Light Technology in Medical Devices

Alicia Corona, Claire Mitchell, Norma Munoz

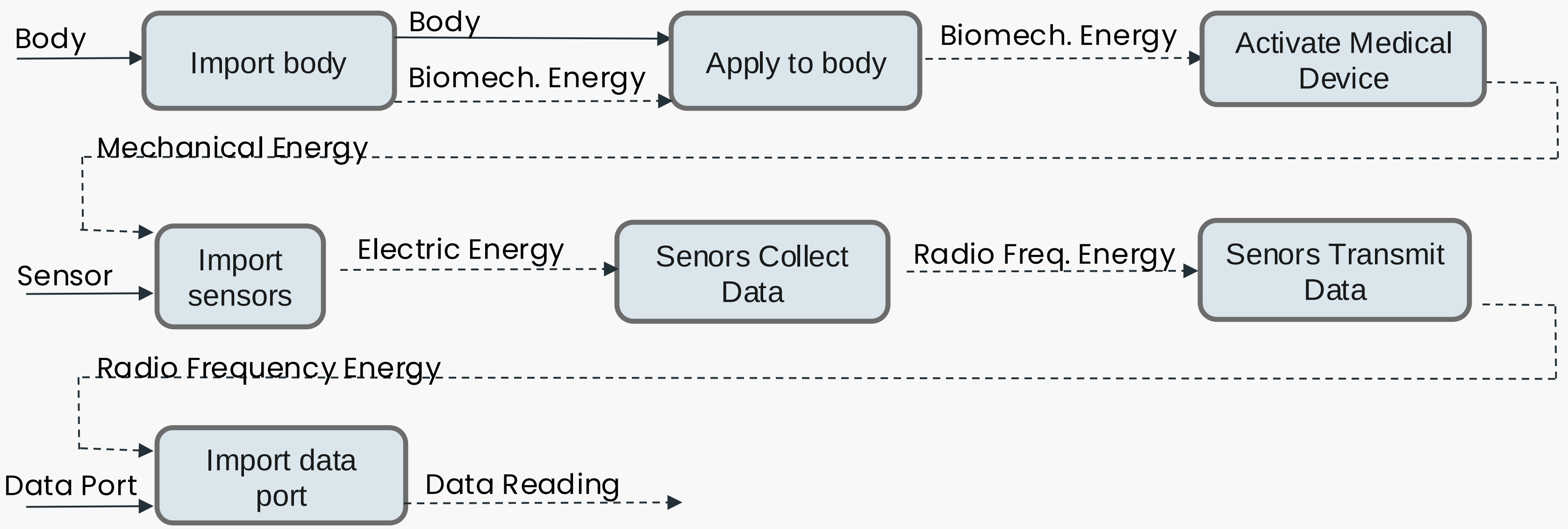
Project Description

- Utilize photo biomodulation (PBM) technology
- Red LED lights, infrared sensors, & rechargeable battery
- Design a cutting-edge tool that monitors blood flow & oxygen circulation
- Offers a non-invasive solution for cardiovascular health monitoring

- Enhances cellular function, promotes tissue repair, and reduces inflammation
- Applicable to medical institutions, rehab centers, military, and sports teams
- Partnering with EE & CS Capstone to enhance teamwork skills
- Jesslynn Armstrong, President, Light Matter Solutions, LLC

Black Box Model

Functional Model



Concept Generations: Morph Matrix

- Improving patient care
- Need for improved non-invasive photo-biomodulation (PBM) device
- Balance user comfort
- Ideal for everyday use
- Provide accurate data

Subsections	1	2	3	4	5
General Shape of device	Square	Circular	Hexagonal	Triangular	Pentagonal
Battery (lithium-ion)	Flexible	Flat w/ connector	Coin Cell		
Sensor	MAX3012	SEN0344	MAX32664		
Circuit Board	ESP32	Arduino	Feather		
LED	LUXEON 2835	LUXEON IR Onyx			

Engineering Calculation

Alicia Corona 1

$$Q = I * t$$

$Q =$ battery charge capacity $(Amp * hours)$

$I =$ current $(Amps)$

$t =$ time $(hours)$

$$E = Q * V_{Battery}$$

$E =$ battery energy capacity $(watt * hours)$

$V_{Battery} =$ battery voltage $(volts)$

Battery Capacity
The total amount of electrical energy a battery can store and deliver.

Mathematical Software
Battery Capacity Calculator:
https://www.omnicalculator.com/other/battery-capacity

Engineering Calculation

Alicia Corona 2

$$I = 3\,A$$

$$t = 2\,hours$$

$$Q = (3A) * (2\,hours)$$

$$Q = 6\,Ah$$

$$V_{Battery} = 5\,V$$

$$E = (6\,Ah) * (5\,V)$$

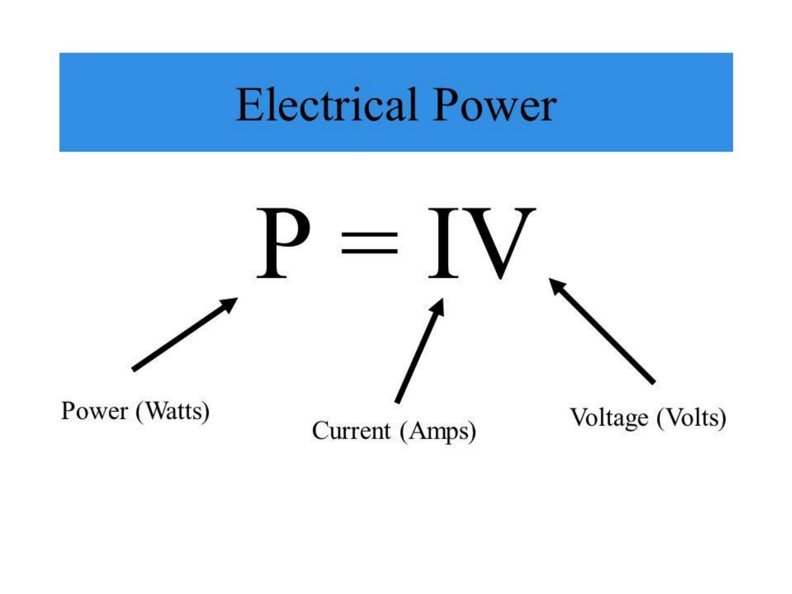
$$E = 30\,Wh$$

Battery Capacity
The total amount of electrical energy a battery can store and deliver.

Mathematical Software
Battery Capacity Calculator: https://www.omnicalculator.com/other/battery-capacity

Engineering Calculation

Claire 1



Electrical Power Equation

I used this equation to determine the power of the batteries we were researching in the specification tables

Engineering Calculation

Claire 2

Electrical Power Equation

I used this equation to determine the power of the batteries we were researching in the specification tables

Item #2

$I = 390\,A$, $V = 3.3V$

$P = IV = (0.39A)(3.3V) = 1.287W = 1287mW$

Item #4

$I = 24mA$, $V = 2\,V$

$P = IV = (0.024A)(2V) = 0.048 = 48\,mW$

Item #5

$I = 200mA$, $V = 2V$

$P = IV = (0.20A)(2V) = 0.4W = 400mW$

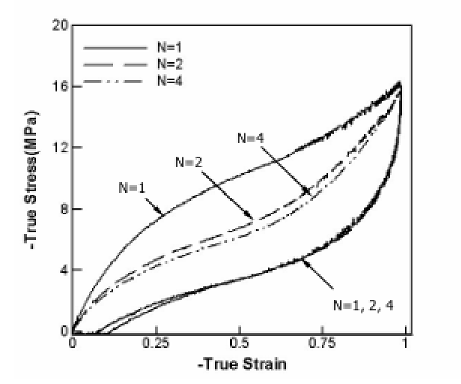
Power Rate
50mW
1287mW
260 mW
48mW
400mW

Luminous Flux (lm) or Radiometric Power (mW)	
Minimum	Typical
1100	1300
280	380
35	49

Engineering Calculation

Norma Munoz

Axial compression true stress-true strain behavior
ε max = 0 . 5 and ε max = 1 . 0



$$E_r^{(0)} \approx 24MPa$$

$$E_r^{(1)} \approx 14MPa$$

$$E_r^{(0)} / E_r^{(1)} = 1.7$$

$$\frac{E_r^{(0)}}{E_r^{(1)}} = \frac{v_{s0} X^{(0)}}{v_s^{(1)} X^{(1)}} = \frac{v_{s0}\left[1 + 3.5(1 - v_{s0}) + 18(1 - v_{s0})^2\right]}{v_s^{(1)}\left[1 + 3.5(1 - v_s^{(1)}) + 18(1 - v_s^{(1)})^2\right]}$$

$v_{s0} = 0.4$ $X^{(0)} = 9.58$ $\lambda_{chain} \approx 1.35$

$v_{ss} = 0.8$ $X^{(1)} = 3.00$ $\Lambda_{chain} = 1.86$

$v_s^{(1)} \approx 0.75$ $\mu_r = 1.40MPa$ $A \approx 1.4$ $N = 6.0$

Stress-Strain Analysis
(for Polyurethane Elasticity)
Polyurethane exhibits elastic behavior under stress

Young's Modulus

Matlab and Excel: advanced modeling and simulation tools

TPU used in the current project is 57% soft segment and 43% hard segment

Concept Evaluation: Specification Tables

Battery Specifation Table

Item #	Name	Type	Charge Type	Flexability	Dimensions	Power Output	Capacity	Wt
1	FLCB	Lithium	plug in	Y				
2	Tenergy Li-Polymer	Li-Ion	tap	Y	102.5 mm x 51.0 mm x 6.0 mm	3.7V	300mAh	61g
3	Jenax Flex	Li-Ion	tap	Y	27mmx48mm	3.8V	30mAh	
4	Libest Flexable Battery	Li-ion	Tap	Y	54mm x 18mm x 2.5mm	4.35V	68mAh	2.4g

Featherboards

Item #	Name	Bluetooth	USB	Power Supply	Works With	Power Usage	Cost	Dimensions	
1	Adafruit HUZZAH32	Y	USB	3.6	Arduino IDE / Li-ion	mid	$21.95	50.0mm x 23.5mm x 19.0mm	9.9g
2	Adafruit ESP32 Feather V2	Y	C	3.3V	Arduino / MicroPython	low	$19.95	52.3mm x 22.8mm x 7.2mm	6g

Concept Evaluation: Specification Tables

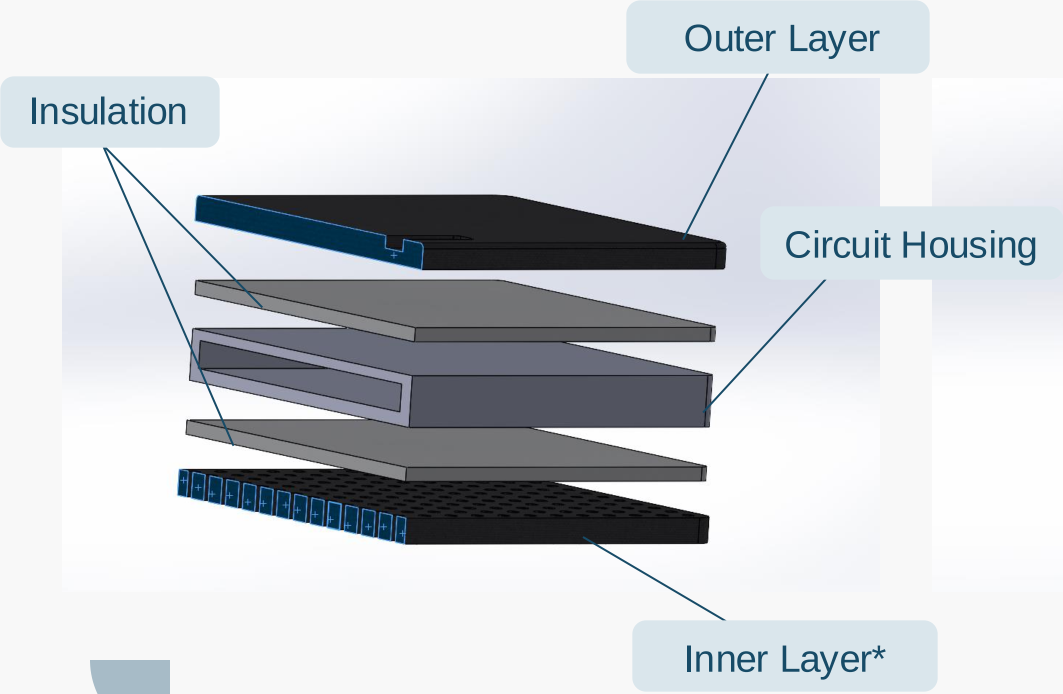
LED Specification Table

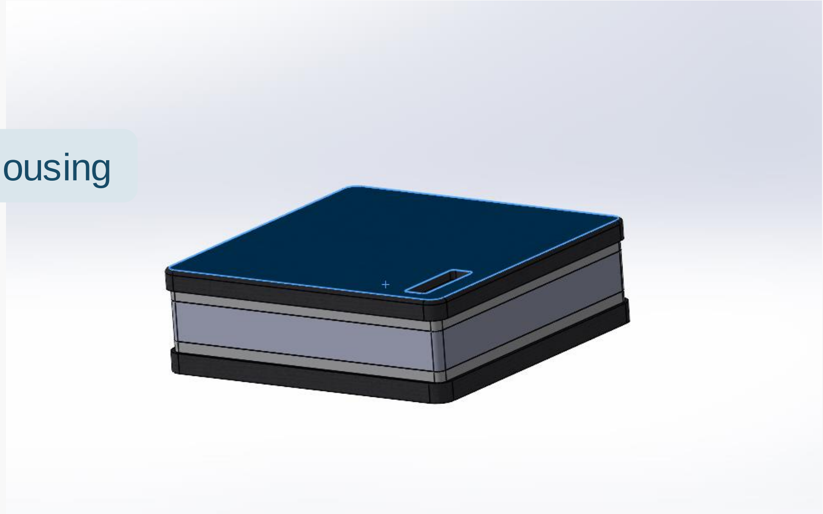
Item #	Name	Type	Shape	Power Rate	Dimensions	Cost	Wavelength
1	Lumiled - L1IG	IR	Flat / Square	50mW	2.75mm x 2.0mm	$3.42	850nm
2	Lumiled- L1IG-085	IR	Flat / Square	1287mW	2.75mm x 2.00mm	$2.68	850nm
3	Lumiled- L128-DRD	RED	Flat / Square	260 mW	3.5mm x 2.8mm x 0.7mm	$0.68	670 nm
4	Lumiled - L1C1-RED1	RED	Square/Round top	48mW	2mm x 2mm x 1.35	$2.26	624-634nm
5	Lumiled - L1C1-DRD1	Deep red	Square/Round top	400mW	2mm x 2mm x 1.36	$1.70	655-676nm

Sensor Specification Table

Item #	Number	Description	Dimensions	Power Supply	LED Supply	Red LED Characteristics	Cost
1	MAX86916EFD+T	Biometric Sensors Heart-Rate and Blood Oxygen Bio-Sensor	3.5mm x 7.0mm x 1.5mm	1.7V-2.0V	3.5V-5.5V	655nm-663nm	$16.17
2	MAXM86161EFD+T	Single-Supply Integrated Optical Module for HR and SpO2 Measurement	2.9mm x 4.3mm x 1.4mm		3.0V-5.5V	660nm	$12.72
3	MAX86174AENE+T	Biometric Sensors Dual Channel Low Cost PPG AFE	1.67mm x 1.78mm, 0.4mm				$6.81
4	MAX32664GTGD+T	Biometric Sensors SENSOR HUB W/ SPO2, HR & BP ALGORITHMS	1.6mm x 1.6mm	1.7V-3.6V			$4.81 (min 2500)

CAD Model



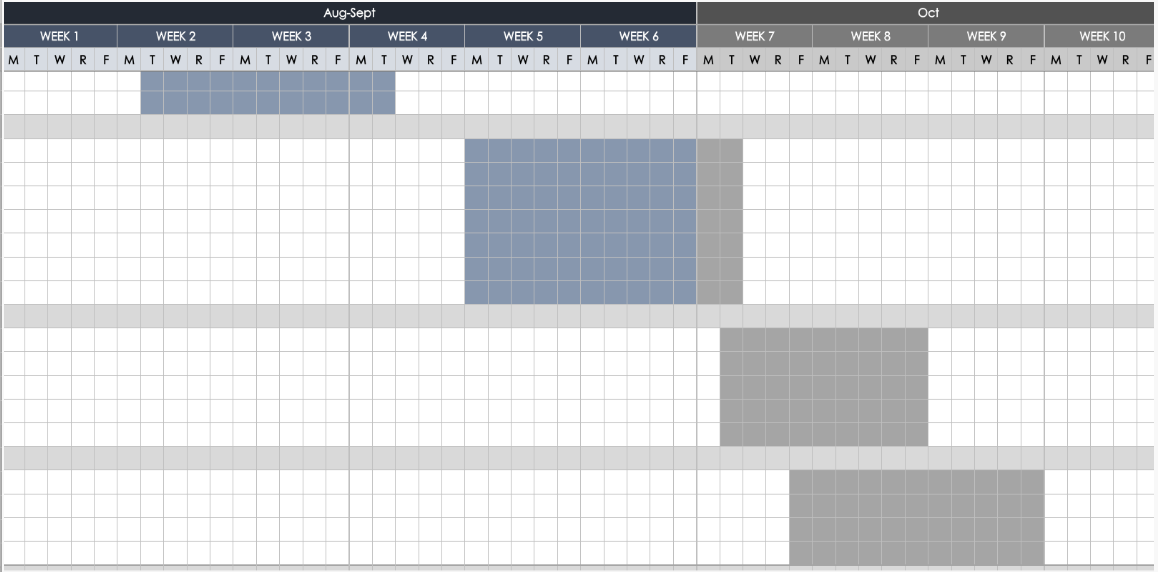


*Houses the LEDs and sensor

Gantt Chart

PROJECT TITLE	Tensegrity Medical
PROJECT MANAGER	Norma
DATE	Tuesday, October 8, 2024

TASK ID	TASK TITLE	TASK OWNER	START DATE	DUE DATE	DURATION IN DAYS	PCT OF TASK COMPLETE
1.5	Project Description	Claire	09/03/24	09/17/24	14	100%
1.6	Benchmarking	All	09/03/24	09/17/24	14	100%
2	Presentation 2					
2.1	Black Box Model	All	09/23/24	10/07/24	14	100%
2.2	Concept Generation & Selection	Alicia	09/23/24	10/07/24	14	100%
2.3	Calculations	All	09/23/24	10/07/24	14	100%
2,4	BOM	All	09/23/24	10/07/24	14	100%
2.5	Budget	All	09/23/24	10/07/24	14	100%
2.6	CAD Model	Norma	09/23/24	10/07/24	14	100%
2.7	Specification Table	Claire	09/23/24	10/07/24	14	100%
3	Report 1					
3.1	Background	Norma	10/08/24	10/18/24	10	0%
3.2	Requirements	Alicia	10/08/24	10/18/24	10	0%
3.3	Research within your design space	All	10/08/24	10/18/24	10	0%
3.4	Design Concepts	All	10/08/24	10/18/24	10	0%
3.5	Appendix	Claire	10/08/24	10/18/24	10	0%
4	Website Development					
4.1	Project Description	Claire	10/11/24	10/25/24	14	0%
4.2	About the team	Alicia	10/11/24	10/25/24	14	0%
4.3	Gallery	All	10/11/24	10/25/24	14	0%
4.4	Documents	All	10/11/24	10/25/24	14	0%



Budget: Pricing Strategy

Up to $5000; additional funding subject to the disbursement within each capstone group involved

- **One unit is about $290**
- **Making 5 units; comes out to $1450**
- **Product parts in next slide**

Project budget	**$5K**
Anticipated Expenses (estimated)	**$3K**
Actual Expenses (to date)	**$1450**
Resulting Balance (to date)	**$5K**

Bill of Materials (BOM)

#	Part Number	Name / Description	Vendor	Quantity	Cost per unit	Total Cost per unit
1	3405	HUZZAH32 – ESP32 Feather Board	Adafruit	1	$19.95	$19.95
2	L1IG-0750100000000	LUXEON IR ONYX - IR	Lumiled	32	$6.67	$213.44
3	L128-DRD1003500000	LUXEON 2835 Color Line - Deep Red	Lumiled	16	$0.68	$10.88
4	()	Tenergy Li-Polymer	Tenergy Power	1		
5	6050100	JFlex - Flexible Lithium Polymer Battery	Jenax	1	$9.99	$9.99
6	MAX86174AENE+T	Biometric Sensors Dual Channel Low Cost PPG AFE - Heart Rate/Blood Oxygen - HRM/SpO2	Analog Devices Inc.	1	$6.81	$6.81
7	()	HP-TPU 3D Printer Filament 1.75mm 1kg	Creality Store	1	$27.99	$27.99
					Total Per 1 Unit	$289.06
					Total per 5 Units	$1,445.30

Thank You, Questions?