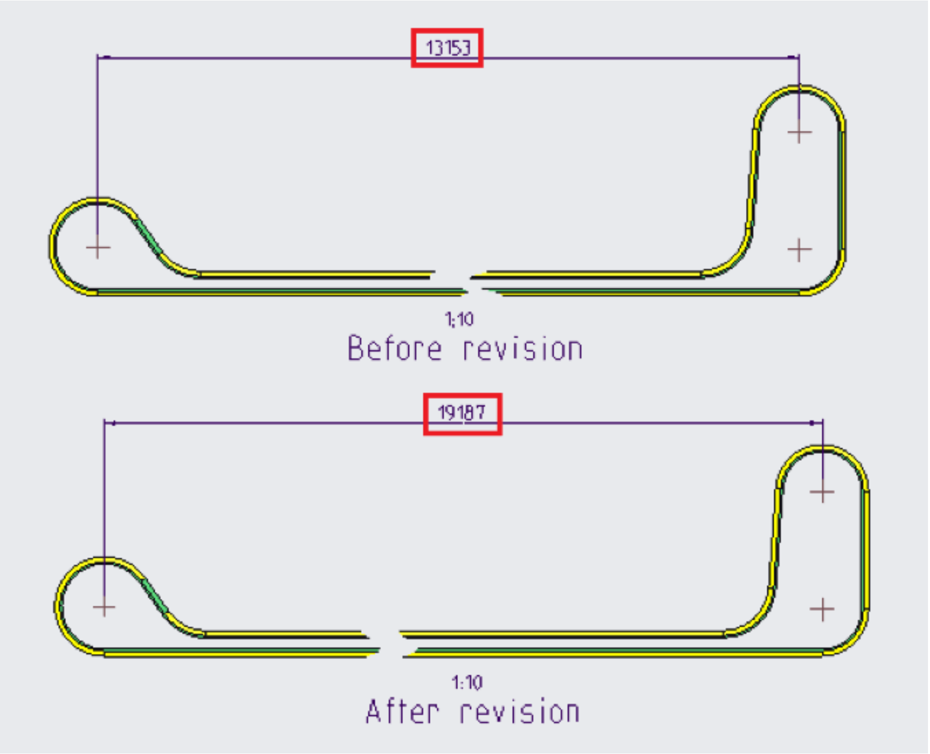


Figure 30. Belt before and after revision

The fourth point of action will be to start the design according to the stated requirements. While designing, one important thing to consider is that since most modernization projects usually have their own project number, it will be wise to design it as a single entity so that it will fit in perfectly into the space created in the main or top-level assembly.

The frame for this simulation will be designed according to figure 31 below. Future modernization of the frame should be designed according to the needs and requirements of the modernization project.

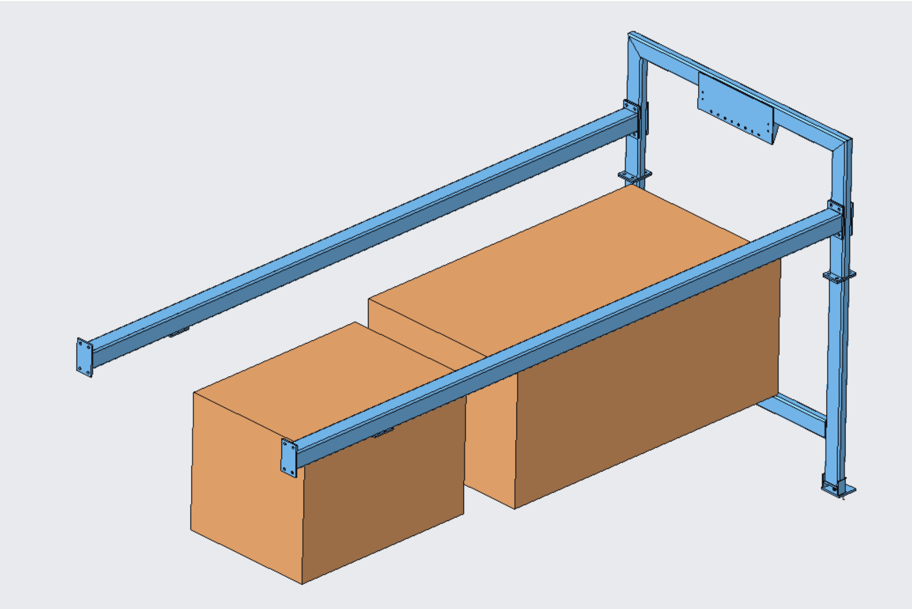


Figure 31. Frame for modernization.

The suction box will be designed as shown in figure 32, so that both ends will be welded to the room created in the revision.

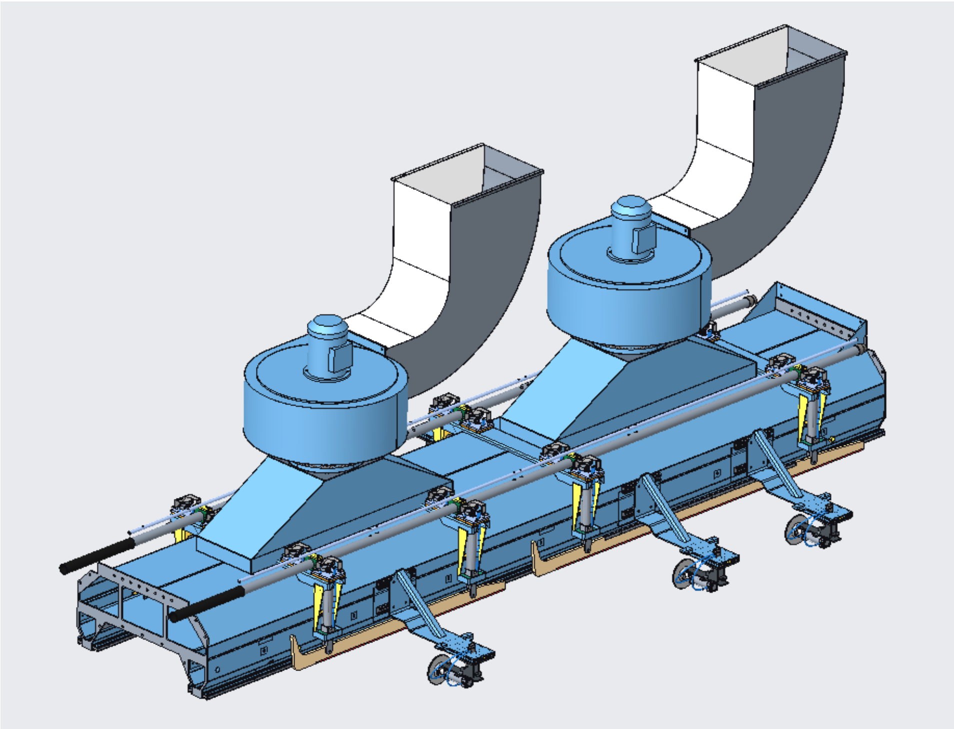


Figure 32. Suction box for modernization

The modernization assembly is shown in figure 33 below. It is basically the assembly of the suction box and frame. The belts can also be included in this assembly as that will reduce the need for some manual work. Details about that will be discussed later.

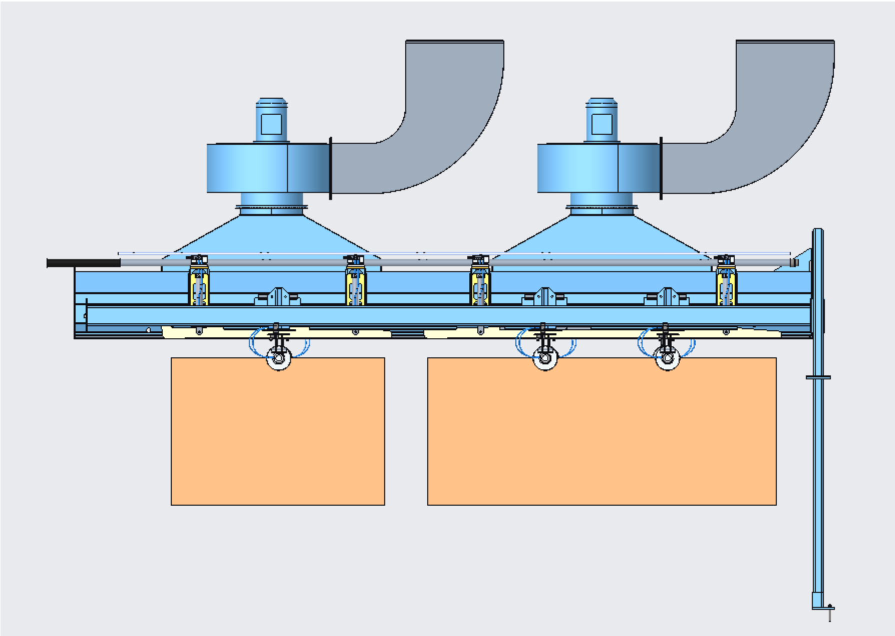


Figure 33. Assembly of the modernization.

The BOM for the modernization assembly without the belts is shown in figure 34 below.

Item	Code	Quality	Form. Dimensions. Type. Standards	Qty	kg
2	1NEW	Suctionbox		1	1976
1	NEW	Frame		1	712

Figure 34. Modernization BOM.

The final step will now be to conclude the revisioning process by adding this new module shown in figure 33 to the old one. By so doing, the structure is unified and the BOM from which the structure in the PDM system will be derived will be updated as shown in figure 35 below.

	Item	Code	Quality	Form. Dimensions. Type. Standards	Qty	kg
A	16	NEW	Module		1	2671
	15	2004728	Name plate 350X100X3		2	0
A	14	2021094	HAMMASHIHNA	32AT10NT+PUR62/17X11 L=40580	4	15
	13	2023041	Belt jointing mold	TK32AT10 / 17x11 for stacker belt	1	0
	12	H007573	Stack squaring plates		14	481
A	11	H056235	PAINEILMAKAAVIO		1	0
	10	H056251	SYOTTOPUTKET		1	177
A	9	H056278	RUNKOPALKIT		1	2048
	8	H056293	OSAT KÄYTTÖPÄÄ		1	400
	7	H056294	VANERI	VANERILEVY s=9 1800x900	1	9
A	6	H056339	Suctionbox		1	3864
	5	H056341	VALMISTAJAN KONEKILPI. EN	. EN	1	0
	4	33R365053	POSITIONING PHOTOCELL		1	0
	3	33R365055	POSITIONING PHOTOCELL		1	0
	2	33R932986	VAROITUSKILPI	ALUMIINI. KELTAMUSTA s=2 -	4	1
	1	22R963234	Hihnankiristin		2	132

Figure 35. Revised from which the unified structure will be derived.

The final model is shown in figure 36 below. The new module is coloured grey for the purpose of visualization.

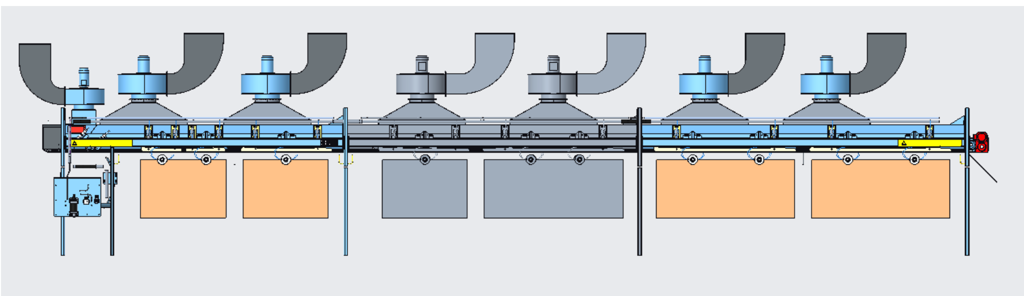


Figure 36. Final model after modernization is complete

5.4 Application of the idea in ERP

When designs are made, all the list of parts and materials needed to manufacture the designed machine are recorded in the BOM. The BOM will then be used to purchase all the necessary parts and materials. In bigger organizations, the BOMs are usually exported to the ERP system in an automated manner. This automated transfer of data, which is the BOM in this case, eliminates errors and improves engineering throughput. As for the case of Raute, the BOM to ERP data transfer is carried out in the sequence shown below.

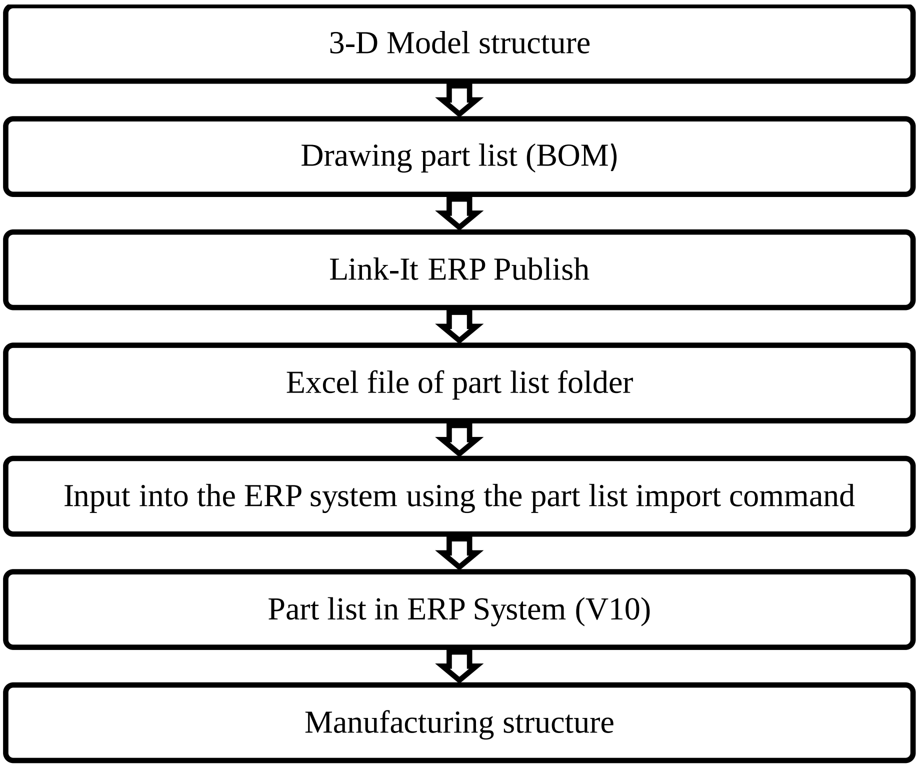


Figure 37. BOM to ERP data transfer steps.

From the assembly, the list of all parts and subassemblies that make up the assembly can be seen as a BOM in the drawing. All CAD software are capable of this. When Link-It publish is carried out, it generates the part list to an excel file in a predefined folder; it is from that folder that the part list in BOM will be transferred to the ERP system by using the import command in the ERP system. It is the part list in the ERP system that eventually becomes the manufacturing structure.

To ensure that the needed parts and materials needed for the modernization project are exported to the ERP system there are two ways to go about it. those two ways are named as follows.

- Use of filter publish
- Modernisation publish

Use of filter publish

The use of filter as the name implies, is simply filtering out parts that are not to be purchased or parts that are not intended to be exported to the ERP system. When the revision is complete, the next point of action is to publish the BOM to the ERP system by clicking on the icon shown below in figure 38. this icon can be found in the Link-It add-ons in Raute’s Creo environment.

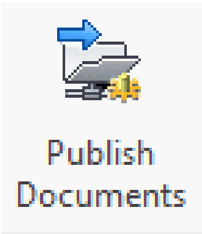


Figure 38. Publish icon.

When the revised drawing is published, all the parts and sub-assemblies, both the ones at customer site and that of the new machine will be published into the ERP system, which will make it difficult to distinguish the parts to be purchased and the ones that need not to be purchased. When the publish document icon shown in *Figure 38* is clicked, the whole part list that will be generated is shown in figure 39.

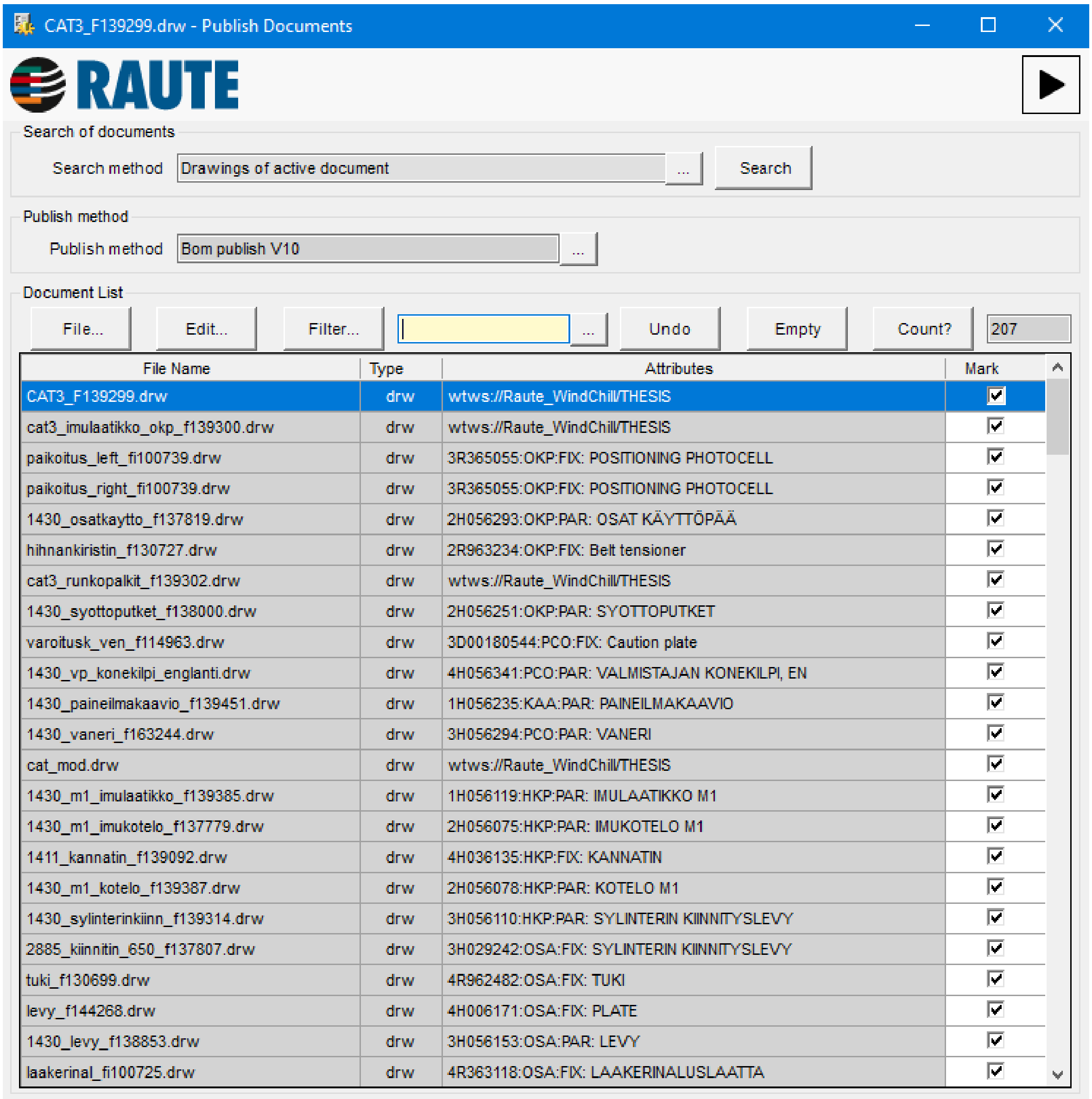


Figure 39. List of all parts when the entire main assembly is published after modernization.

The parts that are not to be purchased and are not to be exported to the ERP system are unchecked. This process of unchecking the box will take a lot of time, cumbersome and prone to errors, as needed part can easily be unchecked, and an unneeded part can easily and mistakenly be checked. For these reasons, this method of publishing will be discouraged.

Modernisation publish

The term modernization publish simply means publishing the new assembly that will be added to the one at customer site. For this reason, it is advisable to design the new modernization assembly as a single assembly unit before adding it to the one at customer site. In this case, the BOM table shown in figure 34 is what will be published, and the result will look like the one shown in figure 40 below.

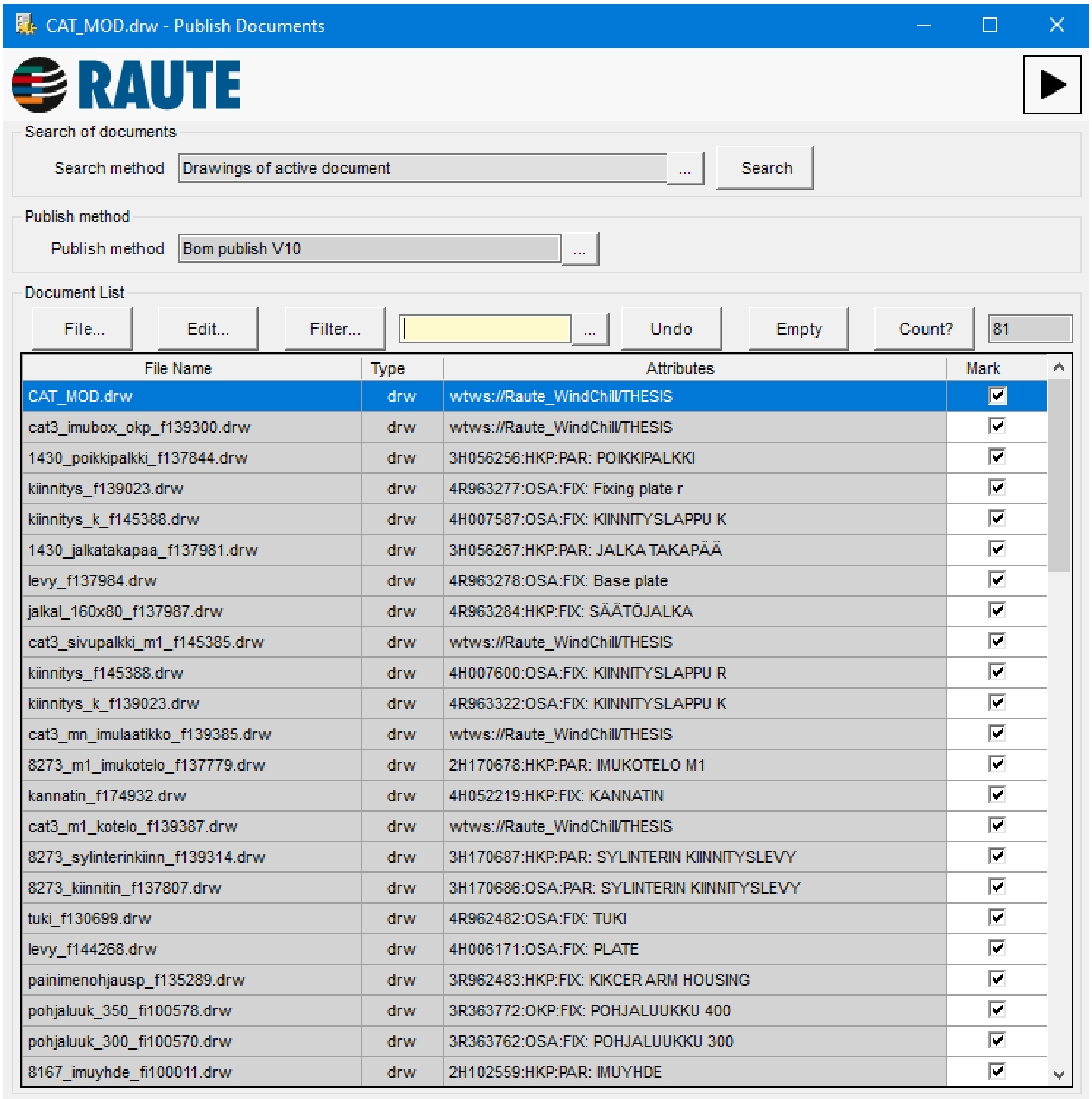


Figure 40. List of parts when only the new module is published.

This method of publishing does not take into consideration the revised belts that was replaced in the main assembly because it does not belong to the level of the assembly that was published. This can however be fixed by manually changing the length of the belt in the ERP system according to figure 41. This method of BOM publishing when compared to the filter publish is easier, less prone to error and straight forward.

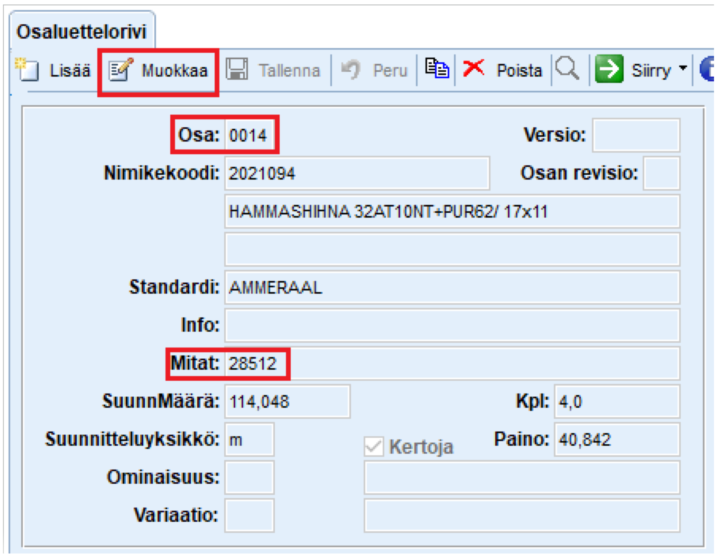


Figure 41. Manual change of belt length.

Manual changing of belt lengths in the ERP system do come with its downside also, this can be avoided by including the belts in the modernization assembly. By including the belt in the modernization assembly, the BOM for the modernization shown in figure 34 earlier changes to the BOM in figure 42 below. And where this is published, there is no need for manual correction of the belt length.

3	2021094	HAMMASHIHNA 32AT10NT+PUR62/17X11 L=40580	4	15
2	1NEW	Suctionbox	1	1960
1	NEW	Frame	1	712

Figure 42. Modernization BOM with belts.

5.5 System structure

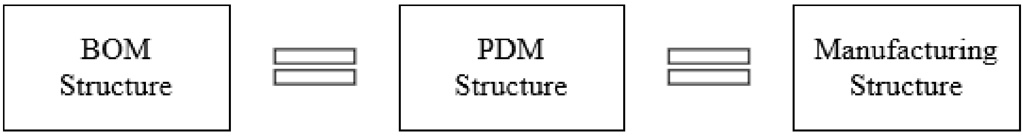
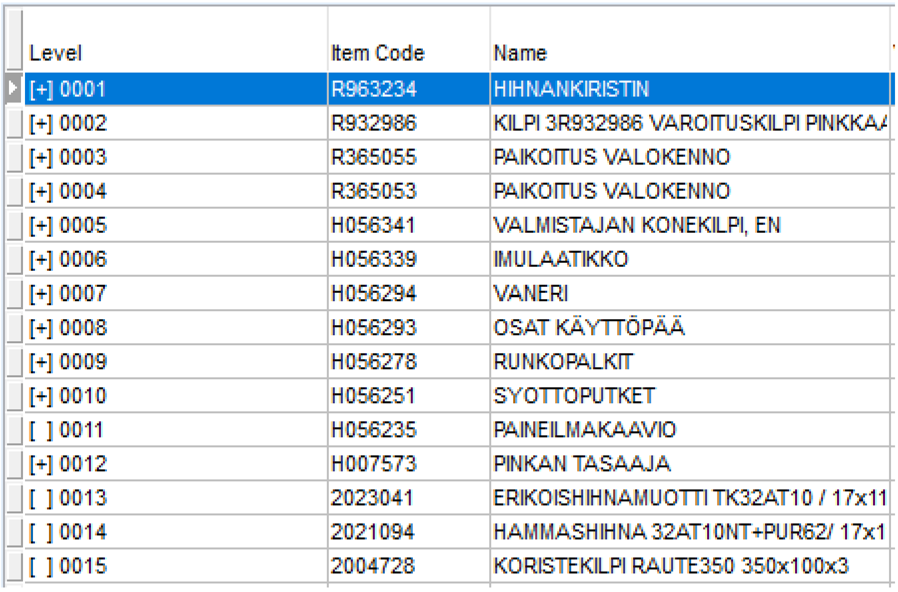


Figure 43. Different structures.

Intuitively, the structure in the BOM, PDM system and manufacturing structure should be the same after the modernization and revision process. In this case, only the BOM structure and the PDM structure are the same, and it is rightfully so because both the PDM structure and the BOM structure come from the same source, which is the main assembly. So, there is a need to fix the manufacturing structure in order to make it tally with the structure in other systems.

One easy way to fix the manufacturing structure would be to make ERP publish of the revised main assembly because the manufacturing structure is derived from ERP publish. This will overwrite the old manufacturing structure. Overwriting the old manufacturing structure could pose some problems because some subassemblies or parts might have changed over the years, or someone might have knowingly or unknowingly made changes to them. For this simple reason, overwriting the ERP is not advised.

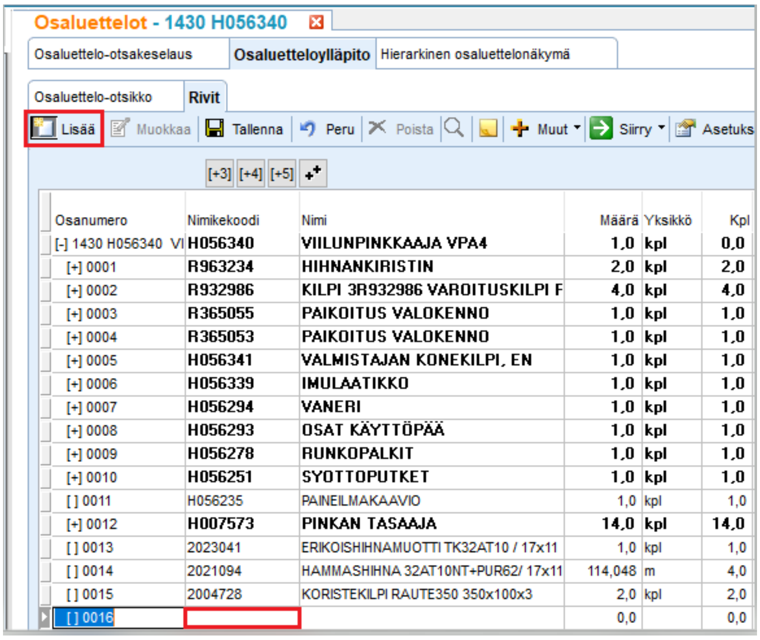
The right way to go about fixing the manufacturing structure will be to manually add it in the ERP system. The manufacturing structure of the stacker used for this simulation is shown in figure 44.



Level	Item Code	Name
[+] 0001	R963234	HIHNANKIRISTIN
[+] 0002	R932986	KILPI 3R932986 VAROITUSKILPI PINKKA/
[+] 0003	R365055	PAIKOITUS VALOKENNO
[+] 0004	R365053	PAIKOITUS VALOKENNO
[+] 0005	H056341	VALMISTAJAN KONEKILPI, EN
[+] 0006	H056339	IMULAATIKKO
[+] 0007	H056294	VANERI
[+] 0008	H056293	OSAT KÄYTTÖPÄÄ
[+] 0009	H056278	RUNKOPALKIT
[+] 0010	H056251	SYOTTOPUTKET
[ ] 0011	H056235	PAINEILMAKAAVIO
[+] 0012	H007573	PINKAN TASAAJA
[ ] 0013	2023041	ERIKOISHIHNAMUOTTI TK32AT10 / 17x11
[ ] 0014	2021094	HAMMASHIHNA 32AT10NT+PUR62/ 17x1
[ ] 0015	2004728	KORISTEKILPI RAUTE350 350x100x3

Figure 44. Manufacturing structure before modernization.

The new subassembly can be added as shown in figure 45. The item code for the modernization that will be added is typed in the second row showing “Nimikekoodi”. the amount and unit should be filled as well.



Osanumero	Nimikekoodi	Nimi	Määrä	Yksikkö	Kpl
[-] 1430 H056340 VI	H056340	VIILUNPINKKAAJA VPA4	1,0	kpl	0,0
[+] 0001	R963234	HIHNANKIRISTIN	2,0	kpl	2,0
[+] 0002	R932986	KILPI 3R932986 VAROITUSKILPI F	4,0	kpl	4,0
[+] 0003	R365055	PAIKOITUS VALOKENNO	1,0	kpl	1,0
[+] 0004	R365053	PAIKOITUS VALOKENNO	1,0	kpl	1,0
[+] 0005	H056341	VALMISTAJAN KONEKILPI, EN	1,0	kpl	1,0
[+] 0006	H056339	IMULAATIKKO	1,0	kpl	1,0
[+] 0007	H056294	VANERI	1,0	kpl	1,0
[+] 0008	H056293	OSAT KÄYTTÖPÄÄ	1,0	kpl	1,0
[+] 0009	H056278	RUNKOPALKIT	1,0	kpl	1,0
[+] 0010	H056251	SYOTTOPUTKET	1,0	kpl	1,0
[] 0011	H056235	PAINEILMAKAAVIO	1,0	kpl	1,0
[+] 0012	H007573	PINKAN TASAAJA	14,0	kpl	14,0
[] 0013	2023041	ERIKOISHIHNAMUOTTI TK32AT10 / 17x11	1,0	kpl	1,0
[] 0014	2021094	HAMMASHIHNA 32AT10NT+PUR62/ 17x11	114,048	m	4,0
[] 0015	2004728	KORISTEKILPI RAUTE350 350x100x3	2,0	kpl	2,0
[] 0016			0,0		0,0

Figure 45. Manually adding the subassembly in ERP system

The final manufacturing structure after adding the subassembly is shown in figure 46.

Level	Item Code	Name
[+] 0001	R963234	HIHNANKIRISTIN
[+] 0002	R932986	KILPI 3R932986 VAROITUSKILPI PINKKAA
[+] 0003	R365055	PAIKOITUS VALOKENNO
[+] 0004	R365053	PAIKOITUS VALOKENNO
[+] 0005	H056341	VALMISTAJAN KONEKILPI, EN
[+] 0006	H056339	IMULAATIKKO
[+] 0007	H056294	VANERI
[+] 0008	H056293	OSAT KÄYTTÖPÄÄ
[+] 0009	H056278	RUNKOPALKIT
[+] 0010	H056251	SYOTTOPUTKET
[ ] 0011	H056235	PAINEILMAKAAVIO
[+] 0012	H007573	PINKAN TASAAJA
[ ] 0013	2023041	ERIKOISHIHNAMUOTTI TK32AT10 / 17x11
[ ] 0014	2021094	HAMMASHIHNA 32AT10NT+PUR62/ 17x1
[ ] 0015	2004728	KORISTEKILPI RAUTE350 350x100x3
[ ] 0016	[redacted]	VIILUNPINKKA [redacted]

Figure 46. Manufacturing structure after adding the subassembly

The structure here is the same as the BOM of the revised drawing shown in figure 35. The structure in PDM system is shown in figure 47.

Number	Quantity	CAD Code	BOM Row Number
CAT3_F139299.ASM		NEW	
HIHNANKIRISTIN_F130727.ASM	2	R963234	1
VAROITUSK_VEN_F114963.PRT	4	R932986	2
PAIKOITUS_LEFT_FI100739.ASM	1	R365055	3
PAIKOITUS_RIGHT_FI100739.ASM	1	R365053	4
1430_VP_KONEKILPI_ENGLANTI.PRT	1	H056341	5
CAT3_IMULAATIKKO_OKP_F139300.ASM	1	H056339	6
1430_VANERI_F163244.PRT	1	H056294	7
1430_OSATKAYTTO_F137819.ASM	1	H056293	8
CAT3_RUNKOPALKIT_F139302.ASM	1	H056278	9
1430_SYOTTOPUTKET_F138000.ASM	1	H056251	10
1430_PAINEILMAKAAVIO_F139451.PRT	1	H056235	11
2860_PINKANTAS_F139022.ASM	14	H007573	12
HIHNANPAISTOMUO_F119659.PRT	1	2023041	13
CAT3_HAMMASHIHN_F139304.PRT	4	2021094	14
KORISTEKILPI_350X100X3.PRT	2	2004728	15
CAT_MOD.ASM	1	NEW	16

Figure 47. PDM Structure after modernization.

As it should be, the modernized BOM structure in figure 35, the manufacturing structure in figure 46 and the PDM structure in figure 47 above are the same.

6 RESULT AND CONCLUSION

The goal of this research work was to research and come up with a suggestion to Raute Oy about how their modernization projects should be carried out in the future such that there will be no need to have two product structure for one machine after modernization in the PDM system. This chapter will present the summary of the key results of this thesis work as well as provide answers to the research questions in chapter one.

The modernization in question is mostly about improving the productivity and capacity of the veneer stacker; that is, adding more modules to existing ones. Since most of the veneer stackers, if not all, are designed in modules, this modularity makes it easier to add a module to an existing stacker. Based on these two claims, making revisions to the stacker at customer site by adding a new module to it in the form of revision will result in a unified product structure in the PDM system. Figure 48 below shows a simple illustration of how product structure can be unified by revision.

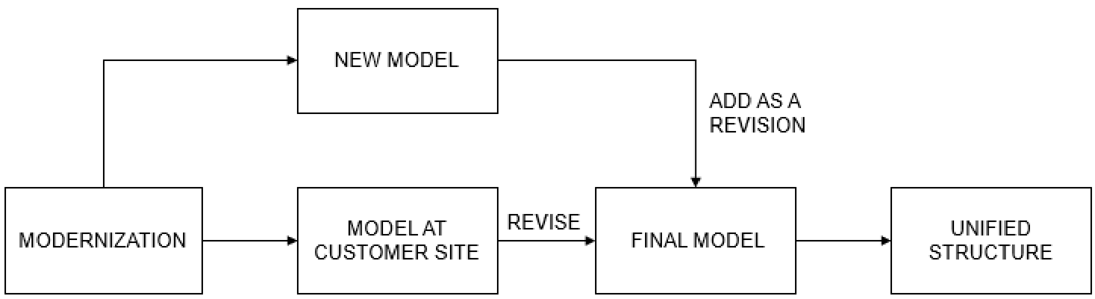


Figure 48. Product structure unification chart.

Without doubt, just adding the module is not enough as there are some few parts that will require total replacement or little changes; those possible changes can also be addressed by revision. The new model to be added should also be designed in a way that all the necessary parts and materials that will be needed to manufacture it can be published to the ERP system. This implies that all parts that will be changed are included in the modernization model assembly level.

6.1 Answer to research questions

RQ1. How can different product structures be unified in a PDM system?

There was no straight answer to this question, neither from literature nor from the interviews and semi-structured interviews conducted. However, the literature, interviews and semi-structured interviews helped to gain an extensive insight into the topic, which then sparked an idea about how the structures can be unified in PDM systems. The idea that came to mind was to make revision to the product that was first delivered to the customer.

The structure of the earlier delivered machine and the new machine which will be added in form of modernization can be unified by revision. Previous modernization projects have always involved disassembly of the machine at customer site and then adding the new module. The revision should be done with this picture in mind, such that the 3-D model of the machine at customer site is disassembled in form of revision, and the new machine coming in form of modernization is added to it.

RQ2. What are the key challenges that will arise in other systems that are linked to the PDM system when the structures are unified and how can the challenges be rectified?

Since the idea of revision is not new in the field of engineering or CAD, then there should not be any challenges that have never been seen before. When the structure is unified by revision, the changes in the CAD environment and in the PDM system automatically sync together. However, such revision does not automatically sync or get updated in the ERP system as in the case of Raute Oy and many other companies. This would require manually updating the ERP system so that the changes in the PDM system can be reflected in the ERP system.

So, what are the challenges in other systems when structures are unified? The answer would be that there are no challenges because even normal revisions at Raute have always required up till now that the ERP system is manually updated to reveal the changes made in form of the revision. Therefore, manually updating the ERP system is not a challenge in this case.

6.2 Conclusion

In conclusion, the stated aim and objective of this thesis have been met, and this study suggested the use of revision as a means to unify product structures. It will be hoped that this suggestion will be put into use whenever there is a modernization project or any related projects that require the need to have two or more product structures combined as one.

The subject of PDM and its many intricacies are rarely taught in most schools; a good reason could be because it is a very extensive topic. For the author, this study has been an eye-opening and a very good learning experience because it presented the opportunity to learn what the importance of proper and efficient management of product data is. Most manufacturing companies have loads of data generated every day, especially the ones that are into ETO. What those product data is and why those product data needs to be managed are what became clearer as a result of carrying out this study.

The ERP system used in this study was V-10 ERP system which is flexible. It will however be recommended to explore how this result will turn out when another ERP system known as Microsoft Dynamics 360 which Raute is planning to implement will respond to the solution presented in this report.

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