

Human Centered Design Studio
Capstone Design Program
Colorado School of Mines
1500 Illinois St.
Golden, CO 80401



March 5th, 2019

Jonathan Kuniholm
President, Open Prosthetics

Cc: Dr. Joel Bach
Professor Chelsea Salinas

Dear Jon,

The purpose of this letter is to articulate the scope of the Open Prosthetics Jaipur Hand project, per our meeting on February 28th, 2019.

As discussed during the February 28th meeting, our project will be broken into two parts. The first segment will focus on recreating the becker hand mechanism on a smaller scale, in order to fit into an aesthetically pleasing outer shell. The team will explore the possibility of designing a universal mechanism that can fit inside any size hand, or designing a mechanism that can be easily built in multiple different sizes. The team will prioritize the design of the palm that would contain the mechanism, and if time permits, will continue the redesign of the fingers. The scaled down mechanism must maintain the basic function used in the Becker hand, including the following:

1. 5 finger voluntary opening with articulated joints.
2. Backlock functionality
3. Conforming grip from tapered spring covers on fingers
4. Cylindrical grasp, Tip/Palmar grasp
5. Cable anchor attachment for a ball end Bowden cable terminator
6. Similar excursion and opening distance

Upon the successful completion of the first part of the project and approval of the updated mechanism from all parties, the team will work to improve the functionality of the existing Becker mechanism. Improvements could be any of the following:

1. Opposable thumb for additional grasps
2. Additional moving finger joints
3. Non-parallel opening of MCP joints
4. Series elastic links in fingers or whiffletree to equalize force in closure of the fingers
5. Increased opening distance

Our team is excited about the opportunity to work with you on this project. We will send all project updates, including CAD models and sprint outlines, through openprosthetics.org.

Best,
Connor Weddle and Addy Bateman

Project Charter

Scope of Document: Project Overview, Project Staff, Project Objectives, Key Project Considerations, Communication Plan, & Project Budget and Resources

Contact Information:

Name: Addy Bateman Email: abateman@mymail.mines.edu Phone: (303) 514 2295

Name: Connor Weddle Email: connorweddle@mymail.mines.edu Phone: (630) 363 1750

The purpose of this document is to identify and communicate the inputs, activities, and responsibilities assigned for the HCDS design project. Any revisions to this document during the course of the project must be reviewed and approved by all parties.

Revision	Notes	Date
1	Initial Release	March 5th, 2019

1.0 Project Overview

Project Description

Jon Kuniholm is in need of a new design for a prosthetic hand, in order to create a hand that is both aesthetic and functional. The functionality will be based around the mechanisms used in the Becker Hand, which is made up of a series of levers, springs, and pins to open the hand when pulling on a cable. The cable is generally attached by a harness to a user's opposite shoulder. The aesthetic component is a rubber outer shell that has been designed by Jon. This mechanism will need to be designed to work for the smallest hand possible, in order to ensure its scalability. This design is intended to help users with the basic functionality of opening and closing the hand, while also providing the visual comfort of an aesthetic hand. If time permits, the design will continue to be updated by meeting other desires of the client, such as additional thumb positions and providing better control of the force while opening and closing the fingers.

Scope Statement

The primary goal of this project is to design a new prosthetic hand with an updated Becker Hand mechanism for functionality, and the ability to fit inside a smaller, aesthetically pleasing outer shell. The team will base its design on the existing Becker mechanism, with the goal of mimicking and improving the functionality of the original design. The team will use commercially available materials and components whenever possible. Once the primary task is completed, the team will work to make functional improvements to the mechanism. A prototype of the updated design will be provided to the client, and all documentation for the project will be shared on the Open Prosthetics website. The long term goal of this project is to use the design for the Jaipur Foot Clinic in India, so the team should be designing the prototype with this intent in mind.

Restrictions, Exclusions, and Assumptions

Based on initial client meetings and/or the project prompt, the following restrictions, exclusions, and assumptions will be used to limit the scope of the project:

- The hand must be designed to fit the smallest cosmetic skin possible, in order to ensure the design is scalable.
- Whenever possible, the hand should be built using commercially available products, in order for the design to be affordable for most users.

Project Charter

- The scope of this project will be focused on designing a durable palm to fit the becker hand mechanism, and if time permits the team will make improvements to the mechanism and attached fingers as well.
- The improved design must easily attach to a standard wrist.

2.0 Project Staff

Team Members

The following individuals compose the core design team and are responsible for managing and completing the project:

Role	Name	Email	Phone
Project Lead	Addy Bateman	abateman@mymail.mines.edu	(303) 514 2295
Project Lead	Connor Weddle	connorweddle@mymail.mines.edu	(630) 363 1750
Technical Lead	Victoria Martinez-Vivot	vmartinezvivot@mymail.mines.edu	(719) 646 9229
Mechanical Design	Bryan Marsh	bryanmarsh@mymail.mines.edu	(720) 384 6088

Supporting Faculty

The team will report to a common Faculty Advisor for internal oversight and have access to Faculty Consultants for additional support. The contact information for these individuals is given below:

Role	Name	Email
Faculty Advisor	Dr. Joel Bach	jmbach@mines.edu
Faculty Advisor	Dr. Chelsea Salinas	csalinas@mines.edu

Client Contact Information

The client contact information for this project is provided below:

Name	Email	Phone
Jonathan Kuniholm	jon@openprosthetics.org	(919) 491 2819

3.0 Project Objectives

Major Milestones

The following key dates will require the presence of key stakeholders and should be reserved. The dates provided are best estimates, subject to adjustment in consultation with expected attendees.

Event	Date	Expected Attendees
Letter of Intent	March 5, 2019	All
Mechanism Design	April 4, 2019	All

Project Charter

Palm Housing Design	April 23, 2019	All
Final Prototype sent to Jon	May 3, 2019	All
Final Design Report	May 9, 2019	All

List of Project Deliverables

The following list of deliverables defines the targeted output of this project that the team will deliver to our Faculty Advisors and Jon Kuniholm. The deliverables (in order of production) are as follows:

1. Letter of Intent
 - a. Project Charter
 - b. Project Schedule
 - c. Preliminary Client Needs Table
2. Design Reviews
 - a. Preliminary
 - b. Intermediate
3. Final Design Review
 - a. Working Prototype
 - b. Final Design Report

Customer Needs

The customer needs (as understood by the team) are attached.

4.0 Key Project Considerations

Applicable Laws, Permits, Codes and Regulations

The following laws, permits, codes, and regulations will govern the design of this project:

- FDA Class 1 Exempt Medical Device Policy

Liability

The work completed as part of this project is the work of engineering students in training. If the client wishes to build/implement the final design, he will need to independently hire a Professional Engineer (P.E.), or another qualified individual, to review and approve the student's work. The P.E., or another qualified individual, would review the drawings, specifications, and/or calculations, modify as required, and take responsibility for the project by signing and sealing the documents. If the client chooses to build the student's design independently (without professional review) then CSM, the students, the faculty advisor, the course faculty, the consultants, and other personnel are not liable for the design.

Confidentiality Restrictions

The team is aware that this project is subject to a confidentiality agreement. Per the client's request the following restrictions on communication and data storage will be observed:

- This design will not be displayed in trade fair or elevator pitch until approved by Jon Kuniholm.

All assignments will be reviewed and graded by course faculty and there are several mandatory presentation assignments including the Elevator Pitch and Trade Fair where the team will be required to present their work publically. However, the team will work with the client to filter the confidential details out of these presentations beforehand.

Project Charter

5.0 Communication Plan

Our team will communicate with the client via email and posts on the Open Prosthetics website for design reviews, design concerns, and any minor questions that need to be addressed. For preliminary and intermediate design reviews, we will schedule a phone call with the client.

Status Reports

The team will communicate the project status on a bi-weekly basis with the client. This communication will be posted on Jon's Open Prosthetics website, to ensure anyone who is interested has access to the progress of the project as well.

6.0 Project Budget and Resources

Preliminary Budget

Quantity	Cost	Material
1	\$400	Becker Hand
N/A	\$150	Miscellaneous Prototyping Hardware
Total Cost	\$550	The Approximate Total Cost of the Device

Equipment Needs

- Computer with CAD and FEA Analysis Software
- Machine Shop Tools
- 3D Printer

Open Prosthetics Jaipur Hand Client Needs

#	Date	Need (N)/Want (W)	Objective
1	3/5/2019	N	5 finger voluntary opening with articulated joints.
2	3/5/2019	N	Backlock functionality
3	3/5/2019	N	Conforming grip of the palm
4	3/5/2019	N	Cylindrical grasp, Tip/Palmar grasp
5	3/5/2019	N	Cable anchor attachment for a ball end Bowden cable terminator
6	3/5/2019	N	Similar excursion and opening distance to existing mechanism
7	3/5/2019	N	Designed to fit the smallest cosmetic skin (6.8" glove size)
8	3/5/2019	N	Built using durable and commercially off the shelf products
9	3/5/2019	W	Opposable thumb for additional grasps
10	3/5/2019	W	Additional moving finger joints
11	3/5/2019	W	Non-parallel opening of MCP joints

Project Charter

12	3/5/2019	W	Series elastic links in fingers or whiffletree to equalize force in closure of the fingers
13	3/7/2019	W	Increased Opening Distance