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Career

Design

Engineering

Aura, a concept vehicle

Leuven, Belgium
Summer Internship, Olin Year 2

I spent my time in Leuven working with renowned nanotechnology research institute, **imec**.

<u>Aim:</u> To design a **concept car** from scratch, with a futuristic aesthetic and high-tech engineering design.

The vehicle targets **Europeans that commute in the cities**. It is to bridge the gap between the bicycle-commute that is commonplace and the unnecessary car commute that is inefficient. It is a push for **renewable energy & sustainability**.

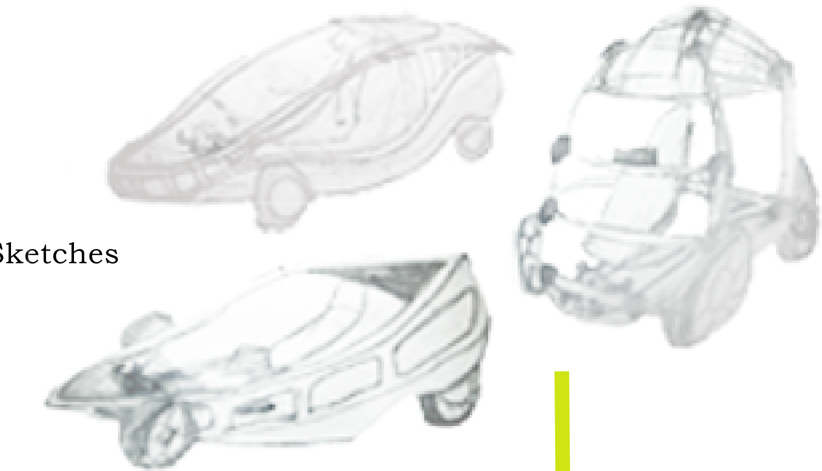
<u>Design:</u> *Aura* is a **3-wheeled pedal-powered vehicle** that aim to preserve the exhilaration of a bicycle ride while integrating the comfort of a car, as requested by our users. It allows the rider to pedal while using electric-motor assist when required. *Aura* is different because of its sustainable 'cradle to cradle' manufacturing cycle and nature-friendly transport.

Aura wants to be more than just a vehicle. It is an accessory, a partner in **connectivity** with the community **via the smartphone or tablet**. The high-tech integration allows for the modern-day user to embrace the power of the social network.

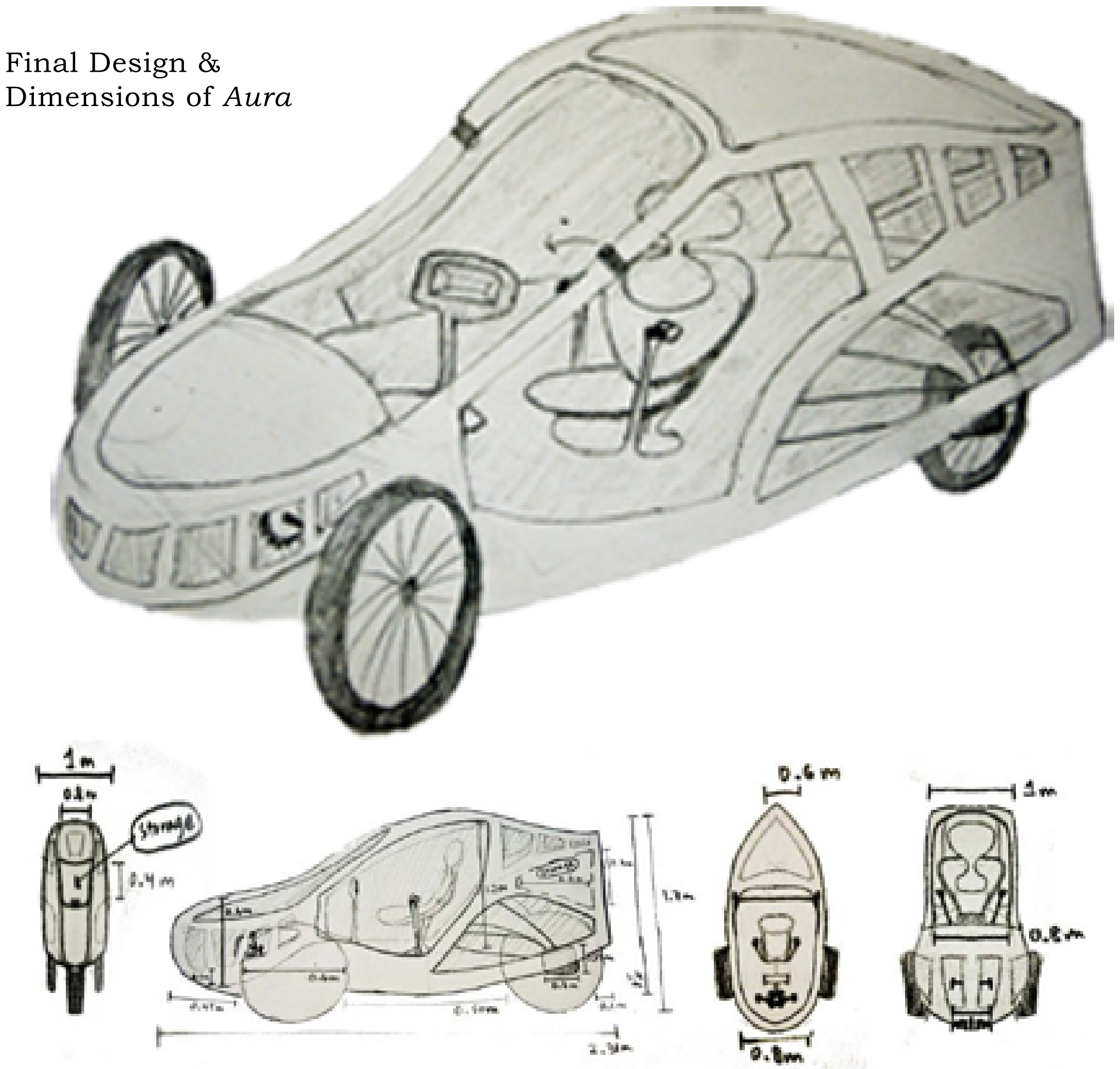
We worked to design the **engineering**: in-hub motor control, its mechanics, and integration with the pedal-power. We laid out the **controls system** that allows the vehicle to decide when to provide the electric-assist and also integrates the user's needs via the smartphone. And we sketched the exteriors and interiors design of the car [as shown].

[Manufacturing is set for a June 2012 start.]

Initial Sketches



Final Design &
Dimensions of *Aura*



CQS GroepT Racing Team

www.cqsgrouptracingteam.be
Leuven, Belgium
Summer Internship, Olin Year 2

Introduction: CQS Group T Racing Team consists of ~30 master students from Group T Leuven Engineering College. The team develops a hybrid and electric drivetrain: *Pegasus* (biethanol) and *Odyssee* (electric) cars participate in the 24h24' for 2CVs at Spa-Francorchamps (Belgian Grand Prix).

Electric vehicle, *Odyssee*

Aim: For 2.5 months, I worked in the Electronics department of *Odyssee*. My main job consisted of 2 tasks. The *first* was to create and **restore wireless communication** between Odyssee and the pitlane when the car is in a race. This enables the team to receive real-time data from the car and optimize their racing strategy.

Design: I worked with *Xbee* modules that can transmit data bytes using the **RS232 protocol** between the car and the pitlane.
Wireless data was read, saved, analyzed via **LabView**, **mySQL**, and **Java**. Incoming GPS data was analyzed through bit-shifting and we plotted GPS coordinates real-time on Google Maps. In July when Pegasus participated in a 2CV race at the Circuite de Bresse, we successfully tested the wireless communication and GPS sensor!

GPS Data Set-up

Xbee transmitter module

Aim: **Re-design** the **data-analysis program** and user-interface to be modular. Suppose the team wants to add new sensors to the car or make adjustments? How can they more easily do this instead of hard-coding sensors in?

Design: I developed the interface, architectural, and and procedural design for the Java program.

The experience taught me about automobiles and electric motorization. It inspires me to continue in the automotive industry and help those 'going green'.

Identity of the Mind

Personality Psychology Research with Professor Jon Adler
June 2010 - June 2011, Olin Years 1 & 2

Over the past year, I have worked conducted **research in Personality Psychology**. Jon is a professor and researcher in narrative psychology and he got us interested in how people narrate their own lives and develop their identity along the way.

Aim: To understand the way in which people diagnosed with **Border-line**
Personality Disorder make sense of their lives. BPD is a third-rail mental disorder that does not have many therapy options or too many (a little from all other disorder treatements) that it is time-consuming and expensive.

Design: We watched, for the first time in recording, video interviews of these people telling their life stories. From that, we identified and coded key thematic characteristics of narrative identity to see how these subjects interpret their lives. Our findings are going to be **published** in the **Journal of Personality Disorders** in the coming months.

Other research included: studying peoples' reconstructions of experi-ence in **psychotherapy**. We studied how their narratives change (for good or for bad) over the course of therapy and how this affects the outcome of their experience. And our most recent study has been about how **mid-life adults make sense of their body** as guided by the ageing process. How do these physical changes alter their personal identity and meaning-making?

My experience with psychology has given me great insight into how people think and make sense of the world around them. As an engineer, having this psychology background is a great asset when designing for users and with users.

BOWtie, a course-planning tool

http://hfid.olin.edu/sa2012/s_engr3220-ajax/team.html

Human Factors Interface Design (HFID)
Fall 2011, Olin Year 3

Aim: HFID is a class in which we explore the design and development of user interfaces. We take into account the realities of human perception and behavior, the feasibility of computer interaction, and aim to build a usable interface.

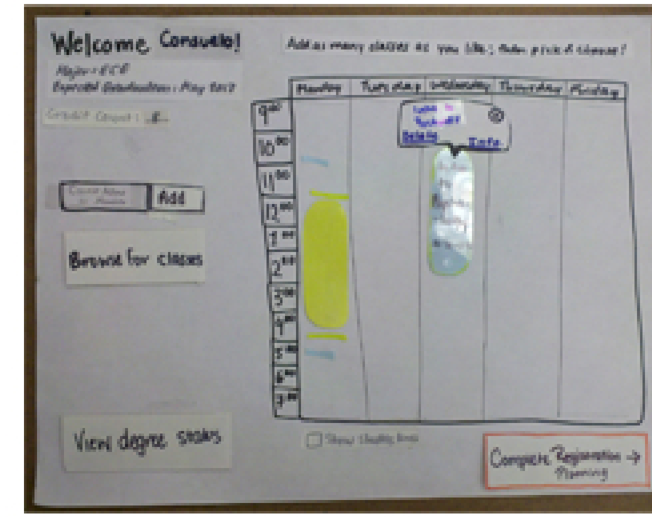
Design: My team *Ajax* is working to **improve the tri-college cross-registration experience** between Babson, Olin, and Wellesley colleges. They have been trying to improve cross-campus interaction and we wanted to help.

The lesson we learned from our users is that the small details of planning & logistics to take a course at another school builds a large activation energy. We created BOWtie as a catalyst to reduce this activation energy by taking care of the smaller details and helping the student focus on the important things - the classes.

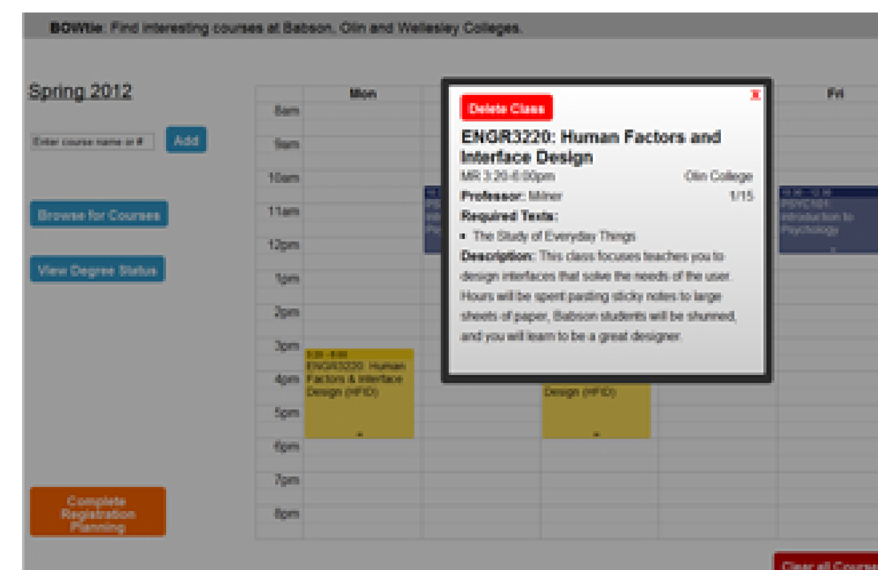
In the design process, we conducted user interviews to get student perspectives on cross-registration and then developed personas. Based on the needs and wants of personas, we created a **paper prototype** of our interface and got user feedback on the paper version. With this feedback we created an initial prototype. With **usability tests and heuristic evaluations, we refined our prototype**.

I was the **user interaction and interface design lead** for the team.

Developing persona:
'Diana the Driven'



Paper Prototype: the first iteration of the Home page



The final version of the Home Page on BOWtie

Sustainable Weedwacking

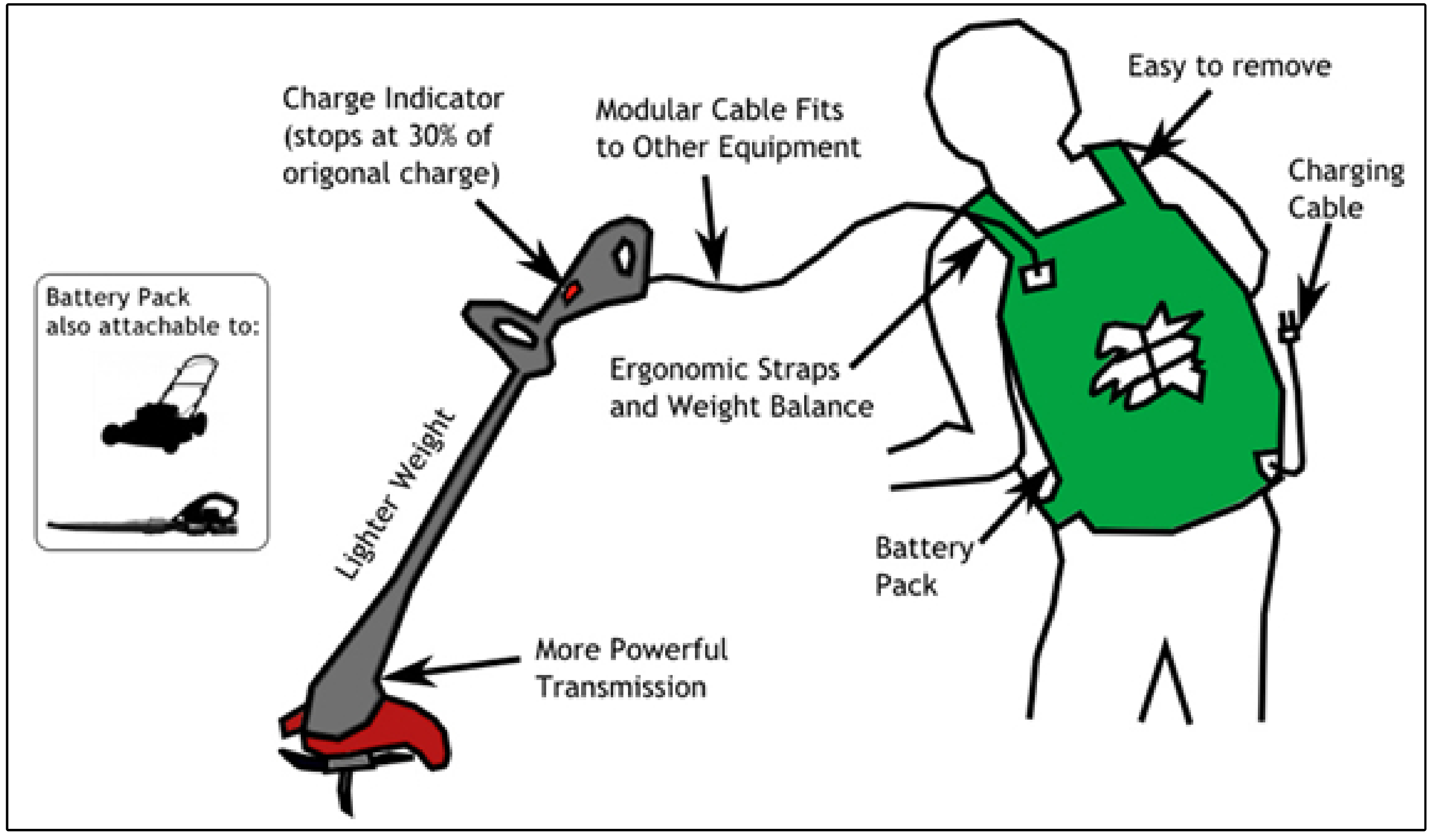
Sustainable Design - Group Project
Fall 2011, Olin Year 3

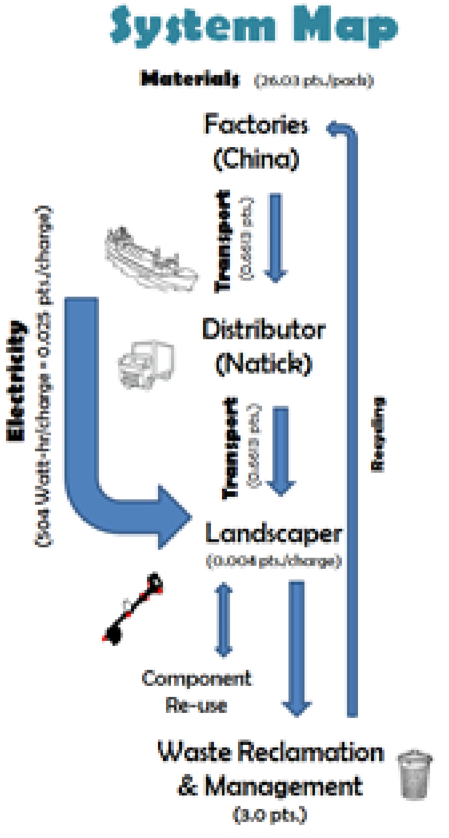
Sustainable Design teaches how to bring sustainability into the product design lifecycle. We learn to use green design principles, conduct life-cycle analysis on an existing product, and strategize to improve the production processes to be more sustainable.

<u>Aim:</u> My team, Green Wackin', studied the Weedwacker, a gas-powered gardening tool primarily used by landscaping companies.

<u>Design:</u> To bring more sustainable practices to the weedwacking activity. We **studied users and developed personas** of people who commonly use the Weedwacker and got their views on the positives/negatives on the product. Then, we tore down the weedwacker and did a **Life Cycle Analysis** to see its effect on nature. Finally, we brainstormed ways to make it a more sustainable product for our personas and came up with the **Universal Battery Pack, S2B2**.

S2B2





Changing Olin Coffee Behaviors

Sustainable Design - Individual Project
Fall 2011, Olin Year 3

My individual project in Sustainable Design was to design around the coffee consumption behaviors of Olin students. An atrocious amount of 250 disposable coffee cups are used by the 330-student population *every day.*

Aim: I wanted to **reduce the unnecessary use of disposable coffee cups** at Olin. I replicated the 'use-and-throw' mentality of the cups but with the ceramic mugs in the Dining Hall.

Design: I started with some user research of coffee-consuming Olin students. It was clear that they preferred coffee cups: can be thrown away, convenient to carry to class, held more coffee than a mug, and had a cover to avoid spills.
I targeted the portability issue. To mimick the 'use-and-throw' of disposable cups, I positioned bins across campus where students can leave used ceramic mugs. For 5 days in December, I worked with the Dining Hall staff to remove the disposable cups completely (only available if asked for) and **campaigned via student ads for only the use of ceramic mugs**.

Results: The use of disposable cups reduced by 7 times in the 5 experiment days. Student feedback suggests that next steps are to prototype a cover for the mugs so they avoid spills. The Dining Hall hopes to keep up this initiative in the coming semester.

Designing for Tattoos

User Design with Boston's Tatttoo Subculture
May 2011, Olin Year 2

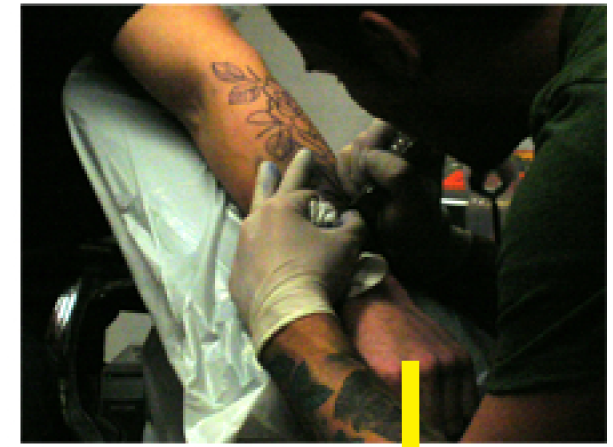
User-Oriented Collaborative Design (UOCD), is the task studying a group of **users** - who are they, what do they want, what are their needs? As engineers, we are taught to build solutions to problems and/or areas of opportunity that are not addressed.

Aim: My team chose to study the '**body modification' subculture** in Boston. Tattooing became legal in the 21st century in the city, and quickly tattoo parlors have risen in the past decade. We wanted to develop a new solution for a common problem they all had.

Design: We started by **interviewing** tattoo artists, tattoo users, people who have friends with tattoos, people who want tattoos, and those who want to get them removed. We talked to users of all tattoo types to learn their ways of life and the people they socialize with and live with. It is to help us step into their shoes and ideate for the subculture.

We **created personas** and **values maps**, **areas of opportunity**, and brainstormed ideas. Then a few weeks later, we went back to our users and presented our ideas. While **co-designing**, these users are asked to work with props of our ideas, wear them and see how they feel, and report to us what they think. This co-design helped us see whether our feet fit well into the users' shoes. If they didn't, it was time to go back and re-think our designs.

My team concluded the 5-month design project with the **3D printed model** of the **product EnhancInk** as shown in the bottom picture. It is a **temporary tattoo pen** that draws like a tattoo and allows tattooed people and their dear ones to give tattoos new meaning. Why this? Well, the sense of a tattoo's permanence is very strong among people of the subculture. They have committed to a piece of permanent design on their skin. This pen helps them embrace the permanence by adapting the tattoo(s) to new experiences and stages in life.



We watched the real iser-experience, someone getting a tattoo!

Brainstormed Areas of Opportunity to develop solutions.

Created final 3D printed product

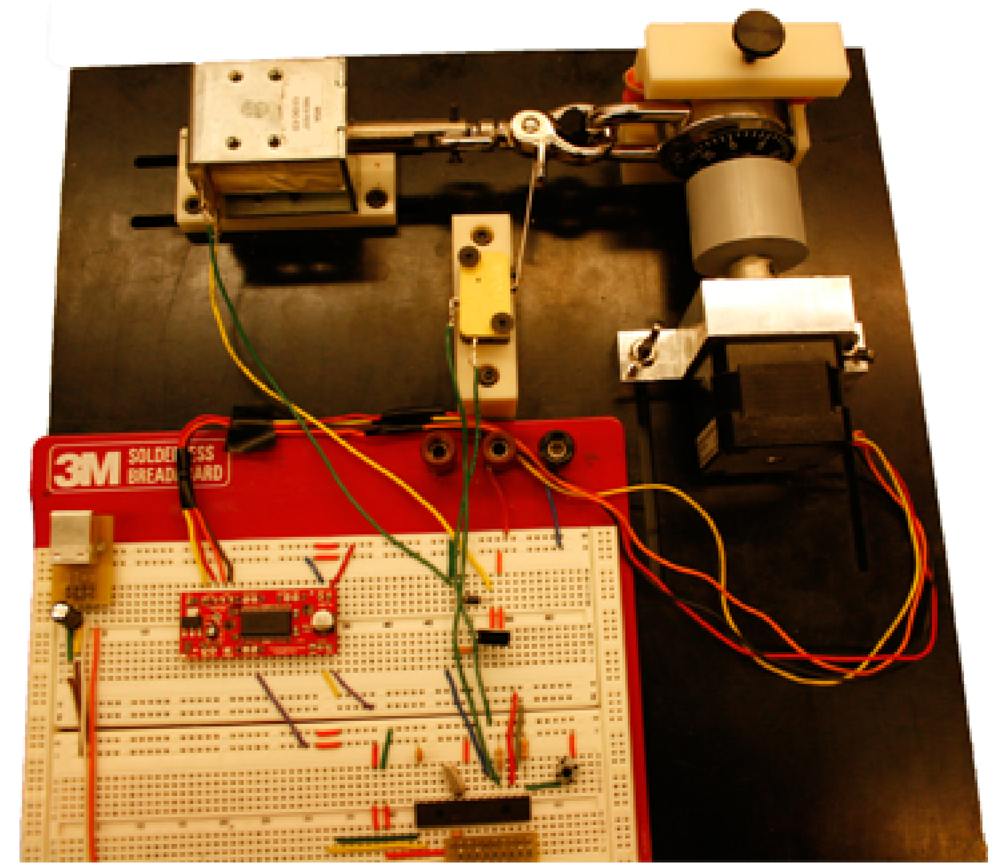
The *LockCracker*

www.thelockcracker.com

Final Project for Principles of Engineering class

By Team *JARJ*

December 2010, Olin Year 2



Aim: The purpose of this multidisciplinary course was to build a **mechatronic** system of our choosing. Team JARJ decided on building a **lock-cracking device**. The LockCracker was set to take a combination lock with an unknown combination and unlock it and **display the correct combination** to the user via a **Python GUI interface**. This flexible electromechanical system should be modifiable to fit any turn-dial lock.

Solution: Team JARJ mechanically turned the dial on the lock and pulled on the latch with every combination that was tried. I worked on the electrical and software systems.

Design: As follows for the electrical & software subsystems:

1. We used a **stepper motor** to turn the lock's dial.
2. A pull-in solenoid pulled the lock's latch every time a combination was tried.
3. A limit switch was triggered only when the latch was opened, telling the system to stop trying combinations and to display to the user.
4. We used a **PIC microcontroller** as the brains behind the controls.
5. We designed a **modular Python back-end** to fit to any type of lock dial.

Finally, the user-interface was designed to **minimize the time taken** by the LockCracker to solve the lock. The user is prompted to enter how many of the numbers they know of the combination and the LockCracker optimizes the procedure accordingly.

Today, the LockCracker has received **publicity** on *Wired.com, Popsci.com, ASME* Magazine, and more.

Stiction in MEMS RF Switches

Final Research Paper for MEMS class
December 2010, Olin Year 2

MEMS is a 'special-topics' ECE course at Olin. The multidiscliplinary field is studied in terms of structure designs, fabrication techniques, and the future of MEMS devices in the semiconductor industry. It is the class that really got me interested in the semiconductor industry.

<u>Aim:</u> Studying the phenomena of **stiction**, the main cause of failure of Microelectromechanical systems (MEMS). What possible solutions exist and how do their **processes, advantages, disadvantages, and manufacturing** contribute to their effectiveness? Stiction is the sticking force that comes in between micro surfaces that touch, and they cannot be separated again. The MEMS device stops operating due to sticking.

<u>Solution:</u> In this paper, the causes and calculations of the stiction force are discussed. The paper places special focus on the **Radio Frequency MEMS switch** (2 types of them), used to transmit radio signals across the world.

The MEMS switch is manufactured as a DC cantilever switch or a DC shunt capacitive switch. The mechanics behind each switch, the fabrication of each switch, and the force of stiction each can encounter, are the target topics of this paper.

Possible solutions include the use of rough surfaces, anti-stiction coatings, partial dielectric charging, and getters or supercritical drying of microstructures on the device. Fully reliable solutions to remove stiction are yet to be found in the world of MEMS.

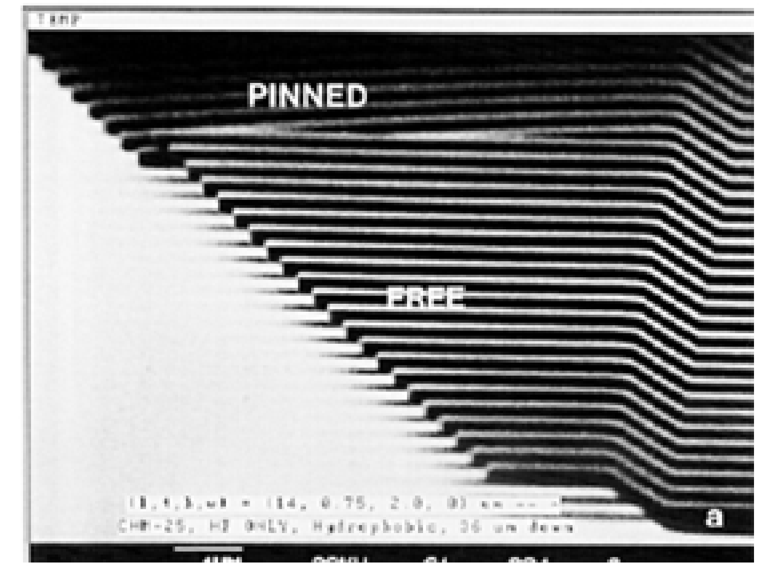
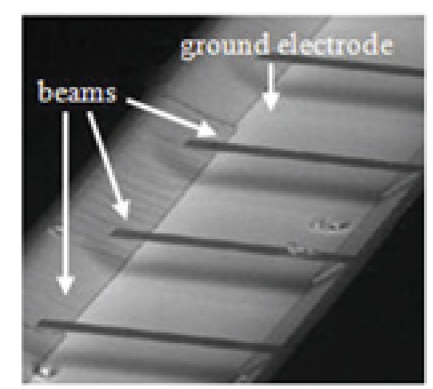
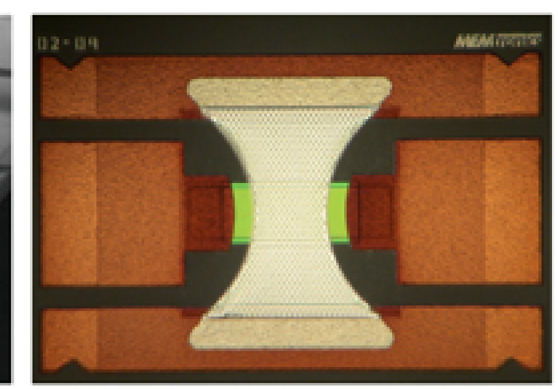


Illustration of stiction in cantilever beams



Cantilever Switch (side view)


Capacitive Switch (top view of membrane)

ProjectWizard

Final project for Software Design class
By: Team ProjectWizard
December 2010, Olin Year 2

Aim: **Aid project-oriented teams** in consolidating their work, organization, and thoughts.

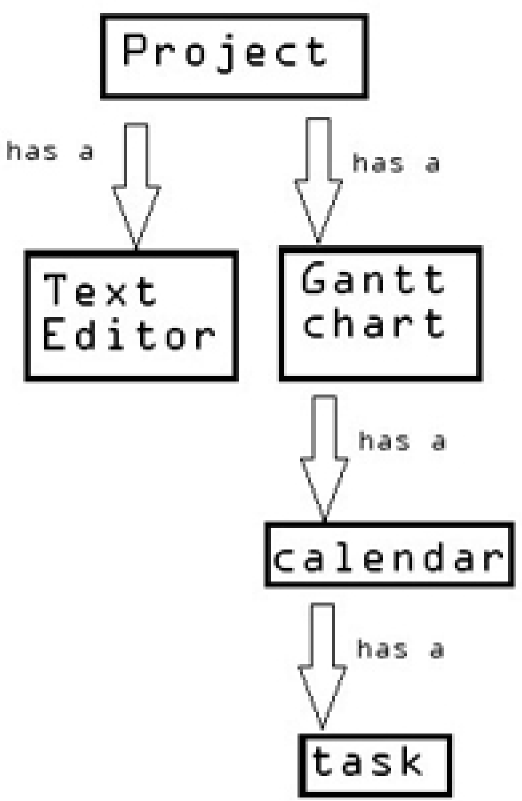
Solution: *ProjectWizard* makes a **virtual workspace for every team** with a **collaborative text editor** and a **Gantt chart creator**. The *ProjectWizard* requires the team to supply a project name and accordingly gives them a text editor to generate ideas and a Gantt chart wizard to create their project schedule. A picture of the Class and Object diagrams of the system are shown to the right.

Design: *ProjectWizard* is hosted on a central server that merges the changes made by every project user.
To make changes, each user has a **Python GUI** that they use on their local machine to update the Project on the server. The Project and the individual client applications for each team member are linked together by a Python networking tool called **Pyro.** With Pyro, the team members can open their Project from any computer running *ProjectWizard*, and changes made to the Project get sent to the server.

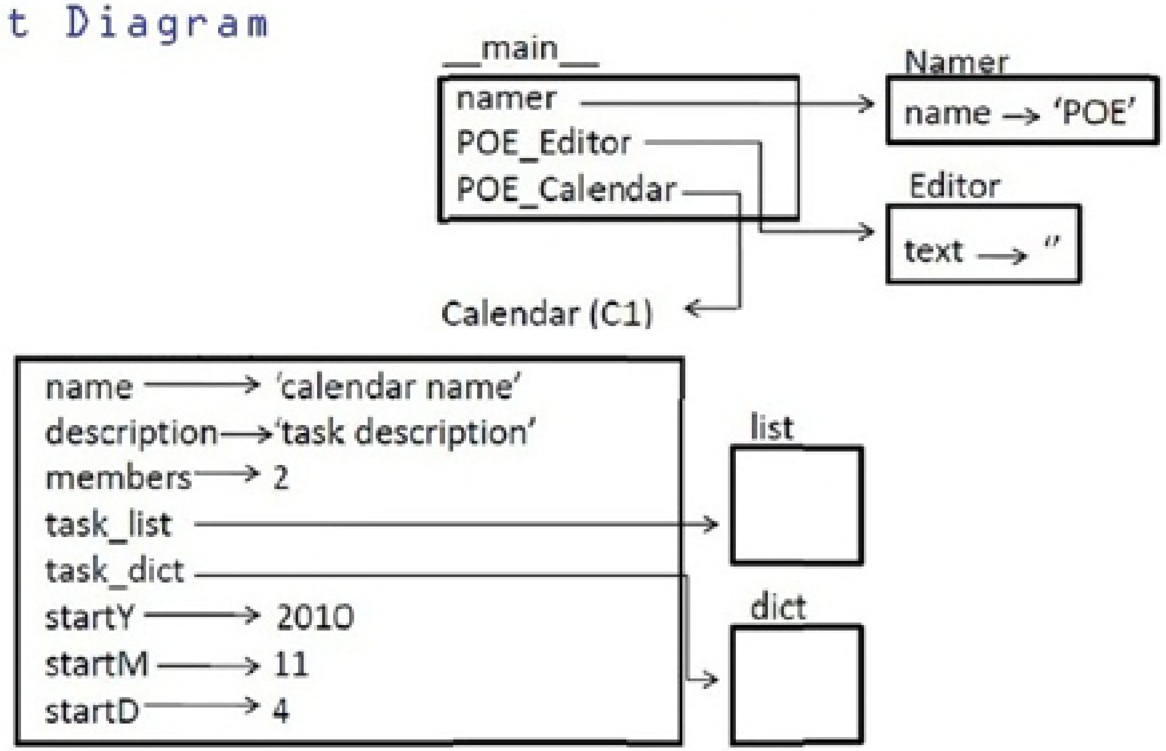
The local **client application** and the **remote server application** communicate back and forth to edit or view the objects living on the server as requested by the user.

My contribution: I **worked on the back-end and some of the front-end** of the **Gantt Chart creator.** The user is allowed to schedule tasks in a timeline, and these are graphically displayed on a GUI.

Class Diagram



Object Diagram



Distance-Sensing Doug

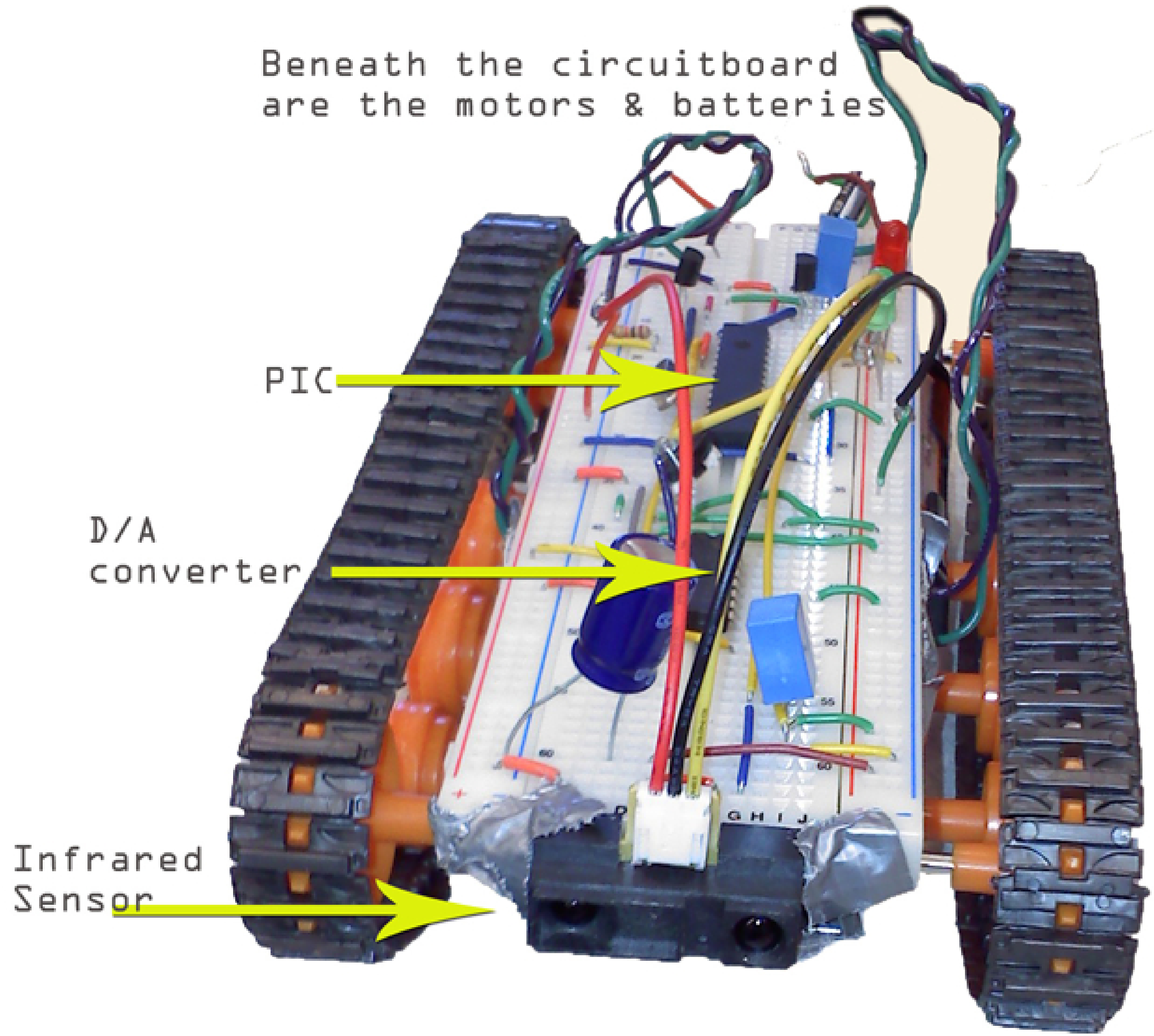
Final Project for Circuiteering Club
December 2009, Olin Year 1

In the Circuiteering club, I learned about microcontrollers, sensors, and basic engineering tools used to build an intelligent creature. I spent 1 month before the bi-annual Expo working on our very first **robot**.

Aim: a smart creature that can **avoid obstacles** and move away from them.

Solution: Using an infrared distance sensor mounted to the front of our robot, Doug, and a a **PIC microcontroller** programmed in **C-language** to sense distances of a few centimeters away. When this distance came between Doug and any obstacle, Dough was commanded to stop, 'turn right by 90°' and accelerate away from the obstacle.

Design: An assembled mechanical 'machine'.
The distance sensor was mounted to the head of Doug and connected to an input of the PIC. The microcontroller made use of **Pulse Width Modulation** to control the DC motors in the wheels of Doug via the use of **H-bridges** in between. The PWM supplied a signal to the H-Bridge-and-motor circuit (via a D/A convertor) so that speed and motor direction could be controlled.

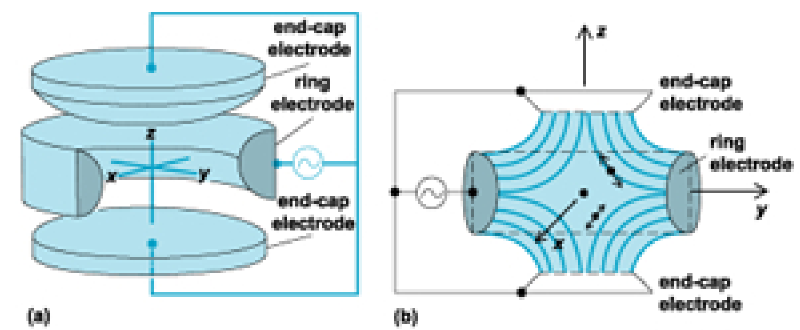


E&M Simulations

Contributors: Samantha Yang, Samantha Becht
December 2009, Olin Year 1

The Characteristics of a Penning Ion Trap

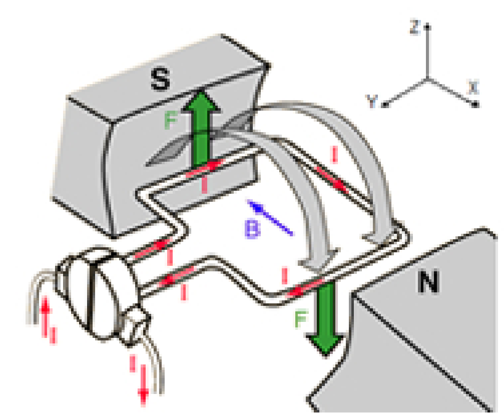
<u>Aim:</u> To present a simplified model for the **conventional Penning Ion Trap**, used to confine single and multiple ions in a trap. It helps physicists to determine charge-to-mass ratios of atomic particles, characteristics of fundamental constants, and advancements in quantum computation. We wanted to prove that existing particles do affect the motion of other particles in the trap.



<u>Design:</u> The design of the trap consists of 2 positive point charges and a negatively charged ring centered halfway between the charges. Charged particles are confined within this configuration due to a combination of a static electric and static magnetic field.
The **MATLAB** simulation **results** support that there must be a **maximum number of ions that can be trapped** at one time.

The Model of a DC Motor

The **direct current motor** was the first type of motor to be created to convert electrical to rotational mechanical energy in the 1800s. In industry, the torque-speed curve of a DC motor is the most-widely used characteristic of a motor, to pick motors that can operate on the required load without stress.



<u>Aim:</u> To verify our hypothesized inverse **correlation between the load torque and the angular speed** of an ideal DC motor. Emphasis was placed on the physics behind the torque-speed relationship.

<u>Design:</u> A MATLAB mathematical simulation of a DC motor with various loads 'placed' on the motor was used to observe the steady state maximum rotational speed reached over time. The motor design was simplified to be a metal loop of wire turning in between 2 magnets of opposite polarity. The **result** was observed to be an **inverse relationship** between the torque and speed of a DC motor.

This poster was a Finalist at the National SWE Conference in Orlando in Nov. 2010.