BiOM Prosthesis Adapter

Dominic Kristich: Project Manager/Client Contact
Leah Liebelt: Document Manager/Secretary
Abdulla Ghayeb: Website Developer
Ebrahim Hubail: Budget Liaison

Project Description

- Design BiOM Prosthesis Adapter to attach to ankle prosthesis
- Design for below-the-knee amputees
- Importance
  - Used to make improvements within the medical field
  - Aide in research for BiOM Ankle Prosthesis
- Clients:
    - Thomas Huck
    - Dr. Zachary Lerner
    - Kiisa Nishikawa

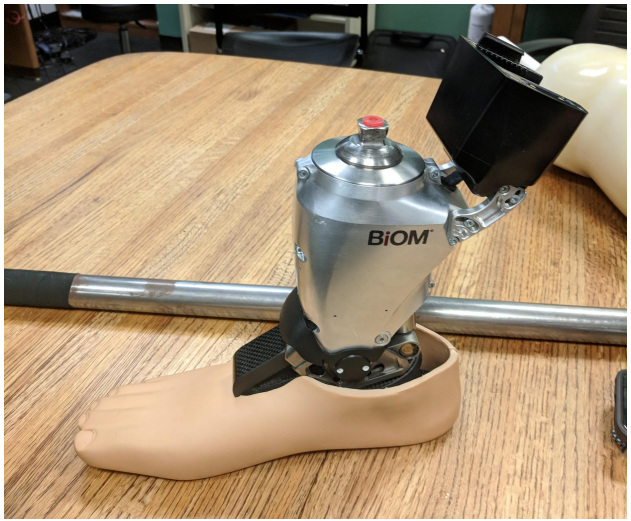


Figure 1: BiOM Ankle Prosthesis [1]

Black Box Model

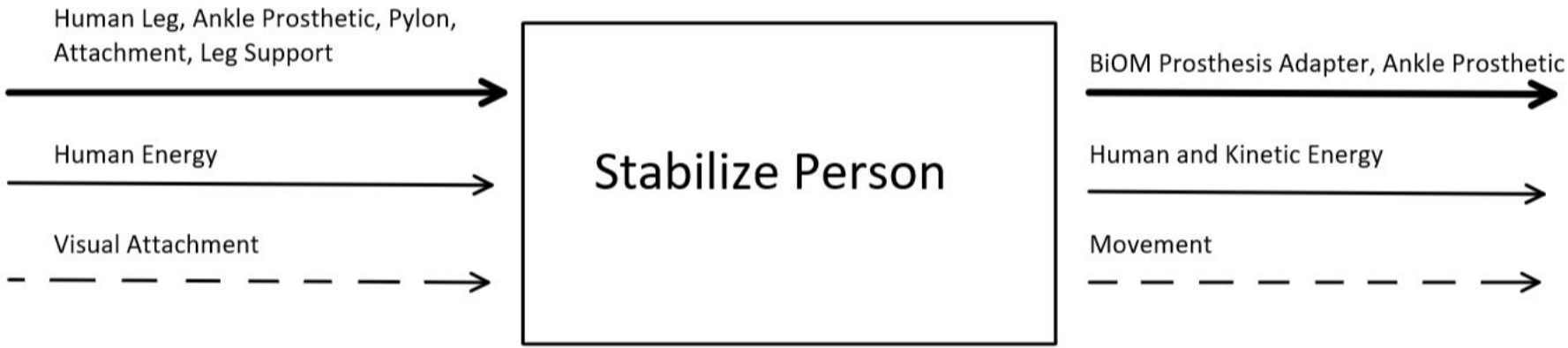


Figure 2: Black Box Model

Functional Model

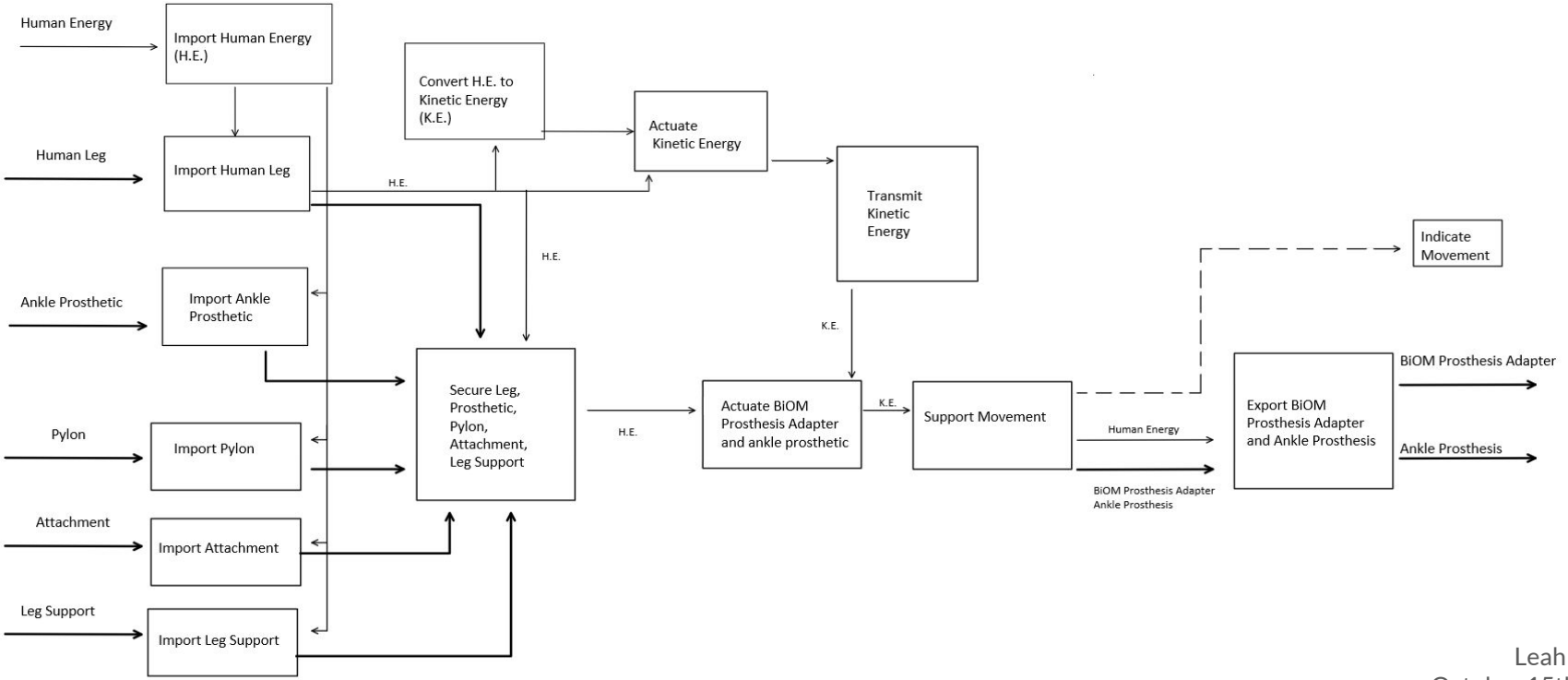


Figure 3: Functional Model

Leah Liebelt
October 15th, 2018
BiOM Prosthesis Adapter B12

Decision Matrices - Subsystems

Table 1: Top Designs from Subsystem Decision Matrices

Attachment				Pylon Decision Matrix				Leg Support			
SET 1		Sketch 23		SET 2		Sketch 17		SET 3		Sketch 3	
Criteria	Weight (%)	Score	Weighted Score	Criteria	Weight (%)	Score	Weighted Score	Criteria	Weight (%)	Score	Weighted Score
Safety	25%	90	22.5	Safety	23%	100	23	Safety	15%	100	15
Durable	17%	60	10.2	Durable	25%	70	17.5	Durable	15%	90	13.5
Quick Attachment	15%	70	10.5	Lightweight	20%	90	18	Lightweight	10%	40	4
Lightweight	18%	50	9	Adjustable	22%	90	19.8	Adjustable	19%	50	9.5
Stability	25%	80	20	Quick attachment	10%	80	8	Quick attachment	19%	90	17.1
Total	**100%**		**72.2**	**Total**	**100%**		**86.3**	comfortable	22%	90	19.8
								Total	**100%**		**78.9**

Pugh chart and additional decision matrices located in Appendix A and B respectively

First Design Considered

Advantages
- Stable
- Durable

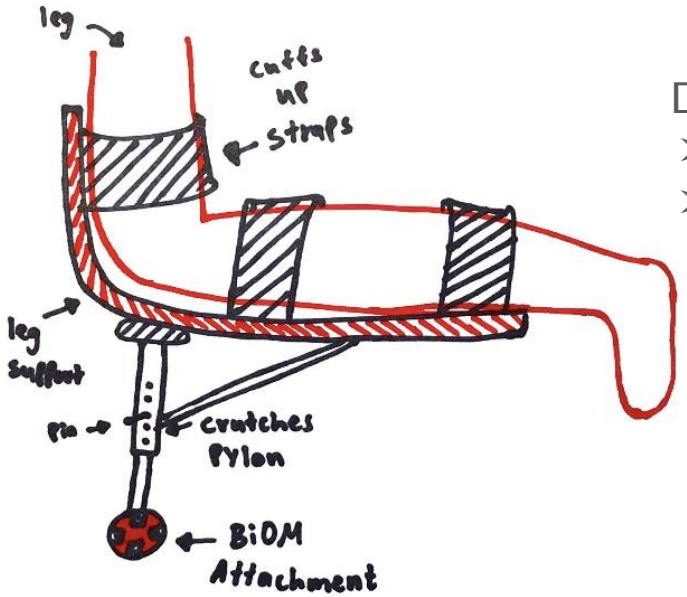


Figure 4: Final Sketch 1

Disadvantages
- Not lightweight
- Takes longer to adjust

Second Design Considered

Advantages
- ➢ Stable
- ➢ Adjustable
- ➢ Durable
- ➢ Comfortable

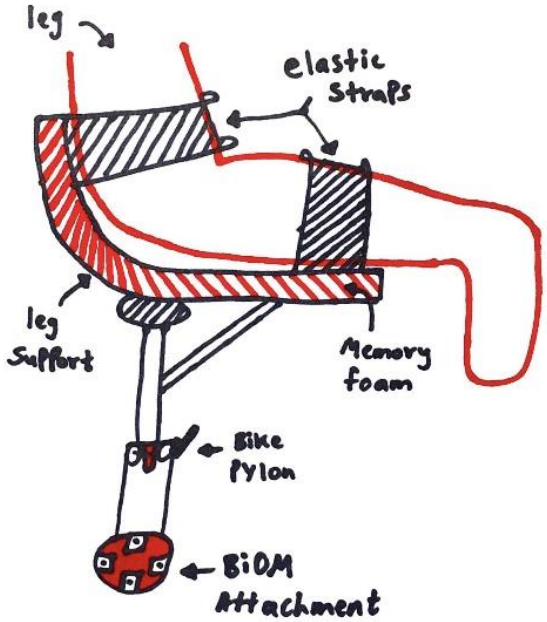


Figure 5: Final Sketch 3

Disadvantages
- ➢ Not lightweight

Third Design Considered

Advantages
- Durable
- Quick attachment
- Lightweight

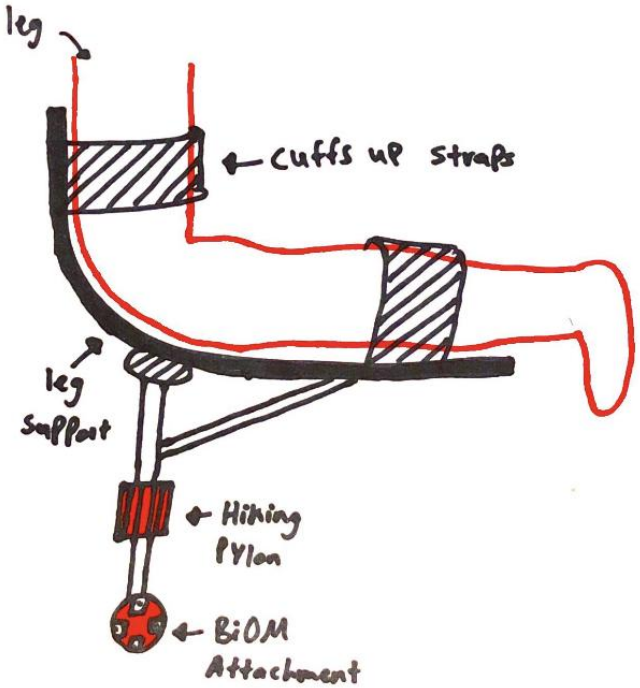


Figure 6: Final Sketch 5

Disadvantages
- Not as comfortable

Decision Matrix - Designs Considered

Table 2: Decision Matrix for final designs considered

SET 4		Final Sketch 1		Final Sketch 3		Final Sketch 5	
Criteria	Weight (%)	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Safety	17%	80	13.6	80	13.6	80	13.6
Durable	15%	85	12.75	90	13.5	75	11.25
Quick Attachment	10%	60	6	70	7	70	7
Lightweight	16%	30	4.8	40	6.4	70	11.2
Stable	13%	70	9.1	75	9.75	70	9.1
Adjustable	14%	90	12.6	80	11.2	75	10.5
Comfortable	15%	80	12	90	13.5	75	11.25
Total	100%		70.85		74.95		73.9

Full decision matrix located in Appendix C

Chosen Design

Customer Requirements

- Lightweight
- Comfortable
- Quick Attachment
- Adjustable
- Durable
- Portable
- Affordable
- Safety

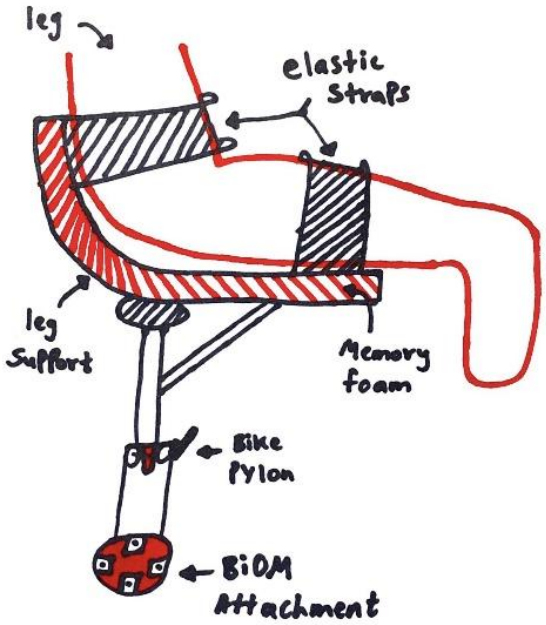


Figure 7: Final Design Chosen

Schedule

Table 3: Gantt Chart

WBS NUMBER	TASK TITLE	TASK OWNER	START DATE	DUE DATE	DURATION (Days)	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10	WEEK 11	WEEK 12	WEEK 13	WEEK 14	WEEK 15	WEEK 16
1	Project Team Charter	Leah	9/3/18	9/10/18	7																
2	Presentation 1 - Background	Ebrahim	9/10/18	9/15/18	5																
3	Website Check I	Abdulla	9/10/18	9/26/18	16																
4	Peer Evaluation I	Individual	10/3/18	10/5/18	2																
5	Analytical Analyses I Team Memo	Dominic	10/8/2018	10/10/18	2																
6	Presentation 2 - Concept Gen and Eval	Leah	10/5/18	10/14/18	9																
7	Preliminary Report	Ebrahim	10/9/18	10/15/18	6																
8	Website Check II	Abdulla	10/22/18	10/31/18	9																
9	Individual Analytical Analysis I	Individual	10/22/2018	11/5/2018	13																
10	Final Proposal Presentation	Dominic	11/5/2018	11/11/2018	6																
11	Peer Evaluation II	Individual	11/14/2018	11/16/2018	2																
12	Final Proposal Report	Leah	10/22/2018	11/21/2018	29																
13	Final Prototypes Summary	Ebrahim	11/19/2018	12/1/2018	12																
14	Final CAD package and BOM	Dominic	11/12/2018	12/3/2018	21																
15	Website Check III	Abdulla	12/3/2018	12/9/2018	6																
16	Peer Evaluation III	Individual	12/10/2018	12/12/2018	2																

Budget

Material: $375

- Aluminum pylon (~$90) [2]
- Screw Lever (~$30) [3]
- Nuts and bolts (~$20) [4]
- Casting material (~$75) [5]
- Comfortable lining (~$50) [6]
- Miscellaneous (~$110)

Manufacturing: $200

Labor: $300 [7]

Total: $875

Questions?

References

[1] A. Ghayeb, E. Hubail, D. Kristich, and L. Liebelt, *BiOM Ankle Prosthesis*. 2018.

[2] Amazon.com. (2018). *Amazon.com: Online Shopping for Electronics, Apparel, Computers, Books, DVDs & more*. [online] Available at: https://www.amazon.com/ [Accessed 15 Oct. 2018].

[3] Amazon.com. (2018). [online] Available at: https://store.buymetal.com/aluminum-round-tube-6061-t6511-1.5-0.125.html?gclid=Cj0KCQjw9ZDeBRD9ARIsAMbAmobBtivf8hbsto_29yGAPJQk5YknA1R9elWnrM_-zQNLleP7Gby7EjAaAnOsEALw_wcB

[4] Amazon.com. (2018). [online] Available at: https://www.amazon.com/gp/product/B001GSSCL4/ref=s9_acsd_topr_hd_bw_bEf1h_c_x_4_w?pf_rd_m=ATVPDKIKX0DER&pf_rd_s=merchandised-search-4&pf_rd_r=A9HBMR682NQWJ96T7TV3&pf_rd_r=A9HBMR682NQWJ96T7TV3&pf_rd_t=101&pf_rd_p=236ead6e-08a6-5ee8-868a-d36c1a616618&pf_rd_p=236ead6e-08a6-5ee8-868a-d36c1a616618&pf_rd_i=3494301 [Accessed 15 Oct. 2018].

[5] Moore Medical. (2018). [online] Available at: https://www.mooremedical.com/index.cfm?No=0&Ntk=all&Nao=0&N=61&Ns=TotalRevenue|1 [Accessed 15 Oct. 2018].

References (cont.)

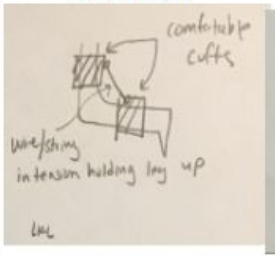
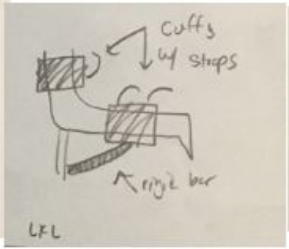
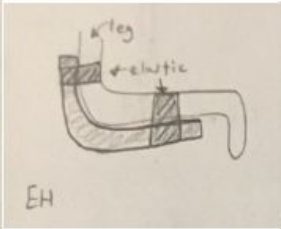
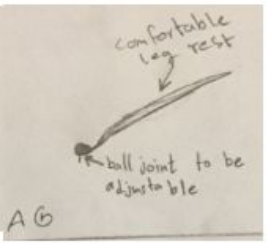
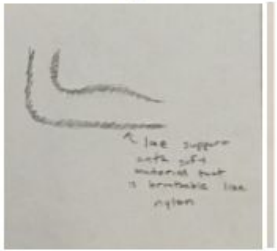
[6] Home Depot. (2018).. [online] Available at: https://www.homedepot.com/p/Future-Foam-4-in-T-Multi-Purpose-Foam-10030BULK4/302082969?cm_mmc=%7cTHD%7cgoogle%7c&mid=s%7cdc_mtid_8903o6225187_pcrid_296546629858_pkw__pmt__product_302082969_slid_&gclid=Cj0KCQjw9ZDeBRD9ARIsAMbAmoYQ-6dawPKfn1PAucTNcq3ARXitkR1yvm1hb4HXhzt3Pc6oPYjYTKwaAm6AEALw_wcB&gclsrc=aw.ds&dclid=CMjo3_emid4CFcKtZAodc6gMJA [Accessed 15 Oct. 2018].

[7] Bls.gov. (2018). *Arizona - May 2017 OES State Occupational Employment and Wage Estimates*. [online] Available at: https://www.bls.gov/oes/current/oes_az.htm#17-0000 [Accessed 15 Oct. 2018].

Appendix A: Pugh Chart

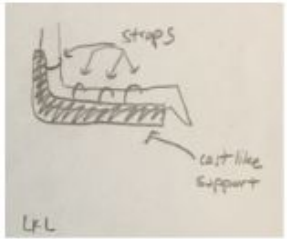
Pugh Chart (Leg Support)

Table A1.1: Leg Support Pugh Chart

	DATUM (1)	2	3	4	5
					
Criteria	DATUM	Rigid Bar	El Hefe	Ball/Joint	The Cloud
Safety	0	0	0	-1	-1
Durable	0	1	1	-1	-1
Light Weight	0	0	-1	1	1
Adjustable	0	0	0	0	0
Quick Attachment	0	1	1	0	0
Comfortable	0	0	1	1	1
Number better: S+	+0	+2	+3	+2	+2
Number worse: S-	0	0	-1	-2	-2
Number same: S0	6	4	2	2	2

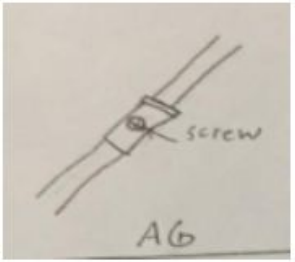
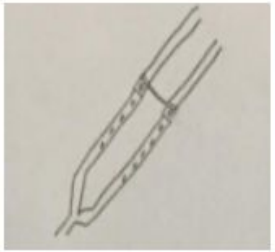
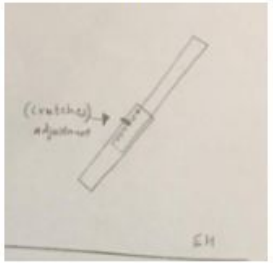
Pugh Chart (Leg Support) continued

Table A1.2: Leg Support Pugh Chart

Criteria	6  The Spider	7  Straps	8  The Cast	9  Bowl of Sand
Safety	-1	0	1	-1
Durable	0	0	1	0
Light Weight	-1	1	-1	-1
Adjustable	1	1	0	-1
Quick Attachment	0	0	0	-1
Comfortable	0	0	0	1
Number better: S+	+1	+2	+2	+1
Number worse: S-	-2	0	-1	-4
Number same: S0	3	4	3	1

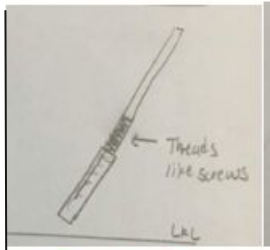
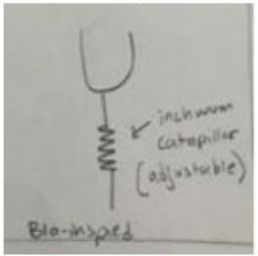
Pugh Chart (Pylon)

Table A2.1: Pylon Pugh Chart

	DATUM(10)	11	12	13	14
					
Criteria	Telescoping rod pylon	Screw pylon	Crutches pylon	Crutches pylon2	Slots pylon
Safety	0	1	1	1	0
Durable	0	1	1	0	1
Light Weight	0	0	-1	0	0
Adjustable	0	0	-1	-1	-1
Quick Attachment	0	-1	-1	-1	0
Stable	0	1	1	0	0
Quick Adjustment	0	0	0	0	1
Number better: S+	+0	+3	+3	+1	+2
Number worse: S-	0	-1	-3	-2	-1
Number same: S0	7	3	1	4	4

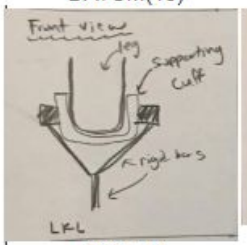
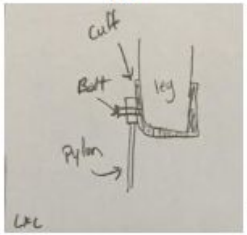
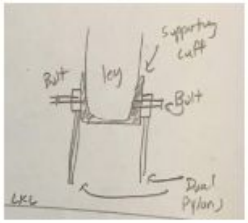
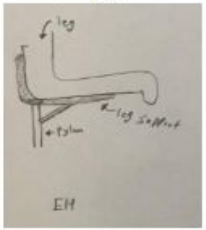
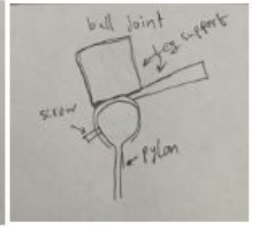
Pugh Chart (Pylon) continued

Table A2.2: Pylon Pugh Chart (cont.)

	15	16	17	18
				
Criteria	Thread pylon	Hiking pylon	Bike pylon	Catapiller pylon
Safety	-1	1	1	-1
Durable	0	0	1	0
Light Weight	0	1	1	0
Adjustable	1	1	1	0
Quick Attachment	0	0	0	1
Stable	-1	1	1	-1
Quick Adjustment	1	1	1	0
Number better: S+	+2	+5	+6	+1
Number worse: S-	-2	0	0	-2
Number same: S0	3	2	1	4

Pugh Chart (Attachment)

Table A3: Attachment Pugh Chart

	DATUM(19)	20	21	22	23	24
						
Criteria	DATUM	Under Knee	Parallel	Double up	Truss	Ball Joint
Safety	0	-1	0	1	1	0
Durable	0	0	0	1	1	0
Light Weight	0	1	1	-1	0	0
Quick attachment	0	-1	1	0	1	-1
Stable	0	-1	0	1	1	0
Number better: S+	+0	+1	+2	+3	+4	+0
Number worse: S-	0	-3	0	-1	0	-1
Number same: S0	5	1	3	1	1	4

Appendix B: Decision Matrix

Decision Matrix (Attachment)

Table B1: Attachment Decision Matrix

SET 1		Sketch 19		Sketch 20		Sketch 21	
Criteria	Weight (%)	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Safety	25%	40	10	60	15	30	7.5
Durable	17%	40	6.8	60	10.2	40	6.8
Quick Attachment	15%	20	3	50	7.5	60	9
Lightweight	18%	40	7.2	60	10.8	50	9
Stability	25%	50	12.5	20	5	60	15
Total	**100%**		**39.5**		**48.5**		**47.3**

SET 1		Sketch 22		Sketch 23		Sketch 24	
Criteria	Weight (%)	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Safety	25%	80	20	90	22.5	60	15
Durable	17%	50	8.5	60	10.2	70	11.9
Quick Attachment	15%	60	9	70	10.5	30	4.5
Lightweight	18%	60	10.8	50	9	60	10.8
Stability	25%	70	17.5	80	20	40	10
Total	**100%**		**65.8**		**72.2**		**52.2**

Decision Matrix (Pylon)

Table B2: Pylon Decision Matrix

SET 2		Sketch 10		Sketch 11		Sketch 12		Sketch 13		Sketch 14	
Criteria	Weight (%)	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Safety	23%	50	11.5	60	13.8	100	23	75	17.25	20	4.6
Durable	25%	20	5	50	12.5	90	22.5	60	15	30	7.5
Lightweight	20%	90	18	80	16	70	14	80	16	70	14
Adjustable	22%	80	17.6	20	4.4	70	15.4	95	20.9	85	18.7
Quick attachment	10%	80	8	50	5	60	6	70	7	55	5.5
Total	**100%**		**60.1**		**51.7**		**80.9**		**76.15**		**50.3**

SET 2		Sketch 15		Sketch 16		Sketch 17		Sketch 18	
Criteria	Weight (%)	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Safety	23%	40	9.2	90	20.7	100	23	20	4.6
Durable	25%	30	7.5	60	15	70	17.5	35	8.75
Lightweight	20%	90	18	90	18	90	18	70	14
Adjustable	22%	75	16.5	80	17.6	90	19.8	20	4.4
Quick attachment	10%	85	8.5	80	8	80	8	75	7.5
Total	**100%**		**59.7**		**79.3**		**86.3**		**39.25**

Decision Matrix (Leg Support)

Table B3: Leg Support Decision Matrix

SET 3		Sketch 1		Sketch 2		Sketch 3		Sketch 4		Sketch 5	
Criteria	Weight (%)	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Safety	15%	60	9	90	13.5	100	15	30	4.5	40	6
Durable	15%	50	7.5	80	12	90	13.5	50	7.5	30	4.5
Lightweight	10%	80	8	70	7	40	4	100	10	80	8
Adjustable	19%	60	11.4	40	7.6	50	9.5	80	15.2	0	0
Quick Attachment	19%	40	7.6	80	15.2	90	17.1	70	13.3	30	5.7
Comfortable	22%	80	17.6	80	17.6	90	19.8	90	19.8	100	22
Total	**100%**		**61.1**		**72.9**		**78.9**		**70.3**		**46.2**

SET 3		Sketch 6		Sketch 7		Sketch 8		Sketch 9	
Criteria	Weight (%)	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Safety	15%	40	6	80	12	80	12	20	3
Durable	15%	60	9	75	11.25	80	12	30	4.5
Lightweight	10%	90	9	25	2.5	30	3	10	1
Adjustable	19%	40	7.6	90	17.1	75	14.25	85	16.15
Quick Attachment	19%	80	15.2	85	16.15	85	16.15	50	9.5
Comfortable	22%	70	15.4	70	15.4	90	19.8	80	17.6
Total	**100%**		**62.2**		**74.4**		**77.2**		**51.75**

Appendix C: Top Concepts

Decision Matrix - Top Concepts

Table C1: Final Concepts Decision Matrix

SET 1		Final Sketch 1		Final Sketch 2		Final Sketch 3		Final Sketch 4		Final Sketch 5	
Criteria	Weight (%)	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Safety	17%	80	13.6	70	11.9	80	13.6	60	10.2	80	13.6
Durable	15%	85	12.75	75	11.25	90	13.5	70	10.5	75	11.25
Quick Attachment	10%	60	6	70	7	70	7	70	7	70	7
Lightweight	16%	30	4.8	50	8	40	6.4	70	11.2	70	11.2
Stable	13%	70	9.1	50	6.5	75	9.75	50	6.5	70	9.1
Adjustable	14%	90	12.6	75	10.5	80	11.2	80	11.2	75	10.5
Comfortable	15%	80	12	60	9	90	13.5	90	13.5	75	11.25
Total	100%		70.85		64.15		74.95		70.1		73.9

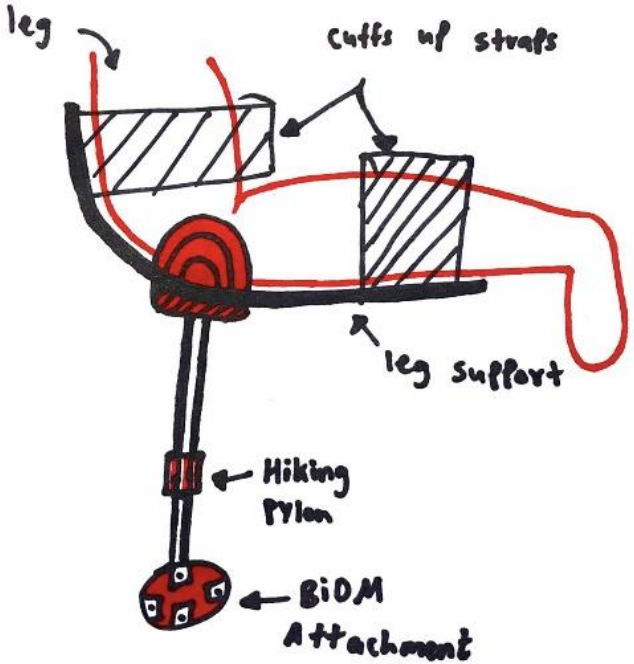


Figure C1: Final Sketch 2

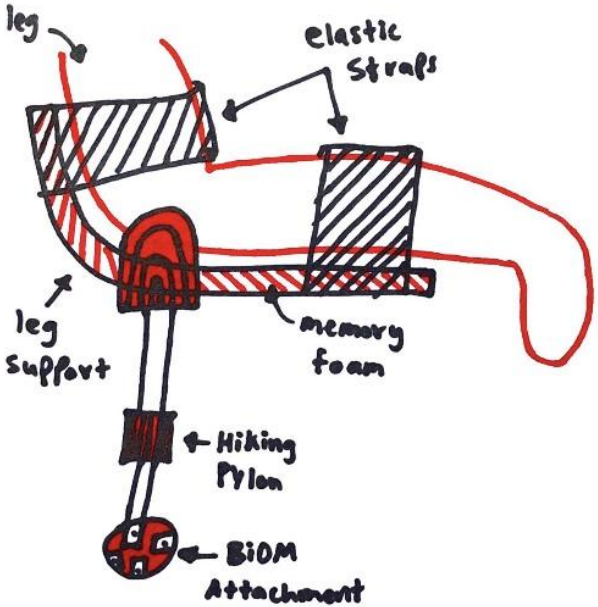


Figure C2: Final Sketch 4