In Home Anti-Gravity Harness

Team 10
Khaled Alosaimi
Eileen Baker
Hasan Farman
A.J. Garcia
Noah Oliver

Client
Dr. Kyle Winfree
Pediatric Mobility

Project Introduction

WEARABLE INFORMATICS LABORATORY

- Children with limited mobility are often unable to socialize, leading to developmental challenges later in life [1]
- The reduced movement during 0-2 years of age can affect the development of bone and muscle used in walking
- A harness system that supports the majority of children's body weight can address both of these concerns

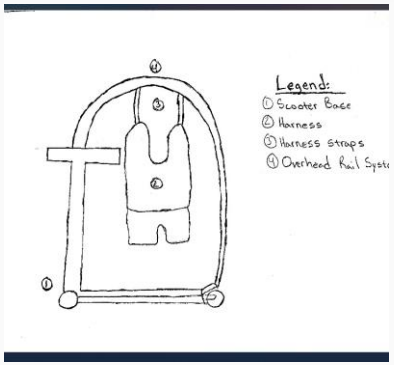
Project Goals

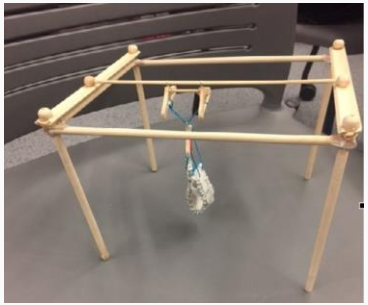
- The system is simple to build, requiring no specialized knowledge or equipment
- The product is directed towards children (under the age of 5) and should aid them in playing with their environments
- The goal of this project was to design a DIY manual for an anti-gravity balancing harness system

Capstone Project Description

Mechanical Engineering Capstone

- Fall Semester 2016
  - Design research
  - Customer requirements
  - Engineering requirements
  - Prototyping
- Spring Semester 2017
  - Manufacturing
  - Testing



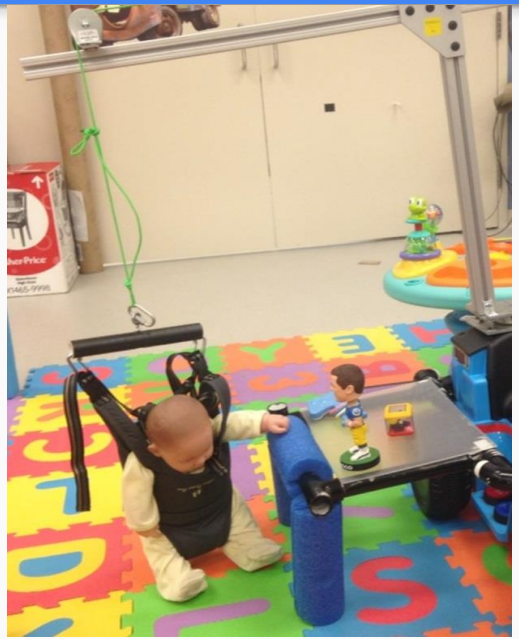


Similar Devices

- Current harness devices for adults require extensive manufacturing
- Designed for rehabilitation (nerve damage, stroke, etc.)
- Can cost upwards of $10,000 for home system

GoBabyGo Devices

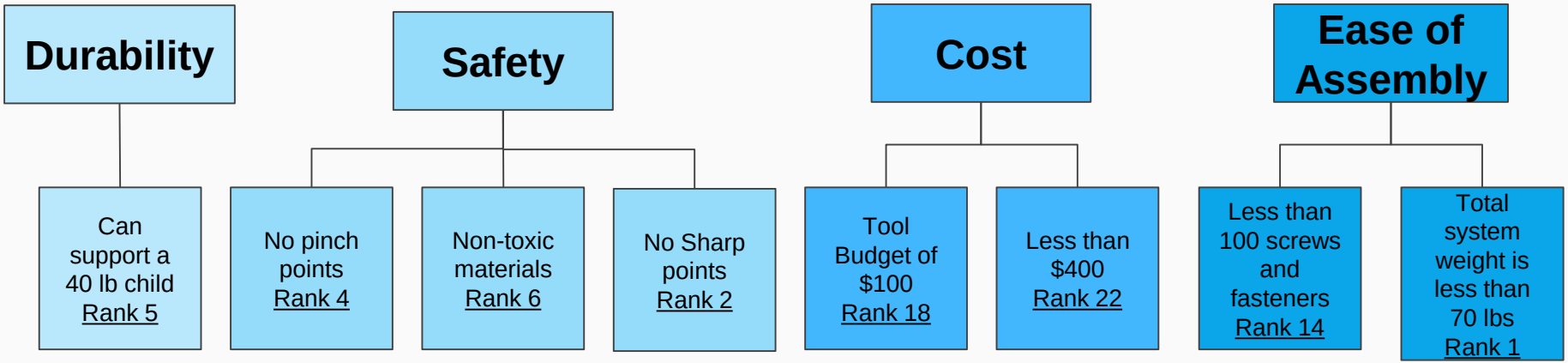
- GoBabyGo aims to aid young children through assistance with social interaction
- The end goal is DIY, so parents with all technical backgrounds can make the device
- The system enables interaction with family, toys, and an environment that helps create future independence



Customer Needs

Customer Requirement	Weight (x/10)
Safety: Low choking/entanglement risks	10
Ease of Assembly: Avoid machining or complex parts	7
Adjustability: Accommodate for different sized children	5
Durability: Materials pass various strength tests	7
Size: Is unobtrusive and allows user to interact with groups	6
Comfort: Refrain from using coarse/irritating materials	8
Aesthetics: Contain multiple colors and child-friendly designs	9
Cost: Keep under target cost	7

Engineering Requirements



Final Design

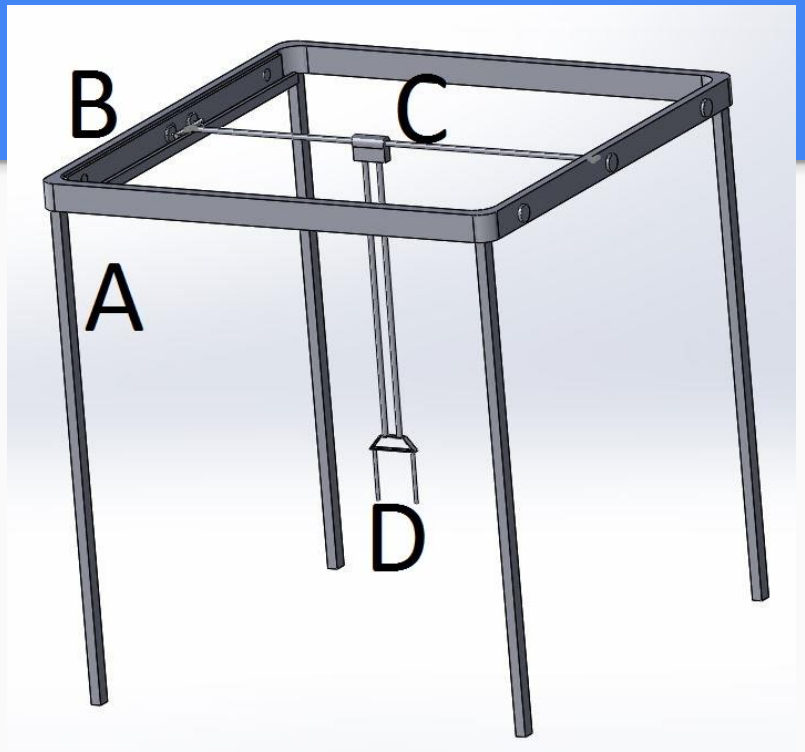
Subsystems:

A) Frame

B) Guide Rail

C) Middle Bar

D) Harness Connections



Design - Frame

EZ-up Shade

- Instant shelters used for outdoor recreational activities and events
- Span area of 10x10 feet

Function

- Provides overall structure of device
- Design allows the device to still be portable after initial assembly

Modifications

- Top tent portion was removed
- Guide rails, support bar, and harness system were added

Design - Guide Rail

Materials

- L-shape slotted angle
- Support strips
- Fasteners
- Parachute cord (nylon)

Function

- Slot allows wheels from support bar to roll
- Vertical strips attach 4 ft sections of track
- Tied sections come loose for disassembly process

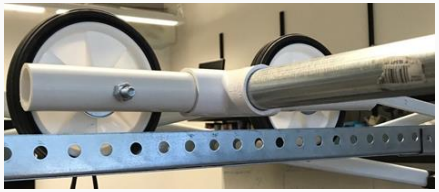
Design - Middle Bar

Materials

• Steel fencing pole	• Four short PVC pieces
• Four training wheels	• Fasteners
• Two T-shaped PVC connectors	• PVC Adhesive

Function

- Supports weight of user and harness
- Bearing and rail enable full Easy Up range of motion



Design - Harness

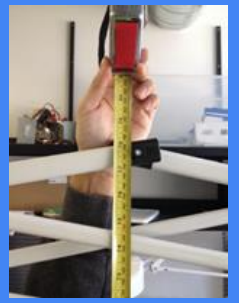
Materials

- Jumping Harness (up to 25lbs)
- PVC Pipe
- Adjustable Tow Strap
- Rock Climbing Swivel
- Linear Ball Bearing

Function

- Cradle user while using device
- Allow full range of movement and interaction with toys or other people

Testing

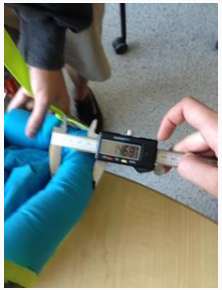


Physical Test	Procedure
Safety	Check EPA for toxic materials; use soft cloth to find sharp edges and pinch points
Device Dimensions	Measure storage (5’x5’) and in use (12’x12’) area with measuring tape
Comfort	Use calipers to measure padding (>0.5”)
Durability	Load system with 40lbs, device should weigh <70lbs
Ease of Assembly	Record time needed to assemble; count fasteners (<100)

Results

Safety

- Materials (polyester, polypropylene, steel) pose no risk with proper use
- Paint should be ~60% water based
- Sharp corners on Easy Up covered with pool noodle sections
- Pinch point on easy release clasp covered with sock



Comfort

- Harness padding 1.4” at chest level

Dimensions

- Folded size: 120”x8.5”x8.5”
- Workspace size: 9.8ft^3
- Total device weight: 57.2 lbs

Ease of Assembly

- Time to assemble: <1 hour
- Number of parts and fasteners: 61

Durability

- Able to support 40lbs*

Final Design

Budget

Frame	Cost
Ez-up 	$175

Guide Rail System	Cost
Guide Rails 	$57
Wheels 	$24
Tee PVC 	$3

Harness System	Cost
Swivel 	$25
Adjustable strap 	$10
PVC 	$2
Harness 	$16

Cost to User

Tool Budget: $48

Parts Budget: $388

Total: $436*

Acknowledgements

We'd like to thank W.L. Gore and Associates for their funding of this project.

Client: Dr. Kyle Winfree

Advisor: Dr. Sarah Oman

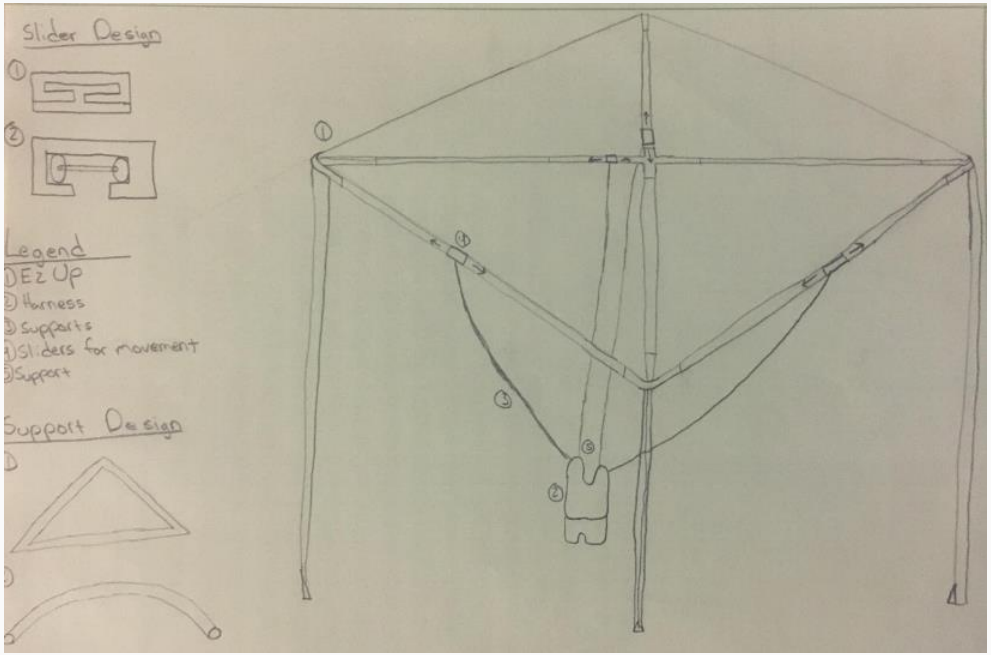
Questions or Comments?

Please come see us and our device(s) at the 2-4pm poster session! (Spot 3B)

References

[1] S. Logan, M. Schreiber, M. Lobo, B. Pritchard, L. George and J. Galloway, "Real-World Performance: Physical Activity, Play, and Object-Related Behaviors of Toddlers with and Without Disabilities," Pediatric Physical Therapy, vol. 27, pp. 433-441, 2015.

January 2017 Concept



House of Quality

Customer Requirement	Weight	Engineering Requirement	Fits in 5ftx5ftx2.5ft Volume Space (Storage Space)	Fits in 12ftx12ftx12ft Volume Space (Work Size)	No Pinch Points	No Sharp Points	Nontoxic Materials	Harness has at least three contact points	No Loose Ropes (Entanglement Risk)	< 20 parts	< 100 Screws and fasteners	Non-elastic materials	Gloss Finish Paints (Non-toxic)	< 300 Dollars	< 100 Dollar Tool Budget	Assembly spans two days	Variety pack for weight bearing parts	Adjustable buckles	Range of Adjustability	No Specialized Parts	Weight of System < 50 pounds	Support 40 pound child	Padding => .5 inch thick	Pad/cover buckles
1. Safety	10				7	10	10	8	10				-1	-1				-3	-3		8	10	3	3
2. Easy to Assemble	7		-2							9	9				-2	10				10	5			
3. Adjustability	5							-1	-3		6	5					7	7	6					
4. Durability	7							4				-4		-5								7	5	
5. Size	6		8	7															4		10	-1		
6. Comfort	8				10	10		7	3			4										-1	8	4
7.Cost	7						-3							7	7		3	3		8				
8.Workspace Size	6		7	5																	6			
9.Aesthetics	9						5	1					10										-1	
Absolute Technical Importance (ATI)			76	72	150	180	124	168	109	63	93	29	80	4	35	70	56	26	24	126	211	135	120	62
Relative Technical Importance (RTI)			12	13	4	2	6	3	9	15	10	19	11	22	18	14	17	20	21	7	1	5	8	16
Target(s), with Tolerance(s)			Max, +1	Min, +-1	0	0	0	Max, -1	0	15,+-5	70, +-5	Max	Max	250,'+100	+- 50	2, +-1	5, +-5	Max	>1	0	30,+- 20	30, +-2	0.75, +- 1	Max
Testing Procedure (TP#)																								
Design Link (DL#)																								

Complete Engineering Requirements

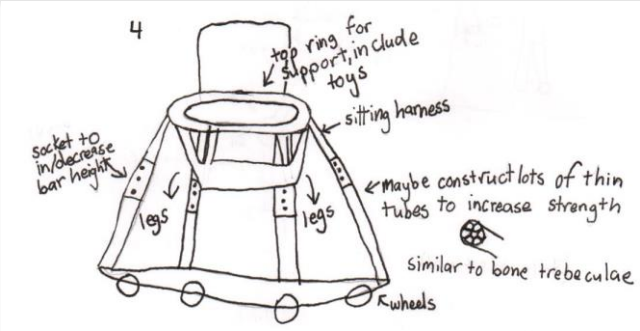
Customer Requirement	Correlating Engineering Requirement
Safety: Low choking/entanglement risk	• No Sharp Points • No Loose Ropes (Entanglement Risk) • Nontoxic Materials
Ease of Assembly: Avoid machining, complex parts	• No Pinch Points • Less than 20 parts • < 100 Screws and fasteners • Assembly spans two days • No Specialized Parts
Adjustability: Accommodate different sized children or growth	• Socket Sliders • Variety pack for weight bearing parts • Adjustable buckles
Durability: Materials pass various strength or fatigue tests	• Weight of System < 50 pounds
Size: Is unobtrusive and allows user to interact freely	• Fits in 12ftx12ftx12ft Volume Space • Weight of System < 50 pounds
Comfort: Refrain from using coarse/irritating materials	• Elastic Materials • No Pinch Points • No Sharp Points • Padding => .5 inch thick
Cost: Keep under target cost	• < 300 Dollars • No Specialized Parts
Workspace Size: Size above user	• Fits in 12ftx12ftx12ft Volume Space
Aesthetics: Contain multiple different colors	• Gloss Finish Paints (Non-toxic)

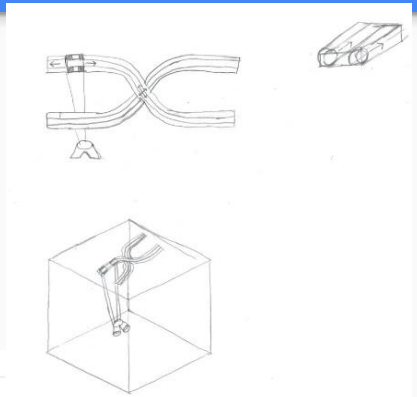
Complete BOM

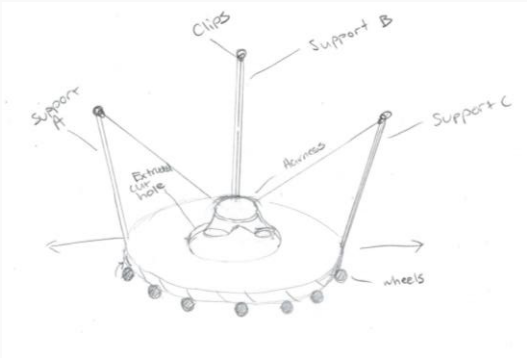
Part Name	Qty	Picture	Cost
Jumper Harness	1		$ 16.00
Nylon Rope	4		$ 6.00
Wrench	1		$ 8.00
Power Drill	1		$ 25.00
screwdriver	1		$ 5.00
Ez-up	1		$ 175.00
Zinc plated	1		$ 57.00
PVC	1		$ 2.00
Tow Strap	1		$ 10.00

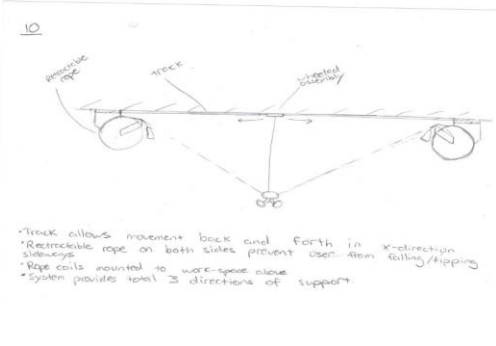
Swivel	1		$ 25.00
Bearings	1		$ 31.00
Galvanized Steel Chain-Link	1		$ 12.00
Tee PVC	2		$ 3.00
Wheels	2		$ 24.00
Screws and bolts	12		$ 4.00
Strap tie	12		$ 21.00
Washer	16		$ 1.92
Hand Saw			$ 10.00
Total	**59**		**$ 435.92**

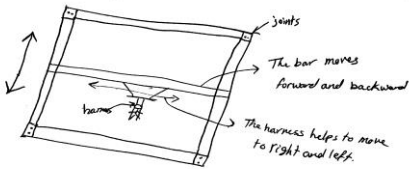
Top Concepts











Pugh Chart

Concept	A	D	E	B	F	Datum	C	G	H	I	J
Criteria											
Safety	S	S	S	S	+		S	S	S	S	+
Easy to Assemble	+	-	-	+	-		-	S	-	S	-
Adjustable	-	+	S	-	-		S	+	-	S	+
Durable	+	S	S	S	S		+	S	+	S	S
Size	+	S	-	+	+		+	S	-	S (depends)	+
Comfort	S	+	-	S	S		S	S	+	S	+
Cost	+	S	-	S	S		S	-	S	S	-
Workspace Size	+	+	S	+	+		+	+	+	S(depends)	-
Aesthetics	S	S	+	+	+		+	S	+	S	S
Sum +	5	3	1	4	4		4	2	4	0	4
Sum -	1	1	4	1	2		1	1	3	0	3
Sum S	3	5	4	4	3		4	6	2	9	2

Decision Matrix

		Concepts							
Weight		A		B		C		Datum	
Criterion									
Safety	0.15	85	12.75	85	12.75	100	15	100	15
Easy to Assemble	0.11	65	7.15	90	9.9	70	7.7	75	8.25
Adjustable	0.08	85	6.8	60	4.8	90	7.2	100	8
Durable	0.11	70	7.7	70	7.7	70	7.7	70	7.7
Size	0.09	100	9	100	9	100	9	70	6.3
Comfort	0.12	80	9.6	80	9.6	90	10.8	90	10.8
Cost	0.14	100	14	86	12.04	85	11.9	85	11.9
Workspace Size	0.09	100	9	100	9	100	9	85	7.65
Aesthetics	0.11	90	9.9	100	11	100	11	80	8.8
Totals			85.9		85.79		89.3		84.4
Relative Rank			2		3		1		4