

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: 04/04/2024

Next Milestone: Final Review

Deadline: 04/05/2024

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

Technical Summary

Each subteam spent the last two weeks further developing their portions of the project as well as working on completing outreach deliverables. For the bone team, communication with Dr. Henak was initiated to set up a testing time for the cartilage tissue with the new bones. Wire testing was conducted to determine the strength of the wire, while the stress analysis was also continued using ANSYS and SpaceClaim software. For the enclosure team, the tibia enclosure was reprinted with two insertion points and a better duct clamp attachment mechanism was brainstormed for leak prevention. Once the enclosure assembly is updated with the new CAD prints and leak prevention mechanism, the team intends to test with the reservoir. For the pump team, the leaks at the connection ports between the sensors were reevaluated and the flow rate sensor was received without any wiring for power/data analysis, so the team inquired with Renesas regarding operation. Additionally, testing with the flow loop with the two pumps and with the enclosure team has been initiated.

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

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. Heank'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
Assemble complete outreach deliverables for		SKR	1 hr

Pump Team

Task Name	Description and Concrete Outcome	Owner	Est. Time
Test flow loop with two pumps	Second pump has been 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

<p>Leak tests on port connections and new valve</p>	<p>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.</p>	<p>CD</p>	<p>2 hr</p>
<p>Flow rate sensor inquiry</p>	<p>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.</p>	<p>CD</p>	<p>0.5 hr</p>
<p>Test enclosure with water and nitrogen setup</p>	<p>At some point in the near future, when the enclosure and pump team connect their 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.</p>	<p>JT</p>	<p>4 hr</p>
<p>Find the ideal setting for both pumps that works best for staying within the acceptable pressure range</p>	<p>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.</p>	<p>JT</p>	<p>2 hr</p>

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
Set up a time to do testing with the tissues on the new bones	Discuss with the team and Dr. Henak a plan for our next round of testing. Should this be on a working prototype? Or should we do one more round of just the tissues and the wire? Find a time to do the testing.	RD	2 hr
Finish outreach deliverables	For outreach, we need a report, activity guide, and presentation to submit to Dr. Puccinelli. Work with the BME side of the team on those items	RD	2 hr
Conduct wire testing	Use random objects/scraps from the makespace to test the strength of our new wire	RD	1.5 hr
Conduct wire testing	Wire testing was performed without the bone models and we have been waiting for the bones to be reprinted. Now we will perform wire attachment testing on the bone models. Record and analyze results.	SGR	2 hrs
Continue stress analysis in ANSYS	Work with Peter Noonan to learn the ANSYS and SpaceClaim software and how to import our model and re-mesh. Goal is to successfully import the re-meshed model into FEBio.	SGR	2 hr
Finish outreach deliverables	Work over spring break to complete all outreach deliverables.	SGR	2 hr

Enclosure Team

Task Name	Description and Concrete Outcome	Owner	Est. Time
Work on outreach deliverables	Utilize spring break to complete all outreach variables.	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
Determine new duct clamp attachment 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	2 hr
Leak prevention development	There are numerous modes of leaks which need to be addressed with the enclosure. I will work with Connor and Delaney to determine any potential solutions and implement them before the next meeting	SKR	4 hr
Tibia enclosure reprint	Once we receive the port valves, reprint the tibia enclosure with two insertion points of the correct dimensions.	SKR	2 hr

Pump Team

Task Name	Description and Concrete Outcome	Owner	Est. Time
Test flow loop with two pumps	Second pump has been set aside but it needs to be brought home from Shrey's lab. Once it is available set up a test that uses both pumps to continue trying to make the current pressure gauge work. If more pressure is required perhaps the outlet pump could be at a slower speed, in reverse to provide back pressure, etc. testing will be completed to try and answer some of these questions.	CD	2.5 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
Continue testing with enclosure team	Continue testing enclosure with fluid flowing through it with Shrey. Need to determine if foam will provide enough extra padding to protect the bags from leaks. Also would be ideal to test second port with second pump.	CD	3 hr
Reevaluate the leaks at the connection ports between the sensor	Once the flow loop is constructed, the ports will need to be sealed to eliminate leakages from the port connections. This could be done using the extra sealant that was used for the reservoir construction.	JT	3 hr
Test enclosure with water and nitrogen setup	At some point in the near future, when the enclosure and pump team connect their 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, but hopefully will still be under 10 minutes which is the maximum time cartilage can live without a media.	JT	3 hr

Technical Section

Author: Rachel Dallet

Conduct wire testing	Use random objects/scrap from the makespace to test the strength of our new wire	RD	1.5 hr
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Prior to our demonstration, Sierra and I were able to test our new wire and new bones with wood scraps we found in the TeamLab. We discovered that the grate that is under the lip of the bone may also serve as a place to wrap the wire in to secure it tighter. We will have to ask Dr. Henak if this is okay and further explain it in the meeting.

Author: Sierra Reschke

Conduct wire testing	Wire testing was performed without the bone models and we have been waiting for the bones to be reprinted. Now we will perform wire attachment testing on the bone models. Record and analyze results.	SGR	2 hrs
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Rachel and I met to test our attachment mechanism with various pieces of wood that we got from the TeamLab. We found that our staple attachment mechanism, grate, and increased number of holes overall led to a successful attachment. However, we will need to test this method and updated design with the actual tissue samples to validate its functionality.

Continue stress analysis in ANSYS	Work with Peter Noonan to learn the ANSYS and SpaceClaim software and how to import our model and re-mesh. Goal is to successfully import the re-meshed model into FEBio.	SGR	2 hr
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Rachel and I worked to try to open our model in ANSYS to re-mesh it to allow for import into FEBio to perform a stress analysis. We initially struggles with SpaceClaim but Rachel was able to communicate with Peter Noonan and ended up successfully meshing the model.

Finish outreach deliverables	Work over spring break to complete all outreach deliverables.	SGR	2 hr
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I worked to complete a paragraph of the report and a few sections of the activity guide. I will need to go back and see if there is anything else assigned to me and review the work my teammates have done. Otherwise, I have completed my portions of the outreach deliverables.

Continue testing with enclosure team	Continue testing enclosure with fluid flowing through it with Shrey. Need to determine if foam will provide enough extra padding to protect the bags from leaks. Also would be ideal to test second port with second pump.	CD	3 hr
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More testing was done to seal the enclosure, using the new enclosure, the foam in addition to the silicon, and a placing the silicon around the outside of the enclosure, the bags did not leak from contact with the edges of the clamps.

Reevaluate the leaks at the connection ports between the sensor	Once the flow loop is constructed, the ports will need to be sealed to eliminate leakages from the port connections. This could be done using the extra sealant that was used for the reservoir construction.	JT	3 hr
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Most of the leaks within the pump system have been fixed and secured. However some of the ports will continue to be reinforced with sealant to minimize the possibility of spontaneous leakages. Now the connection points between the tubes and the inlet and outlet ports of the enclosure will be focused on, as there are problems with leakages there when using a double layer of bags.

Tibia enclosure reprint	Once we receive the port valves, reprint the tibia enclosure with two insertion points of the correct dimensions.	SKR	2 hr
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Tibia enclosure was reprinted and valves were included successfully. Magnets will be fastened to the attachment point this week.

Leak prevention development	There are numerous modes of leaks which need to be addressed with the enclosure. I will work with Connor and Delaney to determine any potential solutions and implement them before the next meeting	SKR	4 hr
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The use of polyurethane foam prevented leaks from being formed at the clamp points. Leaks are still prevalent at the tube port locations due to bending of the enclosure.

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