



Somaita Tasnim

Introduction

Client Statement

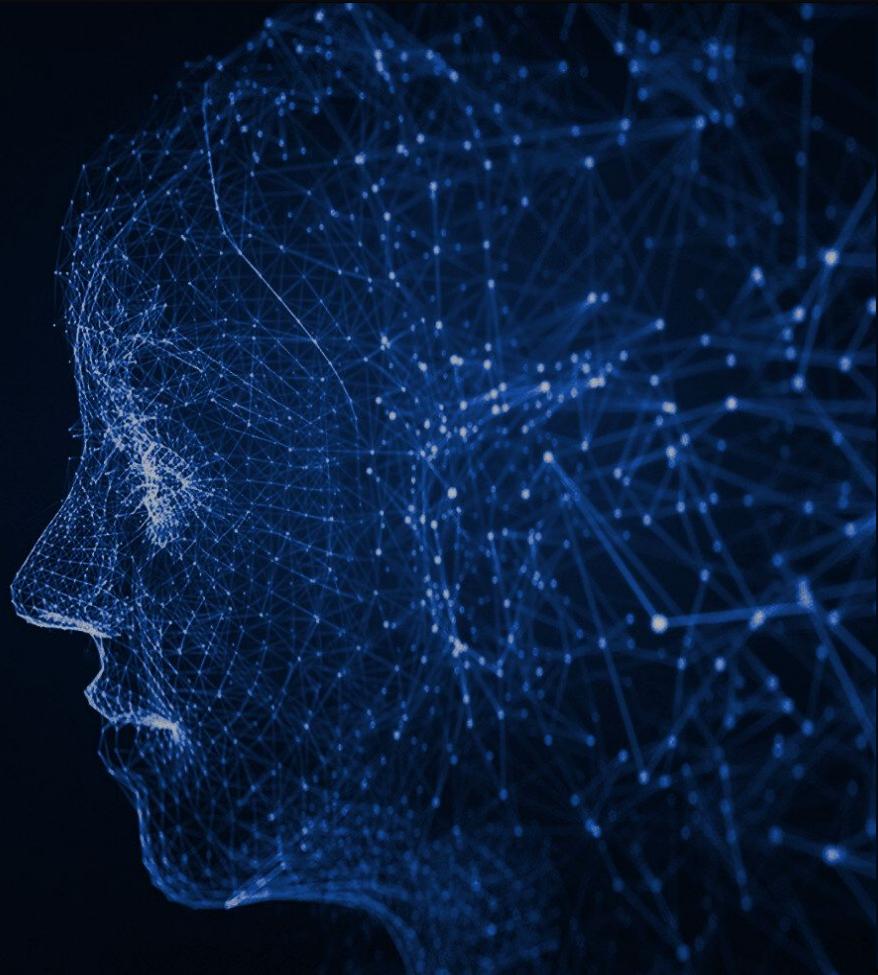
Requirements

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# Stimulus-Response Conditioning



| Team 172

# Our Team



Somaита Tasnim

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**Somaita Tasnim**  
*Team Leader*



**Crystal Jin**  
*Project Manager*



**Junandre Paul**  
*Operations Manager*



**Dominik Adamiak**  
*Contact Person*



**Christopher Jiang**  
*Chief Editor*





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# Disclaimer

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# CLIENT STATEMENT

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*Client Need & Patient  
Description*

*Pressure Sores*

*Gap*

*Final Design Introduction*





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# Client Need & Patient Description

## Client Need

- Develop a design for our patient Coal to prevent pressure sores and reduce his crying behaviour.

## Patient Description

- Non-ambulatory
- No communication system
- Requires constant care from parents
- Increased crying behaviour
- Lost interest in previous sensory activities





# Pressure Sores

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## STAGE 1

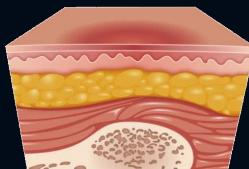
## STAGE 2

## STAGE 3

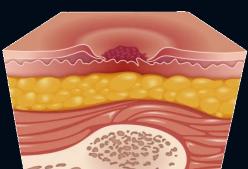
## STAGE 4

- Mildest stage
- Discolouration of affected skin
- Sore to touch
- Increased pain
- Shallow open wound
- Break down of skin
- Reaches fatty tissues
- Signs of infection
- foul odour, redness, pus
- Sever stage
- Affects muscles, tendons, ligaments
- High risk of infection

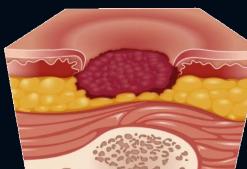
Stage 1



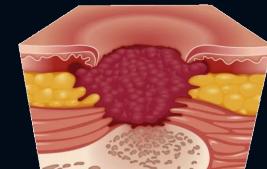
Stage 2



Stage 3



Stage 4





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# Gap

Competitors	Skincare Products	Pressure Relieving Mattresses	Special Cushions	Surgical Procedures
Example	 Cavilon Barrier Cream	Drive Medical Alternating Pressure Mattress		
Inexpensive (\$ < 200)	\$ 19.99	\$1500	\$976	\$3600/month
Suitable for Beds	N/A	YES	NO	N/A
Suitable for Wheelchairs	N/A	NO	YES	N/A





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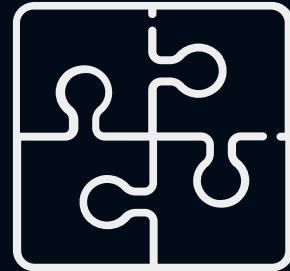
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# Gap

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**Sustainable**

**Suitable for both Beds  
and Wheelchairs**

**Affordable**





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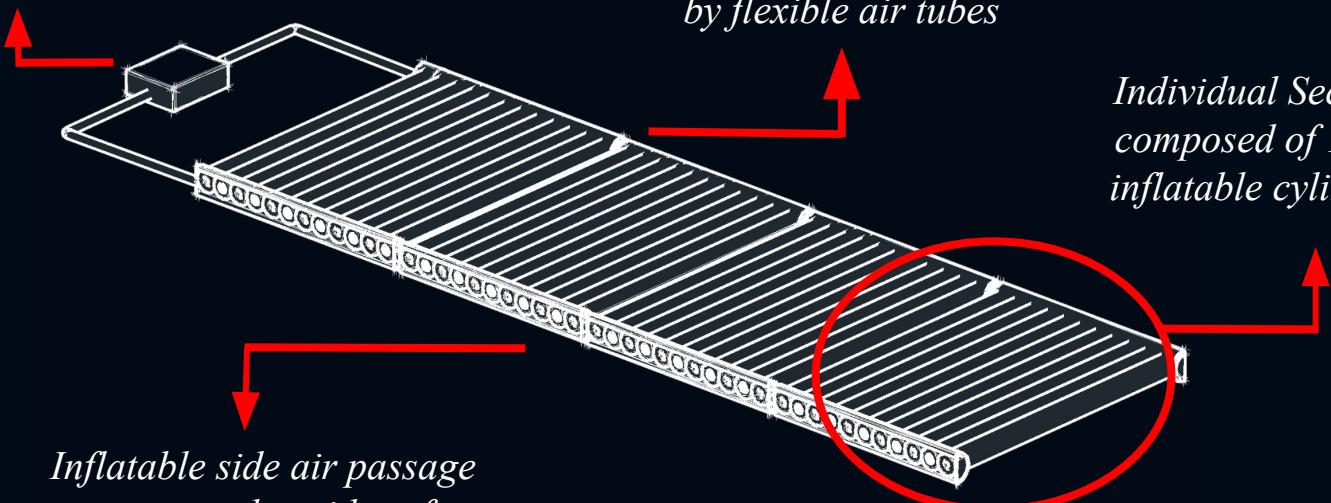
Measures of Success

# Transformable Alternating Pressure Mattress (TAP)

*Pump/Valve system*

*Folding Section spanned by flexible air tubes*

*Individual Section, composed of 11/12 inflatable cylinders*





Christopher Jiang

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# PROJECT REQUIREMENTS

*Functions, Objectives, &  
Constraints*

*Service Environment*

*Stakeholders*





Christopher Jiang

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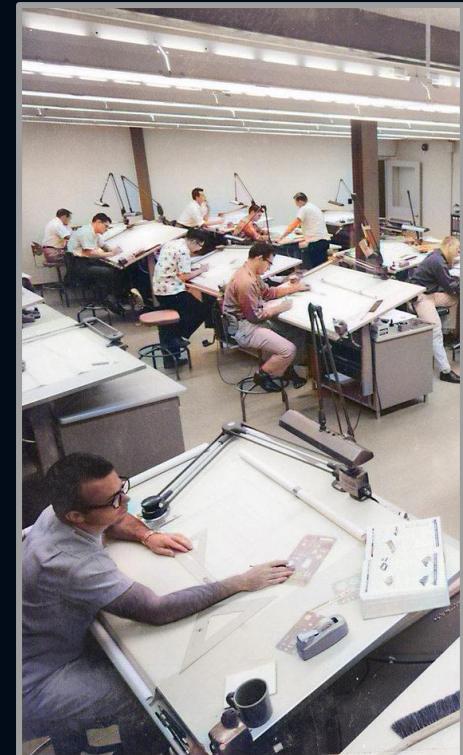
# Functions

## Primary Function

- Limit blood flow obstruction caused by prolonged pressure against skin to prevent pressure sores for patient.

## Secondary Function

- Withstand the weight of the patient.
- Accept operator input to initiate the procedure
- Reduce duration of fixed pressure against the skin.
- Accept operator input to terminate the procedure.





Christopher Jiang

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# Objectives

Objectives	Goals With Metric
Affordability	Price < \$200.00.
Comfort	Cover Surface Area: 137cm x 190cm.
Easy to Use	Require 1 Operator. Maximize # of Accessible Parts.
Life Expectancy	Minimize # of Moving Parts.
Portable	Weight < 10kg Volume < 0.5 cubic meter





Christopher Jiang

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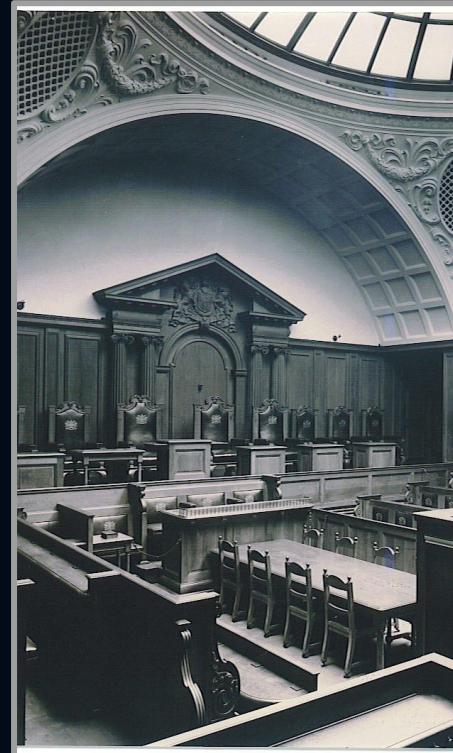
# Constraints

## Operational

- Design with electrical components must have an ingress protection rating above 44 and be tamper proof.
- Must withstand loads of 220lbs.

## Safety and Regulations

- Must not obstruct wheelchair controls.
- Meet CCPSA anti-flammability requirements for bedding textile.
- Must follow SLC policy on research involving humans.
- Be patentable in North America





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## Requirements

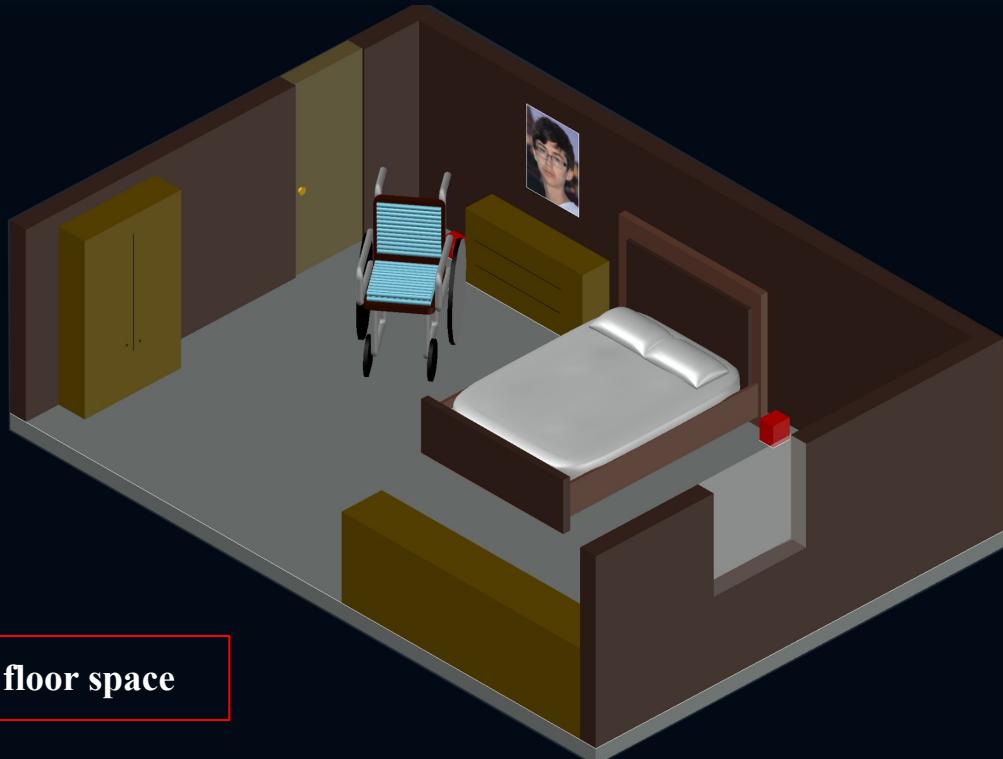
- Functions
- Objectives
- Constraints
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# Service Environment



15.75 m<sup>2</sup> of floor space



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Christopher Jiang

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Stakeholders

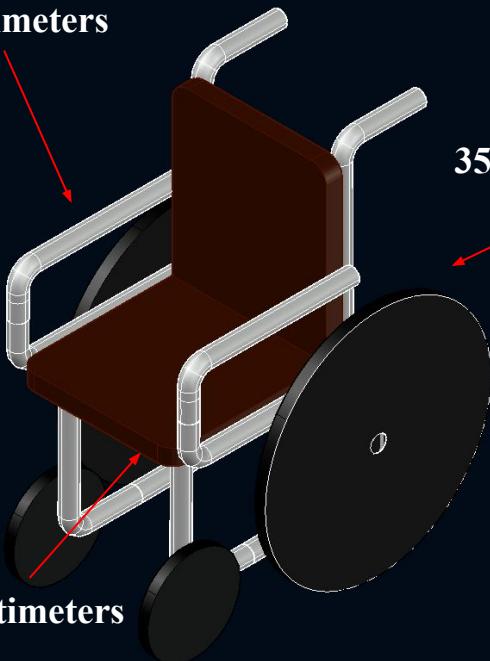
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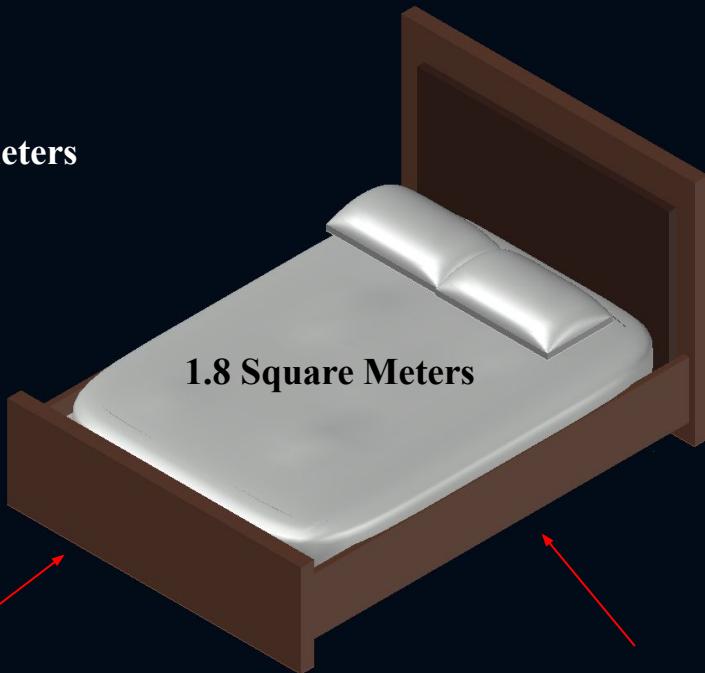
Measures of Success

# Bed and Wheelchair Dimensions

33 Centimeters



35 Centimeters



30 Centimeters

2.0 Meters

0.9 Meters

1.8 Square Meters



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# Stakeholders



Bureau of  
Therapeutic  
Products  
Canada

Assistive  
Devices  
Program  
Ontario



Patient  
Family  
Physician

St. Lawrence  
College  
Centre for  
Behavioural  
Analysis





Crystal Jin

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# ALTERNATIVE DESIGNS

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*Idea Generation*

*Modular Foam Pads*

*Roller Pads*





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Idea Generation

Modular Foam Pads  
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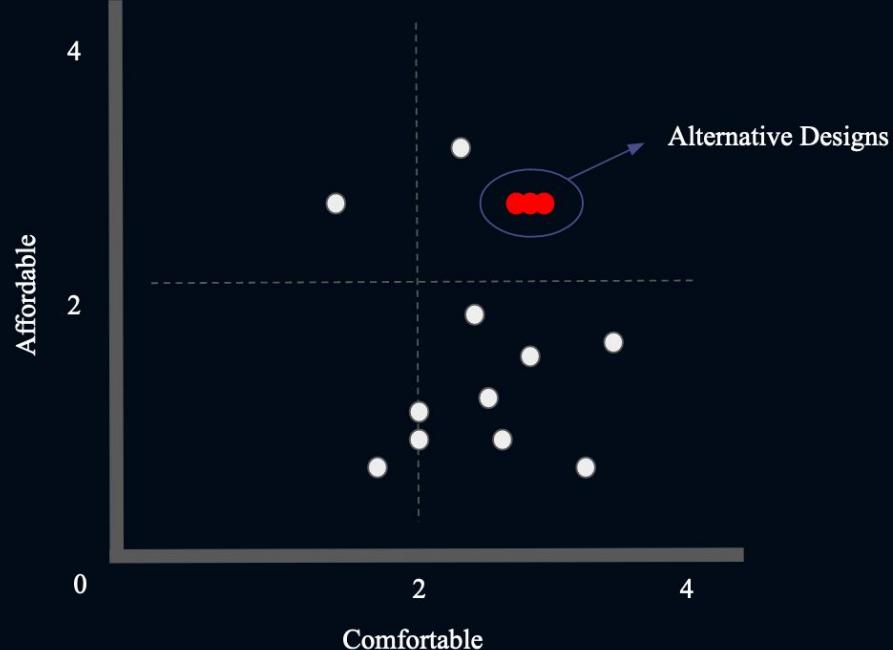
# Idea Generation

## Idea Generation

- Brainstorming
- (SC)AMPER Method
- Morphological Chart

## Idea Selection

- Multi-voting
- Graphical Decision Chart



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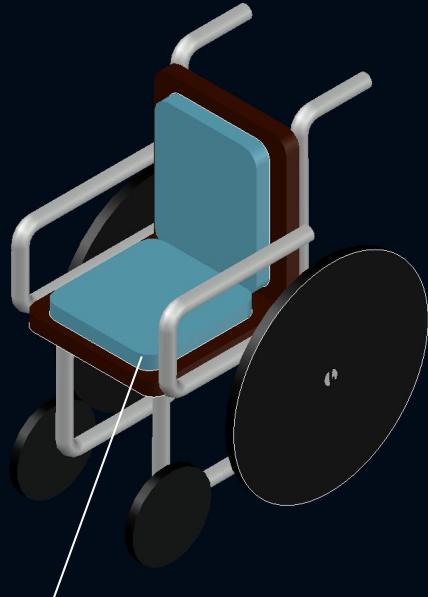
Objectives

Roller Pads

Objectives

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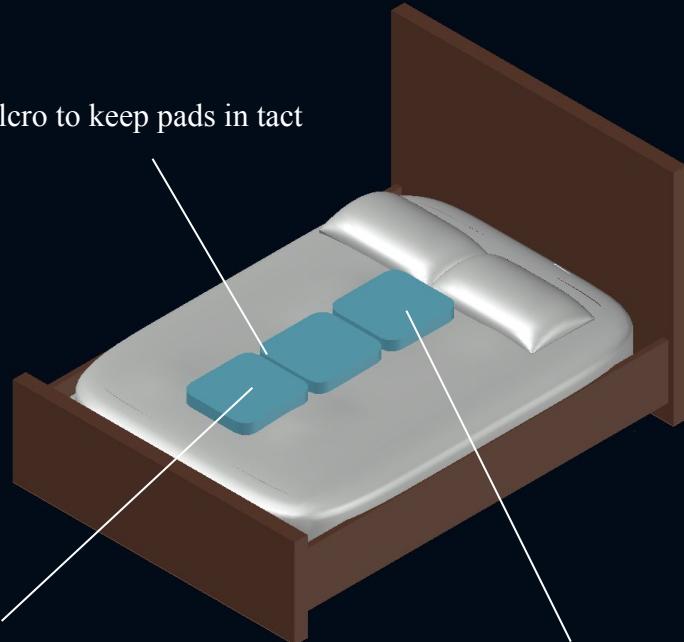
Measures of Success



30cm x 40cm x 2cm

# Modular Foam Pads

Velcro to keep pads in tact



Single Detachable Pad

Pressure Relieving Foam



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Modular Foam Pads

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# Modular Foam Pads

Objective	Assessment
Affordable	\$53
Comfort	Support Surface Area of 0.36 m <sup>2</sup>
Easy to Use	All Parts Replaceable/Repairable Requires 1 Operator
Life Expectancy	2 Moving Parts
Portable	Volume: 0.0072 m <sup>3</sup> Total Weight: 0.576 kg





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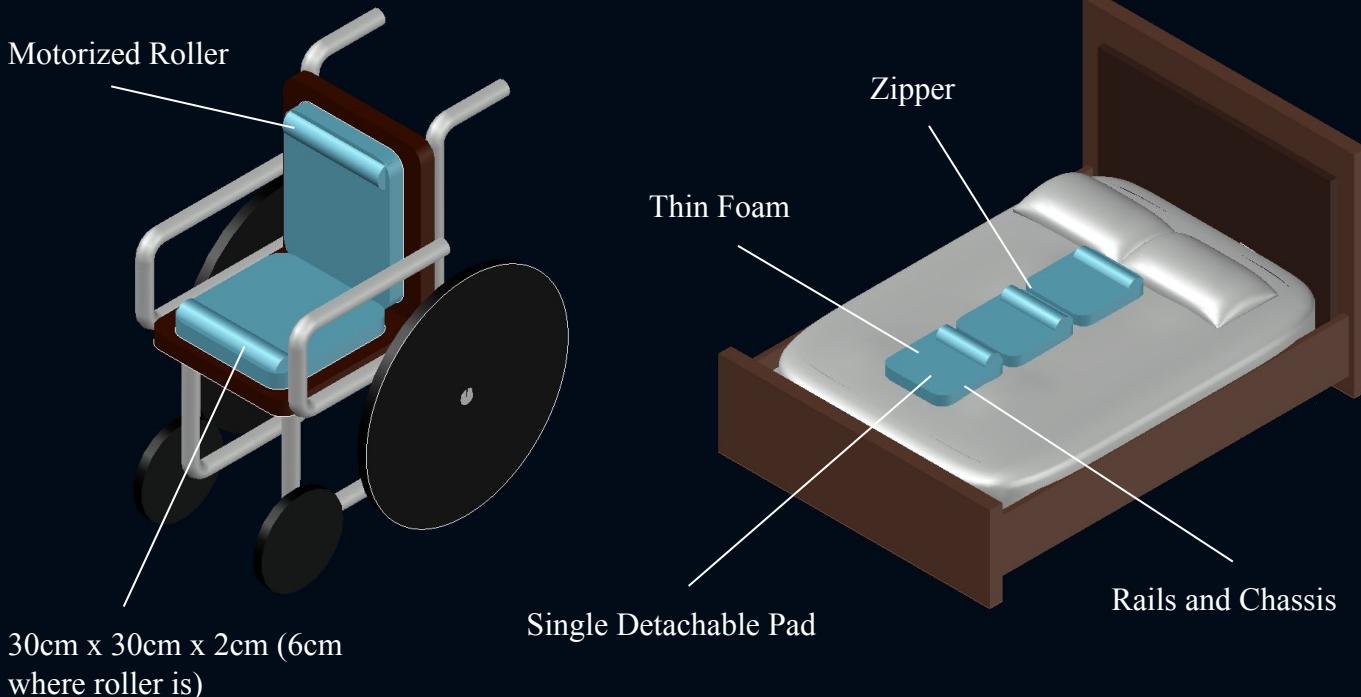
Roller Pads

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# Detachable Roller Pads



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# Detachable Roller Pads

Objective	Assessment
Affordable	\$449
Comfort	Support Surface Area of 0.27 m <sup>2</sup>
Easy to Use	All Parts Replaceable/Repairable Requires 1 Operator
Life Expectancy	5 Moving Parts
Portable	Volume: 0.0072 m <sup>2</sup> Total Weight: 75.3kg





Dominik Adamiak

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# PROPOSED CONCEPTUAL DESIGN

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*Technical Overview*

*Objective Analysis*

*Bridging the Gap &  
Meeting the Need*





Dominik Adamiaak

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Mattress

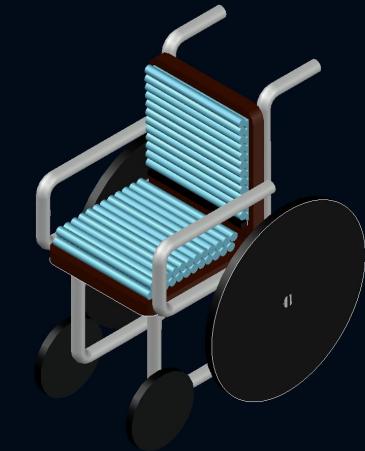
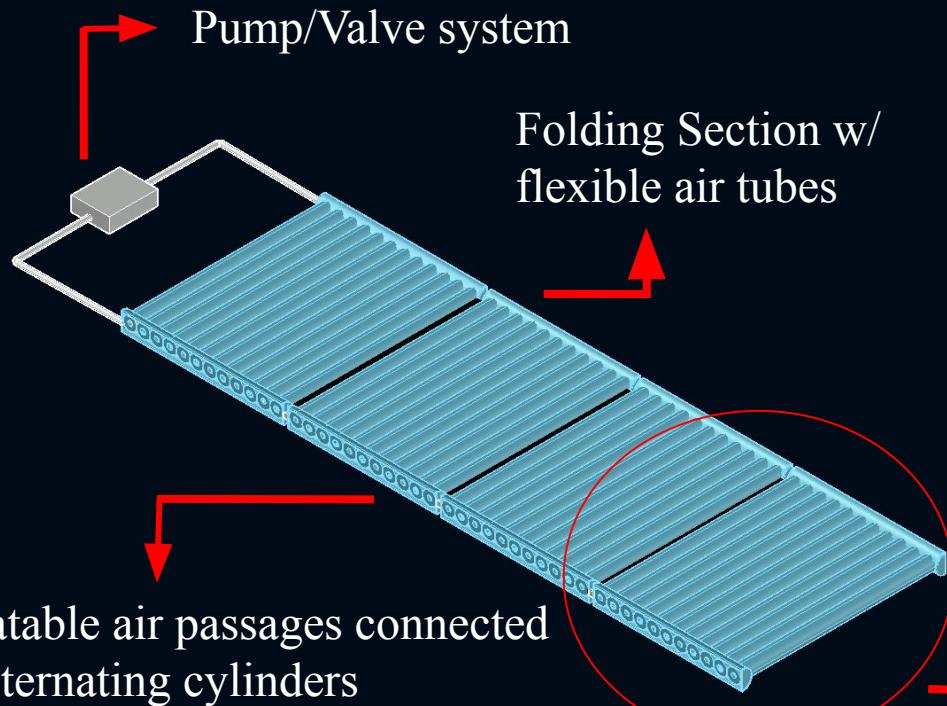
Pump/Battery

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# Transformable Alternating Pressure Mattress



Individual Section,  
composed of 11/12  
inflatable cylinders



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Dominik Adamiaak

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### TAP Overview

#### Mattress

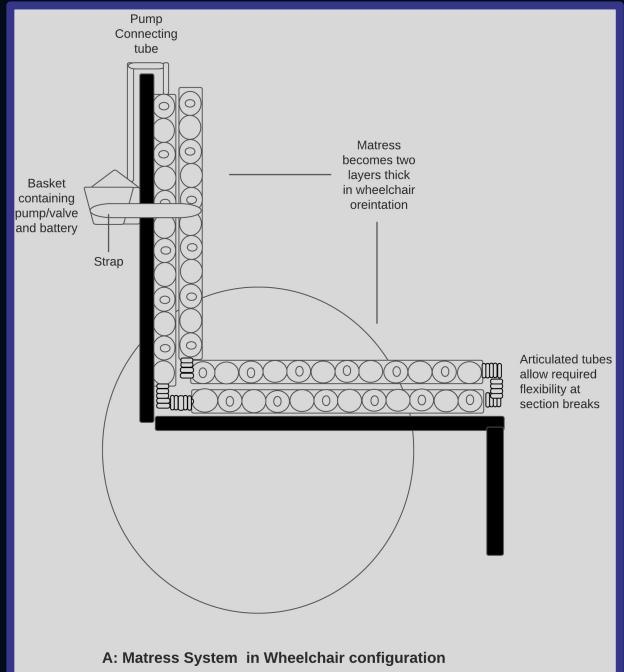
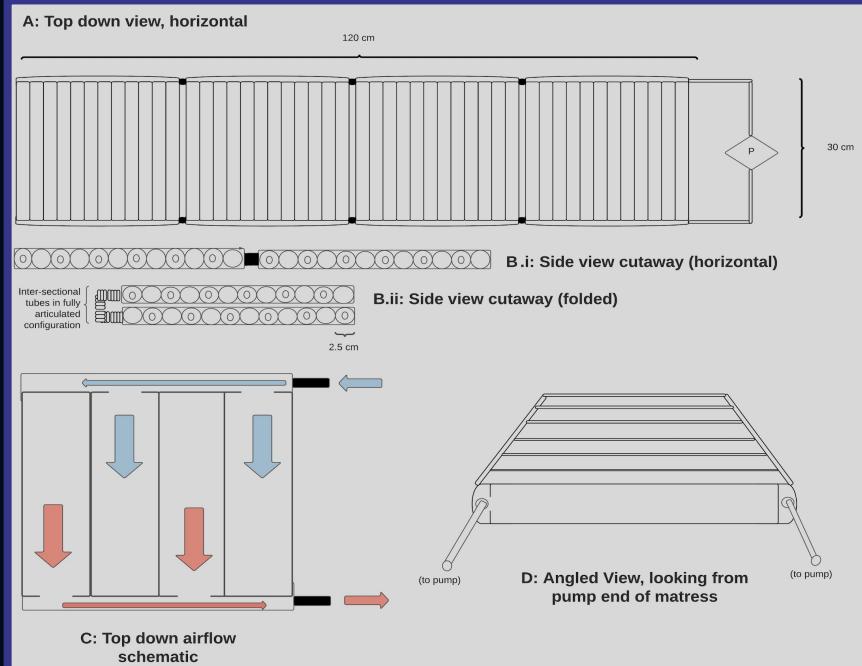
#### Pump/Battery

#### Meeting Objectives

#### Bridging the Gap

## Measures of Success

# Mattress



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Dominik Adamiak

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# Air Pump and Battery

## Thomas 6025SE Diaphragm Air Pump

*4.0 PSI pressure rating = 10x strength factor*

*1.5 A power draw, DC supply option*

*Connected to air mattress tubes through a 3-way ball valve, automatic/manual control*

## Aluratek APBQ16F Power Bank

*16 Ah rating*

*Single charge = 24h*



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# Meeting Objectives

Objective	Assessment
Affordable	\$379
Comfort	Support Surface Area of 0.36 m <sup>2</sup>
Easy to Use	All Parts Replaceable/Repairable Requires 1 Operator
Life Expectancy	5 Moving Parts
Portable	Volume: 0.0072 m <sup>2</sup> Total Weight: 3.9kg



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# Bridging the Gap

Why was the Transformable Alternating Pressure Mattress selected?

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From the weighted decision matrix, with objective ranking:

*ADS-1: 74/100*

*ADS-2: 76/100*

*ADS-3: 59/100*

Ranking was biased towards patient comfort, which ADS-2 scored highest in, and ADS-2 was either #1 or #2 in each of the minor objective rankings.

For non-ambulatory patients, alternating pressure solutions are found to be more than 3x more effective than static solutions in bed sore relief, adequately addressing the need. This, combined with the transformability of ADS-2, which addresses the current gap, allow us to be confident in recommending this design for the client.



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Junandre Paul

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# MEASURES OF SUCCESS

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*MoS Overview*

*Load Resistance*

*Pressure Redistribution*

*Battery Discharge Rate*





Junandre Paul

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- MoS Overview
- Load Resistance
- Redistribution
- Discharge Rate

# Overview

## Prototyping

- Scaled model of mattress to be built to TAP specification.
  - AutoCAD renderings prior to build for improved build approximations.
- Aluratek power bank, Thomas electric air pump to pressurize and power system.
- Generic valves, tubing, and a microcontroller for air flow management.

## Experiments

- Vertical load resistance
- Pressure redistribution
- Battery discharge rate



Requirement	Need met?
Support user weighing up to 90kg	<input type="checkbox"/> Yes <input type="checkbox"/> No
Eliminate risk of developing bedsores	<input type="checkbox"/> Yes <input type="checkbox"/> No
24hr support and untethered use	<input type="checkbox"/> Yes <input type="checkbox"/> No

## University of Toronto Myhal Center for Fabrication Facility



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Junandre Paul

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MoS Overview

Load Resistance

Redistribution

Discharge Rate

# Materials, and Budgeting

Materials	Cost
	Thomas air pump (Used) \$70 (eBay avg)
	Aluratek power bank ~ \$65
	Mat composites ~ \$60
	Raspberry Pi \$0 (Internally sourced)
	Tubing \$0 (Myhal Fabrication Facility)
	<b>\$195</b>

Tools	Cost
	Inline pressure gauge ~ \$7 (Amazon)
	Pipe fitting \$7 (Amazon)
	Pine board 1" ~ \$4
	Force sensors (x4) \$0 (Alibaba Sampling)
	Flatness gauge, various weights and hand/power tools \$0 (Myhal Fabrication Facility)
	<b>\$18</b>

Total cost is expected to be approximately \$213



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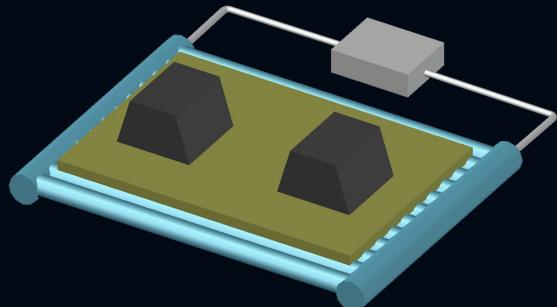
# Load Resistance

## Purpose

Gauge device's ability to sustain the user's increasing weight through its service life.

## Procedure

1. Place air pressure sensor placed along air channel bridging mat and pump.
2. With valves closed, air pump is switched on until system is pressurized to 4 psi.
3. Pine board is placed between the mat and a weight.
4. Flatness gauge is placed on board.
5. Repeat with higher rated weight (60kg, 80kg, 100kg).



## Data interpretation

Deviation of less than 3% and psi rating above 3.8 psi over period of test is considered a success.

Test #	Weight (kg)	Balance variance over 24h (%)	Pressure deviations
1			
2			
3			



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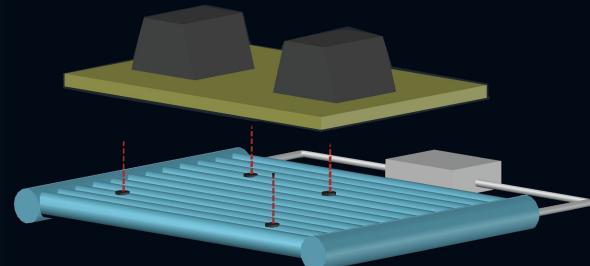
# Pressure Redistribution

## Purpose

Evaluate device's ability to reliably pressurize/depressurize alternating tubes.

## Procedure

1. Place air pressure sensor placed along air channel bridging mat and pump.
2. Air pump is switched on with valves operating normally.
3. Four force sensors are placed between alternating tubes and the pine board.
4. Weight is placed on the pine board.
5. Repeat with higher rated weight (60kg, 80kg, 100kg).



## Data interpretation

Complete inflation/deflation of alternating tubes within programmed time sequence is considered a success.

Test #	Tube ID	Pressure at 10min interval (psi)	Pressure at 20min interval (psi)	Pressure at 30min interval (psi)
1				
2				





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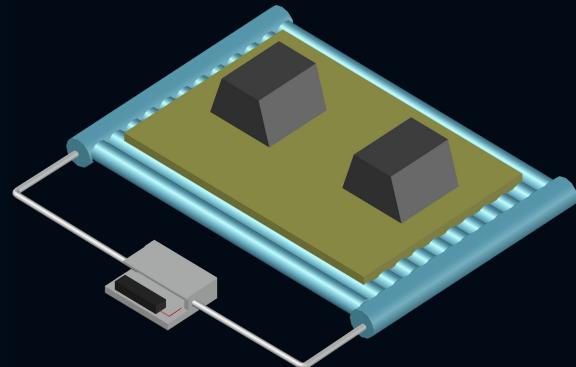
# Battery Discharge Rate

## Purpose

Gauge the battery's ability to reliably power the pump for extended periods.

## Procedure

- Place air pressure sensor placed along air channel bridging mat and pump.
- Pine board is placed between the mat and a weight.
- Air pump is switched on with valves operating normally for 16 hours.
- Repeat with higher rated weight (60kg, 80kg, 100kg).



## Data interpretation

A reading of 30% or more on the battery's integrated gauge at the end of the test will be considered a success.

Test #	Weight (kg)	Charge indication at 16h (mAh)	Power for duration of test (yes/no)	Pressure deviations
1				
2				
3				



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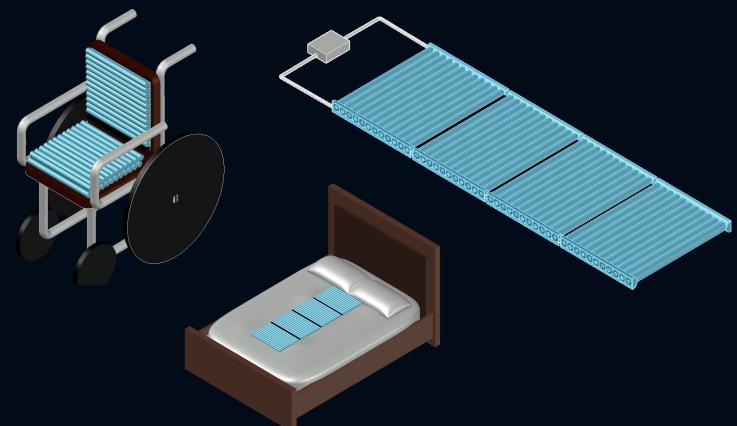
# Conclusion

## Goal

Reduce the chances of developing pressure sores from prolonged periods in a bed or wheelchair.

## Recommended Solution

Transformable Alternating Pressure Mattress



## Future Steps

Prototyping and conducting tests on the design



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# THANK YOU

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If there are any questions feel free to contact us via  
our contact person.



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# References

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- [1] D. P. Bentley, "Could the internet become conscious?," *BBC Science Focus Magazine*. [Online]. Available: <https://www.sciencefocus.com/science/could-the-internet-become-conscious/>. [Accessed: 21-Apr-2021].
- [2] *Explore AT from AT3 Center*. [Online]. Available: <https://exploreat.net/at-discovery/seating-positioning-mobility/>. [Accessed: 21-Apr-2021].
- [3] K. Anthony , "Pressure Ulcer Sore Stages," *Healthline*, 18-Sep-2018. [Online]. Available: <https://www.healthline.com/health/stages-of-pressure-ulcers#stages-and-treatment>. [Accessed: 14-Apr-2021].
- [4] *3M Cavilon Durable Barrier Cream, 92 g. tube (3392C)*: Amazon.ca: Beauty. [Online]. Available: <https://www.amazon.ca/3M-Cavilon-Durable-Barrier-3392C/dp/B00ZX5F5FC>. [Accessed: 16-Apr-2021].
- [5] "Drive Medical Med-Aire 8' Alternating Pressure and Low Air Loss Mattress System," *Halo Healthcare Solutions*. [Online]. Available: [https://www.halohealthcare.com/drive-medical-med-aire-8-alternating-pressure-and-low-air-loss-mattress-system/?gclid=Cj0KCQjwyN-DBhCDARIaFOELTn87zd5F3CBH4LH0m\\_XhEGGOmPJP\\_Pz0fkgaJBUwnXZjeKA2MUzsZsaAu3\\_EALw\\_wcB](https://www.halohealthcare.com/drive-medical-med-aire-8-alternating-pressure-and-low-air-loss-mattress-system/?gclid=Cj0KCQjwyN-DBhCDARIaFOELTn87zd5F3CBH4LH0m_XhEGGOmPJP_Pz0fkgaJBUwnXZjeKA2MUzsZsaAu3_EALw_wcB). [Accessed: 16-Apr-2021].
- [6] "Wheelchair Cushions by JAY," *Sunrise Medical*. [Online]. Available: <http://sunrisemedical.ca/seating-positioning/jay/wheelchair-cushions>. [Accessed: 16-Apr-2021].
- [7] "Canadian Best Practice Guidelines for the Prevention and Management of Pressure Ulcers in People with Spinal Cord Injury," Feb-2013. [Online]. Available: [https://onf.org/wp-content/uploads/2019/04/Pressure\\_Ulcers\\_Best\\_Practice\\_Guideline\\_Final\\_web4.pdf](https://onf.org/wp-content/uploads/2019/04/Pressure_Ulcers_Best_Practice_Guideline_Final_web4.pdf) . [Accessed: 16-Apr-2021].
- [8] NNSA. "#TBT 1960s: The Electronics Drafting Room @Livermore\_Lab Supported Weapons Development. Pic.twitter.com/MNAw0NCmHc." *Twitter*, 13 Apr. 2017. [Online] Available: [witter.com/NNSANews/status/852553975484358656](https://twitter.com/NNSANews/status/852553975484358656). [Accessed 24-Apr-2021].
- [9] "Courtroom 1" *Old Bailey - Central Criminal Court - London*. [Online]. Available: <https://www.facebook.com/pg/OldBaileyCentralCriminalCourt> [Accessed-24-2021].
- [10] *St. Lawrence College of Applied Arts and Technology (Canada)*. [Online]. Available: <https://www.google.ca/url?sa=i>. [Accessed: 21-Apr-2021].
- [11] "Child Safety at the Doctor's Office," *Chicago Children's Advocacy Center*, 11-Jul-2020. [Online]. Available: <https://www.chicagocac.org/child-safety-doctor/>. [Accessed: 21-Apr-2021].
- [12] C. 1st J. 2019, "How to check flatness using an engineer's straight edge?," *Wonkee Donkee Tools*, 29-Feb-2020. [Online]. Available: <https://www.wonkeedonkeetools.co.uk/engineers-straight-edges/how-to-check-flatness-using-an-engineer-s-straight-edge>. [Accessed: 24-Apr-2021].
- [13] "Linear pumps & compressors 6025 DC Series," *thomas*. [Online]. Available: <https://www.gardnerdenver.com/en-ca/thomas/linear-pumps-compressors/6025-dc-series>. [Accessed: 24-Apr-2021].



# References

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- [14] "Aluratek 16 000mAh USB Type-C Power Bank with Qualcomm Quick Charge 3.0 + Built in Rechargeable Solar Panels – APBQ16F," *Better1*, 19-Dec-2020. [Online]. Available: [https://better1.com/product/aluratek-16-000mah-usb-type-c-power-bank-with-qualcomm-quick-charge-3-0/?gclid=EAIAIQobChMI0cyYkNaU8AIvxyzCh09\\_Ap7EAQYAiABEgKpYPD\\_BwE&v=3e8d115eb4b3](https://better1.com/product/aluratek-16-000mah-usb-type-c-power-bank-with-qualcomm-quick-charge-3-0/?gclid=EAIAIQobChMI0cyYkNaU8AIvxyzCh09_Ap7EAQYAiABEgKpYPD_BwE&v=3e8d115eb4b3). [Accessed: 24-Apr-2021].
- [15] "Raspberry Pi." [Online]. Available: [https://upload.wikimedia.org/wikipedia/commons/f/f1/Raspberry\\_Pi\\_4\\_Model\\_B\\_-\\_Side.jpg](https://upload.wikimedia.org/wikipedia/commons/f/f1/Raspberry_Pi_4_Model_B_-_Side.jpg). [Accessed: 24-Apr-2021].
- [16] "Measurement Pressure Gauge 0-30psi/kpa Dry Air Pressure Gauge, 2' Dial Size, 1/4'NPT Lower Mount," *Amazon*. [Online]. Available: [https://www.amazon.com/Measureman-Pressure-Gauge-0-30psi-Lower/dp/B084VRNNJ7/ref=sr\\_1\\_2\\_sspa?dchild=1&keywords=Inline+Air+Pressure+Gauge+60+psi&qid=1619166062&sr=8-2-spons&psc=1&spLa=ZW5jcnlwGVkUXVhbGlmaWVpUEzSDIQN09PMlpZQzRGJmVuY3J5cHRIZEIkPUEwNDM0NzAzMUowMlc3NUw2SjM5USZlbmNyeXB0ZWRBZElkPUEwNTYyOTQxMTc2OEFCUEdNSE1ZTSZ3aWRnZXROYW1lPXNwX2F0ZiZhY3RpB249Y2xpY2tSZWRpcmVjdCZkb05vdExvZ0NsawNrPXRydWU="](https://www.amazon.com/Measureman-Pressure-Gauge-0-30psi-Lower/dp/B084VRNNJ7/ref=sr_1_2_sspa?dchild=1&keywords=Inline+Air+Pressure+Gauge+60+psi&qid=1619166062&sr=8-2-spons&psc=1&spLa=ZW5jcnlwGVkUXVhbGlmaWVpUEzSDIQN09PMlpZQzRGJmVuY3J5cHRIZEIkPUEwNDM0NzAzMUowMlc3NUw2SjM5USZlbmNyeXB0ZWRBZElkPUEwNTYyOTQxMTc2OEFCUEdNSE1ZTSZ3aWRnZXROYW1lPXNwX2F0ZiZhY3RpB249Y2xpY2tSZWRpcmVjdCZkb05vdExvZ0NsawNrPXRydWU=). [Accessed: 24-Apr-2021].
- [17] "Anderson Metals 56101-04 Brass Pipe Fitting, Barstock Tee, 1/4' x 1/4' x 1/4' NPT Female Pipe," *Amazon*. [Online]. Available: [https://www.amazon.com/Anderson-Mets-Fitting-Barstock-Female/dp/B000BQUTBS/ref=pd\\_bxgy\\_img\\_3/130-4326249-0393858?\\_encoding=UTF8&pd\\_rd\\_i=B000BQUTBS&pd\\_rd\\_r=5d0d3bc0-65fd-44a5-aa49-b9c6ceed151&pd\\_rd\\_w=Y3UF6&pd\\_rd\\_wg=TUueb&pf\\_rd\\_p=fd3ebcd0-c1a2-44cf-aba2-bbf4810b3732&pf\\_rd\\_r=SB7AKM0RKF7G8SX6ZRWQ&psc=1&refRID=SB7AKM0RKF7G8SX6ZRWQ](https://www.amazon.com/Anderson-Metals-Fitting-Barstock-Female/dp/B000BQUTBS/ref=pd_bxgy_img_3/130-4326249-0393858?_encoding=UTF8&pd_rd_i=B000BQUTBS&pd_rd_r=5d0d3bc0-65fd-44a5-aa49-b9c6ceed151&pd_rd_w=Y3UF6&pd_rd_wg=TUueb&pf_rd_p=fd3ebcd0-c1a2-44cf-aba2-bbf4810b3732&pf_rd_r=SB7AKM0RKF7G8SX6ZRWQ&psc=1&refRID=SB7AKM0RKF7G8SX6ZRWQ). [Accessed: 24-Apr-2021].
- [18] "2-IN X 12-IN X 24-FT YELLOW PINE LUMBER S4S," *The Home Improvement Outlet*. [Online]. Available: <https://www.hioutlet.com/pd/2-x-12-24-yellow-pine-s4s/31468>. [Accessed: 24-Apr-2021].
- [19] *At8103 Micro Button Compression Force Sensor 100kg - Buy Compression Force Sensor 100kg, Load Cell Sensor 100kg, 100kg Load Cells Sensor Product on Alibaba.com*. [Online]. Available: [https://www.alibaba.com/product-detail/AT8103-Micro-button-Compression-force-load\\_62167524409.html?spm=a2700.wholesale.0.0.60f43bfc8ZCD1y](https://www.alibaba.com/product-detail/AT8103-Micro-button-Compression-force-load_62167524409.html?spm=a2700.wholesale.0.0.60f43bfc8ZCD1y). [Accessed: 24-Apr-2021].
- [20] "EVA TUBING,FLEXIBLE,1.31 IN OD,200 FT.," *GRAINGER*. [Online]. Available: [https://www.grainger.ca/en/product/p/WWG4EGU3?gclid=EAIAIQobChMInfyC7taU8AIvrgSGtBh0VDg5fEAsYBSABEgLevfD\\_BwE&cm\\_mmc=PPC:+Google+PLA&ef\\_id=EAIAIQobChMInfyC7taU8AIvrgSGtBh0VDg5fEAsYBSABEgLevfD\\_BwE:G:s&s\\_kwcid=AL!3645!3!303439923731!!!g!594531344289!](https://www.grainger.ca/en/product/p/WWG4EGU3?gclid=EAIAIQobChMInfyC7taU8AIvrgSGtBh0VDg5fEAsYBSABEgLevfD_BwE&cm_mmc=PPC:+Google+PLA&ef_id=EAIAIQobChMInfyC7taU8AIvrgSGtBh0VDg5fEAsYBSABEgLevfD_BwE:G:s&s_kwcid=AL!3645!3!303439923731!!!g!594531344289!) [Accessed: 24-Apr-2021].

