ErgoEMS

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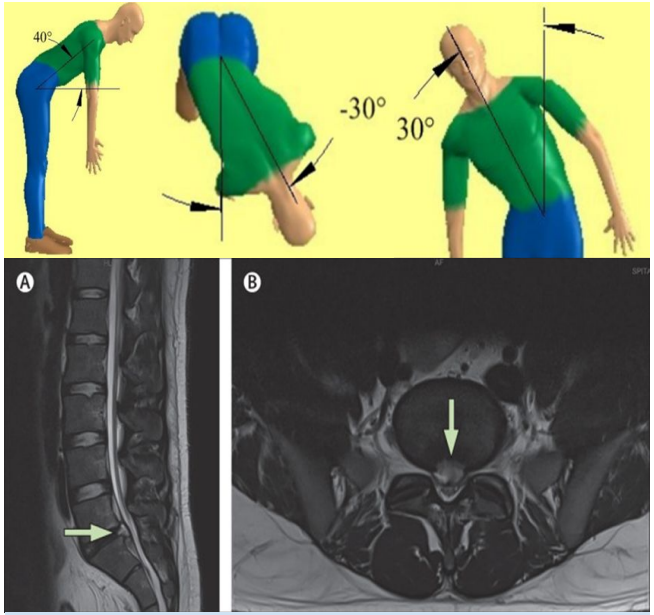
Background

Device



Physiological Need

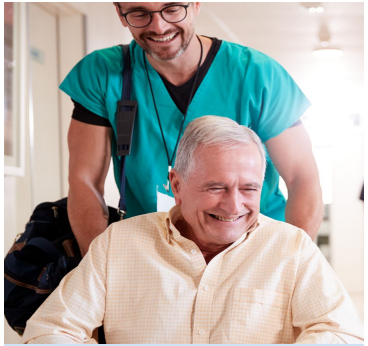
Alternatives

Problem Statement

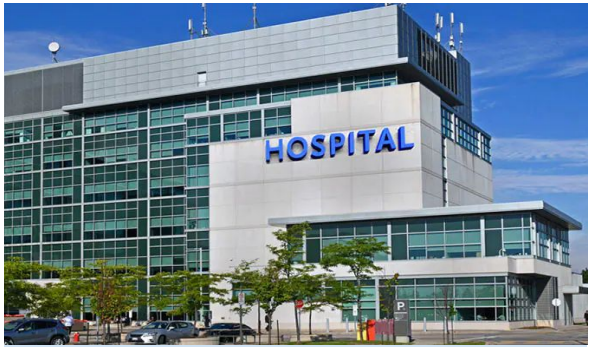
Emergency Medical Service (EMS) personnel encountering stairs while transporting non-ambulatory patients need a device that safely and easily transports patients without increasing their risk for an L5-S1 herniated disc.

Stakeholders

EMS Personnel



Patients



Hospitals

Multi-level Buildings

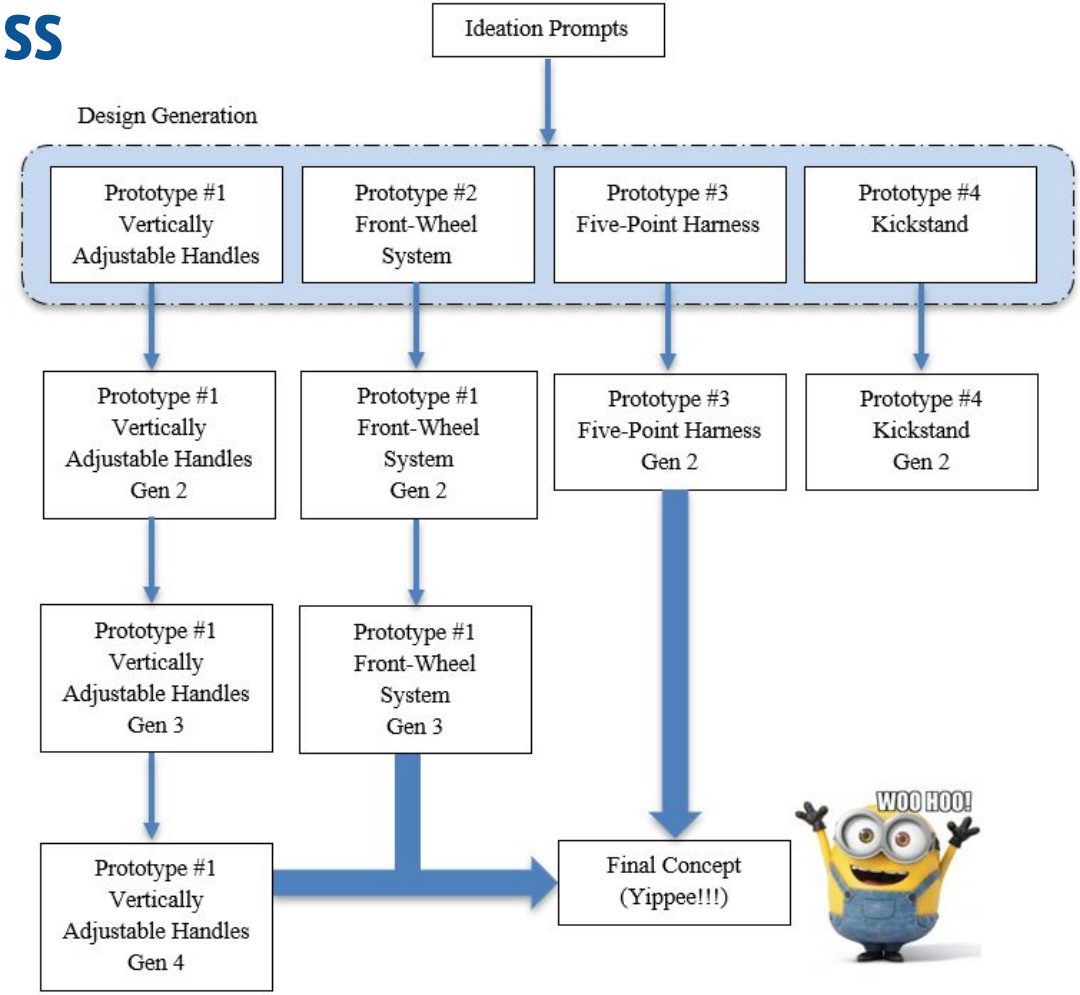
stryker

EVAC+CHAIR®

Emergency Evacuation For Everyone

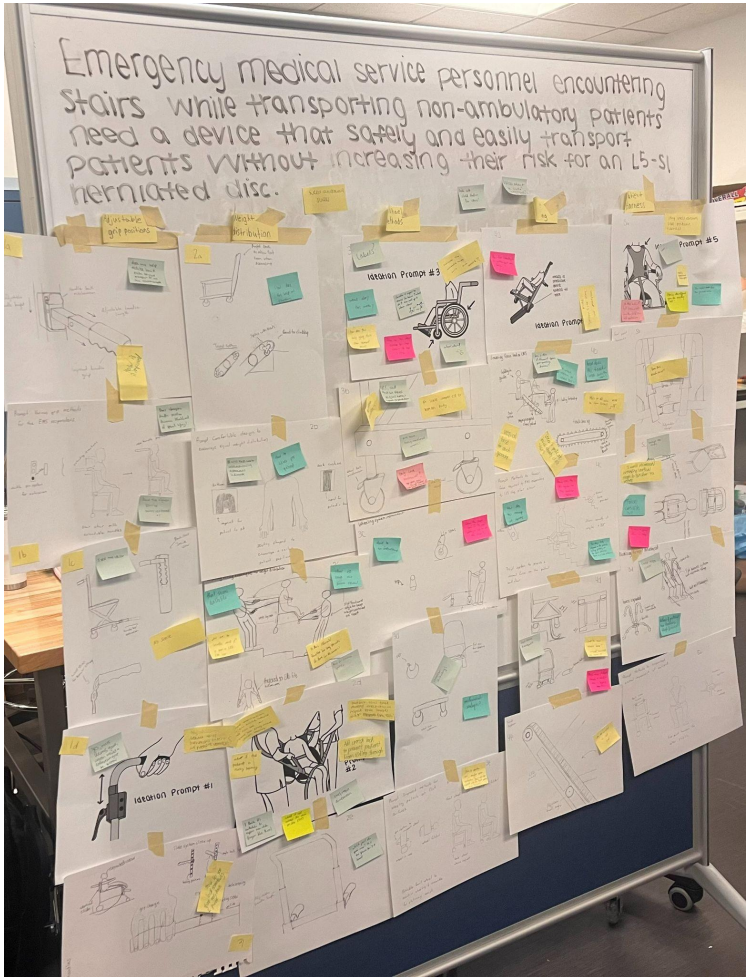
Manufacturers

Design Process

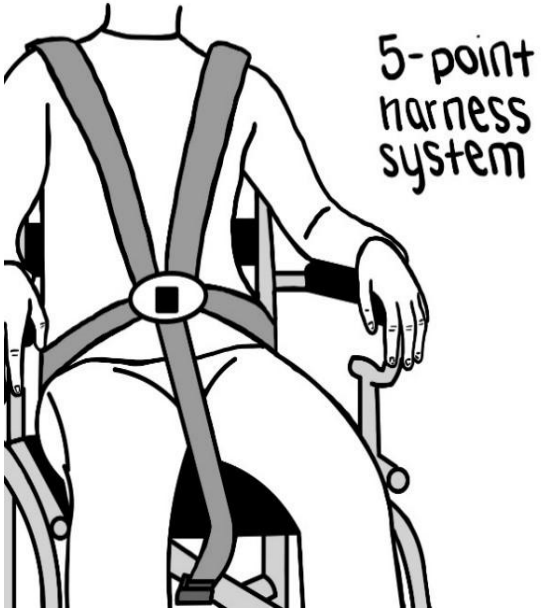


Concept Development

- Utilized a Pugh matrix to evaluate sketches against criteria including:
  - Benefits to the user
  - Simplicity
  - Ability to prototype quickly
  - Use of low-cost materials
  - Minimum training required



Patient Restraint System: Prototyping Process



Concept Sketch

Rapid Prototype

Gen 2

Patient Restraint System: Testing Process

Predicate baseline

	Strap Time(s)	Separation(in)
Mean	32	5.48
Standard Deviation	5.25	3.51

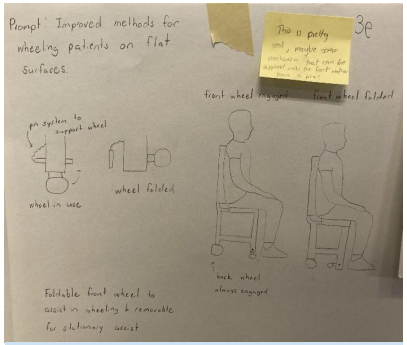
Gen 2 prototype

	Strap Time(s)	Separation(in)
Mean	62	1.39
Standard Deviation	15.8	0.74

Statistical Analysis

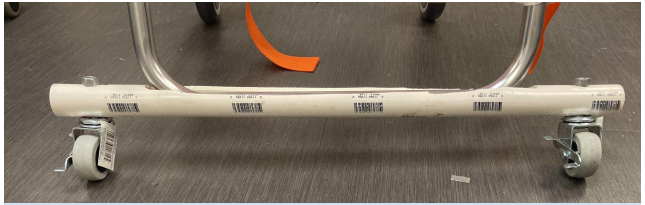
- **Strap Time ->** p value of 0.000013
- **Separation ->** p value of 0.0016

Front Wheel System: Prototyping Process



Concept Sketch

Rapid Prototype



Gen 2

Gen 3

Front Wheel System: Testing Process

Data

Statistic	Initial Deployment	Final Deployment
Mean	12.799 s	8.398 s
Standard Deviation	2.7773 s	1.7926 s
Standard Error of the Mean	0.8782 s	0.5669 s
Degrees of Freedom	9	9

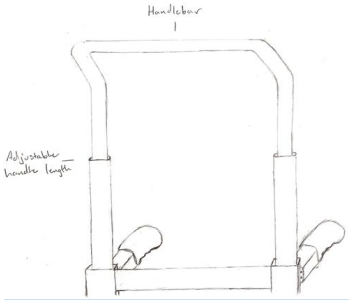
Statistical Analysis

Statistic	Value
Paired t-test	4.0345
One-sided p-value	0.0015
Standard Error of Difference	1.091

Design Inputs

- Deploy time must be less than 10 seconds
- Each front wheel must support 750 N/168 lbs (Appendix B)

Vertically Adjustable Handles: Prototyping Process



Concept Sketch

Rapid Prototype

Gen 2

Gen 3

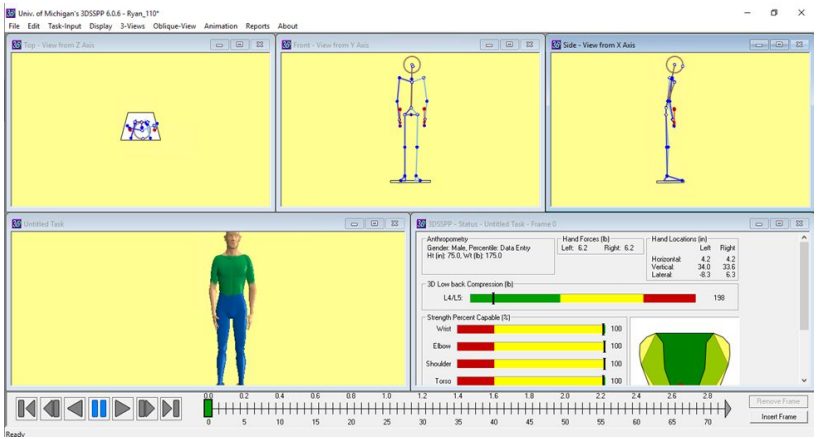
Rapid Prototype

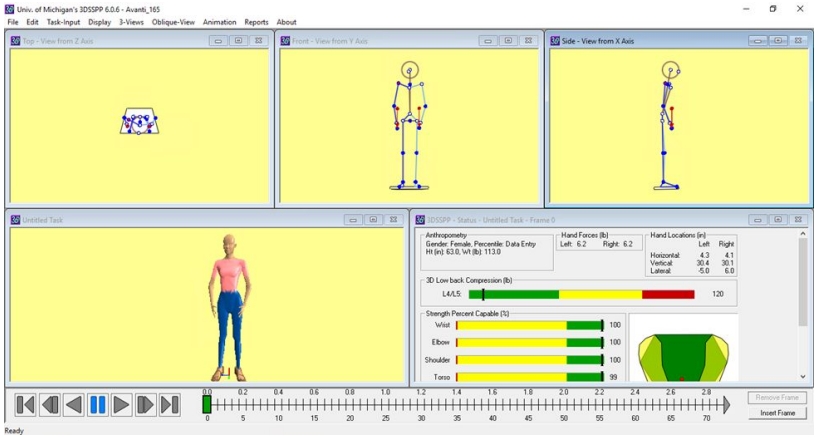
Gen 2

Design Inputs

- Handles must have a vertical height range of at least 4.18 inches

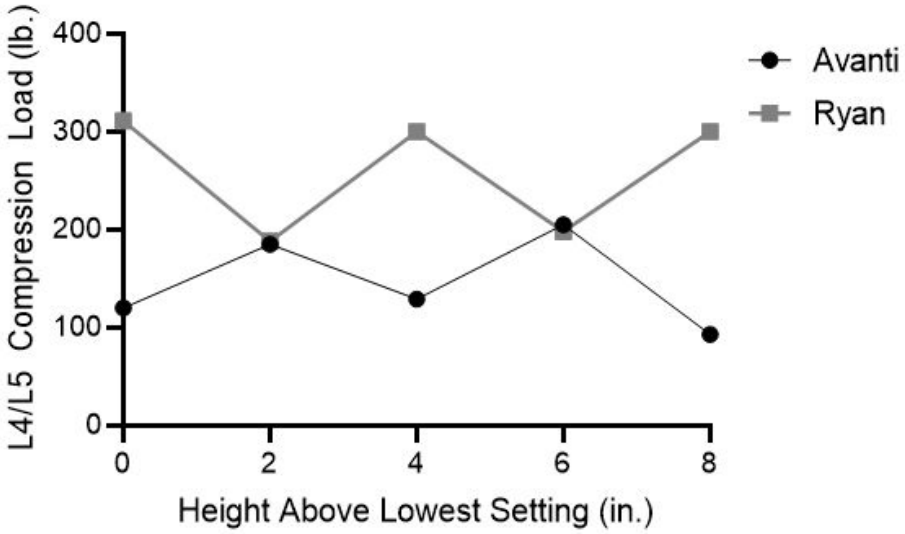
Vertically Adjustable Handles: Testing Process





Vertically Adjustable Handles: Testing Process

Data



Statistical Analysis

Statistic	Value
Unpaired T test (p-value)	0.0110

Other Ideas

Concept Sketch

Rapid Prototype

Gen 2

Final Prototype

Fusion 360 Model

User Feedback

- **Patient Restraint System**: interesting design, very secure
- **Front Wheel System**: simple, but effective
- **Vertically Adjustable Handles**: ensure proper locking mechanism

Market Segment Analysis

Total Addressable Market (TAM)

- $7.46 billion

Service Available Market (SAM)

- $408 million

Service Obtainable Market (SOM)

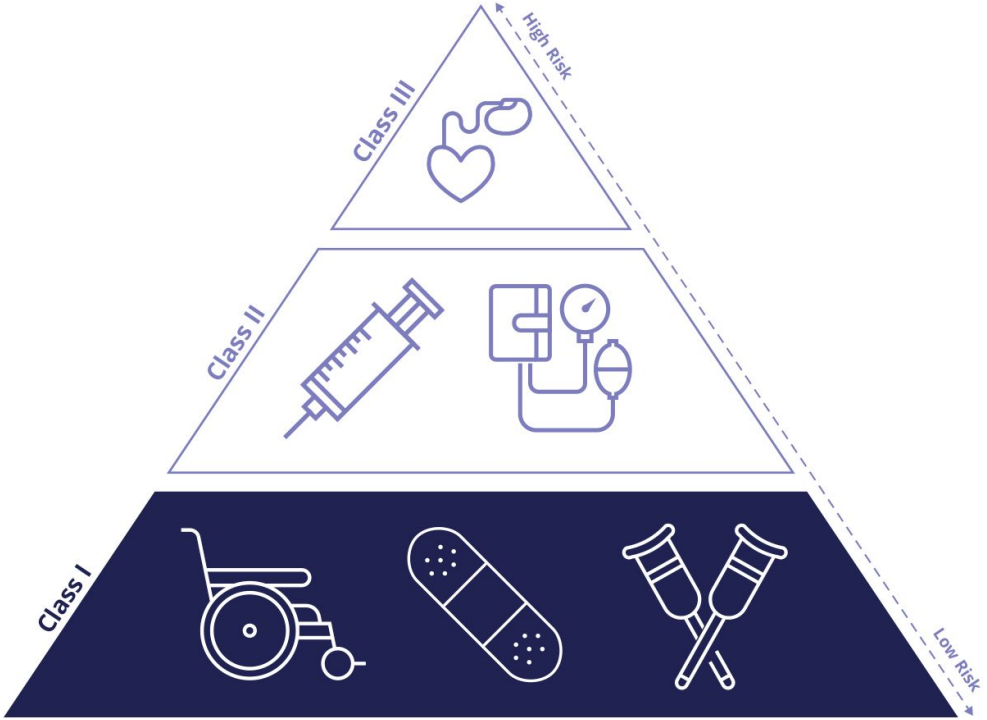
- $37.9 million

Emergency Evacuation Chair Market Report Coverage

REPORT COVERAGE	DETAILS
Market Size Value In	US$ 90.61 Million in 2022
Market Size Value By	US$ 120.95 Million by 2028
Growth Rate	CAGR of 4.93% from 2022 to 2028
Forecast Period	2022-2028
Base Year	2023
Historical Data Available	Yes
Segments Covered	Type and Application
Regional Scope	Global

Value

- Class I medical device and 510(k) exempt
- Less than one month to gain approval from FDA



Value

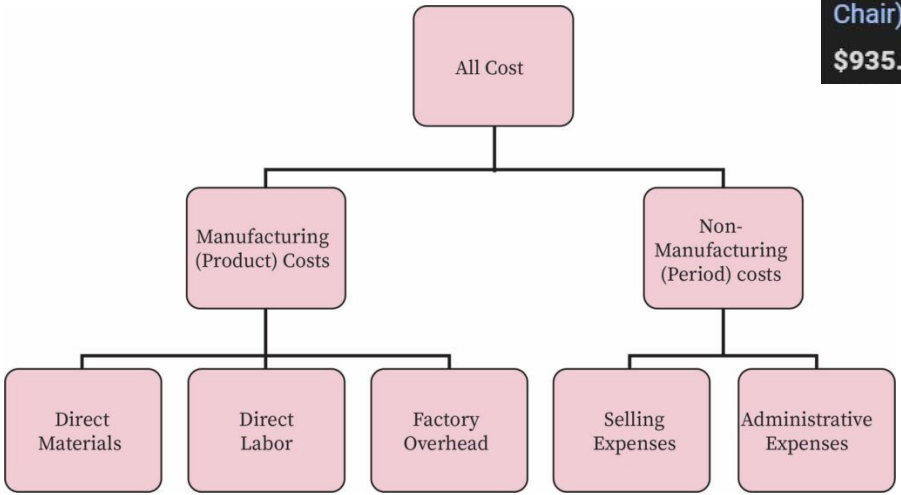
- Costs to begin production may reach up to $500,000
  - May take up to six months to begin manufacturing

- Other costs include registration, permits for sale, and establishing distribution channels

Value

- Bill of materials: cost of one stair chair is $323 (Appendix D)
  - Other costs: labor, utilities, other overhead expenses

- Sales price: ~**$750**
  - More affordable than most other options



Value

- Has benefits over existing solutions
- Meets both user needs and unmet needs
- Overall, the device is a good value over existing solutions

References

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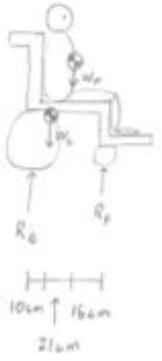
Appendix A

		Concept Sketches						
Criteria	**Weight**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Benefits User	5	+	+	+	+	-	S	S
Simplicity	4	+	+	S	+	S	-	-
Prototyped Quickly	3	+	S	S	+	+	-	-
Low-Cost Materials	2	+	+	+	+	+	+	-
Low to No Training Required	1	S	-	-	+	S	+	-
Weighted Sum of Positives (+)		14	11	7	15	+5	+3	0
Number of Sames (S)		1	1	2	0	2	1	1
Weighted Sum of Negatives (-)		0	-1	-1	0	-5	-7	-10
Total		14	10	6	15	0	-4	-10

Appendix B

Engineering analysis showing each front wheel must support 750 N (168 lbf)

Free Body Diagram



Variables

R_B = reactive force by ground on back wheels

R_F = reactive force by ground on front wheels

Parameters

m_p = mass of patient = 227 kg

m_c = mass of chair = 15.5 kg

g = acceleration due to gravity = 9.81 m/s^2

Equations of Equilibrium

$\Sigma F_x = \Sigma F_y = 0$

$\Sigma F_y = R_B + R_F - W_c - W_p = 0$

$\Sigma M_B = (10cm)(15.5kg)(-9.81 m/s^2) + (31cm)(227kg)(-9.81 m/s^2) + (47cm)(R_F) = 0$

$R_F = 1500\ N$ for one wheel $= R_F/2 =$ **750 N**

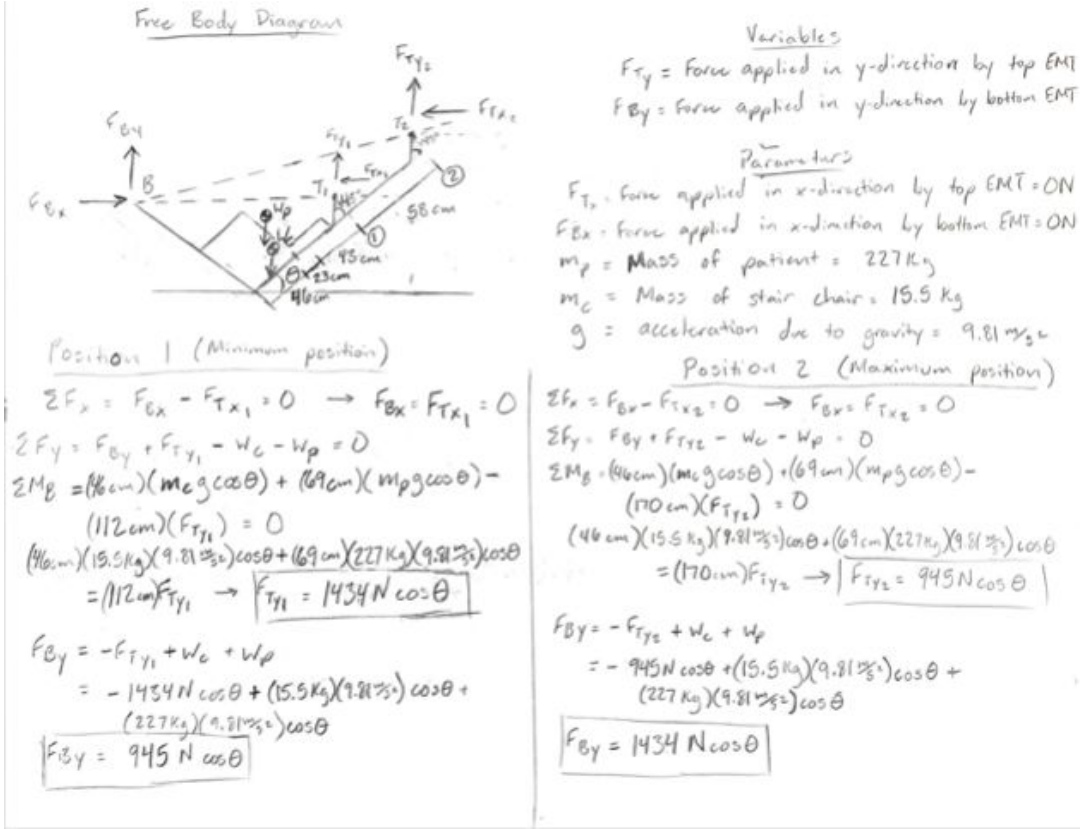
$R_B = W_c + W_p - R_F$

$= (15.5)(9.81) + (227)(9.81) - 1500$

$=$ **880 N**

Appendix C

- At minimum vertical length, top load equals 1434 N (322 lbf) with respect to the angle
- At maximum vertical length, top load equals 945 N (212 lbf) with respect to the angle



Appendix D

Material	Quantity	Source	Cost	Description
Aluminum tube	~200 inches in length	Outsourced as uncut hollow tube	$3.91 per foot (~$65)	Hollow circular aluminum tube (.5 in inner diameter, .75 in outer diameter)
Aluminum tube	~66 inches in length	Outsourced as uncut hollow tube	$3.71 per foot (~$20)	Hollow rectangular aluminum tube (1.75” L x .75” W outer, and 1.5” L x .5 W inner)
Aluminum tube	~48 inches in length	Outsourced as uncut hollow tube	$3.64 per foot (~$14.5)	Hollow rectangular aluminum tube (1.45” L x .45” W outer, and 1.2” L x .2 W inner)
L-shaped stainless-steel connector	2 pieces	Outsourced as pre-made	$3.15 per piece ($6.30)	Holes pre drilled to support rivets and shape to match need

Appendix D

Sliding stainless steel support	2 pieces	Outsourced as pre-made	$3.20 per piece ($6.40)	Holes pre drilled to support screws and hollow center to support sliding handles
U-shaped stainless-steel backing	1 piece	Outsourced as pre-made	$4.50	Holes pre drilled to support screws
Hollow stainless-steel tubing	10 in length	Outsourced as uncut hollow tube	$2.19 per foot (~$1.83)	1/8 in diameter
W-shaped stainless-steel support	2 pieces	Outsourced as pre-made	$6.20 per piece ($12.40)	Holes pre drilled to support rivets and shape to match need

Appendix D

Wheel stainless-steel support	2 pieces	Outsourced as pre-made	$7.10 per piece ($14.20)	Holes pre drilled to support screws and sized to support attached wheels
Large wheels	2 pieces	Outsourced as pre-made	$9.70 per piece ($19.40)	Rubber coated and 5.5” diameter
Small wheels and support	2 pieces	Outsourced as pre-made	$7.50 per piece ($15.00)	Rubber wheels with built-in braking system and 2” diameter
Waterproof Polyvinyl Chloride	~650 square inches	Outsourced as pre-made raw material	~$0.02 per square inch (~$13)	Will be used with injection molding to create the seat
Yarn/stitching	~36 in	Outsourced as pre-made	~$0.01 per inch (~$0.36)	Will be used to stitch the PVC seat

Appendix D

8 in length zipper system	2 pieces	Outsourced as pre-made	$3.60 per 8 inch system ($7.20)	Will be stitched into the seat. Bought as a slider and chain.
Straps	~48 in length	Outsourced as pre-made	$1.76 per foot (~$7.04)	1 in width
Straps	~58 in length	Outsourced as pre-made	$2.42 per foot (~$11.68)	2 in width
Buckle system	1 piece	Outsourced as pre-made	$0.98	Accommodates 1 in width straps
Buckle system	1 piece	Outsourced as pre-made	$1.67	Accommodates 2 in width straps
Rivets	16 pieces	Outsourced as pre-made	$0.45 per piece ($7.20)	.25 in diameter, 1 in length

Appendix D

Rivets	6 pieces	Outsourced as pre-made	$0.76 per piece ($4.56)	.4 in diameter, 1.25 in length
Screws	6 pieces	Outsourced as pre-made	$0.29 per piece ($1.74)	1/8 in diameter, 3 in length
Screws	2 pieces	Outsourced as pre-made	$0.54 per piece ($1.08)	5/8 in diameter, 2.75 in length
Hex nut	2 pieces	Outsourced as pre-made	$0.48 per piece ($0.96)	5/8 in diameter
Hex nut	4 pieces	Outsourced as pre-made	$0.23 per piece ($0.92)	1/8 in diameter

Appendix D

Spring	2 pieces	Outsourced as pre-made	$0.70 per piece ($1.40)	½ in diameter, 1 in length uncompressed
Button	2 pieces	Outsourced as pre-made	$0.12 per piece ($0.24)	½ in diameter, 1/8 thickness
Thin Stainless-steel sheets	~7 feet	Outsourced as pre-made	$4.78 per foot (~$33.46)	2 in width (20 in base length, 22 in outer length)
5-point harness and strap mechanism	1 piece	Outsourced as pre-made	$30.19	Pre-constructed and attached directly to frame
T-handle ball lock pins	2 pieces	Outsourced as pre-made	$11.09 per piece ($22.18)	3/8 in diameter, 1-37/64 in length