iitorque

"No Strain, No Gain"

Power Measurement of Performance Bicycles

IPRO 324 - Project Plan

Advisors: Dietmar Rempfer and Sheldon Mostovoy

IPRO 324 Spring 2011

iitorque
"No Strain, No Gain"

Table of Contents

Team Information 1

[Team Roster] 1

[Team Identity] 4

Team Purposes and Objectives 4

[Vision] 4

[Mission/Goals] 5

[Objectives] 5

Background Information 6

[Ethical Considerations] 6

[Technical Considerations] 6

[Challenges and Solutions] 7

Team Values 8

[Ethics] 8

[Conflict Resolution] 8

Work Breakdown Structure 9

[Team Structure] 9

Work Breakdown Structure 12

[Meeting Times/Gantt Chart*] 12

Expected Results 12

[Deliverables] 13

[Potential Challenges, Risks & Assumptions] 13

[Devising a Solution] 14

Project Budget 15

Designation of Roles 15

Appendix 16

[Contact Information] 16

[Gantt Chart] 17

Team Information

[Team Roster]

Mike Dvorscak

Major: Computer Science
Year: Senior

Mike has experience in both programming and leadership. Involvement in various organizations, such as the Association for Computing Machinery and Atheists and Allies, has given him strong leadership and communication skills. Mike has experience with Ruby, Ruby on Rails, Java, git, and vim. He would like to use his strong leadership skills to help organize and run the team. Mike will be acting as our team leader.

Preston Andrews

Major: Computer Science
Year: Senior

Preston has experience in both programming and leadership. Being involved in everything from student organizations to career projects and even AFROTC has prepared him to effectively work with others and produce quality products without exception. Preston has experience with C, C++, Haskell, Java, git, SQL and vim. He will use his experience and expertise to help the computer science team with the programming of the microprocessor and related activities as well as documentation and project presentation.

*See Appendix for Contact Information

Team Information

[Team Roster*]

James Lee

Major: Electrical Engineering
Year: Senior

James is specialized on power management in electrical engineering. He has an experience to design and simulate electrical devices using PSIM and PSpice. Throughout the previous IPRO, he gained and developed his communication skills. He would like to further improve his communication skills and would work in an electrical team.

Jerome Wisniewski

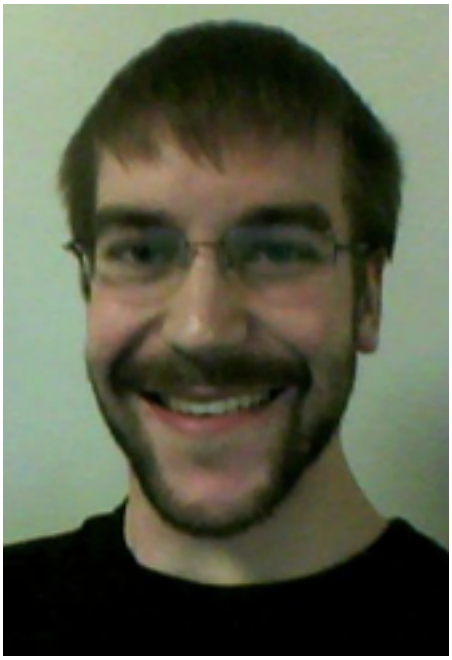
Major : Electrical Engineering
Year : Junior

James comes to Illinois Institute of Technology after studying for two years at the College of DuPage. He has worked as an intern at a small software consulting company where he helped design a time sheet system. This internship involved learning about database design and software engineering, as well as actually implementing the design using Java, Hibernate, Spring MVC, and MySQL. He now hope to continue my studies at IIT learning more about Electrical Engineering.

*See Appendix for Contact Information

Team Information

[Team Roster*]



Michael Fabian

Major : Computer Science
Year : Senior

Mike's major strength lies in programming projects. For multiple years he has worked with assembly debuggers, low level C, but also high level languages such as Java and Perl. Mike, ideally, by the end of the semester would like to see a stable library for communicating with Garmin devices via our specialized hardware developed. On top of this, having very strong documentation in order to have the library passed on to future semesters of this IPRO is paramount.

Elizabeth Frebes

Major : Material Science & Engineering
Year : Junior

Elizabeth currently works for Garmin at their retail store in downtown Chicago. Thus, she hopes to bring her knowledge of the Garmin device to the group, and provide any available resources from Garmin. From previous course work at IIT, she has experience with using strain gages that are involved in the project. She hopes to gain further experience with materials and design through the creation of a prototype for the housing of the gages and circuitry of the system.

*See Appendix for Contact Information

Team Information

[Team Identity]

Power Measurement of Performance Bicycles

Motto: **"No strain, No gain"**

Logo:

Team Purposes and Objectives

[Vision]

Competitive cyclists around the world are using technology to monitor training data in order to improve their training methods. Power measurements are important to such training, however existing power meters are expensive and the cyclist must replace existing crank sets. Thus, IPRO 324 intends to develop a power meter that not only can be applied to any crank set but that will accurately collect and transmit data to current cycling computers as well as cost significantly less than comparable systems.

Team Purposes and Objectives

[Mission/Goals]

- Efficiently build upon the current work for this project and bring it within a semester of completion.
- Effectively utilize all of the members of the IPRO and their specialties.
- Gain useful experience into team building and working as a group for future career application.

[Objectives]

This IPRO will build upon the already existing research and structuring for this project and work to produce a functional system to measure the power output of a cyclist and transmit that data to a specialty computer system.

- Have the system successfully communicate between the circuit board and the Garmin computer system.
- Design a housing for the circuit board that can be attached to most road bike crankshafts and still fit the circuit board and its components.
- Develop a high level interface for the current software. This will allow for input that can change variables and keep the user from having to directly modify the low level code.
- Install a port into the device that can be used for future software or firmware upgrades.

Background Information

[Ethical Considerations]

In order to ensure the final product of this IPRO is viable in the consumer market, there are a number of ethical considerations which must be taken into account as the project moves forward.

Developing a quality product is paramount. Due to the placement of the housing, it must be capable of withstanding vibration and physical wear and tear without breaking. If the product were to break or become dislodged, it could place the rider in a harmful situation as well as possibly damaging the bike itself.

Another potential harm we as a group must take care to be aware of is the use of radio frequencies. For one, it is possible to do bodily harm through extended RF exposure. In order to make sure this does not become a potentially large issue for the project, the group must be aware of FCC legal regulations and limitations placed on the RF system.

There are also concerns over intellectual property ownership and copyright protection since this bike meter is not the first of its kind. The group as a whole must take care not to take their research findings and apply methods or ideas under copyright protection.

[Technical Considerations]

This IPRO project as a whole requires a wealth of knowledge from a number of backgrounds. This semester specifically, we are focusing on electrical engineering, computer science, and mechanical engineering. While the group is composed of 3rd and 4th year students, a lot of knowledge outside the normal academic background is required.

The electrical engineering team will need to learn about the ANT chips required in the product. In order to reduce overall work, these chips have been chosen to remove the work of dealing with the RF hardware directly. While this is certainly a help, learning about the chips initially is very important.

Background Information

The programming team will need to learn a great deal about handling direct access to a microprocessor. In order to do so, the programming team will have to learn about the microprocessor model itself as each is different. Getting to know and work under such an environment will require a lot of background work before officially moving forward to complete the project.

The mechanical team will have to become familiar with the prototyping software chosen. This itself will require a lot of work and is something outside the current realm of knowledge for the mechanical team.

[Challenges and Solutions]

Project challenges:

- Establishing communication between the circuit board and the Garmin unit
- Testing the microprocessor code which communicates with the ANT hardware
- Fitting a circuit board into the housing unit
- Abstracting away from the hardware in order to create a high level programming interface for future versions of this IPRO

Potential solutions:

- Create a simpler circuit using a microprocessor that will allow a program to communicate with the Garmin unit with the correct formatting

Team Values

[Ethics]

All members of IPRO 324 will adhere to the standards set by the Illinois Institute of Technology. In addition, each team member will follow the team's core values.

Team core values:

1. Strive for team unity by articulating problems and communicating effectively.
2. Demonstrate ethical decision-making in accordance with team standards.
3. Respect fellow team members.
4. Remain productive throughout the entire semester.
5. Help to foster a healthy team environment by maintaining a positive attitude.
6. Respect differences of opinion when making team decisions.

Expectations of Team Members:

1. Arrive to team meetings in a timely manner.
2. Arrive at team meetings ready, this entails the completion of assigned tasks and reading the meeting agenda beforehand.
3. Keep team members updated on the progress of assigned tasks and communicate any problems that may arise.
4. Actively participate in team activities.

[Conflict Resolution]

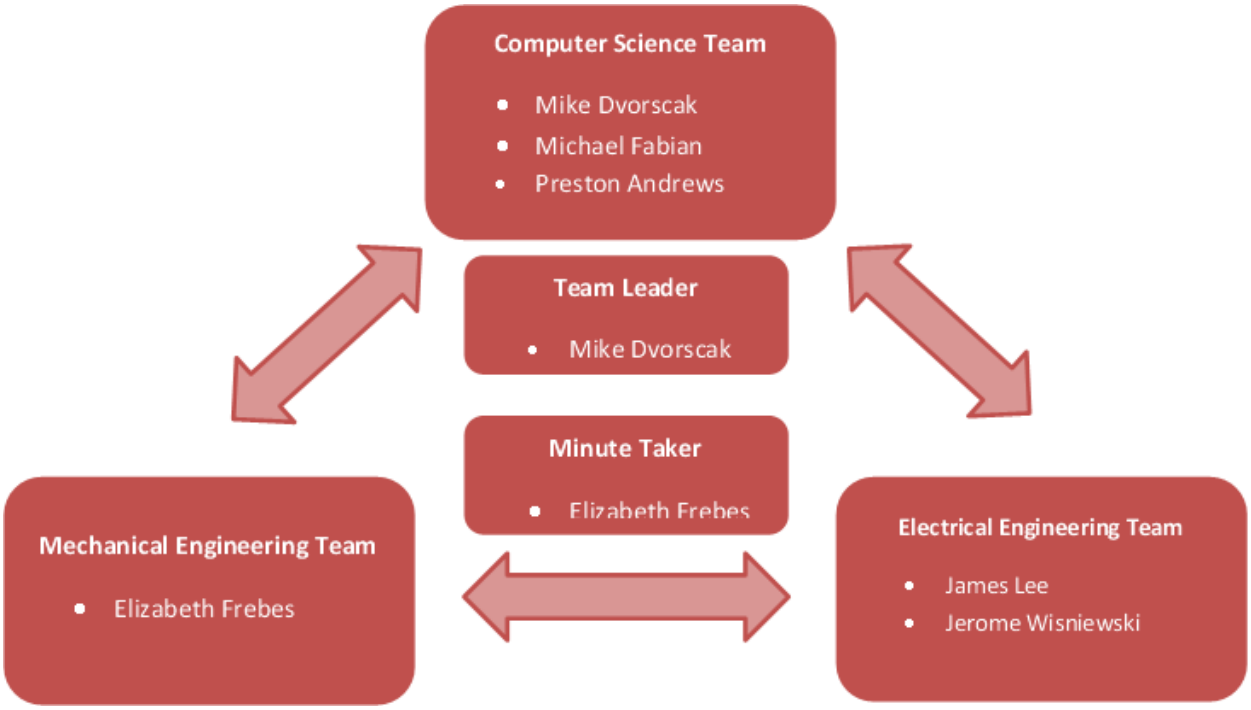
Due to the diversity of our group it is likely that differing opinions will arise. Should these differing opinions lead to conflict, it will be quickly addressed to ensure team stability and productiveness. If a problem should arise the team leader will follow the steps of the following conflict resolution management strategy:

1. Establish a respectful and professional atmosphere.
2. Seek to understand as many aspects of the problem as possible.
3. Discuss possible solutions.
4. Gather outside opinions from sources such as the IPRO faculty.

Work Breakdown Structure

[Team Structure]

In order to take advantage of our groups strengths, we have chosen to split the group into three main teams: electrical, programming, and a mechanical team.



The work breakdown for each team is as follows:

Work Breakdown Structure

[Team Structure]

Entire Team

As a whole, the entire team will work on the main deliverables for the IPRO: the midterm report, the IPRO day presentation, and the final report. Due to the size constraint of the group, we feel it is important to have everyone contribute to the work in order to complete it in a timely manner. On top of this, it is also good to involve everyone in these processes to further their education on group projects.

Electrical Engineering Team

The electrical team will start out by reviewing the last couples semesters work. The spring 2010 group for this IPRO completed an initial circuit design and the fall 2010 group also designed one on their own. From that point, the electrical team will focus primarily on stripping down the previous sections work, simulating, and testing it. It is important for the group to go through the previous work, to figure out what has been accomplished, what didn't work so well, and see what they can take away from the work in order to come out with a usable product. Once the background work has been completed, the team will then continue on to try and devise a final solution which can be implemented.

Work Breakdown Structure

[Team Structure]

Computer Science Team

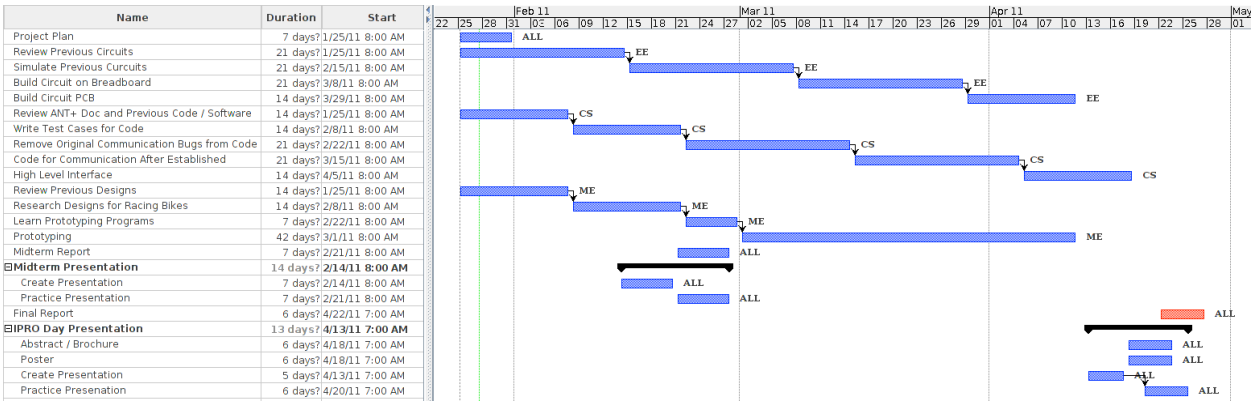
To begin, the programming team will also review previous documents. To start, the team will become familiar with the ANT protocol and using it to communicate with Garmin devices. Once familiar, the team will look back at the spring 2010 group for this IPRO's code. It will be best to continue their work as a starting base enough though it is not functional at this point. To start entirely from scratch once again would require more time than one semester can allot. The programming team will then work completely on trying to debug the code and try to make it operational. If this can be accomplished, it will allow the programming team to move on and work on communicating actual sensor data to the Garmin. Finally, the team will go back and try to refine the code they have produced in order to try and give future IPRO's a high level interface to deal with when trying to communicate with the Garmin. This is paramount as it will require future teams to spend less time learning the protocols and more time working on the actual data which should be communicated.

Mechanical Engineering Team

The mechanical team will also initially start by reviewing work from previous semesters of this IPRO, specifically the housing pieces. From there, the team will research to come up with the minimum specifications for housings on racing bikes. This information is crucial to the project since the housing must be large enough to house the circuit board, fit within the constraints of the bike, and still look aesthetically pleasing. In order to produce these housing, the mechanical team will then proceed to learn the software required to produce a prototype. To conclude, the team will then use this knowledge to generate a prototype housing.

Work Breakdown Structure

[Meeting Times/Gantt Chart*]



Name	Duration	Start
Project Plan	7 days?	1/25/11 8:00 AM
Review Previous Circuits	21 days?	1/25/11 8:00 AM
Simulate Previous Curcuits	21 days?	2/15/11 8:00 AM
Build Circuit on Breadboard	21 days?	3/8/11 8:00 AM
Build Circuit PCB	14 days?	3/29/11 8:00 AM
Review ANT+ Doc and Previous Code / Software	14 days?	1/25/11 8:00 AM
Write Test Cases for Code	14 days?	2/8/11 8:00 AM
Remove Original Communication Bugs from Code	21 days?	2/22/11 8:00 AM
Code for Communication After Established	21 days?	3/15/11 8:00 AM
High Level Interface	14 days?	4/5/11 8:00 AM
Review Previous Designs	14 days?	1/25/11 8:00 AM
Research Designs for Racing Bikes	14 days?	2/8/11 8:00 AM
Learn Prototyping Programs	7 days?	2/22/11 8:00 AM
Prototyping	42 days?	3/1/11 8:00 AM
Midterm Report	7 days?	2/21/11 8:00 AM
Midterm Presentation	14 days?	**2/14/11 8:00 AM**
Create Presentation	7 days?	2/14/11 8:00 AM
Practice Presentation	7 days?	2/21/11 8:00 AM
Final Report	6 days?	4/22/11 7:00 AM
IPRO Day Presentation	13 days?	**4/13/11 7:00 AM**
Abstract / Brochure	6 days?	4/18/11 7:00 AM
Poster	6 days?	4/18/11 7:00 AM
Create Presentation	5 days?	4/13/11 7:00 AM
Practice Presenation	6 days?	4/20/11 7:00 AM

*See Appendix for Gantt Chart

Expected Results

The entire team is expecting to establish communication between the circuit board (PCB) and the Garmin unit, as well as proper housing for the board. To meet this expectation, the electrical engineering team will design and construct the PCB. The computer science team will do the necessary coding required to establish this communication. The computer science team will also look into developing a high level interface for the current software and installing a port into the device which can be used to install firmware and software upgrades .The mechanical engineering team will build an appropriate housing for the circuit board.

Once the bicycle is moving, it generates an input voltage and comes out as a small ouput voltage from the board which goes to the microprocessor. From there, the microprocessor will do the power calculations and send it to the Ant++. After this, a signal will be sent to the Garmin unit to display to the user.

The potential product from IPRO 324 is having the system successfully communicate between the Garmin unit and the circuit board, a housing unit that fits the circuit board and can be attached to the most bike systems. Also a high level interface for the current software and a port into the device that can be used to install future software and firmware upgrades.

Expected Results

[Deliverables]

The team expects to have the following deliverables upon completion of the project:

1. Established communication with the Garmin device
2. Printed circuit board (PCB) of the final circuit used to communicate with device
3. Prototype of housing for the PCB and strain gages

[Potential Challenges, Risks & Assumptions]

The team has identified challenges and potential risks involved in the project thus far.The following lists identify these challenges and risks.

Challenges

- Establishing communication with device: This is an on-going challenge that has plagued previous semester's work on the project, for there has never been substantial or repeatable connections to the Garmin device. A lot of troubleshooting will be involved with obtaining a program and circuit that can communicate with the unit.
- PCB design: Even if connection is established using the circuit built during this project, a design that will fit into the housing that mounts to the crank set could propose a challenge due to the limits and constraints of the available space inside the housing. Power consumption of the circuit must also be taken into consideration.
- Housing design: The design of the housing must take into consideration of the dimensions of the crank set as well as be able to contain the PCB used to transmit the power data.

Expected Results

[Potential Challenges, Risks & Assumptions]

Risks

- FCC Regulations: If communication is established between the circuit and the Garmin device, FCC regulations on the transmission of data could prevent this from eventually reaching an end product.
- Prototype design: Final design of prototype may not be suited for actual use as is. Material selection for a suitable material could prove to be too expensive for production of a final product.

[Devising a Solution]

Interviews with members from previous semesters teams will lend insight to any issues faced with the circuit design and programming in order to determine where to focus initial work on the project. Research of ANT protocol will assist the computer science team when developing a program that establishes communication with the Garmin unit as well as research into cycling standard will aid in the design of the housing of the system.

Project Budget

The following table details the estimated expenses for proper completion of this project.

Item	*Cost*	*Description*
Final Deliverables	$100	Final Presentation items including poster, PCB, final prototype, etc.
Prototyping	$50	Several prototypes of the housing design will need to be generated
Electrical devices/parts	$300	Various electrical components will be needed for the circuit/ PCB.
Team Building	$50	Promote team relationships during meetings including light refreshments
Debugging components	$100	Provide addition resources for computer science team when troubleshooting
Total Cost:	$600	

Designation of Roles

Team Leader: *Mike Dvorscak*

The team leader is responsible for managing the project, leading discussions, delegating tasks, and contributing to overall team cohesiveness. He will ensure that project deadlines are met by keeping team members on task and resolving any issues that may arise.

Minute Taker: *Elizabeth Frebes*

The minute taker is responsible for recording the key points of what we discuss in team meetings as well as what tasks and deadlines are set for the team.

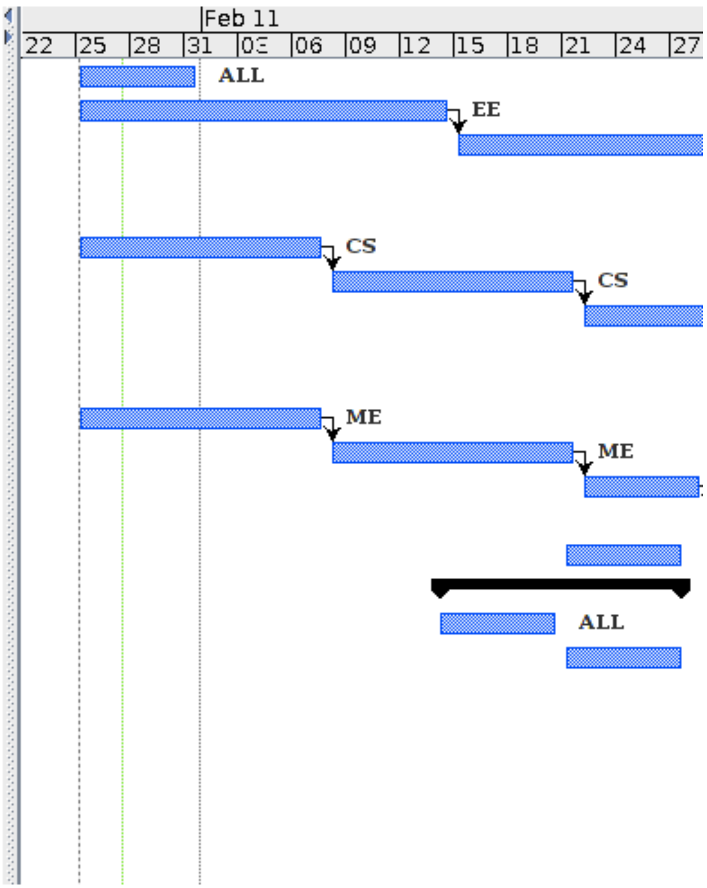
Appendix

[Contact Information]

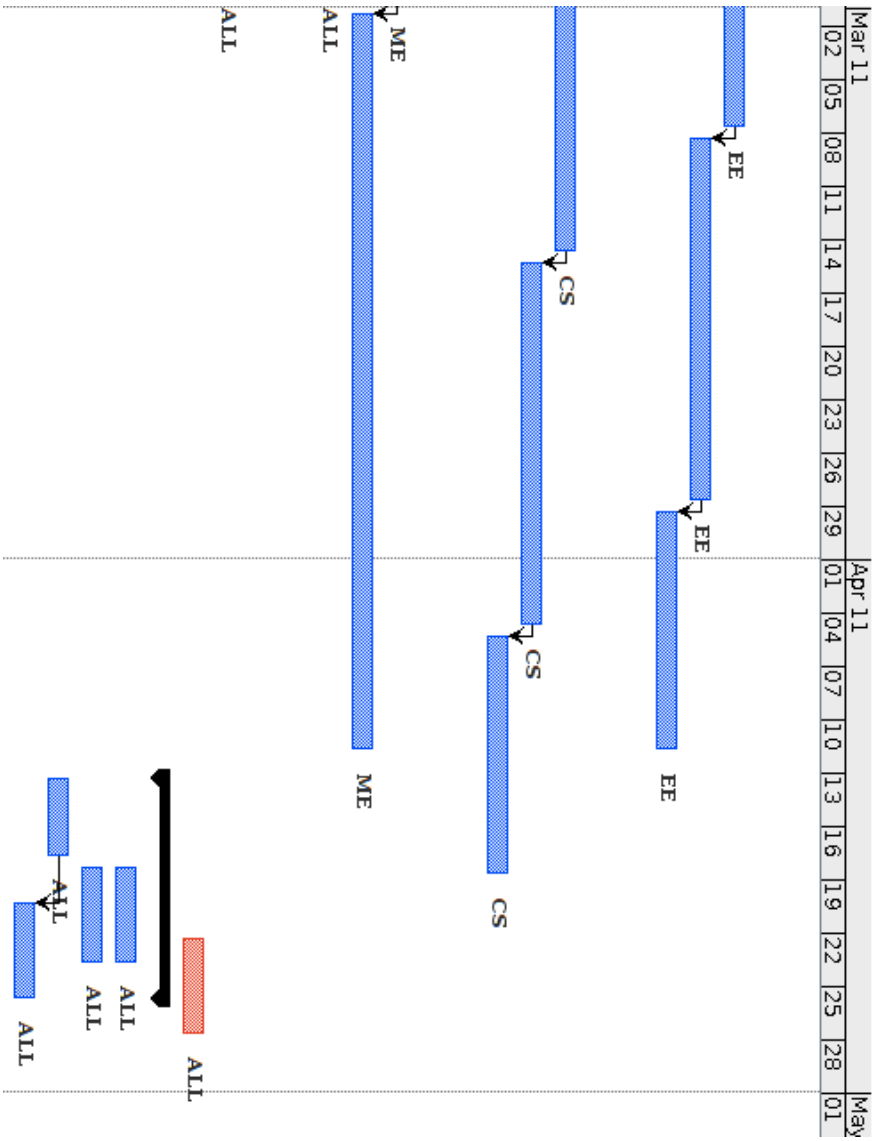
Name	Email	Phone
Andrews, Preston	pandrew4@iit.edu	[redacted]
DeBoth, Ray	raydeboth@cs.com	[redacted]
Devorscak, Michael	mdvorsca@iit.edu	[redacted]
Fabian, Michael	mfabian@iit.edu	
Frebes, Elizabeth	efrebes@iit.edu	[redacted]
Lee, James	jlee192@iit.edu	[redacted]
Mostovoy, Sheldon	mostovoy@iit.edu	[redacted]
Rempfer, Dietmar	rempfer@iit.edu	
Wisniewski, Jerome	jwisnie1@iit.edu	[redacted]

antt Chart]

Name	Duration	Start
Project Plan	7 days?	1/25/11 8:00 AM
Review Previous Circuits	21 days?	1/25/11 8:00 AM
Simulate Previous Curcuits	21 days?	2/15/11 8:00 AM
Build Circuit on Breadboard	21 days?	3/8/11 8:00 AM
Build Circuit PCB	14 days?	3/29/11 8:00 AM
Review ANT+ Doc and Previous Code / Software	14 days?	1/25/11 8:00 AM
Write Test Cases for Code	14 days?	2/8/11 8:00 AM
Remove Original Communication Bugs from Code	21 days?	2/22/11 8:00 AM
Code for Communication After Established	21 days?	3/15/11 8:00 AM
High Level Interface	14 days?	4/5/11 8:00 AM
Review Previous Designs	14 days?	1/25/11 8:00 AM
Research Designs for Racing Bikes	14 days?	2/8/11 8:00 AM
Learn Prototyping Programs	7 days?	2/22/11 8:00 AM
Prototyping	42 days?	3/1/11 8:00 AM
Midterm Report	7 days?	2/21/11 8:00 AM
⊟**Midterm Presentation**	**14 days?**	**2/14/11 8:00 AM**
Create Presentation	7 days?	2/14/11 8:00 AM
Practice Presentation	7 days?	2/21/11 8:00 AM
Final Report	6 days?	4/22/11 7:00 AM
⊟**IPRO Day Presentation**	**13 days?**	**4/13/11 7:00 AM**
Abstract / Brochure	6 days?	4/18/11 7:00 AM
Poster	6 days?	4/18/11 7:00 AM
Create Presentation	5 days?	4/13/11 7:00 AM
Practice Presenation	6 days?	4/20/11 7:00 AM



[Gantt Chart]


Mar 11
02
05
08
11
14
17
20
23
26
29
Apr 11
01
04
07
10
13
16
19
22
25
28
May
01
EE
EE
EE
CS
CS
CS
ME
ME
ME
ALL
ALL
ALL
ALL
ALL
ALL
ALL