Design Issues Paper

Accessible Manufacturing

Design Team 2

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For engineers their first priority is always to design a device that will accomplish the task that has been assigned to it. There are almost always other issues that need to be considered and designed for also. Some of these issues are the lifecycle of the product being designed, how accessible the device is to its users', the liability the engineer has, and how safely the machine operates. In today's modern world information is readily accessible to consumers. Therefore, if a product is going to be successful taking into consideration such issues is vital to the success of the product otherwise, the product might end up being the next Toyota brake recall.

Product Lifecycle Management

Society is beginning to take more responsibility for the disposal of used products. Recycling is becoming more commonplace and in the case metal recycling, very profitable. The ribbon cutter has a simple function to fulfill so it assumed that the machine will not become obsolete from technological advances. The machine is limited in output by the user, so in the interest of making the accessible it also assumed that a higher rate output that could result from more advanced technology is also unnecessary. Also, it has been assumed that this machine will not be mass produced.

The parts that were not ordered as pre-made are mostly brackets for holding the machine together. These parts were made mostly from reused scrap metal, and no hazardous chemicals were involved. The ribbon cutter has been built using mostly parts fabricated from steel and aluminum. The parts that were ordered as already assembled include numerous integrated circuits (IC), a guillotine cutter, and a LEGO Nxt brick. A reused computer power supply is being used as the power source of the machine. Using reused parts in the construction reduces the amount of resources consumed during the construction

of the device, but also had the added benefit of reducing costs.

When the machine is no longer being used it is assumed that it will be mostly disassembled and scrapped for the high value of the metal used in most of its construction. Batteries. It would also be possible to continue to resuse the power supply. Since the machine is to be maintained by high school students participating in a LEGO based competition is assumed that all LEGO parts could be reused as well. The ICs, LED display, and audio circuits could be recycled as a part of a growing e-waste recycling market.

Another design feature was that the NXT brick will be connected to the computer power supply this will have the effect of eliminating the need to change batteries, which would added significantly the amount of waste produced by the machine during its lifecycle. Other than the consumption of electricity to power the power machine is assumed that the machine will not consume any other resources, or produce any other output besides cut ribbon.

Product Accessibility

This project was designed to be operated by a disabled person. Therefore, the accessibility of this final product becomes the major issue of this whole project. During the design process, this ribbon cutting machine was expected to have all the important features that would help a disabled person to operate the machine. Some essential features that are thought would be useful are 7-segment LED display that will show the input length for the ribbon to be cut, speaker which creates output voice of the length summary of the ribbon that will be cut, and also buttons that would be used to navigate all the important features on the controller box.

The 7-segment LED display is designed to make it more accessible for people with difficulties in hearing so they could only read the LED display in order to recognize the length of the ribbon that will be cut. The speaker would also be built in the system for visually impaired users in order for them to identify the resulting ribbon length without the need of reading the LED display. The simplicity to navigate all these essential features described above plays an important role to accomplish the accessibility purpose of this machine. Therefore, buttons will be used in an uncomplicated way to give the disabled user a feeling of the user-friendliness of the machine itself.

The accessibility of this overall machine could be improved by implementing additional important features such as a display or voice feedback of the actual length of every ribbon that has just been cut. Therefore, the length accuracy of the cut ribbon could be easily

changed by the disabled user. Another option in order to improve the accessibility of this machine is to build a system that will automatically remove the ribbon if jamming occurs. Disabled users would not need to manually stop the process and fix the jamming problem by themselves since it has already been taken care of by the machine itself. There would be many ways to improve the accessibility of the finalized machine, but as long as it meets the requirements of the desired customer, the machine would be adequately accessible to be operated.

FCC Standards for Unintentional Radiators: Wired Emissions

One of the standards our project needs to conform to is FCC Title 47 CFR Part 15 specifically parts 15.101-15.107, regarding Conducted limits for class A devices. The FCC divides electronic devices with a clock speed over 9kHz into two categories class A and class B. Class B devices are sold for use in the home while class A devices are for industrial use. Class A is the less stringent of the FCC classifications. Our project is A class a device because it will be used in an industrial setting not in the home. This means that any signals leaving our device via the power cord must be less then 1mv for frequencies up to 1.5MHz and less then 3mV for frequencies higher then 1.5MHz.

While it is likely that we could get away with not conforming to the FCC regulations it would be unwise to try. The high frequency noise generated by a switched mode power supply or even our LEGO MINDSTORMS NXT brick could enter the wiring or the building it is being used in through its power cord. The wiring of a building can then act as a large antenna and potentially interfere with other devices. To test our device we can plug it in through a Line Impedance Stabilization Network (LISN) and then use a spectrum analyzer to measure the high frequency noise. The LISN allows us to measure the worst case scenario for conducted emissions by preventing the unmatched impedance of the wall circuit from effecting the amount of noise being transmitted to the spectrum analyzer. The LISN also prevents the high frequency noise from being transmitted into the engineering buildings power system during the test. CISPR 22 regulates conducted emissions in Europe. The CISPER 22 requirements for conducted emissions are less stringent then the FCC's regulations so if we pass the FCC tests we are also within the CISPR 22 limits.

Our device must also accept interference from other devices without malfunctioning to pass FCC regulations. This is very difficult to test so we will have to make some educated guesses about what kind of interference is likely and how to prevent it from damaging our

device or causing it to malfunction. The precautions we take to reduce our devices emissions both radiated and wired help harden the device against interference. To prevent wired interference and emissions we can add low a low pass filter between the wall circuit and our power supply. In many cases a simple low resistance inductor is enough to solve any problems. Preventing radiated emissions can be harder for many applications but for us it will be simple. Because we are enclosing all of our circuitry in a metal box radiated emissions are blocked except through the wires leaving the box. There should be only three such wires: two motor control lines and the power cord. If the low pass filter used for conducted emissions is inside the box that leaves only the motor controls. The motor control lines are connected to the LEGO NXT and are being used the way LEGO intended them to be used. The LEGO NXT brick is a class B device and has already passed tests more stringent then the FCC class A regulations so it is unlikely to need modification.

Design Safety

Safety is an important feature associated with our project. Knowing that once deployed the machine will be used primarily by a man with both cognitive and visual disabilities, we took making our machine safe very seriously. Perhaps the most dangerous feature of the machine it the cutting mechanism. It is an AZCO produced guillotine style cutter that is powered by compressed air and if supplied enough force is capable of cutting through steel. Another feature that could potentially be a safety concern is the mechanism by which the ribbon is fed through to the cutter, the potential is there for fingers to get pinched or inadvertently fed into the cutter. This portion of the paper will discuss the mechanisms by which we plan to modify these particular features so that they will be as safe as possible without hindering the machine's ability to do its designed jobs.

First we will address the cutter. The simplest addition we will make to help prevent injuries is to add a guard around it to prevent fingers and other body parts from being inserted purposefully or accidentally into the cutting area. However, even this is not fool proof and injuries can still happen. As such a warning label will be put in place recommending that while the machine has power that all appendages be kept away from the cutting device. The goal of these labels and warnings is to ensure that there are no liability issues with the machine should injury occur.

Next is the ribbon feeding mechanism. Overall this is not too dangerous, however the potential is there. We have already implemented a couple of safety features to help. The first

is using the LEGO motors and tires as the feeding mechanism. This helps by the fact that the LEGO tires are less likely to severely pinch fingers since they are made out of soft rubber and weigh very little. The second feature we've added is mounting the motors on a swing bracket that is held down only by the force of gravity, thus anything that is pulled underneath it will not be crushed.

These features will help to make our product acceptably safe for the workplace and ensure that the minimum amount of injuries if any will occur.

Product Liability

"Product liability often refers to the liability of all parties along the chain of manufacture if a product for damage caused by that product" ("Products"). It is our responsibility for ensuring that the product are safe and do not pose a hazard to our customer. In our design, a powerful guillotine knife is included; we have added covers to the knife to make sure when the machine is operating, it has no hazard to the user. Meanwhile, design defect is our primary concern because our customer has eyesight disability and he makes his living by operating the machine. If the efficiency of the machine is low, we fail to satisfy consumer expectation. In term of efficiency, our design mainly focuses on the speed, consistency and accuracy of the machine's performance. An adjustable speed control system has added to the machine which allows user varies different speed as he wants. The knife can be used to cut a wide variety of flexible material and it is able to provide accurate cutting. The machine is controlled by Lego Mindstroms NXT program which is graphical and simple program, all the timing loop is carefully calculated which provides consistency and accuracy to the machine. Easy maintenance what costumer specifically asked and it is the main advantage of using this program. LCD display will be added to display the length of ribbon user input and a speaker will announce the value to make sure correct number has been input. In addition, we have improved the aesthetics of the machine, there are no exposed wires and it is more compact than the old one.

Works Cited

Products liability. Cornell University Low School, 19 Aug 2010. Web. 21 Nov 2010. <http://topics.law.cornell.edu/wex/Products_liability>