To: Dr. Trevas

From: Team 19F03- Hip Exoskeleton A.

Date: March 27th ,2020

Subject: Final Product.

INTRODUCTION:

The structural framework of the exoskeleton is highly reinforced to ensure firmness and stability during the functioning of the device. The support system does not only ensure safe and functional interactions of the joined parts but also it is designed to take care of basic fundamentals that are in line with the objectives of the project after careful analysis. Besides the strength of the material in use, the material's weight as well as its chemical properties which may affect the user is part of the priority on considerations made. These are in line with the safety and health requirements which are key deliverables for the project. Additional desirable characteristics considered for the frame structure that meet engineering properties included:

- Ductility
- Durability
- Flexibility
- Corrosion

The ductility of the structure defines its behavior when they are subjected to pressure under impact such as in the event of falling. Weak materials may experience breakages among other forms of failures such as bending and other manner of deformations which may be experienced due to force under impact. This is an important property considering the use of the device as falling and collapsing of the users due to walking incapacities may not be entirely ruled out. Aluminum has a high tensile strength which significantly reduces its ductility raising its plasticity on the other hand. This allows deformation without fracture on a wide span qualifying the steel material for use in that regard.

DURABILITY:

Generally, the lifespan of the device is dependent on the durability of the main parts the main frame being one of them. Durability defines its behavior under the cyclic loading which exposes it to fatigue hence reducing its durability. Key load concentration points such as at the joints and connections are prone to breakages. Friction at these points also subjects them to wear and tear reducing the life span of the device. The long-term use of the device is put to consideration and therefore necessitating consideration of a hard material which warrants longevity. In this case aluminum as opposed to other materials such as vinyl chrome and vanadium performs pretty well and satisfactorily.

CORROSION:

This is a chemical property. It defines the chemical behavior of the frame structure material upon interaction with elements in its environment. The reaction of the human being upon the material coming into contact with the sin of the user cannot be ignored. At this point, carcinogenic materials, those emitting radiations as well as allergic materials are disregarded. Iron its various forms is relatively cheap and fairly strong but is highly corrosive making it eliminated. The hip exoskeleton is a biomedical device takes care of all stipulated guidelines of health and safety standards.

LOAD TRANSMISSION:

The frame is the key weigh support structure for the entire device. The device works for partially supported individuals where the load from the legs and that of the upper trunk as supported at the hip is supported at the ground aiding the users to move. Hence, the device has more functionality in the movement than providing an entire support mechanism as it would for completely disabled persons. Movement is achieved by powering the movable parts that transmit to the limbs in a cordite operation.

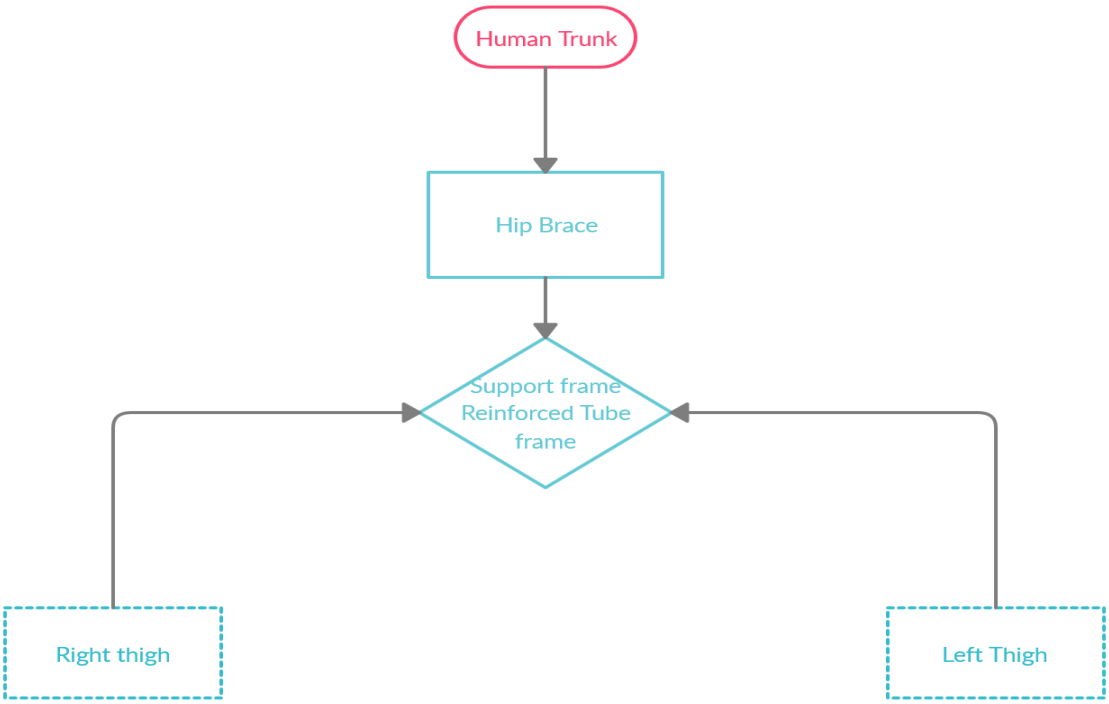

Figure 1*: *Support frame load distribution

THE DRIVING MECHANISM:

The exoskeleton is powered through a motor that generates motion which is converted to linear motion through a set of gears connected. These were connected strategically on both sides of the arms to ensure mobility for the device. Again, this ensured that the weight is adequately distributed and that the power used is utilized in the best way. That way, the motors and the gears were fitted on either side of the exoskeleton enabling motion for the device. In this case the efficiency which ideally is the power output is compared to the power input is of key significance. An efficient system that highly utilizes power fed to the exoskeleton device is desired which eventually provides power for the device.

***Table 1*: Summary.**

Deliverable	**Team Members**	**Scope of work**	**Desirable characteristics**	**Results/Proof**
Motors and gears	**Abdullah Almarri**	Right hand side	1.Motor Torque 2.gear-motor compatibility 3. Efficiency	
	Lahdan Alfihani			
	Meshal Algammas	Left hand side	1.Motor Torque 2.gear-motor compatibility 3. Efficiency	
	Mohammed Janshah			
Final product Milestone	A support framework was adopted, and the gears and motors were also included which provides power and transmission for the device in order to achieve motion.			
Cause of action	With a greater percentage of installation and fabrication of the exoskeleton already done what follows is the actual testing analysis and verification. These may be through: • **Simulations and structural analysis.** • **Actual test by experimentation using live loads.** • **Parts corrections. This may be so for the conflicting moving parts that limit motion.**			

Appendix E: Bill of materials.

Part #	Part Name	Qty	Description	Functions	Material	Dimensions	Cost	Link to Cost estimate
1	Motors&Gear	2	motor with gearbox in each side (left & right)	actuate thigh movment	Plastic & Metal		$1,259.26	https://www.maxongroup.com/maxon/view/product/gear/planetary/gp22f/370782 https://www.maxongroup.com/maxon/view/product/motor/ecmotor/ec4pole/323218
2	controller	2	ESCON Module 50/5 4-Q servocontroller for DC/EC	CONTROLLER			$341.00	https://www.maxongroup.com/maxon/view/product/gear/planetary/gp22f/370782 https://www.maxongroup.com/maxon/view/product/motor/ecmotor/ec4pole/323218
3	Frame (upper)	1	frame that support motors and thigh frame (connected to hip joint) (cutting and modification required)	support motors	aluminum	1.125 x 1.25 x 66"	$ 29.28	https://www.amazon.com/Aluminum-6063-T52-Square-Tubing-Length/dp/B000H9OYN8/ref=sr_1_1?keywords=6063-t52%2Bsquare%2Btubing%2C%2Bastm&qid=1582934364&sr=8-1&th=1
5	Bolt	4	bolts to hold the belts	holding belt	18-8 stainless steel	3/8" long; 0-80 thread size	$6.41	https://www.mcmaster.com/92949a312
6	Ball Joint	2	ball joint in each side to provide required angle movment	angle movement	zink-plated alloy steel	1.4" x 1.8"	$20.53	https://www.mcmaster.com/60745k833
7	Ball Joint Bolt	2	bolt to hold the ball joint to the hip brace	holding the ball joint	18-8 stainless steel	3/4"	$6	https://www.mcmaster.com/92949a599
8	hip brace bolt	2	bolts to adjust hip size	adjusment of hip size	grade 5 Titanum	3/4"	$8.06	https://www.mcmaster.com/94081a102
9	hip brace nut	2	nut to adjust hip size	adjusment of hip size	18-8 stainless steel	7/16" x 1/2"	$4.49	https://www.mcmaster.com/91833a125
10	velcro	4	2 in each thigh brace to fit user size	thigh fitment	Nylon	1" x 15'	$6.97	homedepot
11	Pad	3	pads in the hip brace to ensure comfort for the user	comfort	foam	73" x 37" x 1"	$16.56	Amazon
11	ABS Black plastic	1	Thermoplastic sheet for hip and thigh brace	thigh & hip brace	Thermoplastic	1/4""24""48"	$64	Amazon
14	D profile shaft	2	two neede for the lower support frame (cutting required)	hold gear	1045 Carbon Steel	6" x 3/8" (D)	$7.24	https://www.mcmaster.com/8632t133
			Total Cost Estimate:				$1,769.80	