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Preliminary Stage Development of Portable Steel Chamfering Machine

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ABSTRACT

After a part has been machined, a finishing operation is usually required to remove excess material or burrs to bring the part within tolerance of the specification. The finishing operation is a critical step in the manufacturing of parts made with hard metals. The primary finishing processes are deburring and chamfering. In the past and still presently, the finishing step has been performed manually at a burr bench with a hand held spindle grinder. As expected, there are problems with the manual finishing of parts. Manual finishing is inconsistent and inaccurate. If a part is damaged beyond repair, thousands of dollars spent on the initial machining processes can be lost. Manual finishing is also time-consuming. (Engel et. al. 1992). The development is include the study of the process and the problem occur and the suggestion improvement by design of the new system (portable). The development also considered the material, mechanism and ergonomics. Safety and the efficiency of the process in term of time of the product will be determined at the next stage by using the CAE software and experimental approach.

Keywords: *Development, design, chamfer, portable*

Introduction

In metal chamfering process, a sharp edge or a corner of a machined part can any time be eliminated and the life of an insert will likely be extended. When a chamfer is put on an insert, it will make a dramatic improvement in performance, but the chamfer will leave some semi-sharp corners. Meantime, it will help to add a slight hone to each semi-sharp corner where it will be able to get the maximum benefit from a chamfer. This will be of significant value in extending tool life. (<http://www.metalwebnews.com>)

Chamfering machines

Chamfer machine is the machine which performs rounding and chamfering process of the edges of small parts for steel structure and bridge applications. It equipped with continuous four-surface copy profiling and tracking functions with full automation, unmanned and continuous operations with improved productivity can be performed. It has been used for angle cutting or gear tooth cutting in different size and shapes according to the requirement of the customers and is useful in many Industrial sectors. (<http://www.easy2source.com/products/>)

Different types of chamfering machines like multi function chamfering machine, double end chamfering machine, mini function chamfering machine, gear tooth chamfering machines, semi-automatic and automatic chamfering machine, bolt chamfering machine and many more are available in the market suiting different requirement. Chamfer machine is available with significant features like powered stacker, chamfer dimension setting, metal hood, torque limiter, dust connection points, one operator for entire operations etc. Chamfering machines are manufactured by host of countries such as India and the wide range of chamfering machines in different types and sizes. (<http://www.easy2source.com/products/>)

In addition to depth and width of cut, those have the greatest effect on productivity and forces acting upon the cutter, machine, workpiece, and fixture in milling are the feed rate and cutting speed. These factors determine the stock removal rate, which provides the basis for the power and force calculations. The feed rate for milling cutters is normally expressed in inches per minute (ipm) or millimeters per minute (mm/min) and is generally established by selecting an appropriate feed per tooth (fpt), blade or insert. It should be noted that there is a minimum chip thickness, which varies for different materials, which must be maintained in order to produce good cutter life during selecting feed per tooth. (Goetsch 1991).

Two basic simultaneous motions need in machining operations; one is motion creates cutting speed and the other is the feed motion. The cutting speed is the rate at which the cutting edge of the tool moves past the workpiece

or the rate at which the workpiece moves past the tool. English units for cutting speed are feet per minute (fpm), which is seldom, called surface feet per minute (sfpm or sfm). Metric units are meters per minute (m/min). Higher cutting speed shortens the time required to complete the machining cut but it can greatly shorten the useful life of the cutting tool. When the cutting speeds are too low tend to tear instead of cut, it will distort the grain structure at the surface of the workpiece and produce rough finishes. Then it also can cause early failure of a machined part. Speeds should be as high as can be maintained without causing the tool to wear out too quickly. (Bruce et al. 1998).

Methodology

Engineering design is the process of devising a system, component, or process to meet desired needs. It is a decision making process (often iterative), in which the basic sciences, mathematics, and engineering sciences are applied to convert resources optimally to meet a stated objective. Design of the portable type chamfer machine is based on suitable methodology. Based on the Reverse Engineering concept, the main factors discussed in Engineering Design methodology are such as below (Dieter 2000):













- i. Design issues which are come from the results of the literature research and design of portable type chamfer machine which has been patterned.
- ii. Prepare proposal for the design.
- iii. Design the suitable shape of the chamfer machine based on the chamfer machines which available in the market.
- iv. Go through the fabrication, assemble and modification the components of chamfer machines.
- v. Testing and redo the modification.

Early Stage of Development

Decide the Selection of Suitable Design

In order to make selection based on the concept of designing the portable type chamfer machine, one analysis have been implemented follow the identified procedures where it consists of analysis the specification of the design of chamfer machines which available in the market. Ideas regarding the selection of design have been shown in the Morphology Chart. The explanations in details regarding the design have been explained in the literature research.

Before the design process can be implemented, the basic specifications have been placed as the limit for the design because it is necessary to conclude the information gathered through the research and explain the details which are needed as the guideline for designing the portable type chamfer machine. Figure 1 shows the Morphology Chart for draft components of Portable Type Chamfer Machine.

IDEA	1	2	3	4
A. Type Of Motor	AC Motor 	Stepper Motor 	DC Motor 	Single Face Motor 
B. Cutter	Dual Side Chamfer Tool 	Chamfer Mill-With Removable Cutter Plate 	Chamfer Mill-Carbide Tipped 	Grinder Wheel 
C. Power Transmission	Sprocket And Chain 	Gear 	Pulley And Belt 	Direct From Motor Shaft 
D. Cooling Fan	With Single Cooling Fan	Without Cooling Fan	With Double Cooling Fan	
E. Stand	With Stand	Without Stand	With Roller Stand	With Adjustable Roller Stand
F. Handle	90 degree Handle	180 degree Handle	Without Handle	Adjustable Handle

↓
↓
↓
IDEA A
IDEA B
IDEA C

Fig. 1: Morphology Chart for Draft Components of Portable type Chamfer Machine

Combining the Concepts

All ideas regarding chamfer machine which have been produced through the Morphology Chart Method are in minor solving or sub idea and are needed to be combined in order to produce one designing concept. One designing concept can be produced through combining sub ideas using the Method of Idea A, Idea B and Idea C. Summary of idea combinations for creating the concept are such as below:

- Idea A: A1 – B2 – C2 – D1 – E3 – F1
- Idea B: A4 – B4 – C4 – D2 – E1 – F2
- Idea C: A3 – B3 – C1 – D3 – E4 – F4

Analyze the Suitable Idea

There are full with designing concepts where it consists of Idea A, Idea B and Idea C. The further stage of this will be analyzed for choosing the suitable concept for fulfills the objective of design which must be implemented. During the analyzing process, the main aspect will be identifying the criteria and method of the judgment. The judging method which has been used is Matrix Evaluation Method (Dieter 2000).

Matrix Evaluation Method is the method where it will list out the strength and weaknesses of each concept that have been implemented. Strength and weaknesses of each concept can be revalued again and can be used to modify

the current the concept or producing the new concept which is more practical. It can be implemented through identify the best characteristics of each idea. Positive Mark (+) in the Matrix Evaluation Table shows the strength point for selecting criteria and the Negative Mark (-) shows the weakness point for selecting criteria. Reference Concept is referring to the characteristics of existing designs which to be fulfilled or design the portable type chamfer machines that consists of more practical characteristics which are needed compared to existing design of chamfer machines in the market. Reference Concept has been labeled as Datum. Matrix Evaluation Method has been shown in Table 1. (Dieter 2000).

Table 1: Table of Matrix Evaluation Method used for Designing Portable Type Chamfer Machine

No.	Evaluation Criteria	Importance Of Criteria	Idea A	Idea B	Idea C
1.	Easy to use	5	+	-	+
2.	Structure of the design	9	+	+	-
3.	Size	8	+	+	-
4.	Weight	8	+	+	-
5.	Horsepower	5	-	+	+
6.	Tool life	7	-	+	+
7.	Product safety	8	+	-	+
8.	Ergonomics	6	+	+	+
9.	Less noisy sound	5	+	-	-
10.	Power transmission capability	5	+	-	+
11.	Smoothness of operation	5	+	-	-
12.	Low maintenance required	6	-	-	+
13.	Cost factor	4	+	-	+
	Total (+)		10	6	8
	Total (-)		3	7	5
	Overall Total		7	-1	3
	Actual Total		45	5	11

The Best Idea

Idea A has been selected as the early stage of the design of portable type chamfer machine which to be produced because it is able to fulfill all the criteria which are needed. After the Matrix Evaluation Method has been implemented, Idea A gives the highest actual total value compare to Idea B or C. The selected concept must be implemented and be modified in more details in order to produce the final design of the portable type chamfer machine.

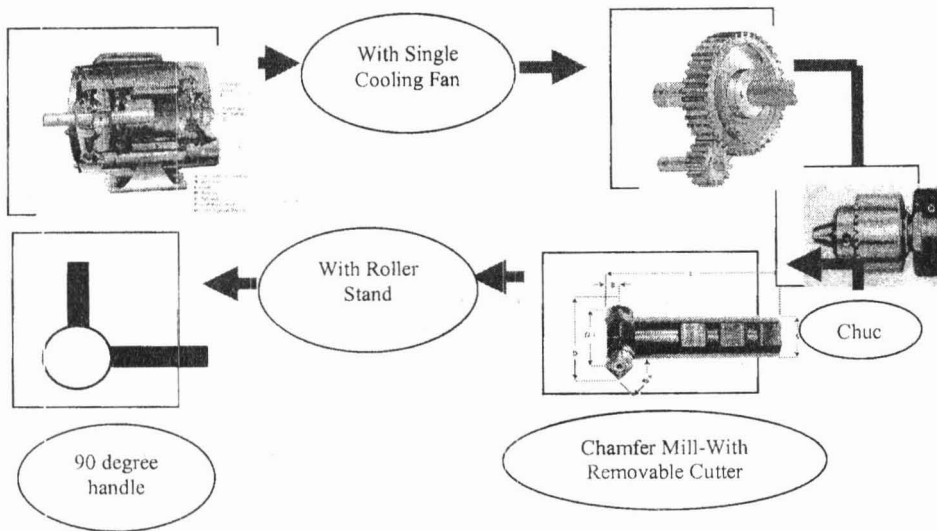


Fig. 2: Concept of Idea to be Implemented

Design Evaluations

Human aspect plays an important role in engineering design because the comfort and safety of the user are the judging factors for the success of the product. For example, the weight of the portable type chamfer machine must be suitable and comfortable for the majority of the user. The size of the portable type chamfer machine must be suitable with the height of the majority of the users. This factor must be taken into consideration mainly in deciding the size and weight of the product. Human factors consist of the following fields:

Physiology, Ergonomics, Anthropometrics

Physiology is the study regarding the functions and activities of living organisms and their parts, including all physical and chemical processes. The factors that will be taken into consideration while designing the portable type chamfer machine are such as efficiency of human physical response, eyesight ability, ability to identify colors, physical ability, level of energetic, muscle ability, and sensitivity of hearing organ. The size of the new portable chamfer machine is designed as small as possible because, by considering the physical ability of the users, the smaller the machine will be easier for the user to handle, and the whole chamfering process can be done more smoothly. By using the chamfer mill, it will be able to reduce noisy sound so the sensitivity of the user's hearing organ can be maintained at the highest level.

Ergonomics is a study that investigates how humans use the environment and the design of environments which enable users to use the environment easily and comfortably. User safety is a main aspect in ergonomics. Designers should be aware that users may wrongly use the portable type chamfer machine, so ways of avoiding errors should be taken into consideration. Warning signs should be given at the level which is dangerous.

Anthropometric is a study and recording of the measurement of physical properties and body part dimensions of the human body such as hand effective distance and suitable weight that people are able to carry. The new portable chamfer machine is designed with a 90-degree handle because it will provide an effective hand distance to the user where the user will be able to carry the new portable chamfer machine at both the x-axis and y-axis of the machine. And it will be able to let the user maintain the highest stability when using this new portable chamfer machine. The weight of the new portable chamfer machine has been maintained as light as possible where it is designed at a suitable weight that the user is able to carry.

Conclusion

After comparing Idea A, Idea B and Idea C, Idea A has been selected as the early stage of the design of portable type chamfer machine which to be produced because it is able to fulfill all the criteria which are needed. In Idea A, AC Motor is used because the no wires are required on the rotor, so it is considerably less expensive and lighter weight than the DC motor. Chamfer mill with removable cutter plate is used because the can change the cutter plate when the sharpness of the cutter plate is decreased. It will able to let the user to maintain the quality of their final products after the chamfering process. Comparing with direct from motor shaft or sprocket and chain, gear is selected because only a small space is required at the new portable chamfer machine, so the size of this new portable chamfer machine can be minimized as smaller as possible. For this new portable chamfer machine, only a single fan is required because one fan is enough to reduce the heat of the motor. With only a single fan, the size of this new portable chamfer machine can be maintained as smaller as possible. This portable chamfer machine is designed with roller stand because it will able to support the user to avoid any scrape occurs during the chamfering process. And with the support of roller stand, the whole chamfering process can be done more smoothly. (Scott 2000)

Handle at the chamfer machine is very important for the user to carry the machine. The design of the handle for this new portable chamfer machine are mainly concerned about the how to give the most stability to the user. So the 90 degree handle is selected because the user will able to carry the portable chamfer machine at both x-axis and y-axis of the machine. It will able to let the user to maintain the highest stability when using this new portable chamfer machine. After every components which to be used for this new portable chamfer machine are selected, the assemble process in practical can be started. (Scott 2000)

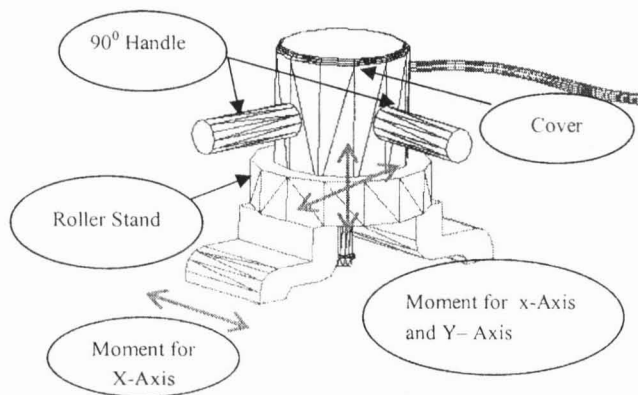


Fig. 3: Drawing for Portable Steel's Chamfer Machine

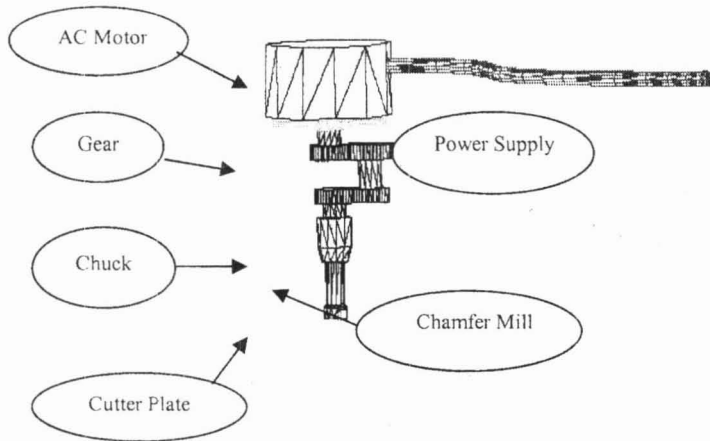


Fig. 4: Drawing of Components for Portable Steel's Chamfer Machine

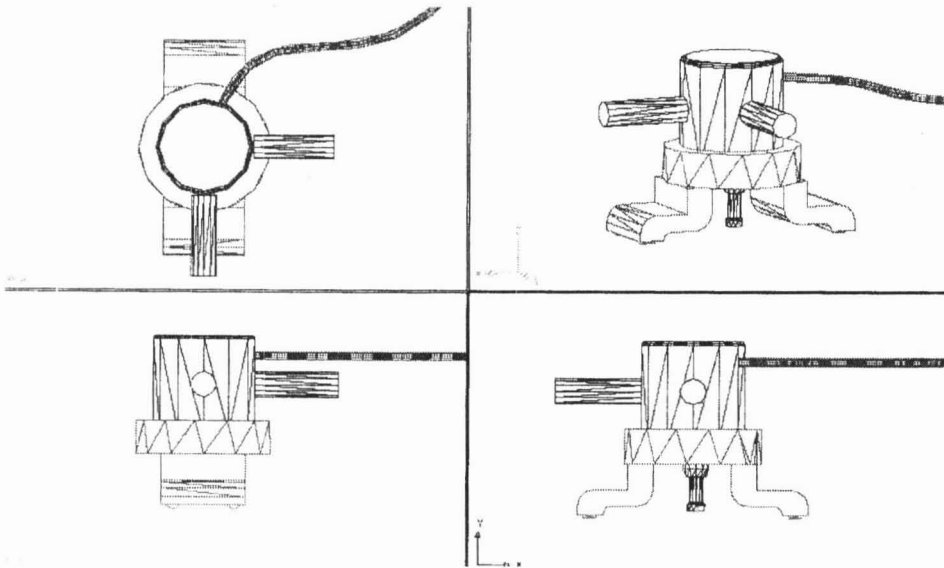


Fig. 5: Four View Ports for Portable Steel's Chamfer Machine

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