Ethical and Environmental Analysis

Year: \_2017\_ Semester: \_\_Fall\_\_ Team: \_\_3\_\_ Project: VR Sports

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Assignment Evaluation:

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| **Item** | **Score (0-5)** | **Weight** | **Points** | **Notes** |
| **Assignment-Specific Items** | | | | |
| **Environmental Impact** | 5 | x6 | 30 |  |
| **Ethical Challenges** | 5 | x6 | 30 |  |
| **Writing-Specific Items** | | | | |
| **Spelling and Grammar** | 4 | x2 | 8 |  |
| **Formatting and Citations** | 5 | x1 | 5 |  |
| **Figures and Graphs** | 5 | x2 | 10 |  |
| **Technical Writing Style** | 5 | x3 | 15 |  |
| **Total Score** | 98 | | |  |

5: Excellent 4: Good 3: Acceptable 2: Poor 1: Very Poor 0: Not attempted

Comments:

*Impressive writing. The research was done very thoroughly.*

1. Environmental Impact Analysis

In general, the Virtual Sport project doesn’t have a lot of harmful effect to the environment. The components of the project consist of PLA materials which were used for 3-D printing, common electronic devices that were commonly used in most ECE projects, a battery box with a 9-V battery and a PCB mounted on top of the self-designed model. Although these components were commonly seen and utilized, some of them have potential hazards to the ambient or consume excessive amounts of energy and environmental resources. These concerns, as well as their solutions, can be found during the manufacturing process, normal use and the disposal process.

The manufacturing of the PCB board and microchips requires hazardous and non-biodegradable chemicals. It also needs huge amount of energy. According to American Chemical Society [1], the chemicals used to fabricate a 32MB DRAM chip have the potential to bring contaminations to local water, air and soil system. The fossil fuels used during manufacturing also emit carbon dioxide. Meanwhile, the fabrication process consumes huge amount of energy while producing very little amount of silicon as stated on the table that the process chain to produce wafer consumes 2,130 kWh and only produces 9.5% of the silicon. Considering these side effects brought to the environment, an environmental-friendly manufacturing process and an optimized and consummate chemical disposal after the manufacturing the Virtual Sport project are needed. The United States Environmental Protection Agency has provided a set of complete guidelines of waste minimization methods for the PCB Industry [2]. For example, using abrasives and non-chelated cleaners during cleaning and surface preparation process is recommended due to its ability to increase cleaning efficiency and to diminish hazardous waste generation. These sets of method of waste minimization bring up fabrication efficiency and reduce industrial waste after the production. However, according to the PCB manufacturing profile in the same guide [2], the raw materials of the PCB include poisonous or inflammable chemicals such as alkaline ammonia and asphalt which will bring pollution to the environment or trigger accidents. Therefore, the manufacturers should recycle all the recyclable materials such as asphalt and neutralize acidic or alkaline materials. For example, using ethanoic acid or adding more ammonia to remove the alkaline ammonia generated [3]. As for the huge energy consumption, improvements can be made during fabrication process. For example, more rational bores spacing is needed to reduce leftover pieces generated in the machining process [4].

In addition to the PCB manufacturing, the soldering process could potentially trigger some health problems. Large amount of soldering fumes is generated during the soldering process. According to the analysis of the soldering fumes [5], these fumes come from the flux used during soldering and the fumes contain 90% resin acid with 10% neutral materials. The fumes would cause health problems such as chest pain, eye and nose irritation and skin diseases. To minimize these side-effects, the soldering station needs to have a good ventilation device to absorb the fumes to prevent the person inhaling the fumes.

During its normal use, the Virtual Sport project does not have obvious negative impact on the surroundings. The project involves communication between the handle the user holds and the virtual reality application. The only energy consumption will be the 9V battery powering the entire system. However, a switch is implemented on the handle so that when the product is not in use, the user can turn off the batter power to prevent continuous consumption of the battery.

The project will trigger some problems under the disposal process. Several critical components have to be disposed: first, the non-rechargeable battery that the Virtual Sport project is using; second, the 3-D printed PLA filament; third, the PCB board and all the electronic devices. The problems of disposing non-rechargeable batteries have always been one of the top environmental problems nowadays. Despite of normal disposal process, the Virtual Sport project can also adapt to a rechargeable battery to eliminate battery disposal problems. However, unlike the batteries, disposing PLA filament is a lot more complicated because PLA is a polymer consisting of various combinations of compounds and distinct types of PLA could have different disposability. News proposes that four methods of disposing PLA are available: landfilling, combustion, fertilizing and recycling [6]. However, the same news also states that not all the methods can be applied to all types of PLA [6]. Thus, investigating the type of PLA before 3-D printing and applying the right method of disposal are suggested. Disposing PCB and electronic components is even much more complicated because different components on the PCB have different ways of disposal. According to Maria Paola Luda [7], the non-metal components of the PCB can be disposed through physical recycling of cutting and compositing or chemical recycling of pyrolysis and gasification. Three methods are also available for disposing metal components [7]. This provides multiple options of disposing various components on the PCB board.

1. Ethical Challenges

The Virtual Sport project has a few ethical challenges when it is brought to the market. However, due to the whole design and the technology involved, some ethical issues still exist when customers use this product such as the customer security and the side effect that Virtual Reality technology might bring to the user.

The stability of the system is probably the biggest issue because each component of the Virtual Sport project handle is connected through hook and loop fasteners stuck on the surface of the PLA filament. Although the hook and loop sides of the fasteners were connected very tightly, the connection between the PLA surface and the fasteners grows weaker triggering a potential of a component falling apart. In addition, all the electronic components are connected with the internal surface of the handle. Breaking one part of the handle would cause a malfunction of the whole appliance. A possible solution to address this stability problem is either using fasteners with stronger stickers, or using screws to connect each component since screw connections are commonly seen in most products on market. Meanwhile, a fragile warning can be issued on the user manual of the product informing customers to carefully use the product.

Besides stability problem, the involvement of the Virtual Reality also brings some side effects. The Virtual Sport project requires the user to wear a VR headset while using the product and the user cannot see the surroundings in the real world. The inability to detect the real world puts the customer into a dangerous situation. Furthermore, due to this inability, the user has difficulty to hold the handle very safely and stably and that triggers a potential physical harm to the customer. As a result, using the product alone is not suggested and the suggestion of having someone to watch over the customer will be written on an obvious and clear position of the user manual. Another method resolving this problem is to switch to Virtual Reality to Augmented Reality or Mixed Reality to allow the customer to see the surroundings.

Finally, the Virtual Sport project potentially causes visual problems. The Virtual Sport project uses a VR headset that allows cell phones to be inserted. The cell phone runs the VR application and the user sees the virtual world on the cell phone from the VR headset. The eyes and the screen of the cell phone stay so close that using the product for a long time leads to near-sighted problems for young users. Except for that, other users could sense the eye-tiredness after staring at the cell phone screen for excessive amount of time at a very close distance. Therefore, the user documentation advises the user not to wear the headset for so long.

3.0 Sources Cited

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