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Iron Shavings Collector: Application of electromagnetism concept for collecting iron fragments on machine as Learning Aid for Electrical Technology Course

Nor Aida binti Mohd Salihin¹, Raja Sharidatul Liza binti Raja Shardin²

Politeknik Ibrahim Sultan, Km 10, Jalan Kong Kong, 81700 Pasir Gudang, Johor

Abstract

Electrical Technology Course is a compulsory hands-on course for semester 1 Engineering Mechanical students of Ibrahim Sultan Polytechnic. Hands-on practice is important to produce highly skilled engineering graduates where students will learn electromechanical concept such as series parallel circuit, basic electronic components and electromagnetism concept. At the same semester, the same students will take a Mechanical Workshop Practice Course which involve machine handling process by producing an iron-based product using lathe machine and drill machine. The idea of producing these 'Iron Shavings Collector' arises based on problems that occur while using an array and lathe machine which is students always facing difficulty to remove an iron fragments that falls into narrow gap of the machine. Cleanliness is one of the most important aspects in the workshop. Housekeeping should be done after the session especially in cleaning iron dust and fragments on the machineries to ensure cleanliness and convenience to other students. Unfortunately, this aspect is not taken seriously because it's very difficult to clean the narrow gap in the machine. Conventional method to do cleaning process are using brushes which is their size unable to reach small area of machine. An electromagnetism concept that has been applied in this product can be used as learning aid for Electrical Technology Course which can help in understanding of students in electromagnetism topic. This product is designed with long and tiny size of iron plate which is suitable for small and narrow area. By applying an electromagnetic concept, 12V direct current (DC) supply is required to magnetize the iron plate which in turn serves as an iron collector. Toggle switch is used in this product to ease the removal of collected iron dust by demagnetized the iron plate. After a few tests, resulted that using this tool can clear the gaps more quickly and students can see physically the effect of electromagnetism in real.

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Key-word: - iron shavings, electromagnetism, shavings collector

1. Introduction

Electromagnetic phenomena are defined in terms of the electromagnetic force, sometimes called the Lorentz force, which includes both electricity and magnetism as different manifestations of the same phenomenon. The electromagnetic force plays a major role in determining the internal properties of most objects encountered in daily life. From observation of Hans Christian Ørsted on 21 April 1820¹, as he was setting up his materials, he noticed a compass needle deflected away from magnetic north when the electric current from the battery he was using was switched on and off. This deflection convinced him that magnetic fields radiate from all sides of a wire carrying an electric current, just as light and heat do, and that it confirmed a direct relationship between electricity and magnetism.

Iron shavings are a byproduct of milling and grinding metal operations. Shavings are produced from the shaving or cutting of metal and then collected for recycling. Metal dust and shavings can be one of the heaviest forms of dust and the trickiest to vacuum. Throughout the implementation process of this project, various references and studies have been conducted to meet the objectives. The effort to find reference material is an important factor in ensuring the overall effectiveness of the iron shavings collector. Among them is the power of magnets that are not strong, and inappropriate size of the core iron. Mechanical Workshop Practice Course is a compulsory hands-on course for Engineering Mechanical students. Workshop practice is important to produce highly skilled engineering graduates where students will learn machine handling process by producing an iron-based product using certain machine in the workshop such as lathe machine drill machine.

The idea of producing these ‘Iron Shavings Collector’ arises based on problems that occur while using an array and lathe machine which is students always facing difficulty to clean an iron dust that falls into narrow gap of the machine. This product also applied with an electromagnetic concept to magnetize the iron plate so that it can well function as iron collector. At the same time, by applying this concept, student can see practically the effect of electromagnet in real life. This factor directly related to Electromagnetism topic in Electrical Technology Course and indirectly double benefits the students.

1.1 Objective

The objective of this project is :

1. To build a Learning Aid for electromagnetism topic for Electrical Technology Course.
2. To produce an “Iron Shavings Collector” that can clean up iron shavings easily and quickly with economically.

1.2 Problem Statement

Research have been done based on the lathe machine which facing as below problem:

1. Based on lecturer observation, most of student are quite hard to understand the electromagnetism concept.
2. Some parts of the machine cannot be reach to clean iron shavings due to small and narrow gaps.
3. Iron shavings can cause injury if not cleaned properly
4. Difficulty to cleaned hot iron shavings.
5. Current iron shaving collector is difficult to remove the collected iron shaving from the iron plate.

1.3 Problem Solution

These are the problem solution from the problem statement above:

1. Application of electromagnetism concept in this product can show the students the effect of electromagnetism in real life at the same time give them a maximum understanding.
2. The iron shavings collector operates using temporary magnet which is easy to remove the collected iron shaving by demagnetized the iron plate.
3. Product designed based on the studies of the reachable gaps at the machine.

2. Literature Research

‘Electromagnetism presents an interesting topic for teaching and learning. On the one hand, the corresponding phenomena are mostly outside the range of student experiences and relevance to everyday life is not immediately identifiable for many.’ (Costas P. Constantinou,2010)¹

‘Electromagnetic interactions play a central role in explaining the natural world and they provide the foundations of most current technology. So, it is important for people to have a basic understanding of electromagnetic phenomena for two main reasons; firstly electricity and magnetism are seen as central topics in the science/physics curriculum at any teaching level and secondly, which is central to the arguments of this paper, the concepts and models involved in Electromagnetism (E&M) are particularly problematic.’(Jenaro Guisasola,2007)²

‘Models and analogies are essential to the teaching of electromagnetism, because in this conceptual area some phenomena cannot be observed directly, but only the consequences of these phenomena can.’ (Michelini, Mossenta, Testa, Viola, Testa, 2007).

‘The metal shavings and slugs pollute the work area. This is particularly problematic when cutting access holes into metallic boxes which contain electrical equipment. The metal debris can damage the electrical equipment and make the area dangerous for those working around the area.’ (Bobby L. Russell, Metal shaving and slug collector,2011)³

2.1 Current method of collecting iron shavings

Manual magnetic collectors in **Figure 2.1** are used to collect metal impurities (shavings, nails, screws, wires). Due to easy manipulation, they are frequently helping in metal-working and locksmith workshops. An easy de-magnetizing – by pulling the handrail in upper collector part, de-magnetizing takes place so caught metals can fall off easily. This product cannot reach a small and narrow gap of machine. Power Tools Cyclone Magnetic Swarf Collector as in **Figure 2.2** has a compact heavy-duty design, strong magnet adhesion, simple quick-release plunger, made of stainless steel and able collect up to 6.5 kg of shavings. The price is quite expensive in Malaysia.

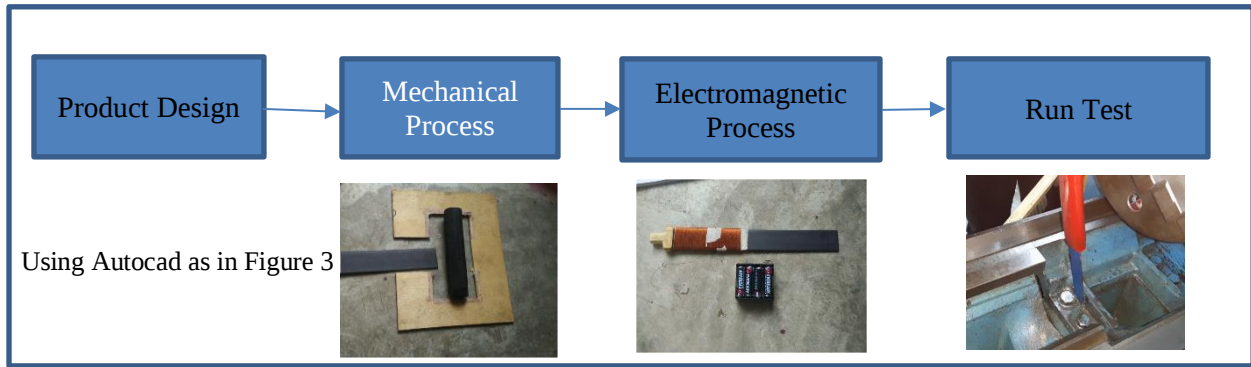


Figure 3.2 Product Process Flow

From **Figure 3.2** above, product is design by using AutoCAD Software. Mechanical process involves of cutting material step for battery storage box and iron plate using iron cutter machine. Electromagnetic process is a preparation process for electromagnetic iron plate. Magnet is divided into two permanent magnets and temporary magnets. The magnet used in producing this project is a temporary magnet. Among the materials used to produce the magnet are copper wire, iron rod and battery. Product test run is done towards lathe machine in Politeknik Ibrahim Sultan Mechanical Workshop.

4. Result and Data Analysis

4.1 Concept of electromagnetism

Refer to **Figure 4.1**, a solenoid is a long coil of wire wrapped in many turns. When a current pass through it, it creates a nearly uniform magnetic field inside. Solenoids can convert electric current to mechanical action, and so are very commonly used as switches. The magnetic field within a solenoid depends upon the current and density of turns. **Figure 4.2** shows that electromagnetism parts involves in Iron Shavings Collector product. When switch is activated, 12v DC will supplied and amount of current will flow to solenoid bar and magnetize the magnet bar. Magnetized bar magnet will absorb the targeted iron shavings as shown in **Figure 4.4**. **Figure 4.3** below shows that the iron plate for this product are able to reach a small and narrow gap of lathe machine

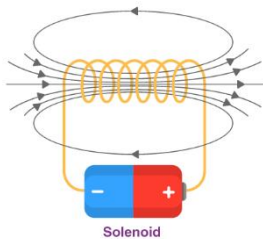


Figure 4.1 Basic concept of electromagnetism

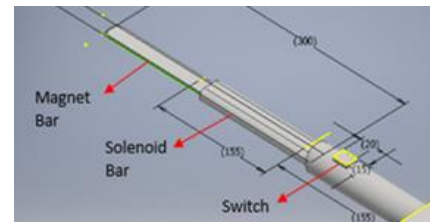


Figure 4.2 Electromagnetism parts in Iron Shavings Collector



Figure 4.3 Iron plate able to reach small and narrow gap of machine

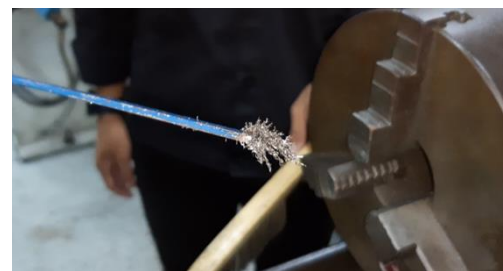


Figure 4.4 Collected iron shavings

4.2 Effectiveness of product

Product run test has been made through a few students of Diploma in Mechatronic Engineering using conventional method that use brush as a method to cleaning the iron shavings and another one method is using Iron Shavings Collector. Data from Table 4.1 shows that cleaning time can be reduced using Iron Shavings Collector and students can finished their work earlier so that they can prepare for the next class.

Table 4.1 Data collected based on time using conventional method and iron Shavings Collector

TEST	TIME (s)	
	CONVENTIONAL METHOD	IRON SHAVINGS COLLECTOR METHOD
Student 1	54	44
Student 2	54	43
Student 3	56	46

4.3 Student understanding on electromagnetism concept

Table 4.2 Data collected based on student's achievement

TEST	STUDENT ACHIEVEMENT (%)	
	Pre-Test	Post - Test
Student 1	65	85
Student 2	50	100
Student 3	55	90

Student understanding on electromagnetism concept is measured using pre-test and post-test method. From Table 4.2 shows that students' achievement is increase after using Iron Shaving Collector as learning aid in Electromagnetism topic for Electrical Technology Course. By using this product in teaching and learning, students can physically experience a real effect of electromagnetism. This method have a potential to attract their interest and improve their understanding.

5. Conclusion

In conclusion, this iron shavings collector is very effective and the cheapest way for cleaning the iron shavings in the narrow gaps of the machine. This iron shavings collector has a potential to benefits factories which operated using machineries and iron-based material as their products as it is easy for them to clean iron waste and save production time. This product also applied with an electromagnetic concept to magnetize the iron plate so that it can well function as iron collector. At the same time, by applying this concept, student can see practically the effect of electromagnet in real life. This factor directly related to Electromagnetism topic in Electrical Technology Course and indirectly double benefits the students.

References (Follow as shown)

- C. P. Constantinou, N. Papadouris (2010) "Teaching and learning about electromagnetism in high school: addressing issues of relevance and epistemic practice, In book: Physics Curriculum Design, Development and Validation, Selected Papers from the GIREP 2008 International Conference (pp.296-310)
- Jenaro Guisasola (2007) "Teaching Electromagnetism: Issues and changes", University of Basque Country, Spain
- Ayodele Abosede Ogegbo (2019), Estelle Gaigher , "Benefits and challenges of lesson study: A case of teaching Physical Sciences in South Africa", South African Journal of Education, Volume 39, Number 1, February 2019

* Nor Aida Mohd Salihin. Tel.: +0107120615 ; fax: 072612488

E-mail address: nor.aida@pis.edu.my

Nor Aida Mohd Salihin / JOJAPS – JOURNAL ONLINE JARINGAN PENGAJIAN SENI BINA 01071206

