

Lab Notebook

Project: Improving Upon Fall Protection Airbag Devices for Seniors

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Whiteside

Advised by Dr. Akshay Potnuru

AME 441A

8/26

- First design lecture! Literature review was successfully completed, and was turned in this morning to give all members a chance to review before submission.
- A meeting was set for 8/29 9am in BHE 301 with Dr. Potnuru to refine the project. All group members are available.

8/29

Shortcomings (meeting with professor) -

Airbags- one-time use/very expensive

"Overblown" solution

Used for automobiles but might not be good for human technology

The weight of the airbags is too much

Airbags are high G, inflator needs to be refilled

"Reduce cost" - not something we can really say

Weight

Notes

Needs to be repeatable and reusable

Phone case design - Use spring action - trigger to spring actuated pop out

Maybe design a jacket with a spring mechanism

Mechanical contraption

Propose less and do more

Increase functionality or be completely innovative (but not a replica)

Not a universal product narrow it down to size and weight as well as height

Pull off a good demonstration

Maybe add a new method to refill the inflator

Come up with a good acronym or name for the product

1- reduce size and weight (not 441 quality)

2- completely innovative (spring loaded) (don't have to fight with anyone else)

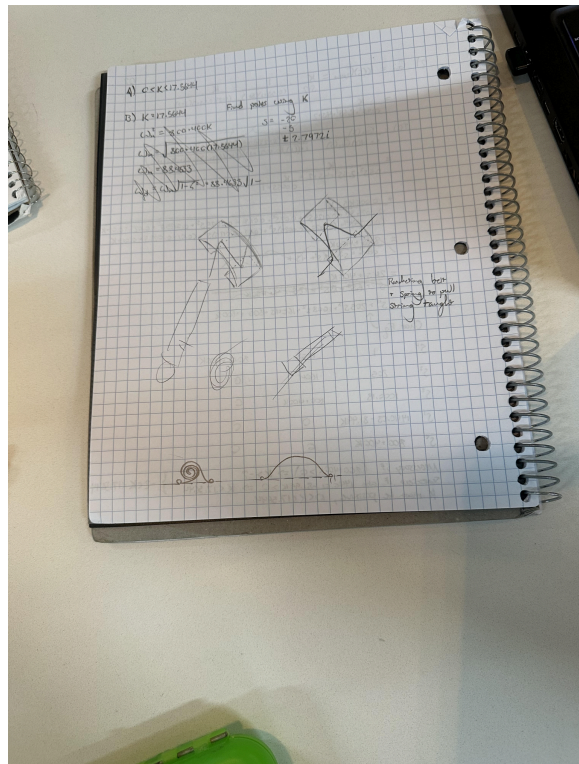
3- functionality part - do what has been done but make in more functional and more reusable

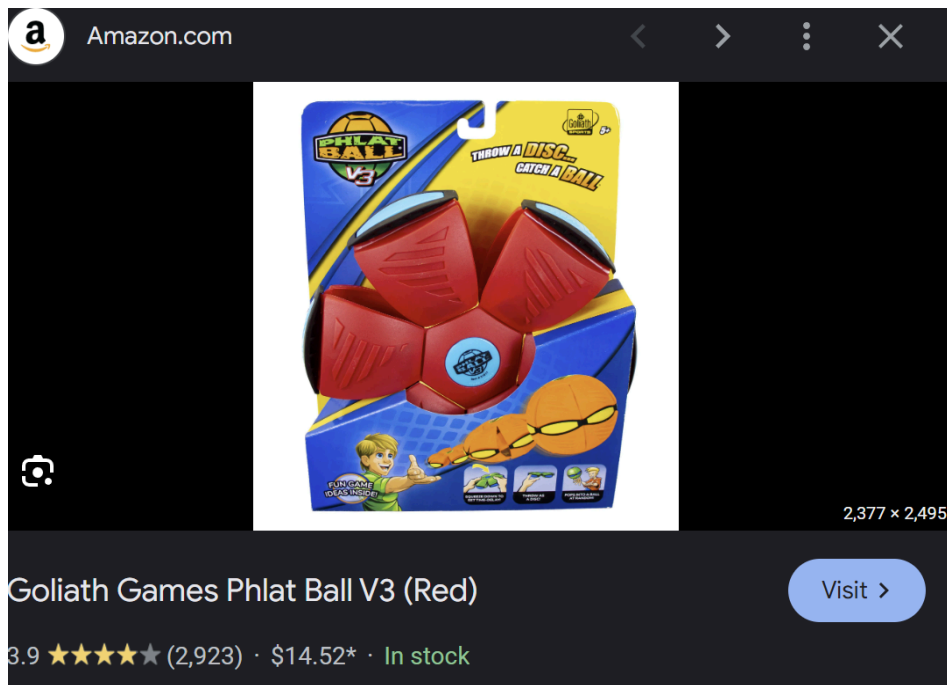
8/29 Meeting at coffee shop

- Spring steel board (like the slap on wrist watches) \
- Eliminate airbag idea (keep it only if we can make a completely modular standalone item)
- Hoop skirt
- Rollipop style armor



- Figuring out the relaxed state vs the deployed state for the spring steel
 - This is probably the idea we are going with sketched below





9/3

Figuring out proposal

- We need to check our preliminary design
- It is due Friday at noon, so we are splitting out who does what.
- We are figuring out the final design. Should we do spring steel, armadillo, phlat ball??
- Probably sticking with spring steel, we can heat treat into a new shape
 - The spring steel needs to be in tension.
 - We can heat-treat the spring steel and we can implement this into the proposal
 - We would have to use the chemistry lab
- Still thinking about the hoop skirt
 - Interlocking pulley system
 - Compressible hoola hoops

9/10

- First meeting with AK about proposal
 - Wants the name to be macho
 - We need a numerical goal (put in abstract)
 - Pull up passive cushion hip protector force reduction numbers
 - Initially imagined a yoga ball contraction that is big

- Concerned about the stiffness of spring steel; want to make sure it deforms and doesn't shoot the person away
 - **Hybrid** of soft material and spring steel; spring steel for high impact force, softer system to prevent launching of human (spring steel absorbs fall stress, softer material absorbs spring steel stress)
 - Or can we have it lock and unlock after the human is resting on the floor?
 - Go back to the jelly fish slow extension
- Look into how elderly fall; what about head impacts?
- Check with Dr. Kwan, Quan? 6 camera room to track human (helped the FROGO group last year) * IMPORTANT
- Suggest to get a mannequin instead of human testing (lets not have Mars fall a million times + more repeatability and smaller uncertainty)
 - Automate falling and resetting system\
- Doesn't like spring steel, reconsider maybe material selection
- Satisfy functionality and safety (weight is secondary to these requirements)
 - Sell repeatability
- Check with Makerspace staff if we can heat treat with a torch in **Makerspace**

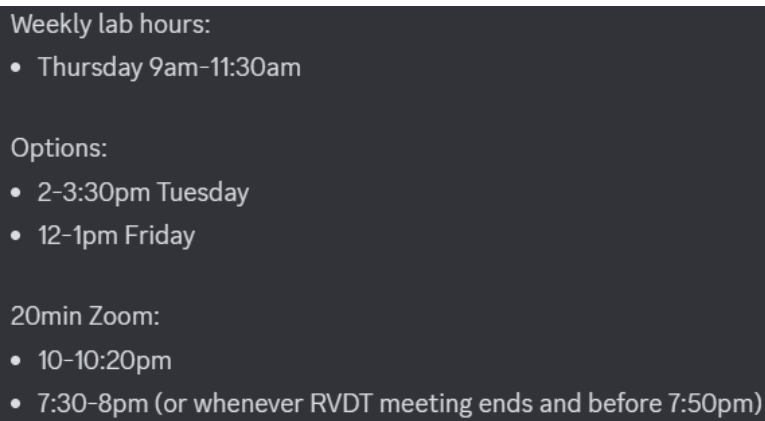
Make spring steel Phlat ball

- Buy the ball, and prototype to see if this is feasible

Have to figure out our story, what are we selling to people

9/10 discord notes

- Set recurring 9-11:30am Thursday and 10-10:20pm full team meetings



- Figuring out tasks, and dividing up work to meet the week 4 proposal deadline.
- Want to test multiple designs before choosing a final method

9/12

- Make either wooden or 3D-Printed baseplate (either over the weekend or sometime next week) for preliminary design and to test viability of spring steel

- Proposed a guillotine style test apparatus as well as inverted pendulum style apparatus as opposed to using a test dummy to simulate falling

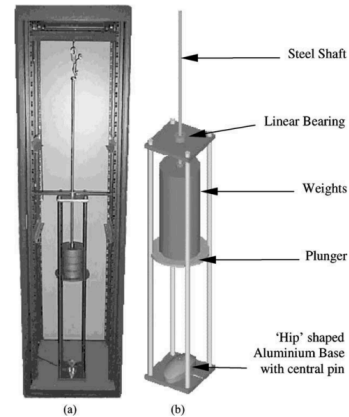
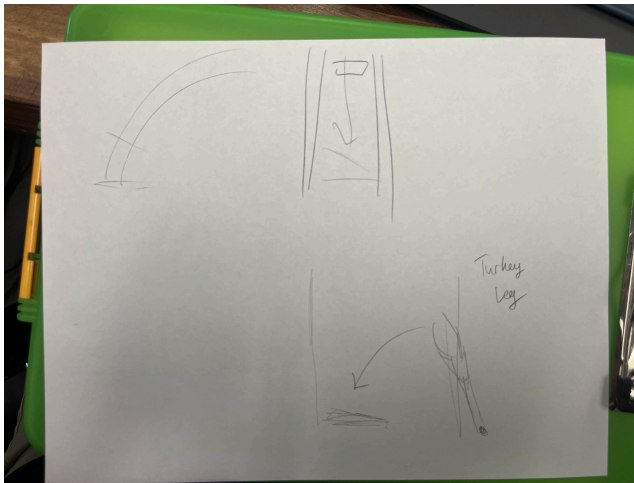


Fig. 2. The test rig shown within the cabinet (a) and as a solid model (b).

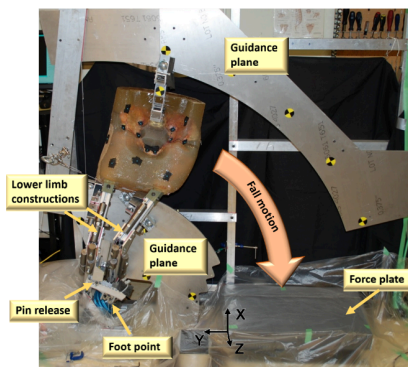


Fig 1. Experimental setup of the pendulum drop tests (reprinted from Fleps et al. [20]). Two planes were used to guide rollers attached to the lower limbs and pelvis. These guides constrained the specimen during the fall phase to a single degree of freedom. Cut guidance planes allowed for a free impact of the specimens, which were only constrained by the ball and socket joint at the foot point at impact. A pin-release constrained the motion of the contralateral leg during the fall phase but released it before impact. Rigid steel masses were added to the lower limb constructs to achieve subject specific target limb masses for each specimen. [22].

- Would need to know what forces the hip experiences during a fall to accurately simulate said event
- Could use a turkey leg or other material in place of a human hip or test dummy
- Test apparatus would be much cheaper than purchasing a test dummy or crash pad and be much more repeatable in successive tests
- Could be made of 80/20 extrusion which would not be counted towards our \$400 budget
- Possibility of using a fluid-damper system to help dissipate the forces from the fall and spring
- Casey to reach out to Dr. Diego Lopez and Dr. Sheryl Flynn regarding fall mechanism for the elderly as well as looking for resources regarding forces experienced in the event of a fall (contact information given by friend, Sarada Lakshmanan, who is in GERO and is part of a research lab centered around fall prevention (A Matter of Balance))

- Arrived at a goal of 20% reduction in forces
 - For the impact energy 49.1 J, the results of hip protector tests could be compared to those of drop tests on the hip model alone (Table 1). With hip protectors, the maximum impact forces varied between 47% and 80% of the mean value found without protector. On the other hand, the resultant forces in the femoral neck were reduced to values between 31% and 67% of the mean value resulting without protector. From the fact that greater reductions were found in F_{neck} , it can be concluded that by means of protectors significant portions of the forces were deflected via the flesh surrogate. As can
- Provided instructions to download NX (student edition) while USC figures out it's licensing issues

9/17 - Meeting with Professor Potnuru

- Above 20% is a reasonable goal
 - Figure out why the lowest one is the lowest, if we fail, we can say we're the best in x category
- Really wants a mannequin, replicate human body mechanics using metal or a skeleton structure.
- Out of the two separate impact force methods, build the **inverted pendulum**
- Go to chemistry or material science department **to get a impact tester**
- We are targeting elderly people, we need to describe human characteristics. 5'5, 150....
- Edges on the backplate need to be re-inforced, stress wont dispiate through the blackplate all the stress will be focused on the edges.
 - Use hinges and rivets
 - Break everything, Break the spring steel, break the plate; figure out what the upper limit is
- Maybe electromagnet, or magnet (NO SOFTCOAT MAGNETS)
- Send piazza message when ordering, then fill the form
 - Ask what we already have in the lab
 - REALLY MAKE SURE WE PUT THE STUFF IN THE FORM RIGHT
 - Then Piazza post to notify Professor Potnuru we filled out the google form
 - Orders go in Tuesdays and Thursdays
 - Accelerometer fusion does the math for you
 - Use spring locking mechanism for the spring steel contraption



- Otherwise come up with a locking mechanism, I (mars) think a twist lock is a bad idea. Magnetic was floated.

9/19 - Thursday Meeting Week 4

- Ordering a [Adafruit 9-DOF Accel/Mag/Gyro+Temp Breakout Board - LSM9DS1](#)
 - Used Jeffery's (Jaiden's) board
 - Jeffery soldered LSM9DS1 to pins
- Have a meeting with materials lab VHE with Mr. Zhang (lab manager)
- Deciding on spring steel thickness
- Went to Materials lab
 - Impact test bed relatively small -> 4 by 6 inches
 - Puncture type test, intended for flat plates
 - Could test dome with drop test by adding pins/standoffs to the base so that it clamps them and not the dome
 - RVDT Hydraulic testing idea: pressure test in order to characterize effective spring constant of the dome. Not at speed, just slow compression measure deformation.
 - Takes force vs time, energy absorbed vs time, deflection vs time
- Potnuru advice wrap-up
 - Make larger base plate to create a pattern instead of custom 3D printing
 - Base has to be metal
 - Base edges too thin -> already has been said but the thoughts continue to exist.
 - Metal lego mock-up
- Confirmed that we can break spring steel samples.

9/24 Tuesday Meeting Week 5

- Met prior to 11am check-in to complete slides and work on ideas
- Test sample to get material properties, do simulation?
- That's good! -> test arch in bed
- Need biomechanics data for force experienced by person -> target impact force
- Some amount of potential energy is getting absorbed
- How are people falling?
- Arch angle will define stress it is experiencing, will change ability to absorb stress?
- Heat treatment to rollover edges
- Cover it in padding?
- Have a goal for data
- AME bridge tester:
 - Can't break it! Ask permission
 - Spring steel too strong
- Knock on door of gerontology people?
 - Potnuru is skeptical
 - Talk to biomed people/biomechanics
 - Ask Riva?
 - Can create data via assumptions if we can't find anything published

- Simplify to inverted pendulum
- Figure out how to implement (for next week?)
- Impact force?
- Load cells good with enough time to measure, difficult for impact
- Sensors don't react
- Requirements for progress report:
 - 5 Page requirement
 - Get designs into 3D (parts we don't manufacture we can download CAD files and site them properly)
 - So much of grade is CAD
 - Have detailed drawings
 - Write paragraph about project, write then about what was done after the proposal
 - Use images
 - Don't repeat
 - Powerpoint good because we just write-up context for images
 - Reference syllabus
- Hard focus proof of concept
- Break the one we have!
- Clamps for spring steel in automobile applications?
 - Talon Jaw to hold?
 - Hook in
 - Aluminum bars with multiple possible places to go

9/26 Thursday

- CAD file for impact drop tester rig
- Progress report 1 doc
- Figuring out the spring latch mechanism/latch mechanism

9/30 Monday

- Finalized and got approval for CAD drawings
- Talked to Alex about machining
- CAD files sent to Uzi for 3d printing
- Began 3D printing baseplate
- AMchien starts 10/01 Morning
- Testing 10/02

10/1 Tuesday

- Got parts in
- 3D printed approved by potnuru, likes it
- Drop sensor: no jumper wires, longer wires and screw clamps or solder
- Find Quan's class schedule, look for his office hours
- Drop testing scheduled for 1pm tomorrow
- How divert the forces around the human body?

- Wooden hip model, sensors on dummy to measure the impact, need to dissipate energy
- Documentation! Look at syllabus for what is being measured etc. Satisfy things on the rubric
- Look for something that already exists with force redistribution
- Fluids are good for absorbency, multiple chambers? For absorption?
- Hydraulic damper
- Magnet induced current to slow -> lenz law
- Spring dynamic energy vibration to discharge?

10/2

- Alex suggest to use **onyx with carbon fiber and use the mark4 forge machine**
- Backplate is complete and machined
- Need to recad and add pins to adjust for angles.
- Working with john to edit our manufactured part

10/10

- Testing happened! Progress report grind began

10/8

- Potnuru feedback
 - Life cycle stuff important - can't say 100 unless we test it, good idea tho
 - Use plain not textured backgrounds for figures
 - If it doesn't work oh well! That's fine
 - Don't need to reintroduce project
 - If interested in graduate school, real results and stuff could be useful and there are assistive technology conferences -> asme in august. Worth publishing if going to graduate school (if successful) if interested in making a product, don't publish it
 - Use overleaf to write reports and avoid formatting issues -> move to this from word <https://www.overleaf.com/>
- Order spring steel by end of week!
- For proof of concept, need perfect data, locking mechanism
- Start inverted pendulum testing structure going

10/15

- Presentations
 - Early is good!
 - Can make claims about what is left to do, what can be accomplished in the time that remains.
 - Slides should be basically what we expect to talk about in Progress Report 2.
 - Sell the idea
 - Live demo? Drop the arduino?
 - Use videos!

- Make functional, then can optimize least amount of power, source battery, etc.
- Aka overload the servo? Choose something a bit larger. Use power supply for now then source a battery
- Buy solenoid imminently
- Possible interference between solenoid magnetic field and arduino or data etc.
 - Should be sequenced in such a way that it is fine
- Functionality over form factor for now, can optimize later.
- Airbag concern was: repeatability
- Try to pull off proof of concept at least a little bit

10/22

- For friday what can happen?
- Camera tracking pendulum force stuff
- At end of slides discuss what is left and what to do
- Sell what we have done so far, frame as we have time for what is left
- First slides big sell the idea, statistics, numbers, present solutions, repeatability
- How evolved from single to multiple
- Strength of thing
- Show videos
- Gantt chart where we are at
- Talk about reaction forces maybe, or talk primarily about impact reduction
- Appendix slides
- Product has to matter! Videos of people falling?
- One day you too shall be elderly

10/23

- Makerspace work session
- 3D printed piece exists,
- Threaded inserts added
- Prototype idea for pendulum created
 - 2by4 arm, mount 3 arch assembly to the top of it, weight the backside, drop onto ground.

10/24

- Built Impact tester rig in maker space using RVDT frame
- Made new iterations to the releasing mechanism
- talked to Potnuru, showed him our prototype
- Worked on fall detection algorithm and accelerometer.

10/26

- Impact tester fully constructed. Added weight rack/holder to back. Mounted 3D printed test rig to wooden impact pendulum.
- Tested data from phone gyroscope on impact pendulum - > very successful

- Preliminary tests with spring steel in place created permanent deformation that only increased in severity. This is with 5kg impact pendulum, no additional weights
- Ideas to fix this
 - Heat treat spring steel into arch shape
 - Steel arches float in rails
 - Rails contain springs
 - Springs and steel arches initially compressed, released on fall, blocks at center of rails so arch cannot get too vertical.
 - Solenoid arch release mechanism remains
- Maintain use of spring steel for innovation -> use of hinges instead introduce additional complexity, possibility of hinge collapse
- How to balance springs? If springs are stronger, the spring steel takes up all the force. If the spring steel is stronger, the springs bottom out?
- Test with one rail???
- Reaction force issue?? Where is it.
- To compress it: screw mechanism for mechanical advantage
- Taking more data to get an idea of expectation

10/29

- Performance better than the data we had
- Sold it well, we did good!
- Heat treating by friday?
- Sell it like proof of concept in progress report
- Each slide was our approach/our engineering, not a path previously explored
- Shes got big force plates and i cannot lie
- Heat treat ASAP
- Battery life issues? Get numbers
- Make own chip, arduino is overkill battery wise
- No extra space for progress report— come early
- Order
 - Steel Foil <https://www.mcmaster.com/3254K7-3254K76/> (ORDERED)
 - Chunky solenoid (ordered)
 - Tachometer
- Progress report division of duties outlined

10/31

- 1 ton Load cell obtained from BHE
- Progress report 2 grind.

11/5

- Progress Report 2
 - Presentation good! Really Solid!
 - Report - Coordinate axis (thats my bad I think I fucked that/deleted them)
 - Label top view in image or smth. Have dims.

- Data decent in terms of presentation
- Live demo somehowwww
 - Linear drop box?
- Ask other group who was doing superelastic stuff to see how they trial and errored it.
- Figure out thickness and then Order
- Do one prototype with one side hose clamp, the other snail ends, test them and see which is better.
- Rushed finish is what its looking like.... Be careful!
- Bend issues? So thought this was overkill.
- Force plate design completed, some machining still to be done
- New baseplate design drawings/stl sent in to be printed
- Lots of work in makerspace
 - Prepping samples for heat treating
 - Bending pre-annealed samples according to guides
 - Weighed all samples
 - Planned heat treating of samples-> which samples would be prioritized to go into the oven

11/6

- Force plate machining with Alex
- Heat treating fiasco! Many miscommunications occurred, the TAs helped in ways that they should not have. Nothing was damaged, nothing unsafe occurred but there was undue risk. Significant cleanup emails, meeting scheduled with prof. Grunenfelder for the next morning.
- Heating and quenching occurred, and the first temper cycle. The oven was significantly slower than expected.

11/7

- Met with professor grunenfelder to pick up heat treated samples
- Wire brushed off scale, cleaned them
- Testing revealed that samples were not successful

11/8

- Work done to get solenoid working. Wired it up to a power supply, arduino program written to test extending it.
- Breadboard uses a transition to trigger things
- Materials were moved to makerspace so that weekend work could occur
- 3D printed baseplate was completed and retrieved from BHE

Arduinio code:

```
int solenoidPin = 9;           //This is the output pin on the
Arduinio
```

```

void setup()
{
  pinMode(solenoidPin, OUTPUT);          //Sets that pin as an output
  Serial.begin(9600);
}

void loop()
{
  Serial.println("turning solenoid on");
  digitalWrite(solenoidPin, HIGH);      //Switch Solenoid ON
  Serial.println("solenoid on");
  delay(200);                            //Wait .2 Second
  digitalWrite(solenoidPin, LOW);       //Switch Solenoid OFF
  Serial.println("turning solenoid off");
  delay(5000);                           //Wait 5 Second
}

```

11/12

- Talking with the professor about Heat treating
- Doesn't recommend a blow torch
 - Need uniform heating
 - Probably won't be good enough
 - Try the cold worked method
- Keep messing with the force sensor
- Work with quans lab
- Work with inna (inverted pendulum)
- Schedule with others (very important)

11/13

- Design clips for spring steel waterjet

11/14

- Stress bending of spring leaf sheets
- Bent into arches
- Buckling mechanism ideated, CAD started

11/15

- Waterjetted clips were drilled and tapped with #6 screws
- Buckling CAD continued

11/17

- Clips finalized with larger screws
- Test assembly.

11/19

- Underplate CADded for buckling rods
- Buckling rods cad refined
- More bending of spring steel
- Spring steel leafs assembled into baseplate

Potnuru:

- Talk to quans ta for advice + additional input, valuable resource
- Moment of inertia on release? Probably not relevant but might be.
- Data from act of release?
- Poster
 - Font size large
 - Present top to bottom not left to right (body blocks)
 - Keywords and bullets not paragraphs
 - Choose rgb colors, others look iffy. Use bright and simple colors
 - Thick lines to see from afar
 - Show edited and pretty data, filter out noise if the noise isnt relevant.
 - Jpeg of text is Bad, retype eqs
 - Captions shorter in large font (but yes caption)
 - Middle area maximize pictures
 - Color code CAD components and annotate
 - Professional photos
 - Print business cards? Linkedin link
 - If no data, leave blank spot, print on chart paper the diagrams and substitute graphs, update stuff. Can correct. Worse case do that for graphs if they arent ready
 - If you cant answer someone, say you do not know and will look into it, and ask them for the answer. If they cant be convinced its better to give up and engage differently
 - Either have good demo to attract people or fish people in. get more people for better average
 - Work on live demo
 - Video running off to the side on a tablet if you want.
 - Print out figures to pass out is allowed
- Mill out the holes that didn't fit
- Modify the broken hose clamp to fit a through bolt

11/20

- Prepped 3D printed buckling rod ends -> required extensive sanding
- Decided to just reprint
- Buckling CAD modified to include wider tolerances for 3D printing (aka any tolerances)
- Prep for testing
- Dry runs without weight
- Prelim data analysis

- Force plate wasn't performing great, decided to include it anyway
- Started design of underplate to guide buckling rods

11/21

- Testing in Quan's lab
- Broke baseplate
- Put in print to be ready for monday

11/23

- Henry worked on data analysis

11/25

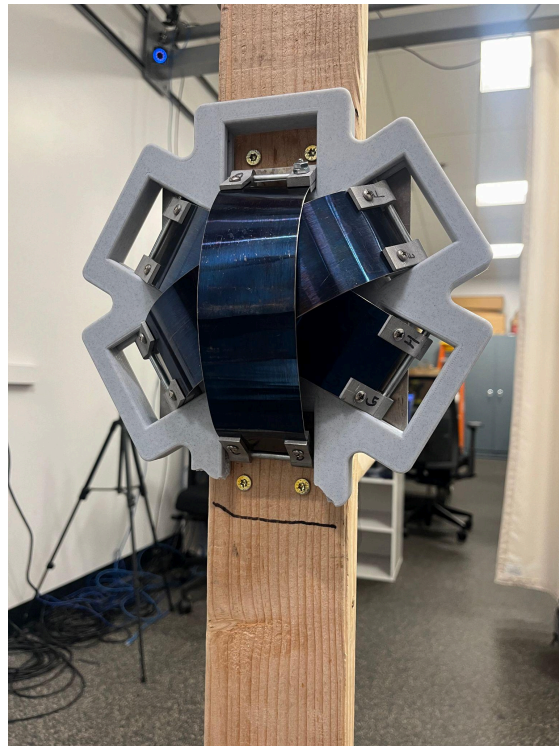
- Print ready! Picked up from BHE
- Poster finalized

11/26

- Checked out high speed camera
- Determined dongle for SD card was necessary
- Feedback from power point reviewed
- Potnuru
 - Bold numbers on poster
 - Sell more in motivation, with Numbers
 - Conclusion should have numbers
 - Justify bullet points
 - Label designs in figure 1
 - Change numbers to letters for labeling, works a bit cleaner
 - Show real design images, can optimize white space
 - Yeet the plot labeled not useful, or zoom in a lot
 - Make table vertical?
 - Annotate peaks/ highlight. Make better since it is central in poster. Or place in a different location.
 - Move future work to corner, smaller font. Real estate usage matters
 - Observers will push on
 - Move experimental setup to center, can move results to the side even
 - Think about order. Experiment in center then move to results.
 - Shorten experimental setup caption
 - Move experiment to setup, keep table in center, push graphs to right or down
 - Poster is a prop, so reduce text in conclusion
 - Show closeup of baseplate, real image somewhere. (right column? Sub out conclusion text block for more images)
 - Really really fill the poster
 - Video is allowed, flyers are meh
- Moved with camera to makerspace, testing planned.
- Access to testing space for afternoon granted

- 2pm testing began. Issues with slots in 3D printed baseplate created issues with leaves sliding.
- Issue diagnosed as being caused by a protruding screw/bolt head on the interior of the leaf attachment point. This was hitting the aluminum anchor plate by which the assembly was attached to the pendulum. This bolt head issue was solved by flipping the leaf with the issue to the other side of the assembly.
- Failure of 3D printed plate occurred on side of plate that originally had the bolt protrusion issue. May have been a cause of the failure? The leaf in the slot that failed had warped/bent slightly from the previous sticking trials.

Failure images:



11/29

- Analysis of new data begun by Henry
- Poster rearrangement in response to instructor comments begun

12/2

- Finalized poster edits for printing. Primarily moved experimental setup to center of board, increased color intensity of NX models for more clear print, added image of assembled device. Behind the scenes issues with the data analysis meant we had good confidence on our hard results numbers so those made it onto the posters, but the graphs did not. Graphs to be added later.
- Feedback from potnuru used, huzzah for working in BHE.
- High speed camera returned.
- Edits to underplate design

12/3

- Reprinted buckling rods
- Went to makerspace in evening and assembled buckling rod release mechanism
- Bent spring steel leaf (7.5in length) to replace leaf bent during testing
- Unbent the one that had issues just in case
- Waterjet more pin retaining brackets
- Drilled out and tapped them
- Extras were made, and a set was made for the replacement leaf

12/4

- Second print of buckling rods, casey assembled at home
- Bar/pin spacers printed for leaves to support buckling rod attachment
- Solenoid tip printed
- Checked on high speed camera return since there was doubt of it getting checked off.
- Uzi expects to start replacement baseplate print today
- Uzi given the underplate STL, expect that print to start tomorrow
- Underplate print attempted to print at home on casey's printer, first layer was failing repeatedly. Put on hold.
- Henry data analysis continued, with more success! 50% reduction pm 20% remains accurate with the addition of more trials, this is good, we now have 26 useable trials. And don't have to paste over poster information.
- Now only waiting on print for full assembly.

12/5

- Underplate print started at home just in case, successfully!
- Power supply + breadboard + arduino situation had a button added. New code activates when button is pressed. Waiting period included to not double-fire arduino. Code has lots of serial mode communication because debugging was Strange
- When in doubt, wipe arduino and reupload.
- Also, double check what comm port its using. The computer is totally willing to download to a device that isn't real.
- Checked in with Uzi, baseplate print starting now (11:30)
- Underplate to be printed on another machine once it became available
- This is cutting it close but should all be good for assembly in the morning

Arduino code:

```
int solenoidPin = 9; //This is the output pin on the
Arduino
int buttonPin = 4; //idk which pin this is fix later
```

```
void setup()
{
```

```

pinMode(solenoidPin, OUTPUT);           //Sets that pin as an output
pinMode(buttonPin, INPUT);
Serial.begin(9600);
Serial.println("setup done");
}

void loop()
{
  while(digitalRead(buttonPin) == LOW){
//nothing
  }
  Serial.println("turning solenoid on");
  digitalWrite(solenoidPin, HIGH);      //Switch Solenoid ON
  Serial.println("solenoid on");
  delay(200);                            //Wait .2 Second
  digitalWrite(solenoidPin, LOW);       //Switch Solenoid OFF
  Serial.println("turning solenoid off");
  delay(1000); //wait a second to avoid retriggers
}

```

- Further graph editing occurred, formatting for the next day finalized.
- 4:30! Crisis! Baseplate unable to be printed because XL printer is out of commission. Uzi suggested sizing down but that is not an option because of how everything needs to fit together.
- Discussed printing at makerspace
- Having Uzi send the print to the makerspace so that we could use our group's funds was an option.
- Stratasys printer large enough, but prints in ABS with dissolvable supports, and supports would not dissolve in time for expo next afternoon
- Markforged X7 has enough bed space, but printing in Onyx (best available option) since PLA isn't available for that machine would take twice as long as normal (9-12 hour print -> 18-24 hour print, too long)
- Discussed with 3D4E club, obtained filament from BHE so that they would not have to use their own and charge us less or not at all.
- Also looked into printing with friends
- Ultimately 3D4E's machine couldn't do it, Noah Tingey printed the Jesus plate, it was done by midnight, crisis averted!

12/6

- First print on printer paper for graph replacement too white
- Reprinted on chart paper
- Rubber cement to victory
- 12V power supply acquired for setup
- Assembled device so that guests can try it, locking mechanism works!

- Electronics ultimately removed and solenoid instead pushed in manually so that we can pass it around to people
- Solenoid needed tuning that we did not have time to do day-of
- Poster setup included video of an example pendulum drop test, scannable QR code with our linkedins, several iterations of spring steel leaves, an example underplate and linkage demonstration aid, and the completed device, manually activated, to show off.
- Presentation went well!





12/10

- Lab Cleaned!
- Report Written!
- MACH-0, signing off.