Project Description

- To design and improve upon the upper body arm exoskeleton called the Myoshirt, designed by ETH Zürich. The suit will assist the user's task of completing pull-ups and other daily activities.
- The sponsor for this project is W.L Gore with a budget of $3,750.
- The client for this project is Dr. Zachary Lerner.

Photo provided by: ETH Zurich

Background & Benchmarking

- State-of-the-art (SOTA)
  - The current progress on exomuscles is very limited
  - ETH Zürich is leading the rresearch in this field with the Myoshirt
- Current Industry Standards
  - Myoshirt – Is a wearable 'shirt' with cables mimicking tendons
  - EMG Signal Reading – Electromyography is used to read the electrical signals of muscles in contraction

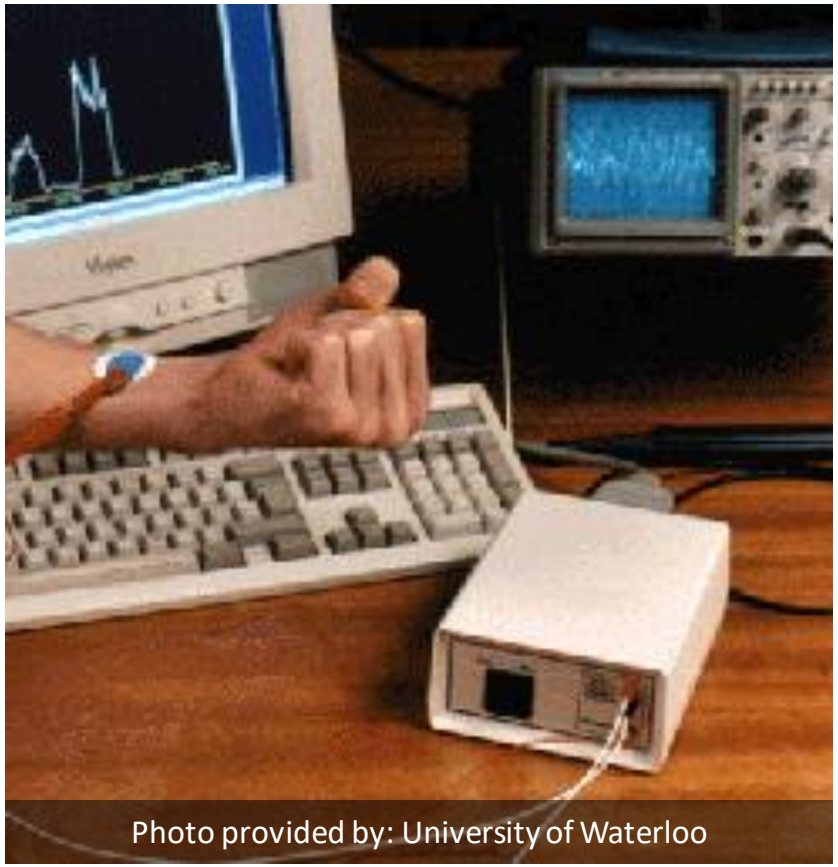


Photo provided by: University of Waterloo

Literature Review

- Myoshirt [1]:

https://sms.hest.ethz.ch/research/current-research-projects/wearable-robots-for-assistance-and-rehabilitation/The%20Myoshirt.html

"The Myoshirt – a modular soft wearable robot – assists the upper limb in daily life" (ETH Zurich).

- High Performance Humanoid Technologies [2]:

https://www.sciencedirect.com/science/article/pii/S0094114X22000234

HPHT's design is a portable cable driven exo-muscle suit, aiming to improve everyday life to those who have upper-arm impairments. The use of Bowden cables reduces the weight issues but having the motor along the hip does not fit our goals.

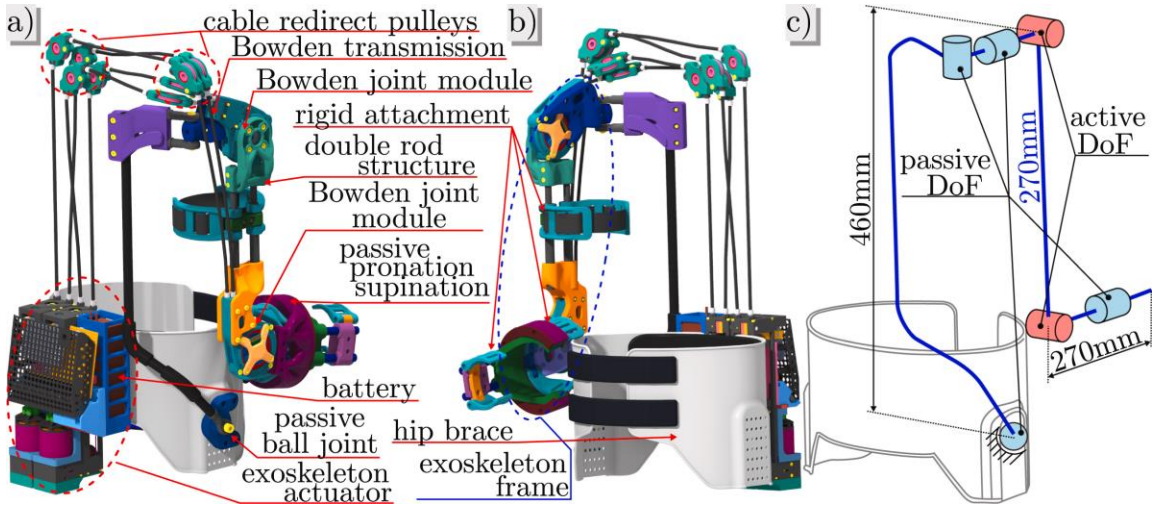


Photo provided by: HPHT

Literature Review Continued.

- Aalborg University [3]:

https://www.mdpi.com/2218-6581/9/1/16/htm

"The key challenges involved in the development of assistive exoskeletons are highlighted by comparing available solutions. This paper provides a general classification, comparisons, and overview of the mechatronic designs of upper-limb exoskeletons" (Gull).

- CAREX [4]:

https://ieeexplore.ieee.org/abstract/document/6174477

CAREX is an exoskeleton arm with a cuff system. Having three cuffs located at: the shoulder, upper arm and forearm reduces the weight of the design to 1.4kg. Motors for the system are mounted on an aluminum frame located above the user.

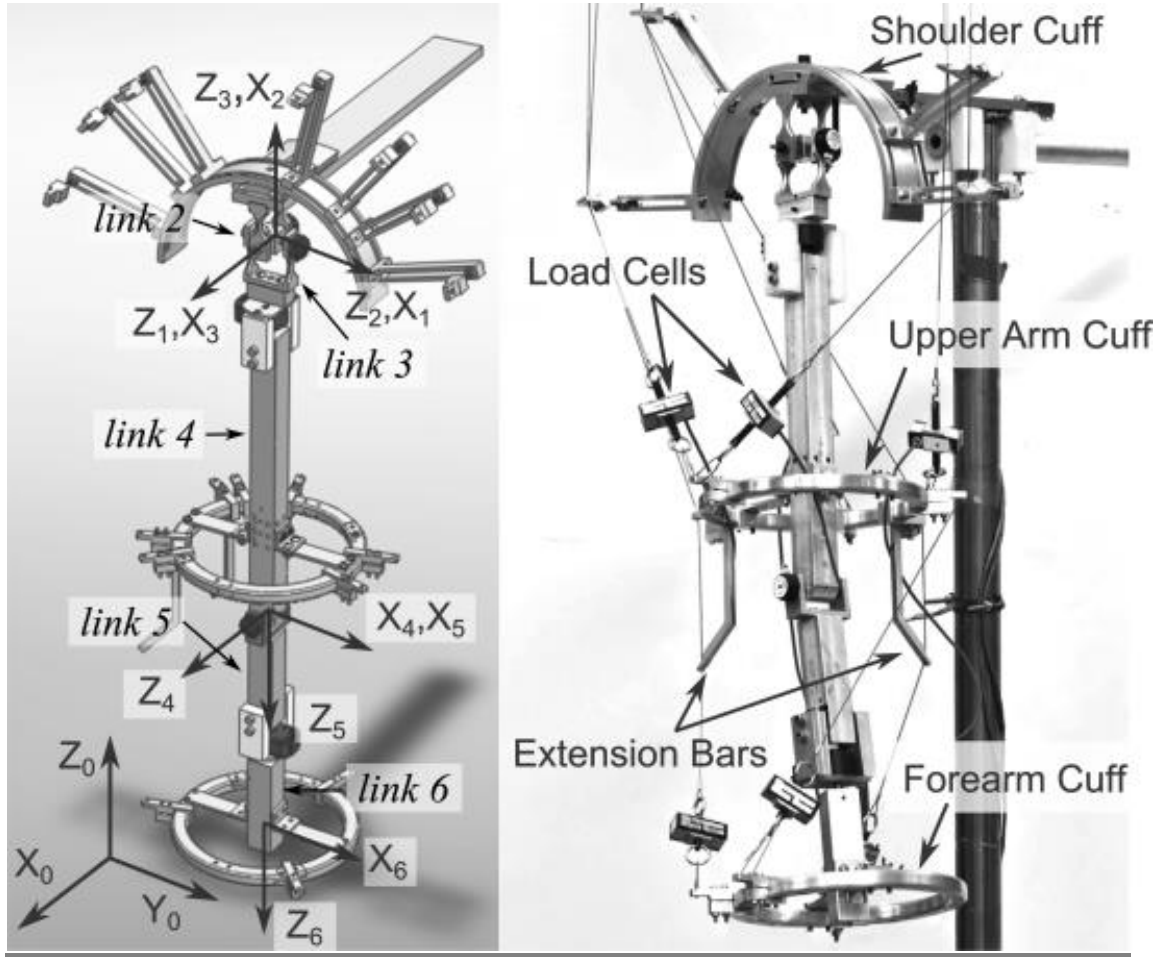


Photo provided by: CAREX

Customer & Engineering Requirements

Customer Requirements:

- Overhand pull-up style.
- Design with free arm motion in mind for other daily activities.
- Features a lightweight design.
- Has a low profile.

Engineering Requirements:

- Use a DC (direct current) motor to aid the pull-up.
- Implement a sensor and cable driven system.
- Must be <6lbs.
- Cannot protrude more than 10cm from the body.

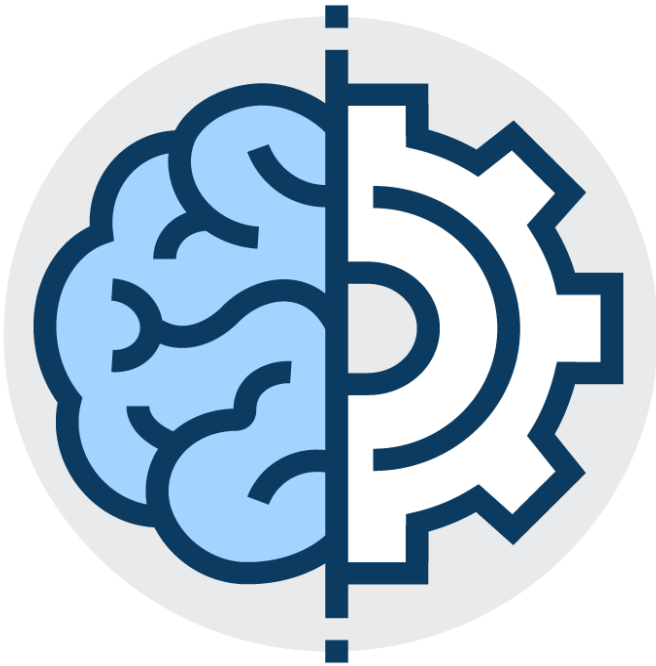
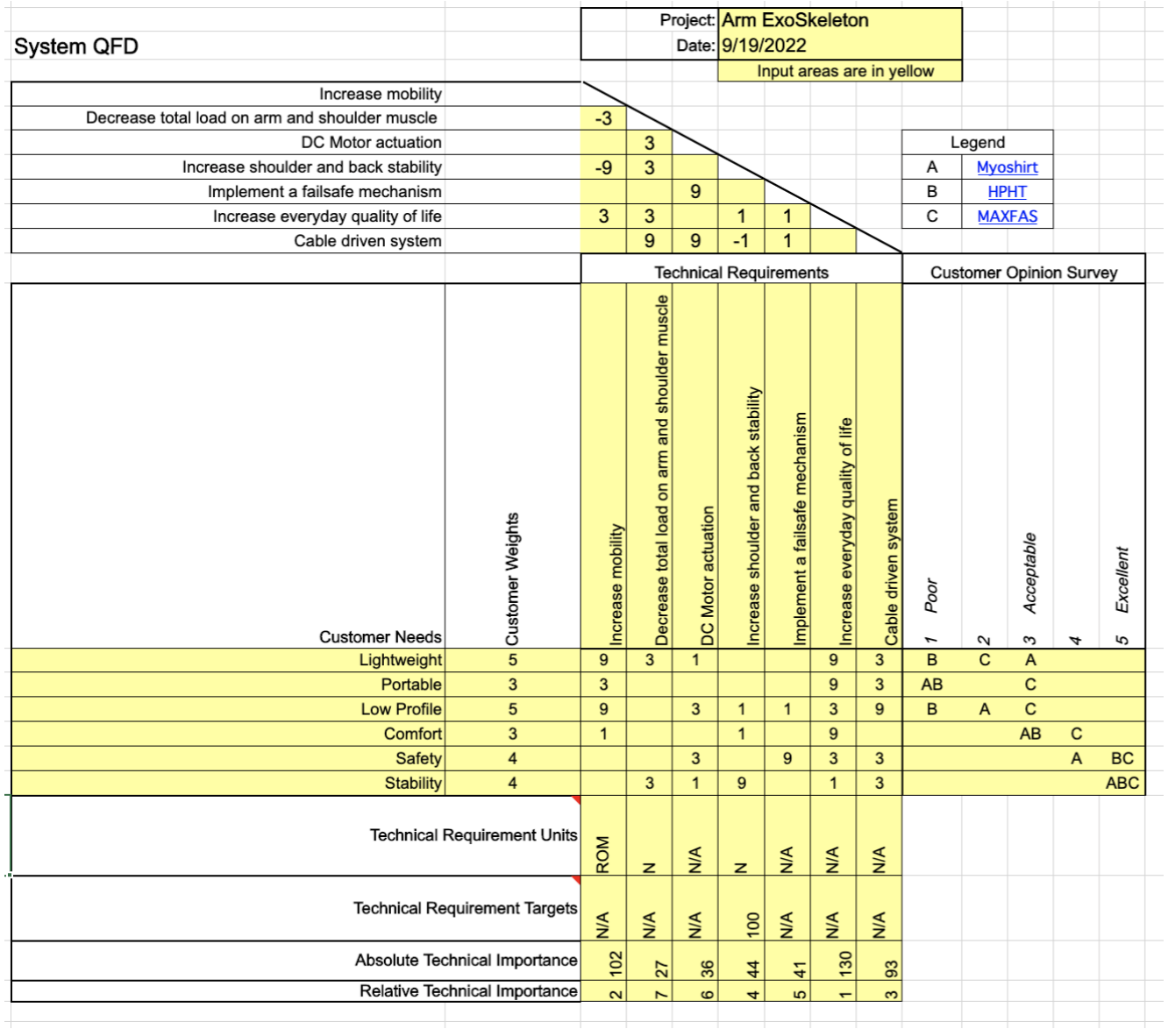


Image provided by: Kontron Technologies

Customer and Engineering Requirements Continued.



System QFD

Project: Arm ExoSkeleton
Date: 9/19/2022
Input areas are in yellow

Increase mobility								
Decrease total load on arm and shoulder muscle	-3							
DC Motor actuation		3						
Increase shoulder and back stability	-9	3						
Implement a failsafe mechanism			9					
Increase everyday quality of life	3	3		1	1			
Cable driven system		9	9	-1	1			

Legend	
A	Myoshirt
B	HPHT
C	MAXFAS

		Technical Requirements							Customer Opinion Survey				
Customer Needs	Customer Weights	Increase mobility	Decrease total load on arm and shoulder muscle	DC Motor actuation	Increase shoulder and back stability	Implement a failsafe mechanism	Increase everyday quality of life	Cable driven system	1 Poor	2	3 Acceptable	4	5 Excellent
Lightweight	5	9	3	1			9	3	B	C	A		
Portable	3	3					9	3	AB		C		
Low Profile	5	9		3	1	1	3	9	B	A	C		
Comfort	3	1			1		9				AB	C	
Safety	4			3		9	3	3				A	BC
Stability	4		3	1	9		1	3					ABC
Technical Requirement Units		ROM	N	N/A	N	N/A	N/A	N/A					
Technical Requirement Targets		N/A	N/A	N/A	100	N/A	N/A	N/A					
Absolute Technical Importance		102	27	36	44	41	130	93					
Relative Technical Importance		2	7	6	4	5	1	3					

Schedule

- Current events have been completed
- Future events are on the schedule
- The Team is on track

TASK	ASSIGNED TO	PROGRESS	START	END
Project Initiation				
1st Team Meeting	Team	100%	9/14/22	9/14/22
Team Charter	Team	100%	9/5/22	9/14/22
CN/ER Presentatic	Team	75%	9/14/22	9/19/22
1st Client Meeting	Team	50%	9/21/22	9/21/22
Research				
Research Lab Visit		0%	9/21/22	9/21/22
Concept Generation		0%	9/23/22	9/28/22
Team Meeting		0%	9/28/22	10/1/22
Concept Generation		0%	9/28/22	9/30/22
Concept Selection		0%	9/28/22	10/1/22

Budget

- Our allowable budget from GORE is $3750.
- Our team will divide the cost between prototyping and final design.

Type	Prototype	Final Design
Materials	$200.00	$1500.00
Manufacturing	$100.00	$1000.00
Emergency funds	$200.00	$750.00
Total	$500.00	$3250.00

Questions?

References

1. "The myoshirt - daily life assistance for the Upper Limb," – *Sensory-Motor Systems Lab | ETH Zurich*. [Online]. Available: https://sms.hest.ethz.ch/research/current-research-projects/wearable-robots-for-assistance-and-rehabilitation/The%20Myoshirt.html. [Accessed: 19-Sep-2022].
2. M. Dežman, T. Asfour, A. Ude, and A. Gams, "Mechanical design and friction modelling of a cable-driven upper-limb exoskeleton," *Mechanism and Machine Theory*, 08-Feb-2022. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0094114X22000234. [Accessed: 19-Sep-2022].
3. M. A. Gull, S. Bai, and T. Bak, "A review on design of upper limb exoskeletons," *Robotics*, vol. 9, no. 1, p. 16, 2020.
4. "Design of a cable-driven arm exoskeleton (Carex) for neural rehabilitation," *IEEE Xplore*. [Online]. Available: https://ieeexplore.ieee.org/abstract/document/6174477. [Accessed: 19-Sep-2022].