

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: 04/17/2024

Next Milestone: Final Review

Deadline: 04/18/2024

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

Technical Summary

Important aspects of this past week include meeting with Dr. Henak and Dr. Johnson to discuss updates on the enclosure assembly and to receive feedback on the progress of each project division, as well as to complete outreach deliverables and begin working on final deliverables such as the final report and poster. For the bone team, the cartilage-bone mechanism was tested and the stress analysis was continued. For the enclosure team, new enclosure materials – dryer vent tubing for flexion mechanism – were ordered and obtained and will be implemented into the prototype assembly and testing of the bent configuration. For the pump team, patch leaks and maintaining the enclosure position were brainstormed, as imaging the knee joint in any other position but upright is limited by the rigidity of the enclosure, further prompting media leakage outside of the enclosure. As the semester is coming to an end, final prototype assembly and testing will be completed in order to ensure there is adequate data to present during final deliverables.

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

Work on assigned section of the poster	Our group set a goal to have a poster draft by Friday. I need to complete the Bone Team section of that.	RD	3 hr
Begin working on final report	Discuss with the team which section everyone will cover in the final report. Start writing my section.	RD	1.5 hr
Read over outreach deliverables and submit	Outreach deliverables are due this Friday. I want to check over everyones sections before submitting.	RD	1 hr
Assist with prototype assembly	Work with the other teams on thinking through the assembly of the full prototype, if this is the decided path.	SGR	2 hrs
Finalize stress analysis results	Determine which outputs are best to analyze for the enclosure stress analysis in FEBio. Analyze these results and convey them in a clear and legible way.	SGR	2 hrs
Complete poster draft by Friday.	Complete a first draft of my assigned sections of our report by Friday. Review received feedback and make improvements on the draft prior to poster presentations next week.	SGR	2 hrs
Begin working on ME final report.	Begin working on my assigned sections of the ME final report. Ask for feedback from my peers and review their work as well.	SGR	1 hrs

Enclosure Team

Task Name	Description and Concrete Outcome	Owner	Est. Time
Assist/test with prototype assembly – Implement dryer vent to flexion point of prototype.	Assist with enclosure prototype assembly and test with reservoir/pump team using rigid enclosure design. Using the dryer vent, test to see if the prototype leaks and lets any light in when the prototype is in bent configuration.	DR	3 hrs
Brainstorm/begin working on final deliverables.	Begin working on final report/poster sections. I will be handling the conclusion/future direction sections of both the report and poster.	DR	3 hrs

Finish assigned poster section	I have been tasked with completing the enclosure section of the poster. After receiving feedback from Dr. Henak and Russ this Friday, I will finalize and print the poster early next week.	SKR	3 hrs
Finish enclosure design with dryer vent and epoxying femur to lid	Once the dryer vent arrives, we will attach it to the enclosure and determine the best method of aligning premade holes with the fluid flow ports and scope ports.	SKR	3 hrs

Pump Team

Task Name	Description and Concrete Outcome	Owner	Est. Time
Complete and practice poster section	I will complete the testing section of the poster before Friday to get feedback during out advisor meeting, then make all necessary changes before the presentation next Friday.	CD	3 hr
Test new enclosure components	O-rings and new screws/nuts were acquired at the makerspace. The dryer vent material has been ordered as well. The enclosure needs to be tested with the new screws/nuts to see if it will be able to hold set angles, the o-rings to potentially seal leakage at the ports, and the dryer vent material around the midsection of the joint. These three changes will potentially address the three major issues the design is facing.	CD	3 hr
Test new O-rings with new leaks	Test new O-rings purchased to see if the leakage from the ports is less than before. If they work like they should, the leakage should be less and hopefully create more of a seal around the ports.	JT	2 hr
Create a more final pump team part of the poster	After feedback from this upcoming Friday meeting, aspects of the poster will need to be altered to create the best possible poster for presentation for next Friday.	JT	2 hr

Test the new joint locking system	Now with the right materials purchased, the bolts and nuts, the joints will need to be tested to see if this locking system will be able to hold the weight of the femur enclosure at various different angles. It will also need to be tested to see if the nut and bolt could damage the PLA if tightened too much. Perhaps, after testing, washers might need to be purchased to help protect the enclosure from permanent deformation.	JT	2 hr
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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
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
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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 working prototype by the time of the deliverables.	JT	~0.5
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	CD	1.5 hr

	what sections of the deliverables I am responsible for.		
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Technical Section

Author: Rachel Dallet

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
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Sierra and I updated the team and faculty on our success from testing. Statistical analysis is not needed for the bone team's testing, as confirmed in our Friday meeting. It can be proven without doubt that the mechanism of attachment is well under 5 minutes. Sierra and I are still working out some stress analysis roadblocks to hopefully be able to display that on the poster.

Author: Sierra Reschke

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
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I spent time modifying the boundary conditions, materials, loads, and analysis steps applied to the model of our enclosure in FEBio. None of the runs were able to successfully terminate (all ended in error termination). However, Dr. Henak was very helpful and sent over a useful doc of ideas she tried as well as a .feb file that runs to 20% completion. Effective stress and displacement magnitude distributions and values were able to be extracted; however, these values are only from the very start of the load being applied. I will continue to work with Dr. Henak and FEBio to see if more useful results can be obtained.

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
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After some brainstorming, the best method that the pump team came up with to keep the joint at certain angles is to have a bolt that pokes through the joint so a nut can be fastened onto the end and tightened at the angle of choice. The materials were picked up at the makerspace and have yet to be tested. However, the mechanism will need to be tested soon to make sure it can hold the weight at a given angle, without being too tight to possibly damage the PLA.

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
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I have started making the pump teams part of the BME poster that will be presented next Friday. The poster was created early to try and get feedback before the presentation itself.

Author: Delaney Reindl

Work on/complete outreach deliverables	Work on/complete assigned portion of outreach deliverables.	DR	1.5 hrs
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For the outreach deliverables, I completed the procedure and discussion to explain the activity and how to complete it. I also added tips and troubleshooting on how to improve the activity and its outcome, as well as completed the going further section where I went into detail on extra knowledge concerning the biomechanics of jumping. I compared jumping on a hard flat surface

Testing	X																	
Redesign and Fabrication	X	X	X	X														
Presentations				X														
Working Prototype Demonstration																		
Redesign						X	X	X	X									
Fabrication						X	X	X	X									
Presentation and Demonstration									X									
Final Presentation																		O
Testing										X	X	X						
Report												X						
Presentation												X						

X = Completed Tasks, O = Milestone Deadlines