DETERMINING ACCURACY OF BILL OF MATERIALS FOR A SURFACE MOUNT TECHNOLOGY MACHINE USING SOLIDWORKS SOFRWARE

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ABSTRACT

Bill of Materials (BOM) is a simple list of the contents of subassembly or material to assembly a complete product. The BOM mainly use for the Material Requirement Planning (MRP) to determine the inventory level should be ke!ep for production. Costing is done base on the BOM to set the total cost for the product. BOM is part of the important list for the production to determine what part, quantity part to be used and as reference with the engineering drawing to do the assembly of the product or machine. In this project, an investigation has been done in a contract manufacturing company which received BOM from Original Equipment Manufacturer. In order to verify the BOM, all the engineering drawing been modeling in 3d format. Process of assembly of the part been done by using Solidworks software. Auto generated BOM from the software has been compared with the Original provide by the OEM. Analysis to determine accuracy of the BOM has been done and Discussion on the reason of the discrepancy has been identified. However, some of the part not been verified as the restriction of the Company Policy.

ABSTRAK

BOM adalah satu jadual yang menunjukkan kandungan sesebuah mesin dan bahan serta kauntiti yang digunakan. BOM biasanya digunakan pada MRP (Material Requirement Planning) untuk menentukan jangkaan stok yang diperlukan' untuk pengeluaran. BOM juga sebahagian daripada bahagian pengeluaran untuk megetahui kauntiti dan jenis barangan yang diperlukan untuk mamasagan sesebuah mesin. Projek ini, penyiasatan tentang BOM yang diberikan oleh OEM (Original Equipment Manufacturer) kepada Syarikat XYZ. Untuk mengetahui ketepatan BOM, lukisan kejuruteraan telah dimasukan ke dalam Solidworks untuk dijadikan dalam keadaan 3 dimensi. Mengunakan fungsi pada perisian Solidwoks untuk mamasang produk dalam simulasi. BOM yang dijanakan oleh perisisan telah dibandingkan dengan BOM yang diberikan oleh OEM untuk tujuan mengetahui sejauh mana ketepatan BOM yang dibekalkan of pihak OEM. Perbincangan dan analysis dijalankan untuk megetahui ketepatan BOM serta sebeb berlakunya kesalahan pada BOM yang diberi oleh OEM. Walau Bagaimanapun, terdapat bahagian bahagian mesin yang tidak dapat dianalisis kerana dilarang oleh Polisi Syarikat.

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CHAPTER 1: INTRODUCTION

1. Introduction

Bill of Materials (BOM) is a simple list of the contents of subassembly or material to assembly a complete product. The BOM is mainly used for the Material Requirement Planning (MRP) to determine the inventory level that should be kept for production. Costing is done base on the BOM to quote the total material cost of for the product. Where by the procurement department will source for the item in the BOM within the cost set by the costing department. BOM is part of the important list for the production to determine what part, quantity part to be used and as reference with the engineering drawing for the assembly of the product or machine.

Original Equipment Manufacturer (OEM) provides BOM and engineering drawing to outsource company for the product or machine assembly. The manufacturer for the OEM will work out for the costing, production and inventory management, base on the BOM and engineering drawing.

Accuracy of the BOM is important for the cooperation of the both OEM and manufacturer provider, as this will affect the quality of the product and also the overall cost of the product to satisfy both OEM and contract manufacturer.

1.2 Problem Statement

Company XYZ assembles the SMT machine for the OEM Company from United State. The Bill of Materials and engineering drawing of the SMT machine were provided by the OEM Company. The engineering drawing given is in the pdf (Portable Document Format) format and BOM is in the format of spreadsheet. Company XYZ wishes to investigate the accuracy of the BOM given as production claimed that the quantity of the part given in the BOM is incorrect. On the other hand, inventory side claims that the production is taking 25% more quantity than the requirement stated by BOM. The accuracy of BOM will affect the cost of the machine, inventory management and also production assembly. All the material costing is charge according to the quantity of the BOM, if the quantity usage is more then what is stated in the Original BOM that mean Company XYZ is charging the price less then what should be, it will be a lose for Company XYZ.

Due the function the machine need to work in the high temperature condition, major of the raw material of the part is made of stainless steel. The entire fastener used in the machine also is manufacturer from stainless steel.

The Chamber of the machine is the largest assembly part for the whole machine. It is the basic requirement for the normal machine as each of the machines will contain two pieces of Chamber. The Chamber also contains the most subassembly part of overall of the machine.

1.3 Objectives

1. To compare the different of the BOM given by the OEM with the generated BOM form the Solidworks software and determine the accuracy of the BOM given by the OEM.
2. To generate the BOM using the function in Solidworks software. Solidworks 2009 is software has the function of generate BOM automatic according to the subassembly simulated. In order for the software able to function correctly, all of the drawing should be render in 3d format and saved as the Solidworks file format.

3. To redraw the machine with Solidworks software and simulate the assembly process of the product as the engineering drawing provided by the OEM is in the format of "pdf' and partly is in the format of CAD.

1.4 Scope Of Work

1. The BOM and drawing analysis done is only for the bottom heating chamber of the machine as the Chamber is the part assembly for the basic machine and most part contains of overall of machine.
2. Comparison of the part was done on the assembly part where raw material is not included.
3. Part of the drawing and item will not be displayed as required by Company XYZ as it is private and confidential.
4. Dimension of all the parts will not be available as requested by the Company. Quantity of part is the focus of this project.

CHAPTER 2: LITERATURE REVIEW

2.1 Bill of Material

The bill of material (BOM), which is the technique document on illuminating the product structure, is used to demonstrate the structure and relationship between the final product, subassemblies, as well as the corresponding quantities of the subordinate parts and materials of each assembly. A BOM describes the component structure of a product, usually as a hierarchical structure implemented within a relational database. These descriptions include the relationship between the end product, subassemblies and materials. (Martawirya, 2008)

Product data represented by a BOM can be used for describing an end product to state raw materials and intermediate parts or subassemblies required for making the product.

Figure 2.1 shows the BOM structure of souvenir clocks. Figure 2.2 gives the corresponding BOM data records in a traditional BOM file structure. Production information is concerned with how it is produced. i.e., the specification of operations sequences to be performed at corresponding work centers along with related resources such as machines, labor, tools, fixtures and setups. (Jiao, 2000)

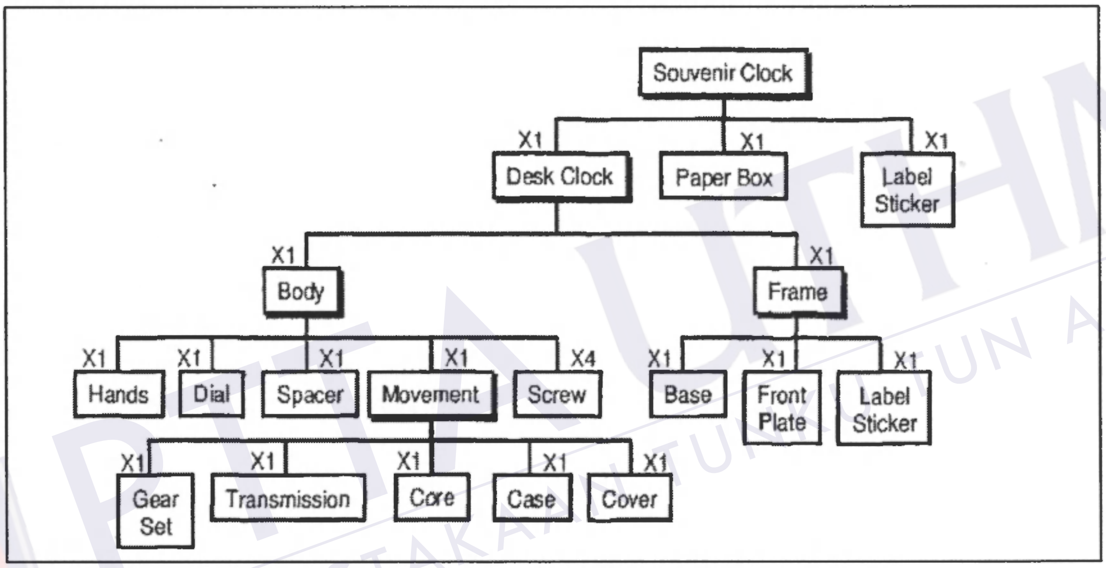


Figure 2.1: BOM structure of Souvenir Clock (Jiao, 2000)

Hierarchy Level	Parent Item	Component Item	Quantity per
1	Souvenir Clock	Desk Clock	1
1	Souvenir Clock	Paper Box	1
1	Souvenir Clock	Label Sticker	1
.2	Desk Clock	Body	1
.2	Desk Clock	Frame	1
..3	Body	Hands	1
..3	Body	Dial	1
..3	Body	Spacer	1
..3	Body	Movement	1
..3	Body	Screw	4
..3	Frame	Base	1
..3	Frame	Front Plate	1
..3	Frame	Label Sticker	1
...4	Movement	Gear Set	1
...4	Movement	Transmission	1
...4	Movement	Core	1
...4	Movement	Case	1
...4	Movement	Cover	1

Figure 2.2 Errors in BOM (Jiao, 2000)

BOM is primarily responsible for MRP and inventory management, and routings for capacity requirements planning and production control. An effective control of a production job at the shop-floor level cannot be fulfilled without the integration of planning and control functions. This necessitates that the material contents of BOM are linked to the relevant assembly operations to reflect the material flow through the production process. The correlation between BOMs and assembly planning is embodied in the materials required by each assembly operation. That is, each component in BOMs is required by the relevant operation as the material for assembling its parent product. (Jiao & Du, 2005)

The main purpose of the materials management organization is to provide the "right parts in the right quantities at the right time." Without a complete and accurate BOM, decisions regarding material planning and replenishment are often made in a vacuum, resulting in excess inventory, stock outs, expediting charges and expensive downtime. For manufactured items, the BOM lists all the raw materials, piece parts and other components required to complete a single unit of an end item. An equipment bill of material (EBOM) lists all of the components of an asset, including its assemblies and subassemblies. With a reliable EBOM, a planner can determine exactly what parts are needed. And in an emergency situation, the EBOM provides valuable information to craftsmen and others to ensure that the right parts are identified and procured.

There are two primary metrics for measuring EBOM effectiveness. With a robust process in place, the data is easy to capture. The measurement is based on completion of the EBOM and the accuracy of the EBOM. EBOM completion is not more than a measure of whether an EBOM exists for each asset. The goal should be 100 percent for all critical assets and 95 percent for others. For the EBOM accuracy: Calculating EBOM accuracy is a bit more complicated. It usually reflects data captured during periodic reviews. The accuracy can be calculated on a line-item basis or on the entire EBOM. In either case, the target for critical assets is 100 percent (i.e. zero errors in the EBOM); the target for other assets is 98 percent (i.e. no more than one error in a sample of 50).

The direct and indirect benefits of accurate EBOMs can be difficult to quantify, but are not difficult to delineate.

- Fewer incorrect material purchases: By utilizing the information contained in the EBOM to generate purchase requisitions, there is less of an opportunity for guesswork, variation or errors in the transmission of material requirement data to suppliers.
- Faster execution of planned work: Accurate EBOMs reduce the amount of time spent researching required materials. This helps to streamline the planning and procurement processes, which in turn reduces the length of time required to obtain the necessary parts to complete the job. \
- Faster execution of unplanned work: An effective EBOM provides craftsmen with quick access to accurate part requirements and descriptions in an emergency situation. Combined with a reliable inventory control system, craftsmen can quickly determine the on-hand quantity and location of available parts in stock. Should insufficient inventory be available, the EBOM can also provide valuable manufacturer and supplier details to facilitate expedited procurement.
- Disposition of inactive inventory: Use EBOMs to determine whether a non-moving inventory item is required for an active asset.
- More effective reliability engineering: Use EBOMs to identify similar items or equipment where individual materials can be standardized or substituted.

2.2 Error in BOM

BOM errors typically fall within three categories. Completeness is the most common defect. Critical pieces of information, such as quantity, part description, reference designation and approved manufacturers list, are often omitted. Missing'AMLs reportedly cause the majority of problems. Consistency is the second categories where information in the BOM sometimes conflicts with information provided in engineering drawings and design files. For example, quantities may not matched — there are may be 10 locations for a particular component indicated on a board, but only a quantity of 9 components specified in the BOM. Another consistency problem is the format. The format of the BOM, although it is from the same customer, can change from one transmission to the next, making it difficult to match and confirm data. Even language can vary from BOM to BOM. The third category is correctness. Incorrect data is a serious problem. Common errors include invalid manufacturer or supplier information, obsolete data and incorrect part numbers (i.e., the MPN given does not match the description of the part, or the MPN is not recognized by the manufacturer/supplier). Again, AMLs seem to be the predominant problem. Additional errors can result from receipt of information in hard copy format, which requires manual entry of date, an error-prone and time consuming task.

National Electronics Manufacturing Initiative (NEMI) organized a team of industry leaders to investigate and define the issues surrounding BOM. The NEMI team gathered anecdotal information from several OEMs and EMS providers, and discovered that companies consistently cited errors and lack of a standard format as leading causes of problems when working with BOM. Estimates of error rates and of the time required to resolve data problems were also similar from company to company. (NEMI, 2003)

One major EMS (Electronics Manufacturing Services) provider provided estimates of defect levels according to process steps. This information is depicted in Figure 2.3. Their estimate of an 80% error rate for neutralizing and validating BOM received from customers is surprisingly high but, unfortunately, does not appear to be unique, based on information received from other EMS providers.

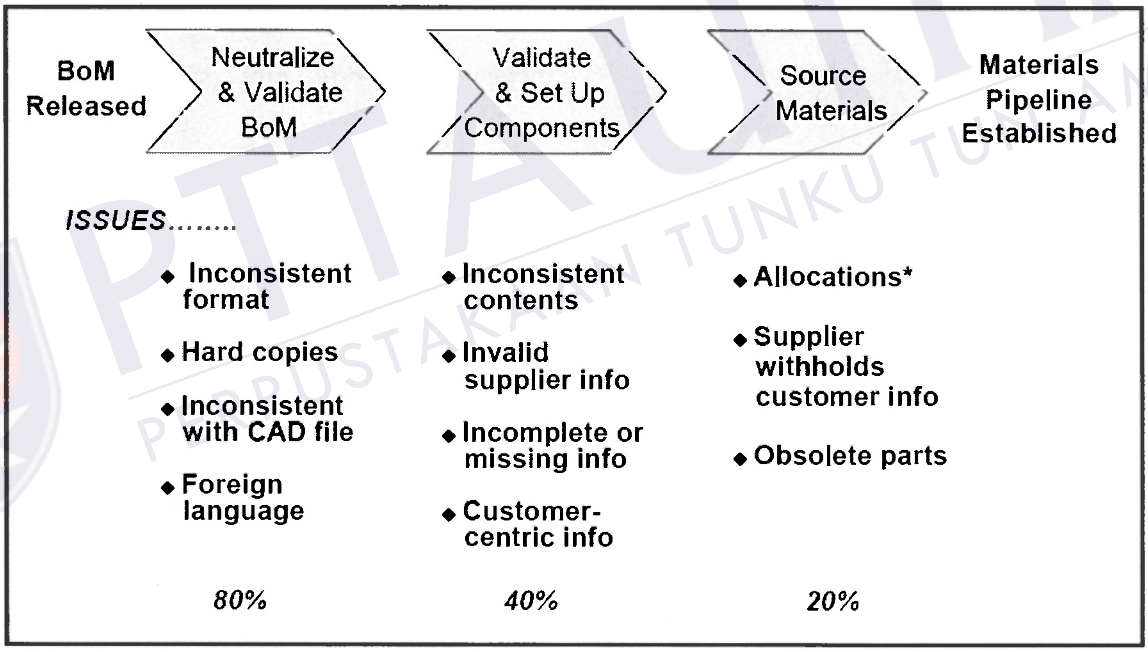


Figure 2.3: Defect levels experienced by an EMS provider at various steps in the BOM data set-up process. (NEMI, 2003)

2.3 OEM and Contact Manufacturer

Outsourcing has been widely considered as one of the major means of improving for both the competitiveness and effectiveness of companies. In manufacturing industry, focusing on the core business and outsourcing the rest has been one of the most central guidelines for a long time. To enable efficient outsourcing practices, the original equipment manufacturers (OEMs) have adopted modular product design techniques. The end product has been divided into modules that can be outsourced and efficiently assembled in the OEM's factory. The OEM specifies only the quality requirements and the interfaces with other modules, the suppliers do the rest. (Kaipia & Tanskanen, 2003)

Contract manufacturing is a supply chain arrangement that allows a manufacturing company to outsource some of its internal manufacturing processes, e.g., assembly operations, to contract manufacturers. There are two different types of contract manufacturing arrangements: part consignment and turnkey arrangement. Under a regime of part consignment, the manufacturing company centrally procures necessary parts from suppliers, sorts the parts to form different kits, and ships them to the contract manufacturers so that they can process (or assemble) the parts to make finished units, which are eventually shipped back to the company. In contrast, the turnkey arrangement allows the contract manufacturers to order the parts directly from suppliers that have been pre-approved by the manufacturing company. (Kim, 2003)

2.4 Generate BOM and Assembly Using Software

Traditionally, there are usually two kinds of bills of materials needed for a product: engineering and manufacturing BOM. The engineering BOM normally lists items according to their relationships with parent product as represented on assembly drawings. But this may neither sufficient to show the grouping of parts at each stage of the production process, nor include all of the data needed to support manufacturing or procurement. These requirements may force the arrangement of the product structure to be different in order to assure manufacturability. Thus, engineering and manufacturing will usually have different valid views for the same product.

Product Data Management (PDM) technology enables changes to be tracked and implemented through the design and engineering change process and then passed over to the MRP system when approved. Therefore PDM systems use BOM to represent configuration management of the product. In PDM, A Bill of Materials is a product data structure which captures the end-products, its assemblies, their quantities and relationships. The structure of a part's list determines the accessibility of the part's information by various departments in a company. It also helps to determine the level of burden put on the computational device in searching for product information. In many companies the BOM is structured for the convenience of individual departments. This, however, engenders problems in other departments.

CAD data corresponding to the part generate visual data through the translator. The other CAD data corresponding to the assembly consist of the connecting and position information's as matrices including the visual data. These assembly data corresponding to sub-parts of the PDM system data are obtained through the check-in process. Using both informations, clients are able to search the data on the PDM. An XML-writer generates an XML files according to the XML schema for the assembly visualization. The XML-writer was developed by using Xerces XML Parser. The management method of assembly data is as followed: First, extract part feature and positional information from the assembly. Then, define the extracted positional information according to the relative position in the assembly structure. 'Id' means the identity information of each part and assembly. The assembly table denotes interrelation between the assembly and subordinated parts. System stores the parent 'Id' value to the 'Higher info' element, and then stores the child 'Id' value to 'Link'. Part's relative positional data corresponding to the higher assembly is stored in 'Position'. (Song & Chung, 2009)

Id	Name	Higher_info	Link	Position
A0	1_Assy1	NULL	A1	NULL
P1	Part1	A0	V1	$M_{2,1}$
A1	2_Assy1	A0	P2	$M_{2,2}$
A1	2_Assy1	A0	P3	$M_{2,3}$
P2	Part2	A1	V2	$M_{3,1}$
P3	Part3	A1	V3	$M_{3,2}$
...	...	...	...	...

Figure 2.4: Date extract using PDM (Song & Chung, 2009)

2.5 ABC Inventory Classification Analysis

Inventory classification using ABC analysis is one of the most widely employed techniques in organizations. This classification is based on the Pareto principle. ABC analysis is easy to use and simple to understand by an average materials manager. Normally, the items are classified based on the annual use value, which is the product of annual demand and average unit price as shown in Figure 2.5. Class A items are relatively few in number but constitute a relatively large amount of annual use value, while class C items are relatively large in number but constitute a relatively small amount of annual use value. Class A items have to be controlled tightly and monitored closely. ABC analysis is successful only when the inventory being classified is fairly homogeneous and the main difference among the items is in its annual use value. (Ramanathan, 2006).

Item no.	Average unit cost ($)	Annual dollar usage ($)	Critical factor	Lead time	Optimal inventory score (%)	ABC classification using	
						Optimal inventory score score	Annual dollar usage
S4	27.73	4769.56	0.01	1	100.0	A	A
S14	110.4	883.2	0.5	5	100.0	A	B
S18	49.5	594	0.5	6	100.0	A	B
S29	134.34	268.68	0.01	7	100.0	A	C
S34	7.07	190.89	0.01	7	100.0	A	C
S45	34.4	34.4	0.01	7	100.0	A	C
S15	71.2	854.4	1	3	96.8	A	B
S16	45	810	0.5	3	91.7	A	B
S28	78.4	313.6	0.01	6	89.0	A	C
S19	47.5	570	0.5	5	86.6	A	B
S40	51.68	103.36	0.01	6	85.7	B	C
S17	14.66	703.68	0.5	4	79.9	B	B
S31	72	216	0.5	5	72.4	B	C
S33	49.48	197.92	0.01	5	71.7	B	C
S23	86.5	432.5	1	4	71.5	B	B
S37	30	150	0.01	5	71.4	B	C
S39	59.6	119.2	0.01	5	71.4	B	C
S43	29.89	59.78	0.01	5	71.4	B	C

Figure 2.5: ABC classification (Ramanathan, 2006)

However, traditional ABC analysis is based on only single measurement such as annual dollar usage. It has been recognized that other criteria, such as inventory cost, part criticality, lead time, commonality, obsolescence, substitutability, number of request per year, scarcity, durability, reparability, order size requirement, stock-ability, demand distribution and stock-out penalty, are also important in inventory classification. A simple model for inventory classification is proposed when multiple criteria are considered. A weighted linear model is first formulated. The model is easy to understand by inventory managers. A transformation is then applied on and which induces a'simple solution mechanism for calculating a unified measurement of overall score of an inventory item. The overall score can be easily obtained by some simple calculations on any commonly available spreadsheet package without any linear optimizer. One of the limitations of exogenous specification of ranking is the number of criteria. When the number of criteria under consideration is small, specification of ranking is not a hush requirement. However, when number of criteria is large, it is not an easy task for decision maker to rank all criteria. (Ng, 2007).

2.6 Engineering Change

Engineering changes (ECs) are the changes and/or modifications in dimensions, fits, forms, functions, materials, etc. of products or constituent components after the product design is released. An EC usually induces a series of downstream changes across a company where multi-disciplines work together dealing with these induced changes. Various functions across the manufacturing company have to adjust their activities in order to deal with ECs and their impacts. Requests for ECs originate across the company, although ECs have different degrees of impact among the disciplinary functions, and implementing ECs involves the participation of a number of disciplines.

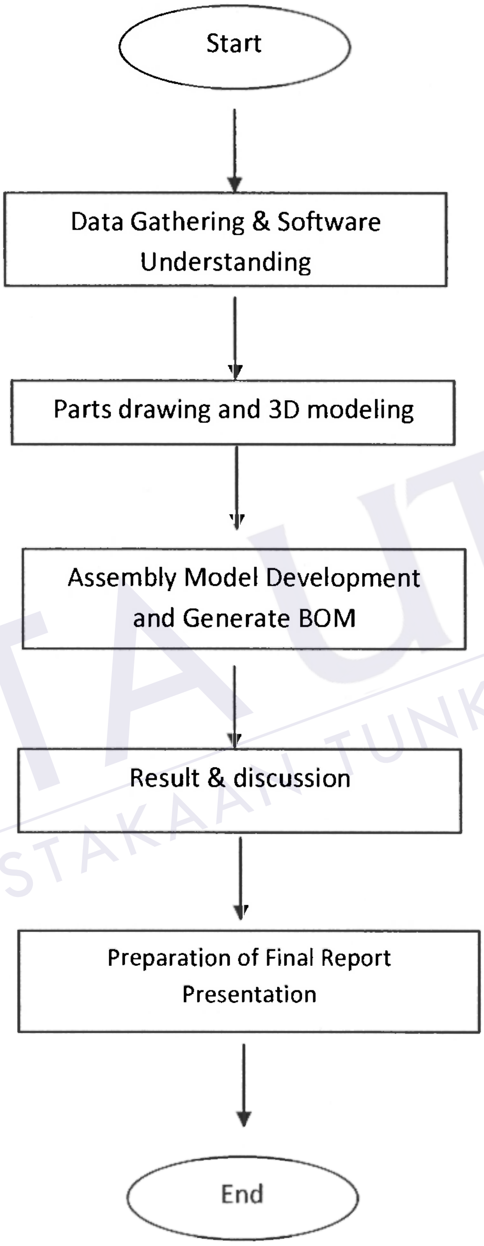
In normal situations, multiple disciplines, such as design and development, purchasing, shop floor workshop, quality control, and so on, are involved in the management of ECs at different stages along the ECM lifecycle. (Huang,G.Q.,Yee,W.Y., et al., 2003)

CHAPTER 3: METHODOLOGY

3.1 Introduction

The methodology chapter will provide the method to achieve the project's objective. First process is gathering data; the data needed is the BOM and Drawing of the Bottom Chamber of the machine. Next, understanding the Solidworks software is the next process. Then, by using the Solidworks drawing to draw the Bottom Chamber's part, render into 3d modeling, after that, the assembly model is done and finally the BOM is generated. The BOM generated will be compare with the original given one in Microsoft excel. Result and discussion will be provided.

3.2 Flow Chart of Methodology



3.3 Data Gathering & Software Understanding

In this project, first what need to be done is gathering the BOM and the drawing of the Bottom Chamber. The format of the BOM will be in Microsoft excel while the Drawing will be either in the "pdf' format cad drawing format.

The software used is Solidworks 2009. This software have the ability to draw, model, assembly simulation and other engineering function like finite or heat analysis.

3.4 Parts Drawing and 3D Modeling

The part drawing given will be in pdf format which cannot be converted in drawing format, so the part will need to redraw in Solidworks software. If the drawing is give in cad format, conversion and adjustment will be done and adjusted as cad format is different from Soildworks format. The part will be rendered into 3D model and output as Solidworks assembly part.

There are few item can be withdrawn from the Solidworks library and online. Some of the electrical and electronic part had been provide the 3d model in the solidworks website. Fasteners can be withdrawn from the software library.

3.5 Assembly Model Development and Generate BOM

All the part will be put on screen and the simulation assembly process will be done using the Solidworks software. All the part should be identified by the name or part number so that the BOM generated will be the same as original BOM given. Mating of the part will be the next process and followed by simulation of the assembly. The BOM will be exported in the Excel form.

3.6 Result and Discussion

Comparison of the Original BOM with the generated BOM will be done using Microsoft Excel. The different of the BOM will be shown in table and chart form. Result of the comparison will be discussed. Suggestion and improvement will be included in this chapter

CHAPTER 4: DRAWING MODELING AND ASSEMBLY PROCESS

4.1 Drawing Modeling

The engineering drawing provided by the OEM is in the "pdf' format and some in "dwg" format. To enable using the Solidworks software to perform the assembly process, redrawing of the part and modeling in 3D are required. If the format of the drawing given is in Soldiworks or other AutoCAD software formats, it should be no problem to convert to the form of Solidworks Part Modeling and assembly. The modeling part will be show is the Chamber, Divider and Wire Cover.

4.1.1 Chamber modeling

Refer to the drawing provided, a plane view (2d) has been drawn - a rectangular. After that, the drawing is extruded to become a box. (Figure 4.1)

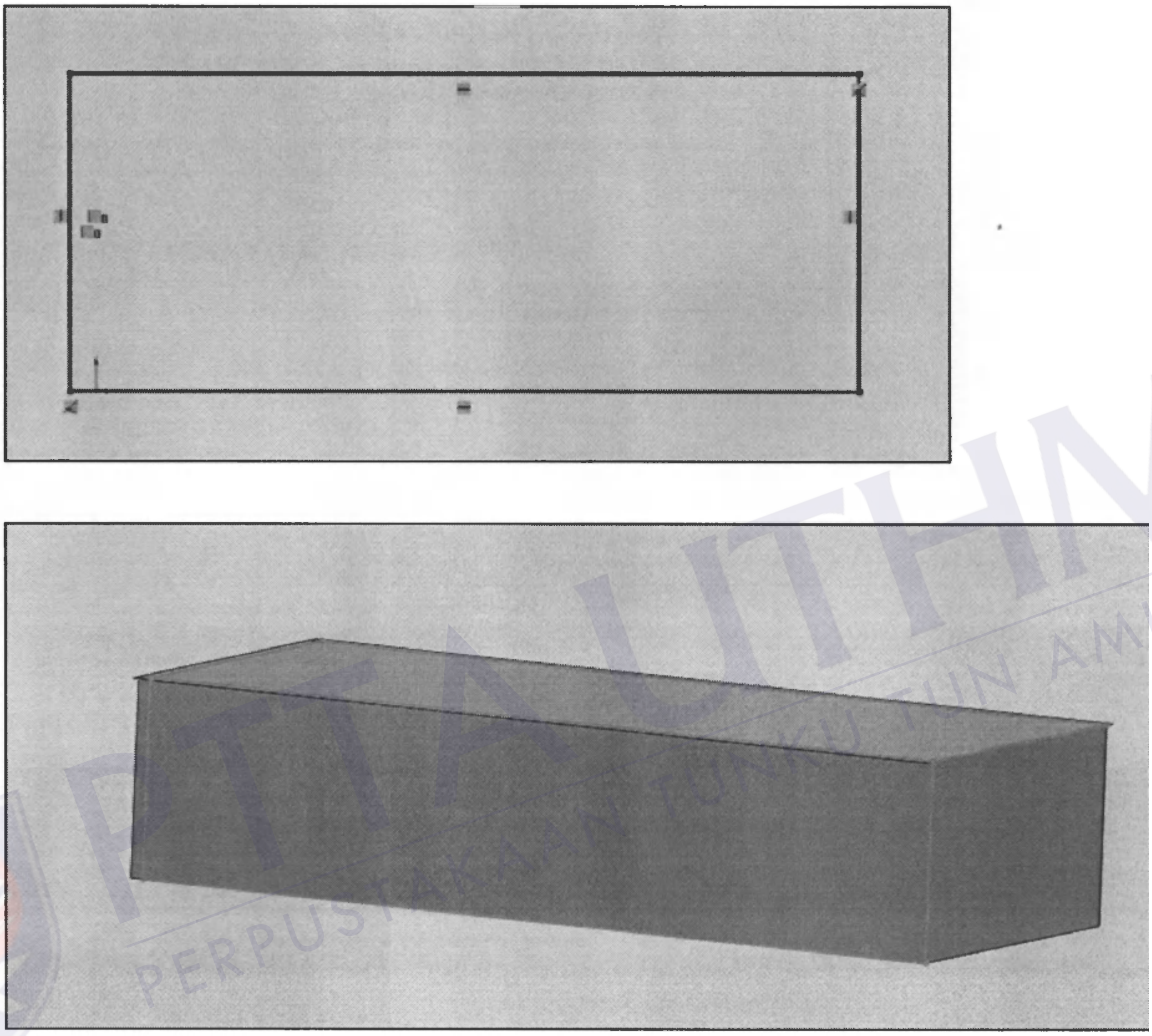


Figure 4.1: Raw Drawing of Chamber

Cut the internal part of the box become a blank Chamber box (Figure 4.2). in this condition, the box needed is blanking with few depth thickness for the bottom part so the function of the cut through is not appropriate, blind function should be selected and offset to the define dept should be inputted.

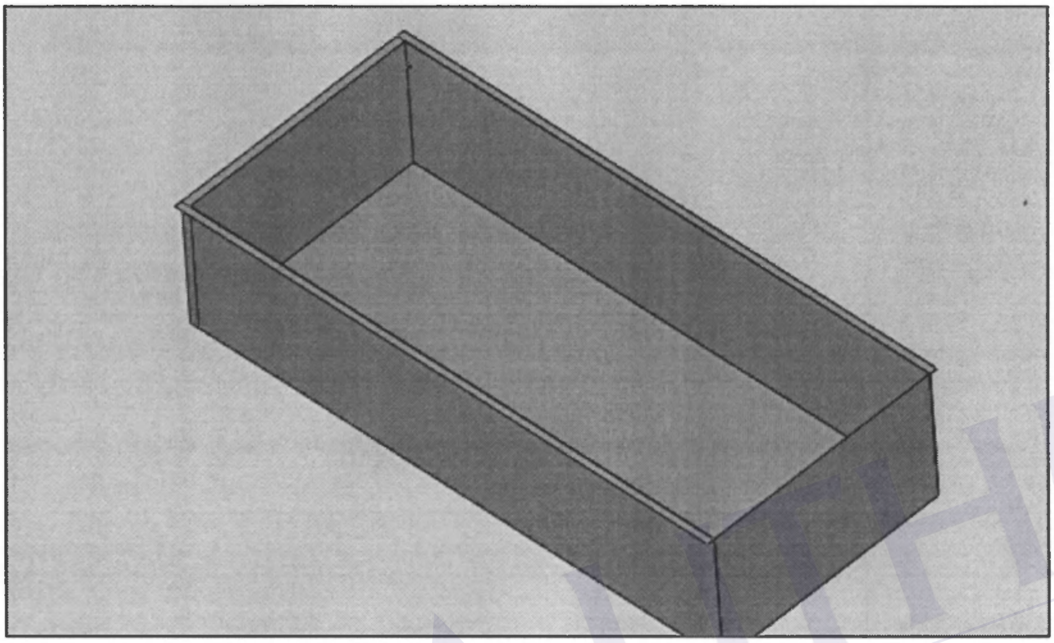


Figure 4.2: Blanking the Box

Select Top view of the drawing and sketch the sub part in 2d form. After that extrude and cut the 2d form become 3d modeling (Figure 4.3). In software modeling, all of the subassembly part will be drawn on the surface of the inside box. In this condition, the function sketch should be selected; when the required plane is ask, click on the inner surface of the box, draw all the part in 2d mode and render all into 3d model after exit from the function of sketch. Holes extrusion can be done by select all circles at once. The other render part need to select base on the similarity of the shape of part, but in the real situation, sub part has to be welded to the body of the chamber.

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