Safe Tool

Team 13
Engineers

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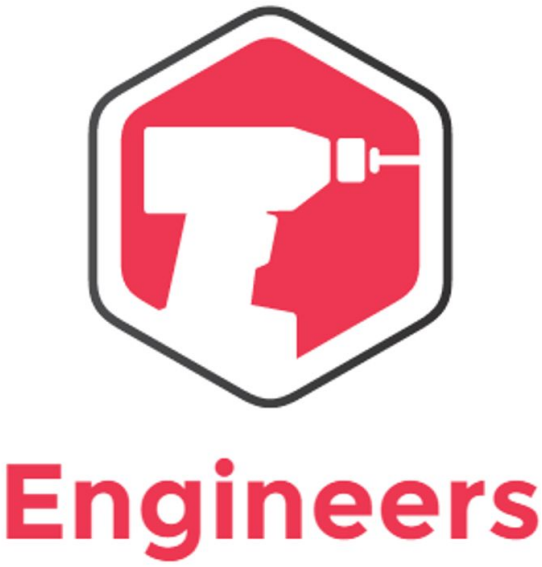

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Executive Summary

The aim of this project is to create a safety circuit within power tools, in order to make the use of power tools, much safer and allow for less injuries and fatalities. Through statistical analysis from Safe Work Australia [1], we identified a trend of accidents through mechanical equipment operation. By using a series of switches, and creating a training program, we were able to generate the safety tool, which would prevent future accidents from occurring. We found that implementing switches allows the user to operate the tool accurately by teaching the user to properly operate the power tools effectively. Failure to do so would result in current disconnecting instantly, which directly reduces the momentum of the tool and the risk to the user. With the addition of the switches, operators of the safety tool can safely operate with a reduced risk to themselves and others. It is recommended that the safety tool to be installed into all mechanical tools and equipment in the workplace to reduce as much risk as possible.

Introduction

Electrical tools and machinery are dangerous pieces of equipment within the workplace and result in numerous injuries every year. According to the Australian Bureau of Statistics, one of the most common industries where injuries occurred over a one year period was 'Technicians and Trades Workers', resulting in '72 per 1000 employed persons' [2]. That's an injury rate of 7.2% per employee in that industry. Also, Australian safety incidents with electrical equipment has been reported up to 25.1 incidents from 2005-2006 and an average of 20.1 serious incidents reported from 2000-2014 (according to the Safe Work Australia statistics on the incidence rate of serious claims [3]). Not only is the safety of employees' paramount, the cost of treating these injuries and the claims arising from these incidents are costly. According to Worksafe QLD [4], the average employee costs a business 1.6 days to recover the loss of that employee. These statistics highlight the importance of maintaining a safe environment whilst at work.

The Safety Tool aims to reduce these numbers significantly, by incorporating a switching circuit which ensures the user operates the machinery and tools properly and carefully. Coupled with a training program, employers can monitor the training and performance of their employees who use the Safety Tool. The program monitors whether the employee is using the tool correctly. First, the two safety switches must be activated before the main power switch can be turned on. Failure to do so in that specific order will result with a warning to the trainer, who will then recommence the program until the trainee has a competent understanding of the operation of the tools.

This report will outline the key details which focus on the operation of the Safety Tool and the results achieved by the design team.

Method

The need to reduce the risk of injury and damage of electric equipment poses a great opportunity for the design of a safety tool which can be incorporated in the most common industries.
The six members of the team, 'Engineers', were assigned to research on different parts of the project. Firstly our aim was to make the tool safer and for that initially the members used the questionnaire method to start on the research and thus came up with different ideas. Through the use of a switching circuit, the device requires the use of both hands in order to be operated. There are 4 switches which are located on various surfaces of the tool and in order for the tool to function, two of the safety switches must be active so the main switch can be initiated. This system can be applied to all devices in order to enhance the safety whilst operating them.
In accordance with our research we made some delicate changes in our safety tools. Initially the Safety Tool we built composed of a switch incorporated in either the electrical or electronic circuits within the tool to protect against short circuits. In addition, the switch can protect against other minor or major faults that have the potential to interrupt the circuit. We have changed the switches in the drill and the angle grinder because we couldn't read the signal of those switches through our OUSB board. The new switches are installed so that we can create a code using our C++ knowledge and can control the drill using a computer through the OUSB board. This will allow us to control the rotational speed of the drill and make it easier for us to find if there is any flaw in the circuit.
Then we worked on showing how the signal runs through the OUSB board to our safety tool. We designed our logic gates using multisim. The design is pictured in Figure 1.3 in the appendix.

A 3D design of our tools has been generated in order to show the communication with the program. This can be viewed in figure 1.4 in the appendix. This will give us a brighter look of what is happening inside the tools and give us a proper view of working mechanism and whether it is being used properly by the trainee.

Results

The Safety Tool protects the electrical machine/tool together with the operator by constantly checking on the currents that flow in the live and the neutral wires that supply the electrical tool. In normal situations currents that flow within the live and neutral wires are equal. If an imbalance between these two points occurs, this means there is an earth leakage or a fault within the circuit. This imbalance will be detected by the Safety Tool, which will automatically isolate power before an injury or damage to the

tool occurs. The Safety Tool that we intend to design will be highly sensitive, and it will be able to disconnect the circuit in 20 to 25 milliseconds after detecting the fault. This will stop the electricity flow through the body of a tool operator to the ground. This response is quite fast and it will be able to lower death risks and even serious injuries.

Safe tool idea will also be important in emergency situations. This switch will be able to isolate the device from power in emergency cases where the electrical tool or machine cannot be shut down in the normal manner. It will operate by shutting down the machine completely and quick even if the operator is untrained or is panicking.
Additionally, this idea can save a lot of costs that may result because of electrical faults. Electrical faults other than hurting machine operators, they can burn down the entire machine or even the entire premise. These are very costly losses that can be prevented by a very simple and cheap safe tool idea.

To further increase the safety of users, we have developed a program to ensure the human operation of the Safety Tool is correct. The program provides feedback to the trainer whether or not the user is operating the tool correctly. If not, the program identifies which switches are being pressed and which order they should be activated to ensure proper operation of the tools.

Design Issues

Technical and Financial issues arise with any project, especially ones that are as constrained as these ones held in Engineering Design 3 at RMIT University. The particular technical issues that were faced by our team for this particular project included:

Technical Issues

- An augmented reality simulation to showcase the products in great detail, including the exterior shell and the components within with an exploded view, however this proved to be incredibly time consuming and required an immense amount of resources to create with the lack of experience that the team has within this field
- Developing a method to connect the products to an OUSB Board for testing purposes. This was with developing a method based on the first product produced, the drill.
- Reading the drill inputs in real time through a computer. This follows on from the previous issue, and was the next issue to be solved, built upon connecting an OUSB Board to the products.
- Implementing brakes within the drill in order to immediately stop the drill bit from spinning when the drill is mishandled. However, this proved to be unviable as an affordable solution would not fit within the drill.
- Reverse current in order to immediately stop the drill bit from spinning when the drill is mishandled. Another method to stop the drill bit from causing harm after the user has let go of the drill, for example. However, this would require many parts within the drill to be replaced within the drill, which is not viable with the budget that is allocated.
- The laptop that would be used for the demonstration did not have Visual Studio 2013 to demonstrate a program to display data of the drill. A trial version will be used during the Trade Fair for demonstration purposes.
- The products could not be tested frequently as there are many safety concerns with handling power tools on campus, including: OHS issues, safety equipment, safety tags, etc.
- Limited time for team members to meet and generate ideas and resolve issues due to their current commitments with classes and work.

Financial Issues

- Technical equipment cost a lot and as a result the team has gone over budget, and feel too restricted by the budget to properly develop within this field.
- Some ideas that were ultimately cut due to the restricted budget include: infra-red sensors to replace the physical switches and a camera for training purposes.

Conclusion

The use of power tools in the workplace, has shown a large amount of injuries occurring as it becomes more popular and used more often. The Safety Tool allows the electricity to be removed from the circuit faster than without and is done by removing the human error that may occur when the user doesn’t use two hands and in short will protect the users, creating a safer workplace for all the workers.

Recommendations

Some improvements for the safety tool is to guarantee some quality and functionalities as an industrial tool which gives similar functionality but decreasing the cost. Further improvment on how to properly handle power tools to ensure safety and efficiency when applying it to different materials. Other future recommendations would be to add more sensors such as ultrasonic sensors to detect drastic changes in the distance from the drill to the wall for more accurate readings from dangerous slips or accidents. The team's optimal vision of the drill is to have a machine/user interaction that can improve the user's drill techniques and can explain the user mistakes as well as the AI learning to optimise stance and torque needed to performance on certain materials. Furthermore, by researching the effects of injuries and adapting those scenarios to the tool will allow for an improved product in the future.

References

[1] Safe Work Australia, Key Work Health and Safety Statistics, Australia, 2014, http://www.safeworkaustralia.gov.au/sites/SWA/about/Publications/Documents/841/Key-WHS-Statistics-2014.pdf

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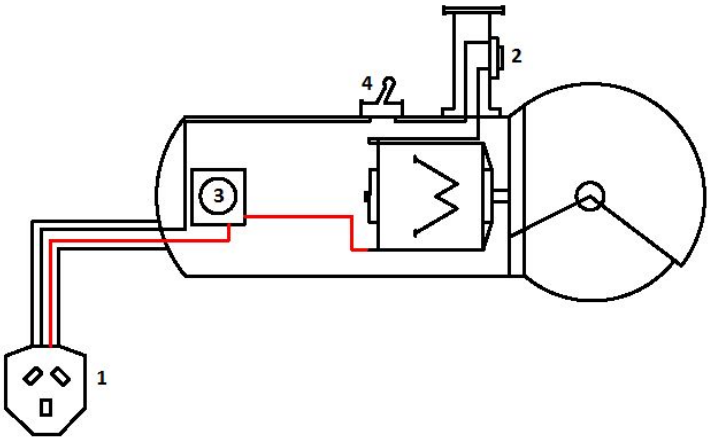
[3] National Data Set for Compensation-Based Statistics (NDS), Safe Work Australia, "Work health and safety statistics: Incidence rates of serious claims by industry, 2000–01 to 2013–14p," September 2015, [Online]. Available: http://www.safeworkaustralia.gov.au/sites/SWA/Statistics/Documents/incidence-rates-serious-claims-industry-2000-01-2013-14.pdf

[4] Workplace Health and Safety QLD, 'A Workplace Industry: The Real Cost To Your Business', July 2015, [Online]. Available: https://www.worksafe.qld.gov.au/__data/assets/pdf_file/0008/82628/ind-cost-calc-construction.pdf

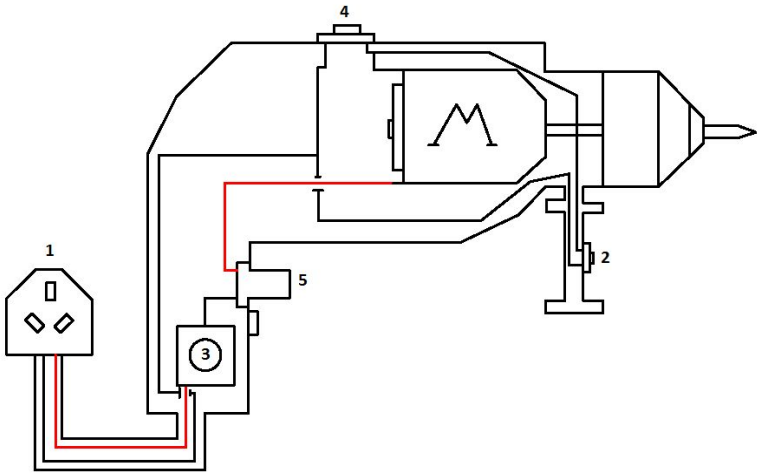
Appendix

Figure 1.1: An Image of an Angle Grinder with an Incorporated Safety Switch



(1):- Electrical Current Source.
(2):- Safety Vertical Switch Added.
(3):- Safety Lower Switch Added.
(4):- Main Switch.

Figure 1.2: An Image of a Drill with an Incorporated Safety Switch



(1):- Electrical Current Source.
(2):- Safety Switch Added to Drill.
(3):- Safety Side Switch Added.

(4):- Safety Switch Added on top of the Drill.
(5):- Main Switch.

Figure 1.3: Circuit Diagram of Switching Circuit

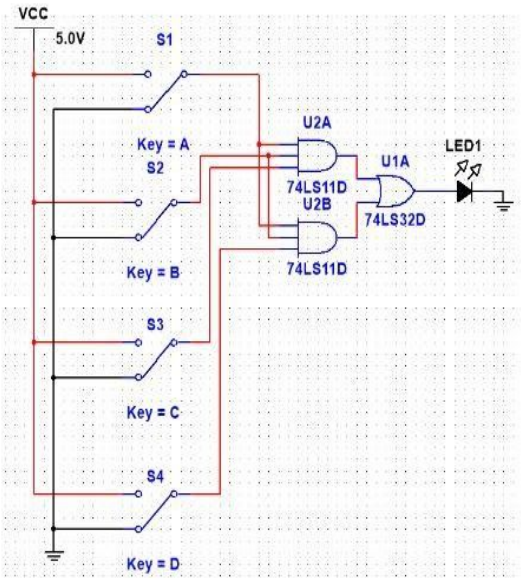


Figure 1.4 Side view of 3D generated tool

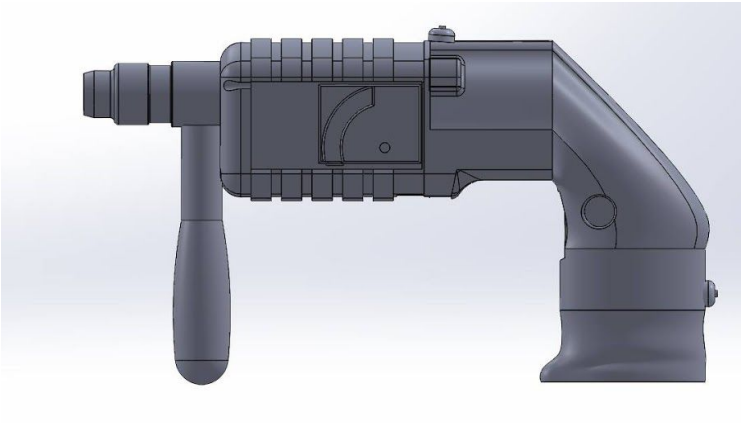


Figure 1.5 Inside the Safety Tool