Modification Design Of Melanger Machine With Reverse Engineering Method And VDI 2221

Kezia Natalia Santoso[1], Frans Jusuf Daywin[2], Adianto[3], Lina Gozali[4], Carla Olyvia Doaly[5], Agustinus Purna Irawan[6]
[1.2.3.4.5].Industrial Engineering Department
[6]Mechanical Engineering Department
Universitas Tarumanagara
West Jakarta 11440 Jakarta, Indonesia
E-mail: keznatalias1998@gmail.com[1], fransjusuf42@gmail.com[2], adianto@ft.untar.ac.id[3], linag@ft.untar.ac.id[4], carlaol@ft.untar.ac.id[5]

Abstract

This study aims to design a melanger machine, which is an alternative machine for processing semi-finished chocolate into ready-to-consume chocolate. The chocolate processing itself is divided into 3 processes, namely the mixing process, the refining process and the conching process. The melangeur machine is an alternative machine that can be used for all three processes. However, the price offered is quite expensive for a capacity that is not too large and it is rare to find similar products made in Indonesia. There are 2 different types of machines used for benchmarking, namely the Premier Wonder Chocolate Melanger Refiner and Elektra 11 Chocolate Melanger. The two machines will be compared in terms of specifications, advantages and disadvantages. The method used in this research is the benchmarking method, the reverse engineering method and the engineering design method. The final result of this engine modification design has increased the capacity of the chocolate by 67%, namely a total of 5 L with the same quality as the existing machines.

Keywords: *Melanger Machine, Benchmarking, Reverse Engineering, VDI 2221*

1. Introduction

Indonesia is the third largest cocoa producer in the world after Ivory Coast and Ghana. Even though it ranks third, it turns out that BPS 2018 notes that the largest cocoa product is semi-finished products from cocoa. These semi-finished cocoa products should be further processed into cocoa products that are ready for consumption and have a higher selling value. There are 3 further processes to process chocolate into ready-to-consume chocolate, namely the mixing process, the refining process and the conching process. Initially, to be able to carry out these 3 processes 2 different machines were needed. However, the development of technology, the three processes can be done by just one machine, namely the melanger machine. Until now, no similar machine has been produced in Indonesia. The selling price of the machine for each process offered is also quite expensive. Therefore, this study will discuss the redesign of the melanger machine so that a machine design that has a larger capacity is obtained but still has the same quality. The methods used in this research are the benchmarking method, the reverse engineering method and the VDI 2221 method.

2. Research Methodology

The research methodology can be seen in Figure 1.

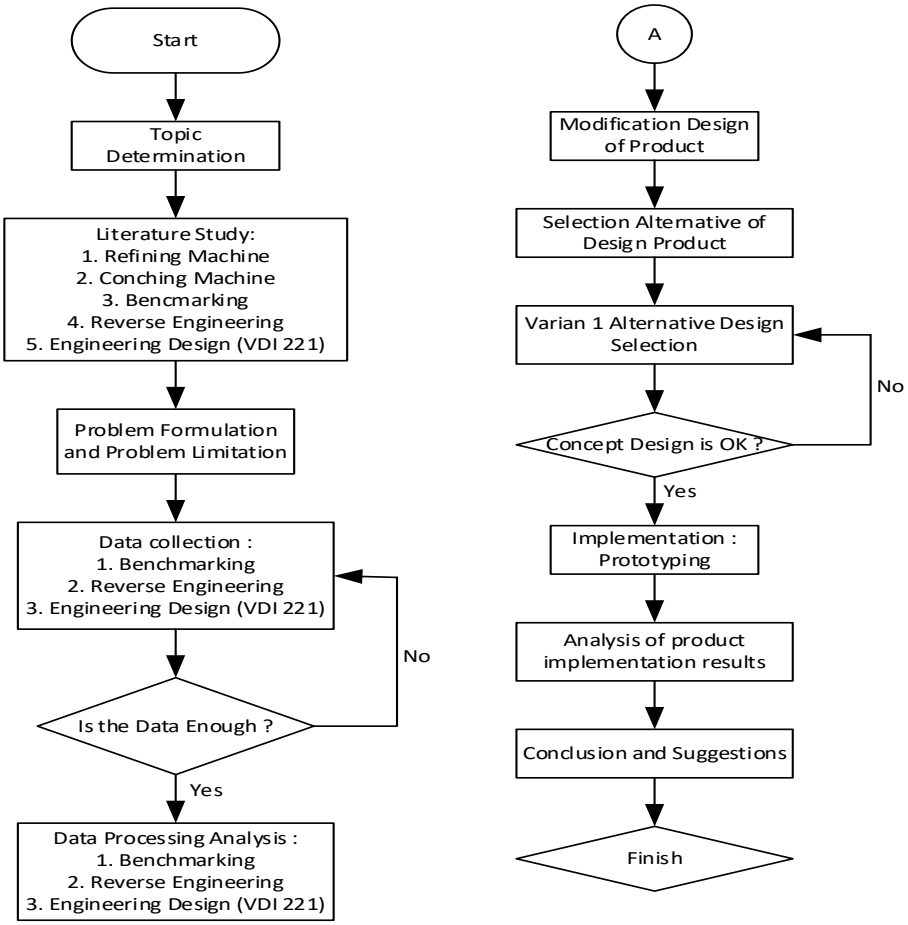


Figure 1 Flowchart Research Methodology of Modification Design of Melanger Machine

2.1 Benchmarking

In this method, there are 2 types of machines that will be used as a reference, namely the 8 lbs premier wonder chocolate melanger refiner machine and the Spectra 11 chocolate melanger machine. The comparison table of the 2 machines can be seen in Table 1.

Table 1 Benchmarking

No.	Differentiator	Premier Wonder Chocolate Melanger Refiner Machine 8 lbs	Spectra 11 Chocolate Melanger Machine
1.	Model		
2.	Price	$ 440	$1200
3.	Capacity	8 lbs	8 – 9 lbs
4.	Material	Outer body layer: Stainless steel Collection drum: Stainless steel	Outer body layer: Stainless steel and plastic Collection drum: Stainless steel
		Grinding wheel: Genuine high quality granite stone Support: Plastic and stainless steel	Grinding wheel: Genuine high quality granite stone Support: Plastic and stainless steel
5.	Dimensions	Machine height: 41 cm Machine diameter: 21 cm Wheel diameter: 10.5 cm Wheel thickness: 3.5 cm	Machine height: 11 inch Machine width: 12 inch Machine length: 20 inch
6.	Power	185 W, 220V/50Hz	220V/50Hz
7.	Switch button	Manual	Manual

No.	Differentiator	Premier Wonder Chocolate Melanger Refiner Machine 8 lbs	Spectra 11 Chocolate Melanger Machine
8.	Machine Weight	11,5 kg	21 kg

2.2 Reverse Engineering Method

Of the 2 types of machines in the benchmarking method, the premiere 8 lbs wonder chocolate melanger refiner machine made in USA is the machine chosen to be processed by reverse engineering and design engineering methods. This is because the specifications are better and the price is cheaper than other machines. This method is divided into 4 stages, including:

1. Disassembly product
2. Assembly product
3. Designing New Designs
4. Prototype

Stage 1 and 2 are included in the reverse engineering method, while stages 3 and 4 are included in the design engineering method or VDI 2221. The following is an explanation of the stages of the melanger machine reverse engineering method.

2.2.1 Disassembly Product

In this disassembly process, it can be seen that the machine is divided into 5 major parts, namely the motor housing, the drum, the supports from the wheels and stirrers, the grinding wheel and the drum cover. The following is a picture of the machine as a whole.

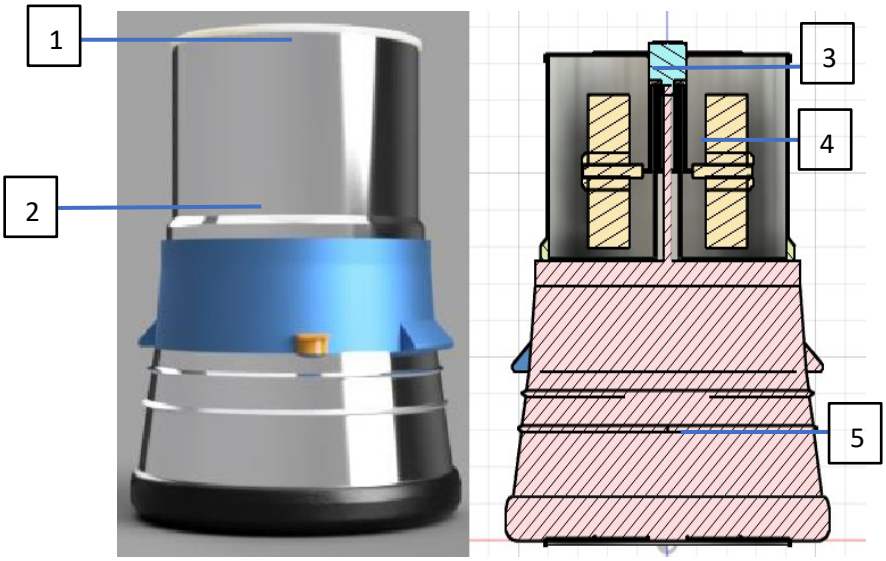
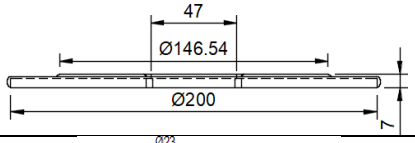
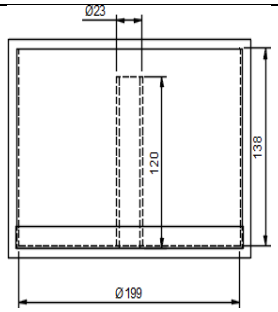
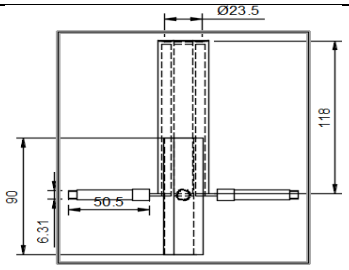
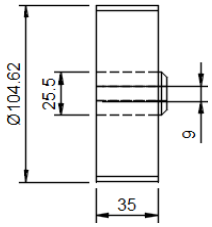
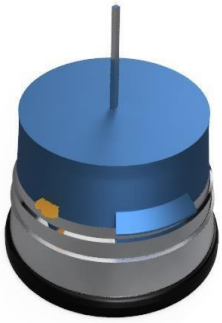
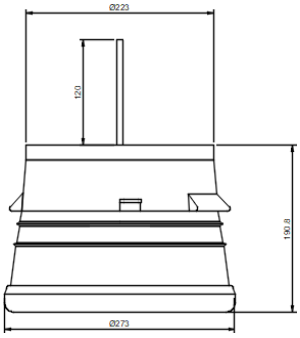


Figure 2 Melanger Machine

Description of engine components 1 - 5 in the image above can be seen in Table 2 below

Table 2 Engine Components and Specifications Before Modification

No	Name	Component Picture	Component Specifications (in mm)
1.	Drum Cover		
2.	Drum		
3.	Mixer support		
4.	Grinding wheel		
5.	Motor		

To clarify the explanation of the components that make up the machine, here is a Bill of Material (BOM) from the machine above which can be seen in Figure 3.

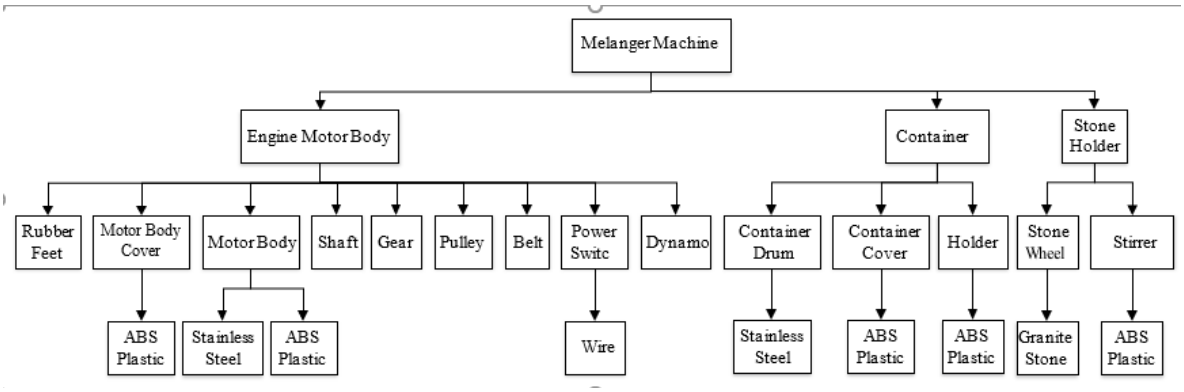


Figure 3 Bill of Material

2.2.2. Assembly Product

After knowing the components of the machine, the machine will be installed as before to get the Operation Process Chart (OPC) from the machine. OPC can be seen in Figure 4

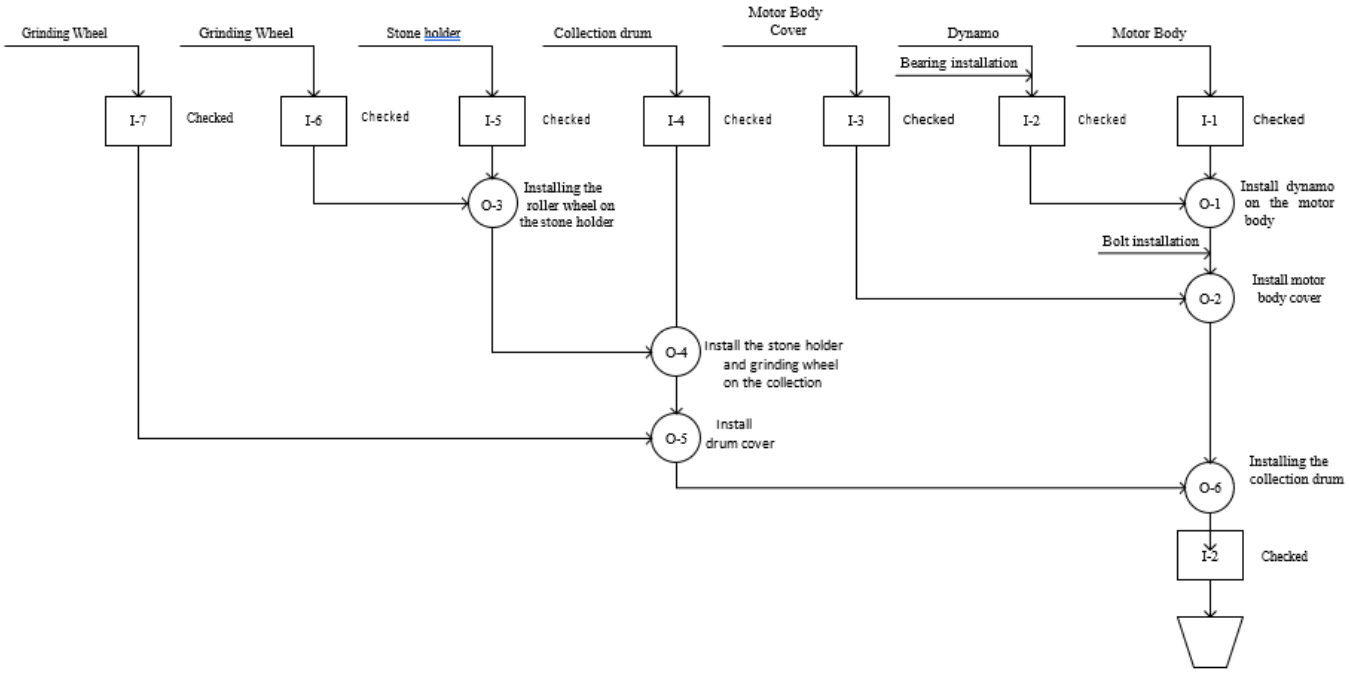


Figure 4 Operation Process Chart

2.3 Engineering Design Method (VDI 2221)

The VDI 2221 method is used to help determine the best machine modification design concept. So that the resulting design is in line with expectations, it is necessary to process the description of tasks that will be included in the will list as a limitation. The following are tasks in designing a new design.

2.4 Tools can be operated easily.

2.5 The tool can process chocolate until it reaches the expected size.

2.6 The tools are made from materials that are safe for food and easy to find.

2.7 The tool is easy to assemble and assemble.

2.8 Safe tool when used.

2.9 The tool is operated by 1 operator.

2.10 Simple tool model.

2.11 Does not require special skills in using this tool.

2.12 Tools have a simple way of working.

Once this list has been obtained, a wish-list can be created. In this table of wishes, there are 2 answer options for each parameter, namely demand (D) and wishes (W) / hope. The following is a table of wills.

Table 3 Wish List

Parameter	Specification	D / W
Function	Process the chocolate until it reaches the desired size either in the form of nuts or butter	D
Geometry	Equipment weight does not exceed 20 kg	W
	Chocolate processing capacity is 5 L	D
Kinematics	The power required is 200 W	W
	Machines can be assembled and assembled easily	W
Material	The tools are made of stainless steel and food-grade plastic	D
	200 Watt dynamo motor	D
	Electrical control	D
	Tool making materials can be obtained easily	D
Making	Using standard components	D
	Simple construction and easy to work with	D
Assembly	The tool is easy to assemble and assemble	D
	The component assembly system is easy to understand	W
Operation	Tools can be operated easily	D
	Safe tool when used	D
	The tool is operated by 1 operator	D
	Does not require special skills in operating this tool	W
Care	Maintenance is relatively easy and cheap	D
	Easy to repair in case of damage	W
	The process of cleaning the tool is easy	D
Marketing	For small and household scale production	W
Price	Affordable for the lower middle class	W

After obtaining this wish list, new alternative concepts can be compiled.

Table 4 Principles of Sub-Functions and Combination of Principles of Variant Sub-Function Solutions

No.	Sub Function/Solution Principle	Information	1	2	3
1	Drum	Made	Stainless stell food grade	Plastic food grade	
2	Motor	Buy	150 W	200 W	
3	Grinding Wheel Diameter	Made	10 cm	15 cm	20 cm
4	Drum Diameter	Made	20 cm	25 cm	
5	Drum Height	Made	15 cm	20 cm	
6	Drum Movement	Made	Static	Dinamis	
7	Grinding Wheel Movement	Made	`Static	Dinamis	
8	Switch Button	Buy	Manual	Otomatis	

From the results of the combination above, it is possible to determine the selected combination of concepts, including:

a. V1: 1.1 - 2.2 - 3.3 - 4.1 - 5.2 - 6.1 - 7.2 - 8.1

b. V2: 1.1 - 2.1 - 3.2 - 4.2 - 5.2 - 6.1 - 7.2 - 8.2

c. V3: 1.2 - 2.1 - 3.1 - 4.1 - 5.1 - 6.2 - 7.1 - 8.1

After obtaining 3 alternative choices of the machine to be modified, these three alternatives will be selected further using a selection diagram. From this selection diagram, one best alternative will be obtained which will be used as the basis for making a new design. In this selection diagram, there are 6 criteria that can help in determining

the best variant to be used as a new design. These criteria include:

1. In accordance with the overall function
2. According to the wish list
3. In principle, this can be realized
4. Within the limits of production costs
5. In accordance with the wishes of the maker
6. Knowledge of concepts is sufficient

Table 5 Selection Diagram

INDUSTRIAL ENGINEERING	**Table of Selection of Variations of Solutions for chocolate mixing**

Selection criteria
+ Yes
- Not
? Lack of information
! Check Specifications

Decision variant solution mark (SV)
+ The solution sought
- delete the solution
? Gather information
! see specs

variant of the solution principle

In accordance with the overall function
According to the wish list
Within the production cost limit
Knowledge of concepts is sufficient
As per the designer wishes
Meets security requirements

	A	B	C	D	F	G	Information	SV
V1	+	+	+	+	+	+	Appropriate	+
V2	+	-	-	+	-	+	Inappropriate	-
V3	+	-	+	-	-	-	Inappropriate	-

From the diagram above, it can be concluded that V1 was chosen as the best variant to be used in designing the new design. The creation of this new design was assisted by the fusion application. The implementation results of the selected variants can be seen in Figure 5.

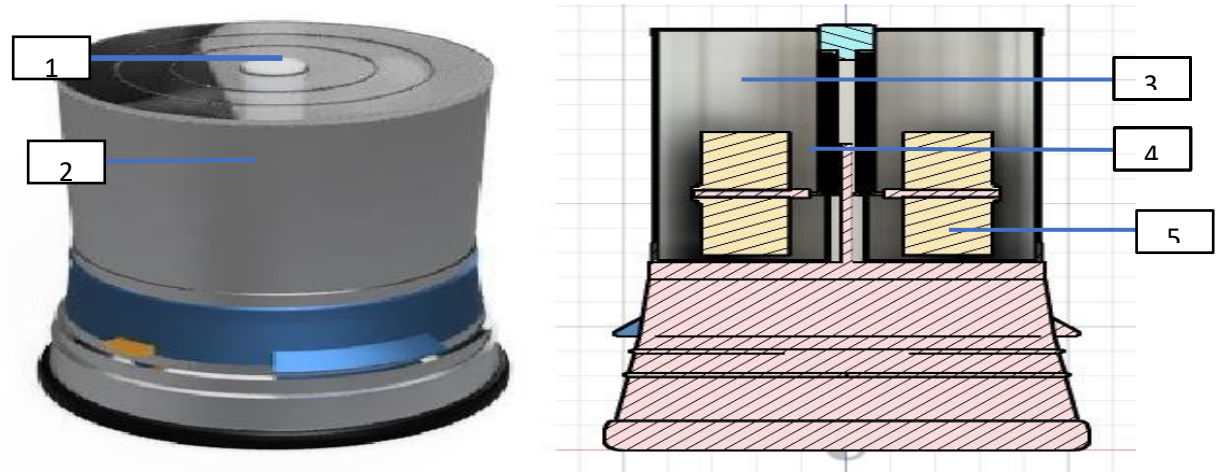
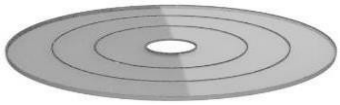
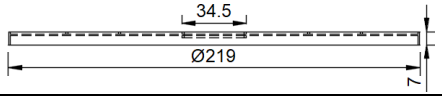
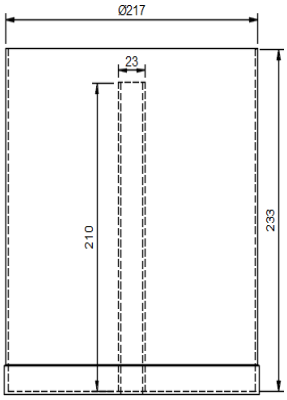
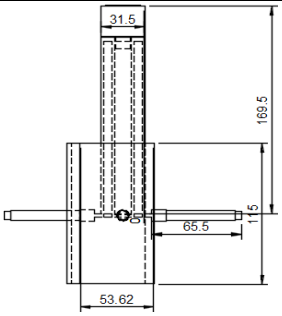
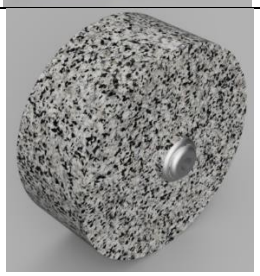
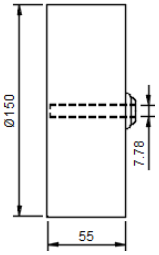
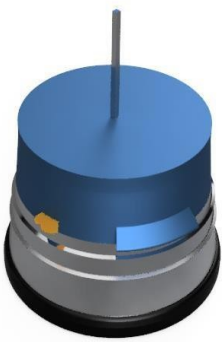
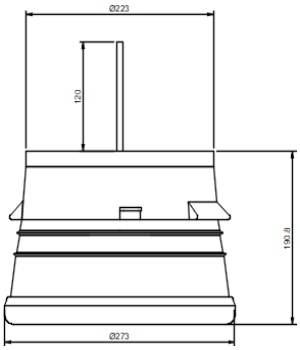


Figure 5 Modified Melanger Machine (Descripstion number of component presented in Table 4)

Table 4 Components and Specifications After Modification

No.	Nama	Gambar Komponen	Spesifikasi Komponen (dalam mm)
1.	Drum cover		
2.	Drum		
3.	Mixer support		
4.	Grinding wheel		
5.	Motor		

After prototyping the chocolate mixing machine using benchmarking, reverse engineering and VDI 2221 methods, a machine modification design was obtained that was better than before. The design results of this machine have a drum diameter and height respectively 217 mm and 233 mm, thickness and diameter of the grinding wheel 55 mm and 150 mm respectively, and a motor power of 200 W. The increase in motor power is due to the dimensions of the storage drum and roller wheel. larger, so that the engine performance remains the same as before. The disadvantage of this machine is that it consumes more power because the resulting capacity is also more.

3. Implementation And Analysis Results Modification Of Melanger Machines

From the design results of this chocolate mixing machine, several conclusions were obtained, including:

1. The use of methods in machine design:
   a. Benchmarking Method
      The machines used as benchmarks for benchmarking are the premiere 8 lbs wonder chocolate melanger refiner and 11 spectra chocolate melanger machines.
   b. Reverse engineering method
      The machine chosen as the machine to be dismantled is the premier 8 lbs refiner machine because of its simple model and capacity that can still be expanded. However, in the development process, it still uses 2 other machines as benchmarks. This machine is divided into 5 parts, namely drum cover, storage drum, wheel support and mixer, grinding wheel and motor.
   c. Engineering Method (VDI 2221)
      In this method 3 alternatives are determined based on the wish list and the selected one is variant 1.
2. Engine design results
   a. Machine specifications:
      1) The drum has a diameter of 217 mm and a height of 233 mm
      2) The drum cover has a diameter of 219 mm and a height of 7 mm
      3) The wheel supports and stirrers are 169.5 mm high, 31.5 mm diameter and 162.5 mm wide.
      4) The roller wheel is 150 mm in diameter and 55 mm thick
      5) The motor case has a diameter of 273 mm and a height of 191 mm.
   b. Machine advantages and disadvantages:
      The advantage of this machine is that the resulting chocolate capacity is larger but still balanced with a good engine performance because it has a 200 W motor. However, by using a 200 W motor, the power consumption in operating this machine is also more than the previous engine.

References

Daywin, F. J., Gozali, L., Widodo, L., Doaly, C. O., & Ross, M. W. H. (2020, July). Community Service Report: Designing The Ergonomic Roasting Machine For Coffee Seed With Additional Electrical Motor At Seduh Kopi Coffee Shop. In IOP Conference Series: Materials Science and Engineering (Vol. 852, No. 1, p. 012091). IOP Publishing.

Daywin, F. J., Utama, D. W., Kosasih, W., & Wiliam, K. (2019). PERANCANGAN MESIN 3D PRINTER DENGAN METODE REVERSE ENGINEERING (Studi Kasus di Laboratorium Mekatronika dan Robotics Universitas Tarumanagara). Jurnal Ilmiah Teknik Industri, 7(2).

Daywin, F. J., Doaly, C. O., Gozali, L., Kosasih, W., & Taek, G. (2020, December). Improving the Quality of Coffee Shops in Jabodetabek Area by Application and Modification of Coffee Roaster Machine Capacity 400-600 Gram Coffee Beans Using the Reverse Engineering and Engineering Design Method. In IOP Conference Series: Materials Science and Engineering (Vol. 1007, No. 1, p. 012132). IOP Publishing.

Daywin, F. J., Gozali, L., Doaly, C. O., Salim, A., Ibrahim, A., Fatima, M., & Inggrid, P. (2020, December). The Design of Coffee Grinder Machine Knockdown With 8 Levels of Coarseness. In IOP Conference Series: Materials Science and Engineering (Vol. 1007, No. 1, p. 012089). IOP PublishingGanang Fitrianto Wibowo, 2016. "Perancangan Ulang Produk PTI 1 Menggunakan Metode Reverse Engineering," Skripsi, Universitas Muhammadiyah Surakarta, Jakarta,Indonesia.

Muhammad Ilham Irsyad, Frans Jusuf Daywin dan Lamto Widodo, 2020. "Modifikasi Mesin Grinder Kopi Dengan Menggunakan Metode Reverse Engineering dan Rekayasa Desain," Jurnal Teknik Industri (2020).

Rahardian Naufal Hadinugroho, 2018. "Perancangan Ulang Penghapus Whiteboard Menggunakan Metode Reverse Engineering," Skripsi, Universitas Islam Indonesia, Yogyakarta, Indonesia.

Rifaldi Ahmad Fauzan, 2017. "Perancangan Ulang Alat Peniris Makanan Dengan Menggunakan Metode Reverse Engineering," Skripsi, Universitas Muhammadiyah Surakarta, Surakarta, Indonesia.

Rifki Dermawan, 2019. "Pengembangan Mesin Pengupas Kulit Kopi Menggunakan Metode VDI 2221," Jurnal Institut Sains dan Teknologi Nasional.

Triyono dan Himawan Hadi Sutrisno. 2019. "Implementation of VDI 2221 Method for Firefighter Motorcycle Design," *International Journal of Innovative Technology and Exploring Engineering* (IJITEE), vol.6.

Wisnu Pradana J., Dyah Rachmawati L. dan Sutrisno, 2018. "Analisis Ekonomi dan Perancangan Alat Pengupas Kulit Ari Kacang Hijau Dengan Metode VDI 2221," Jurnal OPSI, vol.11, no. 2.

Kezia Natalia Santoso was born on December 1, 1998 in Surabaya. She is the first of 3 siblings. She is a graduate from Stella Maris Catholic High School majoring in Science. The choice of this major was the reason she chose to major in industrial engineering. Now she is studying at Tarumagara University, Jakarta and is in his final semester. During school, she was always included in the top 3 in academic achievement both in junior high and high school. She also joined organizations in junior high, high school and college. Not only that, she has participated in many school activities, such as dancing, badminton, journalism, scouting, cooking class, decoration and theater. Some of the achievements she has made are 1st place in journalism competitions and 1st place in theater competitions.

Frans Jusuf Daywin was born in Makasar, Indonesia on 24th November 1942. is a lecturer in the Department of Agricultural Engineering at Faculty of Agricultural Technology Bogor Agricultural University since 1964 conducted teaching, research, and extension work in the field of farm power and machinery and become a professor in Internal Combustion Engine and Farm Power directing and supervising undergraduate and graduate students thesis and dissertation and retired as a professor in 2007. In 1994 up to present as a professor in Internal Combustion Engine and Farm Power at Mechanical Engineering Program Study and Industrial Engineering Program Study Universitas Tarumanagara, directing and supervising undergraduate student's theses in Agricultural Engineering and Food Engineering Desain. In 2016 up to present teaching undergraduate courses of the introduction of concept technology, research methodology, and seminar, writing a scientific paper and scientific communication, and directing and supervising undergraduate student's theses in Industrial Engineering Program Study at the Faculty of Engineering Universitas Tarumanagara. He got his Ir degree in Agricultural Engineering, Bogor Agricultural University Indonesia in 1966, and finished the Master of Science in Agricultural Engineering at the University of Philippines, Los Banos, the Philippines 1981, and got the Doctor in Agricultural Engineering, Bogor Agricultural University Indonesia in 1991. He joined 4-month farm machinery training at ISEKI CO, AOTS, Japan in 1969 and 14 days agricultural engineering training at IRRI, Los Banos the Philippines, in March 1980. He received the honors "SATYA LANCANA KARYA SATYA XXX TAHUN" from the President of the Republic of Indonesia, April 22nd, 2006, and received appreciation as Team Jury from the Government of Indonesia Minister of Industry in Industry Start-Up 2008. He did several research and survey in the field of farm machinery, farm mechanization, agricultural engineering feasibility study in-field performance and cost analysis, land clearing and soil preparation in secondary forest and alang-alang field farm 1966 up to 1998. Up till now he is still doing research in designing food processing engineering in agriculture products. Up to the present he already elaborated as a conceptor of about 20 Indonesia National Standard (SNI) in the field of machinery and equipment. He joins the Professional Societies as a member: Indonesia Society of Agricultural Engineers (PERTETA); Indonesia Society of Engineers (PII); member of BKM-PII, and member of Majelis Penilai Insinyur Profesional BKM-PII.

Adianto was born in Semarang, Indonesia on 29th April, 1955. Adianto completed his "Sarjana Fisika Degree" in 1982 from the Physics Department of the Faculty of Sciences and Mathematics, Gadjah Mada University, Yogyakarta. In 1978 when he got his Bachelor of Science in Physics (B.Sc.) he started working as a Staff of "Field of Nuclear Physics Laboratory", "Pure Materials Research Center and Instrumentation Yogyakarta", Atomic Energy Agency (BATAN). In 1986 to 1993 he received a scholarship from the Ministry of Research and Technology of the Republic of Indonesia to continue his studies in England at the Department of Electronic and Electrical Engineering, University of Salford, England. He received his M.Sc. degree in the field of Computer Instrumentation in 1988 and a Ph.D. degree in the field of Material Science in 1993. He returned back to Indonesia, then in 1994 he moved to Jakarta and appointed as a "Head of Engineering and Advanced Technology", (Echelon IIIA) at "Nuclear Science and Technology Empowerment Center", Atomic Energy Agency, BATAN, Jakarta. In 2000 he was assigned to the Ministry of Research and Technology to serve as Assistant Deputy fpr Science Accreditation and Development Center (Echelon IIA) and in 2005 he was assigned as Assistant Director for Academic Affairs, to Organize Graduate Research in PUSPIPTEK Serpong. In 2008, he took early retirement as a Governmen Official to take a full time lecturer at Universitas Tarumanagara, Jakarta. Adianto started his profession as a lecturer in the Department of Mechanical Engineering, Faculty of Engineering, Tarumanagara University and the Department of Mechanical Engineering, Faculty of Industrial Technology, Trisakti University of Indonesia from 1994 until now. He has taught mathematics, mechatronics, English and physics, but Physics is the main subject he teaches. As a full time lecturer at Universitas tarumanagara, in 2012 he was appointed as a Vice Dean for Academic and Student Affairs, Faculty of Engineering, and in 2016 up to now, he was appointed as a Director for Student Affairs, Universitas Tarumangara. During his profession as a researcher at the Atomic Energy Agency, the Ministry of Research and Technology and as a lecturer at Tarumanagara University, Adianto as an Associate Professor has published scientific and research papers of more than 35 titles at home and abroad.

Lina Gozali is a lecturer at the Industrial Engineering Department of Universitas Tarumangara since 2006 and a freelance lecturer at Universitas Trisakti since 1995. She graduated with her Bachelor's degree at Trisakti University, Jakarta - Indonesia, then she got her Master's Degree at STIE IBII, Jakarta – Indonesia, and she recently got her Ph.D. at Universiti Teknologi Malaysia, Kuala Lumpur – Malaysia in 2018. Her apprentice college experience was in paper industry at Kertas Bekasi Teguh, shoes industry at PT Jaya Harapan Barutama, and automotive chain drive industry at Federal Superior Chain Manufacturing. She teaches Production System and Supply Chain Management Subjects. She did a research about Indonesian Business Incubator for her Ph.D. She has written almost 70 publications since 2008 in the Industrial Engineering research sector, such as Production Scheduling, Plant Layout, Maintenance, Line Balancing, Supply Chain Management, Production Planning, and Inventory Control. She had worked at PT. Astra Otoparts Tbk before she became a lecturer.

Carla Olyvia Doaly is a lecturer in the Industrial Engineering Department at Universitas Tarumanagara graduated with my bachelor's degree from Institut Teknologi Nasional Malang, which study the Industrial Engineering program, then continued my Master Degree at Institut Teknologi Bandung majoring in Industrial engineering and management and a special field of Enterprise Engineering. I am very interested in studying industrial engineering by doing research related to System Design and Engineering, Supply Chain Management, Operations Research and Analysis, Information System Management, Occupational Health and Safety, Facilities Engineering, Quality and Reliability Engineering.

Agustinus Purna Irawan was born in Mataram - Musirawas, South Sumatera, August 28, 1971. Is a Lecturer at Universitas Tarumanagara and has served as Chancellor since 2016 until now. Obtained a Bachelor of Mechanical Engineering from the Faculty of Engineering, Gadjah Mada University (1995), a Masters in Mechanical Engineering from the Faculty of Engineering, University of Indonesia (2003), a Doctor of Mechanical Engineering from the Faculty of Engineering, University of Indonesia (2011), Professional Engineer (Ir) Mechanical Engineering from the Faculty of Engineering, Gadjah Mada University (2019) and Professor of Mechanical Engineering from the Ministry of Education and Culture (2014). The fields of scientific research and publication include: Product Design and Development, Strength of Materials, Natural Fiber Composites with implementation in the field of prosthesis and automotive components. Obtaining Research and Community Service Grants for Higher Education / Research and Technology BRIN / Untar / Others ≥ 100 titles; Patents: 7 and still in process: 4; Copyright: 9 books; Textbooks: 6 books; Book Chapter: 2 chapters; Scientific articles ≥ 100 titles. Obtained a Professional Certificate, namely the Educator Certificate, the Intermediate Professional Engineer Certificate (IPM) of the Indonesian Engineers Association (BKM PII) Vocational Engineer Association (BKM PII), and the ASEAN Engineer Certificate (ASEAN Eng.) From the ASEAN Federation Engineering Organizations (AFEO). He is active in education, various scientific activities, the world of business, professional associations, and various social activities. Received several awards: Best Graduate S2 UI GPA 4.00 cum laude (2003); First best Lecturer Kopertis Region III DKI Jakarta (2011); Best Presentation at the Seminar on Research Results of the Centralized Program, PUPT Dikti (2014); Honorary Member of The ASEAN Federation of Engineering Organizations, AFEO (2018); Best PTS Chancellor for the Academic Leader Award Program (2019).