IPRO 310: Swimming Aid for Visually Impaired Swimmers

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1.0 Abstract

This project aims to help visually impaired individuals to exercise independently. While the primary focus this semester will be enabling visually impaired swimmers to swim independently, other physical activities will be researched for the purpose of choosing three activities to be considered for future projects. A passive device, which is a mechanically-based device that offers tactile feedback to the swimmer, and an active device, which is a sonar-based device, will both be developed in parallel to aid the swimmers. This project, overall, could potentially increase the independence of blind and visually impaired individuals, as well as improve their quality of life.

2.0 Background

IPRO 310 is a continuing project focused on enabling visually impaired individuals to swim independently. While current advances in assistive devices have enabled people who are blind to be involved in more activities than previously possible, there are still areas that lack attention in applying assistive technology, specifically for blind swimming, which is our primary focus.

Current methods involve blind individuals hiring “tappers”, who are tasked with making sure the swimmers do not hit the pool walls. In addition to avoiding the pool wall, blind swimmers need to avoid the pool lane ropes on either side of the lane. Competitive blind swimming does not include the use of extra equipment to avoid the pool lane ropes. The use of tappers at the ends of the pool lane is the only current standard. The result is that the blind swimmer veers left and right in a zigzag pattern, constantly making contact with the pool lanes. It is not uncommon for the blind-swimmer to cut, scrape, and bruise their body while achieving the slower swimming lap time.

Previous IPRO teams have come up with two main methods to avoid this. These include a passive device, where a blind swimmer can freestyle and backstroke though a swimming lane built of injury safe materials, which act as an awareness system of where the swimmers are relative to their lane. Issues that currently need to be developed based on previous IPRO’s designs are:

1. Long-term endurance to pool conditions.
2. Effectiveness of certain device components (ex. Icicle buoyancy after extended periods of time).
3. Overall effectiveness of device during use.

The active team has been working, in parallel to the passive team, on an electronic system utilizing sonar (sound navigation and ranging) signals that will be utilized and coupled with either an aural or physical signal to inform the swimmer of their proximity to boundaries such as a wall or pool lane ropes. The previous IPRO device developed worked by utilizing a radio frequency signal to signal on/off commands to a receiver connected to a circuit board, which in turn were connected to vibration producing motors located within a waist belt. The signals sent to this waist belt were sent from a small remote, which was operated by human interaction. Issues that need to be further developed include:

1. Operability of Unit (current and new) in underwater conditions.
2.. Signal transmission
3. Waterproofing
4. Physiological effects
5. Economic feasibility studies
   (Rose-Hulman Institute of Technology has engineered a system utilizing sonar, however at an unreasonable cost.)
6.. Interoperability of Unit components (ex. Sonar to receiver)

The research team’s role is to support the other teams when needed, structure the pool tests, conduct interviews to gather information, and ultimately research to choose what the future I-Pros should work on. Throughout the

semester, the team will assess numerous physical activities and choose three activities for future I-Pros to pursue. To fully understand the difficulties of being visually impaired, the research team plans to develop contact with individuals from The Chicago Lighthouse for the Blind, as well as other visually impaired individuals.

3.0 Objectives

Active Team

- Research sensing equipment to detect swimming course deviation.
- Test and devise best method of messaging swimmer information to avoid pool walls and maintain swimming course (sound versus vibration).
- Build sonar proximity sensor.
- Waterproof sonar and RF (radio frequency) sensor.
- Test RF (radio frequency) in addition to sonar device and determine superiority as a sensing device (i.e. speed, range capability, and precision).

Passive Team

- Create a device for use in the pool for a school for the blind in Illinois, Indiana, or Wisconsin.
- Perform extensive materials and durability tests on current materials used in passive device.
- Research alternate pool friendly materials and their costs (Co-op with research team)
- Redesign T-Connectors for easy mobility and for mass manufacture.
- Replace current nylon lane lines with official lane line components.
- Find a new type of material for ‘icicles’ that is more durable but not buoyant, and to apply it to lane line side icicles for breaststroke and butterfly.
- Find a new adhesive for tactile pad at ends of side tappers.

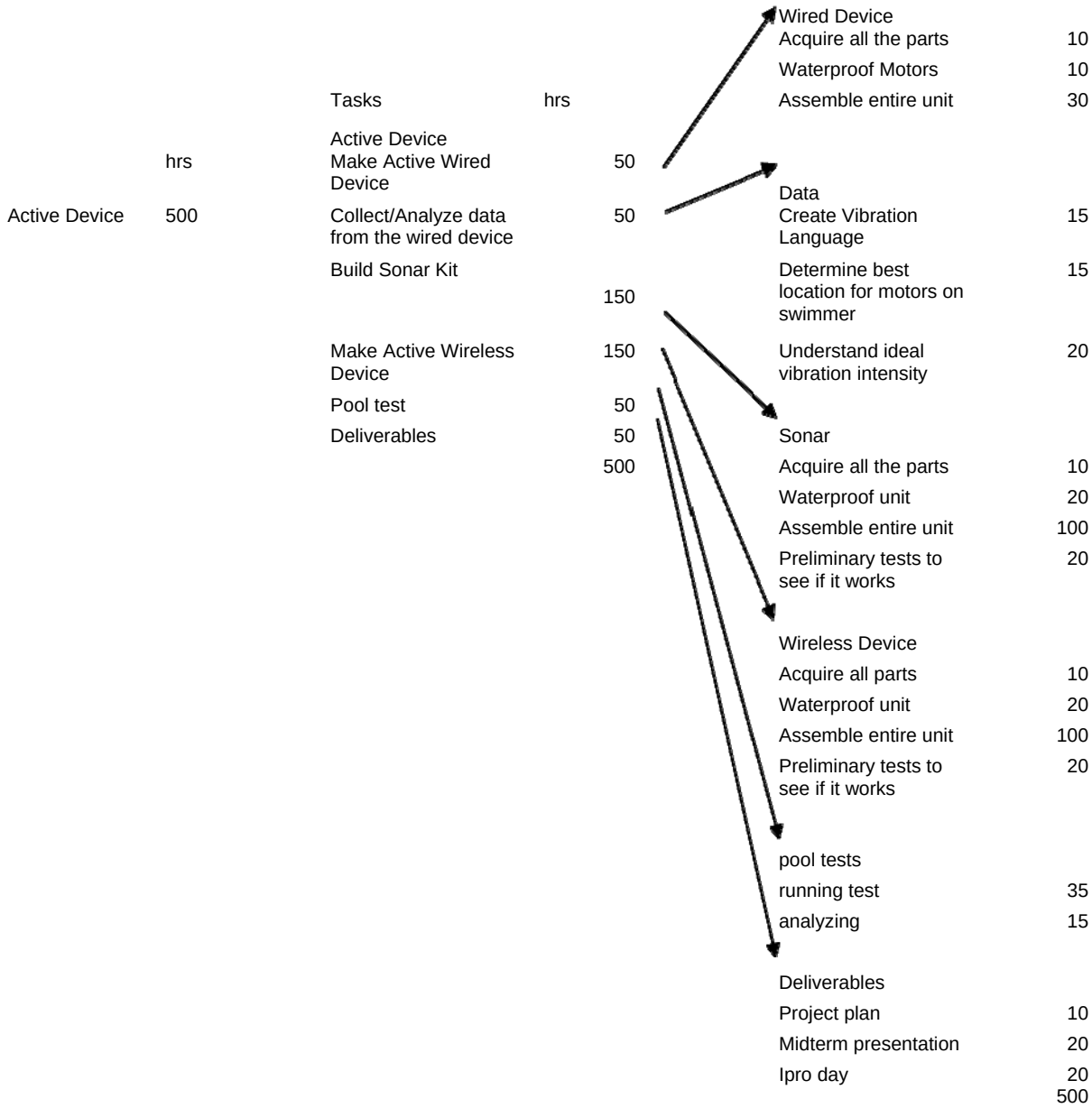
Research Team

- Examine current and future assistive technologies for possible application in our project.
- Educate sub-teams in these assistive technologies.
- Investigate/ identify specific areas of exercise for further research and development via feasibility studies.
- Provide research and analysis for passive/active teams.
- Build potential partnerships with institutions, active groups, and companies for further collaboration.
- Compile all research materials into a readily accessible format.
- Conduct oversight over all pool tests.

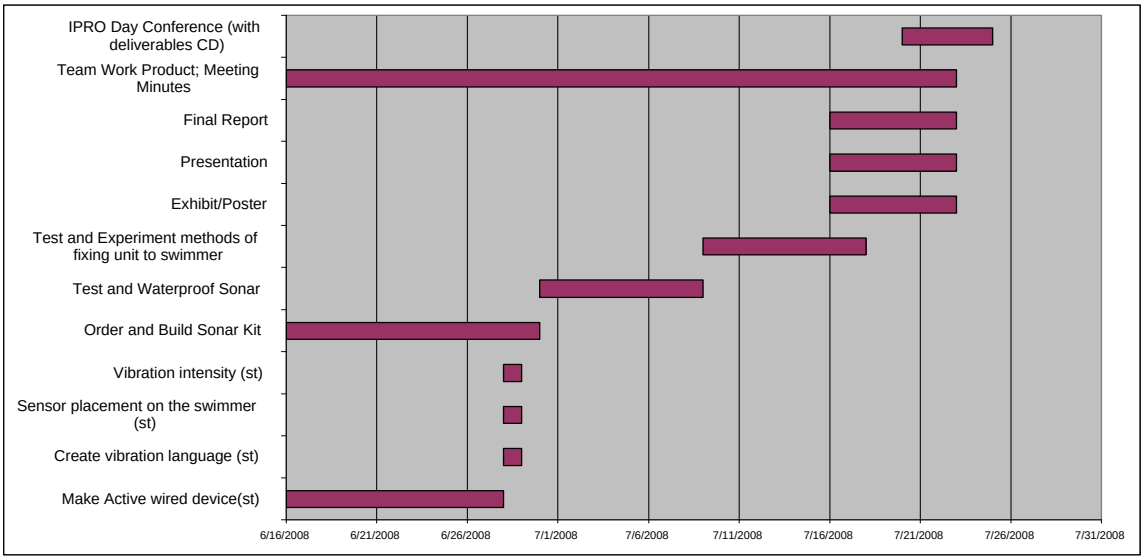
4.0 Methodology

Active Team

Work Breakdown Structure



Gantt Chart



Tasks	Start Date	Duration	End Date
Project Plan	6/8/2008	8	6/16/08
Mid-Term Reviews	6/22/2008	3	6/25/08
Make Active wired device(st)	6/11/2008	17	6/28/08
Create vibration language (st)	6/28/2008	1	6/29/08
Sensor placement on the swimmer (st)	6/28/2008	1	6/29/08
Vibration intensity (st)	6/28/2008	1	6/29/08
Order and Build Sonar Kit	6/16/2008	14	6/30/08
Test and Waterproof Sonar	6/30/2008	9	7/9/08
Test and Experiment methods of fixing unit to swimmer	7/9/2008	9	7/18/08
Exhibit/Poster	7/16/2008	7	7/23/08
Presentation	7/16/2008	7	7/23/08
Final Report	7/16/2008	7	7/23/08
Team Work Product; Meeting Minutes	6/11/2008	42	7/23/08
IPRO Day Conference (with deliverables CD)	7/20/2008	5	7/25/08
Sensing device testing for swimmer path deviation	7/18/2008	7	7/25/08
Pool Test	7/27/2008	1	7/27/08

Passive Team

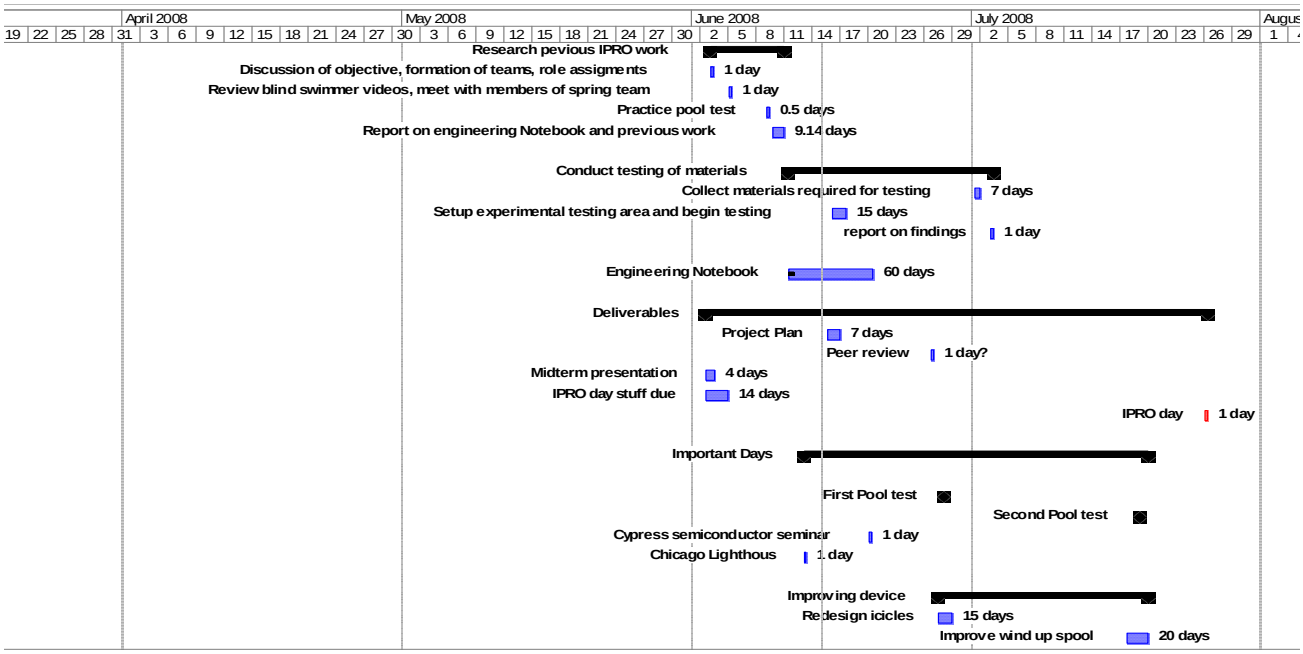
Work Breakdown Structure

	hrs
Passive Device	500

Tasks	hrs
Passive device	
Research previous IPROs	50
Material tests	150
Designing	50
Prototyping	150
Pool test	50
Deliverables	50
	500

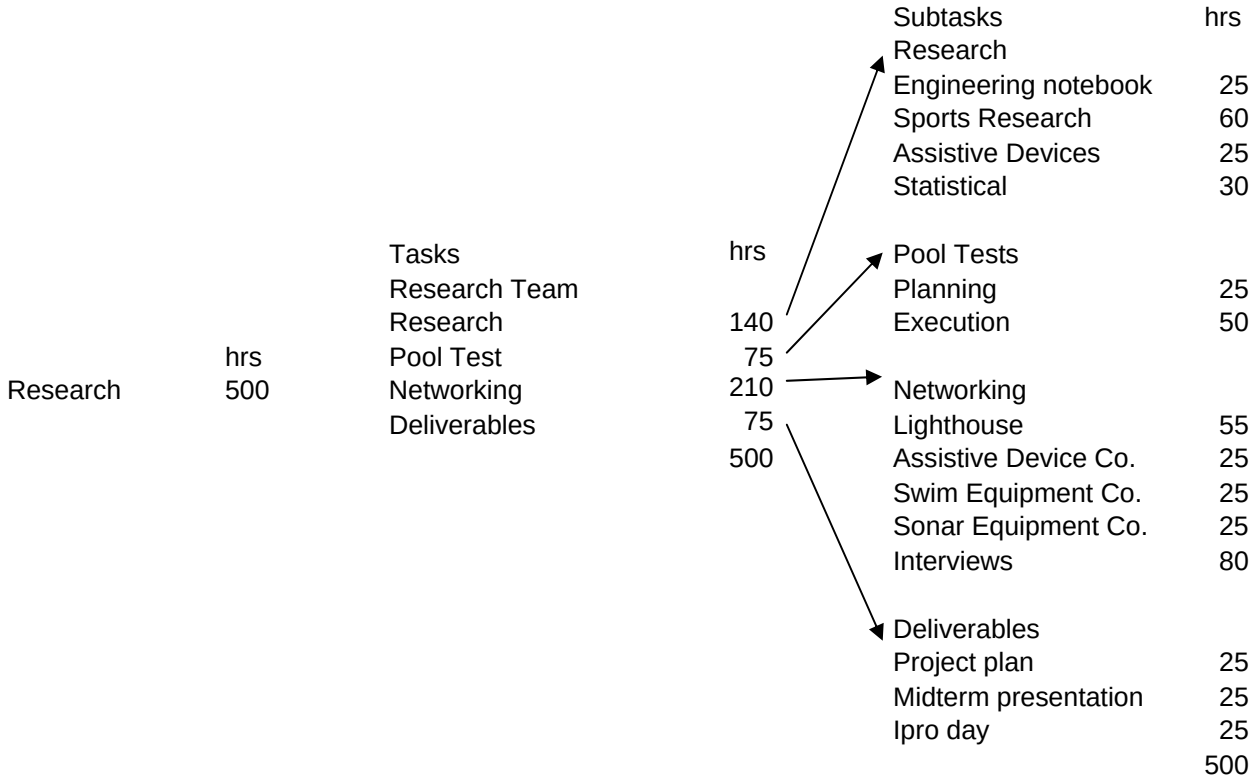
Subtasks	hrs
Research	
Engineering notebook	20
Patent information	20
first pool test	10
Tests	
Acquire materials	10
Run and tests	140
Design	
Redesign T connector	20
Icicle	20
Texture Pad	10
pool tests	
running test	35
analyzing	15
Deliverables	
Project plan	10
Midterm presentation	20
Ipro day	20
	500

Gantt chart

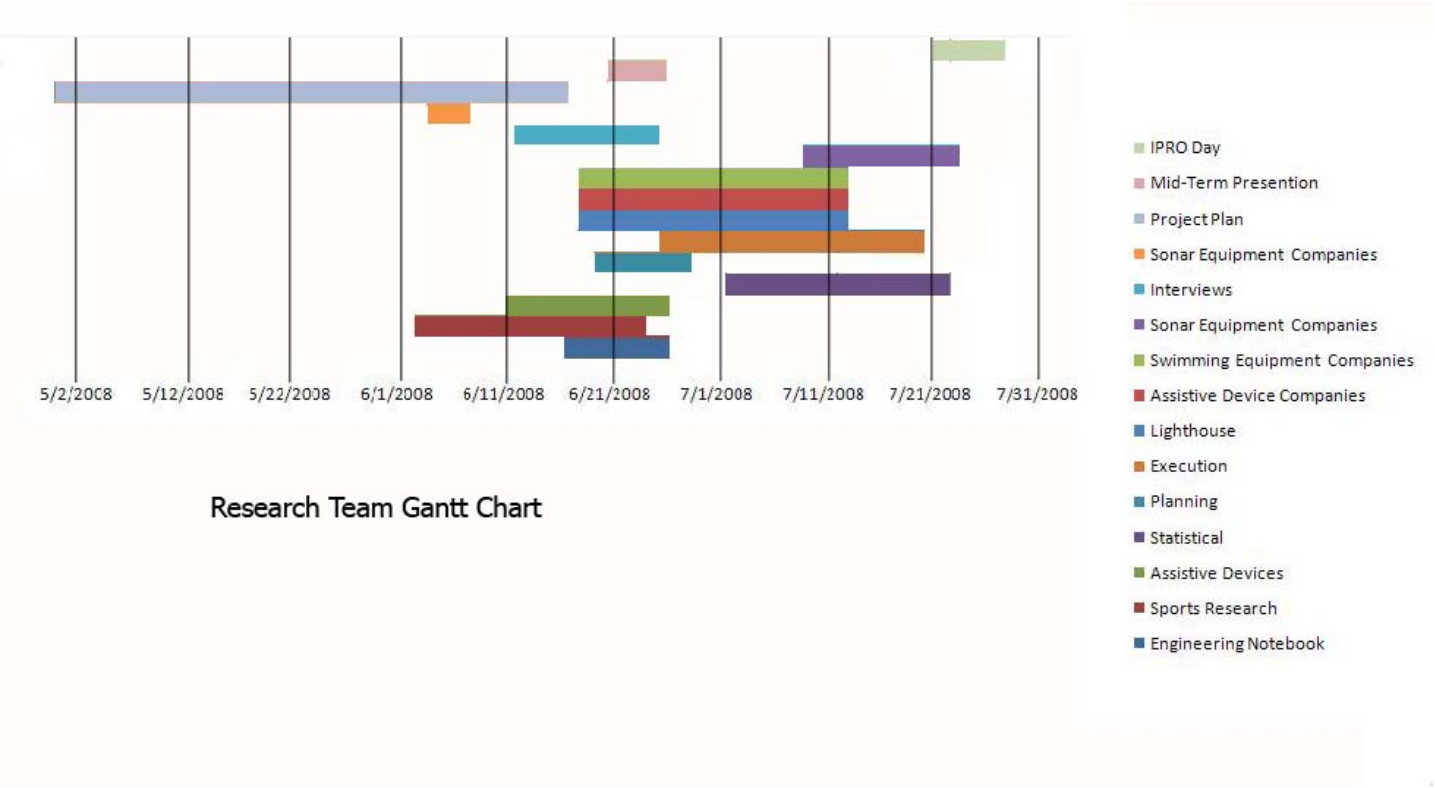


Tasks	Start Date	Hours	End Date
Practice pool test	6/9/2008	5	6/9/2008
Report on engineering Notebook and previous work	6/9/2008	16	6/10/2008
Collect materials required for testing	7/1/2008	4	7/1/2008
Setup experimental testing area and begin testing	6/16/2008	14	6/17/2008
report on findings	7/3/2008	12	7/3/2008
Engineering Notebook	6/11/2008	20	6/20/2008
Project Plan	6/15/2008	15	6/16/2008
Peer review	6/26/2008	10	6/26/2008
Midterm presentation	6/2/2008	25	6/3/2008
IPRO day stuff due	6/2/2008	30	6/4/2008
IPRO day	7/26/2008	9	7/26/2008
First Pool test	6/28/2008	6	6/28/2008
Second Pool test	7/19/2008	6	7/19/2008
Cypress semiconductor seminar	6/20/2008	4	6/20/2008
Chicago Lighthouse	6/13/2008	4	6/13/2008
Trip to school for the blind	TBD	15	TBD
Redesign icicles	6/27/2008	25	6/28/2008
Improve wind up spool	7/17/2008	27	7/19/2008
Building new passive device	7/2/2008	42	7/25/2008
Total Hours		289	

Research Team



Gantt Chart



TASKS	Start Date	Hours	End Date
Research			
Engineering Notebook	6/13/2008	25	6/26/2008
Sports Research	6/5/2008	60	6/26/2008
Assistive Devices	6/12/2008	25	6/26/2008
Statistical	7/1/2008	30	7/21/2008
Pool Tests			
Planning	6/17/2008	25	6/28/2008
Execution	6/28/2008	50	7/19/2008
Networking			
Lighthouse	6/13/2008	55	7/24/2008
Assistive Device Companies	6/17/2008	25	7/22/2008
Swimming Equipment Companies	6/17/2008	25	7/22/2008
Sonar Equipment Companies	6/17/2008	25	7/22/2008
Interviews	7/13/2008	80	7/25/2008
Deliverables			
Project Plan	6/10/2008	25	6/17/2008
Mid-Term Presention	6/19/2008	25	6/26/2008
IPRO Day	7/19/2008	25	7/26/2008

5.0 Budget

Passive Team		
Expenses	**Cost**	**Percent**
Pool Party[1]	$100.00	7.14%
Pool Test 1	$100.00	7.14%
Pool Test 2	$100.00	7.14%
Trip to blind school[2]	$100.00	7.14%
Materials for testing[3]	$100.00	7.14%
Chemicals		
Small Pool		
Foam		
Pads		
Lines		
PVC		
Improve Storage[4]	$200.00	14.29%
Bearings		
Locking Casters		
Commercial Storage Device		
Production of parts/New Device[5]	$700.00	50.00%
Total	$1,400.00	100.00%

1 Each pool test requires $50 to pay for life guards, also for beverages and food for blind participates

2 Money for gas for a 1-2 day trip to a school for the blind in Jamestown WI

3 Simulating pool environment for testing the effects of the material in chlorine

4 Improving the design of the current storage system

5 Materials needed to construct a new device which could be left at the school in Jamestown

Active Team		
Expenses	**Cost**	**Percent**
STASG		
Vibrating Motors[6]	$24.00	5.67%
Variable Switch[7]	$30.00	7.09%
LTASG		
Sonar Kit[8]	$68.00	16.08%
Shipping Kit	$16.00	3.78%
Waterproofing[9]	$75.00	17.73%
Batteries[10]	$15.00	3.55%
Straps[11]	$50.00	11.82%
Shipping Straps	$20.00	4.73%
Variable Expenses		
Integrated Circuit[12]	$75.00	17.73%
Sensing Devices[13]	$50.00	11.82%
Fixed Expenses	$298.00	70.45%
Total	$423.00	100.00%

6 placed within the belt for blind swimmers to feel while swimming

7 Each swimmer has different preference on the strength of vibrations so the variable switch will help each swimmer customize the strength

8 Needed to build proximity alerting device, consists of circuit board/components/transducer

9 Needed to buy resin coatings or machine shop vessel, so that electronics do not come in contact with water

10 Necessary because we are using DC power which allows the device to be portable

11 Needed because the device is needed to be fixed to the swimmer, a belt or restraining module holds the device for the swimmer

12 Cell phone vibrators and aural messaging system will both be built and compared to determine best and safest way to alert and direct the visually-impaired swimmer. So, the components such as chips/motors/wires need to be purchased.

13 No research has been done on swimming path deviation, we will need to purchase potentiometers and various liquids along with construction levelers in order to sense and record deviation. Alternatively and potentially more expensive, is an intertial navigation unit or accelerometers (small scale). These can either be built or bought depending on pool test results. They will sense if the swimmer is turning left or right away from the straight lane pool path.

Research Team		
Expenses	**Cost**	**Percent**
Networking[14]	$50.00	50.00%
Transportation[15]	$50.00	50.00%
Total	$100.00	100.00%

Team		
Expenses	**Cost**	**Percent**
Active Team	$1,400.00	72.80%
Passive Team	$423.00	22.00%
Research Team	$100.00	5.20%
Total	$1,923.00	100.00%

14 Taking blind persons out the eat to interview and gaining further insight on the day to day difficulties of being blind

15 The team plans on making 2-3 visits to the lighthouse on the west side of Chicago to interview individuals and create a relationship with the lighthouse to help future IPRO. Also the team plans on going to the blind musical concert held in the Thompson Center

6.0 Team Structure/Assignments

Skills/Experience

Name	Major	Year/ Level	Skills
Alvargonzalez, Marta	Master of Science in Electrical Engineering	Masters	MS Windows, GNU/Linux, Computer Programing: Java,C, Assembly language of ColdFire MCF527,Network, Security, Protocols, MS Office, PSpice, Matlab, Adobe Acrobat Professional and MicroStation.
Biyawerwala, Hussain	Electrical Engineering Mathematics minor	4th	Analyzing circuits, Power factor corrections, PC proficiency in MS Office applications, PC languages: C++ and JAVA
Cabrera, Joshua	Architecture	4th	AutoCAD, 3D MAX, Sketchup, Photoshop, Illustrator, Flash, Dreamweaver, Ms Office,
Cordogan, Paul	Architecture	5th	Photoshop, Illustrator, AutoCAD, Premier, VIZ, Sketchup
Daay, Fiona	Architecture	5th	sketching, drawing, painting, rendering, model building, Autocad, Architectural Desktop, 3D Studio Max, Rhino, Sketchup, Dreamweaver, Windows MS Office, PhotoShop/Illustrator/ InDesign,
Dudek, Ryan	Architecture	5th	Free Hand Drawing, Drafting, Painting, AutoCAD 2007, 3ds Max 8, Adobe Photoshop CS2, Adobe Illustrator CS2, Microsoft Word, Sketchup 6, Mac OS X.
Hubbard, McLain	Mechanical & Aerospace Engineering	5th	MATLAB, AutoDesk AutoCAD, Pro E and Maple, knowledge of computer hardware, Microsoft Office productivity suites, including Microsoft Word, Excel, and PowerPoint, C++ & Java programming, Circuit construction and analysis devices,
Karns, Nicole	Biomedical Engineering Biology Minor	3rd	Matlab, Ruby, experience with public speaking, MS word, excel, powerpoint
Keane, Robert	Electrical Engineering	5th	UNIX/C/C++ Programming Certificate, programming in C, Visual Basic 6.0, and UNIX shell scripts (csh, bsh), C++, Fortran 77, and x86 and 68000 Assembly Language, MS Word, Excel, and PowerPoint.
Leasenby, Alex	Biochemistry	4th	
Lichaj, Andrew	Business	4th	Communication, Marketing, Carpentery
Lin, Jeffrey	Biomedical Engineering	4th	
Malon, David	Chemical Engineering	3rd	Programming C++, matlab/ mathematica/ maple solvers
Nikhat, Sumayya	Electrical Engineering	4th	Word, excel, powerpoint, PSPICE
Patel, Shital C.	Electrical Engineering	4th	Design simulations using PsPice, Powerworld and Matlab, analysis of Digital Signal Processing using C6713 DSK board, MS Office
Przybysz, Nicholas	Mechanical Enginnering	4th	Matlab, AutoCAD, and Pro Engineer, Microsoft Office (Word, Excel, Access, PPT), C++ and Visual Basic,
Ragauskis, Kevin	Biomedical Engineering Business minor	3rd	
Salimi, Mahdieh	Architecture Music Minor	4th	Free Hand Drawing, Drafting, Painting, AutoCAD 2007, 3ds Max 8, Adobe Photoshop CS2, Adobe Illustrator CS2, Microsoft Word, Excel, Power Point, Sketchup 6, Mac OS X.

Tasks

IPRO 310

Active Team			Passive Team			Research Team		
Team Leader	Marta Alvargonzalez		**Team Leader**	Nicholas Pryzbysz	Materials Listing Design	**Team Leader**	Fiona Daay	Sonar Devices
								Swimming Equipment
Subteam Members	David Malon	Sonar Testing	**Subteam Members**	Kevin Ragauskis	Material Testing			Contact – Institutional, Individual, etc.
		Waterproofing			Icicle Design			Project Plan
		Sonar Kit			Texture pad Adhesion			Recreational Activities-Other/Undefined
	Robert Keane	Sonar Testing		Ryan Dudek	Icicle Design	**Subteam Members**	Joshua R. Cabrera	Assistive Devices
		Waterproofing			Alternative materials research			Fishing Equipment
		Vibration Effects		McLain Hubbard	Materials Testing			Project Plan
		Sonar Kit			T-Connector Design			Recreational Activities-Cycling
		Test Fixing Units			Icicle Design		Nicole Karns	Sonar Devices
	Paul Cordogan	Sonar Testing		Madieh Salimi	T-Connector Design			Swimming Equipment
		Sensor Placement			Icicle Design			Questionnaire/ Surveys
		Vibration Effects						Recreational Activities-Track/Running
		Test Fixing Units					Andrew Lichaj	Swimming Equipment
	Hussein Biyawerwala	Wired Device Assembly						Questionnaire/ Surveys
								Recreational Activities-Soccer
	Jeffrey Lin						Alexander Leasenby	Assistive Devices
								Swimming Equipment
								Contact – Institutional, Individual, etc.
								Recreational Activities-Skiing

Schedules

Active Team

Passive Team

Research Team