BIOM Test Fixture

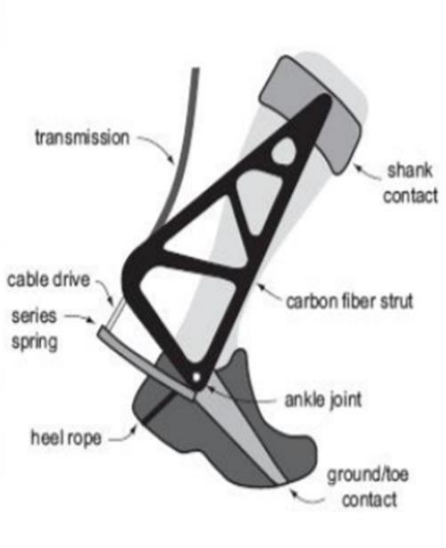
ME476C - section 001
Husain Alshammari
Marzouq Alenezi
Saood Alenezi
Saoud Alenezi
Naser Alowaihan

Introduction

- The BiOM is a prosthetic leg that is under the knee height. It replicates the ankle and muscles surrounding it, propelling the user forward with each step, developed by Hugh Herr, a survivor of lower limb amputation at MIT Media Lab’s Biotronic research group
- A Test Fixture is a device that is used to run tests on any other device (Testing Electronics, Software's and Physical Devices)

Project Description

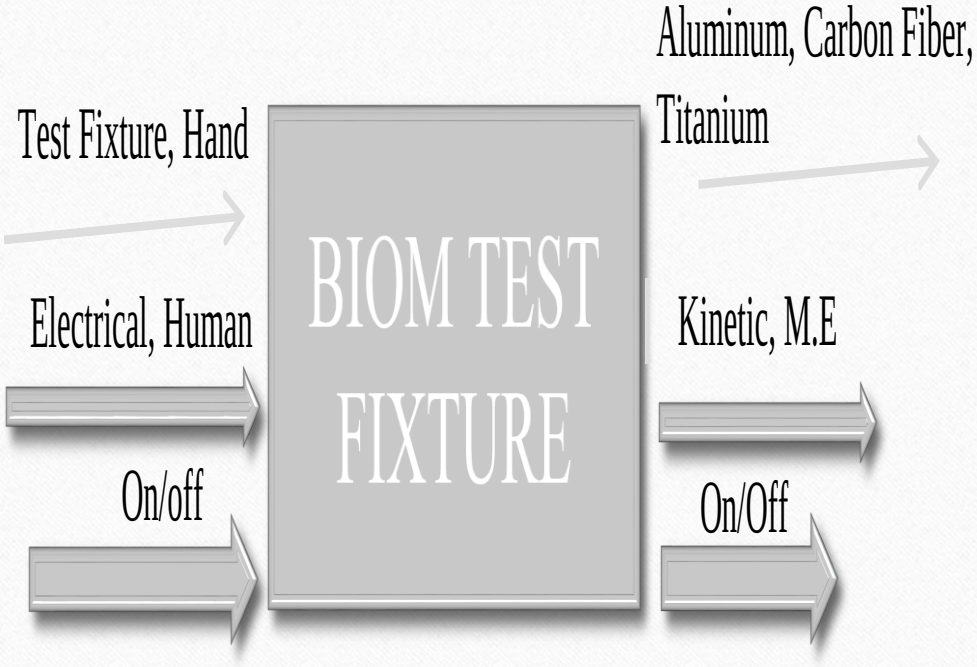
- To design an automated, programmable test fixture for the robotic prosthetic lower limb. A single actuator, Pneumatic design was assigned for reference but were asked to design for either hydraulics or electric motor



Sponsors and clients

- The sponsor and client for this project is Dr. Tester.
- Dr. Tester has been conducting research on the BiOM for several years testing and collecting data on its performance.
- Dr. Tester is also the chair of Mechanical Engineering program at Northern Arizona University

Black Box Model



Naser Alowaihan

Functional Decomposition

- The functional decomposition of the BioM test fixture design under consideration are discussed under the following categories:
  - Engineering Requirements → define the criteria and the requirements for the design
  - Robotics → the actual movements are not possible without the robotics or the mechanical devices that are controlled by the algorithm
  - Mechatronics → brain of the BIOM test fixture is the mechatronics that uses complex algorithms to achieve the necessary movements

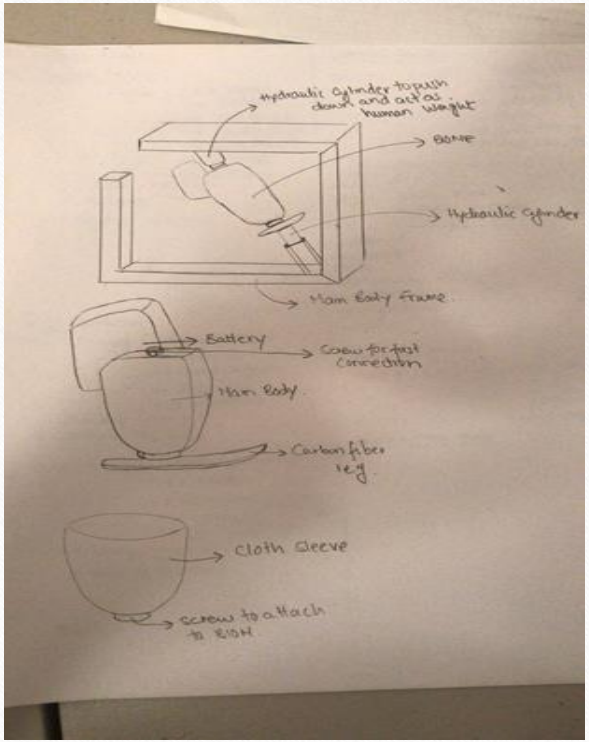
Design Considered

PROS:

1. The carbon fiber leg is lightweight and has great strength and thus can support a larger weight
2. It is also flexible so as to distribute the forces evenly to the ground when the foot touches the ground when the BIOM test fixture is required to slow down
3. The dual hydraulic cylinder design provides 2 degrees of freedom
4. The design also has a cloth sleeve that has durable cushioned material that attaches to the human leg and provides a snug and comfort fit by distributing the forces at the contact point

CONS:

1. The battery limits the power, but that is true for any power prosthetic leg. It is important to optimize the power requirement during the testing phase.



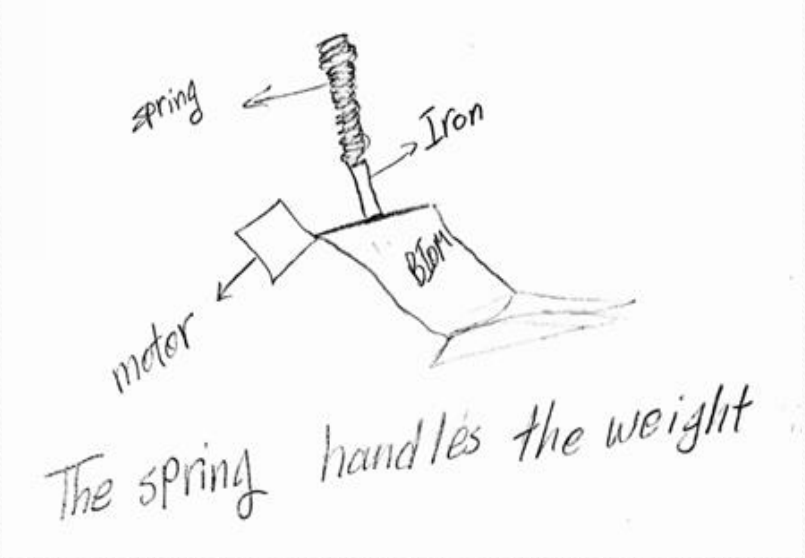
Design Considered

PROS:

1. The prosthetic can be used when it runs out of battery in some situations if special attachments can be provided to it
2. The spring assembly provides limited three-dimensional motion while providing comfort and supporting heavy weight

CONS:

1. If the device is not optimized, the design can get heavy required a bigger motor and thus cannot be used in the manual mode when the prosthetic runs out of power



Marzouq Alenezi

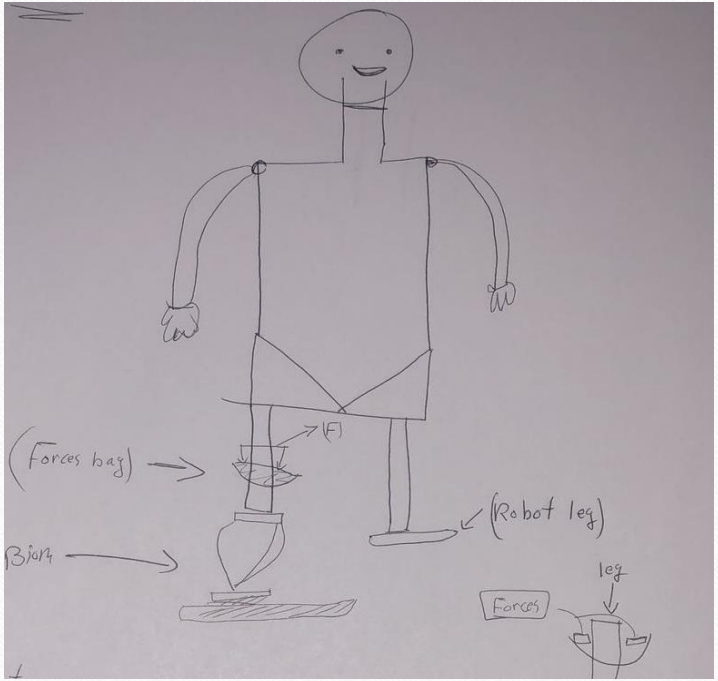
Design Considered

PROS:

1. The success of this design depends on the algorithms that are used to integrate the two BiOMs providing the best functionality to the prosthetic. So, it can be very versatile
2. The multiple legs provide stability that is much needed in uneven terrain

CONS:

1. The integration of two BiOMs can make programming the microprocessor very complicated and the testing can be a challenge



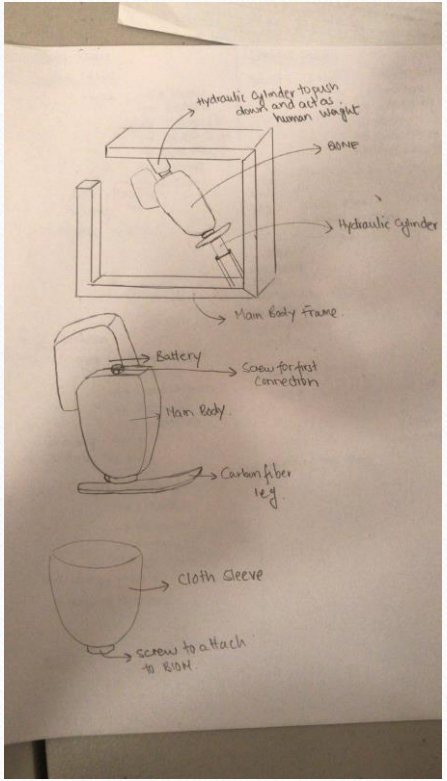
Pugh Chart

- The rationale behind selecting this design is primarily practicality
- the team decided to go with a design that is simple and practical and at the same time efficient
- Design-1 as selected has many pros as mentioned in the previous slide

Criteria/Concept	design 1	design 2	design 3	design 4	design 5	design 6	design 7	design 8	design 9	design 10
A Test Fixture that can analyze the BiOM a prosthetic leg in a fixed and controlled environment.	+	+	+	+	+	-	-	-	-	+
A good design that can work in an indoor laboratory environment (don't need to account for natural causes such as rain, wind and snow)	+	-	+		+	-	-	+	+	+
Can replicate the same effects as if worn in real life.	+	+	S	S	S	-	-	-	-	+
Easy to transport.	S	-	S	S	S	+	+	+	+	S
Durability, needs to with stand forces over time.	+	-	-	S	S	+	S	S	S	-
Hydraulic cylinder	+	+	+	-	-	-	-	+	+	-
Pneumatic Acutator	-	-	-	-	-	-	+	-	-	-
Electrical Motor	-	+	-	-	-	+	-	-	-	+
Σ+	5	4	3	2	2	3	2	3	3	4
Σ-	2	4	3	3	3	5	5	4	4	3
ΣS	1	0	2	3	2	0	1	1	1	1

Selected Design

- The selected design is consists of a text fixture body frame attached with a hydraulic cylinder connected to the BIOM that acts as human weight. This replicates the forces exerted by the human on the prosthetic leg. The prosthetic itself consists of another hydraulic cylinder connected to the BIOM test fixture microprocessor and attached to the carbon fiber leg
- the design uses carbon fiber leg is lightweight and has great strength and thus can support a larger weight
- The power to the device is supplied by a battery attached to the prosthetic leg



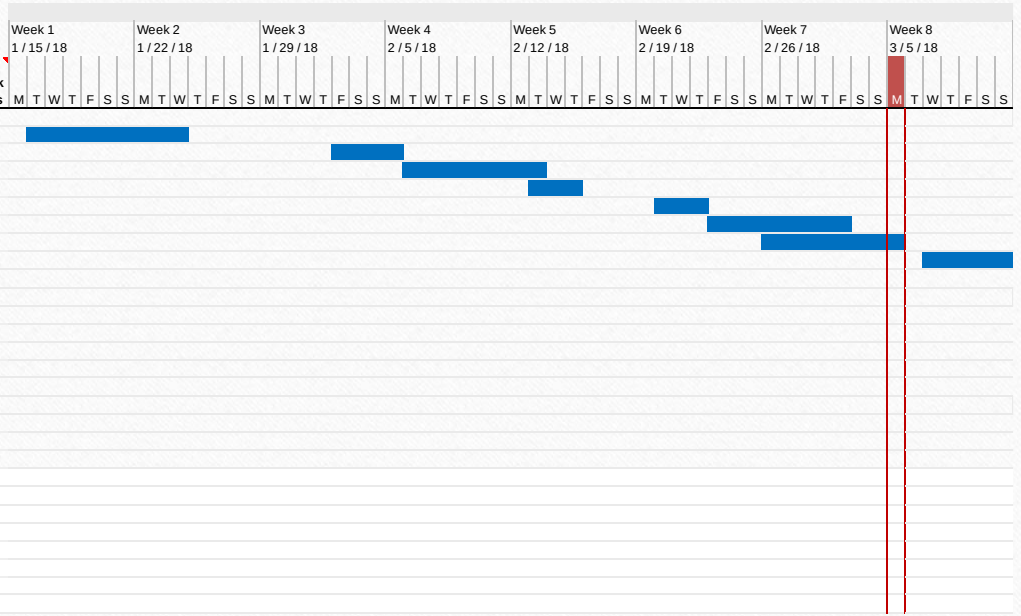
Gantt Chart

Biom Test Fixture

See info on Gantt Chart Template Pro

Project Lead: [John Tester]
Project Start Date: 1/16/2018 (Tuesday)
Display Week: 1

WBS	Task	Lead	Predecessor	Start	End	Cal. Days	% Done	Work Days
1	[Task Category]	[Name]						
1.1	Team Charter	[Name]		Tue 1/16/18	Wed 1/24/18	9	100%	7
1.2	Presentation			Fri 2/02/18	Mon 2/05/18	4	100%	2
1.3	Report 1			Tue 2/06/18	Tue 2/13/18	8	100%	6
1.4	Website 1			Tue 2/13/18	Thu 2/15/18	3	100%	3
1.5	Peer Eval 1			Tue 2/20/18	Thu 2/22/18	3	100%	3
1.6	Conceptual Report			Fri 2/23/18	Fri 3/02/18	8	100%	6
1.7	Presentation 2			Mon 2/26/18	Mon 3/05/18	8	100%	6
1.8	Analyses Memo			Wed 3/07/18	Tue 3/13/18	7	0%	5
1	[Task Category]							
1.1	Website 2			Sun 3/25/18	Tue 3/27/18	3	0%	2
1.2	Analytical Reports			Thu 3/29/18	Tue 4/03/18	6	0%	4
1.3	Peer Eval 2			Mon 4/09/18	Tue 4/10/18	2	0%	2
1.4	Presentation 3			Fri 4/13/18	Tue 4/17/18	5	0%	3
1	[Task Category]							
1.1	Final Report			Fri 4/13/18	Mon 4/23/18	11	0%	7
1.2	Website 3, BOM, CAD			Thu 4/26/18	Tue 5/01/18	6	0%	4
1.3	Peer Eval 3			Tue 5/01/18	Tue 5/01/18	1	0%	1



Student Names:

Marzouq Alenezi
Husain Alshammari
Saood Alenezi
Saoud Alenezi
Naser Alowaihan

Saoud Alenezi

Budget

- This project is an analytical project focusing on CAD simulations.
- After consulting Dr. Tester we were given a 0$ budget.
- A prototype can be built if required and a budget of maximum 500$ is set if team moves forward with the prototype.
- Highest cost = Actuator

THANK YOU FOR YOUR TIME
ANY QUESTIONS