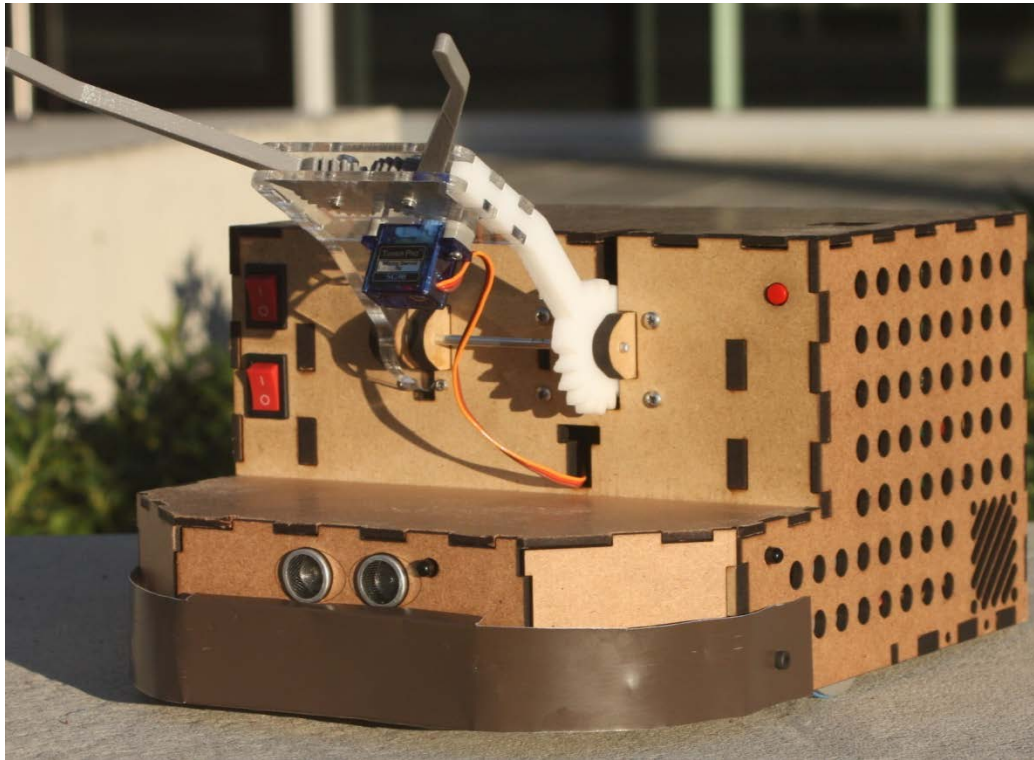


# ENPH 253

## Introduction to Instrument Design



**Instructors:** Andre Marziali, Dylan Gunn, Bernhard Zender  
**TAs:** Adam Schonewille, Yuqing Du, Amar Shah, Cinnie Hsiung

# **DON'T THINK OF THIS AS A COURSE**

## **IT'S A MOCK ENGINEERING JOB**

**You and your team are part of an engineering design firm bidding on a contract to design and build a prototype XXXXXXX**

**Your more experienced co-workers (i.e. the TAs) are here to help you.**

**The contract offeror is a company composed of:**

Andre Marziali (CEO)

Dylan Gunn (CSO)

Bernhard Zender (CTO)

# Focus in ENPH 253

- Basic electronics, mechanical design
- Prototyping skills
- Design
- Troubleshooting and Problem solving
  
- Team work
- Balancing time, effort, performance, scope
- Estimating timelines, scheduling
- You (new for 2018 😊)

# Engineering Design

You can make this by trial and error:



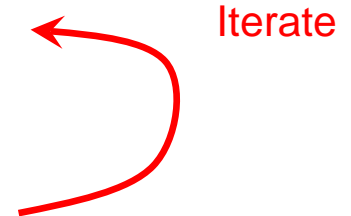
# Engineering Design

You **CANNOT** make this by trial and error in a **FINITE** time (and expect it to work reliably):



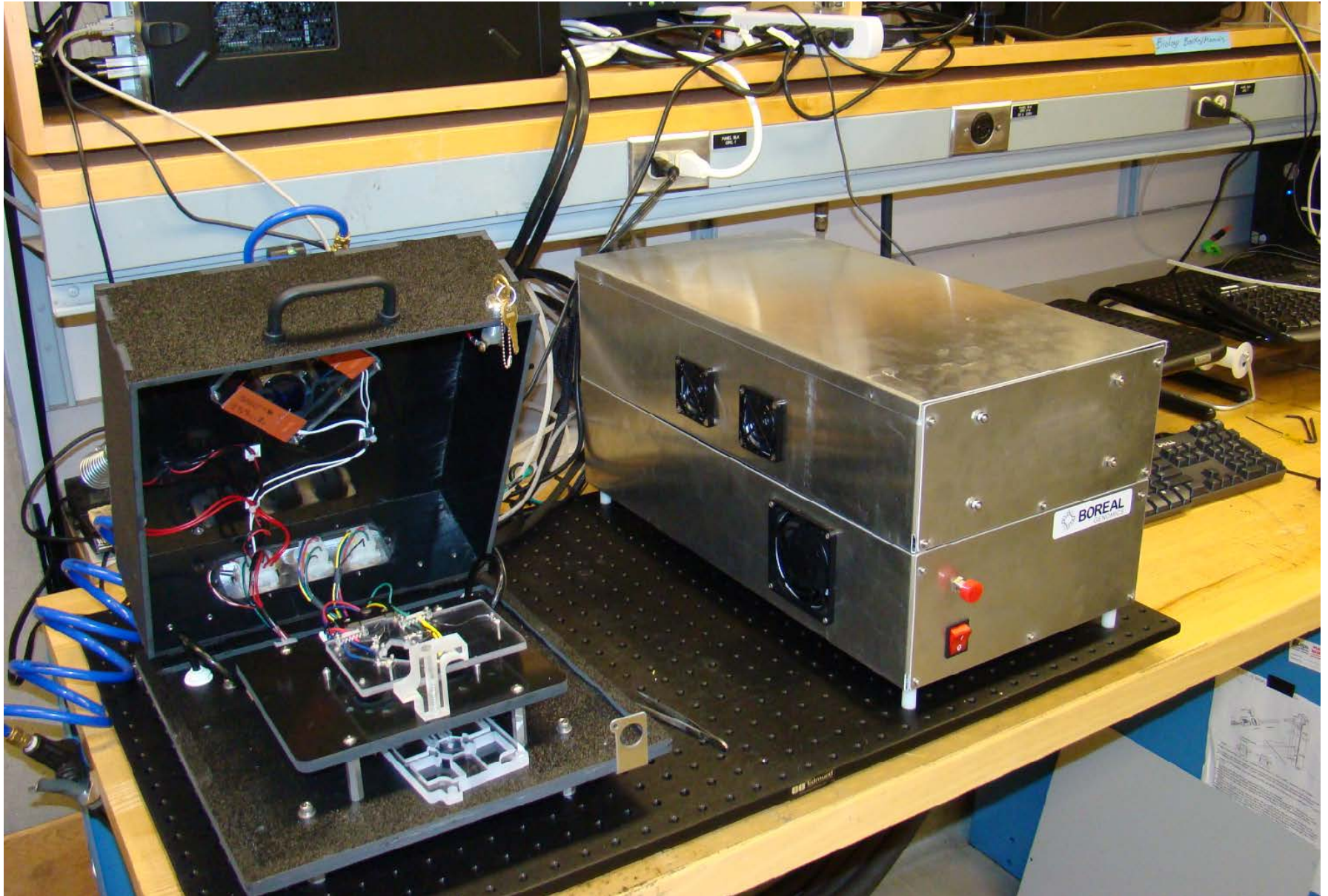
# Design

- Is **THE OPPOSITE** of trial and error (tinkering)
- It is a very rigorous and detailed process of
  - Research on needs, stakeholders, existing solutions etc.
  - Establishing objectives / problem definition
  - Brainstorming potential solutions
  - Conceptual design
  - Assessing feasibility
  - Preliminary design (with detailed calculations)
  - Detailed design
  - Design for manufacturability
  - Construction / Production



- Along the way you'll build
  - **Lab prototype (breadboard)** ... We stop here in ENPH 253
  - **Prototype**
  - Alpha
  - Beta
  - Production model

# Breadboard



# Prototype



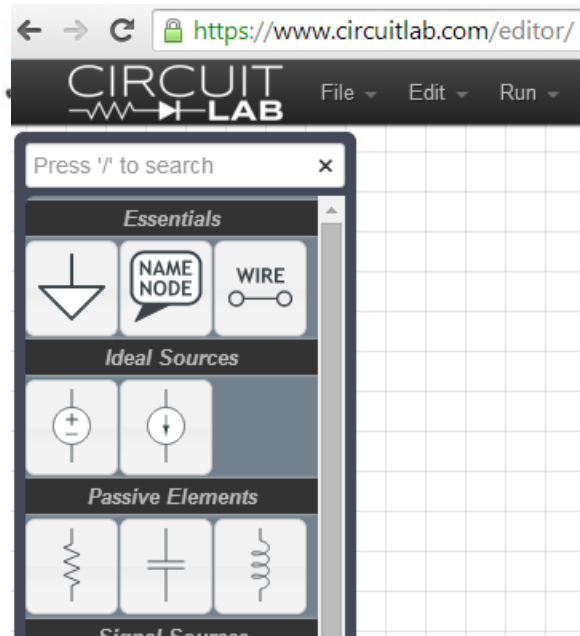
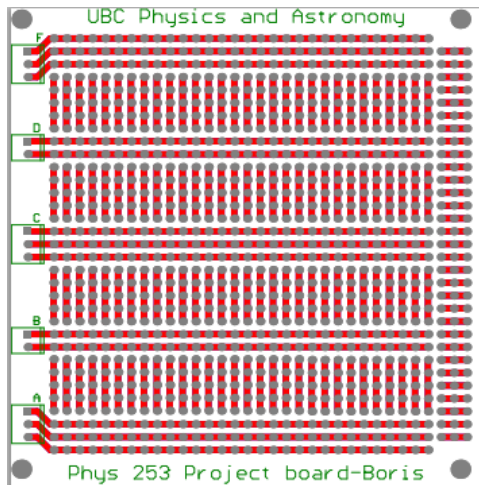
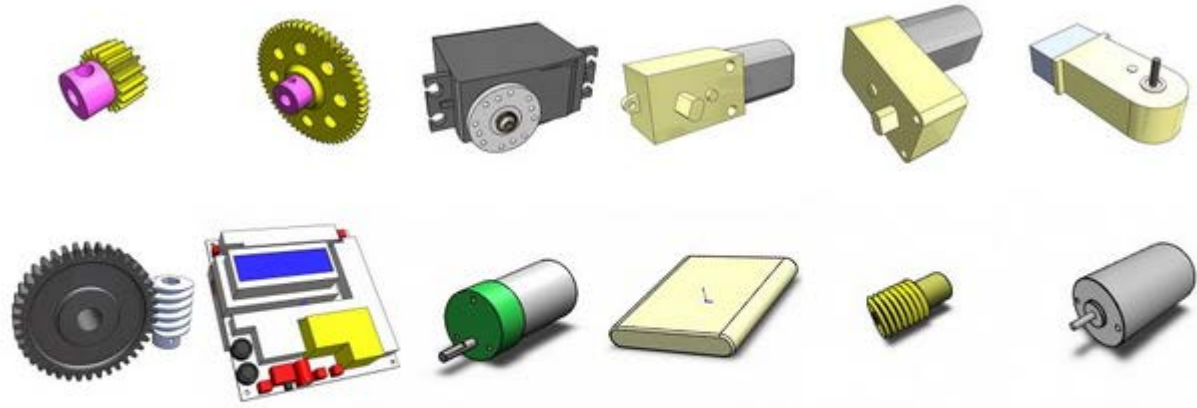


# Beta



# Design Tools

SolidWorks  
 CircuitLab  
 Spec sheets  
 Motor specs  
 PHYS 170/270



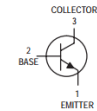
**MOTOROLA**  
 SEMICONDUCTOR TECHNICAL DATA

Order this document  
 by 2N3903/D

**General Purpose Transistors**  
 NPN Silicon

**2N3903**  
**2N3904\***

\*Motorola Preferred Device



CASE 29-04, STYLE 1  
 TO-92 (TO-226AA)

**MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V <sub>CEO</sub>	40	Vdc
Collector-Base Voltage	V <sub>CBO</sub>	60	Vdc
Emitter-Base Voltage	V <sub>EB0</sub>	6.0	Vdc
Collector Current - Continuous	I <sub>C</sub>	200	mA <sub>dc</sub>
Total Device Dissipation @ T <sub>A</sub> = 25°C	P <sub>D</sub>	625	mW

# Breadboarding Tools

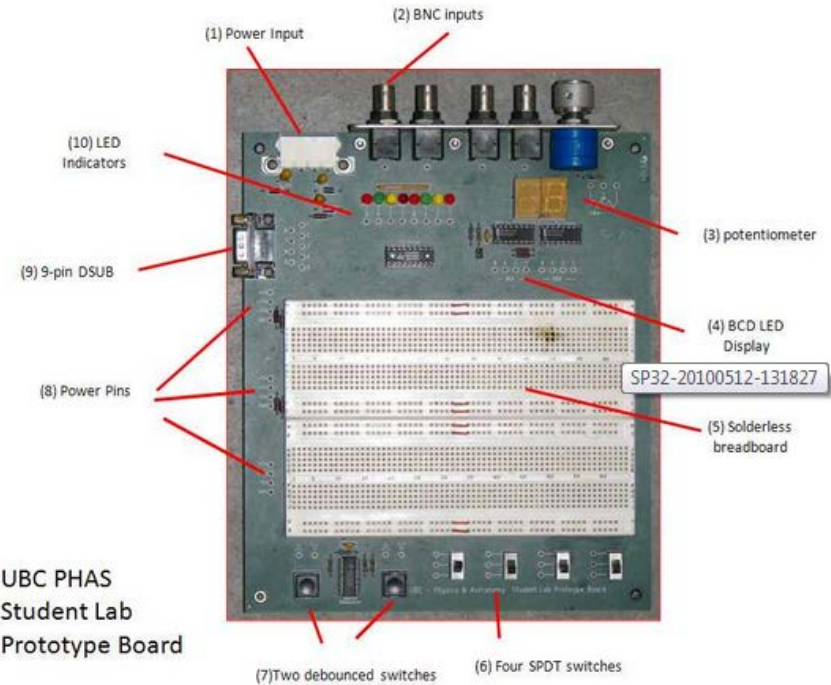
Breadboards  
HandTools  
Paper/cardboard  
Glue, tape and scissors...



MNPCTECH.COM



## Lab Prototype Boards



# Prototype Tools

## Water Jet

- Cut metals and nearly anything that's not too thin or brittle



## Laser Cutter

- For thinner and more delicate materials

## 3D printer

- Makes stuff. Do not overuse.



## Machine Shop

- Old school. Best for approach for many jobs



## Schedule

### First six weeks:

Lecture:	Tue 2:00 – 5:00	LIFE 2201
Lab:	Thurs 2:00 - ? (typically 9:00)	LIFE 2402

### After week 6:

Lab:	Tue & Thurs 2:00 – 10pm + additional days and evenings as required.
------	--

### Communication:

Lecture:	Fridays noon – 1pm (starting May 25)	MCLD 228
----------	--------------------------------------	----------

## Machine Shop Course

**ALL STUDENTS** take the machine shop course (10 hrs + lecture) if they have not completed the 40-hour shop course. Scheduled as part of ENPH 257 labs.

<b>Tue May 15, 2pm – 5pm:</b>	Fabrication Camp.	LIFE 2201/2402
<b>Wed May 16, 1pm – 5pm:</b>	Fabrication Camp.	LIFE 2402
<b>Thurs May 1, 2pm – 5pm:</b>	Fabrication Camp.	LIFE 2402
<b>Fri May 19, 12pm – 5pm:</b>	Introduction to Design.	Henn 201

## **Formal Labs (6 weeks)**

1. Fabrication Bootcamp
2. Microcontrollers and digital I/O
3. Analog circuits and I/O
4. PWM and Power circuits
5. PID control and tape following
6. PID continued.

**Informal design discussions**

**(Weeks 3-5)**

**Oral Design Proposals (20min)**

**June 14, 21**

**Oral presentations**

**July 23 evening**

**Construction**

**(Weeks 6-13)**

**Individual time-trials**

**July 27 (week 11)**

**Competition**

Thurs Aug 9th, 10am

**Cleanup**

Friday Aug 10th, 10am

**Written Report Due**

Friday August 17<sup>th</sup>

## Team Mark

Competition results	30%
Robot design / construction:	25%
Individual time-trials:	25%
Communication component	20%
Inappropriate lab practice	Max -20%

(parts hoarding, unsafe practice, messy space, etc)

## Individual Mark

Team self evaluation:	$\pm 10\%$
Lab performance:	$\pm 20\%$



## References

There is no required text. Lecture notes, labs and data sheets will be posted on web page:

- refer to Wiring programming website (wiring.org.co)
- **Horowitz and Hill**, Sedra and Smith
- MIT 2.007 Course Notes (link on course website)
- Online Component Vendors (Newark, McMaster)

## Logbooks

necessary for labs & construction, but not marked

## Circuit drawing and simulation

<https://www.circuitlab.com/editor/>

# Class Activities

- Some “Teaching” will be done through in-class activities.
- Try to build circuit that we suggest
- Once you are successful, help people around you.
- Do not just build it for them. Explain how you did it instead.
- Bring laptop or smartphone to look up data sheets
- **Memorize** resistor color code!!! (at least first 5)

## Ewok Rescue: A Star Warz Story



Chewbacca and the Ewoks have been trapped inside an Empire stronghold! When you last saw them they worshipped you as a God - now it's your turn to help them.

Figure 1 – Competition Surface

