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## 

## Template (choose one: advisor/sponsor/general): XX/XX/XXXX

Time Start:

Time End:

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho

Sponsor: Tim Sippel

Agenda: (make before the meeting)

Discussion:

Completed Tasks:



Tasks for the upcoming week:



Next meeting date:

## Sponsor - Last meeting: 06/04/2020

Time Start: 10:00AM

Time End:

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho

Sponsor: Tim Sippel

Agenda:

* Last meeting for the capstone
* Ask for Tim’s feedback on the video.
* Does he have any feedback for the group - no hard feeling
* Currently working on the final paper
* I have the materials from the capstone. Waiting for Mohamed’s book then I can bring them to him.

Discussion:

Completed Tasks:



Tasks for the upcoming week:



Next meeting date:

## Sponsor 05/27/2020

Time Start: 10:00

Time End:

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho

Sponsor: Tim Sippel

Agenda:

* Completed the Poster Presentation
* We are going to work on the Virtual Presentation today and tomorrow. Everyone will help make the virtual presentation and Jake will put it together
* On Saturday and Sunday, we will work on the final paper. The sections of the final paper have been distributed. Please work on your appropriate parts.

Discussion:

Completed Tasks:



Tasks for the upcoming week:



Next meeting date:

## Sponsor: 05/21/2020

Time Start: 10:00am

Time End:

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho

Sponsor: Tim Sippel

Agenda:

* Complete transition to writing the final paper, final poster presentation, and the virtual presentation.
  + Poster presentation: Tuesday 05/26
    - We will work on the poster presentation this Saturday and Sunday
  + Virtual presentation: Wednesday 06/03
    - Jake is in charge of making the video. Need to make a script. Ask Tim to send a few pictures of him for the video.
  + Final paper: Friday 06/05
    - The paper has been broken into small chunks and distributed to the members
* Show Tim the 3D printed solar sail - toss out the lithophane idea
* Progress on the animation.

Discussion:

Completed Tasks:



Tasks for the upcoming week:



Next meeting date:

## Sponsor: 05/14/2020

Time Start:

Time End:

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho

Sponsor: Tim Sippel

Agenda:

* Update on the current progress
  + Got the body torque for the GeoShade to be stable
* Will begin to transition to report writing starting Monday for everyone.
* Update on the animation.

Discussion:

Completed Tasks:



Tasks for the upcoming week:



Next meeting date:

## Sponsor: 05/07/2020

Time Start: 10:00AM

Time End:

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho

Sponsor: Tim Sippel

Agenda:

* Update on progress
* Transition to writing the report for the modeling team. Some work on the model can still be done, but focus on writing out the explanation of your model.
  + The modeling team will meet sometime this Sunday to go over all 3 model and pick one that we will verify and one will be scraped
* Update on the animation from Mohamed
* Update on the toy model
* Update on the latch mechanism
* Reminder of deadlines:
  + All work must be wrapped up by May 18, after May 18, full force on writing the final report.

Discussion:

Completed Tasks:



Tasks for the upcoming week:



Next meeting date:

## Sponsor: 04/30/2020

Time Start: 10:00AM

Time End:

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho

Sponsor: Tim Sippel

Agenda:

* Update on deadlines: All deadlines are extended for one more week
  + Mathematical model will be completed next week
  + Check on the status of the locking mechanism. If needed, move the deadline to next week.
* Progress on the animation?
* May 18 is still the main deadline to conclude all work.
* Dedicate someone that will be tasked with the video editing for the final presentation.

Discussion:

Completed Tasks:



Tasks for the upcoming week:



Next meeting date:

## Sponsor: 04/23/2020

Time Start: 11:30am

Time End:

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho

Sponsor: Tim Sippel

Agenda:

* Deadline checking:
  + April 23: 1st 3D printable prototype of the GeoShade - Jonny V. and Johnathan - Jake’s Printer 180mm\*180mm\*180mm
    - STL files will be sent by the end of the weekend.
  + April 23: Locking mechanism of the rods- Johnathan
  + Start printing and iteration till May 18.
  + April 30: complete with the mathematical plotting. - on track.
* Updates
* Check with Tim about the force calculation

Discussion:

* Reminding of tasks:
  + Jonathan Le: locking mechanism
  + Johnny V.: 3D printed toy model
  + Vadim: learning Blender to do the animation of the GeoShade
  + Jake C: plots the graph of the mathematical model and determines how to turn the sail so that the torque vector will stay in one direction.
  + Yahye: Discussed the plot of the Torque model against input angles.
  + Mohamed: animate trajectory on Blender
  + Vladi: Briefly discussed his models and the issues he is dealing with.

Completed Tasks:



Tasks for the upcoming week:

* Vladi will present his simulation models.

Next meeting date:

## 

## Advisor/ sponsor: 04/16/2020

Time Start: 10:00

Time End:

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho

Sponsor: Tim Sippel

Agenda: (make before the meeting)

* Update on progress of the project.
  + Vladi got sim mechanics to work.
  + Vladi is working on theoretically determining front and back emissivity.
  + Vladi needs to do further research on experimentally determining front and back emissivity.
  + Yahye did more refining on the mathematical model of the GeoShade Solar Sail.
  + Yahye will work on doing some Matlab simulation of the torque Equation

Discussion:

Completed Tasks:



Tasks for the upcoming week:



Next meeting date:

## Advisor/Sponsor: 04/09/2020

Time Start: 10:00

Time End:

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho

Sponsor: Tim Sippel

Agenda: (make before the meeting)

* Update on the animation.
* Ask if he has received everyone’s agreement.
* Does he have info to share with us?
* What other expectations does he have other than the one we have on our deliverable and project proposal.
* Update on the mathematical model
  + Update ECA

Discussion:

* Blender is promising. We are still trying to get it to work.
* Include all sources
* Include front and back emissivity resources.
* Animate and make a 3D model for the latching mechanism of the struct that Tim showed.
* 04/30: finish with the plotting
* May 1: start with documentation.
* April 23: 1st prototype of the toy model
* Start printing and iteration till May 18.
* April 23: snapping model of the struts
* Start printing and iteration till May 18

Completed Tasks:



Tasks for the upcoming week:



Next meeting date:

## Advisor/Sponsor: 04/02/2020

Time Start: 10:00

Time End:

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho

Sponsor: Tim Sippel

Agenda:

* Summary of what we are going to do for this term as no physical prototype is allowed
* Impact on the whole project is not significant. Continue what we have been doing:
  + Visualization: folding visualization on SolidWorks
  + Plot the MIMO system of the sail using the mathematical model. We will approximate the masses and dimensions of the sail.
* Timeline:
  + May 18: stop all research and begin working on final report and final poster presentation (this gives us 3 weeks until the virtual fair, virtual fair is assumed to be dead week).
  + April 13: should have a spreadsheet of simple calculations - Johnathan. The actuator team will then help with the visualization.
* Looking into using blender as a physics simulator - don’t know if it’s going to work.
* The modeling team is meeting with Ike at noon for training on mathematical modeling documentation.
* Gyroscopic precession might make the sail uncontrollable.
* Sign the non-disclosure form.
* Design and 3D print a toy model of the solar sail.

Discussion:

* Conveyed to Tim about designing a scaled down CAD model and 3-D print it and also making an animation of the CAD model of the Geoshade.
* The mathematical model will continue to improve on the result to produce more accurate representation of the Geoshade.
* Johnny and Mohammed will work on creating a spreadsheet that includes the weight per area of the individual sail given the mechanical properties of the different motors. More data will be shared by Tim to include some his version to the entire excel
* Unknown with Blender software if it will work with Jks Idea of modelling.
* Everyone signs the agreement and sends it back to Tim before the end of week.

Completed Tasks:



Tasks for the upcoming week:



Next meeting date:

## General: 03/30/2020

Time Start: 1800

Time End:

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho

Sponsor: Tim Sippel

Agenda:

* Discussion of the goal for Spring term
  + Ideas on which aspect of the project that we can simulate and which aspect that we can model.
  + Details for each group:
    - Folding and Deployment team
    - Mathematical modeling team
    - Actuator team
* Mathematical model team needs to come up with the forces calculations and proof of those calculations. They will go into the final report.
  + Make simple assumptions of the mass and geometry of the sail to calculate forces.
  + Some values that can be calculated:
    - Acceleration rates
    - Spinning rates
    - Forces/Stresses acting on different isolated parts of the sail
    - Forces that are acting on the sail
    - Forces that are applied on the sail panel.
  + All of those calculations need to be documented, so they can be put in the final report.
* ~~Email Ike to set up a meeting for the modeling team.~~
* Deployment?
* Revisiting Project Timeline.
* Go over Tim’s email to see what his questions are.
* When do we want to do the general weekly meeting?
  + Email Tim and Dr. Meekisho to see if they can do these hours.
* Discussion on the general weekly meeting in class. Ike said only one person has to be there, but we should have 2 - 3 people who can actually pay attention to join the meeting.
* Send an email update to Tim.
* Send an email today to Lemmy for meetings?
* Questions?

Discussion:

* After class meeting for ME493 on Tuesday, if information for continuing the mathematical model is insufficient we’ll set up a meeting with ike the following Thursday to iron out the rest of the details.
* Intend to do weekly meetings held on Thursdays with both tim and lemmy, scheduling will be decided after discussing hours.
* Aiming to complete data acquisition and modeling tasks within 2-3 weeks of virtual fair to allow for sufficient time to write the final report.
* Actuator team will work on a mass to area ratio calculator with adjustable parameters for approximately 1.5 weeks before pivoting to work on the visualization team
* Visualization team previously modeling team, will work towards animation and modeling for presentation purposes.
* General meetings will be held on the weekends. Possible flexibility. This is for us to be available for one another when we need to grab information from a person.

Completed Tasks:

* No assignments were due for this week. There are some for the coming week.

Tasks for the upcoming week:

* Develop monday.com tasks for spring term schedule
* Email Meekisho about the Thursday general meeting asking if Tim wants to join

Next meeting date:

## 

## 

## General advisor/ sponsor: 03/05/2020

Time Start: 10:00AM

Time End: 10:30AM

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho

Sponsor: Tim Sippel

Agenda:

* Update Tim on exp 1 and exp 2
  + Exp 1 is going smoothly so far. Data were collected and being processed. We should have the analysis, Intro and Method section done this week.
  + Exp 2 changes to measuring influence of length to natural frequency of the carbon fiber rod.
* What exactly did Dr. Sanchez say about the optical property experiment?
* Presentation time has not been narrowed down yet.

Discussion:

Completed Tasks:



Tasks for the upcoming week:



Next meeting date:

## 

## General - Experiment A: 02/23/2020

Time Start: 11:00AM

Time End:

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho

Sponsor: Tim Sippel

Agenda:

* Talk about experiment A - Wave propagation
* Discuss timeline
* Discuss details of the experiment
* Write project overview.

Discussion:

Completed Tasks:



Tasks for the upcoming week:



## Next meeting date:

## Sponsor/Advisor: 02/20/2020

Time Start: 10:00AM

Time End:

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho

Sponsor: Tim Sippel

Agenda:

* Experiment Update: We have received the OpenCM board but the the headers were not the correct one so I had to remove the old header and put on new headers
* We are still waiting for a response from Dr. Sanchez. Expected a response by the end of this week. We are going to swing by today.
* We are going to do the folding experiment if no response by Dr. Sanchez. .
* We are going to work on the presentation this weekend. Ike has agreed to the private presentation. There will probably be one more professor that would attend the private presentation. Tim is also welcome.
* We need to let Ike know the date and time for the presentation and get a response so we can set up a room. Also, if he is available?

Discussion:

* When we fold it, if it’s too thick, can we still roll it?
* Write down the names of the people that help us with the experiment so as to acknowledge them.

Completed Tasks:



Tasks for the upcoming week:



## Next meeting date:

## Sponsor & general; 02/16/2020

Time Start: 1500 hrs

Time End: 1700 hrs

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho

Sponsor: Tim Sippel

Agenda:

* Get on with the details of experiment A
* Start the communication and electronic part of experiment A
* Discuss about the experiment B
* Reflectivity, Transmissivity, absorptivity - Sanchez
* Heat Transfer/Radiation
* Heat Exposure
* Spring
* Actuator
* Deployment (Folding method)

Discussion:

* Tim said we should measure the length of the standing wave. We do not know the frequency at which the standing wave will be present. However, we can vary the frequency at which the Dynamixel will rotate in order to determine the appropriate frequency.
* We told Tim that we’re having trouble getting ahold of Dr.Sanchez. Thus, we might consider testing unfolding rates with different folding patterns.

Completed Tasks:



Tasks for the upcoming week:

* Prepare the presentation and send a pdf copy to instructor as well as Tim
* Have the Exp A conducted by the end of the week

Next meeting date:

## 

## Advisor 02/13/2020

Time Start: 10:00AM

Time End:

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho

Sponsor: Tim Sippel

Agenda:

* Update Dr. Meekisho about the progress of the experiment.
* Quick discussion on wave propagation experiment. Can Yahye and Vladi help set up the physical experiment? I will work on the electronic part.
  + How are we going to hang it up?
  + How do we get the tarp?
  + How are we going to set up the frame?
  + We need access to EB360.
* Update from actuator and deployment team.
* Ask Tim to bring the AX12 next time.
* How’s the animation?
* Ike suggests that we give him a private presentation if we cannot give the presentation in front of class for the 493 presentation.
* Experiment B

Discussion:

Completed Tasks:



Tasks for the upcoming week:

* Talk to a heat transfer professor to get details about testing the CP1 material. We want to blast heat on the non-reflective side of CP1.

Next meeting date:

## 

## General 02/12/2020

Time Start: 5:00pm

Time End:

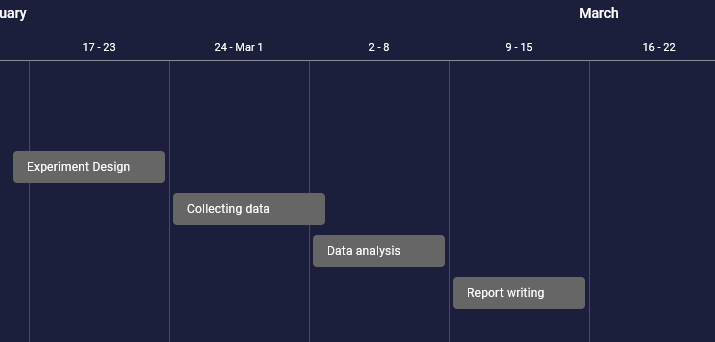
Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho

Sponsor: Tim Sippel

Agenda:

* Discussion on timeline for the wave speed experiment. Everything is on track for completion by the deadline.



* Continue working on the animation
* Brainstorming for experiment 2.

Discussion:

Completed Tasks:



Tasks for the upcoming week:

* The parts for wave propagation experiment have been ordered. They should be here at the beginning of next week. Jake will start working on the communication and electronic components.

Next meeting date:

* Thursday at 10am

## General: 02/09/2020

Time Start: 12:00pm

Time End: TBD

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho

Sponsor: Tim Sippel

Agenda:

* Wave propagation experiment:
  + We need to rederive the theoretical wave propagation.
  + Re-distribute workload for the experiment.
* Experiment 2
* Make timeline per Tim’s request

Discussion:

Completed Tasks:



Tasks for the upcoming week:



Next meeting date:

## 

## Advisor/Sponsor 02/06/2020

Time Start:

Time End:

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho

Sponsor: Tim Sippel

Agenda:

* We got the go on conducting the experiments.
  + Ask where we can get the materials?
  + Can we purchase them?
  + The IMU (Initial Measurement Unit) that we probably will use are <https://www.adafruit.com/product/3463> unless Tim has IMU’s that we can use.
  + We will use sensor fusion to get the best accurate theta values.

<https://x-io.co.uk/open-source-imu-and-ahrs-algorithms/>

* How does Tim feel about us presenting our research? What kind of information that we can share?
* Ask Tim about his calculations for the surface density.

Discussion:

* Lemmy suggests that we use the Least Square method to fit the data that is collected from the IMU.
* The chip company declined to give Tim a quote on the radiation hardening chips.
* There is a robotic arm in space that uses small motors to actuate the arms. Further research should be performed to determine the feasibility of using such motors for our project. The actuator group should take a look at this: <https://www.maxongroup.com/maxon/view/application/MARS-MISSION-AB>
* The model team should determine the model of the sai in order to determine the amount of torque that will be required to rotate the sails.

Completed Tasks:



Tasks for the upcoming week:



Next meeting date:

## General Date: 02/05/2020

Time Start: 4:00pm

Time End:

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho

Sponsor: Tim Sippel

Agenda:

* Need to discuss with Tim about the presentation, which information we are not allowed to talk about in the presentation? Has he gotten through with the patent yet?

Discussion:

Completed Tasks:



Tasks for the upcoming week:



Next meeting date:

## 

## General: 02/02/2020

Time Start: 2:00pm

Time End:

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho

Sponsor: Tim Sippel

Agenda: (make before the meeting)

* Discussion of the potential tests that we can do.
* How are we going to test the torque propagation?
* How are we going to test the unfolding?
* Do we want to look into optical properties?

Discussion:

Completed Tasks:



Tasks for the upcoming week:



Next meeting date:

## 

## Advisor/Dr. Eisenhauer: 01/30/2020

Time Start: 10:00am

Time End:

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho and Dr. Eisenhauer

Sponsor: Tim Sippel

Agenda: (make before the meeting)

* Ask about the MOP’s and MOE’s, do we need to expand on the same expectation that we posted at the beginning, or do we need to come up with two more requirements/expectations from the customer’s a product/system.
* Also, do they have to be a completed task that we looked into, meaning we have answered/attempted to solve the customer’s input/requirement?
* How long the MOP and MOE have to be? 1 paragraph or 1 sentence?
* Ask Ike how much time do we need to dedicate to capstone. Right now we are meeting and working every week but progress seems slow.
* Bring Dr. Meekisho up to speed with the current expectation.
* For testing:
  + Ask Ike if he can teach measurements? He’s probably will be a good teacher for that class.
  + We are planning on testing the motion propagation on the sail. Hook Dynamixels up to one end and IMU’s on the other end to measure the motion. Overlap them and measure the time lag to determine how long it takes for the wave to propagate.
  + Another test is the folding - unfolding test. Ask Vadim to talk more about it.
  + Do signal degradation test.

Discussion:

* Ike suggests that our model considers all the variables that need to be taken into account.
* Look into what needs to be done to bring the cost down for the actuator. What factor is the primary cost driver? Do we need more research on this? What the future would change to drive down the cost.
* Verification - check that each factor makes the correct change in the result.
* Validation - does the model cover each concept properly.
* Identify and the more feasible approach to the sponsor.
* Create a chart that shows actuator performance as a function of cost.
* The actuator performance requirements are based on the system dynamics model.
* Consider using Mathematica in order to relate the equations we derive together.

Completed Tasks:



Tasks for the upcoming week:

* At the end of week 5, we should be able to perform the test required.

Next meeting date:

## 

## General: 01/29/2020

Time Start: 4:00pm

Time End:

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho

Sponsor: Tim Sippel

Agenda: (make before the meeting)

* Update people about the emails from Tim.
* Topics to discuss with Ike for tomorrow's meeting.
* Updates with progress from the teams.

Discussion:

We covered possible experiments that could be used to test the rate at which the sail will unfold for different forces.

Completed Tasks:



Tasks for the upcoming week:

* Yahye and Vladi will create a model for the attitude control of the sail.
* Jake needs to head to the physics department to ask if he can test the optical properties of our sail there.
* Flush out the details of the tests that we as a capstone would like to perform.
* Plan a back-up test.
* Begin brainstorming about testing wave propagation using a net.
* Ask Ike about how much time must be spent for the capstone.
* Ask Ike about deliverables.

Next meeting date:

## 

## General Meeting - Date 01/26/2020

Time Start: 10:00 AM

Time End: 8:00 PM

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho

Sponsor: Tim Sippel

Agenda: (make before the meeting)

Discussion:

* What do we plan to test for 411’s final lab?
* We will talk to Ian for ideas regarding tests that we plan to do in 411’s final lab.
* We intend to talk to Legacy for the 411 final lab.
* We intend to create an extra test if the talks with Legacy don’t work out.
* Within the next two\ weeks, we will brainstorm how we intend to test torque propagation. This is the “extra” test.
* Jake will talk to an expert about what variables will need to be considered to test torque propagation experimentally.

Completed Tasks:



Tasks for the upcoming week:

* Accomplishment

Next meeting date: Sunday 2/1/2020

## Sponsor/ Advisor - Date 01/23/2020

Time Start: 10:00am

Time End: 11:40am

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho

Sponsor: Tim Sippel

Agenda: (make before the meeting)

* Discuss about Tim’s questions, also where are the numbers coming from. Provide more info to assist in answering the questions. Such as;

1- Current specs below young’s modulus limit (290ksi)

2- Minimum tension needed to flatten wrinkles (1.5ksi)

* Sail billowing
* Discuss the testing of CP1. Dr. Wern said that in micro scale thickness, the stress properties don’t scale in the same way as macro scale.
* NASA has an article where they tested CP1.
* PSU doesn’t have any equipment to test the optical properties of CP1.
* Optimization can be done after we have had the mathematical model.
* Discuss possibilities to give the solar sail it’s initial thrust to begin rotation. Should consider looking into a magnetorquer.
* Getting a master document of what we currently need to work on

Discussion:

* Mohammed found an article for a sail that uses CP1. They created a model to estimate the optical properties for the CP1. We intend to use their model for our case.
* Inform Dr.Sippel and Dr. Lemmy about the discussion with Dr. Wern which includes the testing of the material.
* Force to deform at 23 degrees celsius? Can we determine how much force is required to deform it? How does young’s modulus change with temperature?
* Tim wants to know how we will narrow the scope of the project.
* If billowing is negligible, we can assume that we are dealing with a rigid body?
* How do we calculate the steady state temperature of the sail? This will affect the calculations described in Tim’s excel file.
* Do the optical properties change as temperature or geometry changes?
* Can we use Tim’s bird net as an example to perform tests?
* Should we take fail safes into account? Multiple cables for each sail?
* How do we take stress concentrations into account for this material? Are we dealing with a ductile or brittle like material?
* How does temperature affect wrinkles? Think about thermal expansion.
* You can do a physical or virtual mock-up of the sail.

Completed Tasks:

* We have talked to Dr. Yi about the torque propagation of the sail. The model is highly nonlinear and he recommended using FEA to look into it. We might still be able to do the test though.
* We have talked to Dr. Wern about stress testing. He recommends that we talk to the legacy group.

Tasks for the upcoming week:

* Vadim and Johnathan intend to simulate the sail deployment.

Next meeting date: Thursday 01/30/2020

## General - Date 01/22/2020

Time Start: 4:00pm

Time End:

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho

Sponsor: Tim Sippel

Agenda: (make before the meeting)

* Contact the Legacy hospital group to test the material. For micron thin material, the tensile stresses cannot be scaled.
* Dr. Yi recommended to do FEA on the torque propagation of the sheet. It is highly non-linear.
* Discussion with Tim and Lemmy tomorrow.

Discussion:

* We were discussing what we intend to test for the measurements lab.
* We discussed how we should optimize the design of the sail.

Completed Tasks:

* We talked to Dr. Wern.
* We talked to Dr.Yi.

Tasks for the upcoming week:

* Vadim and Jonathan intend to simulate the sail deployment.
* Should we talk to Dr. Zareh if FEA students can create a model based on Dr. Yi’s recommendations?
* Vladi will type up the notes that were collected during the meeting with Dr. Yi.
* Contact Legacy.
* Create a model for the rigid sail.

Next meeting date: Sunday 1/30/2020

## General - Sunday Date 01/19/2020

Time Start: 10:00 AM

Time End: 8:00 PM

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho

Sponsor: Tim Sippel

Agenda: (make before the meeting)

* Discuss how to go about developing test for the Geoshade project. With a prominent focus on the material properties as well as the torque propagation possibilities.

Discussion:

* We intend to investigate as much as possible about actuators, models, and sail deployment.
* Possible questions to discuss with Tim include:
  + Issues with billowing
  + Required tension to maintain flatness

Completed Tasks:

* Plan of attack for contacting Dr.Yi and Dr. Wern

Tasks for the upcoming week:

* Tasks to do for next week:
  + Contact Dr. Yi for thin-membraned mechanics
  + Contact Dr. Wern for using his table -top stress test bench
* Design the custom grip for testing CP1
* Discuss with Tim about getting data sheet of the 2.5 micron CP1
* Continue working on the derivation of the reference frame of the sail panels.
* Continue working on the derivation of the model.

Next meeting date: Wednesday 01/22/2020

## 

## Advisor - Date: Thursday 01/16/2020

Time Start: 10:00AM

Time End:

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Advisor: Lemmy Meekisho

Sponsor: Tim Sippel

Agenda:

* Talk about the possibility of creating cut guidelines along creases of the sail to improve with crease thickness and unfolding procedures.
* Discuss possibilities to give the solar sail it’s initial thrust to begin rotation. Should consider looking into magnet torquer.
* Derive the frame of reference for the mathematical model of the solar sail.
* Begin testing the cp1 and blanket material, with a focus on tensile stress at first.
* Determined whether we should pursue the testing of the CP-1 material as the data sheet made available by the manufacturer is insufficient.
* Billowing problem.

Completed Tasks:



Tasks for the upcoming week:

* Get a second opinion on whether we can calculate tensile strength by scaling.
* Freeflyer modeling software (not free) and STK satellite tool kit (free).
* Talk to trethaway about testing optical properties.
* Ask Mr. Sippel about the optical properties.
* Use a factor of safety for the assumptions that we make?
* How can we relate the CP1 to aluminum so that we can perform tests? This would allow us to perform affordable tests.

Next meeting date:

## 

## General - Wednesday 01/15/2020

Time Start: 4:00pm

Time End: 6:00 pm

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Agenda:

* Discuss what we are going to talk to Lemmy tomorrow.
* Discuss tasks, we are going to meet with Ike in week 5 to potentially scale down or scale up the project.
* Discuss the reading materials from last week.

Completed Tasks:

* Reading materials.

Discussion:

* A concern was brought up regarding the issue of the larger solar sail billowing due to lack of a rigid structure.
* Talked about the possibility of creating cut guidelines along creases of the sail to improve with crease thickness and unfolding procedures.
* Discussed what was required of the actuator team to communicate with the controls team. Touching on points of mass, volume, cost, and strength.
* Discussed possibilities to give the solar sail it’s initial thrust to begin rotation. Should consider looking into magnet torquer.
* Importance of slow rotation to prevent ends of the large sails from experiencing extreme stress.

Tasks for the upcoming week:

* Get price for the actuator that Johny mentioned. Get detail specs on them. Magnetic actuator and less moving parts but heavy.
* Derive the frame of reference for the mathematical model of the solar sail.
* Begin testing the cp1 and blanket material, with a focus on tensile stress at first.
* The Dynamics team will read two articles.

Next meeting date:

* Thursday 01/16/2020 - meeting with lemmy

## 

## General - Date: Sunday, 01/12/2020

Time Start: 10:00 AM

Time End: 8:00 PM

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Agenda:

* Discuss previous weekly reading materials.
* Populate monday.com with tasks following Thursday Advisor/Sponsor meeting.
* Reading assignment for week 2: 3 articles per person, discussion on those articles on next Wednesday at 4pm
* Build mockup.
* Work on project objective statement.
* Reorganize all the meeting notes into one document with an outline.
* Go through Tim’s notes to see if there’s anything useful to us.

Discussion:

* Discussed the potential of a robot assembly located at center bus of the sail. Topic includes concerns about how to have the robot traverse the outer perimeter of the robot.

Tasks for the upcoming week:

Actuator

* Look into actuators or alternatives for unfurling the sails, rotating the sail, and deploying telescopic struts.
* Look into magnetometer, to have the sail tilted against earth magnetic fields.

Deployment/Frame

* Look into springs in space, look into gas expansion based deployment,

Modeling:

* Talk to Dr. Yi about thin-membrane mechanics

Next meeting date: Thursday, January 16th, 10:00 AM

## Advisor/Sponsor - Date: January 9th, 2020

Time Start: 10:00 AM

Time End: 11:20 AM

Advisor: Lemmy

Agenda:

* Do a progress update on research
* Inform Lemmy of our change in scope for the project
* Request assistance in the information of thin membrane mechanics
* Ask his opinion on the testing Nexolve CP1.

Ask Tim:

* What does he think about our current approach to getting a mathematical model? With that mathematical model, we will be able to understand the system and design a control system. The nice thing about the mathematical model is that as long as there are no major changes to the mechanism of the sail, the mathematical model is fine. It is still a very difficult task.
* The model can help to design the attitude control system.
* Ask Tim to get the technical data of CP1 at the 2.5-micron thickness.
* Ask Tim about the specific dimensions of the hub of the prototype.
* Ask what altitude that the sail will orbit again.

Discussion:

* We need to get access to a data sheet for CP1 at 2.5-micron thickness. Tim said he would contact the manufacturer for specifications. Tensile Stress,
* Launched at 1000km to be clear of atmospheric drag. This will simplify calculations.
* Look into Hillblert for thin-membrane mechanics for information on thin membrane.
* We should get the specifications for the carbon rod. The material guys need it.
* Discussed our intent to focus on a mathematical model of a prototype over a goal of understanding the orbital mechanics around it.
* Use the emergency blanket(mylar with aluminum sprayed on it) material to develop tests for the actual CP-1 material. One focus being the propagation of torque throughout a sail when the actuator turns.
* Look into the conservation of angular momentum for an expanding solar sail in rotation. Maybe look into the required centrifugal force to expand the sail.
* We should talk to Dr.Yi about the thin membrane mechanics. We should ask him about torque propagation with such materials.
* Determine what tests could be performed for CP-1 because we have limited equipment.
* The center bus is surrounded by a hub at around 15 meters.
* 20 cm radius by 3m longs for a single folded sail. Folded with a lattice structure. The assume hub is roughly a 15-meter diameter.
* Talk to Dr. Turcic about how energy requirements will affect the dimensions of a controller. Due to this point, we should assume that the dimensions of the hub are variable.
* Look into testing a spring mechanism for expanding the sale horizontally.
* We need to take into account the weight of the tape that will be used to hold the sails together.
* Look into track booms for an idea on how to expand the first sails required to gather rotational energy.
* Tim expects two actuators per sail. One to control the rotation of the sail. One to assist in the deployment of the sail.
* Brushless motor used in space. Can this be used for the actuator?
* Tim wants a camera on the sail. This would add weight to the sail.
* Should we consider fail-safes? Nope, way too far down the road to concern ourselves with.
* Parameters for the hub according to Tim: Hinges, bus (to contain electronics),
* Compare options presented by Tim using weight considerations.
* Look into CubeSat actuators for a cheap alternative against rad-hard.
* Look into 3-D printing options for the printing of grips on a membrane stress test.

## General - Date: Wednesday, January 8th, 2020

Time Start: 4:30pm

Time End: 8:00 PM

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Vadim Naumchuk

Tasks: Discuss topics researched from scholarly articles assigned previously.

Discussion:

* Decided the schedule weekly reading due dates to be the Wednesday evening prior to the advisor meetings. Such that there is sufficient time to discuss and understand the concepts.
* We will be continuing to do research for the following week. But with an emphasis on information that is directly effective to the project.
* We are planning to continue research in the weeks after next, but lowering the quantity while we began the design of tests and other activities.
* We may use LQR to optimize the control system we design for cost-related issues.
* Make it extremely clear
* What kind of design requirements would he required?
* Look at manufacturer specs for the material that will be used for the sail.
* How fast does the torque propagate across the sails?
* Are we narrowing down the categories to actuator, sail design, and prototype?
* Consider collecting data and testing for the space between each fold when we fold it.
* Ask Tim Sippel to request for the technical data of Nexolve CP1 at 2.5 micron thick. The information we need is: tensile strength, Young’s Module, relectivity, conductivity, heat transfer properties, etc.

Completed Tasks:

Tasks for the upcoming week:

* Work on the mission statement on Sunday.
* Vladi should take a look at the following source: Space Sailing

Gordon & Breach Science Publishers, Philadelphia (1992). The following source describes how to derive the amount of solar pressure acting on a body. This may be useful for future analysis.

* Vladi will take a look at the orbital mechanics book for students.

Next meeting date: Thursday, January 9th, 10:00 AM

## Advisor/Sponsor - Date: Jan - 02 - 2020

Time Start: 2:30 PM

Time End: 8:00 PM

Client: Tim Sippel and Lemmy Meekisho

Agenda:

* Show Mr. Sippel what we have completed so far.
* Listen to Sippel idea and design requirements.
* Introduce Sippel to Dr. Meekisho

Discussion:

-We briefed Dr. Meekisho and Mr. Sippel about our progress so far. Specifically, we discussed what articles and resources we will be using for the remaining

- 3 sail panels 50x100m

- the sail material CP1 developed by NASA

- Concept of the helio-gyros

- coronal mass ejector

-No helio-gyro has ever been launched.

-Assume that if something is to be manufactured for this project, the manufacturing process is currently being used in the industry.

Tasks:

* Look into lightweight frame material to minimize overhead while maintaining structure.
* Calculate torque/ moment of inertia for the turning of a sail, as to if standard dynamixel is sufficient.
* Use Abacus (FEA software) to analyze the material that will be used as the sail?
  + Test tear resistance, methods to keep material straight.
* Determine whether or not Tim’s material can be modeled within Solidworks. This would simplify future dynamic analysis. We can use the thickness/density of the material to model the actual material within Matlab?
* Is it possible to use sail projects that were previously accomplished to determine whether or not our models created within Matlab were correct, to begin with?
* Look into steering issues
  + How stable the geoshade is for turning, ex: flapping/curling
  + Methods to steer the geoshade
* We may be working with multiple actuators?
* Deployment methods
  + Track beams - aka tape measure
* Send Dr. Meekisho an email about the meeting on 1/9/2020.
* Test the actuator that is to release the sail panel? The sail panel could be a material of our choosing, which means we can test the actuator.
* Do we create a deployment folder for our google drive? Begin research for the deployment of a sail?
* Mr. Sippel will provide us resources. We intend to sort the resources into the appropriate folders.
* Do we set a minimum or maximum time that can be spent on each task within monday.com?
* Is carbon fiber good for space?
  + Carbon fiber cable and tubing.
* Begin research on the following topics:
  + Dynamics - Jake, Yahye, Vladi
  + Actuator - Mohamed, Jonny
  + Deployment/Frame - Vadim, Johnathan

## General - Date: Thursday, December 26th

Time Start: 1:00 PM

Time End: 8:00 PM

Members: Jake Chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Vadim Naumchuk, Mohammad Afdup

Tasks:

* Discuss the concept of sailing - general
* Look into study materials/references - Vladi, Vadim
* Clean up organization and planning strategies
  + Tasklist (google sheet vs Monday vs etc.) - Jake & Mohamed
  + Calendar
  + Scheduling bot - Johnathan Le

Discussion:

* Sailing concept, the sail is placed at an angle that would allow it to have two forces that will result in a resultant force that makes it accelerate.
* Talked about the possibility of simulating a prototype sail in orbit

Completed Tasks:

* Sailing discussion
* Calenda
* Vladi shared some books discussed within the project proposal in the notes/resources branch.

Tasks for the upcoming week:

-Vladi will research how to simulate a point mass in space.

-Vladi will share any relevant findings from the Design of Mechanisms Book. These findings will be posted in the notes/resources branch.

Next meeting date: Thursday, January 2nd, 1:00 PM

## Date: Thursday, December 19th 2019

Time Start: 6:00PM

Time End: 6:40 PM

Members: Jake chung, Johnathan Le, Vladi Ruchin, Yahye Egal, Johnny Valencia, Mohammad Afdup

Discussion:

* Go online and do research for the general ideas about solar sails.
* Principles of space sailing.
* Research what has been accomplished.
* We will start assigning resources after we are done getting our foot in the doors.
* The next meeting is Dec-26-2019

Completed Goals:

* In the motion of working for our goals.

Goals for the upcoming week:

* Begin research

## 

## General - Date: 12/09/2019

Things to do over the winter break:

* Go online and do research for the general ideas about solar sails.
* Principles of space sailing.
* Research what has been accomplished.
* Assign tasks after everyone has learned about the introduction and taught back to others

We will start assigning resources after we are done getting our foot in the doors.

## Date: 12/4/2019

Time Start: 11:40

Time End: 12:19

Advisor: Lemmy Meekisho

Discussion:

* Talked about what was finalized for the capstone deliverables from the previous meeting. Specifics include a few design requirements of the solar sail singular panel and the actuators. Talk about the different way it rotates and orbits around the earth before it launches off to Lagrange 1.
* Actuator - Intend to do research and design to optimize an actuator in space that is self-powered by a solar panel, capable of putting out the max optimization for turning a panel.
* Talked to Lemmy about how Tim should handle the money
* Discuss some preliminary uses of the budget
* Presented the bid proposal

Todo:

* Talk to Sippel about orientation as it orbits the earth.
* Does the Geoshade itself spin on its own axis as it orbits?
* Look into the software to test the stresses and strains of the panel sheet.
* Look into constraining how fast the panel should spin, which may depend on the requirements given.
* We should do very detailed scheduling and meetings for future purposes.
* Meet up on the final week of the winter break to do important scheduling and meetings.
* Talk to Trisha about the fundings for items needed for the project and forwarded it to Mr. Sippel.
* December 19th, 2019 - Introduce the two capstone members, Johnny Valencia and Mohammed Afdup, to Dr. Lemmy Meekishio.

Next Meeting:

## Wednesday, November 20, 2019 @ 11:30am

Review of previous meeting:

* NA

Goals for today's meeting:

* Update Dr. Meekisho on the current expectations and progress of the capstone project

Agenda:

* Discussion of the current progress of he meeting.

Question?

Next meeting?

**Meeting notes:**

* Deliverable: in term of the capstone project, a literature review, get the confirmation from Ike that the literature review/ research paper is okay.
* Researching about sailing motions to apply on the robotics mechanism.
* Consulting Dr. Alex hunt for more inputs to apply his considerations for the robotic assembly.

## **Thursday, November 21, 2019 @ 6:30pm - Conference Call**

Review of previous meeting:

* NA

Goals for today's meeting:

* Finalizing the capstone deliverable.

Agenda:

* Introducing Dr. Meekisho and Andrew Greenberg to Tim Sippel.
* Since we have many members in our group that are interested and knowledgeable in robotics. We would like to focus on the robotics aspect of the solar sail.
* Robotics aspect of the solar sail is defined as controlling the sail and deployment of the sail (WE ARE NOT FUCKING MAKING THE SAIL)
* We will learn sailing on water and the general motions that are associated to sailing. - ask Andrew will be this doable? Is this too little? Is this too much?
* We will learn robotics motion in space. - ask Andrew will be this doable? Is this too little? Is this too much?
* All of this will be put into a final report that is publishable.
* The report can be seen as a literature review.
* We will probably use the money to purchase subscriptions to literature.
* We might do a mock-up
* Ask Sippel: when we are done with this, can we publish this information in literature.

Question?

Next meeting?

Review what we did in the last meetings.

**Meeting notes:**

* THERE IS A MORE GENERAL ROBOT ASSEMBLY, LIKE BUILDING SMALL mechanisms that displays the motion.
* Use extreme lightweight servos and are wireless.
* Come up with torque requirements for moving the sails.
* Use DC brush motors due to their lightweight.
* Use motors that enhances the torque ability of the mechanism and minimizes the weight for the sails.
* Free body simulation of a sailing sheet.
* Carbon fiber deployable composites boom.
* Carbon fiber rods mechanism that unhinges. (50 meter long)
* MIT parabolic inflatable dish.

Andrew recommendations:

**Deliverables**

-Focusing on the Actuator that is a win right?

- How much torque you need to go at a certain rpm and tilt a required degree?

- Find out a possible way for it to unfold the rods in the assembly.

Build a capstone.

Dynamic simulation of the sheets.

**Resources:**

Arrow astro books

Spacecraft mechanism

Deployable mechanism

Deployable spacecraft structure.

Solar sails

**Collaborative sites and tools :**

Google drive

Google docs

Github

Zotero