BME Design-Fall 2023 - KADEN KAFAR
Complete Notebook

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MATTHEW SHERIDAN

on

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Team contact Information

KADEN KAFAR - Sep 13, 2023, 7:05 PM CDT

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Project description

Dan Altschuler (daltschuler2@wisc.edu) - Oct 20, 2023, 1:23 PM CDT

Course Number:

BME 200/300

Project Name:

Structural and mechanical functions of bones, muscles, and joints by use of 3D models in veterinary medical education

Short Name:

Structural and mechanical function of canine forelimb

Project description/problem statement:

Create realistic models of the forelimb of musculature to replicate muscle and bone interactions of the joint. The models should be easily removable and resistant to wear as training models for veterinary students to learn the mechanics of the important joints in the animal.

About the client:

Dr. McLean Gunderson, UW School of Veterinary Medicine, Department of Comparative Biosciences, Lecturer for Veterinary Anatomy

9/19/2023 Client Meeting

KADEN KAFAR - Sep 22, 2023, 1:32 PM CDT

Title: 9/19/23 Client Meeting

Date: 9/13/2023

Content by: Team

Present: Whole Team

Goals: Meet with client to discuss requirements.

Content:

Do you want us to improve on last groups project or model a different animal/body part?

Last semester was on the right track, she wants us to get out of the experience what we want. It's up to us. The ultimate goal is to have all muscles represented for fore and hind limb. One attachment kept coming off last year; some attachments are large, but some are small so not much surface are to use.

Do you have any additional feedback on last semester's project besides what is already included in their final report? (Client)

What are the technical details for how much of the previous group's work we can use? (Advisor)

Where can we access the CT and MR images to work with?

Contact her to send them to us in STL files; we would need to decide on our size.

There are free ones online and we can decide whether we want to use her scans or online scans

What is our budget for the semester, should multiple models be made?

Probably couldn't do both limbs in the semester, depends if we want to proceed on our own or go off of the other group. Budget was around $500 last year, but it's fine if we go over that.

How often will the devices be handled / How durable should we make it / How long should the device last?

Used for first four weeks of fall semester, four times a week, 100 students handle them

How did they like attachment method, muscle and bone material, amount of muscles/level of detail?

Should weight be considered in the making of the materials and model?

Doesn't make much difference, biggest consideration is bigger=pricier, but bigger can help make attachments work better. Medium sized dog is what they have currently. Cat is similar to dog functionally, just smaller.

Any specific limits on the accuracy of materials or muscle connections?

Don't know the tensile strength of all the muscles, but we want to make sure that the muscle does the action across the joint. Opposite muscle on the other side of the joint needs to oppose that muscle, so that one doesn't overpower the other.

Some feedback for last semester mentioned wanting tendon-like attachments; would that be something you'd like us to pursue?

Muscles don't attach directly to bones, need tendons to attach. Would be wonderful if we could differentiate between muscle and tendon on the model.

Times to Meet in Person (Next Meeting)

All day Tuesday

Lunch hours (Monday)

Most of the day Friday (everything except 2-4)

Conclusions/action items:

Decide as a group what bone limbs we want to work on.

9/29/2023 Client Meeting

Dan Altschuler (daltschuler2@wisc.edu) - Oct 01, 2023, 6:01 PM CDT

Title: Client Meeting

Date: 9/29/23

Content by: Dan

Present: Matt, Dan, Kaden

Goals: View the model and learn what can be done better this time around

Content:

Muscles have to lock the joints in the model

Swing and stance phase (muscles tense when fighting gravity, contract when moving)

Anyway we can get across the principles listed (incredibly complicated with a lot of muscles)

Consider how the muscles act across all of the joints in the limb

Sets of pulleys all the way down the dog limb

Agonist vs antagonistt

stabilization of a joint and mobility

Fasteners were a problem

The last group had a big attachment at the top, but since the lower portion of the limb had such a small surface area, it was hard enough to find a **strong enough magnet**

All the muscles on the model should be done in theory

Focus on the shoulder and elbow mechanism

Have to reinforce the silicone to prevent tearing

Look for higher-strength silicone

Conclusions/action items:

Start work on the design/fabrication process and prepare for the preliminary presentation

2023/09/15 Advisor Meeting

SAMANTHA KAHR - Sep 22, 2023, 1:51 PM CDT

Title: Advisor Meeting

Date: 09/15/2023

Content by: Team

Present: Whole Team

Goals: To establish weekly goals and expectations for the semester.

Content:

-we need to meet with our client, sent out email to set up a time for a Zoom

-went over where to find resources and deadlines

Conclusions/action items:

We will continue to meet with our advisor weekly to check progress reports.

2023/09/22 Advisor Meeting

SAMANTHA KAHR - Sep 22, 2023, 2:02 PM CDT

Title: 9/22/23 Advisor Meeting

Date: 9/22/2023

Content by: Team

Present: Whole Team

Goals: Meet with advisor to go over progress and do notebook checks.

Content:

-went over client meeting with advisor

-3D printing molds for accuracy and simplicity

-working on design matrices for next week

-we want to focus more on muscles than bones to improve last year’s design

-PDS requirements: include references if we have them

-someone else most likely has printed muscles already, check to see what they have tried

Conclusions/action items:

Decide as a group what muscles we want to include on the model and work on the design matrix due next Friday.

2023/09/29 Advisor Meeting

Dan Altschuler (daltschuler2@wisc.edu) - Nov 10, 2023, 12:18 PM CST

Title: Advisor Meeting

Date: 9/29/23

Content by: Team

Present: Team

Goals:

prepare with Dr. Wille for our in person client meeting

review design matrix and design ideas

Content:

make sure to make a list of questions for the client meeting

design matrices for attachment and muscles separate is a good idea

consider the ideas of the groups before but also make our own

bones should be fine to be fabricated the same way, that work has already been done

Conclusions/action items:

make sure our matrices are completely filled out and agreed upon

get a better idea of the scope of our project from Dr. Gunderson at the lab meeting today

2023/10/13 Advisor Meeting

MATTHEW SHERIDAN - Oct 13, 2023, 2:24 PM CDT

Title: Advisor Meeting

Date: 10/13/2023

Content by: Matt Sheridan

Present: Full Group

Goals: To get feedback on our preliminary report progress and our ideas for fabrication.

Content:

We met with Dr. Wille, and she gave us feedback on our preliminary report, and gave advice on some things including images and diagrams, as well as references and formatting.

She also added ideas about fabrication including the use of elastic bands on the end of the muscles to add elastic property, as well as using cow magnets as a cheap alternative yet a strong magnet.

Conclusions/action items:

Tonight we need to finalize our formatting on our preliminary report, and in this coming week we must begin fabrication and testing as soon as possible in order to end up with the best design possible at the end of the semester.

2023/10/20 Advisor Meeting

MATTHEW SHERIDAN - Oct 20, 2023, 1:19 PM CDT

Title: Advisor Meeting

Date: 10/20/2023

Content by: Matt Sheridan

Present: Dan, Collin, Jake, Sam, Matt

Goals: Receive feedback about current prototypes, plans, and notebook checks

Content:

Conclusions/action items:

2023/10/27 Advisor Meeting

Dan Altschuler (daltschuler2@wisc.edu) - Oct 27, 2023, 3:08 PM CDT

Title: Advisor Meeting

Date: 10/27/23

Content by: Dan Altschuler

Present: Entire Group

Goals: Relay new information from group meetings to Dr. Wille to get feedback. Also, discuss the initial design plan with Dr. Wille.

Content:

Pay attention to the feedback on the preliminary deliverables and make those changes for the final deliverables

Discussed whether or not we should use the foot from the other group and scan that

Muscle attachment groups used modeling clay to mimic muscle attachments

Magnets would be flush on the bone and the attachment could snap onto the outside of the bone

Could epoxy the attachments onto the bones

Continued discussion about muscle molding

Dr. Wille recommended the maker space to find an expert on textiles

Conclusions/action items:

continue work based on the plan

prepare for show and tell in our groups

2023/11/10 Advisor Meeting

Dan Altschuler (daltschuler2@wisc.edu) - Nov 10, 2023, 1:20 PM CST

Title: Advisor Meeting

Date: 11/10

Content by: Dan

Present: Team

Goals:

Talk with Dr. Wille about the recently printed bones and also the muscle fabrication

get more ideas from the group and from Dr. Wille

Content:

the bones have very thin parts from the 3d prints

this came from printing them all at the same time

would it be feasible to print them in small intervals?

the bottom part of the silicone on the muscle did not cure

could we print 3d molds for casting silicone?

attachments scanned with handyscan once we have the final bones

epoxy the magnets onto the bones?

sew the magnets into the fabric to hold it all together

(good idea)

Conclusions/action items:

do more research to fix the issues with the silicone casting

get the bones redone to fix the printing issues

once bones are done, attachments can be resin printed

2023/11/17 Advisor Meeting

MATTHEW SHERIDAN - Nov 17, 2023, 1:33 PM CST

Title: Advisor Meeting

Date: 11/17

Content by: Matt

Present: Team

Goals:

Talk with Dr. Wille about the preliminary prototype and ideas about muscle molding and connections.

Content:

We talked to people in MakerSpace about bad 3D print, they told us that's just what happens and can't do anything about it.

We need to add thickness to the scapula bone so that it is fully sturdy, and print the scapula by itself with limited support material to ensure a better print, as well as trying to glue the base down to minimize errors in the print.

We need to do testing on the silicone, which is a difficulty as we need to figure out how to attach the tensile test to the silicone.

We also will have to do a survey about the functionality of our prototype, which we can do at the final presentation and include in our final deliverables.

Conclusions/action items:

Moving forward, we need to complete the prototype as soon as possible and once this is done we can complete everything else.

2023/12/1 Advisor Meeting

Dan Altschuler (daltschuler2@wisc.edu) - Dec 01, 2023, 1:10 PM CST

Title: Advisor Meeting

Date: 12/1

Content by: Dan

Present: Team

Goals: Talk with Dr. Wille about our success with fabrication this week and get advice for our final prototype

Content:

The fabric got sewed into the muscles to show the tendon attachments, and we have all the different colors we need to make tendons

The muscles are starting to come into shape, as are the attachments

the new print for the bones looks a lot better and more filled out so

We could look into trying to include a muscle with the foot to align the prototype

We are going to attach the magnets onto the bones and draw attachment sites

Spring scale testing on the magnets could check force

We could also test the tendon strength with a tensile test

The team is also going to make a google form with questions about the prototype for the poster presentation

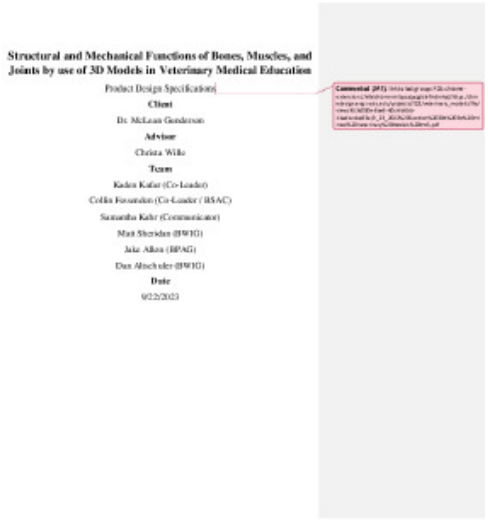
Conclusions/action items:

The team is going to complete our testing and prototyping this week so we will have everything all ready for the poster presentation

Everything is coming together well and we will have a finished prototype for the presentation

Product Design Specifications

Colin Fessenden - Sep 21, 2023, 9:59 PM CDT



Structural and Mechanical Functions of Bones, Muscles, and Joints by use of 3D Models in Veterinary Medical Education

Product Design Specifications

Client

Dr. McLean Gunderson

Advisor

Christa Wilke

Team

Kaden Kafar (Co-Leader)

Collin Fessenden (Co-Leader / BSAC)

Samantha Kahr (Communicator)

Matt Sheridan (BWIG)

Jake Alkon (BPAG)

Dan Altschuler (BWIG)

Date

9/22/2023

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PDS_2_.pdf (206 kB)

Design Matrices

KADEN KAFAR - Sep 27, 2023, 8:08 PM CDT

Title: Design Matrices

Date: 6/28/2023

Content by: Vet team

Present: Everyone

Goals: Use design matrices decide upon the muscle material and muscle connections of the project.

Content:

Attached Below

Conclusions/action items:

Begin preparing initial presentation and report of the project.

KADEN KAFAR - Sep 27, 2023, 8:20 PM CDT

Muscle Material

Design Criteria	Design 1: Elastic Band 		Design 2: Resin 		Design 3: Silicone	
Ease of Fabrication (20)	5/5	20	5/5	20	4/5	16
Durability (20)	4/5	16	4/5	16	5/5	20
Mechanical Similarity to Muscle (20)	3/5	12	2/5	8	4/5	16
Safety (15)	2/5	6	3/5	9	4/5	12
Appearance (15)	1/5	3	3/5	9	4/5	12
Cost (10)	5/5	10	4/5	8	5/5	10
Total (100)	67/100		70/100		86/100	

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Design_Matrices.pdf (152 kB)

Conclusions about the Muscle Attachments

SAMANTHA KAHR - Nov 26, 2023, 1:12 PM CST

Title: Conclusions about the Muscle Attachments

Date: 11/17/2023

Content by: Sam Kahr

Present: n/a

Goals: to establish the updated fabrication plan for the muscle attachments

Content:

-conclusions from the muscle attachment scanning and printing are that creating pieces for each muscle attachment will be too time-consuming and unnecessary

-in order to save time and make sure our deadlines are met, a new solution is necessary

-Dr. Wille suggested using epoxy to attach the magnets to the bones and using markers to color in where the precise attachment site is

-this would also allow us to color-code each muscle-tendon complex so that it is clearer which site is for which muscle

-the muscle group is also having issues getting the silicone to cure, so this would allow us to work around having to cure a magnet into the muscle

-instead of having magnets implanted into the silicone, we could sew a piece of fabric to the fabric that needs to be implanted into the silicone for strength

-this would allow us to use colorful fabrics for the different "tendons" that would match the colors of the attachment sites and also sew the magnets into the fabric to ensure a secure connection

Conclusions/action items:

The current fabrication plan for the muscle attachments is to draw the connection site onto the bone with colored markers and epoxy magnets onto the bone inside of these sites. Then, the muscles will have colored fabric sewn into them for tendons that match the sites. On the other end, the fabric will have magnets sewn into it to attach to the bone.

Axis Scientific Measurements

KADEN KAFAR - Nov 08, 2023, 7:58 PM CST

Title: Axis Scietnific Measurements

Date: 11/9/2023

Content by: Kaden Kafar

Present: N/A

Goals: Measure bones of axis scientific model to scale beagle bones.

Content:

Scapula:

-5 inches from bottom to peak

-2.5 inches wide

Humerus:

-6 inches long

-3/4 inch wide in center

Radius:

-5 3/4 inches long

-3/8 inches diameter in center

Ulna:

-7.5 inches long

-3/4 inches diameter in center.

Foot:

5.125 inches long

2 inches wide.

Conclusions/action items:

Scale beagle bones to axis model size.

Scale for 3-D Prints

SAMANTHA KAHR - Nov 26, 2023, 12:41 PM CST

Title: Scale for 3-D Prints

Date: 11/9/2023

Content by: Sam Kahr

Present: n/a

Goals: to determine the scale for our 3-D printed bones so that the printed components are about the same size as the Axis Scientific model.

Content:

-length of Axis Scientific humerus (as measured by Kaden): 6"

-length of beagle humerus provided by Dr. Gunderson: 4.395"

We want the scans of the real canine bones to be about the same size as the Axis model. Therefore, we need to calculate the percent multiplier for our bones to be the same size as the model. The bone models should be scaled up (6/4.395)*100, or 136.52%.

Conclusions/action items:

For all 3-D printed bones, the STL must be printed with a multiplier of 136.52%.

10/24/2023 - Muscle Fabrication Meeting

Dan Altschuler (daltschuler2@wisc.edu) - Nov 09, 2023, 5:54 PM CST

Title: Muscle Fabrication Meeting

Date: 10/24/2023

Content by: Dan Altschuler

Present: Dan, Colin

Goals: Create a plan for the fabrication of muscle.

Content:

Main Muscles:

Triceps (medial, lateral, long, accessory)

Bicep (long head)

Brachialis

Other Muscles:

Anconeus (connective muscle to assist extensors in elbow joint)

Discussion:

Using the Wiley Online Library data about the greyhound anatomy and belly length of muscles, we can take a ratio of the bone lengths for a greyhound and our printed bone lengths to get a good approximation of the muscle lengths for our model. We can also use the mCSA from the Sciendo article to again apply a ratio based on the approximate lengths of bones to determine the thickness of the muscle models.

Citations:

S. B. Williams, “Functional anatomy and muscle moment arms of the ... - wiley online library,” Wiley Online Library, https://onlinelibrary.wiley.com/doi/10.1111/j.1469-7580.2008.00962.x (accessed Oct. 24, 2023).

A. Vekšins and O. Kozinda, “Assessment of Maximum Cross - sectional area and volume of ... - sciendo,” Sciendo, https://sciendo.com/pdf/10.2478/plua-2018-0008

Conclusions/action items:

Look to purchase clay for molding/casting/testing

communicate with the bones group to make sure muscles will correspond with the model

once acquired, use clay and silicone to test muscle design

10/26/2023 - Muscle Attachment Fabrication

SAMANTHA KAHR - Nov 26, 2023, 12:57 PM CST

Title: Muscle Attachment Fabrication

Date: 10/26/2023

Content by: Sam Kahr

Present: Sam Kahr, Jake Allen

Goals: To start fabrication of a proof-of-concept muscle attachment

Content:

-using the beagle bones provided by Dr. Gunderson and the canine anatomy textbook provided by Dr. Gunderson (Evans & Miller, 2013); we mapped out where the muscles attach to the bones

-the muscles we modeled attachments for were chosen by the muscle group of our design team

-we used oven-bake modeling clay to form the pieces to the bones

-later, the pieces were baked according to the package directions to cure

Conclusions/action items:

With this fabrication session, we proved that it is possible to use clay to form pieces that fit perfectly against the bones we were provided. Although the exact modeling was difficult because of the size, a precise and accurate attachment site is still possible. Additionally, we know that our 3-D printed bones are going to be larger than the real canine bones, so that will make the process easier.

10/27/2023 3d Scans of bones

KADEN KAFAR - Oct 27, 2023, 12:50 PM CDT

Title: 3d scans of bones

Date: 10/27/2023

Content by: Kaden Kafar

Present: The vets

Goals: Get the bones 3d scanned in the makerspace to be ready to print for future models.

Content:

- At the makerspace we used a handyscan 700 in order to scan all the separate bones.

- This left us with .stl files that we can potentially change in order to fit our designs.

- This can be done through any 3d modeling software.

Conclusions/action items:

- Add slots for bones to attach to one another

-Add spots for attachment points of muscles.

10/27/2023 - Muscle Attachment Scanning

SAMANTHA KAHR - Nov 29, 2023, 6:57 PM CST

Title: Muscle Attachment Scanning

Date: 10/27/2023

Content by: Sam Kahr

Present: Sam Kahr and Jake Allen

Goals: to scan and complete fabrication of the proof-of-concept muscle attachments

Content:

-in the Makerspace, the HandyScan 700 was used to get stl files for the modeling clay attachments

-because of time constraints, only two attachments were able to be scanned

-the post-processing for the stl files was very tedious and took a long time to complete

-the attachment was printed with resin and fit well against the bone

Conclusions/action items:

We proved that we were able to make a piece out of modeling clay, scan it with the HandyScan, and print it in resin, all while maintaining the exact shape to fit against the bone. However, we decided to use a different method for attaching the muscles to the bones because this way takes a very long time and is very labor-intensive.

10/31/2023 - Basic Silicone Fabrication/Testing

MATTHEW SHERIDAN - Oct 31, 2023, 11:43 PM CDT

Title: Basic Silicone Fabrication

Date: 10/31/23

Content by: Matt Sheridan, Dan Altschuler

Present: Matt Sheridan, Dan Altschuler

Goals: To get a basic understanding of the silicone material and how it interacts with other materials

Content:

- We fabricated a small amount of the silicone material by combining equal parts of the two EcoFlex bottles.
- Once the silicone cured, which took around 5 minutes, we tested the structural integrity of the silicone, and how each of the different magnets interacted through the silicone material.
- We found that the weaker of the three magnets worked very well across about 1 centimeter of the silicone, and was able to snap together but still be removed easily.

Conclusions/action items:

- This was a good start on understanding the silicone, and now we will need to create larger models as well as test the shear strength of the silicone at different thicknesses.

11/30/2023 - Attachment Fabrication

SAMANTHA KAHR - Dec 03, 2023, 2:17 PM CST

Title: Attachment Fabrication

Date: 11/30/2023

Content by: Sam Kahr

Present: Sam Kahr, Jake Allen

Goals: to sew initial fabric for tendons/attachments onto the two fabricated muscles

Content:

-two muscles have been fabricated: the anconeus and the brachialis

-we assigned colors for each muscle/tendon/attachment site:

anconeus- red

brachialis- yellow

biceps- green

triceps- blue

-the tendon fabric was cut to be about twice as wide as the muscle (2.5”) and 5” wide to ensure an excess for the brachialis

-for the anconeus, the tendon fabric was cut into 2” x 2.5” rectangles

-two tendons were cut for each muscle

-using embroidery floss, the tendons were sewn onto each end of the muscle so that the short side is centered on the fabric protruding from the muscle and the long side is free

Conclusions/action items:

We proved that it is feasible to sew fabric tendons onto the muscles for attachments to the bones. Our next steps are to sew tendons onto the rest of the muscles once they are fabricated and sew magnets into the free ends of the tendons. Once the bones are printed, we also have to draw the attachment sites onto them and epoxy magnets inside of the attachment sites. The magnets on the bones and the magnets sewn into the tendons are how the whole model will attach together.

12/03/2023 - Attachment Fabrication

SAMANTHA KAHR - Dec 04, 2023, 1:42 PM CST

Title: Attachment Fabrication

Date: 12/03/2023

Content by: Sam Kahr

Present: Sam Kahr, Jake Allen, Kaden Kafar

Goals: to assemble the final prototype of the model

Content:

-the biceps and triceps were fabricated but needed to be trimmed and cleaned

-the biceps tendons were cut to be 2.5” x 5”

-there were 5 tendons needed for the triceps, the biggest one was cut to be 5” x 5” and the smaller 4 were cut to be 2.5” x 5”

-the tendons were sewn onto their respective muscles

-the attachment sites were drawn onto the bones with sharpie in the colors that matched the tendons

-epoxy was used to attach magnets to the bones inside of the attachment areas

-matching magnets were then glued and sewn into the tendons, and excess tendon fabric was trimmed

Conclusions/action items:

All of the attachments were completed except for those of the triceps, so the model should be finished by Wednesday. A testing plan will also be created and completed before Friday.

Testing Data

KADEN KAFAR - Dec 06, 2023, 5:04 PM CST

KADEN KAFAR - Dec 14, 2023, 8:28 AM CST

Name	D1(mm)	D2(mm)	Area(mm^2)	Gauge Length (mm)	Peak Force (N)	Strain at failure (mm/mm)	Peak Stress (N/M^2)	Young's Modulus (N/M^2)
Muscle 1	17.15	13.9	238.385	41.3		1.6641	155767	167 KPa
Muscle 2	13.3	9.3	123.69	13.3/53.9		1.66589	295532	356 KPa
Muscle 3	11.18	12.5	139.75	29.9		1.78871	236805	196 KPa
Full	15.3	30.9	472.77	105.6	19.4719	1.3	40830	160 KPa
Silicone	4.3	29.2	125.56	25.2	15.6856	1.65755	124925	100 KPa
Tendon_Mat	0.41	41	16.81	51.1	58.7232	1.93291	3486240	6 MPa
Muscle_Fabric	0.29	46.6	13.514	58.4	30.4192	1.05064	2241080	5 MPa
avg muscles	N/A	N/A	N/A	N/A	35.9704	1.706233333	229368	239.667 KPa

12/06/2023 - Cyclic Loading Test

SAMANTHA KAHR - Dec 06, 2023, 8:43 PM CST

Title: Cyclic Loading Test

Date: 12-06-2023

Content by: Sam Kahr

Present: Sam Kahr

Goals: To run a cyclic loading test to measure the relaxation of the muscle-tendon complex

Content:

Testing Protocol:

the fabricated brachialis and biceps muscles were tested, each muscle was pulled to 25% strain for 50 cycles in a stress-relaxation test

Results:

Brachialis:

Initial length- 13.8 cm

Final length- 13.9 cm

Percent relaxation- 0.725%

Biceps:

Initial length- 15.4 cm

Final length- 15.6 cm

Percent relaxation- 1.299%

Average Percent Change: 1.012%

Conclusions/action items:

The muscle-tendon complexes are within the design criteria because they relax much less than 5% after cyclic loading.

9/13/23 Team Meeting

KADEN KAFAR - Sep 22, 2023, 1:25 PM CDT

Title: 9/13/2023 Team Meeting

Date: 9/13/2023

Content by: Kaden Kafar

Present: Whole Team

Goals:

-Decide upon team name

-Set up client meeting

-Set up advisor meeting

Content:

-Decided to call ourselves The Vets.

-Set up a client meeting for Tuesday

-Meeting advisor on Friday during class time.

Conclusions/action items:

Set up PDS and begin research for the project.

9/20/2023 PDS Meeting

MATTHEW SHERIDAN - Oct 10, 2023, 9:43 PM CDT

Title: 9/20/2023 PDS Meeting

Date: 9/20/2023

Content by: Kaden Kafar

Present: Full Team

Goals:

-Break down PDS

-Set meeting time with client in person

-Communicate expectations for the next week

-Decide upon what project we will be completing

Content:

-Completed the PDS

-Set up a meeting for next week Friday with our client

-Decided upon doing the forelimb of a dog as our project

Conclusions/action items:

-Complete beginning research

-Prepare for advisor meeting Friday

9/27/2023 Design Matrix Meeting

MATTHEW SHERIDAN - Oct 01, 2023, 6:06 PM CDT

Title: Design Matrix/Research Sharing Meeting

Date: 9/27/2023

Content by: Matt Sheridan

Present: Everybody

Goals: To design and fill out our 2 design matrices

Content:

- We each previously researched either a muscle material design or a muscle attachment design.
- We added our design ideas into the design matrix and collaboratively filled out the design matrix.
- Using these design matrices, we decided on the designs we wanted to move forward with.
- We started preliminary research on these chosen designs.
- We sent out emails to our advisor and client with our design matrices included.

Conclusions/action items:

- Move forward with research into these designs.
- Meet with Dr. Gunderson in person to see the previous design and other design alternatives.
- Start designing prototypes to do initial testing on.

10/1/23 Slideshow Meeting

MATTHEW SHERIDAN - Oct 10, 2023, 9:43 PM CDT

Title: 10/1/23 Slideshow Meeting

Date: 10/1/23

Content by: Dan Altschuler

Present: Matt Sheridan, Colin Fessenden, Jake Allen, Samantha Kahr, Dan Altschuler

Goals:

- Prepare for the preliminary presentation

- Assign work for the slides

Content:

- Divided up work for the slides

- Started work on the preliminary presentation

- Confirmed time for presentation with client via email

Conclusions/action items:

- Slides need to be completed by the next team meeting on Wednesday

- Practice presenting before Friday

10/4/23 Preliminary Presentation Meeting

MATTHEW SHERIDAN - Oct 05, 2023, 10:13 PM CDT

Title: Preliminary Presentation Meeting

Date: 10/4/23

Content by: Matt Sheridan

Present: Matt Sheridan, Sam Kahr, Dan Altschuler, Collin Fessenden, Kaden Kafar

Goals: To finalize the preliminary presentation and practice presenting.

Content:

- All slides were finalized, checking for grammar and formatting.
- Sources were edited to ensure proper references page and in-text citations.
- Slides were assigned to everybody, and everybody practiced their respective slides.
- Slideshow was sent to our advisor to look over before the presentation.

Conclusions/action items:

Now that the preliminary presentation is finalized, we will make edits once the advisor gets back to us, and give the presentation on Friday.

10/10/23 Preliminary Report Meeting

MATTHEW SHERIDAN - Oct 10, 2023, 9:41 PM CDT

Title: Preliminary Report Meeting

Date: 10/10/23

Content by: Matt Sheridan

Present: All members

Goals: To finalize our goals for the preliminary report and talk over our process for completing it.

Content:

We began by looking over the work that has been done already on the preliminary report.

Next, we looked at our actions going forward to complete this report as well as we can on time.

We chose who would be completing which part of the report, as well as work that needed to be done outside of the report such as finalizing our lab archives.

We decided that we need to do some editing of the product design specifications, as well as create a good abstract to tie together our report.

Conclusions/action items:

During this meeting, we talked over and finalized our process for the preliminary report. Moving forward, we will need to complete the preliminary report, which involves making the abstract, finalizing our individual portions, making a final design drawing, and looking over everything to make sure that the work was done well. Following this, we will move on to prototyping and testing our designs and moving forward to final stages of our design.

10/12/23 Preliminary Report Final Meeting

MATTHEW SHERIDAN - Oct 13, 2023, 2:16 PM CDT

Title: Final Preliminary Report Meeting

Date: 10/12/2023

Content by: Matt Sheridan

Present: Full group

Goals: To finalize our goals for the preliminary report and make sure everything gets completed on time and well.

Content:

Discussed our preliminary report, and who will complete which portion to complete the report on time.

Talked about beginning stages of prototyping and testing, including how we plan on scanning and printing the given bone models.

Worked on and finalized all entries into the group lab notebook.

Conclusions/action items:

Moving forward, we need to each complete our portion of the preliminary report, and once this is completed we must move towards prototyping as soon as possible.

10/20/23 Attachment Brainstorm

Jake Allen - Oct 20, 2023, 2:11 PM CDT

Title: Attachment Brainstorming

Date: 10/20/23

Content by: Jake Allen

Present: Jake Allen, Sam Kahr

Goals: Brainstorm possible tests and attachment methods

Content:

Ordered 3 magnets:

- Max pull of 2.8 lb, 5lb, 11lb respectively
- Estimate we need roughly 5 lbs but want to test other strengths

Must have:

- attachment site need to be correct shape
- strong enough to hold in place
- durable enough to withstand frequent removal
- easy to use/ wont pinch fingers

Fabricated muscle properties:

- ecoflex 00-35 fast
- max tensile 200psi

Possible alternatives:

- mechanical male/female connection (drill into bone) (better for elastic tendons):
    - snap attachments (https://www.mcmaster.com/products/snap-fasteners/complete-fabric-snaps-with-tapping-screw-stud/)

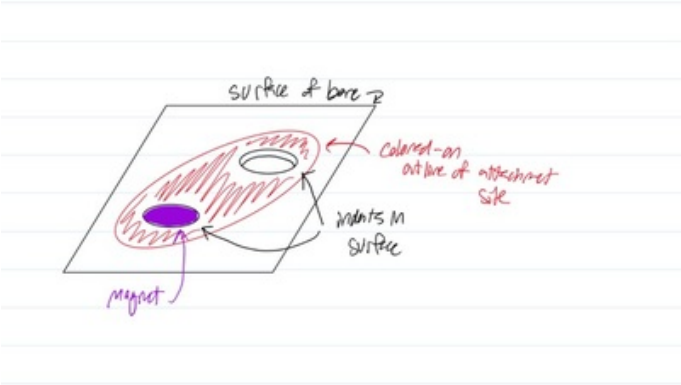
Big idea:

design and attachment with the anatomically correct shape that's added on the muscle/tendon end and traced onto the bone. these sites will be color-coded. likey attached with a magnet and a pin connection for stability/ correct orientation. The magnets may be swapped for snap pins if the tendons are purely an elastic band.

Conclusions/action items:

- embed magnets into silicon
- model and 3d print tough pla test block (2 halves both have a magnet inlay and one has a male pin the other has a female pin)
- possibly get elastic fabric and snap buttons to test

SAMANTHA KAHR - Oct 20, 2023, 2:14 PM CDT



Download

Sketch_of_attachment_site_on_bone.jpg (41.1 kB)

10/26/2023 - Attachment Sculpting

SAMANTHA KAHR - Oct 26, 2023, 1:33 PM CDT

Title: Attachment Sculpting Session

Date: 10/26/2023

Content by: Jake Allen

Present: Jake Allen, Sam Kahr

Goals: Sculpt muscle attachment sites on beagle bones to be scanned and printed.

Content:

Attachments must have space for magnets (1/8in- 3/16in in-depth)

Attachments will be scaled up to our fabricated bones later

Sculpted attachments on beagle bones.

Magnet test blocks have been printed and fit with magnets, but have yet to be tested.

Attachment sites were based on textbook from Dr. Gunderson: Evans, Howard E. and Miller, Malcolm E., “Muscles of the Thoracic Limb.”

Conclusions/action items:

- Attachments will be baked to see how they retain shape and scanned to be printed.

11/1/2023 Show and Tell Meeting

MATTHEW SHERIDAN - Nov 08, 2023, 7:52 PM CST

Title: Show and Tell Meeting

Date: 11/1/2023

Content by: Matt Sheridan

Present: Full group

Goals: To discuss our plans for the show and tell meeting and finalize our 1-minute pitch

Content:

Talked over our elevator pitch for the show and tell and assigned specific people to cover the 3 portions of our project

Thought about questions that we can ask the people we are presenting to to gather feedback on our design.

Practiced our pitch a little bit as a team to improve the flow of it.

Conclusions/action items:

Moving forward, we will have to attend the show and tell, and following this we need to begin fabrication on bones and muscles.

11/3/2023 - Show and Tell Notes

Colin Fessenden - Nov 03, 2023, 12:50 PM CDT

Title: Show and Tell

Date: 11/3/2023

Content by: Colin Fessenden

Present: All

Goals: Get some insight from other design

Content:

Suggestions:

- Possibility of using snap on pins instead of magnets

- Printing with the hole or indent already in the design

- try not to have magnets make direct contact with each other

- inserting the magnet inside the bone then completely fill it with epoxy (maybe too expensive?)

-

Conclusions/action items:

Overall, we got some great suggestions from the other teams. We will review these suggestions as a team and discuss our options.

11/8/2023 Fabrication Meeting

MATTHEW SHERIDAN - Nov 08, 2023, 7:48 PM CST

Title: Fabrication Meeting

Date: 11/8/2023

Content by: Matt Sheridan

Present: Full group

Goals: To come together to talk about fabrication steps that we have gone through and plan to do.

Content:

We discussed that all bone files are done, and printing will begin Thursday or Friday.

Muscle molding and fabrication will begin Thursday, and once one muscle is fabricated, we will begin testing on it and develop other muscle prototypes off of it.

3D models of muscles are in the works, but this is not 100% a viable option so we are going to move forward with both options until we know which we decide on.

Conclusions/action items:

Moving forward, we need to fabricate all of the muscles and bones and combine them together to create a functioning prototype.

11/9/2023 Preliminary Muscle Fabrication Meeting

Colin Fessenden - Nov 29, 2023, 7:36 PM CST

Title: Preliminary Muscle Fabrication Meeting

Date: 11/9/2023

Content by: Matt Sheridan

Present: Matt Sheridan, Dan Altschuler, Colin Fessenden

Goals: To begin fabrication of a preliminary muscle to gather information about functionality of our muscle fabrication process.

Content:

Researched the lengths of canine muscles and figured out a scale to match this muscle to the bones that we have printed out.

Anconeus belly length (greyhound) = 9.4cm

Humerus length (greyhound) = 20cm

Humerus length (Axis Scientific model) = 6 in = 15.24cm

Anconeus belly length (Axis Scientific model) = (15.24cm*9.4cm)/(20cm) = 7.16cm

Anconeus PCSA = 3.7cm = (pi)r^(2) --> radius=1.1cm --> diameter=2.2cm

Volume:

Mold 1: 2 tbsp and 1 tsp

Citations:

[1] S. B. Williams, A. M. Wilson, J. Daynes, K. Peckham, and R. C. Payne, “Functional anatomy and Muscle moment arms of the thoracic limb of an elite sprinting athlete: The racing greyhound (canis familiaris),” Journal of anatomy, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2644772/ (accessed Nov. 29, 2023).

Conclusions/action items:

Moving forward, we need to fabricate all of the muscles and bones and combine them together to create a functioning prototype.

11/29/2023 Team Meeting

Dan Altschuler (daltschuler2@wisc.edu) - Dec 01, 2023, 1:01 PM CST

Title: Team Meeting

Date: 11/29/23

Content by: Dan

Present: Team

Goals: Get everything in order after break and start work towards the final prototype

Content:

Muscle in the middle once it was finally cured had really good tensile strength, if we can get all the muscle to look like that it would be really good

The muscles got sewed and we embedded the fabric so we can attach the magnets

The color of the muscles looks really good and everything is starting to come together

Conclusions/action items:

we will meet again this weekend to finish everything up and complete our final prototype

12/3/2023 Muscle Fabrication Meeting

Dan Altschuler (daltschuler2@wisc.edu) - Dec 13, 2023, 9:41 PM CST

Title: Muscle Fabrication Meeting

Date: 12/3/2023

Content by: Dan

Present: Dan, Kaden, Matt

Goals: Complete all the muscles for the final prototype

Content:

The silicone cures very quickly when we are using the open air molds

we used some mold spray on the terracotta molds to make sure that the silicone wouldn't stick

the smaller bicep muscle worked very well and was very easy to fabricate

the tricep muscle bottom portion cured before all the silicone was poured so it left it a bit misshapen, but it will be easily fixed before attaching on the final prototype

the silicone came out of the molds very quickly so the spray worked very well

the curing would have been perfect if not for the early curing of the tricep

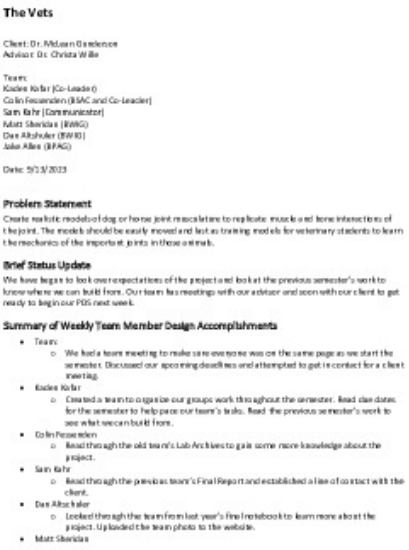
Conclusions/action items:

we will reshape the triceps to fix any holes or larger poking sections that appeared during fabrication

after this, Colin will sew the tendon fabric onto the muscle fabric and it will be attached to the final prototype

Progress Report - 9/13/2023

Colin Fessenden - Sep 21, 2023, 9:32 PM CDT



The Vets

Client: Dr. McLean Glendenning
Advisor: Dr. Christa Wilke

Team:
Kaden Kafka (Co-Leader)
Colin Fessenden (BSAC and Co-Leader)
Sam Kahr (Communicator)
Matt Sheridan (BWIG)
Dan Altschuler (BWIG)
Jake Allen (BPAG)

Date: 9/13/2023

Problem Statement

Create realistic models of dog or horse joint musculature to replicate muscle and bone interactions of the joint. The models should be easily moved and last as training models for veterinary students to learn the mechanics of the important joints in those animals.

Brief Status Update

We have began to look over expectations of the project and look at the previous semester's work to know where we can build from. Our team has meetings with our advisor and soon with our client to get ready to begin our PDS next week.

Summary of Weekly Team Member Design Accomplishments

- Team:
  - We had a team meeting to make sure everyone was on the same page as we start the semester. Discussed our upcoming deadlines and attempted to get in contact for a client meeting.
- Kaden Kafka
  - Created a team to organize our groups work throughout the semester. Read due dates for the semester to help pace our team's tasks. Read the previous semester's work to see what we can build from.
- Colin Fessenden
  - Read through the old team's Lab Archives to gain some more knowledge about the project.
- Sam Kahr
  - Read through the previous team's Final Report and established a line of contact with the client.
- Dan Altschuler
  - Looked through the team from last year's final notebook to learn more about the project. Uploaded the team photo to the website.
- Matt Sheridan

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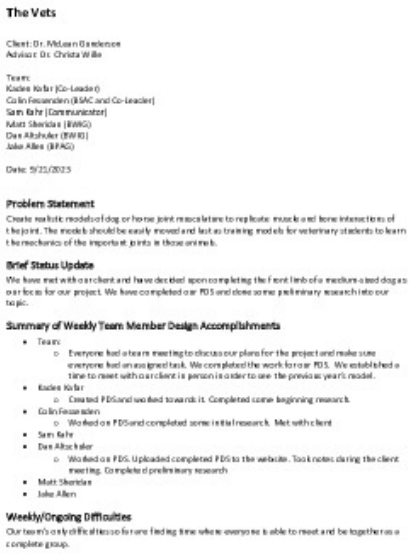
Progress Report - 9/21/2023

Colin Fessenden - Sep 21, 2023, 9:47 PM CDT



The Vets

Client: Dr. McLean Glendenen
Advisor: Dr. Christa Wille

Team:
Kaden Kafar (Co-Leader)
Colin Fessenden (BSAC and Co-Leader)
Sam Kahr (Communicator)
Matt Sheridan (BWIG)
Dan Altshuler (BWIG)
Jake Allen (BPAG)

Date: 9/21/2023

Problem Statement

Create realistic models of dog or horse joint musculature to replicate muscle and bone interactions of the joint. The models should be easily moved and last as training models for veterinary students to learn the mechanics of the important joints in those animals.

Brief Status Update

We have met with our client and have decided upon completing the front limb of a mature-sized dog as our focus for our project. We have completed our PDS and done some preliminary research into our topic.

Summary of Weekly Team Member Design Accomplishments

- Team:
  - Everyone had a team meeting to discuss our plans for the project and make sure everyone had an assigned task. We completed the work for our PDS. We established a time to meet with our client in person in order to see the previous year's model.
- Kaden Kafar
  - Created PDS and worked towards it. Completed some beginning research.
- Colin Fessenden
  - Worked on PDS and completed some initial research. Met with client
- Sam Kahr
- Dan Altschuler
  - Worked on PDS. Uploaded completed PDS to the website. Took notes during the client meeting. Completed preliminary research
- Matt Sheridan
- Jake Allen

Weekly/Ongoing Difficulties

Our team's only difficulties so far are finding time where everyone is able to meet and be together as a complete group.

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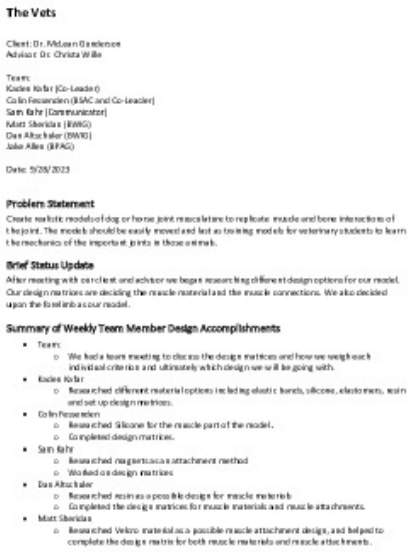
Progress Report - 9/28/2023

MATTHEW SHERIDAN - Oct 10, 2023, 11:27 PM CDT



The Vets

Client: Dr. McLean Glendenning
Advisor: Dr. Christa Wilke

Team:
Kaden Kafar (Co-Leader)
Colin Fessenden (BSAC and Co-Leader)
Sam Kahr (Communicator)
Matt Sheridan (BWIG)
Dan Altschuler (BWIG)
Jake Allen (BPAG)

Date: 9/28/2023

Problem Statement

Create realistic models of dog or horse joint musculature to replicate muscle and bone interactions of the joint. The models should be easily moved and last as training models for veterinary students to learn the mechanics of the important joints in those animals.

Brief Status Update

After meeting with our client and advisor we began researching different design options for our model. Our design matrices are deciding the muscle material and the muscle connections. We also decided upon the femur/tibia as our model.

Summary of Weekly Team Member Design Accomplishments

- Team:
  - We had a team meeting to discuss the design matrices and how we weigh each individual criterion and ultimately which design we will be going with.
- Kaden Kafar
  - Researched different material options including elastic bands, silicone, elastomers, resin and set up design matrices.
- Colin Fessenden
  - Researched Silicone for the muscle part of the model.
  - Completed design matrices.
- Sam Kahr
  - Researched magnets as a attachment method
  - Worked on design matrices
- Dan Altschuler
  - Researched resin as a possible design for muscle materials
  - Completed the design matrices for muscle materials and muscle attachments.
- Matt Sheridan
  - Researched Velcro material as a possible muscle attachment design, and helped to complete the design matrix for both muscle materials and muscle attachments.

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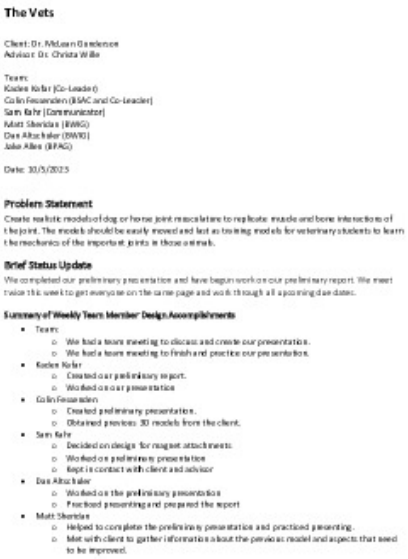
Progress Report - 10/5/2023

MATTHEW SHERIDAN - Oct 10, 2023, 11:28 PM CDT



The Vets

Client: Dr. McLean Glendenning
Advisor: Dr. Christa Wille

Team:
Kaden Kiefer (Co-Leader)
Colin Fessenden (BSAC and Co-Leader)
Sam Kahr (Communicator)
Matt Sheridan (BWIG)
Dan Altschuler (BWIG)
Jake Allen (BPAG)

Date: 10/5/2023

Problem Statement

Create realistic models of dog or horse joint musculature to replicate muscle and bone interactions of the joint. The models should be easily moved and last as training models for veterinary students to learn the mechanics of the important joints in those animals.

Brief Status Update

We completed our preliminary presentation and have begun work on our preliminary report. We meet twice this week to get everyone on the same page and work through all upcoming due dates.

Summary of Weekly Team Member Design Accomplishments

- Team:
  - We had a team meeting to discuss and create our presentation.
  - We had a team meeting to finish and practice our presentation.
- Kaden Kiefer
  - Created our preliminary report.
  - Worked on our presentation
- Colin Fessenden
  - Created preliminary presentation.
  - Obtained previous 3D models from the client.
- Sam Kahr
  - Decided on design for magnet attachments
  - Worked on preliminary presentation
  - Kept in contact with client and advisor
- Dan Altschuler
  - Worked on the preliminary presentation
  - Practiced presenting and prepared the report
- Matt Sheridan
  - Helped to complete the preliminary presentation and practiced presenting.
  - Met with client to gather information about the previous model and aspects that need to be improved.

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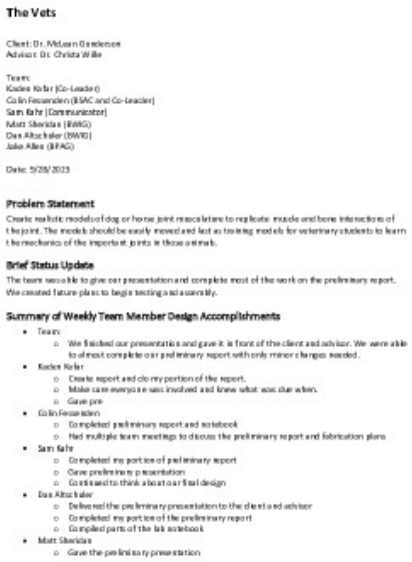
Progress Report - 10/12/2023

MATTHEW SHERIDAN - Oct 12, 2023, 8:20 PM CDT



The Vets

Client: Dr. McLean Glendenen
Advisor: Dr. Christa Wilke

Team:
Kaden Kafar (Co-Leader)
Colin Fessenden (BSAC and Co-Leader)
Sam Kahr (Communicator)
Matt Sheridan (BWIG)
Dan Altschuler (BWIG)
Jake Allen (BPAG)

Date: 9/29/2023

Problem Statement

Create realistic models of dog or horse joint musculature to replicate muscle and bone interactions of the joint. The models should be easily moved and last as training models for veterinary students to learn the mechanics of the important joints in those animals.

Brief Status Update

The team was able to give our presentation and complete most of the work on the preliminary report. We created future plans to begin testing and assembly.

Summary of Weekly Team Member Design Accomplishments

- Team:
  - We finished our presentation and gave it in front of the client and advisor. We were able to almost complete our preliminary report with only minor changes needed.
- Kaden Kafar
  - Create report and do my portion of the report.
  - Make sure everyone was involved and knew what was due when.
  - Gave pre
- Colin Fessenden
  - Completed preliminary report and notebook
  - Had multiple team meetings to discuss the preliminary report and fabrication plans
- Sam Kahr
  - Completed my portion of preliminary report
  - Gave preliminary presentation
  - Continued to think about our final design
- Dan Altschuler
  - Delivered the preliminary presentation to the client and advisor
  - Completed my portion of the preliminary report
  - Compiled parts of the lab notebook
- Matt Sheridan
  - Gave the preliminary presentation

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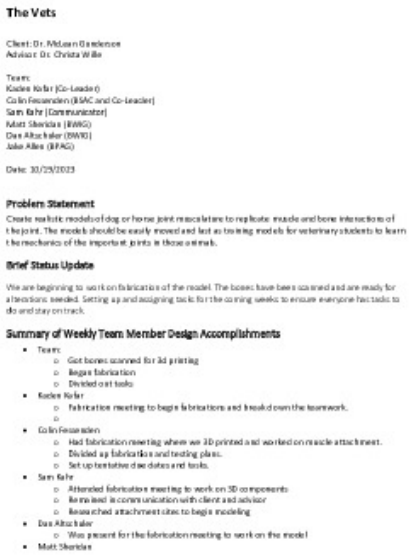
Progress Report - 10/19/2023

MATTHEW SHERIDAN - Oct 19, 2023, 9:35 PM CDT



The Vets

Client: Dr. McLean Glaeleisen
Advisor: Dr. Christa Wille

Team:
Kaden Kellar (Co-Leader)
Colin Fessenden (BSAC and Co-Leader)
Sam Kahr (Communicator)
Matt Sheridan (BWIG)
Dan Altschuler (BWIG)
Jake Allen (BPAG)

Date: 10/19/2023

Problem Statement

Create realistic models of dog or horse joint musculature to replicate muscle and bone interactions of the joint. The models should be easily moved and last as training models for veterinary students to learn the mechanics of the important joints in those animals.

Brief Status Update

We are beginning to work on fabrication of the model. The bones have been scanned and are ready for alterations needed. Setting up and assigning tasks for the coming weeks to ensure everyone has tasks to do and stay on track.

Summary of Weekly Team Member Design Accomplishments

- Team:
  - Got bones scanned for 3d printing
  - Began fabrication
  - Divided out tasks
- Kaden Kellar
  - Fabrication meeting to begin fabrications and break down the teamwork.
  -
- Colin Fessenden
  - Had fabrication meeting where we 3D printed and worked on muscle attachment.
  - Divided up fabrication and testing plans.
  - Set up tentative due dates and tasks.
- Sam Kahr
  - Attended fabrication meeting to work on 3D components
  - Remained in communication with client and advisor
  - Researched attachment sites to begin modeling
- Dan Altschuler
  - Was present for the fabrication meeting to work on the model
- Matt Sheridan

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The_Vets_Progress_Report_Oct_19.pdf (274 kB)

Muscle

KADEN KAFAR - Sep 22, 2023, 11:09 AM CDT

Title: "Morphometric and Anatomic Study of the Forelimb of the Dog"

Date: 9/22/2023

Content by: Kaden Kafar

Present: N/A

Goals:

Research the muscles of the forelimb of a dog.

Content:

Search terms: Forelimb + dog

Citation:

Shahar, Ron, and Joshua Milgram. “Morphometric and Anatomic Study of the Forelimb of the Dog.” *Journal of Morphology*, vol. 263, no. 1, 2004, pp. 107–117, https://doi.org/10.1002/jmor.10295. Accessed 22 Sept. 2023.

Link: https://onlinelibrary.wiley.com/doi/epdf/10.1002/jmor.10295
Notes:
-Gives names and purposes to all the muscles in the forelimb of a dog.

-Gives co ordinates of all the muscle connections and bone landmarks in the animal.

-Gives data on mass, length, and strength of all the muscles in the forelimb of the dog.

Conclusions/action items:

Continue research on locations, strengths, and functions of muscles in the dog forelimb.

Muscle Material

KADEN KAFAR - Sep 27, 2023, 7:00 PM CDT

Title: Muscle Material Research

Date: 9/27/2023

Content by: Kaden Kafar

Present: N/A

Goals: Conduct research on the best material to use

Links: https://formlabs.com/blog/how-to-make-silicone-molds/

https://www.fastradius.com/resources/elastomeric-materials/

Content:

Silicone:

-Easily moldable

-Cheap

-Easy to change color

Elastomers:

-Recommended only 3mm in size

-No easy way to fabricate

Elastic cords:

-Looks cheap

-doesn't get across appearance of muscle

Conclusions/action items:

Decide as a group upon materials to be used.

VetWho

KADEN KAFAR - Sep 22, 2023, 11:13 AM CDT

Title: VetWho model

Date: 9/22/2023

Content by: Kaden Kafar

Present: N/A

Goals: Find competing designs for the forelimb of the dog.

Content:

https://vetwho.com/product/the-model-of-dog-forelimb

-There design models only the bones attached at joints with dowels.

-There is no muscle connections or any muscle at all.

-The cost is $78

Conclusions/action items:

Find other competing model designs of the forelimb of a dog.

Full dog model

KADEN KAFAR - Sep 22, 2023, 11:19 AM CDT

Title: "Anatomy Lab Domestic Canine (Canis lupus familiaris) Anatomy Model"

Date: 9/22/2023

Content by: Kaden Kafar

Present: N/A

Goals: Find competing models of our project.

Content:

https://anatomywarehouse.com/shop-by-profession/veterinarian-zoology/

-Model is full body that has no bones in the model.

-Focuses on internal organ system and external muscle system.

-Does not go into detail on muscle/bone of the fore limb of the dog.

Conclusions/action items:

Conduct more research on the fore-limb of a dog.

9/26/2023 - Silicone Material

Colin Fessenden - Oct 12, 2023, 9:23 PM CDT

Title: EcoFlex Series

Date: 9/26/2023

Content by: Colin Fessenden

Present: N/A

Goals: Find possible silicone type material to model the canine forelimb

Content:

“EcoflexTM Series, Super-Soft, addition cure silicone rubbers,” Smooth, https://www.smooth-on.com/product-line/ecoflex/ (accessed Oct. 12, 2023).

Many different products here. Team can explore which one would most likely fit the scope of the project.

Initial readings show that EcoFlex 00-10 is a viable option.

Conclusions/action items:

Research other materials such as spandex.

10/24/2023 - Molds

Colin Fessenden - Oct 24, 2023, 6:50 PM CDT

Title: Molds

Date: 10/24/2023

Content by: Colin Fessenden

Present: N/A

Goals: Find a moldable clay for the muscles

Content:

Citation:

> Samuël, “Most used materials and methods for making molds,” syntecshop.com, https://syntecshop.com/en/most-used-materials-and-methods-for-making-molds (accessed Oct. 24, 2023).

The most flexible times are casting molds. The easiest way to produce a mold is to build a box around a model so that the casting material can be poured into it and then harden into a hard and solid rubber mold.

Complex molds can be made in parts. Each part is then poured separately. When all parts have been poured and hardened separately, the model is taken out and the mold parts reassembled.

Conclusions/action items:

The idea around this is that the team could create the muscle out of clay or other art material, then pour the mold material over it to create a permanent mold. The team can then use this mold to try different hardness's of silicone.

10/24/2023 - Mold Release

Colin Fessenden - Oct 24, 2023, 6:50 PM CDT

Title: Silicone/Silicone Mold release

Date: 10/24/2023

Content by: Colin Fessenden

Present: N/A

Goals: Find some cost effective techniques to release silicone from silicone molds.

Content:

Citation:

[1] “How do I release silicone from silicone?,” Smooth, https://www.smooth-on.com/support/faq/94/#:~:text=A%20mixture%20of%202%20parts,with%20minimal%20visible%20brush%20strokes. (accessed Oct. 24, 2023).

- A mixture of 2 parts isopropyl alcohol and 1 part dish soap can be used in some cases to release silicone from silicone.
- Petroleum jelly can be used to release silicone from silicone, but it should be thinned with mineral spirits so that it can be applied in a thin layer with minimal visible brush strokes.

Conclusions/action items:

This will be helpful if the team decides to use a silicone type mold. These methods are much more inexpensive than mold release.

9/26/2023 - 3D Printing Muscle Material

Colin Fessenden - Oct 12, 2023, 9:25 PM CDT

Title: 3D Printing with Silicone and Other material

Date: 9/26/2023

Content by: Colin Fessenden

Present: N/A

Goals: Explore alternatives for fabrication of model muscles

Content:

"3D printing with silicone: A worthy complement to LSR molding," Protolabs, https://www.protolabs.com/resources/blog/3d-printing-with-silicone-a-worthy-complement-to-lsr-molding/ (accessed Oct. 12, 2023).

Manufacturing Technology	Material	Color	Durometer	Max Part Size	Surface Finish	Cost	Applications
SLA	Silicone	Translucent white Black	20 to 60A	4.7 in. x 2.8 in. x 3.9 in. (119.4mm x 71.1mm x 99.1mm)	Smooth texture and absence of visible layers	$$$	Prototyping molded silicone parts Seals and gaskets Wearables Buttons
PolyJet	Photopolymer	Black Clear/translucent White	30A to 95A	19.3 in. x 15.4 in. x 7.9 in. (490.2mm x 391.2mm x 200.7mm)	Smooth texture	$$	Overmolding prototypes

Conclusions/action items:

Keep Researching more viable options for materials

10/12/2023 - Mechanical Properties of Canine Skeletal Muscle

Colin Fessenden - Oct 12, 2023, 9:17 PM CDT

Title: Mechanical Properties of Canine Skeletal Muscle

Date: 10/12/2023

Content by: Colin Fessenden

Present: N/A

Goals: Understand some mechanical data from a study of canine muscles.

Content:

The semitendinosus fibers appeared to run parallel to each other throughout the whole length of the muscle. There is a tendinous inscription approximately 1/4 of the total muscle length away from the origin perpendicular to the long axis. The fibers on both sides of the tendinous inscription appeared to be in series with one another. Physically, the muscle could be modeled as an elongated cylinder with constant diameter from origin to the point of insertion. All the muscle fibers functionally run the full length of the muscle. This model was used for the calculation of volume and cross-sectional area. Gastrocnemius Plantaris: Mean muscle length ± SD at L0 was 9.91 ± 1.07 cm and mean CSA±SD was 2.85 ± 0.86. In contrast to the semitendinosus, the gastrocnemius plantaris has a very complicated fiber arrangement around more or less parallel internal tendons. The fiber arrangement was diagonal in relationship to the insertion tendon with a pennation angle of ∼20°. Because of the great variability within the muscle from place to place, fiber lengths were approximately 1/3 to 1/4 of the rest length of the whole muscle.

Citation:

> P. D. Allen and J. K. Barclay, “The mechanical properties of *in situ* canine skeletal muscle,” Frontiers in physiology, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9207469/ (accessed Oct. 12, 2023).

Conclusions/action items:

Begin Fabrication.

9/26/2023- Anatomy of the Forelimb

Colin Fessenden - Oct 12, 2023, 9:27 PM CDT

Title: Anatomy of the Forelimb

Date: 9/26/2023

Content by: Colin Fessenden

Present: N/A

Goals: Find useful literature on material for the forelimb muscle model.

Content:

Document goes over the anatomical structure of the forelimb.

E. Gallant and C. Clarkson, “Appendix A: Supplemental feline notes,” Dissection Lab Guide for Dog and Cat Anatomy, https://pressbooks.umn.edu/dogcatanatomylabguide/back-matter/appendix/ (accessed Oct. 12, 2023).

Conclusions/action items:

Research materials for fabrication.

10/12/2023 - Silicone mechanical properties

Colin Fessenden - Oct 12, 2023, 8:45 PM CDT

Title: Silicone Mechanical Properties

Date: 10/12/2023

Content by: Colin Fessenden

Present: N/A

Goals: Better understand the silicone material when using it to simulate muscle tissue.

Content:

Indentation tests showed similar stress distribution trends in muscle and Ecoflex 0030, but stress magnitudes were higher in Ecoflex 0030 than in porcine muscle. All 3 silicone formulations demonstrated shear moduli within the range of published values for biological tissue. For the experimental conditions reported in this work, Ecoflex 0030 exhibited greater stiffness than porcine muscle.

Citation:

Sparks JL;Vavalle NA;Kasting KE;Long B;Tanaka ML;Sanger PA;Schnell K;Conner-Kerr TA;, “Use of silicone materials to simulate tissue biomechanics as related to deep tissue injury,” Advances in skin & wound care, https://pubmed.ncbi.nlm.nih.gov/25608011/ (accessed Oct. 12, 2023).

Conclusions/action items:

Begin fabrication.

2023/09/21-Individual Research

SAMANTHA KAHR - Sep 21, 2023, 8:56 PM CDT

Title: Individual Anatomy Research

Date: 2023/09/21

Content by: Sam Kahr

Present: Sam Kahr

Goals: Gather a basic understanding of canine forelimb anatomy

Content:

Dogs & Cats | Faculty of Veterinary Medicine | University of Calgary (ucalgary.ca)

Dog, Forelimb, Muscles (1) - 3D model by Vetanat.UZH (@vetanat.uzh) [db19c99] (sketchfab.com)

SimTK: A three-dimensional musculoskeletal model of the dog: Project Home (downloadable model)

-canine forelimbs are actually very similar to humans in terms of number and types of bones and muscles

-there are a lot of little muscles and bones, so we are most likely going to have to pick which ones we include in our model

Conclusions/action items:

I think our next biggest task is to decide specifically which bones and muscles we want to include in our model.

2023/09/21-Individual Research

SAMANTHA KAHR - Oct 12, 2023, 8:16 PM CDT

Title: Individual Competition Research

Date: 2023/09/21

Content by: Sam Kahr

Present: Sam Kahr

Goals: Gather a basic understanding of other canine forelimb models

Content:

Axis Scientific Canine Forelimb with Scapula (anatomywarehouse.com)

-retails at $84

-bones: femur, rotula, stifle joint, tibia, hock, fibula, tarsus, metatarsus, phalanges

-no muscles

-full-sized model: 16.25 in x 5.5 in x 1.5 in; 0.3 lbs

Canine Forelimb right w/ soft tissue - SYNBONE

-bones, ligaments, and soft tissue

-retails at $193.30

Conclusions/action items:

I agree with the previous semester's team and our client in saying that there are not any accurate, affordable, and complete canine models on the market.

2023/09/27-Individual Resesrch

SAMANTHA KAHR - Sep 27, 2023, 7:34 PM CDT

Title: Individual Magnet Research

Date: 2023/09/27

Content by: Sam Kahr

Present: Sam Kahr

Goals: Gather a basic understanding of magnets as an attachment method for design matrix

Content:

Price:

-Amazon link-https://www.amazon.com/s?k=magnets&crid=22A1YCE8FS3TN&sprefix=magnets%2Caps%2C125&ref=nb_sb_noss_1

-relatively very cheap, many different sizes and shapes

-usually less than $0.25 each

Strength:

-wide variety of strength, measured in different ways

-holding power is very straightforward

-Gauss measures remanence (magnetism left in a magnet after the removal of the magnetizing force https://www.first4magnets.com/us/how-is-the-strength-of-a-magnet-measured-i1409)

-100 Gauss is a typical refrigerator magnet

Ease of Use:

-very intuitive to connect and disconnect, no finite dexterity required

-can use circular magnets and 3-D print housings or can use sheets of magnets and cut them into shape of attachment

Safety:

-I couldn't find any major safety concerns in the environment we would be using it in, there's always a small chance of getting pinched but at the strength we would be using there shouldn't be a risk of major injury

Longevity:

-magnets should lose no more than 1% of strength over 100 years when properly cared for (https://mpimagnet.com/education-center/how-long-will-your-magnet-last#:~:text=So%20how%20long%20should%20my,HEAT)

Conclusions/action items:

Personally, I think that magnets are a good option because they are safe, effective, and don't wear out. They are also simple to use, so if a student has issues with fine motor control, they should still be able to use our model.

12/04/2023 Lab Safety Training Documentation

SAMANTHA KAHR - Dec 04, 2023, 1:45 PM CST

Title: Lab Safety Training Documentation

Date: 12/04/2023

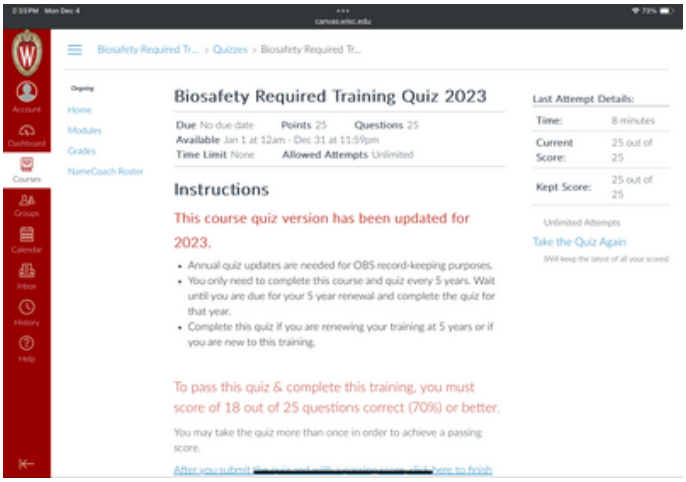
Content by: Sam Kahr

Present: n/a

Goals: to complete and record the required training for access to ECB 1002

Content:

SAMANTHA KAHR - Dec 04, 2023, 2:34 PM CST



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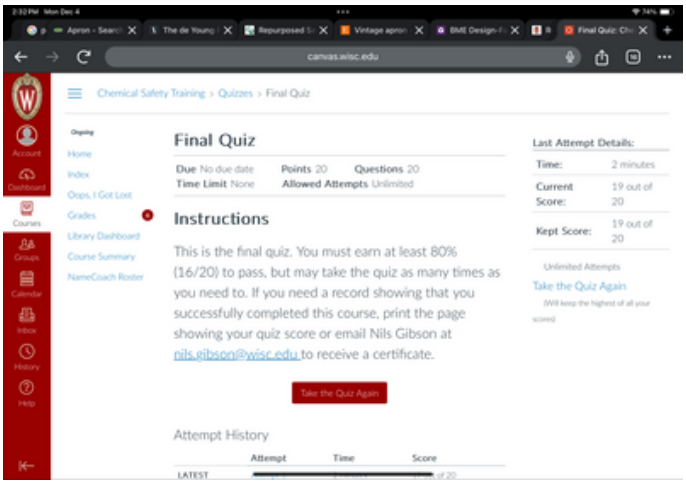
SAMANTHA KAHR - Dec 04, 2023, 2:34 PM CST



Download

IMG_0272.png (371 kB)

Canine Bone Properties

Jake Allen - Sep 22, 2023, 1:10 PM CDT

Title: Canine Bone Properties

Date: 9/22/2023

Content by: Jake Alen

Present: N/A

Goals:

Determine the physical properties of canine bones to be used to find suitable artificial substitutes.

Content:

Notes on "Analysis of Mechanical....":

Notes on "Interspecies Differences...":

Search terms: canine* bone* analysis

Citations:

Changqi Luo, Junyi Liao, Zhenglin Zhu, Xiaoyu Wang, Xiao Lin, Wei Huang, "Analysis of Mechanical Properties and Mechanical Anisotropy in Canine Bone Tissues of Various Ages", BioMed Research International, vol. 2019, Article ID 3503152, 7 pages, 2019. https://doi.org/10.1155/2019/3503152

Jeroen Aerssens, Steven Boonen, Geert Lowet, Jan Dequeker, Interspecies Differences in Bone Composition, Density, and Quality: Potential Implications for in Vivo Bone Research, Endocrinology, Volume 139, Issue 2, 1 February 1998, Pages 663–670, https://doi.org/10.1210/endo.139.2.5751

Links: https://academic.oup.com/endo/article/139/2/663/2987138, https://www.hindawi.com/journals/bmri/2019/3503152/ (This one looks very promising)

Conclusions/action items:

Button Release Locks

Jake Allen - Sep 27, 2023, 5:33 PM

Title: Button Release Lock Connections

Date: 9/27/23

Content by: Jake Allen

Goals: Find possible button locks to be used as connection mechanisms.

Content:

Options:

- Hood locks (https://www.amazon.com/Universal-Aluminum-Vehicle-Release-Fastener/dp/B0B564DYWT/ref=asc_df_B0B564DYWT/?tag=hyprod-20&linkCode=df0&hvadid=598295320795&hvpos=&hvnetw=g&hvrand=4990700711580771539&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=1028057&hvtargid=pl

1729350064934&psc=1)

- easy to obtain (amazon)
- relatively inexpensive (15$ for 4)
- would need to replace bolts to the correct size
- overall very large for our scale (1.25" diameter)
- clean appearance
- very sturdy

- Guitar strap locks * (https://www.amazon.com/Dreokee-Security-Straplocks-Buttons-Retainer/dp/B07S8TS25H/ref=asc_df_B07S8TS25H/?tag=&linkCode=df0&hvadid=343211985571&hvpos=&hvnetw=g&hvrand=14286605089916432972&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=1028057&hvtargid

782079310976&ref=&adgrpid=73034475990&th=1)

- easy to obtain (amazon)
- inexpensive (8$ for 2 good quality or 4 questionable quality)
- need to screw into the printed bone
- clean appearance
- very sturdy
- 0.9' diameter

- Button quick-release pins

- Way too expensive to be viable

Price:

- Both options will be ~ 15$ for four (pretty affordable for our budget)

Strength:

- Both options are meant to withstand far more force than will ever be put into them

- No chance of either breaking off from the applied force from moving the muscles and bones

Ease of Use:

- Both options should be very intuitive to use and have a satisfying feel to them

- Button would likely be simpler to use than strap lock

Installation:

- Requires drilling into the bone and through 2 points of the muscles

Obvious cons:

- Takes up more space than other options

- Will put more stress on the bone than other options (may need to reinforce)

- Maybe on the more expensive end of the connection options

Conclusions/action items:

Button locks/ strap locks would be an extremely durable connection system that is intuitive and would feel substantial to use. These would eliminate the loose connection issues of magnets bu would also take up more real estate on the bones. May not be a viable solution if you were to add more muscles beyond the ~5 or so planned. It is possible that we could also design a similar mechanism that is smaller, but that time is likely better spent elsewhere.

Preliminary Anatomy Research 9/21/2023

Title: *Preliminary Anatomy Research*

Date: *9/21/2023*

Content by: *Matt Sheridan*

Present: *Matt Sheridan*

Goals: *To research basic structure of canine forelimbs*

Content:

https://en.wikivet.net/Canine_Forelimb_-_Anatomy_%26_Physiology

https://www.physio-pedia.com/Anatomy_of_the_Canine_Front_Limb

https://the-balanced-dog.com/2019/04/14/triceps-injuries-in-dogs/ (photo)

Bones/joints

- Bones on the proximal forelimb
  - Scapula: basis of shoulder region, has extrinsic and intrinsic muscle attachments
  - Humerus: long bone of the forearm
  - Radius: bone attaching humerus and distal forelimb
  - Ulna: runs alongside the radius, separated by pronator quadratus muscle
- Joints on proximal forelimb
  - Shoulder joint
    - Ball and socket joint
    - Limb flexion involves shoulder extension, (limb flexion ≠ shoulder flexion)
  - Elbow joint
    - Hinge joint
- Bones on the distal forelimb
  - Carpal bones
  - Metacarpal bones
  - Phalanges
- Joints on distal forelimb
  - Carpal joint
    - Hinge joint

Muscles

- Elbow muscles
  - Extensors
    - Triceps brachii
      - 4 heads (long, lateral, medial, accessory)
      - Long head attaches to scapula
      - Other heads attach to shaft of the humerus
    - Tensor fasciae antebrachii:
      - Connects to latissimus dorsi
  - Flexors
    - Biceps brachii
      - Connects to scapula
    - Brachialis
      - Connects to humerus

Conclusions/action items:

Plan on doing research into possible muscle attachments in the future.

Velcro Attachment Research 9/26/2023

MATTHEW SHERIDAN - Sep 29, 2023, 1:09 PM CD

Title: *Velcro Attachment Research*

Date: *9/26/2023*

Content by: *Matt Sheridan*

Present: *Matt Sheridan*

Goals: *To gather information on the strength and durability of velcro as a possible muscle attachment design.*

Content:

http://www.oandplibrary.org/poi/pdf/1982_02_093.pdf

https://www.velcro.com/news-and-blog/2020/08/which-velcro-brand-fastener-is-the-strongest/#:~:text=VELCRO%C2%AE%20Brand%20Sticky%20Back%20Fasteners&text=These%20general%20purpose%20fastening%20solutions,lightweight%20items%20on%20the%20wa

- Velcro, or hook and loop fasteners, can be used as a method of attaching and detaching things fairly easily
- Standard velcro has roughly 48 attachments per cubic centimeter
- In shear, with a 50x72mm overlap space, standard velcro can withstand a force of 195 Newtons.
- After load cycling (100 uses at 50% max strength), the standard velcro with the same overlap space withstood a force of 182 Newtons, and after 500 cycles, it withstood 137 Newtons.
- According to the Velcro brand, velcro can withstand 1 lb per cubic inch up to 5 lbs.

Conclusions/action items:

Need to use this information to help fill out the design matrix for possible designs. The overall takeaway from this research is that velcro does a decent job of attachment, but likely not good enough or durable enough to withstand the load that it will need to for this problem.

Anatomy Research 9/21/23

Dan Altschuler (daltschuler2@wisc.edu) - Oct 31, 2023, 12:02 AM CDT

Title: Anatomy Research

Date: 9/21/23

Content by: Dan Altschuler

Present: Dan Altschuler

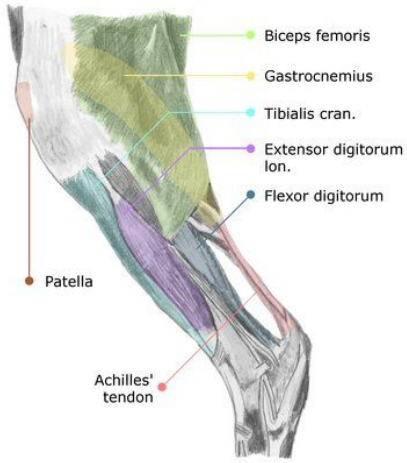
Goals: General Anatomy Info

Content:

- Forelimb (thoracic limb) has 7 different bones
    - Scapula, humerus, radius, ulnar, carpus, metacarpals, phalanges
- Canines do have a clavicle, but has no functional role in their shoulders
- There are 7 different carpal bones
- Radius and ulnar are standard bones
- Radial and intermediate carpal bones are fused, forming the canine ‘radial’ carpal bone

Joints

- Scapulo-trunk
    - Synsarcotic connection, so union of the skeleton from just muscles
    - Muscles sling from the trunk to scapula and act as shock absorbers
- Shoulder
    - Ball and socket joint
    - Shoulder flexion is unrelated to limb flexion, which requires shoulder extension
    - Bicep tendon sits on the cranial part of the joint and connects to the humerus by a ligament (the only true ligament in the joint)
- Elbow
    - Hinge joint
    - Both medial and lateral ligaments that limit rotation when elbow is flexed
- Carpal joint
    - Hinge joint
    - Many carpal bones and ligaments to stabilize the joints
    - There exists a carpal canal that nerves, tendons, arteries and veins all pass through
    - Normal rom in flexion is between 20-30 degrees but in hyperextension the rom becomes 10-15 degrees



Conclusions/action items:

Continue research on anatomy

Links:

“Chapter 3. animal anatomy: Dog anatomy, anatomy, Animal Anatomy,” Pinterest, https://www.pinterest.com/pin/302515299964404638/.

“Anatomy of the canine front limb,” Physiopedia, https://www.physio-pedia.com/Anatomy_of_the_Canine_Front_Limb.

Muscle Material 9/26/23

Dan Altschuler (daltschuler2@wisc.edu) - Oct 31, 2023, 12:00 AM CDT

Title: Epoxy Resins

Date: 9/26/2023

Content by: Dan Altschuler

Present: N/A

Goals:

Research resin as a possible muscle material for the team model

Content:

Epoxy Resin

- majorly marketed as an adhesive and for paint coating

- hardens after casting/can use a mold to cast but then need to be aware that the material will not deform a lot after movement

- would be hard to balance tensile strength in muscles and also match up with the weaker tendons

- excellent chemical and water resistant properties/ good adhesion to surfaces

- could use 3D printed molds to cast the resin into place

- resin casting is unfortunately very expensive and can be pretty heavy as well

- epoxy resin also has a very low viscosity

- can do well in very high temperatures

Plastic Resin

- thermoplastics are very quickly moldable and colorable

- plastic resin is also a cheaper version than epoxy resin

- environmental worries about plastic resin (not sure if this matters that much, though it can be recycled)

- other additives are in the plastic resin to prevent heat damage and keep bacteria off (cleaning issue solved?)

- multi-faceted and surprisingly strong for the low cost involved

- heat required for the molding and casting (of course it is)

- since plastic resin is so multipurpose, it is concerning on whether or not it would be useful for the project

Conclusion and Action Items:

Resin is a decent option for muscle material, as we can find pretty inexpensive methods for molding and casting

Need to finish design matrix and fill out with resin as my material

Links:

Gantrade, “Epoxy resins,” #1 Global Industrial Chemical Supplier, https://www.gantrade.com/blog/epoxy-resins (accessed Oct. 30, 2023).

Jodee RedmondLast Modified Date: September 16, “What is plastic resin?,” About Mechanics, https://www.aboutmechanics.com/what-is-plastic-resin.htm?expand_article=1.

10/30/23 Skulls Unlimited Bone Model

Dan Altschuler (daltschuler2@wisc.edu) - Oct 30, 2023, 11:58 PM CDT

Title: Skulls Unlimited Competing Design

Date: 10/30/23

Content by: Dan

Present: N/A

Goals:

Research a competing design to our project to consider possible flaws in our design, and also to examine why our design is better

Content:

Model only contains bones, so our model is a cut above with respect to prospective muscles and tendon connections

Price for the bone only model is also $195, and while we do not currently know our price for fabrication, it should not be anything more if not less

Models stand with a wood base, so they are not strong on their own

The model is also not uniform in length or color, so differences between models makes it less reliable

Citations

“Real domestic dog forelimb,” Skulls Unlimited International, Inc., https://www.skullsunlimited.com/products/real-domestic-dog-forelimb-disarticulated

Conclusions/action items:

Continue to look at more competing designs

Include new content for the final report

Muscle Prototyping and Initial Ideas

Dan Altschuler (daltschuler2@wisc.edu) - Oct 26, 2023, 6:20 PM CDT

Title: Muscle Ideas

Date: 10/24/23

Content by: Dan

Present: N/A

Goals: Research and choose the priority muscles for the final design

Content:

Elbow:

Extensors;

Triceps brachii (4 heads in a dog)

Long head originates from the caudal border of the scapula; Lateral, medial, and accessory heads originate from the shaft of the humerus

Tensor fasciae antebrachii

Origin: tendon and lateral surface of the lat (may not work for our model)

Flexors;

Biceps brachii

Origin: supraglenoid tubercle of the scapula

runs through the intertubercular groove of the humerus

Brachialis

origin: proximocaudal humerus

inserts proximal to biceps

Anconeus

origin: lateral epicondylar crest, the lateral epicondyle and the olecranon fossa

action: extends the elbow and tenses the antebracchial fascia

DISCUSSION:

Biceps and triceps are a must for the prototype

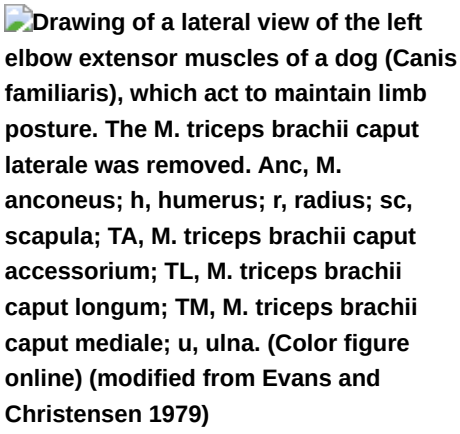
Including all 4 heads of the tricep as well as both heads of the bicep is a good goal for representing muscles action over joints

Need to consider how these muscles interact with the joints, and how these joints are going to be made (correspond with bone group)

Brachialis and anconeus seem to be great smaller muscles to include for more representation of elbow muscles

Could consider shoulder muscles, but depends on how high up the model goes, and how those connections can be accurately depicted

Tensor facsiae antebrachii connects to the latissimus dorsi which will likely not be on the model



Drawing of a lateral view of the left elbow extensor muscles of a dog (Canis familiaris), which act to maintain limb posture. The M. triceps brachii caput laterale was removed. Anc, M. anconeus; h, humerus; r, radius; sc, scapula; TA, M. triceps brachii caput accessorium; TL, M. triceps brachii caput longum; TM, M. triceps brachii caput mediale; u, ulna. (Color figure online) (modified from Evans and Christensen 1979)

Citations:

R. A. Meyers, Drawing of a lateral view of the left elbow extensor muscles of a dog ..., https://www.researchgate.net/figure/Drawing-of-a-lateral-view-of-the-left-elbow-extensor-muscles-of-a-dog-Canis-familiaris_fig1_333431165 (accessed Oct. 24, 2023).

“Canine forelimb - anatomy & physiology,” Canine Forelimb - Anatomy & Physiology - WikiVet English, https://en.wikivet.net/Canine_Forelimb_-_Anatomy_%26_Physiology#Muscles_of_the_Forelimb (accessed Oct. 24, 2023).

Dr. A. Micheau and Dr. D. Hoa, “Anconeus muscle - vet-anatomy,” IMAIOS, https://www.imaios.com/en/vet-anatomy/anatomical-structure/anconeus-muscle-11077963980 (accessed Oct. 24, 2023).

Conclusions/action items:

2014/11/03-Entry guidelines

John Puccinelli - Sep 05, 2016, 1:18 PM CDT

Use this as a guide for every entry

- Every text entry of your notebook should have the **bold titles** below.
- Every page/entry should be **named starting with the date** of the entry's first creation/activity, subsequent material from future dates can be added later.

You can create a copy of the blank template by first opening the desired folder, clicking on "New", selecting "Copy Existing Page...", and then select "2014/11/03-Template")

Title: Descriptive title (i.e. Client Meeting)

Date: 9/5/2016

Content by: The one person who wrote the content

Present: Names of those present if more than just you (not necessary for individual work)

Goals: Establish clear goals for all text entries (meetings, individual work, etc.).

Content:

Contains clear and organized notes (also includes any references used)

Conclusions/action items:

Recap only the most significant findings and/or action items resulting from the entry.

2014/11/03-Template

John Puccinelli - Nov 03, 2014, 3:20 PM CST

Title:

Date:

Content by:

Present:

Goals:

Content:

Conclusions/action items:

BME Design- Fall 2022 - Notebook

KADEN KAFAR - Sep 08, 2023, 1:25 PM CDT

BME Design-Fall 2022 - Zach Spears
Complete Notebook

PDF Version generated by
Emily HUTSELL
on
Dec 14, 2022 @09:21 PM CST

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