# Smart Voting Joystick for Accessible Voting Machines Proposal

ECE 480 Team 5

Yangyi Chen, Tyler Dennis, Graham Pence, Behdad Rashidian, Joy Yang

Sponsor: MSU Resource Center for Persons with Disabilities

3/17/13

**Executive Summary:**

The Michigan State University Resource Center for Persons with Disabilities requests a voting interface that is convenient to use for individuals with a wide variety of motor skill capabilities. This system needs to accommodate a variety of different motor needs. It has been determined that a force feedback joystick that can be interfaced with voting software on a secure PC will be constructed to satisfy the request of the sponsor.

## Table of Contents

Design Specification........................................................ 3
FAST Diagram........................................................ 4
Conceptual Designs........................................................ 4
Design Solution........................................................ 8
Risk Analysis........................................................ 9
Project Management........................................................ 11
References........................................................ 23

## Customer Needs/Requirements:

The Usability/Accessibility Research and Consulting (UARC) and Resource Center for Persons with Disabilities (RCPD) of Michigan State University (MSU) would like to develop and implement a dual-axis joystick on a computer system that will replace the manual interaction with a voting system. Such a device would allow many individuals with dexterity limitations and special needs to vote without significant frustration. It would also allow individuals with special needs to vote within a standard time frame when compared to an individual without special needs. Research has indicated that people with disabilities are less likely to vote than individuals who do not have disabilities (statistics show 7% of the disability population in the survey conducted are less likely in 2008 and 3% less likely in 2010, see Rosenberg). Voters would likely be more attracted to vote if a device was created that would allow all users to vote conveniently, comfortably, and in an efficient manner. To address those issues, Team 5 of ECE 480 is going to design a device that will attract more special needs individuals to the voting booth - a user-friendly voting machine to assist with special needs so that those individuals can cast a private ballot. Specifically, the design will be a dual-axis joystick with force feedback.

Current accessible voting machines for individuals with special needs have not overcome the timeliness and convenience issue presented to such voters. Moreover, it is likely for users to become frustrated and fatigued with these machines, resulting in potential cramping of the hand and/or arm. According to Dr. Sarah Swierenga, Director of the UARC of Michigan State University, an example existing accessible voting machine that has a dual rocker switch (dual button switch) with audio requires 1,200 button presses (only if no mistakes have been made)! An average voting time of 40 minutes has been allocated for this particular device based on expectations for individuals with special needs. The proposed double axis joystick would significantly decrease the time spent in the monotonous button pressing voting process. The double axis joystick may also be implemented with audio (with use of headphones) to address privacy issues.

The proposed double axis joystick will be implemented with a force feedback control to enhance user interaction with a standard graphical user interface (GUI). While standard joystick devices are input-only, force feedback control utilizes the sense of touch in a user interface design to provide physical information to a user. For example, an application of a force feedback control in a joystick is a vibration when the joystick has "entered" information. Force feedback implemented in the proposed double axis joystick would provide physical sensations to a user for confirmation or reminder purposes.

To make the proposed double axis joystick compatible with any electronic voting machine system, the joystick must have USB connectivity. USB connectivity will replace the serial input currently used in various precincts across the country (a local precinct that uses this input is in East Lansing, MI). It will also allow any voting machine/computer that has USB access to use the joystick. A prototype of this joystick device will to be developed and tested by Design Day, April 26th, 2013.

## Background:

Previous special needs voting machines have been proposed and implemented in voting booths in local precincts (precincts in East Lansing, as an example). One or two button voting devices have been commercialized and already implemented in voting booths. An example of a one or two button voting device is a rocker switch. The dual rocker switch has a silent option and an audio option. Studies show that while using the silent option, a person without special needs will press the rocker switch buttons 872 times within 18 minutes while the audio option utilizes 1,200 button presses within 37 minutes for the standard ballot. 37 minutes for a user without disabilities is a significant amount of time to vote (without other factors considered, such as wait time, etc...). To determine the approximate time for persons with special needs to vote using this system, a factor of four should be multiplied to the time for a user without disabilities (Swierenga, Propst, Pierce, and & Sung, 2011).

Other devices that have been commercialized include features such as: screen-touches, sips, puffs, and other physical actions taken by the user to interact with the voting system. Individuals with dexterity limitations are physically limited by the number of interactions that they can initiate. For example, the size of a button, the location of a button, the number of presses required, etc... all contribute to the amount of strain that must be applied by users with disabilities. These factors must all be taken into consideration when designing a special needs voting machine.

**Design Specification:**

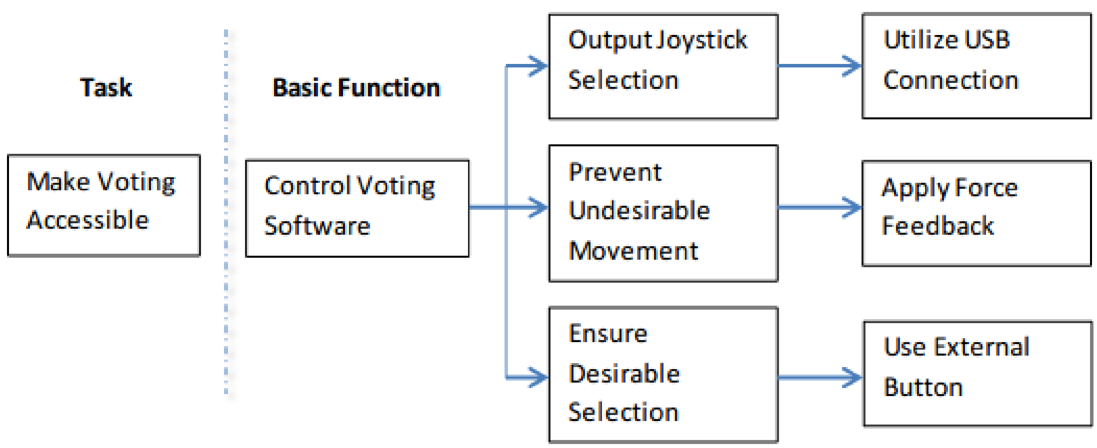
Various requirements must be met in order to create an effective accessible voting system. An interface needs to accommodate needs of special individuals with a wide variety of motor skill functions. Because the focus of this project is on special motor skill needs, the group will not be focusing on people with unique sensory abilities, such as blind individuals. A wide variety of conditions is the biggest challenge in the design. A system that works well for someone with cerebral palsy may not work as well with someone who has difficulty grasping their hands with force, for example. The design will also include a software component. This interface needs to be easily accessible and intuitive for anyone who uses it. Ideally, the time a special needs individual requires to complete a ballot using this system should be comparable to the time it takes for the typical voter to complete their ballot.

In order to find the best design solution for the required specifications, it is extremely helpful to create a list of criterion by which each design solution can be assessed. A first criterion is compatibility with existing voting software. It is extremely important for the hardware to seamlessly interact with the voting software with which the design is tested. In this case, the voting software being used is an HTML ballot program designed by the Georgia Institute of Technology. This software will be discussed later in the proposal. A second criterion is voting privacy. It is vital that the confidentiality of each individual's vote is ensured. A third criterion by which the designs will be assessed is accuracy. It is crucial that the design ensures the accuracy of the user's vote. Another important aspect is the cost of developing and implementing the design. Since the group is allotted a $500 budget, it is essential that the design can be built using $500 or less. Customization is another very important design trait. The joystick must work well with a wide variety of motor disabilities, and thus should be programmable compatible to fit a variety of needs. Finally, the joystick needs to be durable. Some special skills users may exhibit exceptional strength that could damage a structurally weak design.

**FAST Diagram:**

Figure 1 shows a FAST diagram that has been created for the joystick. The FAST diagram is a graphical representation of the voting system's functions.

**Figure 1. FAST Diagram**




**Conceptual Designs:**

One available option is to buy a joystick and program it to meet the requirements of the project. Numerous joysticks exist with a wide range of functionalities; they range in durability, number of buttons, and ease of control. Many of these joysticks are sold to a specific audience, ranging from video game players to users of remote control devices. When purchasing a joystick, it is important to keep in mind the audience's unique abilities. The range of applicants that have special motor control functions is a large, diverse group of people ranging from highly severe to minor limitations. It may be difficult to satisfy everyone within this category but it is necessary to ensure equal voting among individuals of motor disabilities. Individuals with motor disabilities may have problems controlling their levels of strength, or even twitch uncontrollably.

A force feedback joystick would improve the precision and voter stability when voting. Using the force feedback feature, a set resistance could be applied to the joystick preventing any acute motor movements from moving the joystick. This would help reduce the number of errors on a voter ballot, as the user would have more precise control over the joystick. The resistance would need to be modified within the programmable joystick for varying users of dexterity control.

A standard universal serial bus (USB) interface would best suit the needs for the joystick, having direct access to a multitude of devices. Devices such as a computer or iPad have USB input allowing the joystick to connect at numerous voting sites with USB capabilities. With direct computer support, the joystick could be easily modified with programming techniques. The joystick should look relatively simple - it should have one button if possible, at most two. Complicated devices with additional, unnecessary features will give the user more room for error when voting. One button will have an enter functionality. The other button will have a reset functionality that would return the user to the top of the voting page. The joystick will also need to be housed within durable materials, allowing the joystick to survive strenuous activity during times of voting.

There are many advantages and disadvantages to buying a joystick instead of building one. A commercialized joystick available for purchase would significantly save time on the work required to create a connection between the microprocessor and the joystick. Force feedback would be a difficult feature to install if it were implemented in a built joystick (as opposed to purchasing a joystick). Some disadvantages in buying a joystick include a lackluster design with less control for the modifications in the microprocessor. It is also very difficult to find all the features that are wanted for individuals with motor control disabilities. The exterior housing of the joystick would also need to have a more durable design if building a joystick. Each option has different benefits and problems; the best plan will be to weigh out the negatives and positives of each option and pick the best solution.

Another option is to build a dual-axis joystick from scratch. This would involve purchasing a microcontroller and parts to build the joystick. The joystick would need to support force feedback in order to provide stability for users who make uncontrollable, sudden movements with their bodies. A couple of the microcontrollers that are being considered are the Arduino and the TI MSP430. Both are affordable and have the functionality required to complete the joystick. There are several different models of the Arduino, so it will be imperative to research the pros and cons of each to choose the best model for this project.

Although it was not suggested by the sponsor, voice recognition offers another potential solution. The use of one's voice to vote eliminates the chance that impaired motor skills would interfere with the voting process. In order to implement this, the speech would need to be captured using a microphone. This captured signal would be converted to an input that is recognizable by the software. While this system would be quite intuitive, there are a few obstacles that prevent it from being the best solution. Firstly, many individuals with impaired motor skills are unable to speak clearly enough (or at all). This became apparent to the group after meeting with an individual on campus who has cerebral palsy. This particular individual communicated using a speech synthesizer. However, it would be negligent to assume the availability of this speech technology to all who would need it at the voting booth. In the case of an individual with such a speech disability, a tactile input device would be necessary. Another potential issue is voter confidentiality. Privacy is mandatory when voting; using one's voice to cast votes may compromise this. A possible solution to the privacy issue is to give an arbitrary label to each candidate. These labels could be colors, numbers, objects, etc. The voter would simply recite the label which corresponds to their desired candidate in order to cast a vote. For increased privacy, the candidates and their corresponding labels could be randomized.

For any of these three designs, some kind of voting ballot interface would be needed for testing. For this project, the group has chosen to use an HTML ballot developed at the Georgia Institute of Technology. This ballot software can be accessed online and provides several different methods of input. This will allow the use of joystick-to-keyboard software to interface the joystick with the ballot. Figure 2 shows the graphical user interface of the Georgia Tech ballot's input selection page.

**Figure 2. Georgia Tech Ballot GUI**

As one can see, there are a few potential solutions to the voting ballot problem. In order to come to a consensus on the ideal design solution, a decision matrix was created.

**Table 1. Decision Matrix**

| **1 = Worst**<br>**3 = Best** | Compatibility with Existing Ballot Software | Voting Privacy | Accuracy | Cost | Customization | Durability | **TOTAL** |
|---|---|---|---|---|---|---|---|
| Purchase Joystick | 3 | 3 | 2 | 1 | 1 | 1 | 11 |
| Build Joystick | 3 | 3 | 2 | 2 | 3 | 3 | 16 |
| Voice Recognition | 1 | 2 | 2 | 3 | 3 | 3 | 13 |

Due to the great importance of each criterion, a non-weighted decision matrix was implemented. After ranking each design option based on the design criteria, it was decided that the best option is to build a dual-axis joystick from scratch.

**Design Solution:**

The team has decided to build a dual-axis joystick with a force feedback feature. This joystick will utilize the USB interface to connect with compatible computing devices. The force feedback feature will be implemented using two actuators, two force sensitive resistors, and a microcontroller. When a user applies force to the joystick, the resistance of the force sensitive resistors will change. This change in resistance will manipulate the electrical signal that is sent to the microcontroller. The microcontroller can be programmed in a way that will trigger the actuators to move the joystick when a threshold force is applied to it. The drivers for the joystick will allow this force to be adjustable to meet the needs of several different users.

The team has decided to use the Arduino Leonardo microcontroller for the joystick. The Leonardo is designed to function as an input device, such as a mouse or keyboard. Several programming libraries have been written in C and C++ that can be used to program the Leonardo. These libraries will greatly streamline the process of writing drivers for the joystick. The Arduino Leonardo has several characteristics that make it a great choice as the microcontroller for the joystick. First, it is cost effective and has a small form factor. The low price leaves a substantial portion of the budget available for other components, and the small form factor will make it easier to integrate the microcontroller with the mechanical housing of the joystick. The Leonardo also has a built-in micro USB port. This will make interfacing the board with a computer quite simple.

The team will also have to address the power requirements of the joystick. The Arduino Leonardo can supply power using both the micro USB connection and an external power supply. It is likely that an external power supply will be necessary since only five volts can be supplied through the USB connection for the joystick. It will be important to keep in mind the voltage limitations of the Arduino to avoid burning out the board.

In order to assess the design, a proper testing procedure will be implemented. In conjunction with the UARC group on campus, the team will be working with disabled individuals to test the prototype and make design improvements based on their feedback.

**Risk Analysis:**

There are some risks that need to be acknowledged when working on the accessible joystick project. These risks are identified and categorized in Figure 3 below.

**Figure 3. Risk Analysis**

| **Risk Summary** |
|---|
| **High Risk – Damage to Internal Electronic Components**<br>➢ Internal hardware design of the joystick is critical. Any damage to the internal circuits or chips will delay our project schedule. If a component related to the force feedback function is damaged, the team's cost will dramatically increase. In addition, any potential replacement of a component during the testing phase will be more complicated since the whole internal circuit may need to be broken down. |
| **Medium Risk – Material Selection of the Joystick Body**<br>➢ When building a desired joystick for people with special needs, the materials used to make the joystick body will require a special level of hardness. Any damage to the joystick body while testing will disadvantage the team by having to rebuild the joystick. Without the complete joystick, testing cannot be arranged. |
| **Low Risk – Software Integration**<br>➢ This project requires the joystick movement to adjust to the testing interface, meaning the input data analysis and the GUI have to be compatible. It will take time for the team to ensure the communications between hardware and software are effective and fully functioning. |

**Project Management:**

There are five members in group 5 that are working on the joystick project. This group consists of one computer engineering student and four electrical engineering students. The students working on this project are all seniors. The list of group members is shown below:

1- Behdad Rashidian ( Task: Manager / Major: Computer Engineering )

2- Tyler Dennis ( Task : Documentation / Major: Electrical Engineering )

3- Graham Pence (Task : Web / Major : Electrical Engineering )

4- Joy Yang (Task: Presentation / Major : Electrical Engineering)

5- Yangyi Chen ( Task: Lab Coordinator / Major : Electrical Engineering )

The tasks assigned above are non-technical assignments that each member must commit to. These tasks are described in more detail:

*Manager*: The management portion of this project is assigned to Behdad Rashidian. His assignment is to maintain the quality of the design process. Scheduling meetings, reporting to the team's facilitator, designing a timeline and group processing are also among his tasks.

*Document Prep*: Tyler Dennis has been assigned to do the documentation for the team. His task is to provide support for high-quality written communication in the engineering design process. In particular, he will be using software tools such as Microsoft Word and Adobe Acrobat to coordinate the preparation of written reports and maintain a documentation portfolio.

*Web*: The task of webpage design has been assigned to Graham Pence. Graham's goal is to maintain the team's shared information workspace and to present a great image of the team to the public. More specifically, he is assigned to do Unix directory maintenance, webpage coordination, CD-ROM writing, and use of digital devices such as scanners and cameras to showcase the group's process with photos and videos.

*Presentation Prep*: Joy Yang will be using software such as Microsoft Powerpoint and Adobe Acrobat to coordinate preparation of oral reports and presentations to fulfill her duties as presentation prep. Maintaining a documentation portfolio and coordinating poster preparation will also be among her non-technical tasks.

*Lab Coordinator* : The task of lab coordination is assigned to Yangyi Chen. She will help to coordinate the ordering of parts for the team and reporting problems with lab equipment to the ECE shop.
All group members are collaborating on technical parts of this project. The team will also be working with a facilitator. Working with a facilitator will help the group to improve the documentation of the project (among others). The facilitator will help the team with presentations and will encourage consistent progress of the team throughout the semester. Information about the facilitator is listed below:

- Professor John Deller (Unit: Electrical and Computer Engineering)

In addition to the group members and facilitator, the team's sponsor will also have a vast impact on the project process and requirements. The sponsor will help the group to define a goal of the project and what exactly is needed to accomplish the task. Different approaches will be discussed with them and it will help to obtain opinions on any particular approach. The budget for the project is a very important concerns. The budget greatly depends on the sponsors. The sponsor that we are working with is the MSU Resource Center for Persons with Disabilities. Sponsor names and titles are listed:

- Stephen Blosser (Unit: Resource Control for Persons with disabilities / Title: Specialist-Advisor)
- Sarah Swierenga (Unit: Usability/Accessibility Research and Consulting/ Title : Director)
- 

All group members are collaborating on technical parts of this project. Each member will contribute ideas regarding the ideal project design. Although there are different approaches, the team members have been assigned to a particular portion of the project. The technical tasks have been assigned as the following:

- Graham Pence: Research about the required resistors that are needed for the project and maintaining significant information about them.
- Tyler Dennis: Software development for Arduino Leonardo and testing the HTML code for the ballot.
- Joy Yang: Mechanical design of the body of the joystick and making interface between actuators and the bread board of the system.
- Behdad Rashidian: Research on the coding processes of the project that will be implemented on the board and the software that is needed to use for Adruino Leonardo.
- Yangyi Chen: Research on light emitting diodes and switches to be used for the joystick and connecting them to the board.

In order for the design to start being implemented, the group needs different resources. These resources could be hardware components or software. Here is the list of hardware and software resources that are being considered for this project.

1- Open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. This platform includes computer systems and components which help to make an interface between software and hardware parts of the project. (e.g. Beagle Board , Ethernut , Arduino, Maple ). This hardware is not available at ECE 480 lab and it needs to be purchased from the website.
2- Circuit board is necessary for any additional wiring and will be obtained from ECE 480 Lab.
3- Handle for the joystick. This component could be purchased for a very cheap price. Online ordering could be an option.
4- Java and C++ programming languages.
5- Sensors are also components that the design requires and they should be obtained from ECE 480 shop
6- Light emitting diodess could also be used in the project and can be obtained from ECE 480 shop.

After collecting data about the deadlines and resources, the team manager has assigned the following timeline.

| Task Name | Duration | Start | Finish |
|---|---|---|---|
| Schedule Meeting Times | 2 days | Mon 1/14/13 | Tue 1/15/13 |
| First Meeting With Sponsor | 7 days | Wed 1/16/13 | Wed 1/23/13 |
| First Meeting With Facilitator | 1 day? | Wed 1/23/13 | Wed 1/23/13 |
| Brainstorming | 9 days? | Fri 1/18/13 | Mon 1/28/13 |
| Pre-Proposal | 9 days? | Mon 1/21/13 | Wed 1/30/13 |
| Start Website | 4 days? | Sat 1/26/13 | Wed 1/30/13 |
| Order/Receive Parts | 16 days? | Sat 1/26/13 | Fri 2/15/13 |
| Build Prototype | 16 days? | Sat 2/16/13 | Fri 3/8/13 |
| Complete GANTT Chart | 5 days | Fri 1/25/13 | Wed 1/30/13 |
| Voice of Customer Assignment | 3 days? | Mon 2/4/13 | Wed 2/6/13 |
| FAST Diagram | 27 days? | Wed 2/6/13 | Wed 3/13/13 |
| Troubleshoot/Refine Prototype | 52 days? | Fri 2/8/13 | Fri 4/19/13 |

| | | | |
|---|---|---|---|
| Final Proposal | 12 days? | Mon 2/4/13 | Mon 2/18/13 |
| Proposal Presentation | 13 days? | Mon 2/4/13 | Tue 2/19/13 |
| Progress Report #1 | 5 days? | Mon 3/11/13 | Fri 3/15/13 |
| Individual Application Notes | 5 days? | Mon 3/25/13 | Fri 3/29/13 |
| Technical Lecture | 11 days? | Fri 3/15/13 | Fri 3/29/13 |
| Design Issues | 11 days? | Thu 3/28/13 | Thu 4/11/13 |
| Progress Report #2 | 5 days? | Mon 4/8/13 | Fri 4/12/13 |
| Self-Assessment Papers | 5 days? | Thu 4/11/13 | Wed 4/17/13 |
| Final Report | 9 days? | Fri 4/12/13 | Wed 4/24/13 |
| Poster | 6 days? | Wed 4/17/13 | Wed 4/24/13 |
| Design Day | 1 day? | Fri 4/26/13 | Fri 4/26/13 |
| Team Evaluations | 1 day? | Mon 4/29/13 | Mon 4/29/13 |
| Return Equipment | 1 day? | Mon 4/29/13 | Mon 4/29/13 |
| Final Presentation | 11 days? | Wed 4/10/13 | Wed 4/24/13 |

1- Scheduling meetings is a task to be done by the project manager. This is going to be done by looking at the schedule of each member and setting right times for meetings so that everyone in the group can attend.

2- First meetings with the sponsors and the facilitator are important since the group gets to know the people with whom they will collaborate with during the semester.

3- In order to narrow down ideas about the project, the group needs to compile all the ideas of each group member. Hence after the first meeting with the facilitator and sponsors, it is a great time to start brainstorming about the project.

4- The next step is to make a pre-proposal so that a customer or sponsor could understand the concept of the project in detail. It also gives them a great view of the project and outcomes they should expect.

5- Creating the website is the next assigned task and should be done so that people around the world can understand the project better. Graham Pence will be in charge of this assignment.

6- After brainstorming and coming up with the correct idea, the team needs to order parts in order to get the project started. Yangyi Chen will be in charge of this task.

7- Building the prototype will take a long time so the team will dedicate weeks to this task. Building of the prototype must start right after the parts are received. The entire group will be collaborating to get this task done on time.

8- The GANTT chart, which shows all the deadlines and timings, should be created so that the group can follow and get the tasks done on time.

9- The voice of customer must be done in the next step which should be done by Tyler Dennis.

10- The FAST diagram should be done after voice of customer so that the group gets a better idea of what the prototype should like.

11- The team will be doing troubleshooting while the prototype is being built and also after it is done. It is necessary to do so since the prototype should be perfect. If the group leaves troubleshooting until after it is done, then the final prototype will not function up to standards.

12- Writing the final proposal is the next step which demonstrates what path the team took and what they are actually doing in the project. It is more specific than the pre-proposal.

13- The proposal presentation is the task that should be done by Joy Yang who is in charge of presentations for the team. The team should present their project and more specifically, present the proposal which is done before presentation.

14- All the technical tasks that have been done in this project should go on paper which is the report. The team needs to start writing the report right after the presentation of proposal. This part should mostly be done by Tyler Dennis.

15- Application notes should be done by 29$^{th}$ of March by every member of the group.

16- The technical lecture is the next assignment that should be done by the team.

17- Design issues are going to be discussed in the group and sponsors. These issues must be documented so the group can solve them on time.

18- Progress report #2 is continuing the report and revising it for second time. This should be done by the entire group by 12$^{th}$ of April.

19- There is a six day period for the team to finish the self-assessment paper.

20- After first progressing on the report, it is time to get the report done. This should be done by the 24$^{th}$ of April. The last report is the most important one since it includes every aspects of the project.

21- The poster is really helpful to present the project to engineering and non-engineering majors, and also the customer. It should include advantages that the customer will experience by using the product. It also demonstrates how much the product costs and brief description of the entire product.

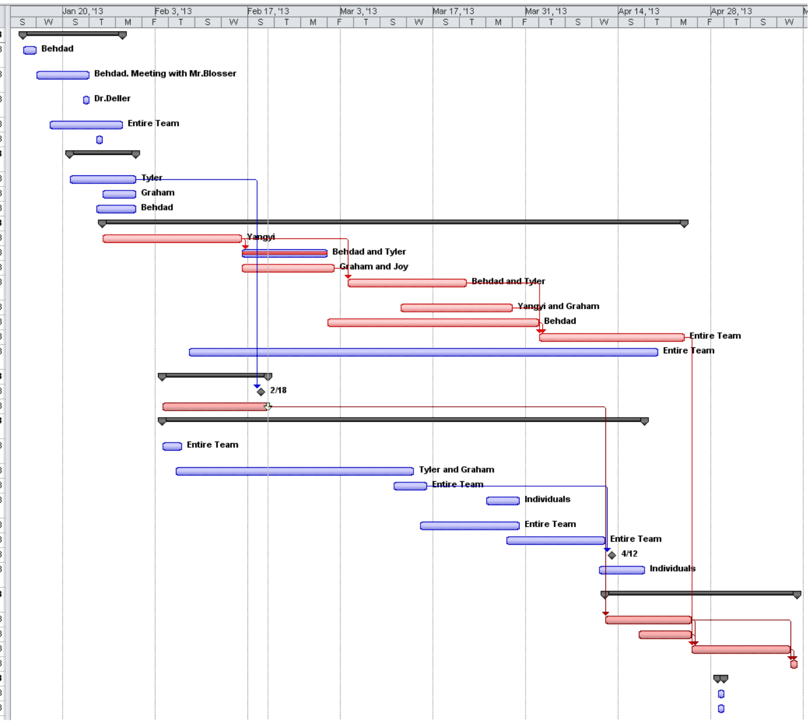
22- Design day is the day to present the final product and how it works. The design must be done a few days before this date. Moreover, the final presentation should be ready by this time.

23- Team evaluation and returning equipment is the last task that should be done after design day.

A graphical representation of the project schedule was created in the form of a GANTT chart. This GANTT chart can be seen in Figure 4 below.

## Figure 4. GANTT Chart

| | Task Name | Duration | Start | Finish |
|---|---|---|---|---|
| 1 | **Preparation** | **13 days?** | **Mon 1/14/13** | **Mon 1/28/13** |
| 2 | Schedule Meeting Times | 2 days | Mon 1/14/13 | Tue 1/15/13 |
| 3 | First Meeting With Sponsor | 7 days | Wed 1/16/13 | Wed 1/23/13 |
| 4 | First Meeting With Facilitator | 1 day? | Wed 1/23/13 | Wed 1/23/13 |
| 5 | Brainstorming | 9 days? | Fri 1/18/13 | Mon 1/28/13 |
| 6 | <New Task> | 1 day? | Fri 1/25/13 | Fri 1/25/13 |
| 7 | **Create Initial Documents** | **9 days?** | **Mon 1/21/13** | **Wed 1/30/13** |
| 8 | Pre-Proposal | 9 days? | Mon 1/21/13 | Wed 1/30/13 |
| 9 | Start Website | 4 days? | Sat 1/26/13 | Wed 1/30/13 |
| 10 | Complete GANTT Chart | 5 days | Fri 1/25/13 | Wed 1/30/13 |
| 11 | **Design Construction** | **64 days?** | **Sat 1/26/13** | **Tue 4/23/13** |
| 12 | Order/Receive Parts | 16 days? | Sat 1/26/13 | Fri 2/15/13 |
| 13 | Test Adruino | 10 days? | Sat 2/16/13 | Thu 2/28/13 |
| 14 | Test Joystick | 11 days? | Sat 2/16/13 | Fri 3/1/13 |
| 15 | Install keyboard to joystick | 14 days? | Mon 3/4/13 | Thu 3/21/13 |
| 16 | Install Actuators | 13 days? | Tue 3/12/13 | Thu 3/28/13 |
| 17 | Programming joystick | 22 days? | Fri 3/1/13 | Mon 4/1/13 |
| 18 | Build Prototype | 16 days | Tue 4/2/13 | Tue 4/23/13 |
| 19 | Troubleshoot/Refine Prototype | 52 days? | Fri 2/8/13 | Fri 4/19/13 |
| 20 | **Proposal** | **13 days?** | **Mon 2/4/13** | **Tue 2/19/13** |
| 21 | Final Proposal | 0 days? | Mon 2/18/13 | Mon 2/18/13 |
| 22 | Proposal Presentation | 13 days? | Mon 2/4/13 | Tue 2/19/13 |
| 23 | **Create Supporting Documents** | **54 days?** | **Mon 2/4/13** | **Wed 4/17/13** |
| 24 | Voice of Customer Assignment | 3 days? | Mon 2/4/13 | Wed 2/6/13 |
| 25 | FAST Diagram | 27 days? | Wed 2/6/13 | Wed 3/13/13 |
| 26 | Progress Report #1 | 5 days? | Mon 3/11/13 | Fri 3/15/13 |
| 27 | Individual Application Notes | 5 days? | Mon 3/25/13 | Fri 3/29/13 |
| 28 | Technical Lecture | 11 days? | Fri 3/15/13 | Fri 3/29/13 |
| 29 | Design Issues | 11 days? | Thu 3/28/13 | Thu 4/11/13 |
| 30 | Progress Report #2 | 0 days? | Fri 4/12/13 | Fri 4/12/13 |
| 31 | Self-Assessment Papers | 5 days? | Thu 4/11/13 | Wed 4/17/13 |
| 32 | **Finalize Project Documents** | **21 days?** | **Fri 4/12/13** | **Fri 5/10/13** |
| 33 | Final Report | 9 days? | Fri 4/12/13 | Wed 4/24/13 |
| 34 | Poster | 6 days? | Wed 4/17/13 | Wed 4/24/13 |
| 35 | Final Presentation | 11 days? | Thu 4/25/13 | Thu 5/9/13 |
| 36 | Design Day | 1 day? | Fri 5/10/13 | Fri 5/10/13 |
| 37 | **Post-Design Day** | **1 day?** | **Mon 4/29/13** | **Mon 4/29/13** |
| 38 | Team Evaluations | 1 day? | Mon 4/29/13 | Mon 4/29/13 |
| 39 | Return Equipment | 1 day? | Mon 4/29/13 | Mon 4/29/13 |



**Description:**

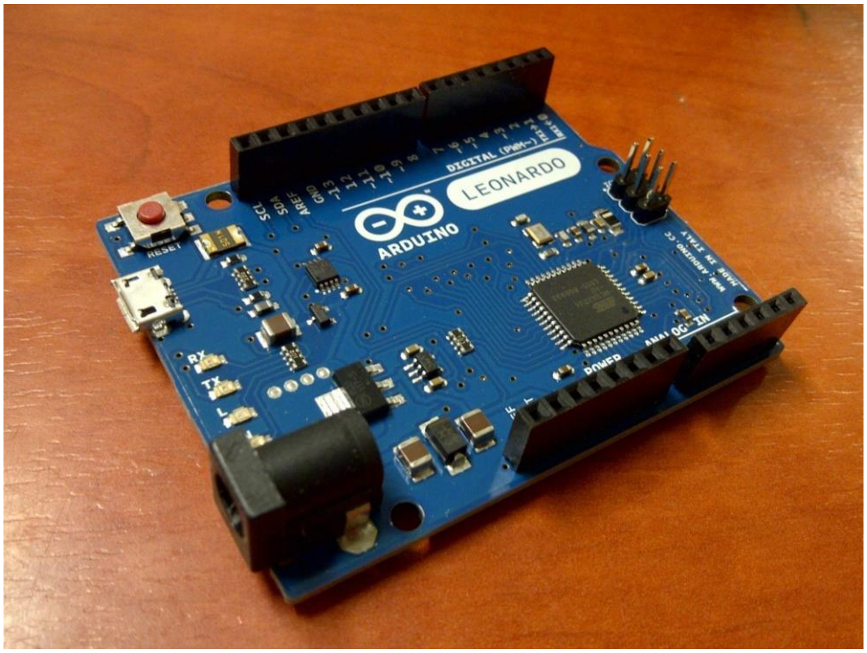
The team's objectives is to build a double axis joystick for people with special needs to vote. The main challenge of this project is to design the internal structure of the joystick, optimize the interface the team choose, and adjust the joystick movement according to the modified testing interface. Based on the above, hardware components will be the main cost. In addition, most compatible software needed is available online without any billable costs. Stephen Blosser, the team sponsor, will give the team support regarding mechanical manufacture.

| **Items** | **Costs** |
|---|---|
| Logitech Joystick | $29.99 |
| Force-feedback joystick | $166.48 |
| Arduino Leonardo | $24.95 |
| Electro-mechanical components | $50.96 |
| **Total** | **$272.38** |

**Force-feedback Joystick**

**Force-feedback Joystick:**

Force-feedback is a function that both the sponsor and team 5 consider important and useful for our project objection. Through purchasing an existing commercial products with a force feedback function, the team will learn and analyze the internal circuit designs. This will help the team obtain a better idea regarding how to build a force feedback system. On the other hand, this force feedback joystick allows the team to reprogram the existing joystick and adjust the movement to our testing software.




**Arduino Leonardo**

**Microcontroller:**

The microcontroller is the most important component in our joystick design. In order to build the double axis joystick and to adjust the joystick movement to the testing interface, the team needs to program the joystick for the desired functionality. The microcontroller is the key component that will allow the team to detect the position of the actuators and replies them to the testing interface. The team has decided to use Arduino Leonardo as the microcontroller since it is affordable and reprogrammable. The Arduino has a crucial built-in USB connection.

**Electro-mechanical components:**

Based on the design, a lot of electronic components like actuators, resistors, and potential power source are required. Some of them can be readily provided by Michigan State

University's Electrical and Computer Engineering shop, but the ones not provided by the shop may also factor into the budget. Through connecting the electronic components to the microcontroller and programming the communications between them, desired functions can be achieved. Mechanical components will be provided by the project sponsor.

**References**


1. http://www.sigchi.org/chi96/proceedings/shortpap/Rosenberg/rl_txt.htm
2. Testing Usability Performance of Accessible Voting Systems by Sarah J. Swierenga and Graham L. Pierce