Teaching Physics and Engineering Remotely (and What We Plan to Keep When We're in Person)

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Teaching labs

- An important part of physics and (more so) engineering
  - Teaches important applications and lab skills
  - Provides connection of theoretical material to the real world
- (As you probably know) very hard to do online!

Some things we tried

- Simulations (using Phet) and video labs (using Pivot Interactives) – covered in another talk by Anastasia Perry and Brooke Schmidt
- Daily quizzes
- Having students build labs at home
- Analyzing YouTube videos
- Creating prototypes from sets of materials sent to homes

Daily quizzes

- Remote classes at IMSA meet for 50 minutes twice per week
- Started each class with a short (10-15 minute) quiz related to the homework that was due that day
- Most often multiple choice or numerical response, but sometimes switched things up with the occasional group quiz or qualitative short-answer question
- No large tests
- Administered quizzes using Canvas

Daily quizzes: the verdict

- Generally, was as good as large tests at determining student knowledge
- Needed substantial tuning and adjustment during the semester
- Student response was mixed
  - Some found it less stressful to have no big tests
  - Some found it more stressful to have tests every day
  - Either way, student performance was fine
- Worth another try

Labs at home

- Asked students to create their own simple experimental setups at home for a specific task
  - Eg. a system that transfers energy from a non-gravitational potential form to kinetic form
  - Eg. Capture constant or non-constant acceleration
- Students recorded the video with a webcam or phone
- Had students use Pivot Interactive's tools to analyze the video, but in many cases that wasn't necessary – they used stopwatches, rulers, and the Internet to find the values they needed.
- Asked students to calculate values based on their measurements – e.g., the amount of energy stored as non-gravitational potential energy.
- Asked students to calculate displacement from area of v curve, even if non-linear

Labs at home: the verdict

- No complaints (out of 35 students) about the assignment
- A variety of submissions, some with good ideas, cleaner data, novel analysis
- For harder topics like energy, a clear diversity in the quality of the answers (some people did it wrong)
- On the other hand, took a while to grade
- Worth taking another look at

YouTube videos

- Paired with the video of the labs at home, students also were asked to submit a link to a YouTube video that demonstrated a relevant event
  - For example, an example of energy conservation being violated, as in a cartoon or a superhero movie
- Students submitted the link (using the timestamp feature in YouTube to start at the right spot, so I didn't have to watch the whole thing) and then analyzed its physics
- Had to give arguments and estimates for various values, such as mass, distance, and velocity
- Calculated values; for example, how much energy was illegally created or destroyed in the video

YouTube videos: the verdict

- Make sure you set content guidelines if you try this!
- Generally, students seemed to have a lot of fun with this
- Mostly superhero movies, but plenty of variety, including some real-life videos and some totally bizarre movies
- A more careful rubric would have helped for grading, but students had to apply physics concepts to consider real-world difficulties, such as terminal velocity
- Definitely trying this one again!

Prototype Building

- Sent set of materials at the start of the semester
- Did not commence building until 3-4 weeks into semester
- Some were once and done, others underwent revision
- All were peer reviewed in the end
- Revised prototypes received intermediate feedback
- Final presentation involved user manuals and infomercials

Prototype Building: the verdict

- No complaints as hands-on was the expectation when course chosen
- Hands-on activities are a nice change of pace
- Creativity and pride was evident in most artifacts
- Presentation format was effective, recorded visual evidence
- Would (and am) doing again.

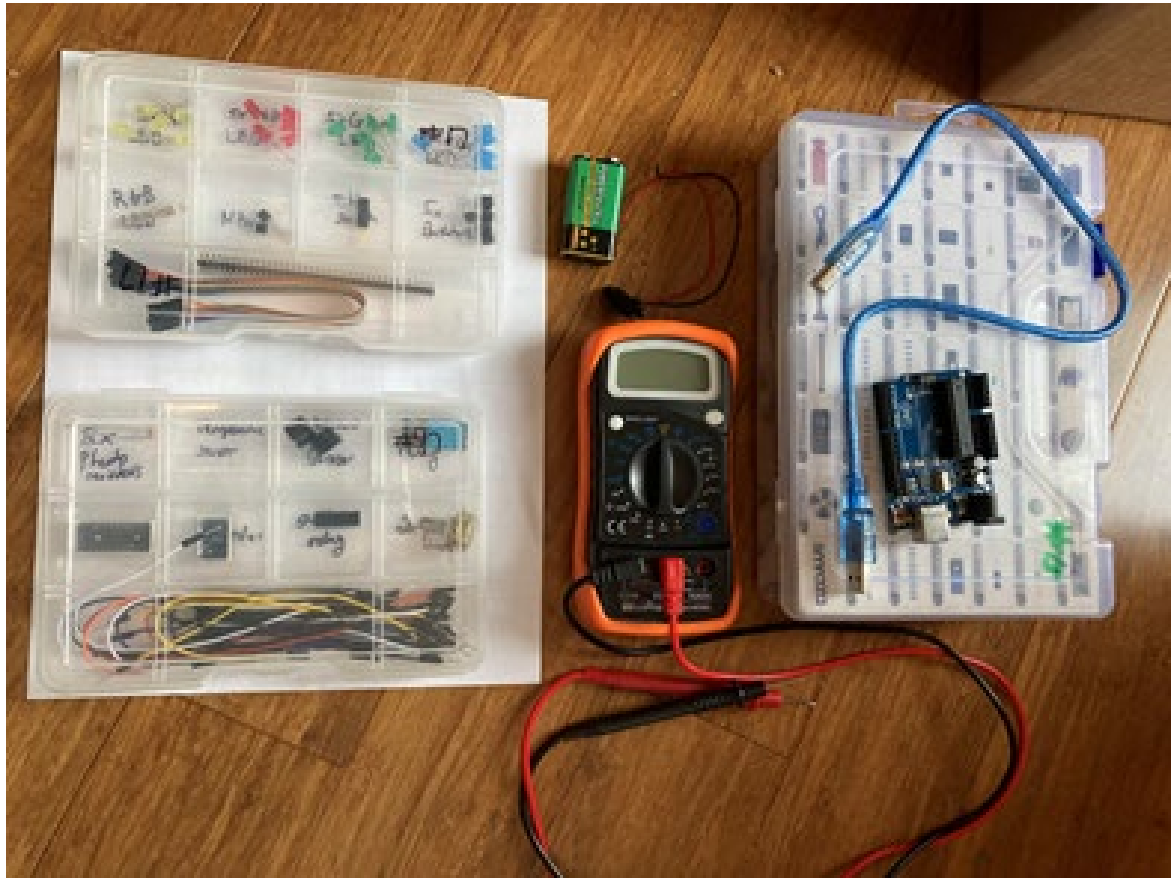
Prototype Building: Supplies & Recovery

- Engineering - ~$25 (shipping)
  - Disposable materials
    - Transparencies
    - Duct tape
    - Paper clips
    - Balsa wood
    - Balsa airplane kit
    - String
    - Fishing line
- Microcontrollers ~$80 (2xshipping)
  - NOT disposable
    - Intro Arduino kit with sensors
      - Additional Organization
    - Budget multimeter
      - Replacement multimeter fuses
    - Miscilania
      - Alligator clips
      - 9-volts (tape terminals)
      - Relay
      - 1 W resistor

Prototype Building: Supplies

Engineering

Microcontrollers



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Prototype Building: Plan

Engineering

- CAD & Design projects to start
- Safety
- Inventory
  - Early
  - Thoroughly

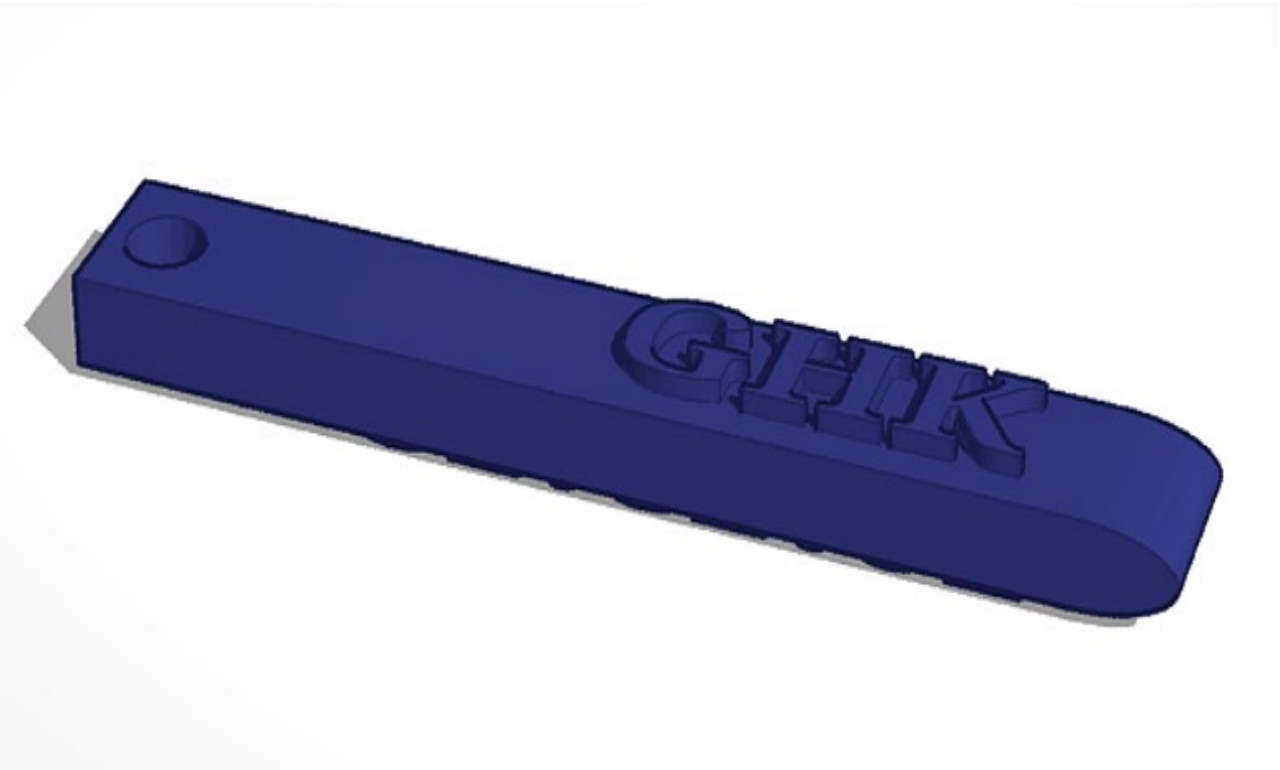
Microcontrollers

- Online Arduino tools to start
- Safety
- Equipment Maintenance
- Inventory
  - Early
  - Thoroughly
  - Pre/Post

Prototype Building: Design

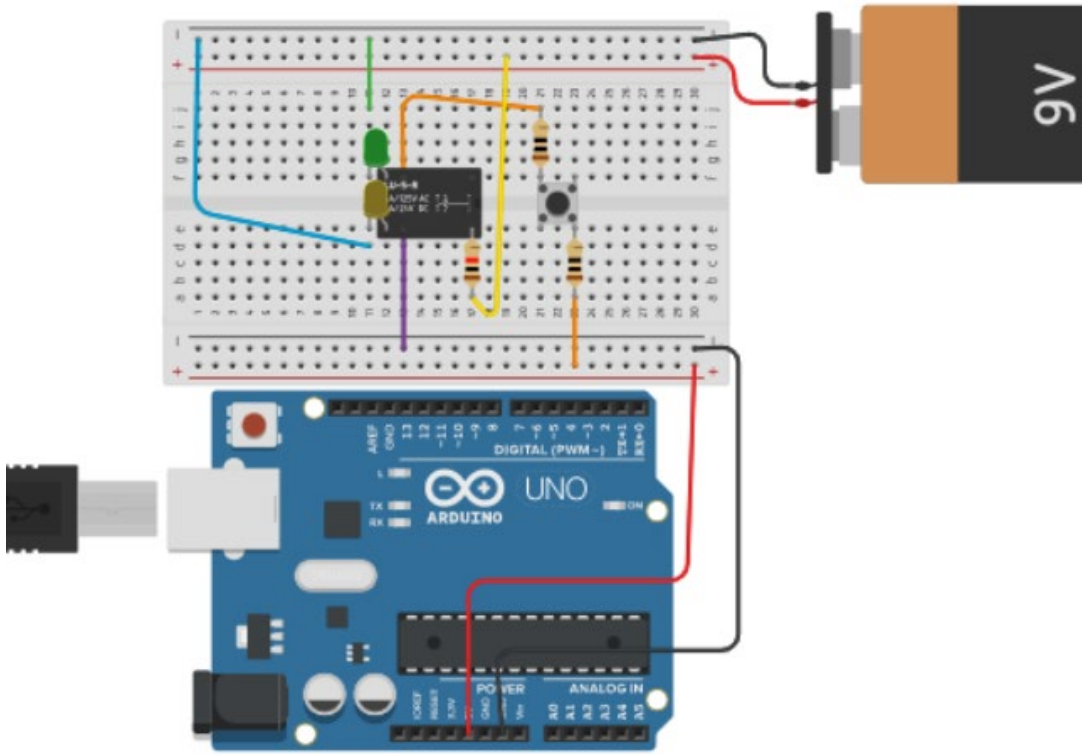
Engineering

- TinkerCAD



Microcontrollers

- TinkerCAD



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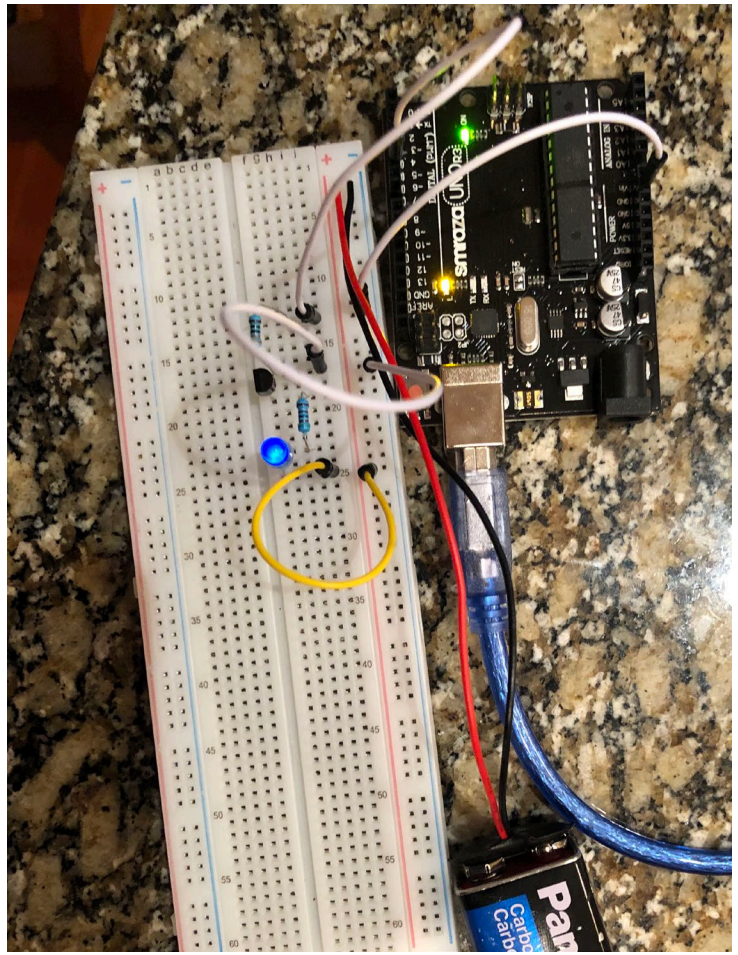
Prototype Building: Prototype Examples

Engineering

- Airplane Revision

Microcontrollers

- Arduino control of external Circuit



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Prototype Building: Write-ups

Engineering

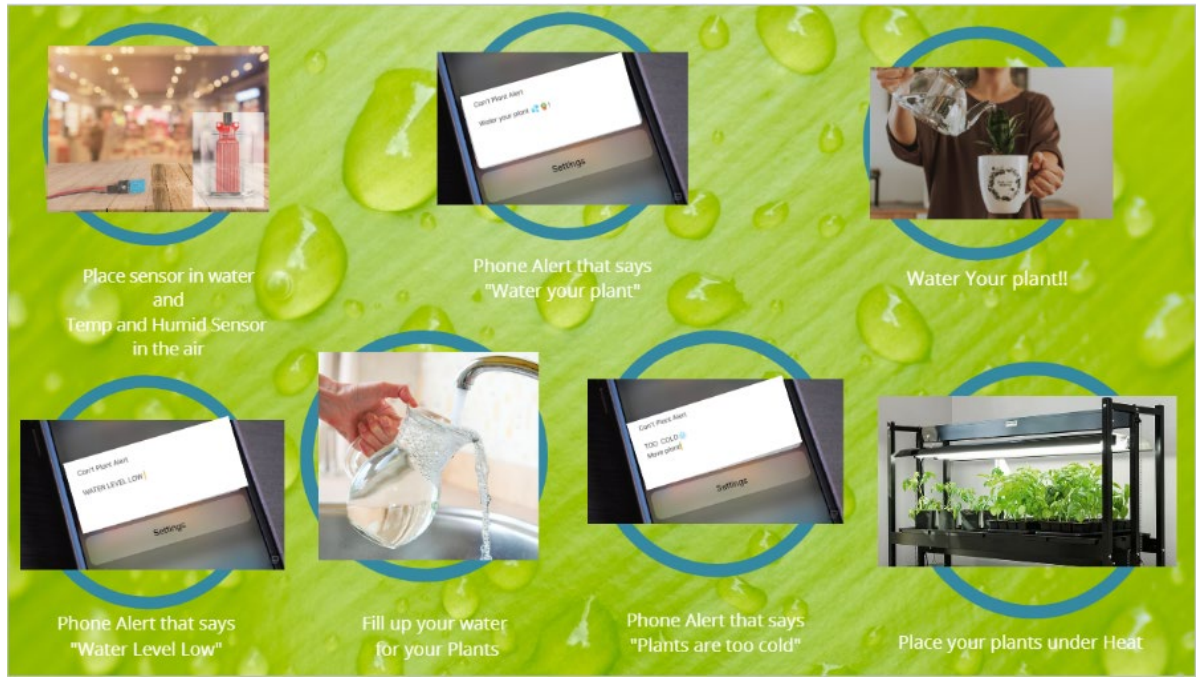
- PPE mask

3. Then draw an ellipse (mask like) sha
side of the line.

4. Then cut that piece out with scissors, and use it to trace the same shape on the other side.

Microcontrollers

- Indoor Plant Monitor



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How about you?

- What other things have people tried that have been helpful during remote teaching?
- Thanks for your attention!