Knee Arthroscopy Manikin

Client: Corinne Henak

Consultants: Corinne Henak, Russ Johnson

Team: Shrey Ramesh (leader), Delaney Reindl (leader), Jack Thurk (accountant), Connor Dokken (communicator), Sierra Reschke (admin), Rachel Dallet (admin)

Status

Report Date: 04/11/2024

Next Milestone: Final Review

Deadline: 04/12/2024

Status: on schedule (green), deadline at risk (yellow), deadline unachievable (red)

Technical Summary

Important aspects of this past week include meeting with Dr. Henak to discuss updates on the enclosure assembly and to receive feedback on the progress of each project division as well as working to complete outreach deliverables. For the bone team, the second round of tissue testing was conducted in Henak Lab and the stress analysis is still in the works. For the enclosure team, a thinner silicone to facilitate easier bending of the enclosure was researched with the new assembly mechanism still in progress. For the pump team, leak tests on port connections were conducted, new valves were ordered, and a test was conducted on the pumps to determine the best method to remain within the acceptable pressure range during prototype use. Going forward, each team will continue to develop and test with the overall prototype.

New Tasks

Bone Team

Task Name	Description and Concrete Outcome	Owner	Est. Time
Update BME and ME websites	Add the progress reports to both the ME and BME websites. Update the project status as well.	RD	0.5 hr
Update team with testing results and discuss next steps for bone team	Go through our comments and notes from Wednesday's testing with the team and advisors. Meet with Sierra to discuss how we want to display our testing.	RD	3 hr

Start brainstorming final deliverables/assembly	Work with the other teams to discuss how and when we will assemble the final prototype and how we want to test as a team	RD	2.5 hr
Assist with prototype assembly	Work with the other teams on thinking through the assembly of the full prototype. Provide updates on the results of the most recent sample attachment mechanism testing.	SGR	3 hrs
Continue stress analysis	Continue working on the stress analysis both in FEBio as well as in SOLIDWORKS. Specifically, experiment with different materials, time steps, displacements applied, and force definitions.	SGR	3 hrs

Enclosure Team

Task Name	**Description and Concrete Outcome**	**Owner**	**Est. Time**
Assist/test with prototype assembly	Assist with enclosure prototype assembly and test with reservoir/pump team using rigid enclosure design.	DR	3 hrs
Brainstorm/begin working on final deliverables	Begin working on final report/poster sections.	DR	1.5 hrs
Work on/complete outreach deliverables	Work on/complete assigned portion of outreach deliverables.	DR	1.5 hrs
Test enclosure in bent configuration	After successful testing with Connor and Jack of the enclosure in the upright orientation, we will work together again to test the enclosure in the bent configuration. We expect this to be more challenging due to the rigidity of the silicone.	SKR	4.5 hr
Begin work on final deliverables	With two poster presentations, an oral presentation, and an oral presentation approaching quickly, I will begin work on slides and compiling relevant images/documentation for these deliverables	SKR	1.5

Pump Team

Task Name	**Description and Concrete Outcome**	**Owner**	**Est. Time**
Patch leaks and better mechanism for keeping the enclosure in place	From running another test where the enclosure was kept in the upright position, there was much less leakage than our initial test. However, it is easy to keep the enclosure in the upright position due to the rigidity of the silicone casing. But to image the knee joint in other positions presents a challenge as the silicone does not like to bend. So the pump team will help to brainstorm ideas for how the enclosure can be locked in place for imaging while also keeping leakages and light exposure to a minimum.	JT	4
Begin brainstorming deliverables	Although it is early, the end of the semester is coming fast. To prevent a cram at the end of the semester, it will be beneficial to get a headstart on looking at some of the criteria for the deliverables and begin putting something together.	JT	1.5
Help others who need help to finish a task before the end of the semester.	The pump team has been making good progress and, besides continuing to find better ways to minimize leaks, is close to having a pretty complete pump prototype. If others in the group need help as the semester begins to wrap up to finish their tasks, I will offer help to the Manikin Skywalker team so that there is a higher chance of having a fully complete	JT	~0.5

	working prototype by the time of the deliverables.		
Test leakage with the joint at different angles.	Finalizing the design is still the highest priority this week. Tests with the knee in the upright position went well, but tests at different angles need to be conducted. Team will need to brainstorm a way to hold the current design at an angle as the current bolts cannot do this on their own.	CD	4.5 hr
Begin reviewing final deliverables	Reviewing rubrics and expectations for final deliverables, begin brainstorming/outlining what sections of the deliverables I am responsible for.	CD	1.5 hr

Old Tasks

Bone Team

Task Name	Description and Concrete Outcome	Owner	Est. Time
Update BME and ME websites	Add the progress reports to both the ME and BME websites. Update the project status as well.	RD	0.5 hr
Perform tissue testing with new prototype in Henak Lab	I set up next Wednesday, April 10th to do our second round of testing for the bone team. We need to make sure staples are made ahead of time and hopefully get quantitative data this time around.	RD	2 hr
Assign Outreach activity guide sections and complete section	We finished the Outreach report and still need to finish the activity guide. I assigned the group members with their portion of that. I need to complete my section as well.	RD	2 hr
Finish stress analysis	Get back onto an ME desktop computer and finish the meshing of our enclosure based on Peter's (grad student) instructions.	RD	1.5 hr

Conduct second round of tissue testing	Next Wednesday Rachel and I will be going into Dr. Henak's lab to test the new prototype with the live tissues. We will test the sample attachment mechanism and hopefully insertion of the bone models into the updated prototype.	SGR	2 hr
Continue mesh and stress analysis work	Now that Rachel was able to (almost) successfully mesh the model in ANSYS, we will work to import it into FEBio to re-mesh and perform the stress analysis.	SGR	2 hr
Finish outreach deliverables	Look over and make edits on our outreach activity guide and report. Finalize all documents for submission	SGR	2 hr

Enclosure Team

Task Name	**Description and Concrete Outcome**	**Owner**	**Est. Time**
Work on assigned outreach deliverables	Will work on my assigned portion of the activity guide.	DR	2 hr
Test with updated enclosure and reservoir	Once the CAD is updated and the leakages are mediated, we will work on attaching the enclosure to the reservoir and testing the fluid system.	DR	2 hr
Assist in enclosure assembly	Assist Shrey in the enclosure assembly.	DR	1 hr
Determine new duct clamp mechanism	The clamps are currently causing small tears within the plastic bag of the enclosure causing leakages. We are currently considering using the polyurethane foam to cover the area that's ripping and then applying the clamps over that.	DR	1 hr
Create femur swing CAD	After talking with Russ Thursday morning, a new method of femur bending was proposed. I will CAD a new enclosure which does not bend but the femur will sit on a "swing" which will allow the femur to be flexed to various angles without requiring the rest of the enclosure to move	SKR	4 hr

Find and order new silicone	Find thinner silicone to facilitate easier bending of the enclosure	SKR	1 hr

Pump Team

Task Name	Description and Concrete Outcome	Owner	Est. Time
Test flow loop with two pumps	Second pump was acquired yesterday. Team will set up flow loop with all components of pump/enclosure teams. For the pump team, the main goal of this test is to see if the pumps will effectively circulate the water, or if it will pool in the plastic bags. This will likely be easy to see visually, but if not the water level in the reservoir can be recorded before and after the test to quantify if water is being recirculated back into the reservoir. This test will also include the current pressure gauge and we will experiment to see if different settings of the pumps will give different pressure readings, or any readings at all.	CD	3.5 hr
Leak tests on port connections and new valve	Major leakage issues of the enclosure bags due to the clamps have been solved, but leakage from port connections is still questionable. Need to do repeat tests with one and two bags and see if simply screwing the ports in through bags is a viable solution to leakage. Also new valves were obtained today, need to test the fit and seal with water of the different sizes ordered.	CD	2 hr
Flow rate sensor inquiry	We received a flow rate sensor from Renesas, but they did not provide wiring to power and read data from the sensor. Need to check if they will provide it as they did with the last sample.	CD	0.5 hr
Test enclosure with water and nitrogen setup	At some point in the near future, when the enclosure and pump team connect their	JT	4 hr

	projects together, it would be valuable to test the oxygen concentration test again with a more accurate volume of liquid. To do this, we would have to bring both the enclosure and the full setup for the pump team to Dr. Henak's lab and fill the whole thing with liquid and begin deoxygenating. Most likely, the process will take longer to deoxygenate to the desired oxygen concentration due to an increase in the volume of liquid, but hopefully will still be under the 5 minute constraint for the cartilage being outside of the media.		
Find the ideal setting for both pumps that works best for staying within the acceptable pressure range	A test will be run using both pumps in a closed loop system with the pressure gauge. Through testing the system, the ideal setting for the pumps will be recorded so that the pressure stays within 0.75-1.5 psi. This will help give a baseline value for when setting up the pump system to work how it is supposed to work.	JT	2 hr

Technical Section

Author: Rachel Dallet

Perform tissue testing with new prototype in Henak Lab	I set up next Wednesday, April 10th to do our second round of testing for the bone team. We need to make sure staples are made ahead of time and hopefully get quantitative data this time around.	RD	2 hr

Sierra and I went to Dr. Henak's lab on Wednesday morning to do our second round of testing with our new bones and wire. Testing was successful as we were able to attach the cartilage in under 5 minutes. I captured a lot of what that looked like and put those photos into the drive for the team to see. Here is one of those:

Assign Outreach activity guide sections and complete section	We finished the Outreach report and still need to finish the activity guide. I assigned the group members with their portion of that. I need to complete my section as well.	RD	2 hr

I assigned the remainder of the outreach deliverables to the team and completed my own portion. We will need to submit that ideally within the next week.

Author: Sierra Reschke

Conduct second round of tissue testing	Next Wednesday Rachel and I will be going into Dr. Henak's lab to test the new prototype	SGR	2 hr

	with the live tissues. We will test the sample attachment mechanism and hopefully insertion of the bone models into the updated prototype.		

Rachel and I went into Dr. Henak's lab on Wednesday morning to perform sample attachment mechanism testing with the live cartilage samples and new (more malleable) wire. Overall, we were very pleased with the results and the stability of attachment. It took less than a minute to attach the samples with the wire already inserted.

Finish outreach deliverables	Look over and make edits on our outreach activity guide and report. Finalize all documents for submission	SGR	2 hr

I completed my portions of the outreach deliverables and reviewed the portions my teammates have completed thus far. There are still a few sections that need to be written but once everyone has a chance to finish their assigned parts we will review and submit.

Find the ideal setting for both pumps that works best for staying within the acceptable pressure range	A test will be run using both pumps in a closed loop system with the pressure gauge. Through testing the system, the ideal setting for the pumps will be recorded so that the pressure stays within 0.75-1.5 psi. This will help give a baseline value for when setting up the pump system to work how it is supposed to work.	JT	2 hr

After running a test with the enclosure team, an ideal pump setting was settled on. Now, the teams will have to shift their focus to patching up any smaller minor issues with leaking and fastening the enclosure in the correct position to avoid leaks from the bags ripping.

Leak tests on port connections and new valve	Major leakage issues of the enclosure bags due to the clamps have been solved, but leakage from port connections is still questionable. Need to do repeat tests with one and two bags and see if simply screwing the ports in through bags is a viable solution to	CD	2 hr

	leakage. Also new valves were obtained today, need to test the fit and seal with water of the different sizes ordered.		

Test was completed with the manikin in the upright position. There was still leakage from the port area, but it was very minimal as the majority of tears around the ports came from bending the manikin after the ports were in place, which was eliminated in this test. There was no noticeable change in volume of fluid in the reservoir or manikin due to leakage.

Gantt Chart

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Feb				Mar				Apr				May		
Task	2	9	16	23	1	8	15	22	29	5	12	19	26	3	10
Individual Presentations				O											
Testing	X														
Redesign and Fabrication	X	X	X	X											
Presentations				X											
Working Prototype Demonstration									O						
Redesign						X	X	X	X						
Fabrication						X	X	X	X						
Presentation and Demonstration									X						
Final Presentation															
Testing															
Report															
Presentation															

X = Completed Tasks, O = Milestone Deadlines