WISCONSIN

UNIVERSITY OF WISCONSIN–MADISON

BME Design 200/300

Design of Weight Distribution Monitoring System

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Overview

- Introduction
  - Objective, Problem Statement, Client Information, PDS, Weight Distribution Mechanism, Balance Biofeedback Devices, Previous Design
- Prototype Designs
  - Audio, Vibratory, Visual
  - Visual: Projection, Lasers, Wireless/Mounted
- Discussion
  - Timeline, Future Works, Acknowledgements, References

Objective

- Design and fabricate a sensor board that can be used to measure human weight distribution for the purpose of correcting balance

Problem Statement

- Stroke is a major issue in the United States with more than 800,000 yearly occurrences and 133,000 deaths every year. Many survivors of strokes experience brain damage that can leave their body permanently injured. An individual who suffered a stroke nine years ago and lost all sensation from the left side of her body wishes to improve her standing posture and balance. We are working on a portable device that will allow her to practice proper weight distribution by providing her with valuable biofeedback. We hope that by practicing with our device, our client will be able to improve her balance and overall quality of life.

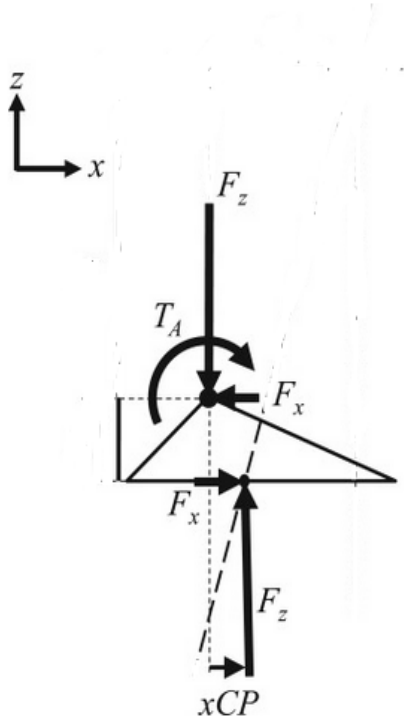
Product Design Specifications

- Client requirements
  - Biofeedback should be clear and easily interpreted.
  - Design cannot require client to look down or hold an object as this affects weight distribution.
  - Free of metal hinges or parts that could damage flooring.

- Board Specifications
  - Measures weight distribution accurately
  - Is portable, light, and able to be carried in one hand.
  - Is safe to balance without falling
  - Must be as thin as possible

Weight Distribution Mechanism

- Center of pressure (COP) determined using the force and moments measured from the plate's sensors.
- Center of mass within the body when standing is constantly in motion.
- Xcp= -My/Fz Ycp=Mx/Fz.



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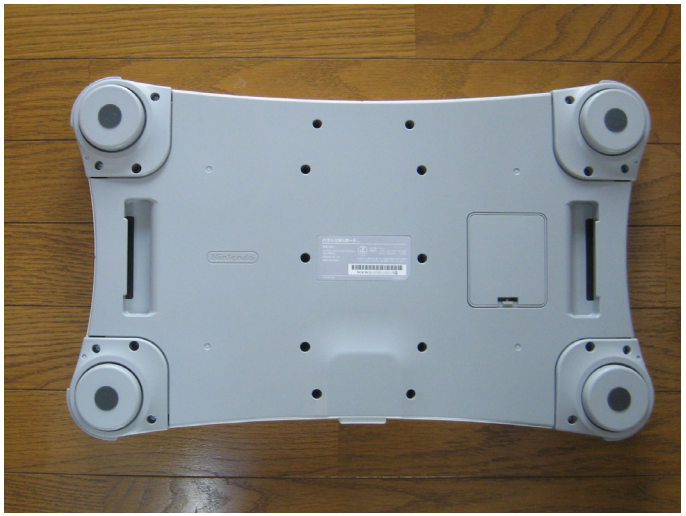
Balance Biofeedback Devices

- The act of calculating the center of pressure in an object.
- In humans this is done by calculating forces normal to an individual's feet
- Currently done by products like:

Wii Balance Board



http://upload.wikimedia.org/wikipedia/commons/b/b1/Wii_Balance_Board_2.JPG

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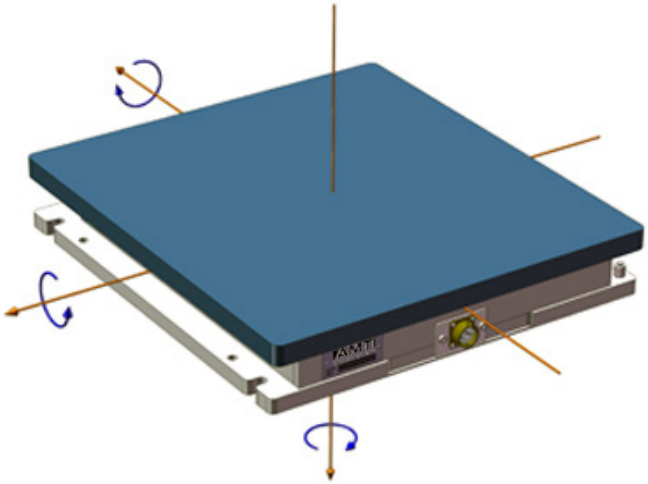
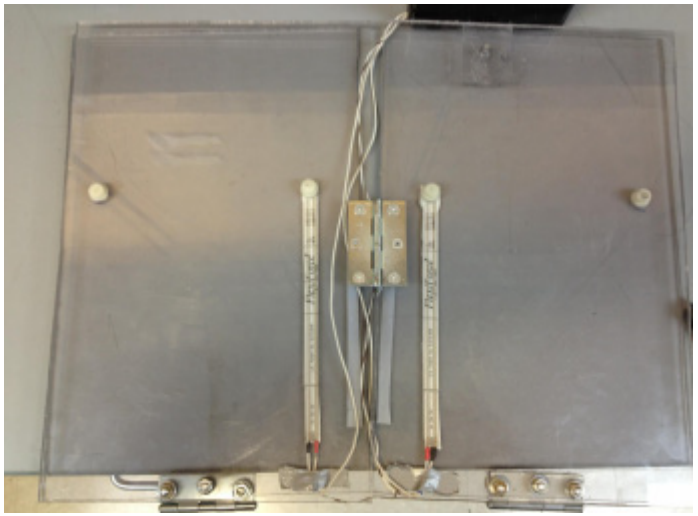


http://www.amti.biz/images/0R6-7-forces-diagram.jpg

Previous Design

- Improvements we would like to make
  - Overall durability
  - Damage to hardwood floors from metal hinges
  - Biofeedback mechanism hands free



Prototype Designs

- Force sensing device incorporates four FSRs, the FlexiForce® PS-03 (Image SI Inc.), 1 in each corner
- Uses an Arduino microprocessor

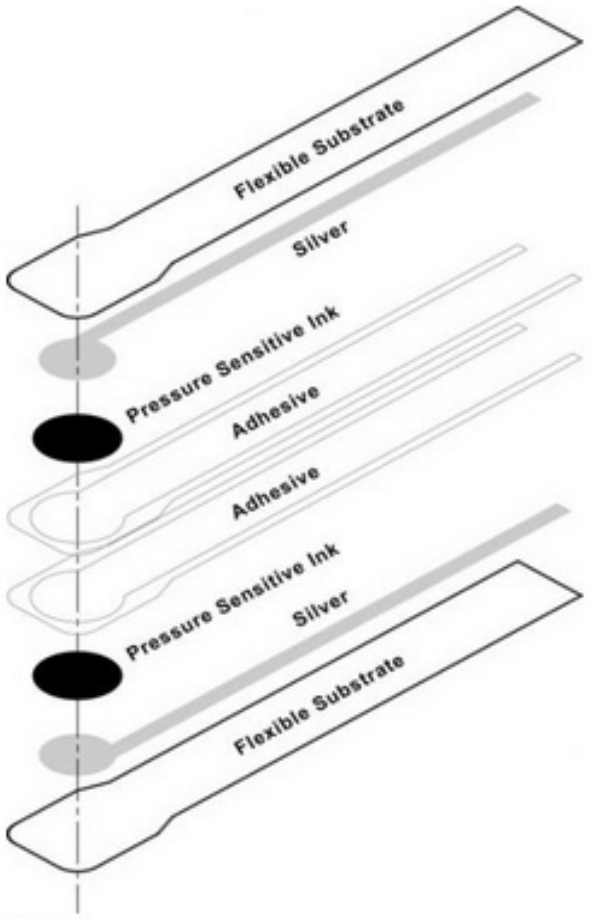


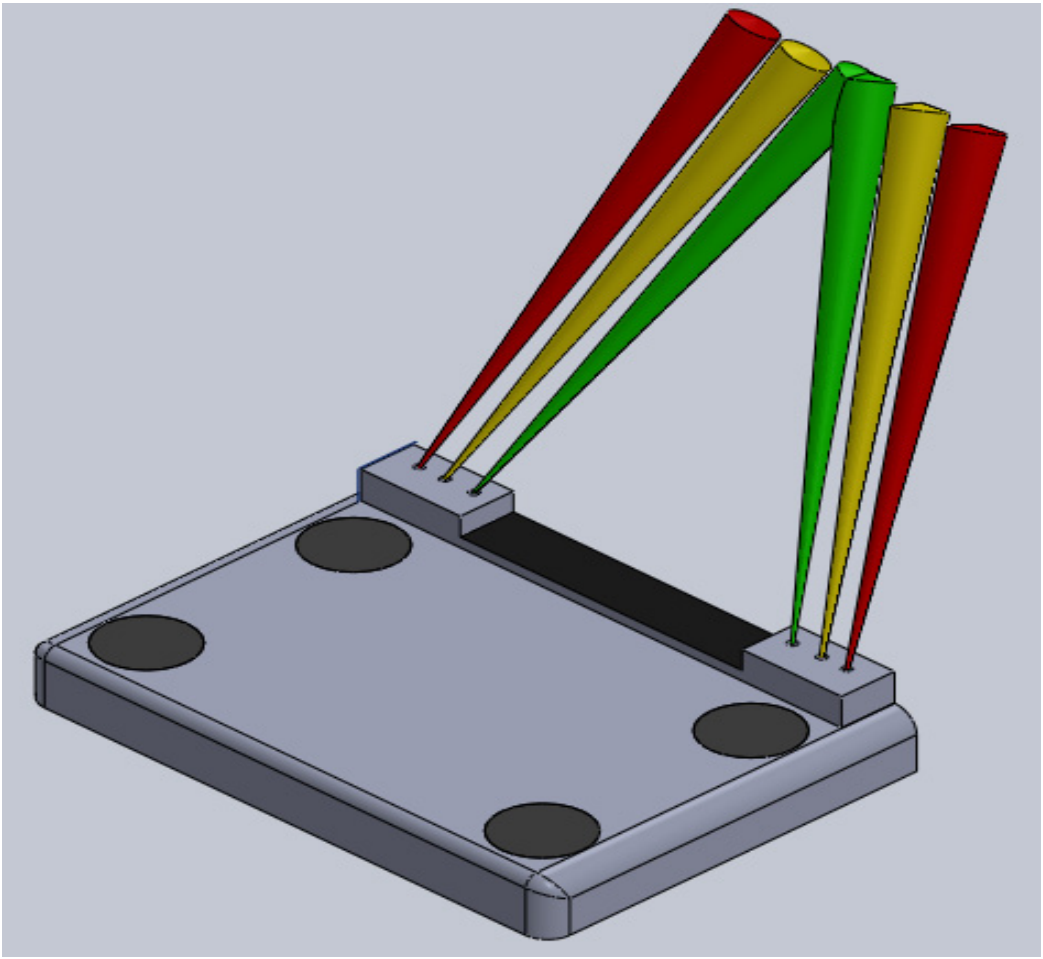
Figure 1 FSR Sensor

http://www.tekscan.com/custom-OEM-force-sensors

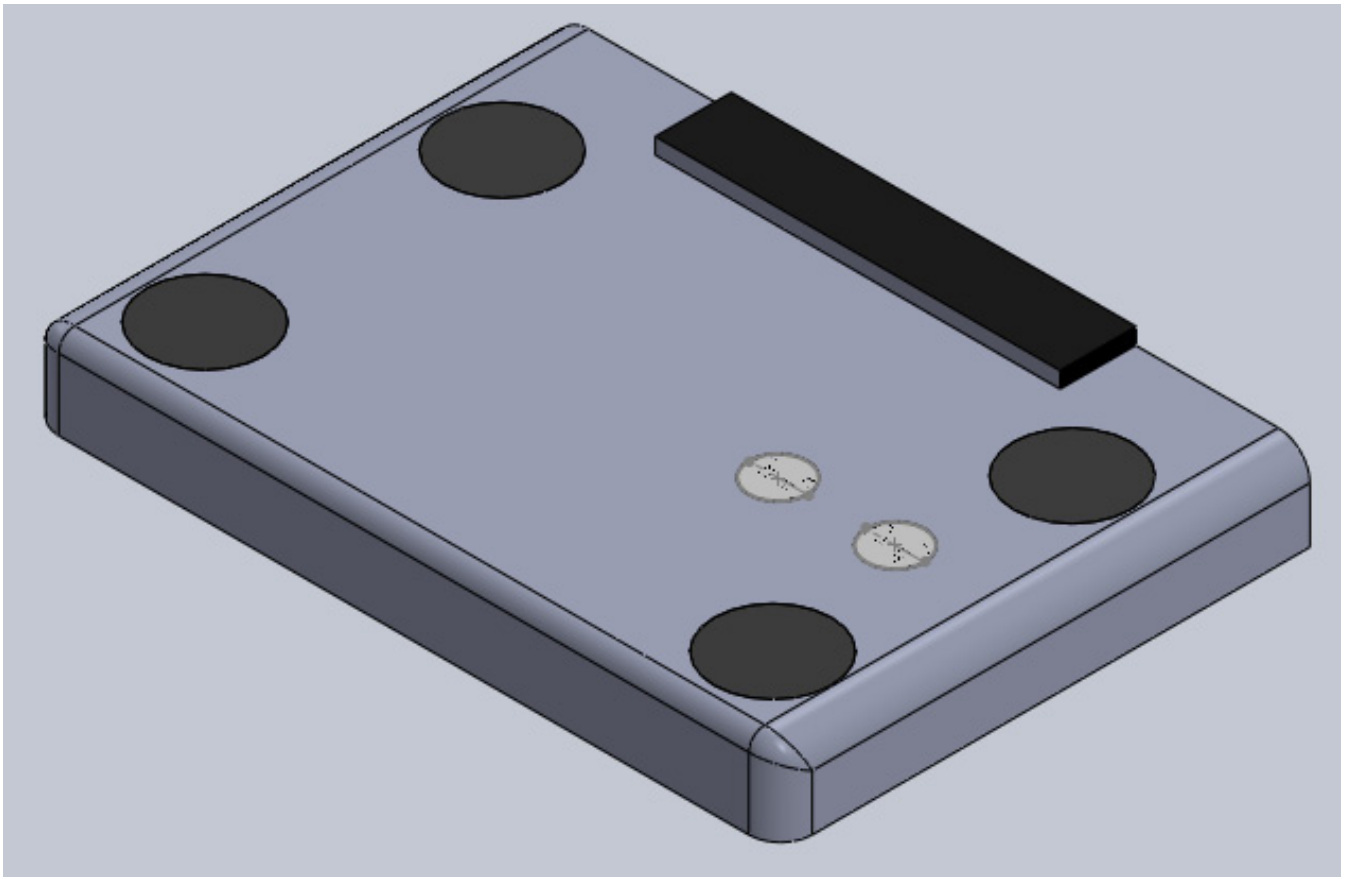
Viable Biofeedback Methods

- Visual Biofeedback with a visual display
- Vibration Biofeedback with motors below feet
- Audio Biofeedback with speakers on opposite sides

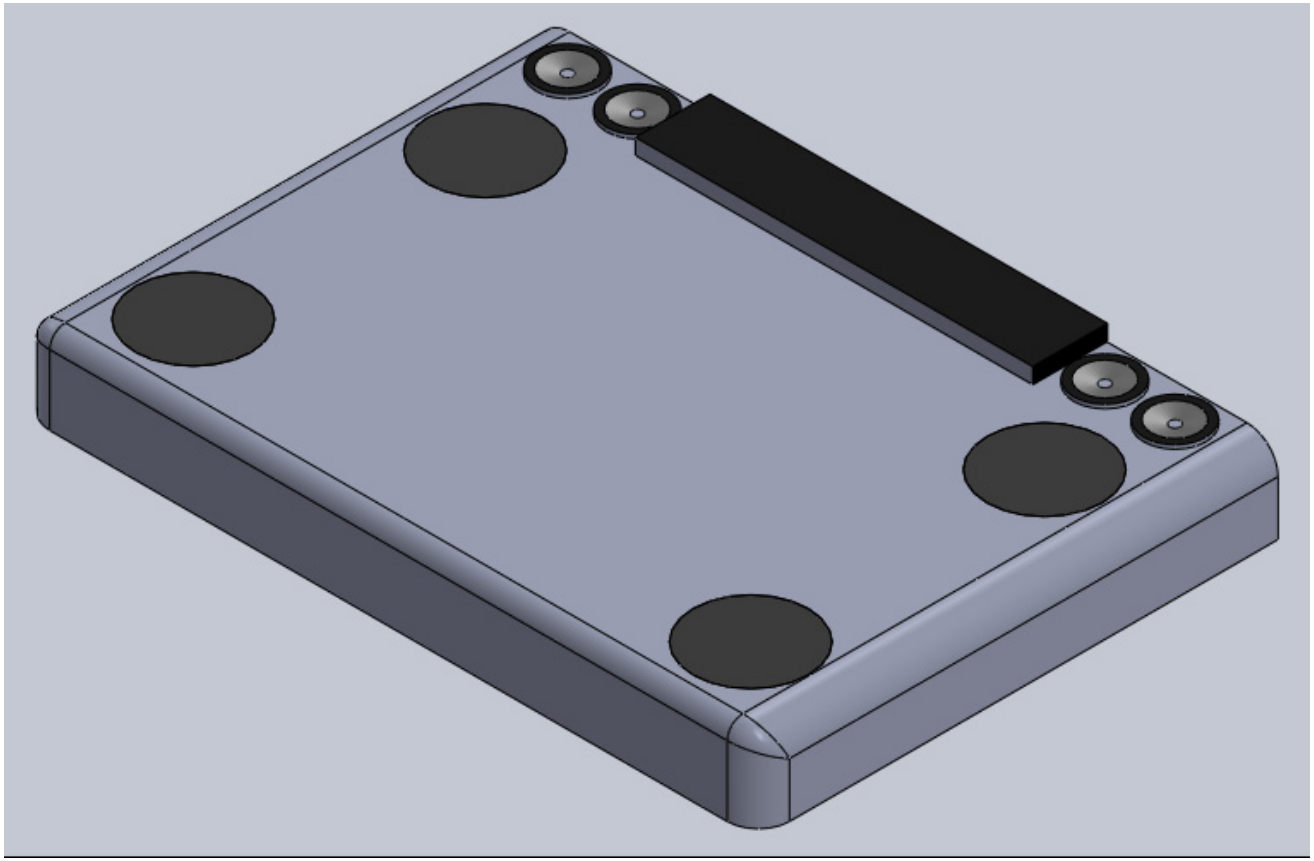
Prototype Design: Visual Biofeedback



Prototype Design: Vibration Feedback



Prototype Design: Audio Feedback

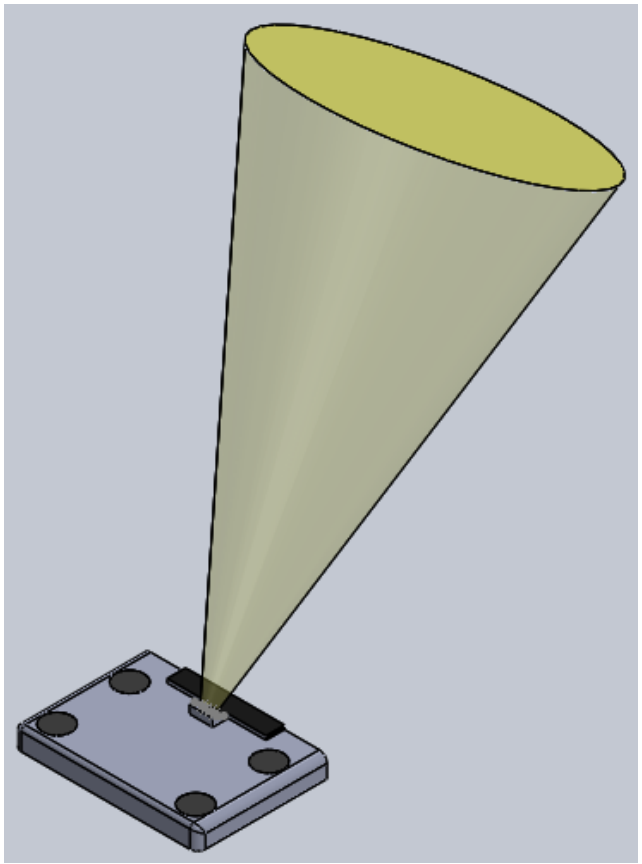


Design Matrix

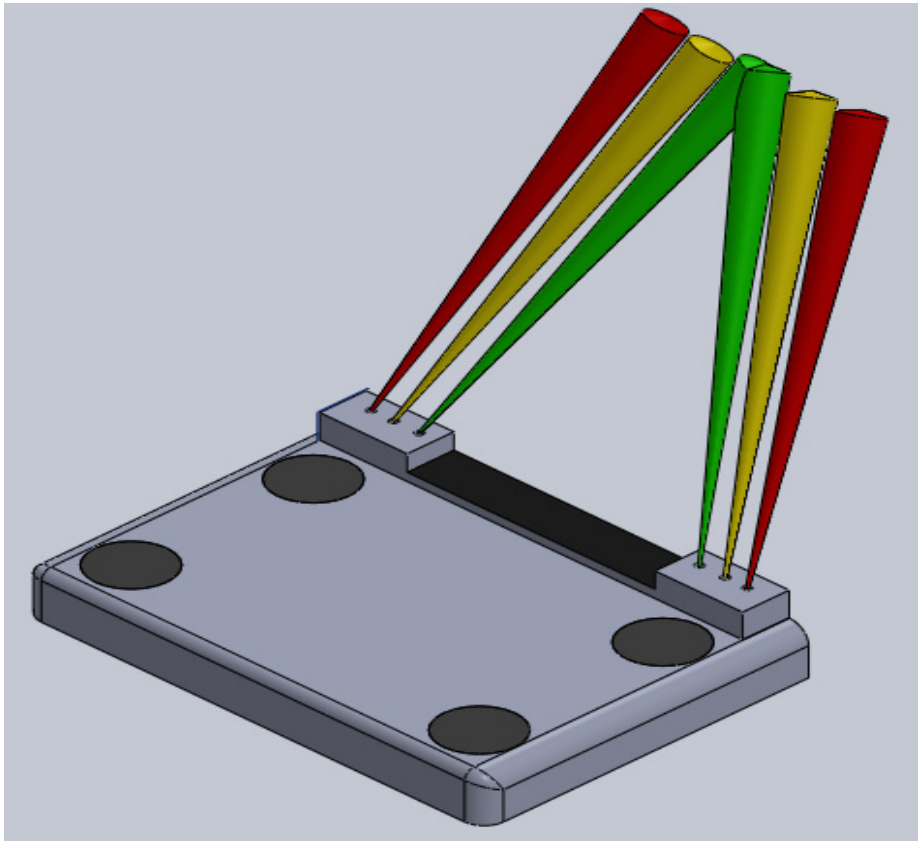
Design Criteria (weight)	Visual Feedback	Vibrational Feedback	Audio Feedback
Ease of Use (30)	5 | 30	4 | 24	4 | 24
Effectiveness (25)	4 | 20	2 | 10	4 | 20
Comfort (20)	4 | 16	2 | 8	3 | 12
Safety (15)	4 | 12	3 | 9	3 | 9
Cost (10)	3 | 6	4 | 8	3 | 6
Total (100)	84	58	71

*Grading out of 5

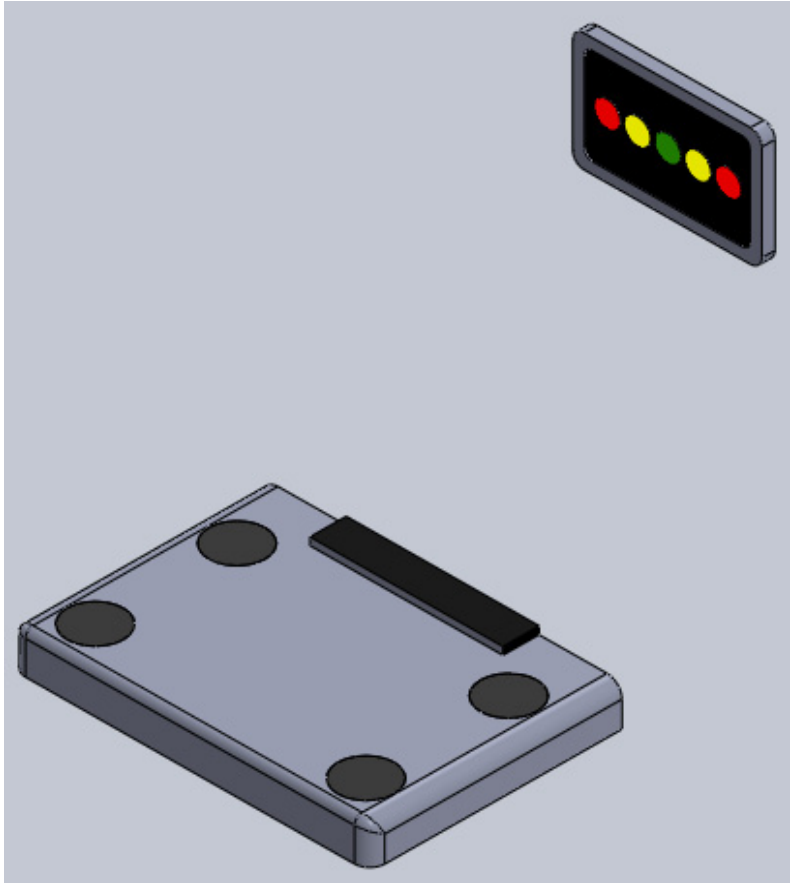
Prototype Design: Visual Biofeedback (Projection)



Prototype Design: Visual Biofeedback (Lasers)



Prototype Design: Visual Biofeedback (Wireless/ Mounted)



Design Matrix

Design Criteria (weight)	Projection	Lasers	Wireless / Mounted
Ease of Use (30)	3 | 18	5 | 30	3 | 18
Effectiveness (25)	5 | 25	4 | 20	4 | 20
Comfort (20)	4 | 16	4 | 16	3 | 12
Safety (15)	5 | 15	4 | 12	5 | 15
Cost (10)	3 | 6	5 | 10	2 | 4
Total (100)	80	93	64

*Grading out of 5

Discussion

- Future Works
- Timeline
- Conclusion
- Acknowledgements
- References

Future Works

- Purchasing materials
- Fabricating prototype
- Calibration of prototype
- Expected pitfalls
  - Applying our own FSR to thin force plate
  - Microprocessor integration with FSR and lasers
  - Proper time management

Timeline

Task	September				October				November					December
	6	13	20	27	4	11	18	25	1	8	15	22	29	7
Project R&D														
Lit. Research	X	X	X	X	X									
Manufacturing														
Cost Estimation				X	X									
Prototyping														
Deliverables														
Progress Reports	X	X	X	X	X									
Midsemester					X									
Final Poster														
Meeting														
Client	X			X										
Team	X	X	X	X	X									

Conclusion

- Hemiplegic client with trouble balancing
- Device to monitor weight distribution
- Ease of use and portability
- Current design: visual laser biofeedback

Acknowledgements

- We would like to thank:
  - Dr. Yen
  - Dr. Tompkins
  - The BME department

References

- http://www.stroke.org/site/PageServer?pagename=stroke
- http://www.strokecenter.org/patients/about-stroke/stroke-statistics
- http://www.cdc.gov/stroke/facts_statistics.htm
- http://www.stroke.org/site/DocServer/STROKE_101_Fact_Sheet.pdf?docID=4541
- http://www.cdc.gov/stroke/facts.htm
- http://menshealth.about.com/od/lifestyle/a/vital_stats.htm
- http://link.springer.com/article/10.1007%2FBF02441555#page-1
- http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3019192/