Ethical and Environmental Analysis

Year: 2019 **Semester:** Spring **Team:** 2 **Project:** Guard DAWG System
Creation Date: March 31st, 2019 **Last Modified:** March 3, 2015
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1.0 Environmental Impact Analysis

The team behind the Guard DAWG System designed the product with environmental impact as a major design consideration. The main environmental impact from our product stems from manufacturing waste, repair costs, and end-of-lifetime disposal. In order to deal with these environmental challenges, the main goals for this product would be extending the product life cycle, minimizing the amount of pollutants produced during PCB manufacture, and finding a good way to recycle the product when it needs to be disposed of.

Most of the waste from manufacture will stem from chemical byproducts of PCB manufacturing. For example, the main components in a PCB are epoxy, fiberglass, and copper, and dangerous compounds such as ferric chloride and copper chloride are used to etch the PCB. In addition, there are several other wet chemicals, plating chemicals, and gases used for treating the board. [1] These kinds of materials are a serious health hazard, being difficult to dispose of or recycle, and costly to the environment to procure. The ferric chloride is rated by the HMIS as a 3, meaning it is a "serious hazard" [2]. When manufacturing the PCBs we can limit the production to fab houses that are known or certified to prioritize minimizing their environmental impact, and use safe practices so that their employees aren't put at stake.

The device will be responsible for a small amount of noise pollution in the form of Bluetooth communication and EMI. When driving the door motor, a small amount of inductance may result from sending an amp of current through the cables that connect the PCB and motor driver, as well as in the form of parasitic inductance from flyback current when the motor is powered off. However, this isn't a major concern, since the Bluetooth and other signals will not be sent often enough to require special consideration.

Firstly, due to the nature of some of the components on the board, if the board is operating under maximum load continuously (which is a worst-case scenario), then it has an estimated lifetime of 10 years. The components most likely to fail on the board are the Schottky diode, power NFET, buck converter, linear dropout regulator, and aluminum electrolytic capacitor. Performing RMA's (Return to Manufacturer) are somewhat environmentally inefficient, due to the transportation and shipping costs, but overall would help minimize the amount of e-waste produced by the product.

Next, we would have to consider the environmental impact from manufacturing the housing. The prototype housing is ABS and aluminum, but in an actual product, it will primarily be manufactured from extruded aluminum and rubber, due to cost, ease of manufacture, and relative environmental safety. The main pollutants that would result from aluminum shavings, casting chemicals, and coolants used during the manufacturing process. In addition, the rubber could begin to wear out and weaken, which may increase the number of small pollutants that end up in the form of microbeads and plastics, which is extremely hazardous to ocean wildlife [5]. To mitigate this, we can make sure that the rubber fittings and O-rings are rated appropriately for the usage and lifecycle of the product.

Finally, for extending the life cycle of the product, we could add more protections for some of the power components that are more prone to failure. The second iteration of the product will have a flyback Schottky diode parallel to the motor power connector, which will help mitigate the EMF and flyback current, and prolong the overall life cycle of the FET. In addition, we could treat the PCB with epoxy and add some additional heat-sinks for the voltage regulation system. While this would increase the cost and make repairs more difficult, it would require us to put greater consideration in the environmental impact, and have a marked effect on increasing the product lifetime.

For proper disposal, it is imperative that we inform the user of ways of recycling e-waste. Most municipalities within the US have recycling centers, many of which are able to handle the recycling of e-waste. To make sure that the information is readily available, the EPA has set up initiatives such as WasteWise, which encourages businesses to achieve sustainability in their practices, and has a list of valid e-waste manufacturers for every region within the United States. [4] We can link to this information in our technical documentation, as well as possibly putting recycle symbols and simple instructions on or inside the housing. If these notices are ignored or forgotten however, it is more than likely that the product will end up in an electronic waste landfill, further contributing to the growing problem of pollution.

2.0 Ethical Challenges

In order to ensure that the end product delivered to users is safe and secure, the product would require several different kinds of testing for extended periods of time. The primary users of our product are in the commercial space, as well as small businesses, to whom safety is paramount. Overall, this product is ethically sound, if the correct disclosures are made to the customers, and certain precautions are taken before the product is shipped out.

To make sure the device meets the required physical standards, then it must meet an IP65 rating in the IP (Ingress Protection) Code [3]. In order to meet these requirements, it must be able to withstand water from a 12.5mm nozzle, at 100 kPa from a distance of 3 meters for at least 3 minutes. [3]. This would ensure that the device would be able to withstand physical weather conditions, such as rain, hail, snow, and sleet. The test would mostly revolve around ensuring that the device would operate correctly under different temperature conditions. In addition, the tests must determine to which extent the device is tamper-proof, so there can't be any easy or obvious methods of access for unauthorized or malicious users. Some of the ways we could do this are to make the drill holes and mounting holes less accessible without the right tools, and keep the lock from being too easy to pry open. This means that disclosures of the safety concerns must be well-disclosed in the instruction manual and other technical documentation. Some of this will also have to exist in the form of child-proofing, so we would place some warning labels and tags on the power cables.

Next, the device must ensure that the data exchanged between the PCB and Raspberry Pi, and the Raspberry Pi and server are cryptographically secure. Fortunately, the MSP432 "E-series" has several hardware accelerators for different encryption schemes, such as DES and AES. [6] This would be most useful when making sure that the signals being sent between the Raspberry Pi and microcontroller are valid. The more pressing concern would be making sure that the image data being passed between the Raspberry Pi and server is encrypted. The Raspberry Pi does not have any hardware accelerators for encryption schemes, but overall it would not be completely necessary due to the clock speed and processing power on the SoC. Therefore, it would be able to use asymmetric encryption schemes such as RSA and ECC to establish a shared session key, before passing any information through WiFi or Ethernet.

However, it is important to note that this product has not been heavily tested with the addition of encryption schemes. As of this moment, we cannot accurately determine if this would have a marked impact on the time required for a user to gain access to the lock. This would have to be something to be tested as development of the product continues to move forward.

With all of these considerations, we can conclude that the product is ethically sound. It has the capability of being damaging to the environment, but we have, at the very least, attempted to supply users with the requisite amount of knowledge to take proper precautions when using the product, as well as making sure that it can be properly looked after and maintained, and eventually disposed of in an environmentally safe manner.

3.0 Sources Cited

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