Tibial Stent Design Team Progress Report

Client: *Dr. Matthew Halanski*
Advisor: *Dr. Paul Thompson*

Team:	*Evan Lange*	*elange2@wisc.edu (Team Leader)*
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Date: *March 7th, 2014 – March 14th, 2014 (Week 7)*

Problem Statement

(revised 02/03/14)

Tibia fractures are common in children, and these injuries are currently managed nonoperatively using casts; however, a surgically implanted device would provide more structural stability and aid the healing of the fracture. Adult patients with this injury typically have a rigid intramedullary device implanted into their tibia bone. Unfortunately, these implants cannot be used in pediatric patients due to the presence of growth plates at the implantation site. A previous design team produced a working device that can enter the medullary canal through a hole in the side of the bone and then expand outward to stabilize the fracture, held in place by static friction against the canal wall. This device is flexible enough to fit into the canal, yet rigid enough to maintain fracture reduction, can be secured in place with screws, and can be removed from the canal when desired; however, the device is not fully fixated against the walls of the bone canal, and the friction force of the device is not sufficient to prevent axial rotation within the canal. This rotation can lead to device failure resulting in unnecessary pain for the patient and extra surgery to correct the issue. Last semester, this team designed a theoretical device consisting of a threaded segmented centerpiece inside of a metal biaxial braid. When the centerpiece is rotated, the braid experiences a compressive load, which causes it to expand radially. This radial expansion would ultimately provide the force to stabilize the fracture; however, the current design does not allow for sufficient force to be applied to the centerpiece.

The goal of this semester is to improve the design from last semester by strengthening the centerpiece joints, which will give us the ability to build and test a prototype, and develop a novel tool that can rotate the centerpiece when the implant is placed into a bone.

Last Week's Goals (14-7 days ago)

- Complete SolidWorks modeling of cap designs
- Contact fabrication firm
- Obtain new K-wires from Dr. Halanski
- Complete bend testing of K-wires and determine appropriate diameter to use as centerpiece for this design

This Week's Goals/Individual Goals (7-0 days ago)

- Complete bend testing of K-wires and determine final diameter for use as centerpiece in this design
- Complete SolidWorks modeling of caps, determine quantity to be ordered, and contact fabrication company
- Contact a Biomechanics, Engineering Physics, or Mechanical Engineering professor for guidance on the best method to obtain a benchmark bending stiffness for our device
- Outline plan for testing of braided cylinder

This Week's Accomplishments

- Structures lab says bend testing will not be informative for bending yield – they recommend calculating maximal elastic curvature using the results of a tensile test

- Emailed Prof. Krishnan Suresh (teaches Mechanics of Materials) to set up time to discuss both K-wire maximal elastic curvature and modeling of how our design affects the bending properties of fracture
- Team has set goal to have caps ordered from fabrication firm and all mathematical modeling complete by Friday, March 28 (the Friday after Spring Break)

Project Difficulties

- none

Next Week's Team Goals

- Over spring break:
  - Further investigate mathematical analysis of K-wire bending to determine how tensile test results may be used to compute maximal elastic curvature
  - Conduct extensive investigation of existing products or brainstorming of design to apply torque to device inside the bone canal
  - Determine thread count on each K-wire
- Week after spring break:
  - Complete tensile testing of K-wires in Structures Lab
  - Use mathematics to determine maximal elastic curvature
  - Complete SolidWorks modeling of caps (and possibly nut)
  - Order caps (and nut) from fabrication company

Summary of Design Accomplishments

- The team is meeting weekly to accelerate the design process
- The team has a meeting scheduled with the client to discuss goals for this semester and to obtain information about quantifying device performance constraints
- The team has met with Dr. Halanski to discuss goals for this semester
- The team has completed the Design Matrices for this semester and the Midsemester Presentation
- The team has completed the Midsemester Report

Expenses

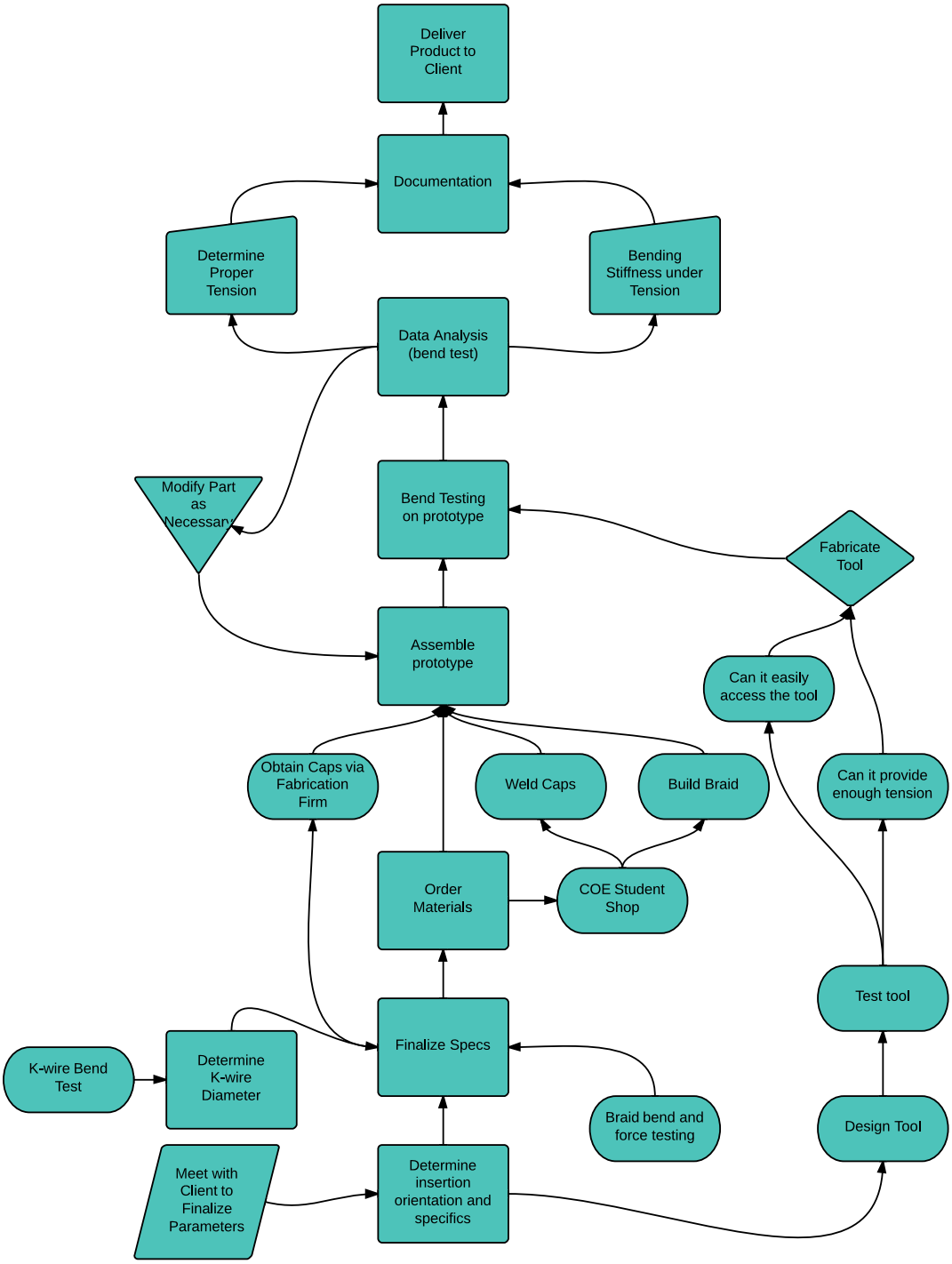
- none at this time

Schedule for Spring 2014

Task	*January*	*February*				*March*					*April*				*May*	
	31	7	14	21	28	7	14	21	28	31	4	11	18	25	2	9
Groundwork																
Set Meeting Time	X	X														
Brainstorming	X	X	X	X	X	X	X									
ECB 2005 Access	X	X	X	X												
Testing																
Cast Material					X	X	X									
Braided Structure					X	X	X									
Prototyping																
Order Materials						X	X									
Build Prototype							X									
Test Prototype																
Deliverables																
Progress Reports	X	X	X	X	X	X	X									
Notebooks	X	X	X	X	X	X	X									
PDS	X	X	X	X												
Midsemester Presentation				X												
Midsemester Report				X	X											
Final Poster																
Final Report																
Meetings																
Advisor Meeting	X	X	X	X	X	X	X									
Team Meeting	X	X	X	X	X	X	X									
Client Meeting			X			X										
Website																
Update	X	X	X	X	X	X	X									

Activities

Person(s)	Task	Time (hrs)	Weekly Total	Semester Total
Evan	*Team Role (Leader)*		5.0	50.0
	Weekly progress report	1.0		
	Developed next week's team goals	1.0		
	Other			
	Weekly Team Meeting	2.5		
	Emailed Prof. Suresh	0.5		
Karl	*Team Role (Communicator)*		5.0	50.0
	n/a			
	Other			
	Weekly Team Meeting	2.0		
	Structures Lab	3.0		
Tyler	*Team Role (BPAG)*		4.5	36.0
	n/a			
	Other			
	Weekly Team Meeting	2.5		
Sarah	*Team Role (BWIG)*		3.0	35.0
	Updated design website	0.5		
	Other			
	Weekly Team Meeting	2.5		


Deliver Product to Client
Documentation
Determine Proper Tension
Bending Stiffness under Tension
Data Analysis (bend test)
Modify Part as Necessary
Bend Testing on prototype
Fabricate Tool
Assemble prototype
Can it easily access the tool
Obtain Caps via Fabrication Firm
Weld Caps
Build Braid
Can it provide enough tension
Order Materials
COE Student Shop
Test tool
K-wire Bend Test
Determine K-wire Diameter
Finalize Specs
Braid bend and force testing
Design Tool
Meet with Client to Finalize Parameters
Determine insertion orientation and specifics