Modeling and Simulation of Coffee Bean Process Industry in Malaysia Using Solidworks Softmotion

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Abstract – **This paper presents about how to use the Solidwork softmotion software to design a coffee bean processes. By using the software, we can create a process of coffee bean in 2D, 3D and also able to design each part then assembly the parts. Lastly, simulate the assembled parts. There are 2 stages in coffee bean process which are the first stage is heating and stirrer the raw of coffee bean. The second stage is cooling the raw of coffee bean. All stages during the process are fully automatic and the process is a continues process where a conveyor belt is used. The purpose of project is to help the small or medium coffee industry to increases more production and can be contenders with big company. Besides that, generally this project study about the automation industries in Malaysia. Hopefully, after finishing this project, the industries especially for Small and Medium Industries (SMI) can improve their production and save man power cost by changing their system into fully automatic system.**

Keywords – Coffee Bean Process System; 2- Solidworks 3D CAD; Soft motion, Simulation Xpress study, motion study.

I. INTRODUCTION

Around the world, automation has been introduced to increases productivity. For the software designer, this mean they have pressure to maintain the productivity and produce the better design than others company in shorter time to reduce the costing [1]. So, this is the reason why people nowadays choose Solidworks as their software to design the product. Solidworks will be always updated year by year with new capabilities and new ways of creating better designs faster. But in Malaysia is little bit behind this technologies in or industries especially SMI companies has not been take the advantages of this technology to improve their production process [2]. In our country, almost small or medium company still using man power or labor workers in their production compare to other Europe country which over the year automation industry has experienced a huge growth worldwide [3]. This make the company is far behind from other company and they cannot optimize their production and these phenomena also give some impact to our country economic growth [4]. The use of the Solidworks in this project is for the following objectives:

- To design a coffee bean process system this enables to understand the 3D geometry model.
- To analyze the pass stress analysis of part of the machine by using simulation xpress study.
- To analyze the movement coffee bean system operation by using motion study.

II. METHODOLOGY

The methodology is the overview of the all the works and process done in order to complete this project. This software is more too mechanical design that is allows the designers quickly sketch out ideas, experiment with features and dimensions, and produce models and detailed drawings [5]. Figure 1 shows the flowchart which contains the four important sections.

A) Manual Sketching

It is very important to do manual sketching first before proceed to 2D and 3D. We must understand the parameter of this project. Parameters refer to constraints whose values determine the shape or geometry of the model or assembly. Parameters can be either numeric parameters, such as line lengths or circle diameters, or geometric parameters, such as tangent, parallel, concentric, horizontal and vertical.

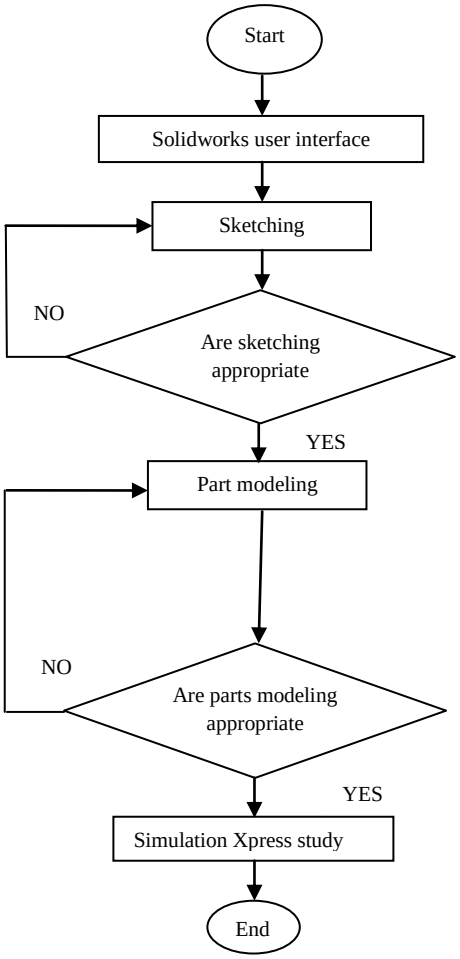

Figure 1: Methodology flowchart.

B. Part Module

This part module consists of four units which are user interface, sketching 2D, part modeling and simulation xpress study [6]. This is the part that is must be done first proceed with other module.

a) User interface: With a customizable Solidworks user interface, user can create their own convenience Solidworks environment. Some main elements of the SolidWorks user interface are: menu bar, search, status bar and toolbars.

b) Sketching: Solidworks can be created a geometry drawing 2D if the manual drawing is done. This geometry sketch includes the lines, arcs, circles, and ellipse. This can be viewed by 3 sides which is top, side and upper. The part sketching 3D is same as sketching 2D process but it create or add a dimension to the sketch. This 3D design include the reconstruction process involves three-line-junction analysis, reference junction determination and vertex calculation, hidden topology recovery and planarity enforcement. With the functionalities provided by the Solidworks, the designers are able to sketch on any part, even the "backside" of the object, enabling a nice design [6]

c) Part Modeling: this part modeling process will create a solid feature. The solid feature will be created after the sketch is defined as a closed loop sketch. A closed loop sketch is means by an area without gaps.

d) Simulation xpress study: Simulation Xpress is a pass analysis tool. It's also been called as COSMOS. Using this method it has an able to determine the effect of force or pressure. One of the benefit Simulation xpress, it can help to overcome the costing by testing designs only on the computer instead of expensive and time-consuming field tests. SimulationXpress uses the same simulation technology that Solidworks Simulation uses to perform stress analysis. In order to perform the stress analysis it requires part information such load and material. The load can be either force or pressure that is been applied to the surface of parts. The uses of the force are to induce the stress and deform the part. Moreover over, there are several results that will be obtained from the test such as stress distribution, displacement distribution strain distribution and factor of safety (FOS). Von Mises also known as a stress distribution is to determine the strength in tension by display the minimum and the maximum value. FOS usually is for determine the actual load that have been applied. This is very important to know how much stronger the structures. If the FOS is less than 1.0, it means the material already overstress and is not a good structures but if FOS is greater than 1.0, it means the material is not overstress and the structures is safe[7].

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C. Assembly Module

This assembly parts are consists of many components, which it can be part by parts. This will creates a link between each part of the components by adding it to the assembly. Moreover, it consists of three important units such are bottom up assembly, motion study and using assemblies [6].This bottom up assembly section are created by adding all the parts in one assembly. The position of the first part will be lock and it will be the reference to others parts. By adding the part of component, it can be mate with other different parts of components. The mate types such as concentric, coincident and locked. Formerly motion study knows as animator. The word animator is referring to study of moving system. There are having three types of motion study which is animation, basic motion and motion analysis. Each motion study provide different of study. The animation is the basic simulation the will ignore the inertial properties, solid contact, forces and similar. Basic motions have a level for the inertial properties of the components but it does not apply externally force. Motion analysis is the latest motion analysis. The motion analyses have all the requirement analysis features as inertial

properties, external forces, contacts, mate friction. For the coffee bean system process is use motion analysis which provides the motion using motor, spring, gravity and solid contact. For the gravity are 9.8m/s^2. For the motor, there are three types which rotary motor, path mate motor and linear motor.

III. DESIGN AND SIMULATION OF COFFEE BEAN PROCESS SYSTEM.

A. Design and assemble of the parts of the coffee bean process system.

Figure 3 shows the process of designed coffee bean process system. The design and simulation was built in the Solidworks 3D cad software. Firstly, to start this, roughly sketch the whole process of coffee bean system. There are two stages which are heating and stirrer the raw of coffee bean and cooling the raw of coffee bean. The entire machine for all two stages was drawn as a part using Solidworks by referring to the sketch. This part was namely parts. After that, the small components for all the machines in the parts were drawn. Other part component that was drawn was the sample of coffee bean, the model engine, a container for the stirrer, the valve. All these components are for stage 1. For the stage 2 contains the hopper, a half tank for the stirrer. Other than that is the box, conveyor A and conveyor B were the other part in completing this coffee bean process system.

Figure 2 shows the component part and the whole system after assembly them. After the system was assembly, simulation can be created.

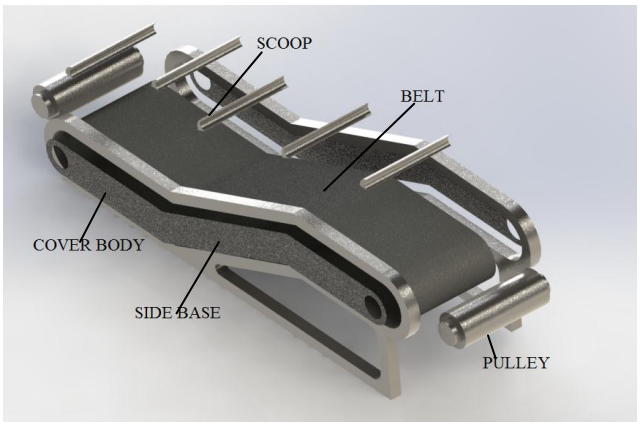

Figure 2 (a): Part components.

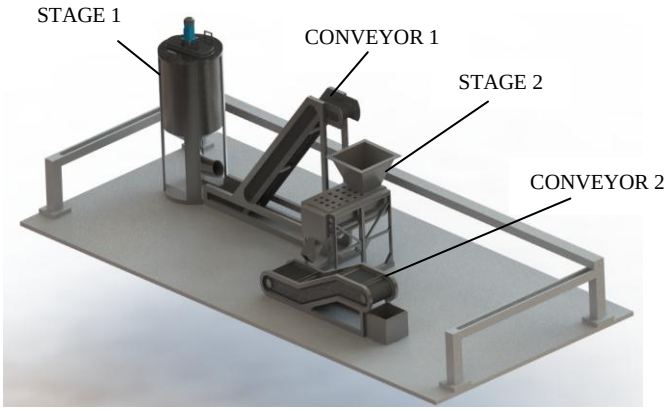

Figure 2 (b): Coffee bean process system assembly.

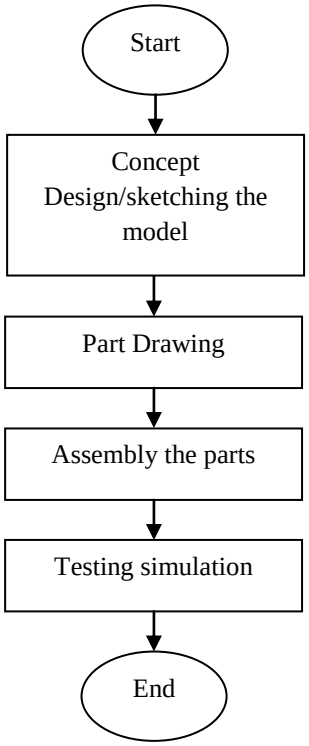

Figure 3: Methodology flowchart.

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B. Simulation Coffee Bean Process System.

The operation of coffee bean process system is follow by the sequences. The raw of the coffee bean will be placed into the tank by manually at stage 1. Then the raw of coffee bean will be heated until it meets the specific temperature. In the same time, it will be stirrer. After being heated, the valve will be open to allow the raw move to the next section which is the stage 2. The raw will be transfer by the conveyer A. The clotted raw will be separated in the section B which at this section the cool air will be flow to make sure the raw is not in high temperature in order to proceed to next step. During at this, the stirrer will make the raw separated again. Then it will move to container. The movement from the section B to the container will be same like section A which using the conveyer.

IV. EXPERIMENTAL ANALYSIS AND RESULTS

The completed 3D model of coffee bean process system that was assembled using a combination of the created parts. Then, the model was tested using Xpress study and its movement and operation analyzed using motion study.

A. Simulation Xpress study

The stress analysis was carried at the conveyor belt and in this coffee bean process system. The stainless steel was used as the material for pulley and the belt was the rubber. And the assembly feature is set as belt, so when one pulley rotates, the other pulley will follow its rotation. Since the two pulleys are the same size, so this study is only need to focus on half of the model. Besides than, it is a static study, there should be tension in the belt, torque and centrifugal force on the contact surface between the pulley and the belt. By referring Euler's formula it can calculate the tension force on the both side of belt. The equation as stated as below.

$$F_1 = F_2 e^{f\alpha}$$

Where:
F: is the coefficient of friction between the belt and the pulley surface
α: is the Wrap angle (rad)
e: the natural logarithms (e ≈ 2.718).

Euler's formula used to describe the tension between the F_1 and F_2 on the both sides of the belt. For the tight tension is 1N, so after applied the calculated the loose side force was 0.04N for the F_2. The loose side tension is very small compared with the tight side tension. When the pulleys are rotating, there have a little bit centrifugal force in the belt. The friction force will appears as the torque between the contact surfaces. The stress distribution, displacement distribution and factor of safety (FOS) tests were carried out.

Figure 4 is shows the stress distribution result distribution of the belt. There was no stress on the belt with maximum is 1.7MPa while the minimum value is 0. This condition during when the F_1:1N, F_2:0.004N, angular speed: 2 rad/s, torque1:1N·M, torque2= 2 N·M. for the material the belt is made from the rubber while the pulley material is stainless steel. This stress analysis is to determine the strength of the belt and pulley when forces have been applied. Figure 5 shows safety of the belt at the conveyor. When force was applied, the FOS results were safety due to the blue color on the surface. The red color will show the unsafely result. The maximum value is 59051.20 and the minimum value is 355.32 as shows in Figure 5. Figure 6 shows the displacement distribution of the belt at the conveyor. It shows that the maximum value for the displacement distribution was 6.233e+001 and the minimum value was 1.000e-030.

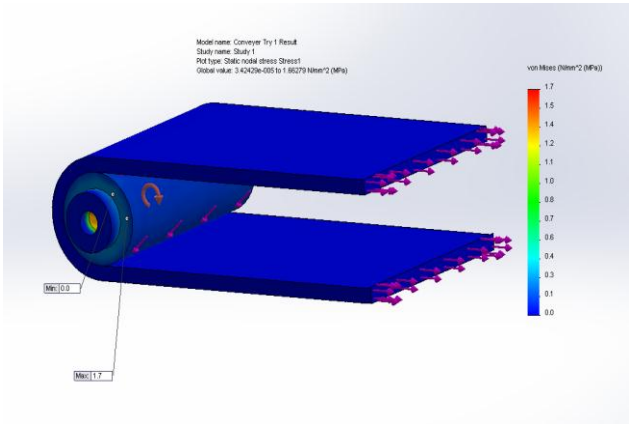

Figure 4: Stress distribution.

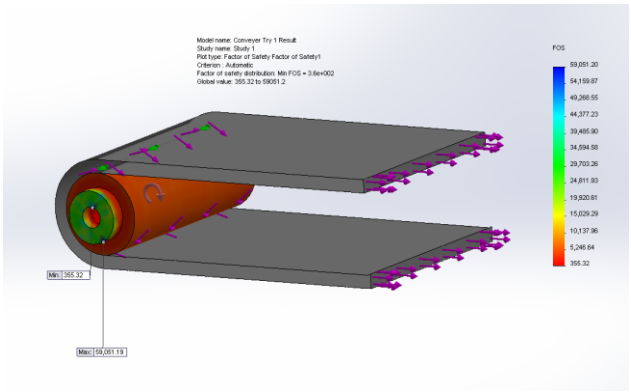

Figure 5: Factor of safety.

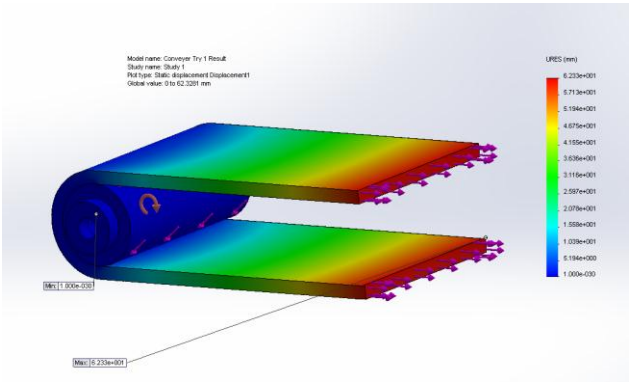

Figure 6: Displacement distribution.

B. Motion study

In the motion analysis the result have been analysis by focusing on the movement of the conveyor when it moving. The conveyor already has a scoop that will move around the belt. These scoops will move using the path motor mate. Figure 7 shows the timeline conveyer. The estimate distance of belt is 158.60 cm. the speed of each scoop can be adjusted depends on the force, material and load. All the analysis comes out with two graphs which are the linear velocity versus time and linear displacement versus time. Figure 8 shows the velocity versus time at the scoop and conveyor belt. From the velocity versus time, it shows the highest linear velocity is 5.8 centimeter per second at 1.75s. Figure 9 shows the linear displacement versus time at the scoop and conveyor belt. From the graph, it shows the highest displacement is 17 centimeter at 7s.

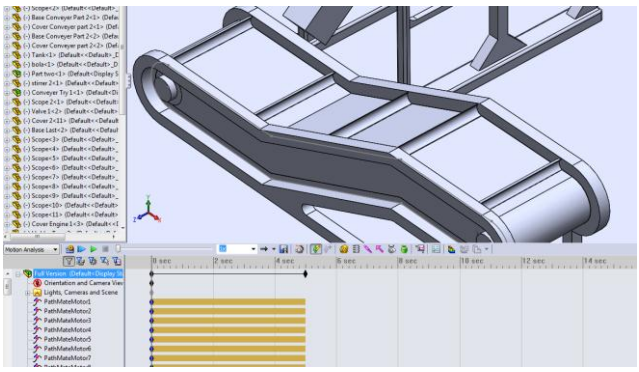

Figure 7: Timeline for conveyor.

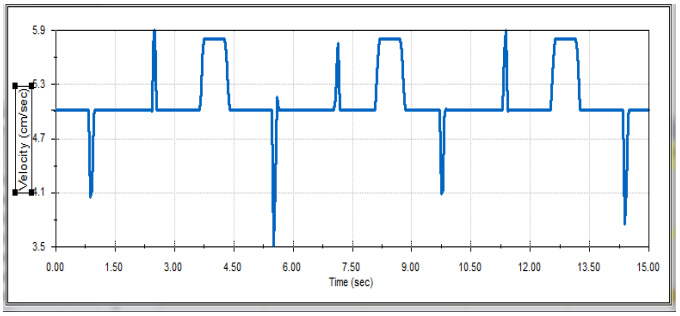

Figure 8 : Linear velocity versus time

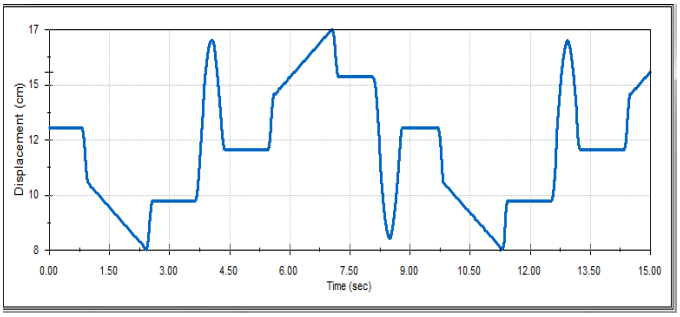

Figure 9: Linear displacement versus time.

V. CONCLUSION

The Solidworks which is 3D CAD software was used successfully to design a coffee bean process system. The software enabled easy simulation of the system and was able to detect errors in the design of the parts. The analysis of the simulation Xpress study and motion study shortened the design period and improve the modelled system efficiency. The simulation Xpress study enabled stress analysis to ensure that the modelled parts are safe. The motion study enabled the user to develop the most efficient movement by minimizing displacement to shorten and save the time.

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VII. REFERENCES

[1] M. West. (2013, 16 May 2013). My.SolidWorks, SolidWorks World 2013. Available: http://blogs.solidworks.com/solidworksblog/mysolid works/

[2] Burhanuddin,M.A ; Ahmad, A.R. : Desa, M.I. Industrial Electronics and Applications,2007.ICIEA 2007, 2nd IEEE Conference on

[3] Terzic, I ; Zoiti, A ; Favre, B ; Strasser, T.Emerging Technologies and Factory Automation, 2008. ETFA 2008.IEEE International Conference on.

[4] Tahir Z, ; Burhanuddin, M.A ; Ahmad,A.R ; Halawani, S.M; Arif,F Industrial and Information System (ICIIS), 2009 International Conference on

[5] "SolidWorks 2006 training manual", Solidworks Essentials Parts and Assemblies, Solidworks Corporation, 300 Baker Avenue, Concord, Massachusetts 01742 USA

[6] R. M. Bothom, "Why Choose SolidWorks 3D CAD For Mechanical Product Design & Drawings?."

[7] R. C. Hibbler, "Mechanics of material", Seventh Edition, SI Conversion by S. C. FAN Nanyang Technological University.