Hilary Anna Johnson

" mechanically-minded design & impact driven problem solving "

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Education

Thayer School of Engineering | June 2015

Bachelor of Engineering, Mechanical Concentration

Dartmouth College | June 2015

Bachelor of Arts, Engineering Sciences

Coursework

- Computer-Aided Mechanical Engineering Design
- Machine Engineering
- Engineering Design Methodology
- Product Design
- Microprocessors
- Structural Analysis
- Solid Mechanics
- Systems
- Distributed Systems & Fields
- Statistical Methods
- Digital Electronics
- Thermodynamics
- Material Science

- Differential Equations
- Linear Algebra
- Multi-variable calculus
- Calculus of Vector-Valued Functions
- Scientific Computing

- Development Economics
- International Development
- Contemporary Architecture
- The Modern Healthcare System
- Human Biology
- Intro to Sociology

Engineering Work Experience

Thayer Design Fellow

July – Present | Thayer School of Engineering

Medical Engineering & Design Intern

June – August 2014 | Insight Product Development LLC

Research Assistant Amulet Mobile Health Project

February - May 2014 | Thayer School of Engineering

Dartmouth Biomedical Engineering Center Research Assistant

Sept. 2012 – June 2013 | Thayer School of Engineering

References

Peter Robbie, Thayer School of Engineering

603•646•9396 | peter.j.robbie@dartmouth.edu

John Collier, Thayer School of Engineering

603•646•2355 | john.collier@dartmouth.edu

Gregg Fairbrothers, Retired Tuck School, Entrepreneurship

603•646•0290 | gfairbrothers@gmail.com

Skills

Applications | Certified SolidWorks Professional, Pro-E, SketchUp, Photoshop, Microsoft Office Suite

Production | CNC milling & routing, injection molding, mill, lathe, laser cutting, 3D printing, MIG welding, plasma cutting + prototyping

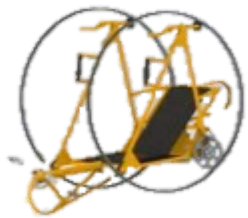
Programming | C, C++, Matlab, Processing, Arduino, Assembly

Languages | conversational Spanish, basic Serbo-Croatian

About me

I am an adventurer and problem solver. I love tough challenges. Whether it's a mountain or a medical device, I see both the sweeping landscape and the minute details. I learn fast and love learning. I became an engineer because I deeply care about serving people by solving their problems. I grew up in Portland, Oregon and went to high school in Bosnia and Herzegovina. I've spent the last four years absorbing as much as I can at Dartmouth while earning both engineering and liberal arts degrees.

Projects



Diwheel

Mechanical | 04

// A two wheeled pedal powered vehicle

An Adjustable Sling

Biomechanical | 08

// For post-prostatectomy continence

Playful Robots

Mechanical | 12

// Thayer Baja machine design

Amulet

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// Wearable body-area health network hub

Diwheel

// A two-wheeled, pedal powered vehicle

Team | Mechanical Engineering

SolidWorks rendering of the final vehicle.

Challenge: Design, build, and race a pedal-powered diwheel

Creative Fields	Course/Client	Completion Date	Skills
Engineering	ENGS 146 Computer Aided Mechanical Design	Spring 2015	SolidWorks Professional Certificate SolidWorks Simulation Tools MIG Welding

Team: Bevel's Advocate

Winner of the 2015 ENGS 146 Diwheel Competition
& the Best Fits and Finishes Award

At an applied rider torque of 26 lb-ft, converting to 5.5 lb-ft per wheel, this diwheel accelerates from 0 to 5 mph in under 10 seconds. Helping to make Bevel's Advocate's sublime driving dynamics possible is a rigid open chassis that features hardened steel and Thayer machine shop manufacturing and welding techniques. The suspension is derived from hoop spring between the offset drive wheel several inches above the center of mass and the front guide wheel, and the custom made rear differential maintains smooth turning for tight maneuverability. Anti-gerbilling mechanisms provide both stylistic additions as well as balance and over-correction protection.

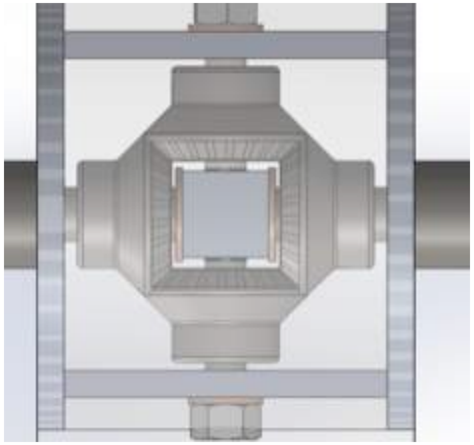
Differential Design & Drive Train

To the right are SolidWorks renderings of the differential and drive train, as a full sub-assembly and also integrated into the frame. The differential I co-designed and built with a teammate uses four bevel gears to transfer power from the chain and sprocket to the drive shafts. Building a low friction differential was one of the central challenges of this project. Tight tolerances, precisely aligned bearings, and co-axial shafts were essential to building a low friction system.

Properly welding the frame was a key part of making sure the drive shafts were co-axial. I built a welding jig to hold the shaft collars and their gussets rigid during welding to ensure that heat from the welds did not deform the frame.

I was the project manager for my team, making sure we finished several days ahead so that we could test, break and fix any weakness in our design before competition day.

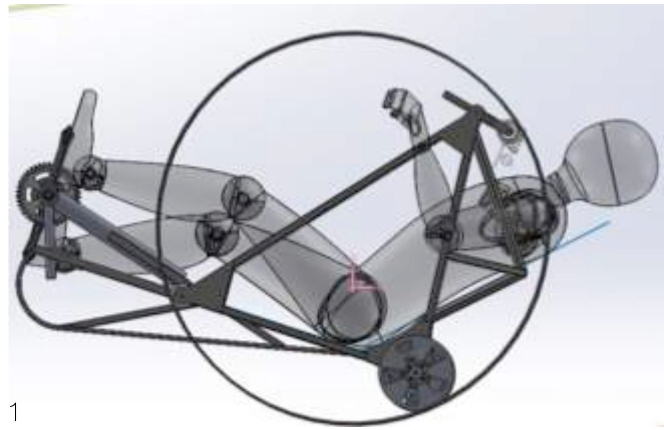
I also designed, prototyped and built the steering and braking system and I MIG welded the entire chassis frame and built welding jigs for precise alignment.



Manufacturing and Assembly

Key Manufacturing Processes

- Plasma cut 1/8" steel gussets
- MIG welded steel bar stock frame (2,4)
- CNC milled drive wheels and differential case from SolidWorks model using HSM Works (3)
- Lathed retaining ring grooves on drive shafts and polyethylene tensioning wheels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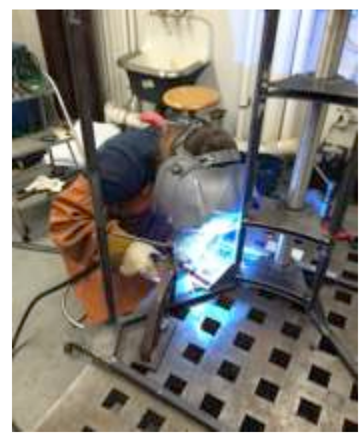
The Bevel is in the Details

As our team philosophy, we knew that doing an excellent job on even the small details would make a difference on race day (5). We put extra care into making sure alignments were precise, that welds were strong and balanced heat across members to avoid deformation, and our shifter worked consistently under tension. We even calculated center of mass (1) of our diwheel with a dummy to ensure a balanced weight distribution to optimize speed and agility.


3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An Adjustable Sling

// For Post-Prostatectomy Continence

Team | Biomechanical Engineering

SolidWorks rendering of the preliminary prototype.

Challenge: How might we develop better products to restore urinary continence for post-prostatectomy males?

Creative Fields	Course/Client	Completion Date	Skills
Engineering Medicine	ENGS 89/90 Capstone Design Project American Medical Systems	March 2015	Design methodology Project management Design for medicine SolidWorks design Requirement testing

Goals

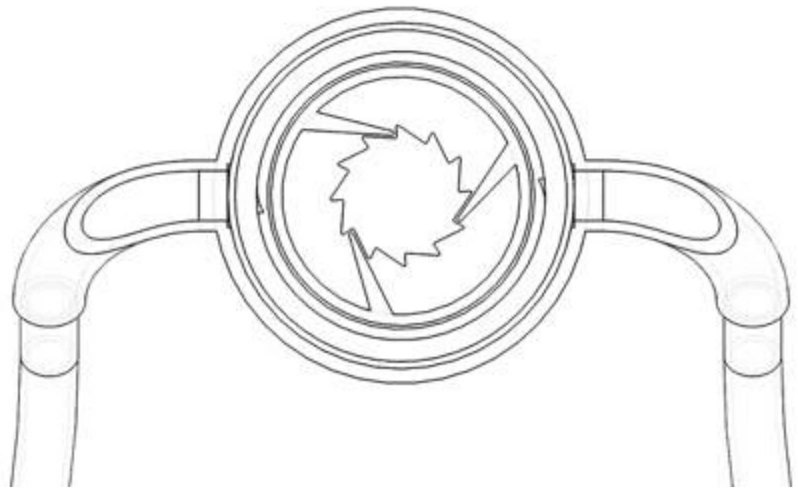
1. Draw germane insights & specifications from physician research
2. Thoroughly investigate the solution space and develop a comprehensive set of alternative concepts
3. Refine these concepts based on the most important specifications, technical feasibility, and IP-defensibility
4. Present a feasible product concept developed through engineering analysis, testing and design

Solution

An adjustable sling that allows surgeons to easily implant and then fine tune adjustment post-surgery without re-incision to provide optimal urethral tensioning for maximum continence.

Patent

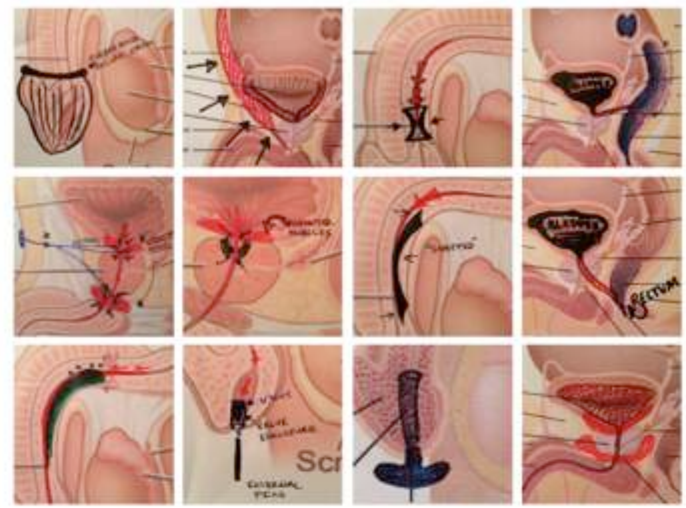
Filed by American Medical Systems in June 2015: **Implants, Tools, and Methods for Treatment of Pelvic Conditions**



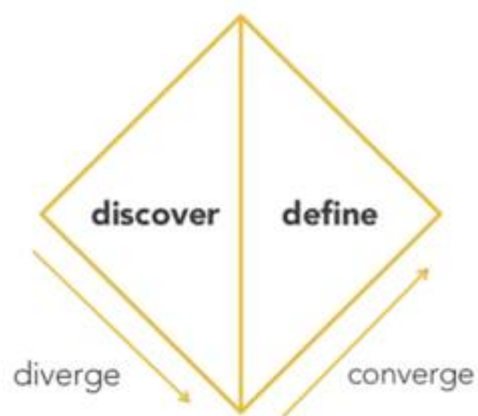
Cross sectional SolidWorks view of the interior ratchet mechanism.

Design Method

Discover |
We conducted 8 in-depth physician interviews with prostatectomy and continence experts from the US, Germany and Egypt. Through a review of 35 medical journal articles and ex vivo pig dissections we characterized incontinence pathophysiology and identified six underlying biological bases of incontinence. We studied current state of the art for incontinence solutions, including European competitors to AMS's US products. All of this led us to generate 65 initial concept ideas.



Define |
Using specifications we developed, and judging concepts based on feasibility and IP-defensibility we distilled the 65 concepts into three new solutions: an electronically actuated artificial urinary sphincter, a new prostate removal procedure that preserves the urethral length, and a non-invasively adjustable urethral sling. We identified failures in current state of the art through physician interviews and reviewed our concepts with physician experts.

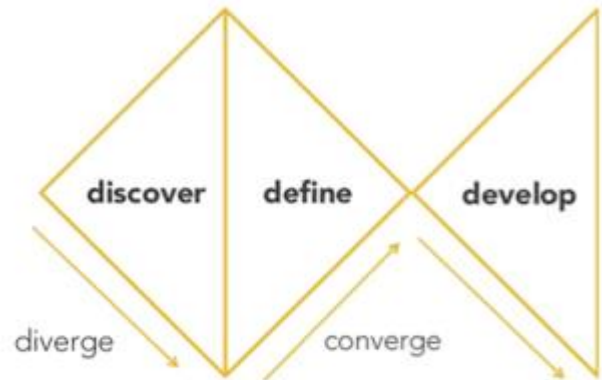


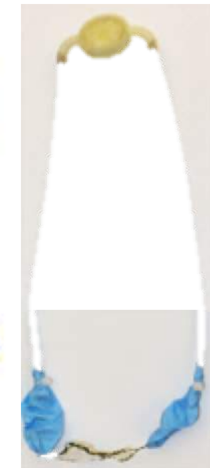
1. Electronic AUS
2. Urethral Length
3. Adjustable Sling

Design Method

Develop |

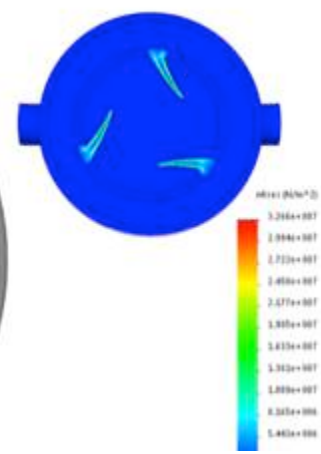
I iteratively prototyped the adjustable sling design concept in parallel with testing and feedback. The design process included sketches, rough physical mock-ups, SolidWorks models, and a works-like, looks-like functional prototype. Getting early prototypes into the hands of surgeons and physicians was essential to our development process.





Deliver |

We refined prototypes and conducted testing for adjustability, ratchet torque, flow rate efficacy, sling base force, sling base failure, and preliminary FMEA analysis. We also laid out initial flow of the new surgical procedure for implantation and adjustment. We documented our design decisions and provided recommendations on further refinement, materials and initial cost estimates. All our development, testing and recommendations were compiled into a product concept paper to deliver to sponsor.



Analysis & Deliverables

Analysis

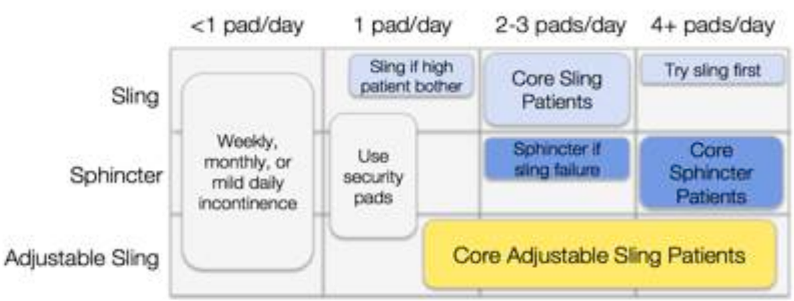
I developed both SolidWorks analyses and bench-top prototype testing for the force exerted by the sling, the torque necessary to rotate the spindle, and stress analysis of the pawls in the ratchet.

Deliverables to our Sponsor

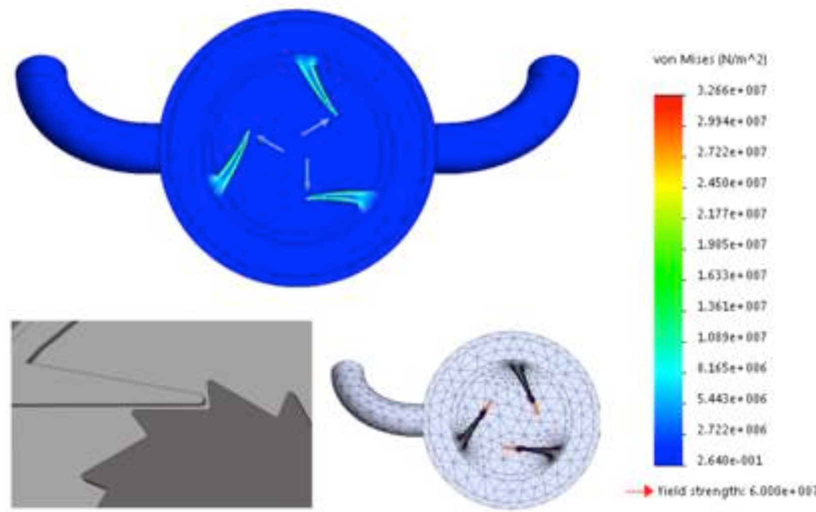
- *Product Concept Paper* |
  - Preliminary descriptions and analysis for three concepts
  - Work-like prototype of adjustable sling design
  - CAD models and simulations for prototype
  - Desktop and bench-top testing, literature review and recommendations
- *Final Patent Disclosure* | Adjustable ratchet sling embodiments for patent filing

Interior ratchet mechanism

Force testing with prototype



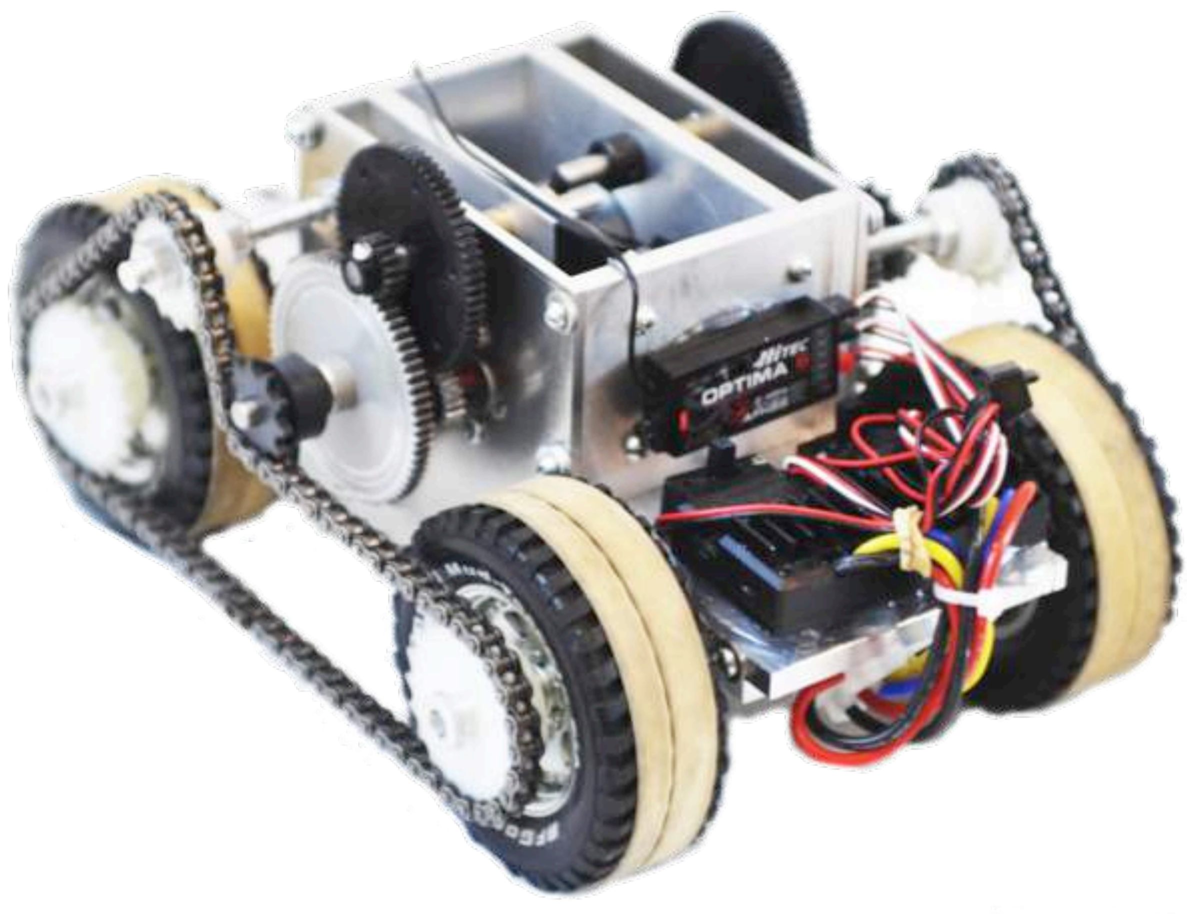
User Segmentation in US markets and adjustable sling niche.



Data driven physical design and materials selection based on SolidWorks von Mises stress and deformation analysis.

Playful Robots
// Thayer Baja Machine Design

September – November 2014, Team | MECHANICAL ENGINEERING



Challenge: Design & build a robot to navigate a challenge course

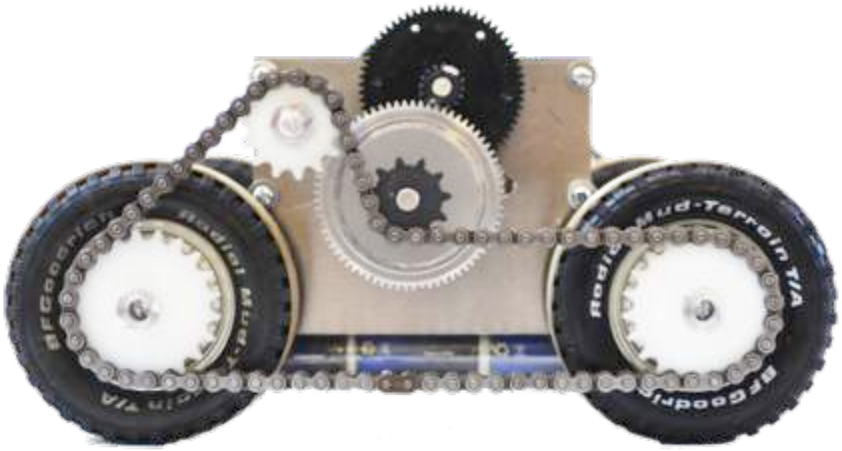
Creative Fields	Course/Client	Completion Date	Skills
Mechanical Engineering	ENGS 76 Machine Engineering	Fall 2014	SolidWorks Certification Mechanical Design Milling, lathing, gear box design

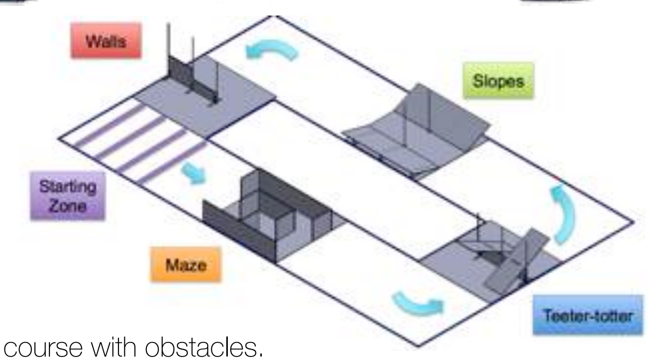
Objective

To design and manufacture a remote controlled robot using limited materials to navigate a four part obstacle course. Our requirement specifications drove the design process and testing. The goals of the course were to develop an understanding of the machine design process develop competency in mechanical CAD design and machining to specification.

My Contribution

- Created 25 iterative designs with sketches, foam core, SolidWorks and machining
- Led chassis/gearbox design, manufacturing & assembly
- Calculated optimal gear ratio & fits necessary for bearings & bushings
- Created chassis and gearbox engineering drawings





Challenge course with obstacles.

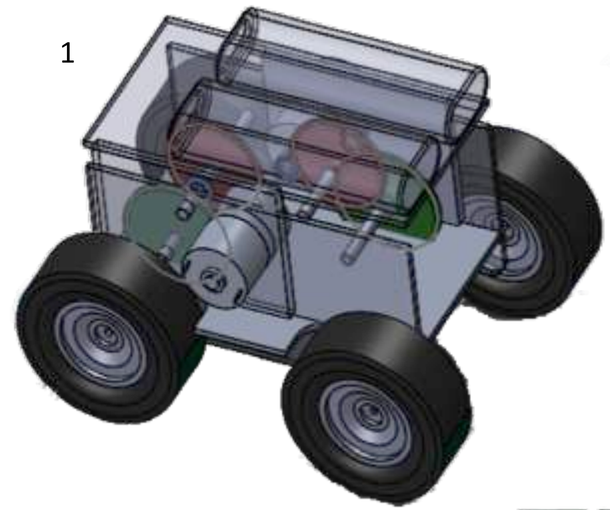
The Design Process

Initially, our team brainstormed and prototyped competing designs. To the right (1) is my initial design, which my team chose to pursue for the final competition. Advantages: low to the ground chassis, parallel motor configuration, and optimized gear box design resulted in a small footprint best for the maze challenge, and it also maintained a low center of mass critical for the slope and teeter-totter challenges.

To optimize the gearbox ratio for our desired torque and speed specifications using the motors given, I developed a flexible model which suggests the gears necessary to achieve desired velocity and Newton-meter inputs.

I also used a flexible CAD assembly of the motor and selected gears (3) to arrange the gearbox between the wheels (2), keeping the vehicle narrow. Knowing from previous competitions that access to the gearbox is important for refinement and repair I placed it accessibly on the outside of the chassis wall, and secured the chain on sprockets outside the wheels for ease of removal.

1



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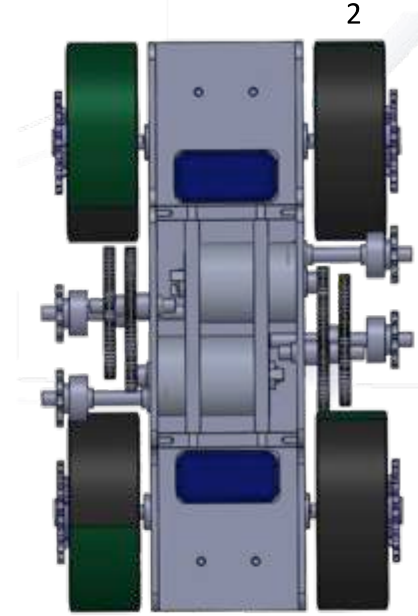

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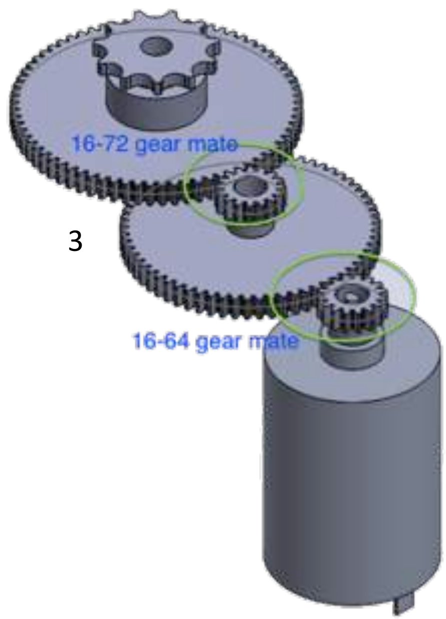
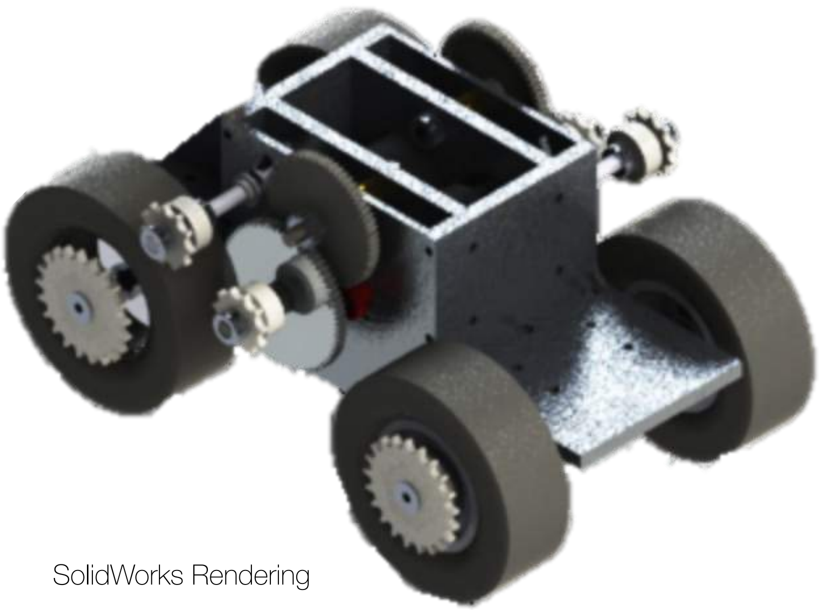


Design Constraints & Manufacturing

Constraints

- **Two Mabuchi motor drive system & high gear reduction** provides both necessary speed and torque, mitigates need for a differential
- **Maneuverable steering** through tank drive system
- **Small 10"x 7" footprint** enables vehicle to fit through the hard maze
- **Low center of mass** maintains stability over the teeter-totter and slope challenges
- **Rigid chassis** enables precise meshing of the gearbox for efficient power transmission and smooth driving

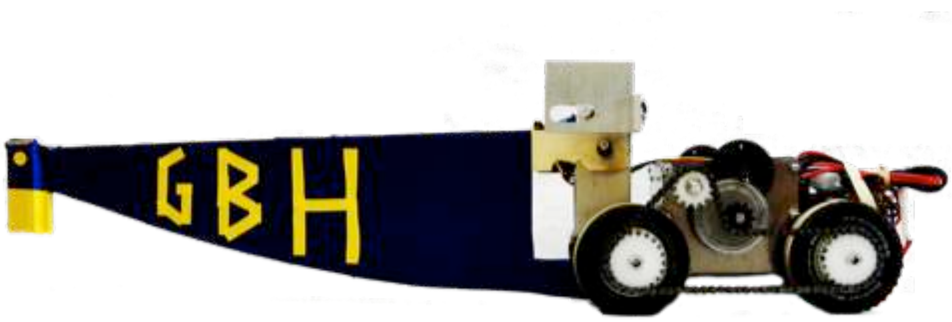


SolidWorks Rendering

Manufacturing

One of our key specifications was ease of manufacturing. In designing the chassis, I thought carefully about the aluminum plate thickness, 1/8" versus ¼". Eighth inch minimizes weight, but quarter inch is thick enough to tap a 3/16th screw hole. I also knew that a rigid chassis was important for precise gear meshing. This forethought enabled our team to easily assemble and disassemble our design for quick changes and refinement.

All of our components were made using traditional milling and lathing techniques. Engineering drawings were made for each component. Wheels and gears were given as part of the material constraints.



Arm attachment added to knock down the hard teeter-totter obstacle.

Amulet Wearable

// Body area health network hub

January – May 2014, Individual | PRODUCT DESIGN

Two Amulets: a developer model made to fit the current hardware, and a future model once hardware is miniaturized.

Challenge: Design a secure wearable mobile health device

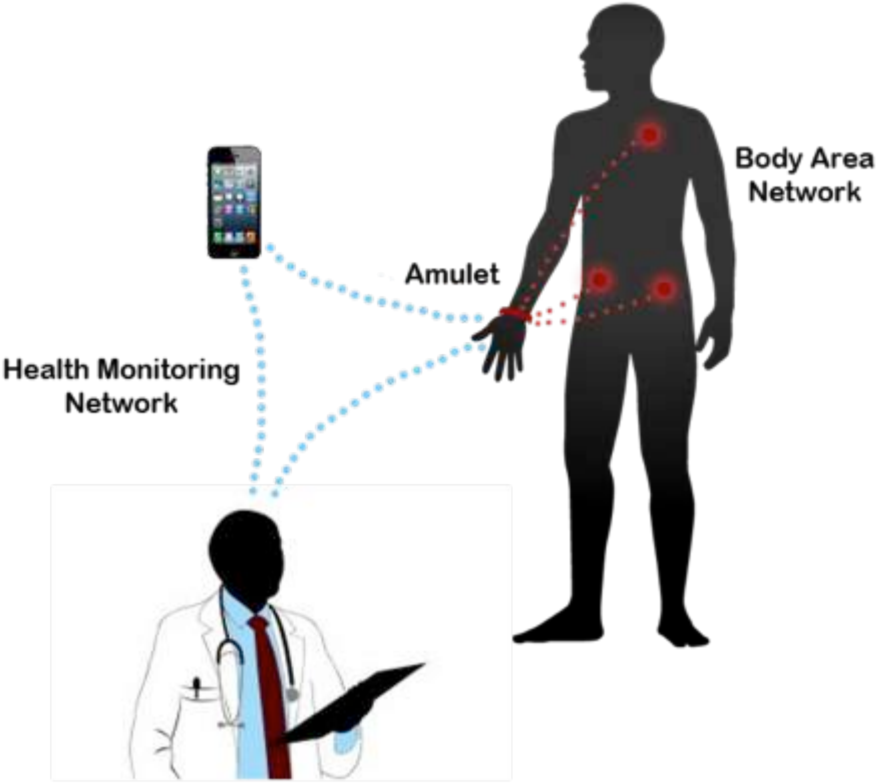
Creative Fields	Course/Client	Completion Date	Skills
Engineering Product Design	Dartmouth Center for Technology, Security & Society	Spring 2014	Product Design Injection Molding Integration of electronics Human factors

Overview

The Amulet is a mobile health hub which interacts with body area sensors to streamline data collection, actuation and data analysis. Working in conjunction with an interdisciplinary team of Dartmouth professors, I iteratively prototyped several physical bracelets and envisioned the UI/UX. This project was begun and envisioned in the early days of mobile and wearable health. The core idea behind the Amulet network hub is important both for medical researchers as well as users who need to consistently monitor symptoms of chronic disease. The vision is that computational jewelry will provide available, reliable and secure hubs for body-area mHealth networks.

My Contribution

This project gave me my first insight into the breadth of the human centered design process. I spearheaded initial user research, brainstorming, rapid prototyping, the integration of the physical bracelet and hardware, user interaction design, and future thinking on development of the brand and use cases.



Case Study: How might we enable people with type II diabetes to consistently monitor symptoms and improve health outcomes?

Future envisioning

Key Insight

Consistently monitoring health indicators provides the opportunity to accurately diagnose and intervene at critical moments to prevent or manage the exacerbation of chronic diseases. Amulet is a disease disruptive technology.

The Solution

I envision Amulet providing a multifaceted mobile health intervention for this case study by integrating glucose monitoring, insulin injections, exercise monitoring, and healthy eating on one platform.

"The Evolution of Amulet" showing iterative prototyping was featured at the Dartmouth Arts Exhibition digital arts showcase.
The Amulet was presented at the 2014 USA Science and Engineering Festival and funded by the NSF.

Design & Manufacturing Process

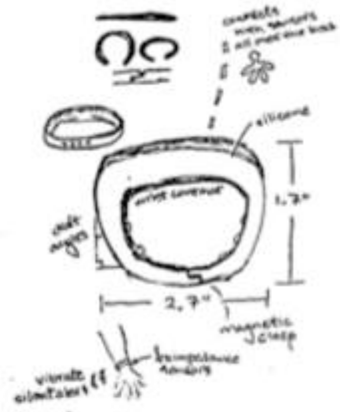
The goal for this prototype was to create a flexible molded wristband to integrate with current electronics, using Thayer machine shop resources.

My design and manufacturing process involved numerous sketches, rough proof of concepts, rapid 3D printing, silicone molding, all building up to a hand injection prototype with a 3D printed mold. I designed our shop's first 3D printed molds and created numerous wrist band iterations with different materials as well as experimented with potting electronics into the wristband.

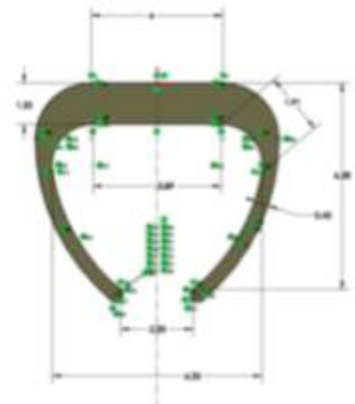
While 3D printing an injection mold is not cost effective for large quantities, and does not deliver precise GD&T - for this case where only several prototypes were needed it was a flexible and relatively fast method.

I conducted the entire research, ideation, and prototyping process, including self-teaching myself the basics of injection molding and SolidWorks advanced mold design in eight weeks to finish a working prototype with integrated electronics for a presentation at the USA Science and Engineering Festival and the National Science Foundation.

Sketches



SolidWorks



3D Printing

Silicon Mold

Hand Injection

Embedded Electronics

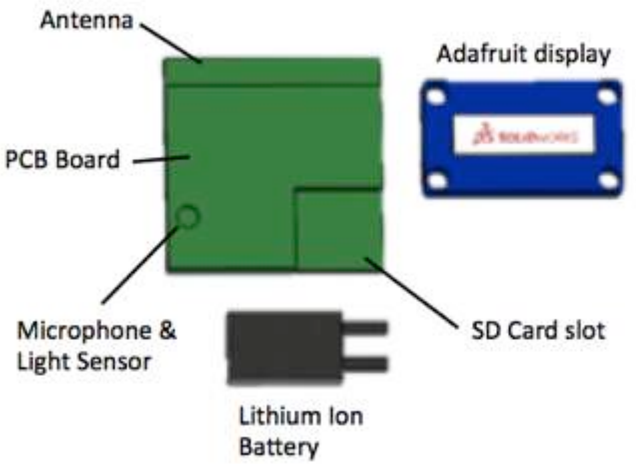
Electronic Integration

Features

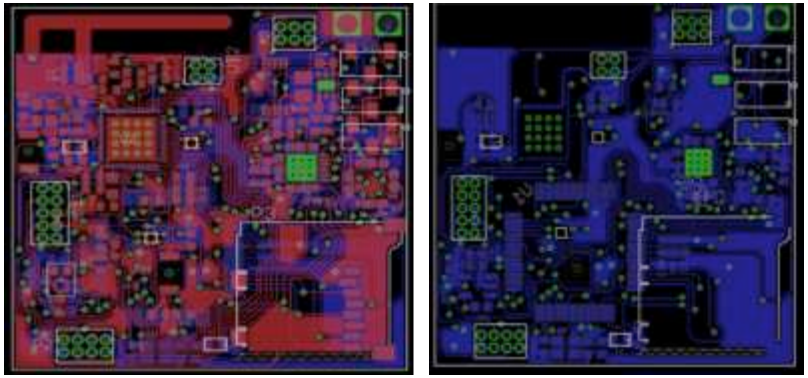
- Monochrome 128x32 I2C, 7x25mm OLED display
- Polymer lithium ion battery, 110mAh, 3.7V, 7.5x12x28mm, 2.65 g
- Band 7.35 inch inner circumference, approx. 2.2 oz.

Requirements and Constraints

- Microphone and ambient light sensors need to be accessible from the top surface
- Display must be flush with surface of the band
- The antenna cannot be covered by the display or battery due to interference with transmission
- Battery leads face outwards for ease of connectivity
- SD card slot must face outwards for easy access
- Worked with hardware engineer to consolidate board from 24 sq. inches to 2 sq. inches, and optimally position components



Current Electronics



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