The Lazy Man’s MP3 Player

Second Semester Report

Spring Semester 2008

By

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Prepared to partially fulfill the requirements for

ECE402

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Abstract

Life is strenuous. Everyday, you wake up, go to work, come home, and then there’s more work. Technology helps to ease the workload throughout your day. New technology is invented everyday to lighten the load that we carry each day. The car gets to our destination so we do not need to walk; the microwave makes instant dinners so we do not need to slave over a stove; Cell phones keep people easily connected. Technology not only lightens our daily work load, but it also makes life a lot easier. You could even say that it makes people LAZY.

Lazy, that is the keyword for what our project is about. Not saying that we are lazy people who are lazy with our project. Our project is built especially for the lazy man. We have a device for a lazy music lover. Our device is not only controlled by your hand, but also by your voice. Yes, our MP3 player will be controlled by one’s voice, freeing up their hands to be able to do other things. The average person loves to multitask. Although it is less efficient, it does seem to get a lot done at once. Our device is all about the multitasking. It lets you use another part of your body that is not normally used to get tasks done, unless you have a slave or butler that you use your voice to command to get things done. Think of our MP3 player as your very own music butler.

There are recently developed advances in technology that have incorporated our idea to some extent. The new Microsoft Sync that is placed in new Ford vehicles have a semi-hands free approach to navigate through songs and function through voice commands. By “semi-hands free” I am meaning that the voice is inputted into the system when a button is pushed. However, since you are in your car, the distance from your mouth to the microphone is relatively close. With our MP3 player, the idea of a person needing to be close to the microphone defeats the whole “lazy” factor. Background noise also is a humongous factor when you distance the microphone and the person. Our design plans to bring the two together in order to make the ULTIMATE LAZY MAN’S DEVICE!!!!
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Chapter I – INTRODUCTION

The MP3 Player, presently one of man’s highly used piece of technology in the USA. Almost everywhere you go you can find an MP3 Player. Some examples would be a car, cell phone, computer, PDA, sunglasses, home theatre systems. Our group decided to take on this task of not adding to the list of MP3 systems, but making life easier for a music lover at home. Current home MP3 systems have navigation. Their navigation is so simple that you would have to manually cycle thru a list of songs in order to play the desired song you want to listen to. If your MP3 is set up correctly you could have an easier time cycling thru songs, but what if your songs are not organized well. Most people just throw songs on their device with no organization. Our MP3 Player will make it much easier to navigate thru songs without having to get out of your seat. Another problem is that everyone is lazy nowadays. What we want to do is add to that problem, and make a device that will make listening to music even more relaxing.

With all the advances in technology today, we decided to bring two pieces together into one functional device. Our project consists of an MP3 Player for your Home Entertainment System that can be controlled from your couch via wireless remote control. However, that isn’t the only thing that our MP3 Player will be able to do. Navigating thru songs by wireless remote is such an easy task. We plan on taking it to the next level with Voice Navigation. A microphone will be mounted on top of the remote control and will communicate with our MP3 Player using Bluetooth technology. The remote control will run our voice recognition software and analyze the voice of the
user. It will then transmit the command to the MP3 Player and navigate to the desired command.
Chapter 2 – MP3 Players of the Past

A voice recognizing MP3 player was first designed for cars, an amazing strategy to rise up the music industrial technology level. This mp3 player will allow the driver to explore his/her music library using an installed microphone inside the car and choose the song he/she wants by only saying either the name of the singer or the song's name out loud. This is an encouragement for others to start developing devices that work wirelessly and this is where it all started for us.

Another "You Say It, We Play It" portable mp3 player is one of the first in the world to have an "On Demand" function using voice recognition. A person can download the song, directly speak it out, and within one second the song will be played.
Chapter 3 – Design Decisions

After researching for the perfect MP3 player, we ran into multiple mp3 player designs, we decided to create something that has not been done before, or at least are not popular marketwise. An mp3 player that will receive voice commands through voice recognition software installed to it was a perfect decision for our group, we were confused on whether it should be portable or stationary, and we had mixed opinions and many ideas.

Throughout the time of our research, our group finally came to an important decision. It was to update an already built and tested MP3 player by adding voice recognition software to it to enable wireless controlling of the MP3 player. It was a decision to create a stationary mp3 player that will receive a voice command through the voice recognition software installed via Bluetooth and it would take the song from the hard drive (storage) and play it. Since this decision was made, we were left only with one more job, which is to purchase the equipment and parts and start working on building the Lazy Man’s MP3 player.

Since we decided to transmit the voice signal through the voice recognition software, but didn’t decide how we would do that. One of our group members came up with an idea of a wireless microphone that has Bluetooth installed to it to transfer the voice signal to the stationary MP3 player, we decided to take his idea into action and start searching for wireless microphones, we ran into a good amount of microphones so we decided to add that to our design as a part of the mp3 player.
We discussed how to use Bluetooth and where we would find a kit that is compatible with our system. Our project advisor brought a Microsoft employee Mr. Dave Rohn to our discussion table and that he welcomed the idea of building a wireless voice recognition MP3 player and that Mr. Dave Rohn donated a Bluetooth kit to our group project. Therefore we were left with the actual MP3 player to build.

Since we haven’t exactly decided which way we will go on building the MP3 player, our group members found an already built and tested MP3 player online for purchase. Our main focus was the voice recognition part on the MP3 player since MP3 players are popular as it is and it would be considered a duplicate project of millions of projects in the world, we wanted something special added to our project other than audio. We decided to purchase the built MP3 player to save us time on building an actual MP3 player from scratch then actually taking voice recognition into consideration since it will take up most of the time to get the MP3 player up and running. After we ran into problems as stated in the problems section, we found that our design decisions have changed. We instead of using the Bluetooth kit device donated found a Bluetooth Headset that would connect to a USB device that is attached to our computer, and transmit voice to our voice recognition software through that. We also decided to use voice recognition software that will allow us to write our own codes into, therefore control the way our commands are heard into the voice recognition software.

When we talk about an MP3 player, we automatically think a portable MP3 player, but in our case its not. Therefore we need power. But how are we going to
power up our hard drive? Well, our built MP3 player came with its own power supply, therefore saving us the time of powering up the MP3 player. Attached to the MP3 player through the IDE interface output is a hard drive, which needs power. Our group decided to use a computer hard drive power supply (5v) pulled out of one of the group members' computers to power up the hard drive. It worked correctly and now we have our hard drive functioning with our MP3 player.

Speaking into our Bluetooth Headset is not efficient if there is no way to transmit it to the MP3 player. Therefore we decided to go with "E-speaking", which is our voice recognition software, software that will allow us to write our own commands, transmit our words through the Bluetooth Headset into text and sends it to our MP3 player, and it would be the MP3 player's job to grab the songs from the hard drive and play it. E-speaking software was our decision on the voice recognition part and it functioned correctly.
Chapter 4 - Problems

At the beginning of the semester we ran into problems on deciding which way to go would be the best for us as a group, what components to purchase, and how much money are we allowed. Since our project will probably cost more than any other project at CSU, we decided to speak with our project instructor Mrs. Olivera Notaros to discuss money issues with her. She gave us the solution and we figured that our decisions would be based more on our budget rather than exceeding it. We planned our project and hoped for a donation, Mr. Dave Rohn as mentioned before donated a $3000 dollar Bluetooth kit to our group project as support, and it was the perfect donation at the perfect time.

As we all know, every project has to have its ups and downs. Our goal was to get our Bluetooth kit working with our MP3 player, but we ran into a problem. Our Bluetooth kit does not function with Windows XP, the system we are operating. It only works on Windows 2000, which is rarely found on computers these days. We decided instead of actually installing Windows 2000 on a computer, we would try to find a driver for our Bluetooth kit to configure correctly with Windows XP.

Another problem was time. If we were to build an MP3 player from scratch, test it, run it, and maybe correct any errors, it would've wasted our time without getting to the main goal. We purchased an already built and tested MP3 player online as a solution to our time problem. Since we couldn’t find any solution to the Bluetooth kit Mr. Rohn donated to us. We as a group decided to look for other ways to finish this project, and
we just decided to use a Bluetooth headset and a USB receiver to receive a signal from the headset and send it to the voice recognition program that operates with our MP3 player. Therefore solving our Bluetooth kit problem, and implementing an easier way to operate with our MP3 player. Using this still allowed us to get to our goal which is to use Bluetooth as our communication tool to our MP3 player. These were the main problems we ran into.

Another problem we ran into was developing the right voice recognition software, and writing codes to program the software to function with our list of commands, but we solved the problem right away as we were able to find the right software and got to the code writing immediately to save time.

Another problem we ran into was the search function. It was highly recommended for our group to finish the search function as it would increase the development and work intensity for our MP3 player which could fall back as a benefit to our future. But time was an issue in this case, since it would take us beyond this semester just to finish writing the code for the search function. We tried to overcome this issue by writing a code for randomizing the songs in the hard drive, as a way to give our user another option to listen to a variety of songs.

During our testing, we ran into problems again! Our Bluetooth headset would function correctly if we were to test our device in quite areas. We figured that it would be hard during E-days to test and demo our MP3 player, but by the time we got to our testing, there was so much little time to fix this problem. This would be one of our main
concerns besides the search function if we were to think about marketing our MP3
player. But overall our device was functioning correctly.
Chapter 5 – Fall 2007 Work

5.1 - Bluetooth

Our Bluetooth kit will be the transmitter/receiver for our voice command sent by the user, transmitted via Bluetooth that is installed on the wireless microphone, and received by the kit installed inside the MP3 player. It is a new technology that will be a great marketing project if succession is to happen.

5.2 – Voice Recognition Software

The Voice Recognition software we plan to develop and implement into the mp3 Player will be aimed mainly for Hands-Free use. While we wish to detail the software for the mp3 Player specifically, we do not want to limit the use of the software and see possible uses for it in Cell Phones, Cars, Computers, and other electronic devices.

The main goal we wish to accomplish with the Voice Recognition software is to be able to convert a common person’s voice into a digital signal that will accomplish one of many mp3 Player commands.

The mp3 Player commands we wish to implement in the software are mainly the basic play, pause, stop, next, previous, rewind, and fast-forward. We are also looking into developing a search protocol to go with the voice recognition software in order to simplify finding artists, albums, songs, and etc.
The end product of the Voice Recognition Software will allow a user to for example state, “Search Artist U2,” and the software will reply through the speakers of the mp3 Player by listing the songs or albums by U2. If no artist by that name is found the software will reply accordingly and the software will reply with close matches.

When we first thought of including this voice recognition capability into the mp3 player we did not know Microsoft would be coming out with their similar Microsoft Sync. Since seeing commercials and researching the Sync, we have decided to model our software towards what they have accomplished with the Sync. While it will be a challenge to include all the features of the Sync into our voice recognition software, we feel this is a great learning opportunity for us to match ourselves against a successful product from a successful company.

Other features we will work on for the voice recognition software is the ability to understand voice commands from different people. The world is filled with people differing from each other and everyone has a different sound when they speak. We want to figure out how to allow the software to know the correct mp3 Player commands to complete whether told by someone with or without an accent.

5.3 – MP3 Player

The mp3 Player we will be building in January will be comprised of the PJRC High Capacity mp3 Player Circuit Board. The player will be standalone and will connect through an IDE interface to a hard drive containing mp3 files. The board will provide
audio output by a 24 bit DAC using line level outputs and an amplified headphone output. This will support mp3 bitrates of up to 256 kbps and 320 kbps which is very high for mp3 players. The player will have six pushbuttons which will control the main mp3 Player commands. The hard drive for the mp3 Player will need to be formatted as FAT32 which is for Large Disks. In order to put music onto the hard drive we can use Windows explorer, and just drag and drop files like we would any other hard drive. The board will be powered by four AA batteries.
Chapter 6 – Spring 2008 Work

A lot of goals were accomplished in this Spring 2008 semester. We got a working MP3 player, the ability to get a Voice Recognition software to understand commands, and get the MP3 Player to understand those commands and execute them. Although it wasn’t as difficult as it may seem, it did require a lot of thinking and putting pieces of the puzzle together.

6.1 - Bluetooth

At the start of the semester we still needed to figure out how to get our Bluetooth Development Kit to work. It wouldn’t function until we got the correct Windows Operating System, Windows 2000. A ton of research went into looking for a Windows XP driver so that we could run the kit with Windows XP. That was a bust.

Taking a step back out of the picture, we realized that Bluetooth dongles paired with Bluetooth headsets were already being used by computers today. Using equipment that we personally owned, we were able to completely exclude the Bluetooth Development Kit from our project. We used a Bluetooth USB dongle with a Samsung Bluetooth Headset. Using a laptop with the Bluetooth USB dongle and provided software, we were able to successfully pair the dongle and Bluetooth headset to make the headset function like a wireless computer microphone. Step 1 done!
6.2 – MP3 Player

The next step was to get the MP3 Player to be able to recognize commands from the computer. We needed to do a bit of research to figure out a way for the MP3 Player to communicate with our laptop. We discovered that using the MP3 Players on-board Serial port, using a serial cable, we could connect the laptop and MP3 Player via Windows Hyperterminal. The user would be able to input commands thru the Hyperterminal window, and the MP3 player would recognize commands and execute. Of course, it was easier said than done. In order to achieve this, we needed to first figure out what exactly was going on within the MP3 Player. This was achieved by dissecting the firmware and analyzing the pieces of the code to see how they functioned. After realizing how everything worked with each other, we were able to edit and add coding that would have the MP3 player would recognize simple commands from the Hyperterminal window and execute that command. Some example functions were “next song”, “previous song”, “volume up”, “volume down”, and “search”. The “Search” function is still under construction. The difficulty of it comes from how the search parameter is assessed. The search parameter would iterate thru each individual file of the hard drive and compare each section in the ID3 tag looking for a match. The ID3 tag holds, Song name, Artist Name, Album Name, year, etc. The problem we are having is the iteration and comparing. Also, another problem deals with our Voice Recognition software, but we’ll get into that later. So the MP3 Player was functional, recognizing simple commands and execution. Step 2 done!
6.3 – Voice Recognition

The last step was to program the Voice Software, E-Speaking. The way we got E-Speaking to work for us was, it would recognize the voice command taken from the microphone and send the command, in simple text, to the Hyperterminal window. This would transmit the command to the MP3 player to execute there. This was a very simple task because we knew what commands we needed to program. The only tough part was getting a “Search” with this Voice Recognition software. The reason why there was trouble was because the software had a tough time recognizing what exactly we were saying and to print out the exact word we were saying. The software can recognize commands and words that are programmed into it. However, it had a tough time recognizing words that it didn’t know. The search function could be called, but the search parameter was where the trouble was at.

Finally, we were able to tie all three parts together. The Bluetooth headset acted as a microphone, which inputted into the Voice Recognition software, which would output commands to the MP3 Player, and finally execute the command that was being called. The bulk of the work was in understanding and programming the firmware of the MP3 player. One of our members wasn’t used to programming, so he watched over our shoulder and we tried to explain what was going on to him. We were able to get a working product that did most of the things that we wanted to achieve.
Chapter 7 – Marketing

The main goal of this project is to create hands-free software, capable of working with any electronic device. Imagine a world where you can say “Lights On,” “TV On,” “Watch ESPN,” or “Find U2” or even “Call Home.” This convenience will be big in the near future. The world is filling with new information, music, movies, and people. Voice recognition software with proper search protocols could change the way everybody does things. This software could be used with any electronic device if designed properly.

Using the software in cell phones, we could have the software search for a phone number for a friend and dial the number with you just saying “Call Bob.” Using it with Televisions we can easily tell the TV what show or station we want to watch. The market to voice recognition technology is booming. Ford Motor Company has their new cars coming standard with Microsoft Sync, a voice recognition technology, in an effort to boost sales of those cars. The main sticking point in their ads is “only available with Ford.” Google currently has a team investigating search by voice.

The main goals of our project are right in line with what is going on in Today’s Market. Search by voice will surely be the next best thing to come out of the voice recognition market. With this project, I see big things coming.
Chapter 8 – Budget

As a senior design group, we were initially given $150 per semester to spend on materials. We needed to seek out as much help as we could get in order to maximize our minimal funds. It was very difficult to find donations. Companies did not take us or our project seriously it seemed. The parts that we needed for our potential design seemed way out of our budget. After a lot of discussion and searching, things finally started falling into place. Our budget for $150 per semester was raised to $200 a semester. Gerod, our project advisor, got in touch with his friend, Dave Rohn from Microsoft, who helped lead us onto the right path. He donated a $3000 Casira Bluetooth Development Kit that we could work with to figure out how we could extract our voice signal and input it into our voice recognition program. We did however run into more slumps with money. Prior to meeting with Dave Rohn, we purchased two pieces of an MP3 player that we were going to build from scratch. A digital to analog converter chip and a microprocessor were purchased. With no circuit board to place those two chips onto, we were shown a company that would make us a custom board for $50. However, we still didn’t have every part we needed for the MP3 player itself. So as a group, we decided to forego the building an MP3 player from scratch and purchase a MP3 player kit instead. This kit costs $150. Our two chips that we already had purchased were $45 total. We decided that the time that it would take to solder, receive, and plan for the parts and board would cost us more than the $150 board that
we purchased assembled and ready to go. Budgeting deals with your money and time. The saying goes, “Your time is worth more than...” Well for us, our $150 MP3 kit.

Not much more was needed to be purchased in the Spring 2008 semester. We had most of the components that we needed in order to finish what we needed to finish for the project. A lot of the components we had lying around in our houses, so that saved us a lot of time and money looking for these components. We were able to use an existing hard drive from an old computer that we had. Also from that old computer, we were able to obtain a power supply that we used to power our hard drive. We scrapped the idea of using the Bluetooth development kit and used a Bluetooth dongle and headset that we had been using on our own personal computers.

There were a few things that needed to be purchased. Our MP3 Player kit initially did not come with any RAM. We had to purchase the RAM from the same site for total of $14. There was also the lack of a Voice Recognition software. We were able to download demos for a bunch of them, and test them to see if it was what we were looking for. E-Speaking was the best software that we could find that fit our needs. Unfortunately, a license needed to be purchased in order to take full advantage of the program. The program set us back $14. The last item that we needed to purchase was a gender changing converter to be able to hook up our serial cable from the MP3 Player to the computer. The connection allowed E-Speaking to send commands to the MP3 Player. The gender changing kit was purchased at Best Buy for $16. These were the only expenses that we had to cover for Spring of 2008. Hopefully, the next group that
takes on this project won’t need to purchase as many things as we did over this entire year.
Chapter 9 – Plans for Project Continuation

Over the course of the year, we have determined exactly what we wanted to accomplish with the mp3 Player and Voice Recognition software. The following chapter will talk about some goals and a possible schedule for next semester.

The first thing that needs to be accomplished next semester is to get the search function implemented into the mp3 Player firmware and to allow the voice recognition software to give the player a query for the mp3 Player to search the hard drive. In order to get the search function to work, we will need to cross check the query from the voice recognition software with information from the mp3 files id3 tags. Also, on the voice recognition side, we will need a way to convert speech to text which can be sent to the mp3 player via the serial port. The voice recognition software will most likely need a database to cross check the converted speech so that we know the software is converting the speech to the correct text.

Once the software is able to convert speech to text and the mp3 Player search function is implemented, the mp3 player should be tested thoroughly. Using use cases the player should be tested for speech sensitivity, search efficiency, and correct functionality. These tests should assure correctness with the search function and the voice recognition software.

After the mp3 Player and voice recognition software have been tested with the new additions, it should be researched whether or not the whole system can be on the mp3 player board. To be able to include the voice recognition software on the mp3
player would be ideal. Of course this would also need Bluetooth to be installed and
enabled on the mp3 player also. We currently have Bluetooth through a computer
which speaks to the mp3 Player through the serial port. The mp3 Player would need to
be able to support Bluetooth, voice recognition software, and the mp3 Players
firmware, along with any mp3 files or playlists the mp3 Player will use.

Future work beyond what was mentioned above could possibly include using the
Bluetooth capabilities and Voice Recognition Software to operate other electronic
devices such as cell phones, computers, etc. Hands free capabilities are going to be not
only essential but beneficial in the near future. Hands free capabilities could be used to
help people with disabilities get things done and could also help make it safer to talk to
cell phones with the need for using your hands minimal.
Chapter 10 – Reflections on the Year

The group members decided to individually write conclusion paragraphs on their reflection towards this past years senior design project.

Yasir Al-Saggaf

During this semester we've had our project ups and downs. We tried to accomplish everything on time, we tried to maintain perfection as we moved on, and tried to benefit as much as possible.

On my behalf, I surely developed skills as we learned how to work as a group instead of individually. We shared information, taught each other many aspects, and believed in each other as a whole team. This whole year has been a fantastic experience for my team and I, we learned not to give up when we run into a problem or a misunderstanding.

I also learned to accept other opinions, open my mind to new ideas, and apply also share my own ideas since it became obvious that it is very beneficial as we moved further with our project.

In the end, what I learned from this project wasn’t just the programming or coding we’ve done. It wasn’t just powering up a hard drive or an MP3 player, but most importantly team work and how to become a good team member and at the same time an effective team member.

Michael Cieslak

The Senior Design program began for me as a requirement to graduate. I was told I needed to apply for a project, get accepted to said project, and complete work on
said project. It seemed so forced upon me that I wasn’t sure how to feel about the program. I expected it to be a not so fun time with lots of work for maybe at best, resume filler. However what I did not expect was a worth my time experience that I am glad to have be “forced” to complete. The main things I will take from Senior Design this year are teamwork and communication.

Teamwork is a very valuable asset in the real world. When you’re able to work in a team efficiently, you become an invaluable part of that team. Many engineers struggle with this in the real world as they have gone through their whole curriculum working alone and competing with all of the others in order to be the best. My experience on this team has helped me become a better worker in the team setting. I, personally, am a Computer engineer, while one of my team members is an Electrical engineer. This created some issues where when we were working on the project together, one of us had more knowledge than the other on certain areas of the project. This forced us to have to listen to each other and trust each other’s knowledge. This is the basis of what team work is and I will be a better employee for someone because of this experience.

Communication is the ability to convey your thoughts to another person in a way that the person fully understands your thoughts. This is also very valuable in the real world. Today in engineering, there are many projects or tasks that are outsourced to other countries because it is cheaper than to have it done here in the U.S. The ability to communicate with those workers in those other countries is what will get the job done
faster and better. If you are not able to communicate you will be wasting precious time and energy. It is already hard to have tasks being outsourced because of time differences and language barriers, but to not be able to communicate in your own language will downright kill your company.

These two abilities have made me a better engineer and a better candidate to be a superb employee wherever I decide to start my career. While it was “forced” upon me at first, I gladly accept the program and recommend it for all engineers.

**Nicholas Dang**

This past year of senior design was a great learning experience. It taught me team work, communication, time management, budgeting, and deadlines. I learned a great deal from my team and the work that we did. Without any communication things can’t and won’t get done in an efficient manner. There would be no team work because everyone would be trying to do the same thing and there would be a lot of overlap in the work. Time management was important because without a strict working schedule, nothing would ever get accomplished. Budgets were especially important in our project. We learned the hard way. Without careful and thorough planning, a team wastes money by buying unnecessary things like we did. We should have sat down and planned out the entire project before doing anything else. If this step was done thoroughly, we wouldn’t have wasted money on parts that we didn’t end up using in the end. Deadlines were also very important to learn. Deadlines need to be made in order to keep progression in any project up. Without deadlines, work would continually be put off until the end. Procrastination is the enemy of deadlines.
All in all, the Lazy Man’s MP3 Player Project was a great learning experience. One thing that I wish we could have done differently was the planning. I wish we could have done a thorough and well thought out plan of our project goals before we dove into anything. I think we wasted a lot of time and money regrouping our thoughts and plans of what our final goals of the project. I hope that the group that continues our project has great success that we had.
Appendix – Budget Figures

**Items Bought**

- STA013 MP3 Decoder Chip $12.00 (Nick) Fall 2007
- 24 Bit Digital to Analog Converter $11.63 (Nick) Fall 2007
- On Board IDE Interface $4.00 (Nick) Fall 2007
- AMTel ATMega103L Microcontroller Chip $27.90 (Mike) Fall 2007
- PJRC MP3 Player Kit $157.00 (Yasir) Fall 2007
- RAM Module $14.63 (Nick) Spring 2008
- E-Speaking Software $14.00 (Nick) Spring 2008
- Serial Connectors $14.93 (Nick) Spring 2008

**Total $ Spent Fall ’07**

- $212.53

**Total $ Spent Spring ‘08**

- $43.56

**Grand Total Spent 07-08 Year**

- $256.09 - $400.00 (Budget) = -$143.91

**Donated Items**

- CSR Bluetooth Development Kit $3000
  
  Donated by Dave Rohn of Microsoft
Reference

Project Advisor

Mr. Gerod Melton

Microsoft

Mr. Dave Rohn

Project Coordinator

Olivera Notaros

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http://www.pjrc.com

http://www.csr.com

http://www.engr.colostate.edu/EE401

http://www.e-speaking.com
Figure 1. MP3 Circuit Board
Figure 2. MP3 Processor

Figure 3. MP3 Interface Section
Figure 4. MP3 Decoder and Audio

Figure 5. MP3 Power Supply
Figure 6. MP3 Block Diagram

Figure 7. Bluetooth to MP3 Diagram
Figure 8. Final System Diagram