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: 02/15/2024

Next Milestone: Individual Presentation

Deadline: 02/16/2024

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 weekly updates as well as to receive feedback on the progress of each project division. Within this past week, the bone team created a testing protocol for the cartilage attachment to the bone. The magnet order was finalized and then placed. For the enclosure team, the PE film and biocompatible caulk were finalized in the client meeting, research went into hose clamps as well as a flow rate sensor, the bone and enclosure CAD were updated for print. For the pump team, the reservoir was fabricated and assembly of the reservoir pieces was initiated. Future tasks involve ordering parts for each team division, finalizing printing, and beginning assembly.

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
Find new wire to order	Go to the makerspace and experiment with different wires to find a more bendable wire to order	RD	2 hr

Decide on new magnets to order	After talking with the group, the original magnets I found aren't ideal. We might need to look into strength testing of the magnets and order different ones.	RD	2 hr
Begin working on my individual presentation	Start making slides for next week's individual presentation. Ask Josh logistical questions at our upcoming meeting.	RD	1.5 hr
Implement attachment mechanism changes	Update the wire, bone models, and sample attachment mechanism based on the main takeaways from testing last week.	SGR	2 hr
Complete individual presentation.	Begin and finish making slides for my individual presentation next Monday. Practice my presentation and ensure it is under 5 minutes.	SGR	2 hr
Assist with finalizing the ordering of magnets	Assist Rachel with researching better magnets and with the ordering if we find suitable ones. Begin to implement them into the bone model design if/when they arrive.	SGR	2 hr

Enclosure Team

Task Name	**Description and Concrete Outcome**	**Owner**	**Est. Time**
Order biocompatible caulk, PE film	Place order for PE film. Research went into new biocompatible caulk to purchase as the previous option is not purchasable for personal use.	DR	2.5 hr
Determine enclosure material attachment plan	Develop an exact enclosure material attachment plan. This will involve determining which region of the enclosure frame will need which specific material. It may be helpful to devise back up plans as well.	DR	2.5 hr
Find and order hose clamps	Need to research various types of "hose"clamps that will function to help keep the PE film attached onto the frame.	DR	1 hr
Update Bone CAD	Update the bone CAD based on feedback from Rachel and Sierra's testing. Some of the	SKR	4 hr

	changes to be made include adding more points of attachment and adding a “lip” below the mounting edges of the model.		
Order flow rate sensor for Pump team	Request a free sample of the fluid flow rate sensor from Renesas	SKR	.5 hr
Prepare and deliver individual presentation	Prepare slides summarizing individual contributions to the project and deliver it to other ME 352 students and TAs	SKR	1.5 hr

Pump Team

Task Name	**Description and Concrete Outcome**	**Owner**	**Est. Time**
Re-evaluate/design bubbler attachments	Decide on a final bubbler attachment and create final prototype, or order selected bubbler stone	CD	2 hr
Research flow rate sensors	Research whether or not the acquired flow rate sensor is compatible with liquids, or if the company offers a similar product that is designed for use with liquids.	CD	1 hr
Begin work on individual presentations	Start reviewing requirements and making slides for individual presentations next week	CD	2 hr
Dissolved oxygen sensor placement	Brainstorm how the dissolved oxygen sensor will be used with the design of the reservoir during testing	CD	1 hr
Work on individual presentations	For the individual presentations on Monday at 4:30 the slides will need to be created and practiced this weekend in preparation.	JT	2 hr
Order medical tubing suction cup holders	To reduce permanent features and therefore possible leaks in the reservoir, suction cup holders that would clip on to the tubing and suction to the inside of the reservoir will be used. This would minimize potential leaks or errors when drilling holes into the side of the reservoir	JT	1 hr
Fabricate the reservoir box	The plastic was cut but the bonding agent is still being delivered. Once delivered, the	JT	3 hr

	bonding agent will be applied to create the box and test it for potential leaks and durability.		

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
Create testing protocol	Finalize the protocol to test the attachment mechanism before Sierra and I go in to test. Discuss this with the team	RD	2 hr
Test attachment mechanism	Meet with Dr. Henak and Sierra and test the attachment mechanism based on the protocol the team came up with	RD	2 hr
Get the magnets ordered	Confirm on the magnets that we decided on and make sure Jack gets them ordered.	RD	1.5 hr
Finalize testing protocol	Finalize the attachment mechanism implementation and strength of attachment testing protocol. Ensure data collection method is organized and sufficient to draw accurate conclusions.	SGR	2 hr
Test attachment mechanism	Meet with Rachel and Dr. Henak to perform testing on the attachment mechanism in terms of both time to implement and strength. Record data and observations in testing protocols document.	SGR	2 hr
Assist with finalizing the ordering of magnets	Assist Rachel and Jack with the ordering of the magnets. Begin to implement them into the bone model design if/when they arrive	SGR	2 hr

Enclosure Team

Task Name	Description and Concrete Outcome	Owner	Est. Time

Order PE film, Order biocompatible caulk	Talk with Shrey to confirm the exact PE film and biocompatible caulk that should be ordered. Then submit the order form to Josh.	DR	2.5 hr
Find what enclosure clamps we want to use	Need to research various types of “hose”clamps that will function to help adhere the PE film onto the frame.		1.5 hr
Reach out to Dr. Puccinelli about outreach	Reach out to Dr. Puccinelli regarding our outreach plan. Ideally we want to take part in Engineering EXPO, happening April 19-20th where we would volunteer multiple times for different activities.	DR	0.5 hr
Develop enclosure material attachment plan	Develop an exact enclosure material attachment plan. This will involve determining which region of the enclosure frame will need which specific material. It may be helpful to devise back up plans as well.	DR	1.5 hr
Update Bone CAD	Update the bone CAD based on feedback from Rachel and Sierra’s testing. Some of the changes to be made include adding more points of attachment and adding a “lip” below the mounting edges of the model.	SKR	4 hr
Print Enclosure CAD	Make final changes to the enclosure CAD based on magnet dimensions and print at the makerspace	SKR	1.5 hr
Order flow rate sensor for Pump team	Request a free sample of the fluid flow rate sensor from Renesas	SKR	.5 hr

Pump Team

Task Name	**Description and Concrete Outcome**	**Owner**	**Est. Time**
Optimize the plastic sheet to find the dimensions needed for cutting and trace it out.	Now that the plastic sheet has been found for fabricating the reservoir, now the box itself has to be put together. The current dimensions are around 15.5 inches by 40.5 inches. Since the box only has to have 5 sides (no plastic	JT	1 hr

	cover needed), the box dimensions will be optimized to produce the best size box possible that will accommodate the liquid.		
Reserve a time slot in the Team Lab	Reserve a time slot at the Team Lab at ECBto fabricate the box. The band saw will need to be reserved in order to cut the plastic to the dimensions needed.	JT	30 min
Fabricate the reservoir box	Go to the Team Lab and cut the plastic. Use the recently ordered glue to create a bonding agent between the edges to ensure there will be no leaking. This reservoir will be used to hold PBS liquid and will be crucial in ensuring the PBS is at the correct oxygen concentration.	JT	4.5 hr
Begin assembling reservoir	Fabricate the walls of the reservoir with a band saw at the team lab. Use an ordered bonding agent and caulk to seal the walls.	CD	4 hr
Research flow rate sensors	Research whether or not the acquired flow rate sensor is compatible with liquids, or if the company offers a similar product that is designed for use with liquids.	CD	1 hr
Finish designing reservoir	Finalize the dimensions for each of the walls and if any other acrylic pieces are needed	CD	1 hr

Technical Section

Create testing protocol	Finalize the protocol to test the attachment mechanism before Sierra and I go in to test. Discuss this with the team	RD	2 hr

Author: Rachel Dallet

Editor: Sierra Reschke

Here is the link to our testing protocol document:
https://docs.google.com/document/d/1fjLsk5vq9IiaF3CG4ZHiiFgP1XZBkuoivFfNMdVoy20/edit

After talking with the team, our main priority for testing right now is to determine the time of attachment for the attachment mechanism. Once we have a full working prototype, we will be more interested in testing the whole system and looking at other aspects.

Test attachment mechanism	Meet with Dr. Henak and Sierra and test the attachment mechanism based on the protocol the team came up with	RD	2 hr

Sierra and I met with Dr. Henak and tested the attachment mechanism. We didn't wind up actually getting data but rather got a feel for what we were dealing with. It was very helpful as it gave us a better idea of what we are actually doing and dealing with the live tissue taught us a lot. The first thing we learned is that all the tissue discards are various sizes, therefore we need staples that fit these different sizes. For the staples, we need them pre made into multiple sizes ahead of time. We also need to look into a more bendable wire as I was not able to bend the staples on the spot. We also learned that we need to update the CAD to include more attachment holes so the tissue is more secure.

Bubbler Design Matrix	Tube (1-5)		Bottlecaps (1-5)	
Ease to fabricate (25)	3/5	15	4/5	20
Ability to disperse Nitrogen (35)	4/5	28	2/5	14
Ease of anchoring (25)	3/5	12	4/5	16
Longevity (15)	2/5	6	3/5	9
Total (100)	61		59	

I created a design matrix and assigned categories I thought to be essential in deciding what design would be best. The bottlecap proved to excel in more categories than the tub solution but the tube really excelled in the ability to disperse nitrogen. This was because the tube was longer and could be wrapped around to disperse more bubbles across a greater range of space. Therefore, as our mission with the bubble disperse design is to deoxygenate the PBS first and foremost, the ability to disperse nitrogen category carried the most weight and was the reason for deciding that the tube was the better design choice.

Finish designing reservoir	Finalize the dimensions for each of the walls and if any other acrylic pieces are needed	CD	1 hr

The reservoir design has been finalized. It will be a 6” x 6” x 6” cube, with an open top. There will be no ports drilled into the sides of the reservoir, instead the inlet, outlet, and bubbler tubes will be inserted through the open top of the box and fixed to the sides using suction cup mounts

Author: Sierra Reschke

Finalize testing protocol	Finalize the attachment mechanism implementation and strength of attachment testing protocol. Ensure data collection method is organized and sufficient to draw accurate conclusions.	SGR	2 hr

I finished writing the attachment mechanism implementation and strength of attachment testing protocol. There are specific steps to be performed to ensure sufficient testing and tables outlining the data and observations that should be collected. While this testing protocol did not get implemented during our initial testing this week, we will be sure to implement it in the future when we have a better ability to attach the samples and updated model.

Test attachment mechanism	Meet with Rachel and Dr. Henak to perform testing on the attachment mechanism in terms of both time to implement and strength. Record data and observations in testing protocols document.	SGR	2 hr

Rachel and I went into Dr. Henak’s lab to test the attachment mechanism for the samples onto the bone models. We learned a lot about our bone models, the characteristics of the samples, and how well our attachment mechanism is going to work. The main take aways were that we are going to need to add more holes and a grate to our bone models and that we won’t be able to puncture the wire through the bone of the sample. We are also going to order more malleable wire.

Author: Delaney Reindl

Reach out to Dr. Puccinelli about outreach	Reach out to Dr. Puccinelli regarding our outreach plan. Ideally we want to take part in Engineering EXPO, happening April 19-20th where we would volunteer multiple times for different activities.	DR	0.5 hr

Determined that Engineering EXPO is a sufficient outreach option, and as a chair member for the club I can help determine what exactly my group can do to contribute.

Optimize the plastic sheet to find the dimensions needed for cutting and trace it out.	Now that the plastic sheet has been found for fabricating the reservoir, now the box itself has to be put together. The current dimensions are around 15.5 inches by 40.5 inches. Since the box only has to have 5 sides (no plastic cover needed), the box dimensions will be optimized to produce the best size box possible that will accommodate the liquid.	JT	1 hr

The dimensions were traced out for the box and cut using a band saw in the team lab. The box as of right now has about 6 inches on each side which will be enough to deoxygenate the PBS using Nitrogen gas.

Reserve a time slot in the Team Lab	Reserve a time slot at the Team Lab at ECBto fabricate the box. The band saw will need to be reserved in order to cut the plastic to the dimensions needed.	JT	30 min

After some research, it was not necessary to schedule a time for the teamlab to use the bandsaw. The makerspace laser cutter could not be used due to not having the laser upgrade. Therefore the band saw was used with a straightedge to make as straight of cuts as possible.

Print Enclosure CAD	Make final changes to the enclosure CAD based on magnet dimensions and print at the makerspace	SKR	1.5 hr

After picking up magnets from the makerspace, the new femur enclosure was modified and printing has begun. The material used for this prototype is formlabs clear.

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

X = Completed Tasks, O = Milestone Deadlines