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: 03/07/2024

Next Milestone: Working Prototype

Deadline: 03/08/2024

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 weekly updates as well as to receive feedback on the progress of each project division. For the pump team, the reservoir box was fabricated and it was tested with the current nitrogen bubbler and dissolved oxygen sensor. Any areas of the reservoir were further sealed with epoxy to prevent leaks. For the bone team, the attachment mechanism was updated by acquiring new wire. The stress analysis of the bones/enclosure mechanism and experimentation with the new wire are still underway. For the enclosure team, the complete enclosure was assembled and was attached to the reservoir. All teams are currently in the process of assembling the full prototype containing the bones, reservoir, and enclosure, ensuring that liquid can properly flow through without leakage or obstruction of attachments.

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

Continue working on the stress analysis	After emailing with Dr. Henak, we tried to use Gmesh instead of FEBio. Our computers still don't seem to be working with either software. I might need to go into an engineering lab and do it on one of those computers. I will also try her new suggestions: GIBBON and Tetgen.	RD	2.5 hr
Plan and attend our BME outreach activity	The BME side of the team signed up to run an activity at a local elementary school science fair. Meet with the team to figure out the details on that and go to the school on Tuesday, March 12.	RD	3 hr
Continue working on stress analysis	The .step file I downloaded from the SOLIDWORKS model does not open in either FEBio or gmesh due to the fillets. Dr. Henak suggested trying GIBBON or tetgen, which Rachel and I will both try to implement this week. We will continue to work with Dr. Henak as needed.	SGR	2 hrs
Plan and prepare for outreach	Now that the team has our outreach date planned and have decided on an activity, we will work to write up a detailed outline and plan. We will also need to continue communicating with the event coordinator to ensure the supplies we need are either available or can be borrowed.	SGR	2 hrs
Attachment mechanism wire and prototype assembly	Work to implement the wire for the attachment mechanism and test its functionality. Work with the other teams to hopefully have a full initial prototype assembled for next Friday.	SGR	2 hrs

Enclosure Team

Task Name	**Description and Concrete Outcome**	**Owner**	**Est. Time**

Assist in enclosure assembly	Shrey and I will assemble the enclosure with the materials and frame. This will also involve ensuring the bones fit properly into the model.	DR	2 hrs
Help prepare/plan for outreach	We are deciding on what activity to go forward with for outreach.	DR	1.5 hrs
Attend BME Outreach	We will be attending our BME Outreach on 3/12. At this we will be presenting a biomedical engineering activity to children.	DR	2.5 hrs
Test Enclosure	Put the enclosure through standard use scenarios including bending and applied pressure	SKR	1 hr
Attend Outreach	Attend and participate in outreach at the middle school	SKR	2.5 hrs
Connect the enclosure to the reservoir	Coordinate with the pump team to determine how the enclosure handles fluid flow.	SKR	3 hrs

Pump Team

Task Name	**Description and Concrete Outcome**	**Owner**	**Est. Time**
Finish reservoir and bubbler	Finish sealing reservoir and constructing new bubbler	CD	1.5 hr
Test reservoir and bubbler	Communicate with Dr. Henak and test the reservoir / bubbler to see how long it takes to de-oxygenate water with nitrogen gas using our current bubbler	CD	2 hr
Help setup testing for whole system	Help set up and test the entire enclosure assembly and inserting the ports for the pumps. Set up pumps for testing with enclosure if testing is going well.	CD	2.5 hr
Fasten the bubbler to the bottom of reservoir	To disperse the nitrogen effectively, the bubbler might have to be fastened to the bottom of the reservoir to bubble the PBS from the ground up. To do this, a design, a possible ordering of materials, and a fabrication will be needed to secure the bubbler to the bottom of the reservoir. This	JT	3 hr

	task will be most effective once some testing is done with the more permanent bubbler, finished reservoir and Nitrogen testing.		
Test the reservoir with nitrogen and the dissolved oxygen sensor.	Now that the reservoir has been fabricated, the bubbler will be fastened in a more permanent way to the bottom of the reservoir. Once fastened, the bubbler and reservoir should be tested with the Nitrogen source and Oxygen sensor to make sure that all runs well.	JT	3 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
After asking clarifying questions, retry the stress analysis.	Sierra and I ran into some issues running a stress analysis that are listed in the technical section below. Clarify with Dr. Henak at the meeting and run it again.	RD	4 hr
Experiment with new wire	Some group members are going to Home Depot to test out some new wire. Once we buy that, I need to see how easily it can bend compared to the last wire.	RD	1.5 hr
Work on stress analysis	Ask Dr. Henak about the issues Rachel and I ran into with conducting the stress analysis on the enclosure. Import the new model and try to run the analysis again based on feedback received.	SGR	3 hr
Update attachment mechanism wire	Work with the team to test and order a thinner wire. Once it arrives, work to implement the attachment mechanism with the new wire	SGR	2 hr
Assist with full prototype assembly	Continue working with the enclosure and pump teams to make sure we are all on the same page and begin to start thinking about	SGR	1 hr

	assembling a full prototype and conducting tests.		

Enclosure Team

Task Name	Description and Concrete Outcome	Owner	Est. Time
Assemble complete enclosure	Assemble the enclosure using the plastic bag, silicone, and hose clamps. Fill with water to determine points of potential leakage and brainstorm solutions	SKR	3 hrs
Connect the enclosure to the reservoir	Coordinate with the pump team to determine how the enclosure handles fluid flow.	SKR	3 hrs
Help with complete enclosure assembly	Assemble the duct clamps, press-to-close bag, and silicone along with the frame as the first enclosure. Test using water to determine if the assembly prevents fluid leakage.	DR	3 hrs
Finalize material enclosure plan	Determine material enclosure plan for assembly.	DR	3 hrs

Pump Team

Task Name	Description and Concrete Outcome	Owner	Est. Time
Test all components together with enclosure team	Check the reservoir for leakage and put together inlet/outlet/bubbler tubes using suction cup clamps. Test fluid flow rate sensor with pump to see if it is a suitable replacement for pressure gauge (pending shipping time). Test the seal of the ports on the enclosure and assist Shrey with the enclosure testing as necessary, and if all is going well test the entire system except bones/live cartilage.	CD	4 hr

Test current bubbler with dissolved oxygen sensor and reservoir	If possible (or worthwhile) test the current bubbler and reservoir with Nitrogen gas and dissolved oxygen sensor to determine whether or not the current bubbler design can effectively lower dissolved oxygen concentration in the selected reservoir volume.	CD	2 hr
Test the reservoir with nitrogen and the dissolved oxygen sensor.	Now that the reservoir has been fabricated, the bubbler will be fastened in a more permanent way to the bottom of the reservoir. Once fastened, the bubbler and reservoir should be tested with the Nitrogen source and Oxygen sensor to make sure that all runs well.	JT	3 hr
Seal ports to prevent leaks	Once the whole pump system is put together and even tested with the enclosure, sealant should be applied to the ports and connection points to help prevent leaks as well as prevent possible vibrations from loosening the port connections. The sealant that would be used will be biocompatible and would be suitable for sealing connection points between the pressure gauge and T-bracket. However, sealant will not be ordered until the new fluid flow rate sensor Connor ordered has been shipped and tested.	JT	3 hr

Technical Section

Author: Sierra Reschke

Update attachment mechanism wire	Work with the team to test and order a thinner wire. Once it arrives, work to implement the attachment mechanism with the new wire	SGR	2 hr

The wire was ordered and Rachel and I will work to implement it in the upcoming week. We will conduct tests to determine its functionality (even if we just simulate the live tissue prior to scheduling a time to go into Dr. Henak's lab to test with the live tissue again).

Author: Delaney Reindl

Help with complete enclosure assembly	Assemble the duct clamps, press-to-close bag, and silicone along with the frame as the first enclosure. Test using water to determine if the assembly prevents fluid leakage.	DR	3 hrs

The enclosure was assembled with the duct clamps, press-to-close bag, silicone sheeting and 3D printed frame. This will be attached to the reservoir tubing to ensure that fluid can flow through without any leakages.

Connect the enclosure to the reservoir	Coordinate with the pump team to determine how the enclosure handles fluid flow.	SKR	3 hrs

The enclosure is completed, but the ports to ensure compatibility with the pump system have not been attached. Feedback from Dr. Henak and Russ will help us choose a direction on how this is completed.

Assemble complete enclosure	Assemble the enclosure using the plastic bag, silicone, and hose clamps. Fill with water to determine points of potential leakage and brainstorm solutions	SKR	3 hrs

I updated the CAD for all the components to ensure compatibility with each other and printed them at the makerspace. The assembled product will be ready to show in the meeting on Friday

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															
Fabrication															
Presentation and Demonstration															
Final Presentation															
Testing															
Report															
Presentation															

X = Completed Tasks, O = Milestone Deadlines