Homework 4: Packaging Specifications and Design

Due: Friday, February 13, at NOON

Team Code Name: FlacTrac **Group No.** 9

Team Member Completing This Homework: Greg McCoy

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NOTE: This is the first in a series of four "design component" homework assignments, each of which is to be completed by one team member. The body of the report should be 3-5 pages, **not** including this cover page, references, attachments or appendices.

Evaluation:

SCORE	DESCRIPTION
10	***Excellent*** *– among the best papers submitted for this assignment. Very few corrections needed for version submitted in Final Report.*
9	***Very good*** *– all requirements aptly met. Minor additions/corrections needed for version submitted in Final Report.*
8	***Good*** *– all requirements considered and addressed. Several noteworthy additions/corrections needed for version submitted in Final Report.*
7	***Average*** *– all requirements basically met, but some revisions in content should be made for the version submitted in the Final Report.*
6	***Marginal*** *– all requirements met at a nominal level. Significant revisions in content should be made for the version submitted in the Final Report.*
*	***Below the passing threshold*** *– major revisions required to meet report requirements at a nominal level.* ***Revise and resubmit.***

* *Resubmissions are due within* ***one week*** *of the date of return, and will be awarded a score of "6" provided all report requirements have been met at a nominal level.*

Comments:

Comments from the grader will be inserted here.

1.0 Introduction

The "FlacTrac" is a mobile digital audio player which decodes FLAC files stored on a SecureDigital (SD) card and synthesizes the sound data to a 3.5mm headphone jack which could be routed to earphone. As a mobile digital audio player, the main packaging constraint is making a device that is small enough to be handheld and light enough to be carried around. This report will analyze current digital audio players in the field to better grasp the challenges we face and gain insight on good practice in packaging, and then show our plan for the "FlacTrac."

2.0 Commercial Product Packaging

Fortunately, there are many examples of commercial digital audio players. As a highly competitive consumer market, packaging style and utility is of high importance in the marketability of a digital audio player. To help design the "FlacTrac," we will look at three commercial product lines: the Apple iPod, Microsoft Zune, and the Sansa series by SanDisk. Table 1 compares the specifications of a few select devices from each product family.

2.1 Apple iPod Family

Though not the first consumer, portable digital audio player, the iPod line has captured an extremely high market share (as high as 82% in 2004) [1]. Apple Inc. released the original iPod in October 2001 as a hard-drive based, Macintosh-only device, but over the next few years a line of iPods was developed available with either a miniature hard drive or onboard Flash memory; and also began to support both Macs and PCs running Microsoft Windows, using proprietary software to load music onto the device.

Figure 1: iPod classic [2]

Figure 2: iPod nano, the smallest full-featured iPod to date [3]

The iPod is notable for its simple, minimalist user interface, which many find easy to use. All incarnations of the iPod (with the exception of the iPhone-like iPod Touch, which is more related to the touch-screen iPhone) are controlled primarily using a rotary wheel, originally mechanical on the first iPod design but capacitive-sensing design on later models. Mechanical buttons for "next track," "previous track," "home," and "play/pause" are placed under the capacitive wheel, so that the user can slide his or her finger around the wheel to make selections or push on the wheel to perform the appropriate function [4]. A select button is then placed in the middle of the wheel. This, along with a relatively minimalist onscreen interface compared to other devices, sets the iPod apart from the competition and may be a key to its popularity.

There are only two major ports on most iPod models – a simple 3.5mm audio connection for headphones and a 30-pin proprietary dock connector; which facilitates FireWire and/or USB (depending on model); charging (often as a by-product of the FireWire/USB connection); line level audio; and on some models, video output. The resolution of the onboard LCD screen was a modest 160 by 128 pixels for the first iPod to 320 by 240 pixels on the current iPod classic model.

2.2 Microsoft Zune 80

The Microsoft Zune is a product family quite similar to the iPod. The Zune 80 is a much more complicated device than the iPods we examined. It has essentially all of the features of the full-sized iPods, plus an IEEE 802.11b/g wireless interface for connecting to the Internet and to other Zunes, as well as a broadcast-band FM radio. These features allow the Zune to implement some advanced features. It can wirelessly share music with other Zunes,

and purchase music from the online Zune Marketplace. Synchronization with the Windows PC can be accomplished wirelessly as well. Songs heard on FM radio can be purchased by automatically taking the Radio Data System (RDS) data and finding the matching song on the Marketplace.

Figure 3: Microsoft Zune 80 [5]

The Zune interface consists of two buttons ("play/pause" and "back") and a capacitive touchpad known as the "Zune pad." Unlike the iPod click wheel, the Zune pad allows the user to make directional gestures in all four directions and tapping to select. This might make the Zune more intuitive than the iPod click wheel for some users, but it seems to be a matter of personal preference.

For the most part, other than the differences already mentioned the Zune is fairly similar to the iPod, although it might be marketed towards a more tech-savvy crowd who would take advantage of the network capabilities.

2.3 SanDisk Sansa

The SanDisk Sansa devices are different from the iPod and the Zune in that many models can use removable storage, in the form of microSD cards; which isn't exactly surprising since SanDisk is one of the largest manufacturers of flash memory cards. The microSD works with SanDisk's slotMusic system, which is an attempt to sell popular music on flash memory cards instead of compact discs or online downloading, allowing use of a small MP3 player without a computer.

The Sansa Fuze is the most inexpensive model that offers the microSD card slot. It is available for $79.99, $99.99, or $119.99 for 2, 4, or 8 GB models respectively. The Sansa Clip is a smaller, inexpensive player which

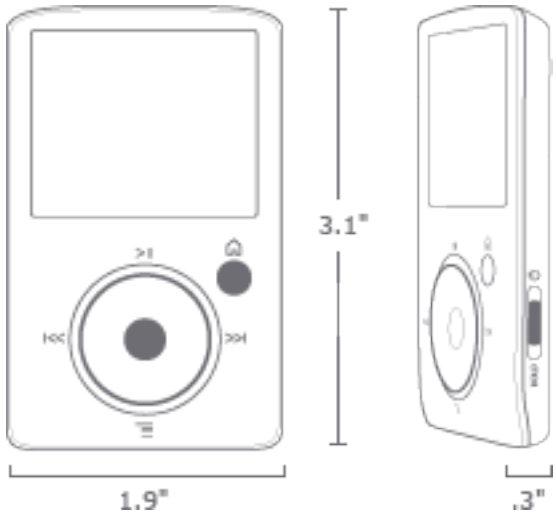

Figure 4: SanDisk Sansa Fuze [6]

uses internal flash memory, but is available for as little as $39.99 for the 1 GB model.

Both models have a user interface very similar to (and clearly inspired by) the iPod. The Fuze is smaller than the iPod classic and the Clip is even smaller than the iPod nano, already an impressively tiny device (although it is a bit thicker).

3.0 Project Packaging Specifications

The central concern in designing a digital audio player is making it small enough and light enough that it will be easy to carry. Some manufacturers take this to extremes – the iPod nano and the Sansa Clip are undoubtedly *too small* for many individuals. The biggest constraint in our packaging design is our LCD display, which is the largest component. Our desire to have a graphical LCD display (and the challenges of finding an appropriate device) dictate much of the resulting packaging.

Figure 5: Hammond 1553 Enclosure [7]

In order to make a comfortable device to hold, we wanted to use a prefabricated enclosure that was designed for the purpose, if possible, since we can't afford to spend much time on ergonomic mechanical design. To achieve this we selected the Hammond Manufacturing 1553D enclosure (as pictured in Figure 5) because it appeared it would accommodate the LCD and lithium ion battery as well as a reasonably sized PCB. The results of squashing everything into this enclosure are shown in the drawings in Appendix A.

There are no requirements for spacing for heat dissipation listed in the data sheets for either our battery or the LCD, so we will have to wait until these parts are acquired to evaluate the effect of this on our packaging design. To maximize available space and the utility of the device, we plan to orient the LCD in a vertical fashion. Conventional buttons for controlling the device will be placed below the LCD screen. An SD card slot will be located in the bottom edge of the device.

4.0 PCB Footprint Layout

The datasheet for the Hammond enclosure dictates the optimal dimensions of the PCB it is designed to contain. This forms the biggest constraint to our PCB footprint. The basic dimensions of the PCB are 139.11 mm by 67.83 mm. A detailed drawing of the approximate layout and the exact notches and gaps required by the enclosure is available in Appendix B.

5.0 Summary

Table 1 outlines the features of the devices profiled, and the "FlacTrac" itself.

	FlacTrac (projected)	Apple iPod (2001)	Apple iPod classic	Apple iPod nano	Microsoft Zune 80	Sanza Fuze
Height	127.4 mm	102.1 mm	103.5 mm	90.7 mm	108.2 mm	78.7 mm
Width	89 mm	61.7 mm	61.8 mm	38.7 mm	61.1 mm	48.3 mm
Thickness	25 mm	19.8 mm	10.5 mm	6.2 mm	12.9 mm	7.6 mm
Weight	256 g	185.9 g	140 g	36.8 g	128 g	59.5 g
Display	2.68" B/W 128x64 px	2" B/W 160x128 px	2.5" color 320x240 px	2" color 240x320 px	3.2" color 320x240 px	1.9" color 220x176 px
Cost	$100	$400	$250	$150-200	$230	$80-120

Table 1: Comparison of Various Digital Audio Players

We don't expect the "FlacTrac" will beat the iPod for any industrial design awards, or beat the Sanza products on weight or size, but then it's not really a fair comparison because large production devices have the benefit of custom made components and mechanically engineered enclosures. Our packaging plan appears to be in the ball park of the state-of-the-art and should provide the end user with a sensible, capable device.

List of References

[1] "Apple's Jobs Taps Teen iPod Demand to Fuel Sales, Stock Surge," bloomberg.com, Oct. 11, 2004. [Online]. Available: http://www.bloomberg.com/apps/news?pid=10000103&sid=a58iozj_2jXM. [Accessed: Feb. 12, 2009].

[2] "Apple – iPod classic," apple.com, Sep. 5, 2007. [Online]. Available: http://www.apple.com/ipodclassic. [Accessed: Feb. 4, 2009].

[3] "Apple – iPod nano," apple.com, Sep. 9, 2008. [Online]. Available: http://www.apple.com/ipodnano. [Accessed: Feb. 4, 2009].

[4] "How iPods Work," howstuffworks.com, Mar. 14, 2006. [Online] Available: http://electronics.howstuffworks.com/ipod4.htm. [Accessed: Feb. 12, 2009].

[5] "Zune.net – Zune 80." zune.net, Jun. 13, 2008. [Online] Available: http://www.zune.net/en-us/mp3players/zune80/default.htm. [Accessed: Feb. 12, 2009].

[6] "Sansa," sansa.com, Mar. 28, 2008. [Online] Available: http://www.sansa.com [Accessed: Feb. 12, 2009].

[7] "Hammond Mfg. – Soft Sided Hand Held Enclosures (1553 Series)," hammondmfg.com. [Online] Available: http://www.hammondmfg.com/1553.htm [Accessed: Feb. 12, 2009].

Appendix A: Project Packaging Illustrations

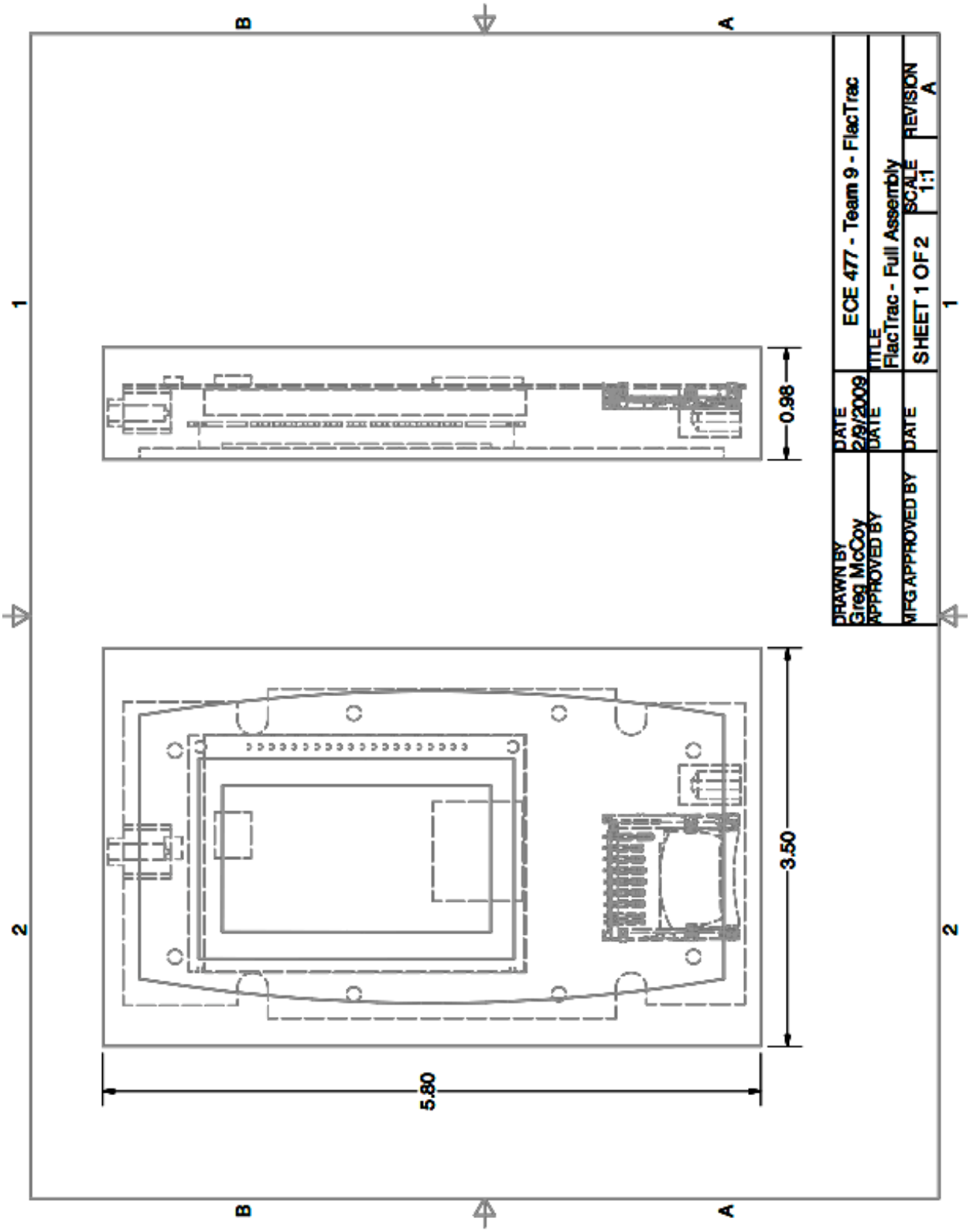

Figure 6: Exterior Dimensions

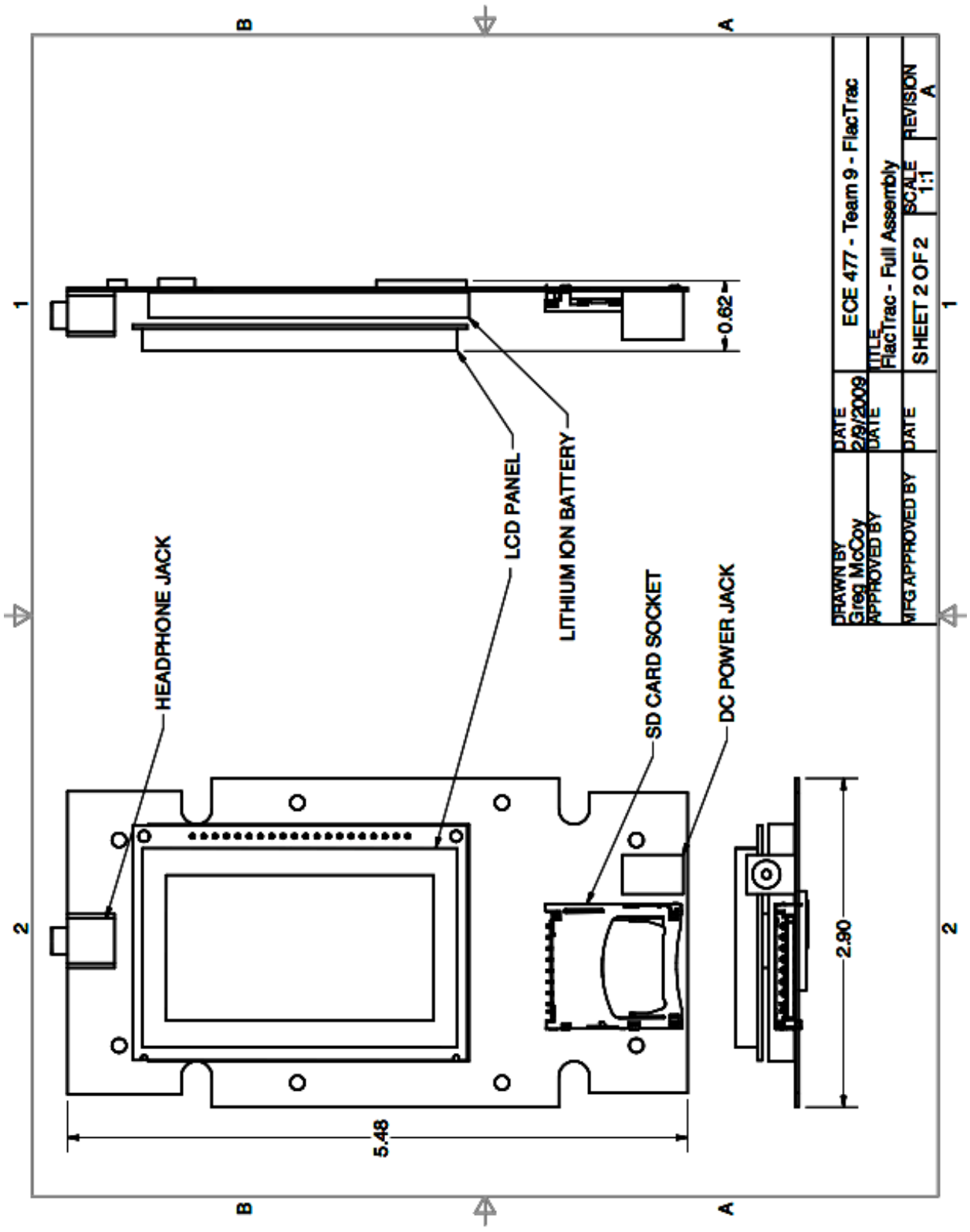

Figure 7: Internal Dimensions

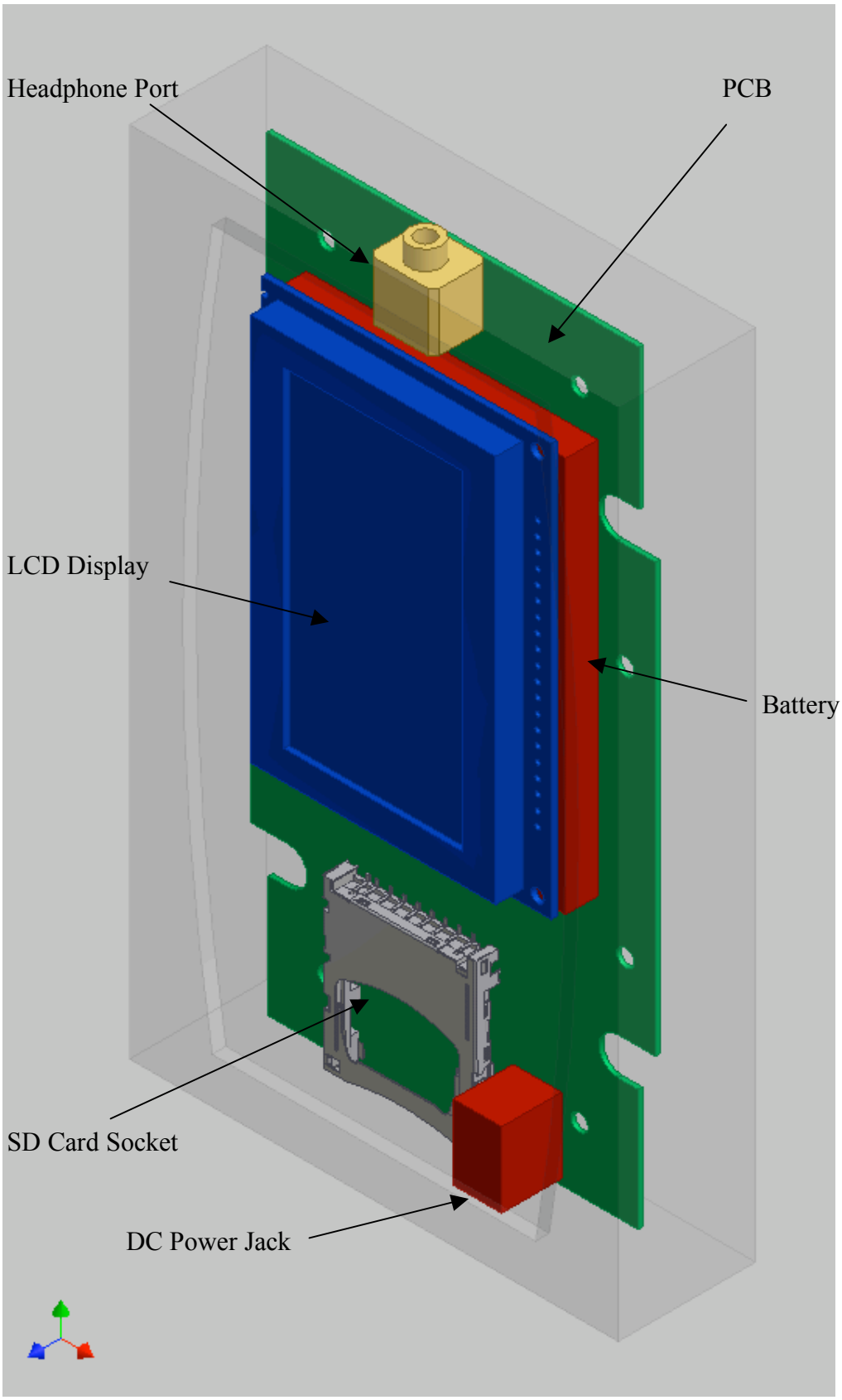

Figure 7: Isometric View

Appendix B: Project Packaging Specifications

Table 2 shows the major components of our design, along with the cost to us for a single unit of each (prototype cost) and the quoted cost for 100+ parts in a production setting. Cost savings of 40% are possible on these components alone when even modest quantities of the device are produced. We are confident in our ability to design a product that can meet the $100 price point when mass-produced.

Manufacturer	Part No.	Description	Qty	Prototype		Production	
				Unit Cost	Total Cost	Unit Cost	Total Cost
Analog Devices	ADSP-21262	3rd Gen Low Cost 32-Bit SHARC DSP	1	$ 30.69	$ 30.69	$ 25.58	$ 25.58
Crystalfontz	CFAG12864BTMIV	128x64 Graphic LCD w/ Parallel Iface	1	$ 33.30	$ 33.30	$ 10.25	$ 10.25
Analog Devices	AD1854JRSZ	Stereo, 96 kHz, Sigma-Delta DAC	1	$ 8.80	$ 8.80	$ 6.60	$ 6.60
Analog Devices	SSM2135SZ	Dual Audio Operational Amplifier	1	$ 5.65	$ 5.65	$ 3.01	$ 3.01
Hammond Mfg	1553DGY	Handheld Plastic Enclosure	1	$ 7.48	$ 7.48	$ 4.86	$ 4.86
Kobiconn	163-7620-E	Coaxial DC Power Jack	1	$ 0.63	$ 0.63	$ 0.15	$ 0.15
Ultralife	UBBP01	Lithium Ion Rechargable Battery	1	$ 14.45	$ 14.45	$ 10.58	$ 10.58
Molex	67840-8001	SD Card Connector	1	$ 3.66	$ 3.66	$ 2.46	$ 2.46
Kobiconn	161-352N-EX	3.5mm Audio Jack	1	$ 1.32	$ 1.32	$ 0.73	$ 0.73
				Total	$ 105.98	Total	$ 64.21

Table 2: Major Parts List

Oddly enough, several of the components in our design have no weight specification listed in their datasheets (the LCD and enclosure in particular). Still, the lithium ion battery is likely one of the heavier components, and comes in at 46 grams. While we don't expect to win a contest against the iPod nano or the Sanza models, we expect the device will be manageably lightweight, but with little concrete evidence to verify at this point.

Minimal machinery will be necessary to cut the enclosure at the necessary points for the LCD display, jacks, etc. Unless the enclosure proves to be unworkable and we have no other choice but to fabricate our own enclosure, we expect our machining needs to be minimal.

Appendix C: PCB Footprint Layout

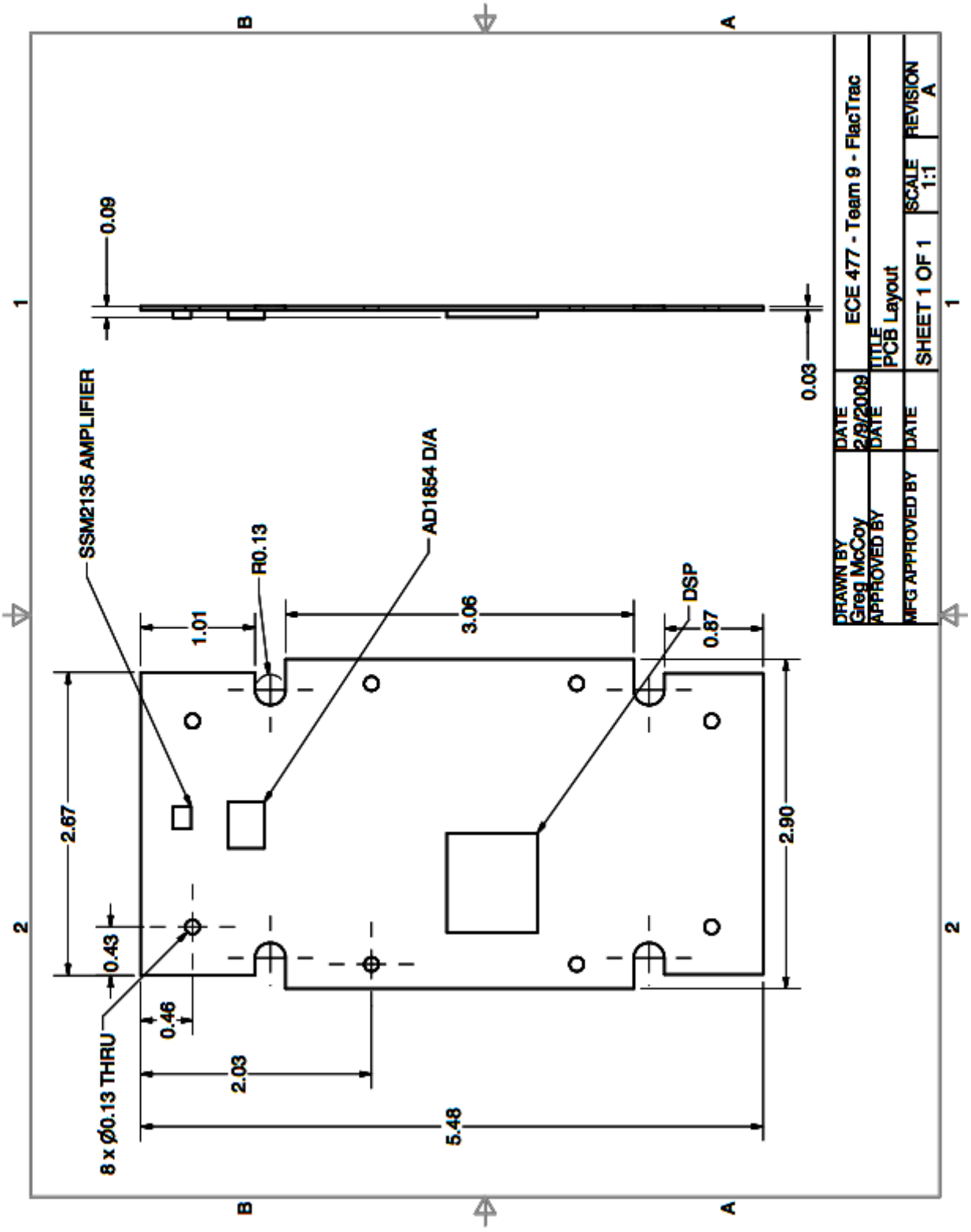

Figure 7: Isometric View

The PCB layout shows the available space for a circuit board usable inside the Hammond enclosure. More intelligent layout will be possible when we have finalized the schematic and determined all components, but for now it appears that there will be enough space available. The A/D converter and the amplifier for the headphone jack are naturally placed towards the top of the device. Sufficient space for the SD card connectors, power supply, and various discrete components appears to be available.