

Ethical and Environmental Analysis

Year: 2017 **Semester:** Spring **Team:** 12 **Proj:** Guitutar Embedded Learning Device
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Assignment Evaluation:

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	5	x2	10	
Formatting and Citations	4	x1	4	
Figures and Graphs	5	x2	10	
Technical Writing Style	5	x3	15	
Total Score	99/100			

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

Comments:

I don't really have a lot more to say on this piece. This was an excellent analysis, and I especially appreciated that you broke the product's lifetime into natural segments to explain the environmental impact at each.

1.0 Environmental Impact Analysis

The Guitutar guitar-neck embedded learning device consists of a machined guitar neck without an attached wooden fretboard, neck-mounted device printed circuit boards (PCBs) with mounting points for frets, and a plastic overlay to act as separation between the user and the PCBs themselves.

Just as with many typical consumer devices, there are three stages of the product's life cycle: manufacturing and production, consumer possession, and product disposal. While these three stages are sequential, the consumer possession stage consists of alternating usage phases: active usage and device idling.

1.1 Manufacturing and Production Environmental Impact

Guitutar differs from other electric guitars in its production as it not only requires the materials to create the guitar's body and neck, the pickups, and the actual electrical connections, but also requires the manufacture of several neck-mounted PCBs and the plastic overlay.

Guitars have long been a source of issue regarding the wood that is used to produce them. Infamously, Brazilian rosewood was used for guitar manufacture because of its rich sound and reverberant tendencies. In 1969, many major producers stopped using it in favor of Indian rosewood due to the fact that it was evident that Brazilian rosewood harvesting was depleting coastal forests [1]. Ultimately, the use and export of Brazilian rosewood, famous for its inclusion on many of the best vintage guitars up to the late 60s was banned by a 1992 addition to the CITES treaty [2]. Brazilian rosewood, however, is simply an example of the damage that the creation of millions of guitars a year can have. While Guitutar is simply a small addition to that market and would not be the tipping point for the international deforestation issue in which guitars are merely a niche share, the wood consumption used in the process of production is one of the primary environmental contributing factors.

Production of Guitutar requires several neck-mounted PCBs to support its packaging, tolerances, and precision, each of which must go through an involved production process. Basic PCB production process begins with a raw board that consists of thin copper plating around a laminate epoxy and consists of four primary steps: masking, copper addition (the additive process), chemical masking, and chemical etching (the subtractive process). Ultimately, the final board has only the plated copper traces that were defined in the original masking process. Unfortunately, however, PCB production has serious implications environmentally due to the chemicals involved in the production process. The primary waste streams produced during PCB manufacturing are contaminated rinse water, waste chemicals, effluents containing metals, organic solvents, acids, and cyanides, waste boards, and emissions [3]. Because PCB production generates this hazardous waste and may require additional treatment, the disposal processes of this waste as defined by the EPA must be followed just as with any other production process. As this is a necessary process for many electronics, outside of reduction of PCB usage in favor of more discrete components in the design there isn't much of a way to reduce waste.

1.2 Consumer Possession

While in possession of the consumer of Guitutar, there is no environmental impact from it simply existing. The wood, PCBs, and plastic materials that are used in the production of Guitutar have no ambient environmental impact. Additionally, the design has no emissions associated with its operations outside of the nominal electromagnetic radiation associated with any operating electronics.

1.3 Product Disposal

Guitutar's disposal is different than many other guitars due to the fact that failing digital electrical components cause more frequent disposal than a purely analog device and that it has more analog points of failure such as the general driving and power circuitry necessary for operation. Regardless of these failures, the guitar is still usable when the digital components of Guitutar fail as it is simply an augmented guitar which maintains all of its original functions, meaning that the device does not explicitly require disposal upon inoperability of the teaching functions.

The primary packaging components that go into Guitutar are the guitar components themselves and the plastic overlay that goes over the fretboard. These are entirely comprised of wood and plastic except for the pickups, frets, and wiring, all of which are metal and can be melted down and recycled. The wood and plastic components of Guitutar's body can simply be recycled as well, allowing the entirety of the package to be reused or, in the case of the wood, to simply decompose if it is not reclaimed.

The design specific PCBs, unlike the packaging components, cannot simply be melted down or recycled and must be disposed of using specific methods for PCB recycling. PCB recycling is a field that is currently undergoing research and currently is in a state where the recycled products are not of great value, but the processes still exist. The primary method of PCB recycling consists of shredding and smashing the PCB into small enough parts that they can be repurposed, the primary issue with which, however, is the emission of industrial dust, irritant odor, and immense noise pollution [4]. Methods for PCB destruction are being researched and improved right now, though. New processes are aimed to counteract those large disadvantages by such methods as superimposing a spray water process to catch particles before they become airborne and to surround equipment with cabin mounted sound-absorbing material to protect operators [5]. In the context of mass production of Guitutar, the PCB is limited to the surface area of the fretboard and does not have an enormous impact, but nonetheless at the time of device disposal, the PCBs are to be recycled.

The final component within Guitutar that is sensitive to disposal is the battery that powers the entirety of the system. The battery within Guitutar is a rechargeable Lithium ion battery that cannot be disposed of by simply being thrown in the trash due to the presence of corrosive chemicals and charged electrodes. A Lithium ion battery when punctured erupts into flame, a leading cause of recycling and trash truck fires due to the pressure and heat put onto a battery while being transported [6]. To address this, disposal of batteries must be done at a specified battery recycling facility in order to be disposed of properly after separation from the final Guitutar packaging.

2.0 Ethical Challenges

While it is difficult to make a musical instrument that is made to teach a consumer into an unethical venture, there are a couple aspects to be considered when bringing the finalized product to market. Due to Guitutar's usage of playing songs as well as its intention to allow self-teaching, there is capacity for unauthorized usage of unlicensed songs as well as, to a lesser degree, the possibility of hurting the privatized music education industry.

Guitutar's primary engine of unethical usage comes in the form of song presentation and licensing. In order to present a song to a consumer and market a device based on its capacity to contain that song, there is the potential for licensing to be needed. Just as the lawsuits with tablature, or informal transcription of songs for guitar in a string-by-string and fret-by-fret format, where the music industry pursued tablature sites who displayed tabs without licensing, the inclusion of tabs in the device at the time of shipping would infringe upon the copyright of the artist who wrote the song [7]. In Guitutar's case, however, the songs are not preprogrammed, but are rather user-input. There are no songs to be included on the final device, but the capacity of the consumer to copy a tab and input it into the device via the application is unrestricted. This leaves open an opportunity for an ethical breach on the part of the consumer, but is not endorsed by the producers and designers of Guitutar - a similar philosophy to that of BitTorrent.

To a lesser degree of potential ethical breach than that of copyright infringement, Guitutar's primary purpose is to allow a student to teach themselves songs that are programmed into the device. If the device were to have mainstream success, there is a possibility that the privatized music education industry, many businesses of which are comprised of one or a few lifetime guitarists trying to run a small business, would see an impact due to the lack of a need for the industry. This issue is analogous to that of factory workers being replaced by machines - the familiar plight of automation replacing jobs that is ultimately an inevitability.

3.0 Sources Cited

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