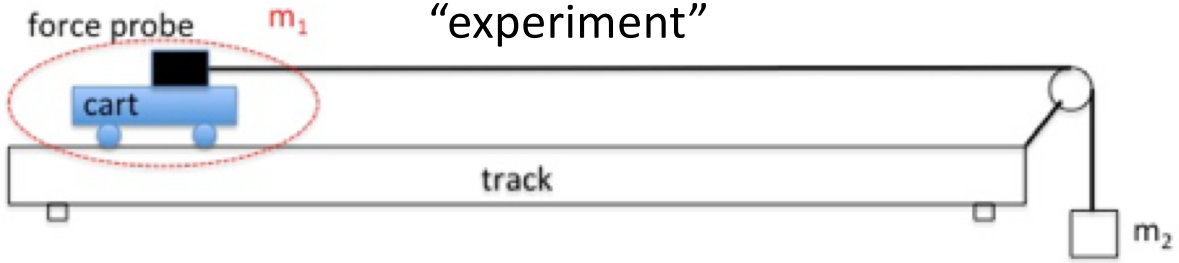
The Feasibility Proposal:
An Alternative To Lab Reports

Stefan Jeglinski UNC Chapel Hill

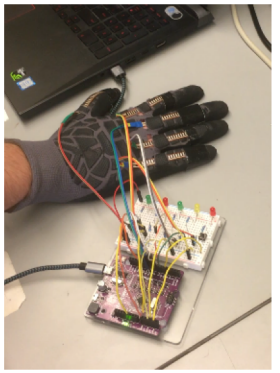
AAPT Provo 2019

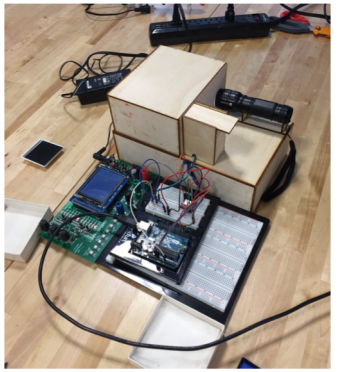


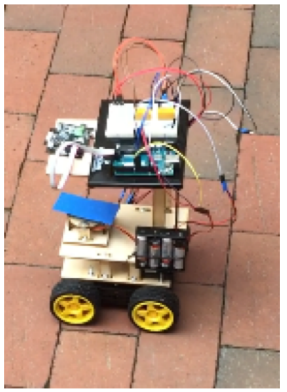
"experiment"

- *Abstract*
- *Introduction*
- *Analysis*
- *Discussion*

"prototypes"







- *Abstract*
- *Background*
- *Significance*
- *Technical Objectives*
- *How to Measure Success*

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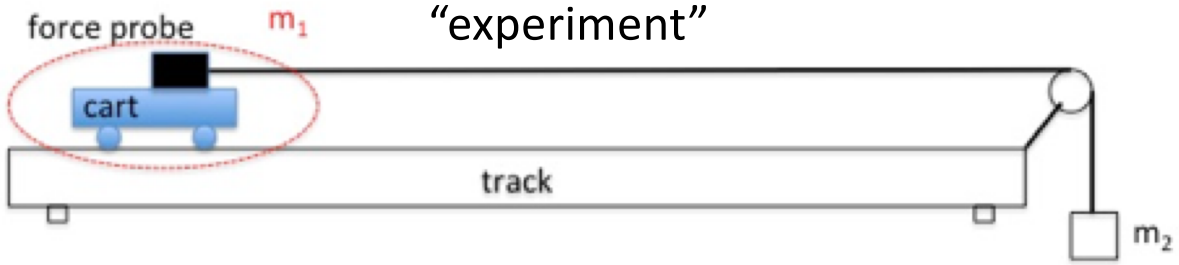

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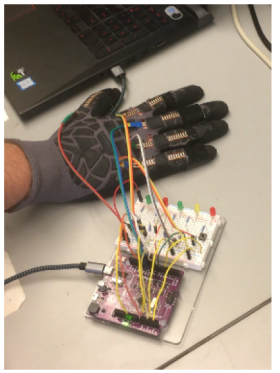

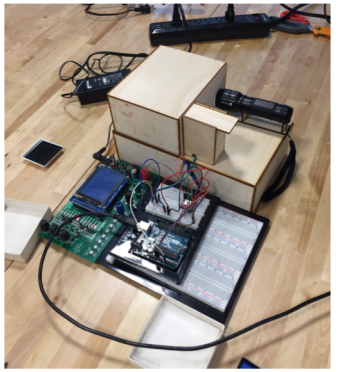

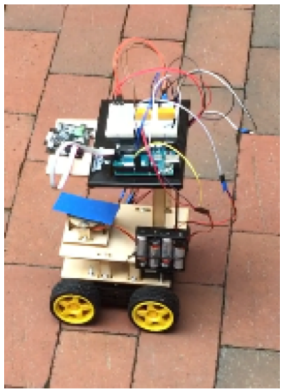

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Background Components

- Instructor:
  - private sector career, programming + product development
  - 9 years intro courses
  - what could I bring to the academic setting?
- 2xx Course: “Physical Computing” (enrollment ~21)
  - credit: Tom Igoe, Tisch School of the Arts NYU
  - Microcontrollers and Sensors
    - Arduino+NodeMCU, C, Python, D+A I/O, IoT
- 5000 sq ft UNC BeAM Makerspace (poster 2 D-5)
  - rapid (re)design, (re)prototype, (re)manufacture
- Course is designed to be Lab- and Project-oriented
  - labs: baseline skill set
  - prototyping project: apply skill set

Motivations

- Physics students hired to industry (trend?)
  - high-tech: small business, startups, mfg+control; “analytics”
- Their job description:
  - solve a problem or create a product
  - must understand all phases:
    - conception
    - formulation in writing
    - prototyping
    - feasibility?
  - possible AGILE environment (real-time input ⇔ real-time response)
- In many cases, work may be external or internally reminiscent of:
  - **S**mall **B**usiness **I**nnovation **R**esearch grant (SBIR)
  - **S**mall business **T**echnology **TR**ansfer grant (STTR)

Q: how to achieve an approximation of this at the undergrad level?

Process

- Elevator pitch
  - initial idea
  - can be unique or derivative
- First Draft of Feasibility Proposal/Study
  - terrible; hardly a TO to be found anywhere
  - critical misunderstanding: *background* vs *goal* vs *objective*
- Multiple Drafts as design/mfg proceeds
- Cheating Encouraged (not a "real" feasibility study)
  - every unexpected issue = missed TO
  - *solve the issue and ADD it as a TO to the proposal*
  - at conclusion, feasibility proposal ⇒ magically brilliant
- Me: "So… what are you doing right now (in the lab)?"
  - Student: "I'm learning how to [insert goal here]"
  - Me: "NO. What.are.you.doing.right.now?"

Evolution of Student Capability: First Draft of TO

My spectrophotometer will be able to measure the absorbance of bromothymol blue in its acidic form. This was chosen as the benchmark because it is a simple measurement to do, there is a large amount of literature regarding its absorbance properties. And it has a relatively low absorbance value so my device must be sensitive even to small changes in light. I can also test the basic form of this chemical for similar reasons, though it has high absorbance at its peak. My device will be able to measure the concentrations of highly dilute chemicals which absorb in the visible range and identify unknowns. It will be a useful tool for underfunded classrooms and even citizen scientists.

Evolution of Student Capability:

goal or measure of success

First Draft of TO

background

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not a single TO, aka “what are you **going to do** to demonstrate feasibility?”

Evolution of Student Capability: 100% TOs in Final Draft

- **Arrange** the optics and light source of the device to find a balance between a phototransistor's ability to detect the light and the dispersion of the wavelengths.
- **Map** the desired range of diffraction grating positions to a stepper motor's steps by fixing the reflecting mirrors in place and aiming the light spectrum at the exit slit using the grating.
- **Establish** the effectiveness of different slit widths by cutting several slits and testing their ability to transmit detectable light, while keeping the slit as small as possible.
- **Create** code which can rotate the grating, detect phototransistor signals, calculate absorbance, and plot data with minimal user interfacing.
- **Design** code which can account for spectral response of the light sensor and cuvette by dividing experimental absorbance values by corresponding reference values. These values will be obtained from a blank solution (deionized water in this case) and stored in the Arduino temporarily.
- **Measure** the response of the phototransistor to a constant light source in relation to the pull-down resistor in series with it. This is to find an optimal resistance value for detecting the light through the exit slit.
- **Manufacture** hardware that can mount the mirrors, grating, stepper motor, and light source and attach the grating to the stepper motor.
- **Minimize** light scattering by covering the interior of the monochromator in black felt and confirming its function.
- **Test** the functionality of the spectrophotometer using a blank sample of water and two bromothymol blue solutions by finding the isosbestic point.

Postive Anecdote

- Student feasibility project: laser galvanometer
- End of junior year: internship with CA company
- Excited intern: “guess what, I started and they were all like ‘do I know anything about writing a feasibility (grant) proposal?!?’”
- End of senior year: 3 principals hired student as 4th employee of their new technology drone startup (Pittsburgh)

Summary and Take Home

- The lab report is an important and integral part of intro physics courses – but:
- Few students get a job and are asked to write a report (but eventually yes)
- The feasibility study teaches students to:
  - focus their ideas to create a goal
  - figure out steps to accomplish that goal (objectives)
  - write it in the form of a proposal
  - ALL of which makes one eminently employable!