Final Design Review Notes

- **Smooth PDMS mold (Emily Adams)**
- **Send Mike the Arduino code (Emily Wood)**
- **Update Bill of Materials (Emily Wood)**
- **Find time to hand off supplies, discuss purchasing with Dr. Bailey (Natalie)**
- **Create Imagine schedule (Natalie)**

Tuesday, April 24

- **Lightning Slide**
- **Gate review time and Imagine schedule**
- **Design Review slides**

Monday, April 23

- **Important dates**
    - Poster/Draft Report due today
    - Final Design Review: **April 26 at 10am**
    - Lightning Talk: **April 26 at 11am**
    - IAB table: **April 27 12-1:30pm**
    - **IMAGINE: April 28 9-5pm**
    - Gate Review: Wednesday May 2 morning?
- Purchasing - Natalie will get reimbursement form from Christine
- Fibronectin Coating
    - Goldyn: 50 cells/mm2 were plated on fibronectin (20 µg/ml) (Sigma-Aldrich, Munich, Germany)-coated poly(dimethylsiloxane) (PDMS; Corning Sylgard, Midland, MI) elastomeric membranes. 3T3 cells used!
    - Jungbauer: incubated overnight (12–14 h) with a 5 mg/ml Fibronectin solution. Some kind of fibroblast used.
    -

Thursday, April 19

- **Important dates**
    - Poster/Draft Report due today
    - Final Design Review: **April 26 at 10am**
    - Lightning Talk: **April 26 at 11am**
    - IAB table: **April 27 12-1:30pm**
    - **IMAGINE: April 28 9-5pm**
    - Gate Review: TBD
- Dynamic cell culture
    - PRIORITY: get good results from at least one condition.
    - 15% at 0.9 Hz - today
    - 15% at 0.1 Hz - weekend?
    - 5% at 0.9 Hz - Tuesday April 24
- Clear lid for PDMS?

- Final documentation
    - Imagine poster - finished today with cell culture results
    - Technical Report - draft to be submitted to Mike today
    - Lightning Slide - DISCUSS
        - Do we want a video component? Slide only?
    - Experiment protocol - Natalie has been updating with pictures.
    - EDGE page - can be completed by design review/Imagine
    - Performance vs Requirements - Natalie will look into this

Tuesday, April 17

- Lightning Slide presentation:
- Assembly Issues
    - Slight difficulty with stickiness getting hole covers into PDMS
    - Difficulty fitting the PDMS holder onto the mount (pegs are crooked)
    - Random actuator movement back to default. This snapped the PDMS.
- Imagine exhibit ideas
    - Interactive: Buy balloons or other stretchy material
- Action Items:
    - Dynamic cell culture testing: 15% strain, 0.9 Hz testing tomorrow night
    - Final edits to Image poster and technical paper update (Natalie)
    - Get timeline for clear cell chamber cover (Emily Adams/Amanda)
    - Purchasing (Emily Wood)
        - Screwdriver/alan wrench with phillips head and flat head
        - Stretchy material for kids to play with and see shape deformation
            - Black polka dot spandex?

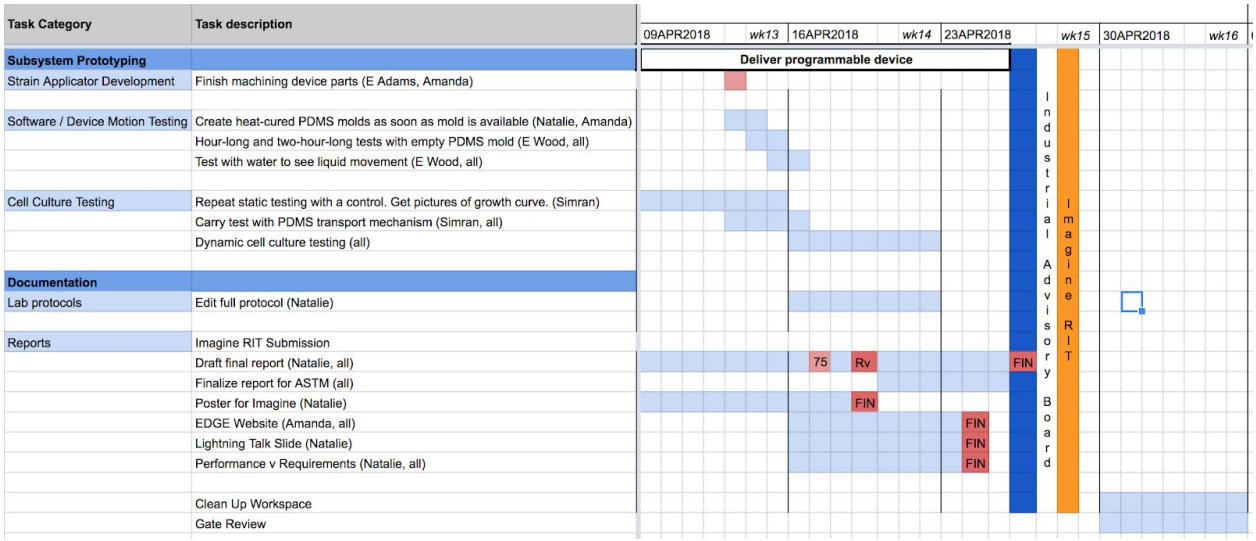
Thursday, April 12

- **Get pictures of the assembled product!**
    - Natalie will update the technical paper, poster, and work on lightning slide.
    - Natalie will email Mike with progress.
- Update on machining of mold
    - Once mold is done, make 10 molds.

Tuesday, April 10

- **Machining Update**
    - Mount could be done by Wednesday. Mold finish date unknown.
- **Technical Report Draft**
    - Add actuator results to results section.
    - Add people who helped us out to the acknowledgements :)
- **April Plan**
    - Can we be ready for movement testing once machining is finished?
    - Can we be ready for dynamic cell culture once movement testing is finished?
- **Dynamic Cell Culture Priorities**

- Do high/low strain% and frequency. Then do longer test?
    - 15% strain at 1 Hz and 0.1 Hz (or whatever actuator allows)
        - 2 hrs for cells to settle, 6 hrs of cyclic stretching
        - Pause to take pictures every 2 hours
    - 5% strain (or lowest actuator allows) at 1 Hz and 0.1 Hz
        - 2 hrs for cells to settle, 6 hrs of cyclic stretching
        - Pause to take pictures every 2 hours
    - Overnight cell culture with cyclic stretching? Or is this too risky?
    - 10% strain at 1 Hz and 0.1 Hz



Task Category	Task description
Subsystem Prototyping	
Strain Applicator Development	Finish machining device parts (E Adams, Amanda)
Software / Device Motion Testing	Create heat-cured PDMS molds as soon as mold is available (Natalie, Amanda)
	Hour-long and two-hour-long tests with empty PDMS mold (E Wood, all)
	Test with water to see liquid movement (E Wood, all)
Cell Culture Testing	Repeat static testing with a control. Get pictures of growth curve. (Simran)
	Carry test with PDMS transport mechanism (Simran, all)
	Dynamic cell culture testing (all)
Documentation	
Lab protocols	Edit full protocol (Natalie)
Reports	Imagine RIT Submission
	Draft final report (Natalie, all)
	Finalize report for ASTM (all)
	Poster for Imagine (Natalie)
	EDGE Website (Amanda, all)
	Lightning Talk Slide (Natalie)
	Performance v Requirements (Natalie, all)
	Clean Up Workspace
	Gate Review

Thursday April 5

- Testing after machined parts come in
    - Mold first PDMS chamber by heat cure (1 hour)
    - Check strain percentages of chamber off of incubator (half day)
    - Do hours-long testing with entire device set-up, no liquids (full day)
        - Hour-long test with empty PDMS mold
        - Pause for 10 minutes
        - Two-Hour-long test with empty PDMS mold
        - Pause
        - Hour-long test with empty PDMS mold in incubator
        - Pause for 10 minutes
        - Two-hour-long test with empty PDMS mold incubator.
    - Do testing with water to see liquid movement (1-3 hours)
        - Carry test with PDMS transport mechanism
    - Do experiment testing with cell culture (full day, take pictures every 2 hours?)
        - Note: Length of test may **be manual or coded. Follow up.**
- **Action Items:**
    - Emily Adams and Amanda

        - Keep machining things
        - Emily will take a 3 day nap once machining is finished
    - Emily Wood
        - Develop program for cyclic testing
    - Simran
        - Get new cells and begin second static test
        - Read papers to prioritize conditions for dynamic testing
    - Natalie
        - Email Mike tomorrow with updates? Machining, actuator video, poster...
        - Draft lightning slide
        - Read papers to prioritize conditions for dynamic testing

Tuesday April 3

- **Imagine RIT Poster** - draft due by Thursday. Natalie will edit.
- Procedure for electrical system will be drafted by Natalie and Emily Wood on Thursday
-

Thursday March 28

- Peer evals due Friday at 5pm!
- Design Review Notes:
    -

Tuesday, March 26

Upcoming:

- **Next Design Review**: March 29 at 10am
- Submit draft poster for peer feedback: Thursday, April 5 by 4:30pm

Review:

- How close are we to a full assembly?
- How close are we to finishing cell culture/machining?
- How can we quantify device movement? Camera-tracked movement?
    - Theoretically, 0.25% tolerance on device movement
    -
- Review Agenda
    - Goals and Deliverables
    - Update on machining (Emily Adams)
    - Update on device movement (Emily Wood)
    - Strain % Tolerances Discussion
    - PDMS Material Testing Results (Amanda)
    - Static Cell Culture Results/Images (Simran)
    - Risk Assessment Update (Natalie)
    - Bill of Materials Update (Natalie)
    - MSD II Project Plan (Natalie)
- Action Items

    - Email Mike with updates on machining - two parts done, seems to be happening slowly
    - Look up PDMS strength benchmark (Amanda)
    - Talk to expert or figure out test plan for % strain analysis

Thursday, March 22

- PDMS transport
    - How are the static holder/petri dishes working? What do we want for our final designs?
- PDMS mold design
    - Still considering vents or is our current process ok?
- Strain % tolerances - Mike wants us to discuss this at the design review
    - Emily Wood working on….. Right now around 2.5%-1.25%
- Update on machining
- Update on cell culture in PDMS
- Update on actuator movement
- **Next Design Review**: March 29 at 10am
    - Goals and Deliverables
    - Update on machining (Emily Adams)
    - Update on device movement (Emily Wood)
    - Strain % Tolerances Discussion
    - PDMS Material Testing Results (Amanda)
    - Static Cell Culture Results/Images (Simran)
    - Risk Assessment Update (Natalie)
    - Bill of Materials Update (Natalie)
    - MSD II Project Plan (Natalie)

How close are we to assembling and testing the whole system?

Tuesday, March 20

- **Next Design Review**: March 29 at 10am
- Machining Update -
- Actuator Update -
    - Figure out error in strain percentage for design review.
- Material Testing Update - Amanda and Emily will meet to discuss results.
- Final Documentation - Natalie add material testing results

Thursday, March 7

- **Next Design Review**: March 29 (second Thursday after break)
- Machining:

    - Goal: Have all parts machined by next design review
    - Submit simple parts, order pins
- Actuator Development
    - Goal: Have predictable, defined movement by next design review
    - Buy plug-in
    - **Schedule meeting with Mike after break**
- Cell Culture Testing
    - Goal: Complete static cell culture testing by next design review.
    - When completing experiments, shadow to develop method
    - Make one more PDMS mold before leaving
- Material Testing
    - Completed. Can Amanda or Natalie analyze?
- Final Documentation
    - Natalie will keep working on Technical Report and draft ideas for video

Tuesday, March 5

- Machining - how will we machine parts? How can we find out the timeline?
    - Priority: Cell Culture Mold
    - Buy metal thick enough for PDMS mount. Find rods for attachment and prongs
    - Should we meet with Mike to discuss?
- Cell Culture Testing - what do we need?
    - Shadow Simran and write draft protocol
- Update from Emily Wood: Actuator progress and protocol? Team training?
- Material Testing Results - More testing will be done tomorrow. Do results look usable?

Tuesday, February 27

- Cell Culture Plan - meeting with Abhyankar tomorrow, **Wednesday 9am**
    - PDMS holder - Simran will talk to Michelle about container options today.
        - Amanda will update dimensions on holder and 3-D print
    - Items to order
        - Silicone release spray
        - Clear transport container?
    - Experiment goals
        - Successfully image cells in PDMS holder
        - Observe cell growth progression
        - Test cell orientation analysis
- Actuator progress
- Material tab testing - **Friday at 8am**
- Machining - talk to machine shop about machining timeline. Perhaps only machine at end of semester

Friday, February 23rd

- Meeting with Dillon Flood

    - They have switched to 3T3 cells as well
    - Ordered everything on Wednesday, Feb 21st
    - Would like to come to the meeting because they use PDMS and would be willing to go in on getting a can.
    - Thought we were not going to share
    - Shena said they would need all 4 gallons
    - Have Labview interface working.
    - Updating BOM on day of review (Monday 27th)
    - Asked why we ordered everything when we could have gotten “donations”

Thursday, February 22

- PDMS molding
    - Schedule meeting with Abhyankar to see PDMS-molding process
- Cell culture
    - PDMS sterilization: Ethanol soak 1-2 minutes and PBS rinse
- Plastic forming
    - Plastic laser cutter in Construct good for clear plastic parts
    -
- ORDER
    - PBS - VWRL0119-1000 PBS $16.81/unit for 1000mL
    - Aluminum, Screws
    - Power source (buy later)
    - Silicone mold release spray

Tuesday, February 19

- Update on machining and metal/screw ordering
- Content for review - practice on Wednesday or Thursday morning?
    - Video of actuator
    - Machined pieces
    - Demo of cell analysis
- CELLS COMING NEXT MONDAY - Can we get static PDMS stand by Monday?
    - Bring PDMS mold to discuss, mold more pieces for static test.
    - Discuss warping of PDMS molds.

Thursday, February 8

Meeting with Mike

- Try 12 V input with power supply and take off
- Buy 3Amp power source, but don’t run that power through the Arduino
-

Tuesday, February 6

- Potential meeting with Mike at 10am on Thursday
- Steps for prototyping

    - Buy metal stock - choose between metric and English units
    - Choose screw type and purchase if necessary
    - Finish and print PDMS mold chamber. Static mount with lid?
- Download and test out cell analysis software - Simran
- Work on drafting technical paper - Natalie
- Look at Imagine RIT poster design - Amanda

Thursday, February 1
Build & Test Design Review

- Team questions
    - Do you think it would be helpful to start making individual 3-week plans since we have less time together as a team?
    - Are you satisfied with the amount of time that we've been meeting? Do you feel that we would accomplish more if we had another usual meeting time?
    - Would it be helpful to set aside a meeting to talk about how our roles have changed and our work loads? This was brought up in peer evaluations.
- Action Items
    - Problem Tracking document
        - Use CMO spreadsheet with problems just for that phase
        - Have more specific problem sheets for each issue. Just major and critical.
    - Send Imagine RIT submission after team reviews (Natalie)
    - Fix model of cell chamber and 3-D print (Emilys)
    - Add electrical and modeling info to EDGE with any edits Mike suggests (Amanda)
    - Update Home page documents if needed (i.e. meeting notes) (Amanda)
    - Draft technical paper intro and research Saha, John Pelchek 2006 paper Abhyankar suggested
    - Set up next design review time (Natalie)

Friday, January 26
Discussion with Dr. Abhyankar

- Search “ImageJ threshold” to find methods on cell culture orientation analysis
- Smooth On silicone spray - for easier removal of PDMS from mold
- Circular membrane for lower mold forces?
- Saha John Pelchek 2006

Thursday, January 25
Questions for Mike

- Update on electrical system
    - Use a shield with Arduino code and microcontroller
    - Use LED screen for user interface
- Heat Cure testing is being pushed back - is it critical to test control RT samples or humidified samples for all conditions?
- Problem tracking spreadsheet use

Team Discussion

- Research profile of movement for strain (Simran)
- Update on modeling
- Documentation for design review
    - Electrical flow chart (Amanda)
    - Risk Assessment - add risks for electrical system
    - Bill of Materials - (Simran will talk to 18082)
    - Problem Tracking - DONE
    - Project Plan - Natalie will update
    - Test plans (Natalie will fix test plan 10, look at software test plan)
    - Add to slides as completed

Tuesday, January 23

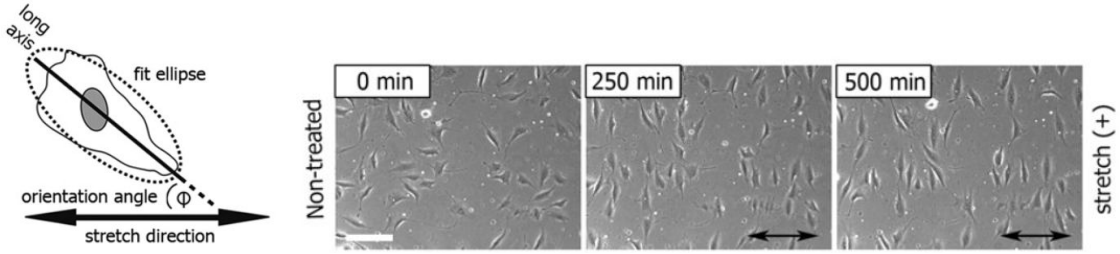
Discussion about Electrical System

- Look into Motor Controllers (ServoCity; specifically for our actuator)
    - https://www.servocity.com/actoboticsr-dual-motor-controller-assembled
    - Could we get away with Motor Shield add-on?
- Continued research into components of Electrical Schematic and how we will communicate desired signal
- Talk more with Dr. Kolodziej about system/controls set-up

Discussion with Bailey about Cell Analysis

Quantifying Cell Changes - what process/software is available?

- Cell Elongation
- Cell Orientation - cells should orient perpendicularly to force when stimulated enough



Golyn et al. Stretching forces induces cell repolarization in a microtubule-independent manner. (A) Cell reorganisation was analysed by fitting an ellipse to each cell outline and measuring the orientation angle, φ, between the long axis of the cell and the stretch direction. Three still images of a time series of an 8-hour phase-contrast movie of stretched (+) non-treated (upper row), nocodazole-treated (middle row) and taxol-treated (lower row) NIH3T3 cells illustrate the cell reorganisation. The direction of cyclic stretch is indicated by the double-headed arrows. Scale bars: 100 μm.

Thursday, January 18

Team Discussion

- Needed for review
    - Device Modeling
        - Model device mount and actuator-chamber connection (Emily Adams)

        - Finalize chamber mold and 3-D print (Emily Wood)
    - Electrical Schematics
        - Prepare to meet with Hoople & Mike for feedback (Amanda, Wood, Adams)
    - Labview Interface
        - Clean up draft interface for review (Emily Wood)
    - Cell culture analysis
        - Review research on cell analysis and discuss possible methods with Bailey (Simran, Natalie - Natalie will email about meeting)
    - Completed test plans - Add condition and analysis detail to test plans (Natalie)
        - Test Plan 10 - Heat Cure Testing
            - Specify heat cure testing conditions
        - Test Plan 11 - Dynamic Cell Culture Testing
            - Exactly what strain % and frequency will be used
            - Will we repeat any conditions?
            - How will we image and analyze cell change? Quantitative if possible.
    - Technical Paper
        - Draft introduction. Begin adding resources we have used in benchmarking. (Simran)
    - Heat Cure Testing - postponed until vacuum oven is functional (week 2-3)

Action Items

- 3D print any pieces that are ready
- Review cell analysis methods, email Dr. Bailey about using myDAQ and imaging
- Email Mike about electrical stuff
- Update Test Plan 10 based on research (Natalie)
- Update Test Plan 11 based on research (Simran)
    - Discuss imaging and analyzing cells with expert.
- Technical Paper - draft intro (Simran)

ITEMS FOR PHASE I REVIEW

- **Finalized device design**
- **Electrical schematic and draft Labview interface**
- **Updated chamber mold and PDMS piece**

Tuesday, January 16

Team Discussion

- Update on Arduino microcontroller (connections: powersource, Labview, hardware)
- Update on software layout
    - Schematics for electrical drawings
- Update on mechanical drawings
    - Plans for sliding support on strain applicator

    - Detailed mechanical drawings needed - **DONE**
- Move things to lab and ask Michelle about vacuum oven

Action Items

- Update Team Schedule document - choose times to meet.
- Research actuator movement and finalize device model
- Update PDMS mold (Emily Wood)
- Electrical schematics - ask Mike about layout (Amanda, Wood, others)
- Sketch Labview front page (Emily Wood)
- Ordering: breadboard, wires (Simran look into purchasing)
- Technical Paper - (Natalie will draft introduction)
- Update project plan and Draft problem tracking document - (Natalie)

Next Steps

- Electrical Questions:
    - Can mydaq act as microcontroller
        - If it is a microcontroller how do you program the mydaq
        - Can the microcontroller handle voltage from power?
        - Which microcontroller should we use?
    - How to wire our actuator ? https://www.servocity.com/hda2-2

    - Ask Bailey if we can use a myDaq
    - Can myDaq supply 12V to system?
    - If we can't use the myDAQ, what suggestions are there for a power source and how to connect it? Would we need a transformer/adapter of some kind?

MSD I GATE REVIEW Notes

- Keep all links on home page up to date (BOM,
- Detailed mechanical drawings with link from home page
- Order actuator before leaving
- Check photos on EDGE for
- MSD II Plan - mark as original and compare original to iterations during MSD II
- Put materials testing on link on home page
- **Create schematics for electrical drawings before going home for break**
- Thicken the cell chamber wall (Emily Wood)
- Create larger cell chamber (4x4)
-