Design of a compact grinding machine

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Abstract. The availability and cost of tools are among concerns to the public and industries as key operation device used either for commercial or maintenance purposes such precision grinders or polishing machines are usually expensive. Assorted grinding tools in the market differ in terms of cost, required user proficiency levels and have different tool designs that can lead to limitations of flatness of ground surface and significant vibrations with prolonged use. The aim of this study is to develop a design compact grinder that is able to perform precise grinding and polishing while being cost efficient. Both functionality and ergonomic aspects were taken into consideration with market standards derived from datasheets. An initial design of the grinding machine was made using SolidWorks CAD software. A prototype was subsequently constructed and tested by using typical metallurgical sample preparation process with test parameters of grade of grinding paper and usage of lubricant. Microscopic image of ground specimens showed improvement in the quality of grinding with emery paper grades from coarse to fine grits with lubricant during the grinding process. Moreover, the designed compact grinding machine showed better surface finish when compared to using a typical angle grinder on aluminium sample.

1. Introduction

In the midst of the COVID-19 pandemic, a significant shift of customer dependency towards contract home improvements to Do-It-Yourself (DIY) improvements were seen over the months. According to an article in newspaper [1], many retailers have been caught off-guard by coronavirus restrictions and shifting consumer habits, but DIY stores are enjoying a boom as people spend money on their homes and gardens. Consumers and home users are moving towards newer trends of fixing and maintaining home appliances and products by themselves. Amidst of DIY home improvements, polishing and grinding finds an important role in restoration and refurbishment of common household items such as jewelry, kitchen ware, metal fasteners and components. Grinding is a machining process that employs an abrasive grinding wheel rotating at high speed to remove material from a softer material. In modern industry, grinding technology is highly developed according to segment of product and process requirements [2]. Most DIY work at a small level is tied to finesse, being able to get the right tool to the right place and deliver the right results [3].

The challenge with polishing & grinding tools is that most tools are it is either too large and complex to use or it is light but simply not sufficient. Commercial grinding and polishing machines are heavy weight tools which causes immobility which makes it difficult to store and operate. The upside of commercial grinders is its efficiency in providing a refined high quality finished product. On the other
hand, handheld grinders or polishers have gained interested in the present market due to its lightweight and mobility. However, when the job is smaller it just simply requires more precise work around less material. A foul-up working on something big is easier to conceal and harder to ruin the entire thing. On something small, a small screw-up might require a start-over. [3] Ergonomically, handheld grinders have high vibration and tend to cause tiredness when used in long term applications. Exposure to strong vibrations can cause various long-term issues to users such as white finger syndrome as shown in Figure 1.

![Figure 1. A person with white finger syndrome due to prolong exposure to vibration from handheld device [4].](image)

Proper grinding removes deformed surface material, while limiting the extent of added surface deformation. Amongst which, the precision grinder or polisher is a device that is able to successfully achieve the goal of a plane surface with minimal damage and removed when polished with respect to a quick time interval. Precision grinding is able to provide extremely high precision, fine surface finish and has the ability to machine harder materials. [5] Most importantly, precision grinders have capabilities that include parallel polishing, angle polishing, site-specific polishing or any combination thereof. It provides reproducible results by eliminating inconsistencies between users, regardless of their skill [6]. Figure 2 is a sample precision grinder that most vastly available in the market.

![Figure 2. An example of precision grinding and polishing machine [7].](image)
Precision grinding and polishing is a useful tool used in mechanical preparation for preparing specimens for microscopic examination, a key process in material science as the data obtained from the microscopic structures after polishing can help determine the reliability and material failure. Hence, this tool is most commonly marketed in laboratories and research institutes focusing on material research. However, precision grinding can also be used in a wider scope whereby it can be utilized in residential environments for tool management. For instance, knife and cutting objects can be sharpened evenly with this device. In addition, various stainless-steel fasteners that are customized made for a certain product may whereout in time, and due to discontinuation of the product may result to refining the presently owned fasteners. The application of this tools can be used in laboratories, university platforms, and home DIY applications where polishing and grinding is required.

Despite its excellent features, there are various shortcomings to available products such as cost and operational issues. Precision grinders used in the market currently are extremely expensive and is over advanced for a slightly general application as desired. In the context of operation, most grinders and polishers have fixed diameters for the grinding and polishing sheets as well as abrasive discs. Readily available tools that support various modes of operation often cost higher.

This design research is centred on the development of a laboratory grade grinding machine using locally sourced materials to perform metal polishing in home DIY applications or metallographic examinations in start-up business. The improved design comprises of the 2 main components namely key features and design feasibility. The key features comprise of core elements needed to fulfill the grinding/polishing operations such as platen discs, fluid dispenser, specimen holder. Other features include splash guard, safety stop button and a control panel for the motor. The design of compact grinder aims to reduce the cost by approximately 85% by downsizing the readily available market products. The targeted price range will be approximately kept at RM 2500 to 3500 which include material cost and production costs such as overheads, labor and transportation costs. In line with light weighting, the product must weigh less than 20 kg while ergonomically, the product will reduce the effects of vibration to the user by avoiding direct contact with the specimen and user’s hand.

The improved designed is produced by the means of a SolidWorks drawing and working prototype that will be used to perform test to accumulate results grind surface finishing of samples using dry conditions and lubricants and the appropriate abrasiveness of grinding sheets.

2. Methodology

The methodology is divided into two main sections, the development process and the experimental method required to produce results.

2.1. Development of Compact Grinding Machine

Development of the compact grinding machine can be divided into 4 stages, the design stage, simulation stage, prototype stage and manufacturing stage.

2.1.1. Design of Compact Grinding Machine. The design of the compact grinding machine is based on the idea of precision grinding/polishing machines. The primary reason for this decision is because precision grinders can easily be used by users without prior skillset. The design of the compact grinder is based on the following criteria: compactness, safety, ease of use, maintainability and cost effectiveness. The SolidWorks design concept of the compact grinding machine is shown in Figure 3. The reasons for using an existing design as an idea for this project and its relationship to the primary criteria listed is further explained by breaking down the design into sub-components.

The entire product of the compact grinder weighs 16 kg based on the mass properties tool in SolidWorks. The system consists of key sub-systems such as the platen disc, removable splash guard, specimen holder, fluid dispenser, body of system, and motor. In terms of maintenance, the product will only require basic routinely checks on the motor and speed controller. The platen disc is easily replaced from the motor shaft.
As shown in Figure 4(a), the platen disc is removable and can be replace by other disc with variant sizes. The basin for water dispensing is kept larger to allow room for larger disc. At default, the disc dimension is 250 mm. It can cater up to 350 mm disc sizes. However, this is unnecessary as most operations are around 150 – 300 mm. The disc is material is made of aluminum alloy (6063 T-5) as it is a lightweight high-performance material. It has high corrosion resistance that is vital as the lubricants used are mostly water based. The removable splash guard, as shown in Figure 4(b), is made of acrylic (medium-high impact) plastic. This material is to ensure light weighting of the system. The splash guard plays the role to avoid lubricant from splashing out of the system. It is removable to allow easy of cleaning and to allow the user to access the platen disc to replace it with other size discs.

![Figure 3](image)

**Figure 3.** Design concept of the compact grinding machine as shown in (a) SolidWorks CAD model and (b) part of the structural body of the system.

Based on Figure 4(c), the specimen holder is an addition made to the system to ease the user. In manual operations, the user is required to hold the specimen in place at a constant force for high quality grind. This difficulty is mitigated by using a simple sample holder to hold the specimen in place. This will also avoid the user from being exposed to vibrations produced from the specimen and platen disc contact. The arm is movable as it can rotate outwards if the user does not wish to use the holder in their application. The stud is a 10mm screw which can be moved vertical to tighten the specimen to the disc planar surface. The tightening is done by two bolts. The holder is to hold the specimen in place uniformly. The material used is stainless steel, AISI 304. This part is vital to mitigate the white finger syndrome that occurs due to long term exposure to vibrations. Ergonomically, the user need not require physical contact when product is in use. The user would just need to fix the sample to grind in place to the holder. However, should the user require physical contact to move the sample manually, the width of the system and structural design allows plenty of room to work with safely. This means that the product is not rigid to space for working but rather large for working conditions. Hence, elevating the safety and ergonomics criteria for the product design.

The fluid dispenser is made of stainless steel and works as a faucet to channel lubricant on to the working space of the platen disc. This feature is vital to as the lubricating effect of a grinding fluid reduces friction between the abrasive grains and the workpiece, as well as between the bond and the workpiece. Beyond the influence on process parameters, achievable surface quality and subsurface characteristics crucially depend on the cooling lubricant used [8]. Hence, for home users, lubricant will allow a better finishing to desired grind/polish surface. The knobs allow the control of fluid velocity where users can easily adjust the lubricant volume. The lubricant is channelled from a source which is foreign to the system. This means a bottle of lubricant is connected to the faucet tube. In terms of clean-
up, the water can easily be channelled out as the system operates as that of a simple wash basin. The residue can be channelled by a tube located at the bottom of the system.

![Figure 4](image)

**Figure 4.** Designed components of the compact grinding machine: (a) platen disc, (b) splash guard and (c) specimen holder with indication of arm, stud and holder sub-components.

The body of the systems is entirely covered in acrylic (medium-high impact) plastic. This helps in light weighting. The structural body however is made of stainless steel. This is to ensure structural integrity and support of component weight. The total weight of the structure is 11.3 kg and 16 kg without and with the motor respectively. The dimension of the system is 390 mm height, 798 mm long and 484 mm wide. The dimensions are decided by taking into consideration the size of the platen disc. The maximum diameter of platen disc is set to 350 mm. Hence the width cannot be lesser than 350 mm. The height of the system is dependent of the motor length (170 mm). Considering the fastening of the components, the control panel placing for motor control, and the wiring insulations, the dimensions are translated from the user needs and component needs.

Lastly, the motor is the key running component of the system. The motor used is Oriental Induction Motor KII Series. The motor parameters are: 0.1 kW, 220V AC, 1 Phase, 50 / 60 Hz speed controller motor. Induction motor or AC motor is widely available in the market and cost of ownership is low. The suitability of the motor for this application is determined by referring to the standard specifications in traditional specimen preparation in Table 1.

Silicon carbide (SiC) papers will be used for grinding as it is suitable for almost all materials. Hence, according to Table 1, the platen disc should be able to rotate at a speed of 200-300 RPM. The synchronous speed of Oriental Induction Motor KII Series is 1500 RPM, with a gear ratio of 5. A quick division of the motor speed of 1500 RPM by the gear ratio of 5 yields the motor speed of 300 RPM. Thus, the motor used is highly suitable for the grinding and polishing application.
Table 1. Specimen preparation parameters for general use [9].

| Surface                  | Lubricant  | Abrasive Type / Size ANSI (FEPA) | Time (sec.) | Force (N) | Platen (RPM) |
|--------------------------|-----------|----------------------------------|-------------|-----------|--------------|
| Planar Grinding          | water     | 120 – 320 (P120-400) grit SiC/Al₂O₃ | 15 – 45     | 20 – 30   | 200 – 300    |
| paper/stone              |           |                                  |             |           |              |
| Fine Grinding            | water     | 240 (P220) grit SiC              | 15 – 45     | 20 – 30   | 200 – 300    |
| paper                    | water     | 320 (P500) grit SiC              | 15 – 45     | 20 – 30   | 200 – 300    |
| paper                    | water     | 600 (P1200) grit SiC             | 15 – 45     | 20 – 30   | 200 – 300    |
| Rough Polishing          | compatible lubricant | 6 µm diamond                  | 120 – 300   | 20 – 30   | 100 – 150    |
| low/no nap cloth         |           |                                  |             |           |              |
| Final Polishing          | compatible lubricant | 1 µm diamond                  | 60 – 120    | 10 – 20   | 100 – 150    |
| medium/high nap cloth, synthetic suede | water   | 0.04 µm colloidal silica or 0.05 µm alumina | 30 – 60 | 10 – 20 | 100 – 150 |

2.1.2. Simulation of Compact Grinding Machine. The simulation process is important to study the effect of the motor to the support frame of the compact grinding machine. Since the motor is mounted to the frame, the simulation of the upper bound axial and bending stress, resultant displacement and factor of safety is found. Figure 5 shows both the actual model and the model for structure and motor analysis respectively. The study properties applied for the simulation are as indicated in Table 2. Results of the simulation study are as shown in both Figure 6 and Table 3.

Table 2. Study properties for model simulation analysis.

| Property    | Specification |
|-------------|---------------|
| Analysis Type | Static        |
| Mesh Type    | Beam Mesh     |
| Material     | Plain Carbon Steel |
|              | Yield strength: 2.20594E+08 N/m² |
|              | Tensile strength: 3.99826E+08 N/m² |
|              | Elastic modules: 2.1E+11 N/m² |
|              | Poisson’s ratio: 0.28 |
|              | Mass density: 7800 kg/m³ |
|              | Shear modulus: 7.9E+10 N/m² |
| Load 1       | Displacement (Direct Transfer) |
|              | Remote Mass: 6 kg |
| Load 2       | Gravitational Load (Top Plane) |
| Mesh (Total Nodes) | 554            |
Mesh (Total Elements) 288

Figure 5. Simulation models for the compact grinding machine: (a) actual model and (b) model used for structural and motor analysis.

The results shown in Table 3 show that the structure is able to withstand the motor loading as the yield strength of the system is 2.20594E+08 N/m² while the max stress acting on the system 287711.906 N/m². The factor of safety is at 3.55, the application of grinding is light and now very vigorous, hence the factor is satisfactory. The prototype is safe to be built with intended specifications.

Table 3. Model simulation results.

| Type                     | Minimum Value | Maximum Value     |
|--------------------------|---------------|-------------------|
| Upper Bound Axial & Bending Stress | 621.711 N/m² | 287711.906 N/m² |
| Resultant Displacement   | 0 mm          | 8.754E-04 mm      |
| Factor of Safety         | 7.67          | 3.55              |

Figure 6. Simulation results from the model for analysis: (a) upper bound axial and bending stress, (b) resultant displacement and (c) factor of safety.

2.1.3. Prototype of Compact Grinding Machine. The next stage of the project development is the prototyping stage. The prototype of the product is important for testing the feasibility of design in
performing test. It is simply putting the theory of research into practice. Taking into attention the design specifications justified, a simple prototype is developed for further studies on the effectiveness of the product. The built prototype is shown in Figure 7.

Due to budget and movement control order constraints, a simple prototype is built which consist of only a few vital components. The prototype mainly constitutes of the 5IK100VES-100 induction motor as the driving component for the platen disc. A speed control unit is utilised to control the motor speed and properties. The speed of the motor is controlled by turning the speed knob on the controller. A simple lubricant dispenser is installed to allow the lubrication during grinding. The platen used in the prototype has a diameter of 200 mm, this can be changed by simply removing the grinding sheet and replacing it with a bigger or small sized sheet. The platen disc is made out of aluminium alloy where the it is screwed on to a shaft above the motor. The overall structure is made of stainless steel. There are PVC sheets placed around the structure to avoid water splashes and debris splashes from the system. The total weight measured is 16 kg. The dimension of the prototype is 490 mm height, 535 mm length and 375 mm width which is similar to the proposed design.

The components that have not been installed in the prototype are the emergency stop button, basin and splash guard. The emergency stop button is a feature that would definitely be considered in the end product but not vital for testing processes as the invertor has a built-in stop sequence. The basin is designed to channel the residue of the slurry out of the system. This again is not vital for testing. The splash guard is an aesthetic and added feature often used in the end product. The prototype is important to obtain data obtained from test which is further explained in the experimental setup section.

Figure 7. Constructed prototype of the compact grinding machine.

2.1.4. Manufacturing of Compact Grinding Machine. The manufacturing of the product is based on material preparation, production time and cost analysis. All the materials used are all standards than can be purchased and sized to its respective dimensions. Thus, there is no need for a customary process for material development. In terms of time, the entire product can be completed within the time spend of 4-5 hours. For the ease of cost analysis, the time is taken for the duration of 1 day. The manufacturing is mostly dependent on the cost that will procure. This is important as the project design aims to have a total cost consideration of below RM 3000. Considerations such as the production cost, transport cost, advertising cost and other miscellaneous cost must be considered to ensure it is well
within budget. To calculate these costs, the cost of goods sold (COGS) is first found. COGS refers to the direct costs of producing the goods sold by a company. The COGS cost is shown in Table 4.

Aside from the cost of goods sold of product, all other cost can be categorized under selling, general and administrative (SG&A) cost. SG&A is the dollar value of costs indirectly related to goods and services sold. It is mainly composed of what you can think of as corporate expenses such as sales, marketing, advertising, customer service, human resources, legal fees, accounting and finance, and IT expenses. [10] It is calculated in the percentage of the 15 to 25%. Assuming the highest percentage of 25% for SG&A translates to SG&A cost of the product to be RM 470.90. Cost per product is RM 2354.40, which is derived from the sum of COGS and SG&A. Thus, the cost of the product is within the planned cost and way below the market value.

Table 4. Cost of goods sold of product.

| Components                       | Quantity | Details               | Price (RM) |
|----------------------------------|----------|-----------------------|------------|
| Electronics                      | 1        | Speed controller      | 430.00     |
|                                  |          | Wiring                | 19.00      |
| Support frame                    | 8        | RM 7 per meter        | 56.00      |
| 5IK100VES Oriental Motor         | 1        | Induction motor       | 910.00     |
| PVC Sheet                        |          |                       |            |
| a. Size 535mm x 490mm            | 1        |                       | 30.00      |
| b. Size 1200mm x 2400mm          | 1        |                       | 140.00     |
| c. Size 375mm x 490mm            | 2        |                       | 40.00      |
| Fluid dispenser faucet           | 1        | RM 50 per unit        | 50.00      |
| Platen disc aluminium sheet      | 1        | 300mm diameter        | 53.50      |
| Emery paper (silicon carbide)    | 1        | 300mm diameter        | 12.00      |
| Stop button                      | 1        |                       | 13.00      |
| Labour cost                      | 1 day    | Rate of RM 2000/26 days | 80.00    |
| Miscellaneous cost               |          | Fasteners, adhesives  | 50.00      |
|                                  |          |                       |            |
| Total Cost (RM)                   |          |                       | 1,883.50   |

2.2. Experimental Procedure of Compact Grinding Machine

There are three tests that were performed to evaluate the performance of the compact grinding machine. The objectives of the three tests are as follows:

- To study the effect of different grades (grit size) of grinding paper on the quality of grinding.
- To study the effect of lubricant on the quality of grinding.
- To compare the performance of the machine to a typical angle grinder.

2.2.1. Materials. The materials and apparatus used in the experiment is listed as follows:

- Acrylic resin – to make the specimen mount
- Aluminium samples – test samples to study the quality of grinding
- Silicon carbide grit papers – to grind the test samples with grades P50, 100, 240 and 400
- 3% Nitol – etching reagent with content of 97% alcohol and 3% nitric acid
- Polishing paste – to polish samples after grinding with 1 µm diamond bits.
- Microscope – to evaluate surface of test samples

2.2.2. **Method.** The experiment would begin with specimen preparation where the aluminum samples are placed in small mounting cup individually and resin was poured to allow it to cure and form a cylindrical-like specimens. Subsequently, each test samples undergo grinding, polishing and etching process. Platen disc speed was kept constant at 250 RPM. Etching is a controlled corrosion reaction used to attack the chemically active areas like grain boundaries where the misalignment of atoms gives them higher surface energy. The lubricant used in the experiment is water. After etching, samples were inspected under the microscope. The microscopic images are taken by focus the camera lens on the eye piece.

For experiment 1, a grinding or emery paper of grit P50 was secured to the platen disc and rotation speed was set to 250 RPM. The resin mounted test sample was then oriented with the metal surface against the abrasives on grinding paper. Uniform pressure was applied by hand to grind the sample for 30 seconds. With water line closed, these steps for grinding were repeated with grinding papers of grade P100, P240 and P400 for grinding test samples under dry condition or without water as the lubricant. In experiment 2, the entire grinding process similar to experiment 1 was conducted but with water being used as the lubricant. In experiment 3, test samples were ground using an angle grinder instead of the grinding machine for comparison.

Upon completion of grinding, all test samples were then polished with using 1 μm diamond polishing paste before being etched by rubbing the polished surface with swab immersed with 3% Nitol reagent and cleaned with distilled water. Finally, all test specimens were observed under microscope to determine the quality of grinding.

3. **Results and Discussion**

3.1. **Experiment 1**

The objective of the first experiment was to study the effect of different grinding paper grade (grit) on the quality of grinding. Results of this experiment are as shown in Table 5.

Based on the findings from Table 5, the aluminum samples that were ground using different grades of silicon carbide papers or grinding papers resulted in a unique set of results. Visually, the coarser the grit, the higher level of crazing on the aluminum specimen. The crazing lines were linear and extremely visible microscopically for grade P50. There was significant damage visible on the top right of the specimen. At grade P240, the crazing lines appeared blurry and more particle-like while at grade P400, these observations were not visible. Crazing lines are formed by the deformation of specimen surface with respect to the direction of the specimen movement above the grit. The lesser the visibility of crazing line, the lesser the damage on the specimen. Since the application of the project is intended largely for home users and higher learning institutions such as colleges and universities, the grit paper grade must be chosen appropriately. For instance, home users need not require extra fine grit as it may not necessarily affect the outcome of the finished surface. However, for applications in institutions, the project may be used in material research, thus, P400 or a grade finer will be better suited for the application.

3.2. **Experiment 2**

The second experiment aimed to study the effect of lubricant to the quality of the grinding. The results of experiment 2 are shown in Figure 8 where the aluminum specimens were ground for 30 seconds at platen disc speed of 250 RPM with and without water as the lubricant.

The grinding was done in a unidirectional motion of frontward backward horizontally. The marks of grinding are highly visible without lubrication indicating damage to the surface as shown in Figure 8(a). When lubrication is added, the damage drops significantly and barely visible as shown in Figure 8(b).
This finding indicated that dry conditions are not efficient to provide high quality grind and lubrication plays an important role in the grinding of the specimen.

**Table 5.** Results from experiment 1.

| Silicon Carbide ISO Grit Grade | Average Particle Diameter of Silicon Carbide Grit (µm) | Microscopic image of the aluminium test sample after grinding (200 µm) |
|-------------------------------|--------------------------------------------------------|---------------------------------------------------------------------|
| P50                           | 336.0 (Coarse)                                         | ![Microscopic image of the aluminium test sample after grinding (200 µm)] |
| P100                          | 162.0 (Fine)                                           | ![Microscopic image of the aluminium test sample after grinding (200 µm)] |
| P240                          | 58.5 (Very fine)                                       | ![Microscopic image of the aluminium test sample after grinding (200 µm)] |
| P400                          | 35.0 (Extra fine)                                      | ![Microscopic image of the aluminium test sample after grinding (200 µm)] |
3.3. Experiment 3
The third experiment was to integral part of this research paper as it allowed the performance comparison between the current design of grinding machine against a typical angle grinder as commercially available grinding tool. Results of this experiment is as shown in Figure 9.

It is evident from the Figure 9 that both grinding tools resulted in specimens that were relatively well ground with no directional lines of damage (crazing). Nevertheless, the application of the current design of compact grinding machine showed cleaner and smoother surface compared to that of the angle grinder, possibly due to the absence of lubrication of water in angle grinders. In addition, it is also postulated that application of grinding machine would also allow for higher flatness to be achieved apart from bestowing better ergonomics to the user with prolonged usage. From this experiment, the compact grinder was found to positively able to grind/polish a specimen with high precision. This benefit is crucial for material removal, grinding and polishing process for a variety of engineering materials [11-13].

4. Conclusions
To summarize, this paper initially identifies the need of a compact grinding machine in the market for the target market which are home users, universities and business startups. The needs include the present challenge to find a portable grinder that is highly efficient and most importantly be used without prior skillset. The cost of owning an efficient tool is also a challenge. There is also a concern on the long-
term exposure of the using such tools where white finger syndrome can be developed. As a result, the idea of a compact, low cost, and safe grinder is formed.

From the ideation process, the design of the compact grinding machine is produced in SolidWorks with a range of key components such as platen disc, removable splash guard, specimen holder, fluid dispenser, body of system, and motor. The design is made of readily available materials and lightweight materials to reduce the weight and cost of production. The total weight of the system is 16 kg where the motor comprises of 6 kg. The objective of portability is achieved as the objective aim to be less than 20 kg. The design is than simulated to study the factory of safety which is 3.55. The structure is rigid and stable as well as the bending and axial stress acting upon the structure is way lesser than that of the products yield strength. Yield strength of the system is 2.20594E+08 N/m² while the max stress acting on the system 287711.906 N/m².

In terms of manufacturability, entire product can be completed within the time spend of 4-5 hours where the total cost of per product is at RM 2354.40. The cost calculated is based on the material cost, labor cost, and other productional cost. The cost objective is achieved as the project aim to cost less than 80% of the market value which is equivalent RM 3000. In terms of maintenance, the product will only require basic routinely checks on the motor and speed controller. The platen disc is easily replaced from the motor shaft.

Three sets of experiments were carried out on the prototype of the compact grinding machine. Firstly, the grit paper grade suitable for grinding a specimen is P240-400 at condition; motor speed 250 RPM and water as lubricant. Next, the lubrications play a vital role in reduction of surface damage during grinding. Lastly, the compact grinding machine was efficiently able to produce a specimen with clearer microstructure when compared to typical angle grinder. Thus, objectives of the project design are achieved.

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