Mobile Computer Cart

Final Project Proposal

Mohammed Aldosari, Abdulrahman Alhamdi,
Joel Asirsan, Sam Martin, Trevor Scott

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Overview

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- Testing Environment
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Project Description

- Client : Dr. Srinivas Kosaraju

- Dr. Kosaraju is currently managing multiple student teams for capstone classes at Northern Arizona University. He is requesting for two mobile computer carts capable of traveling outside to perform experiments.
  - Must be adjustable
  - Weather proof
  - Cost under $500

Needs Statement

“The current available mobile computer carts are too expensive and are not designed for outside use.”

Goal Statement

The project goal is to design two mobile computer stations that are less expensive than available marketed products, which can be operated in outside conditions.

Objectives

Objectives	Measurement Basis	Criteria	Units
1. Inexpensive	Cost for 2 prototype production	Cost	Dollars
2. Be able to hold CPU, Monitors, and testing equipment	The amount of the storage area	Volume	ft^3
3. Should be adjustable for multiple users	Able to change the height of the station	Height	ft
4. Should be easily maneuverable	Time it takes to transport inside and outside easily	Time	Minutes
5. Weather Resistant	Ability to resist weather conditions	Water accumulation	in
6. Reasonable size	Fit through a door and is light	Volume and Weight	ft^3 and lbs
7. Remain functional after transported	Material not deformed after rolling outside	Material Strength	Psi

Table 1 : Objectives

Constraints

- Yes-No constraints
  - The mobile cart has to support two screen monitors.
  - The mobile computer cart has to hold a CPU, keyboard, and a mouse.
  - The mobile computer cart has to move through rough terrain.
  - The mobile computer cart must be easily transported with only one individual.
  - The mobile computer cart must be weather resistant.
- One-sided inequality constraints
  - The cost of each mobile computer cart must be less than $500.00.
  - The storage space must accommodate 2 ft^3.
  - The width of the cart must be less than 3 ft.
  - The height of the cart must be less than 7 ft.

Testing Environment

- Field Test
  - Terrain
    - Rocky, grass, dirt
  - Function properly
  - Undamaged during transportation
  - Simulate rain
  - Transport with no assistance
    - Fit through door, weight, maneuverability, time it takes to transport

QFD

		Engineering Requirements										Bench Marks	
		Yield Strength	Max Deflection	Weight	Time to transport	Force	Material thickness	Cost	Volume	Center of Gravity	Wheel Diameter	Deluxe Diagnostic Fusion Cart	Ergotron WorkFit-C
Customer Requirements	Holds Dual Monitors	X		X					X				O
	Aesthetics						X					O	O
	Inexpensive			X			X	X					
	Adjustable height	X				X		X				O	
	Storage space			X				X	X	X			
	Mouse and keyboard platform							X	X	X		O	O
	Hold CPU							X	X			O	O
	Portable				X	X				X	X	O	O
	Light weight			X			X	X	X	X	X	O	O
	Easy to transport			X	X	X		X			X	O	O
	Weather proof			X			X	X					
	Durable	X	X	X		X	X	X			X		
	Move through rough terrain	X	X				X	X		X	X		
	Units	psi	in	lbs	min	lbs	in	$	ft^3	ft	in		
								500 x2					
		Engineering Targets											

Table 2 : QFD

Benchmarking

Deluxe Diagnostic Fusion Cart

- Pros
  - Cost = $459.00
  - Adjustable monitor
  - Holds CPU
- Cons
  - Only one monitor
  - Inside use only
  - No storage

Figure1 : Deluxe-D fusion Cart

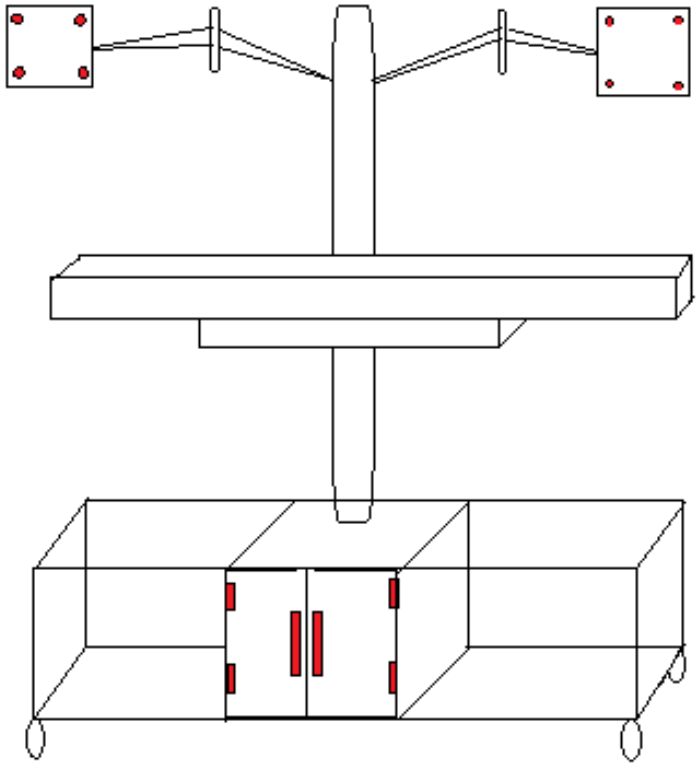
Ergotron WorkFit-C

- Pros
  - Dual monitors
  - Adjustable monitor
  - Mouse/keyboard platform
- Cons
  - Inside use only
  - Cost = $854.99
  - No Storage

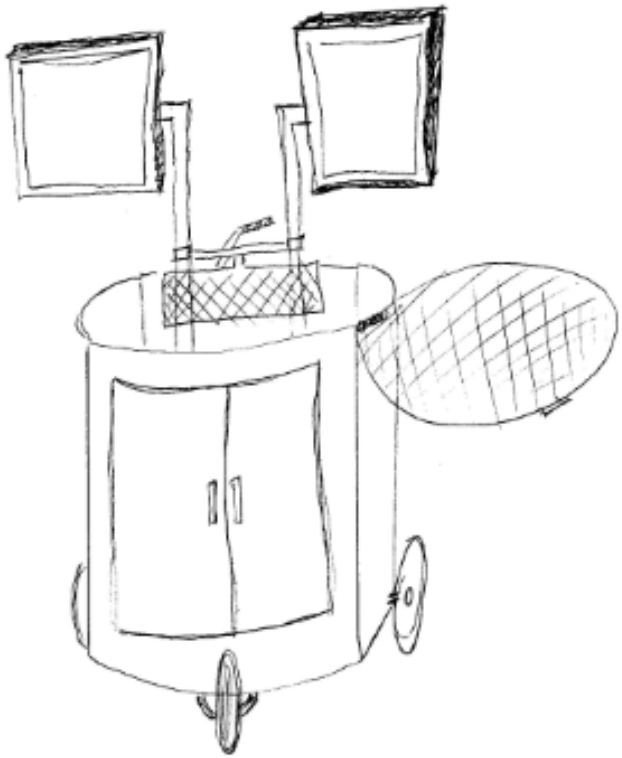
Figure 2: Ergotron Cart

Concepts 1-2

Design #1

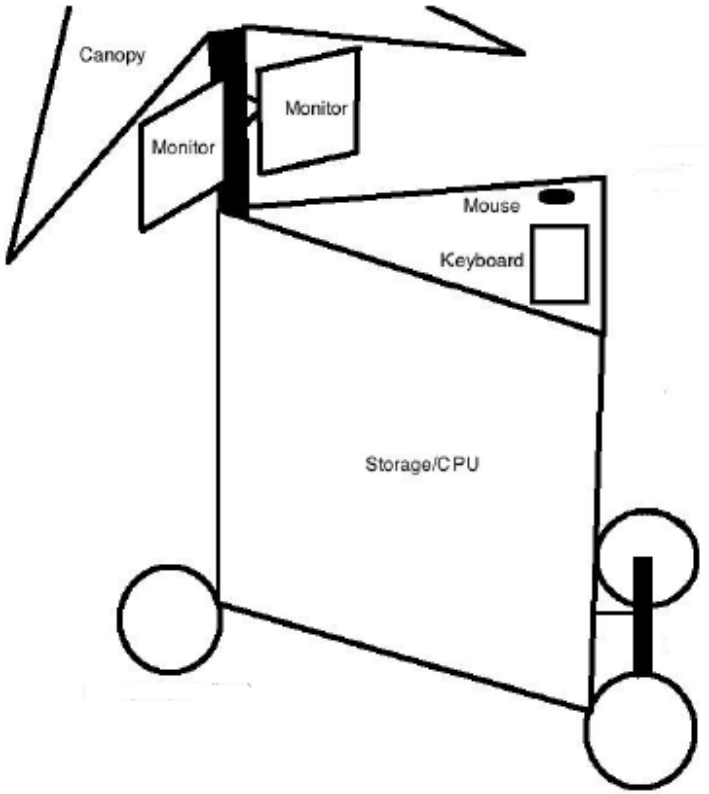


Design #2

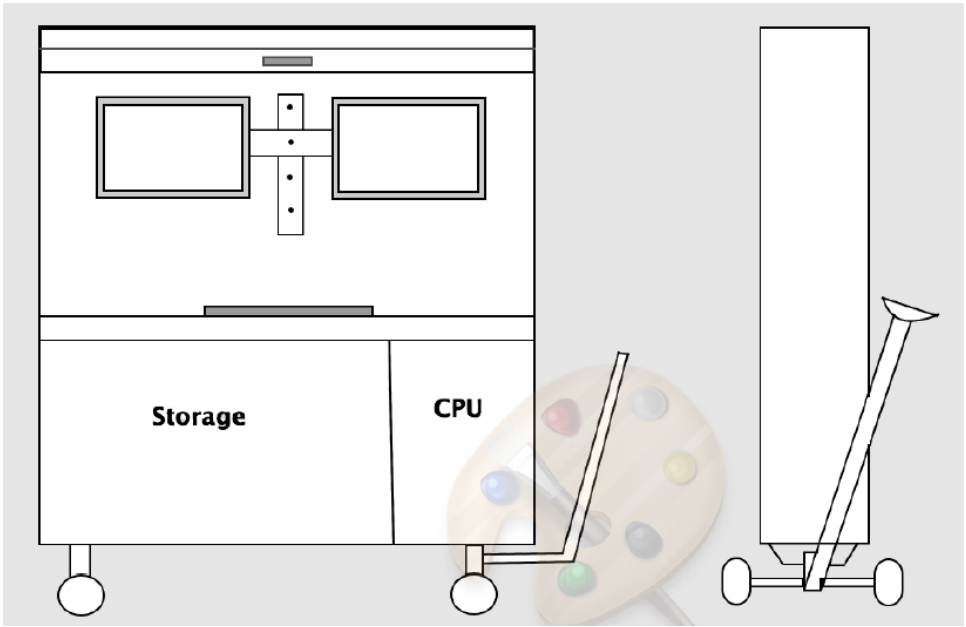


Concepts 3-4

Design #3

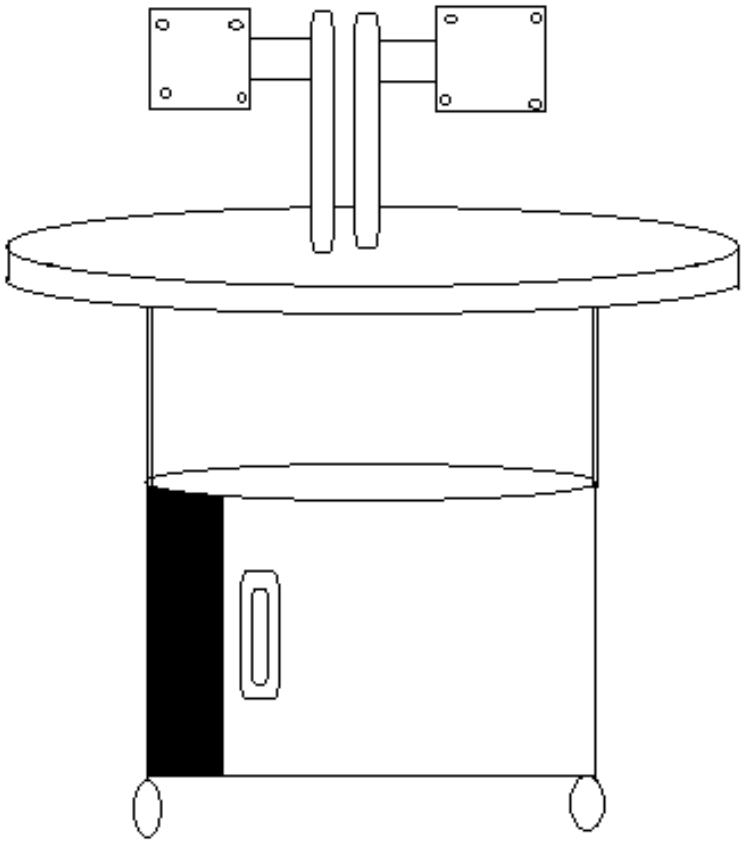


Design #4

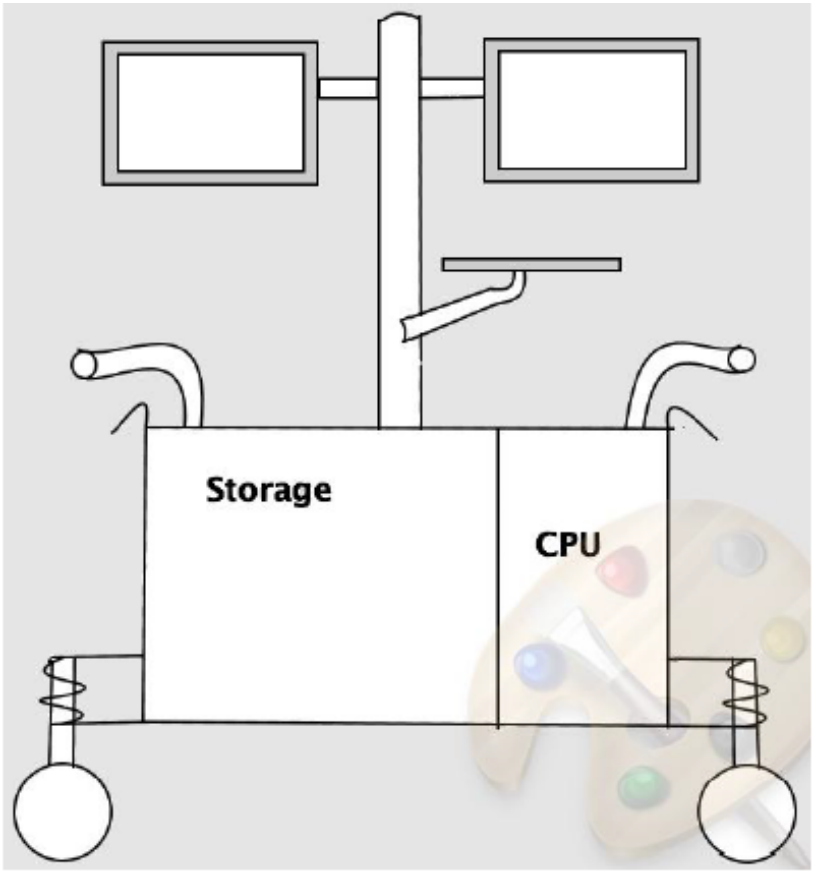


Concepts 5-6

Design #5

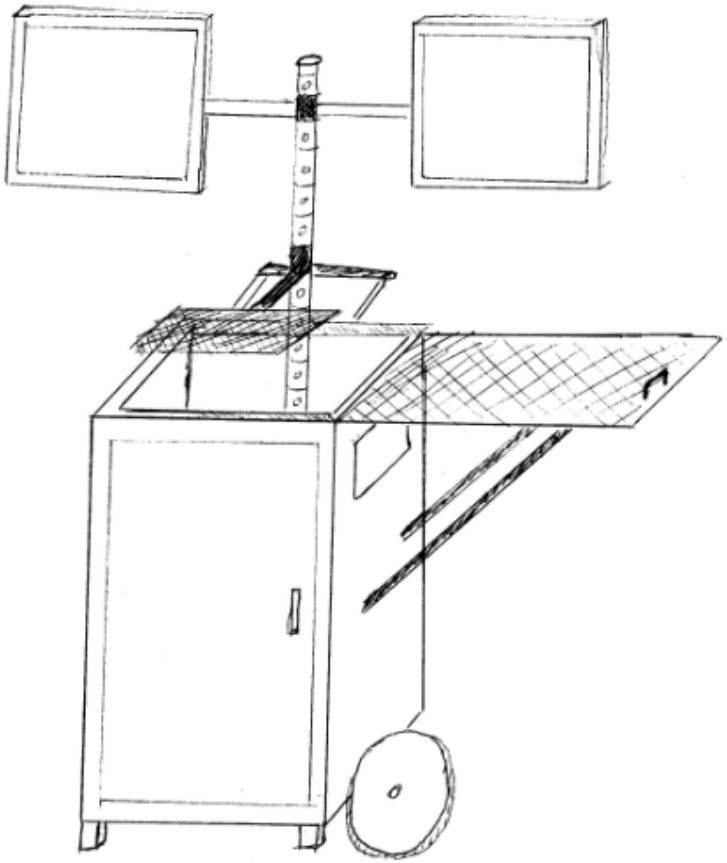


Design #6

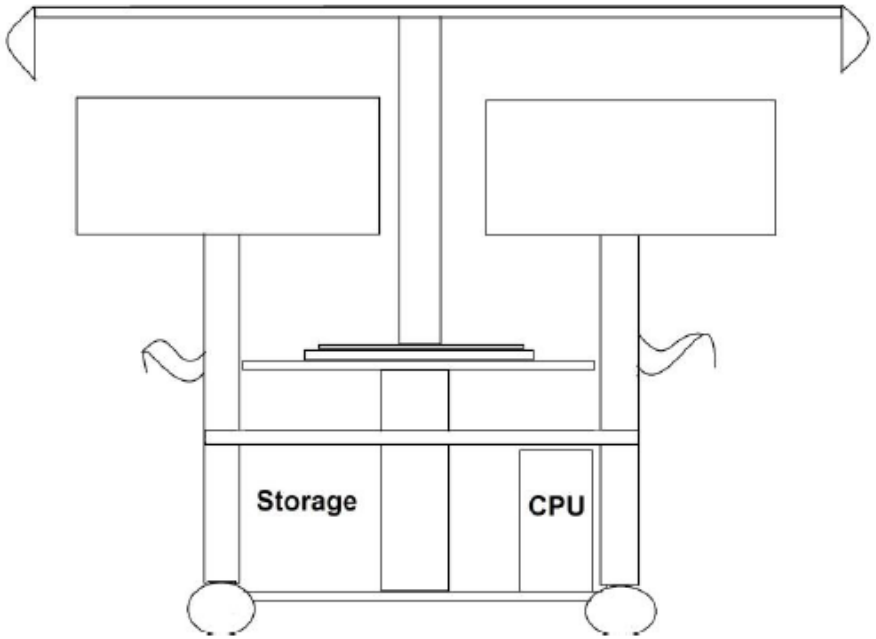


Concepts 7-8

Design #7

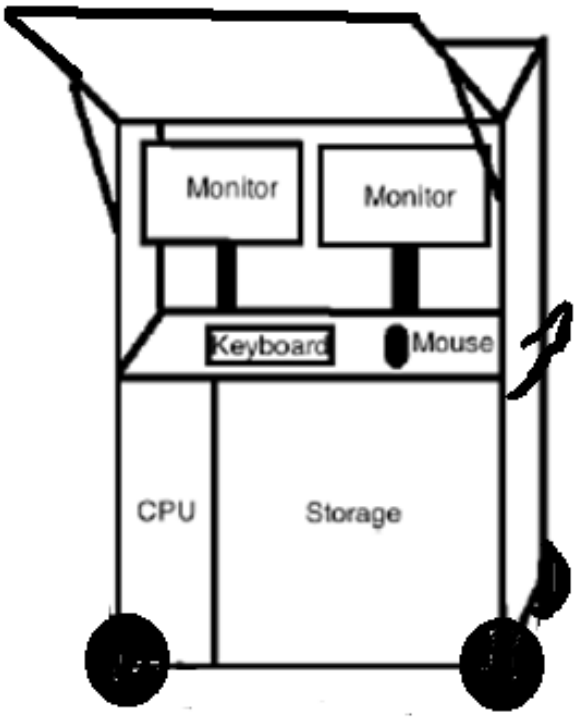


Design #8

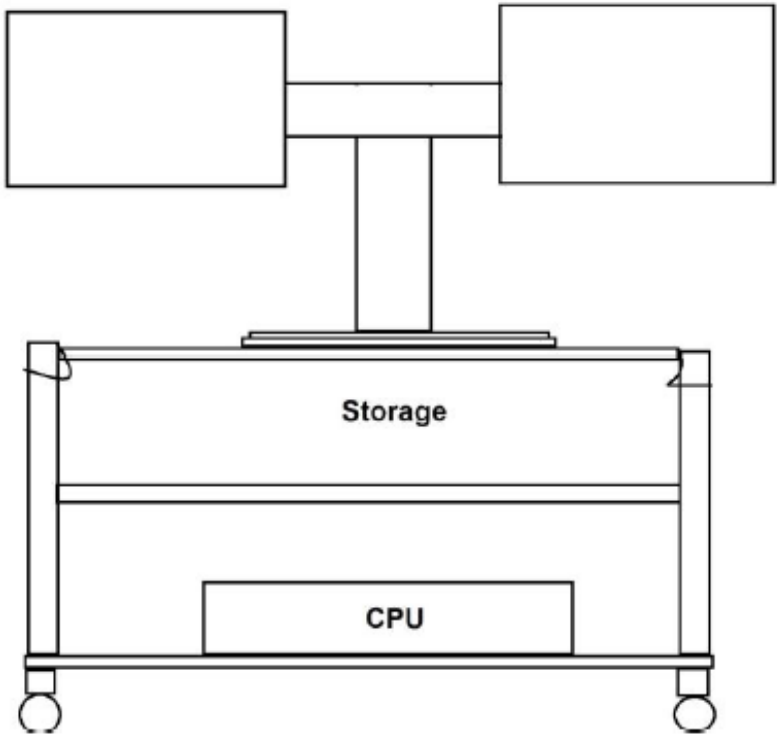


Concepts 9-10

Design #9



Design #10



Decision Matrix #1

Decision Matrix # 1				
Concepts	**Criteria**			**Score**
	Cost	Ease to Manufacture	Aesthetics	
Design #1	6.8	7.4	7.4	21.6
Design #2	4.8	6.8	6.6	18.2
Design #3	6	5.8	6.2	18
Design #4	4.8	6.6	7	18.4
Design #5	6	6	7.4	19.4
Design #6	5.8	6.4	6.2	18.4
Design #7	6.4	5.4	8.2	20
Design #8	7.4	7	6.2	20.6
Design #9	6.6	5	7.6	19.2
Design #10	8.2	8.4	6	22.6

Table 3 : Decision Matrix 1

10 = High , 1 = Low

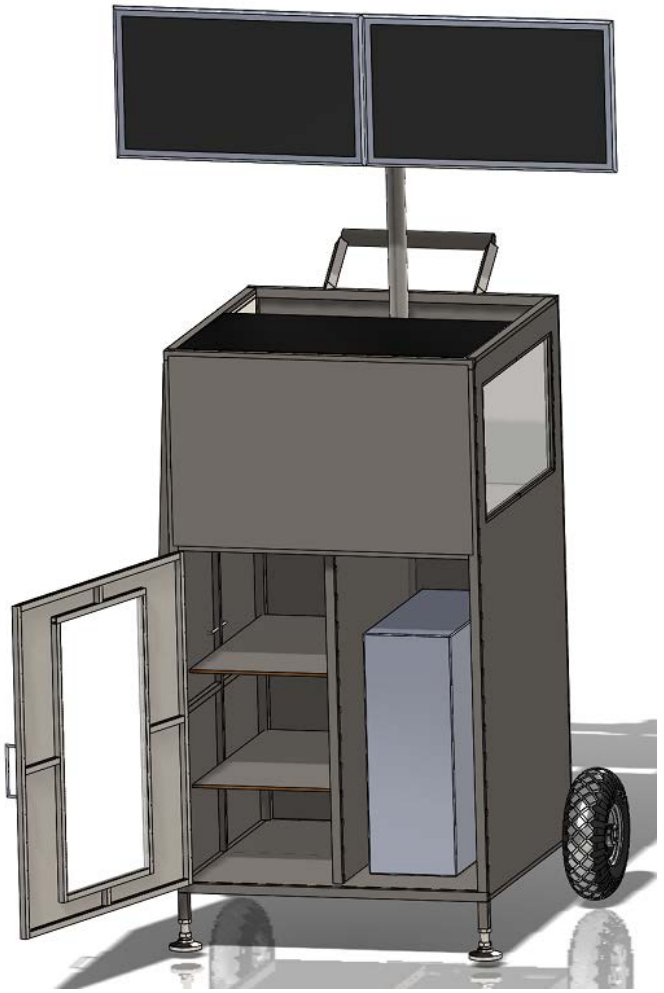
Decision Matrix #2

Decision Matrix # 2									
Concepts	**Criteria**							**Score**	**Total :** Matrix 1 and 2
	Weather Proof	Durability	Overall Adjustability	Storage Space	Maneuverability Inside / Outside	Weight	Overall Size		
Design #1	1	5.4	9	8.4	5.6	6.8	6.4	42.6	64.2
Design #2	9.4	8.8	4	7.8	6.6	4.8	5.8	47.2	65.4
Design #3	5.4	6	5	5	7.2	7.2	6.8	42.6	60.6
Design #4	9	8	5.2	9	6	4.2	5.4	46.8	65.2
Design #5	1	5.6	7	6.8	5.6	6.6	6.6	39.2	58.6
Design #6	2.2	6.2	7.4	7.6	6.6	6.2	6.6	42.8	61.2
Design #7	7.6	7.6	9.2	6.6	9	7.8	8.8	56.6	**76.6**
Design #8	4.8	5.6	4.8	5.8	5.4	7	5.8	39.2	59.8
Design #9	7.6	7.2	8.8	6.4	8.4	7.2	7.4	53	**72.2**
Design #10	0.8	5.4	4	6.6	5.4	7.6	6.8	36.6	59.2
							10 = High , 1 = Low		

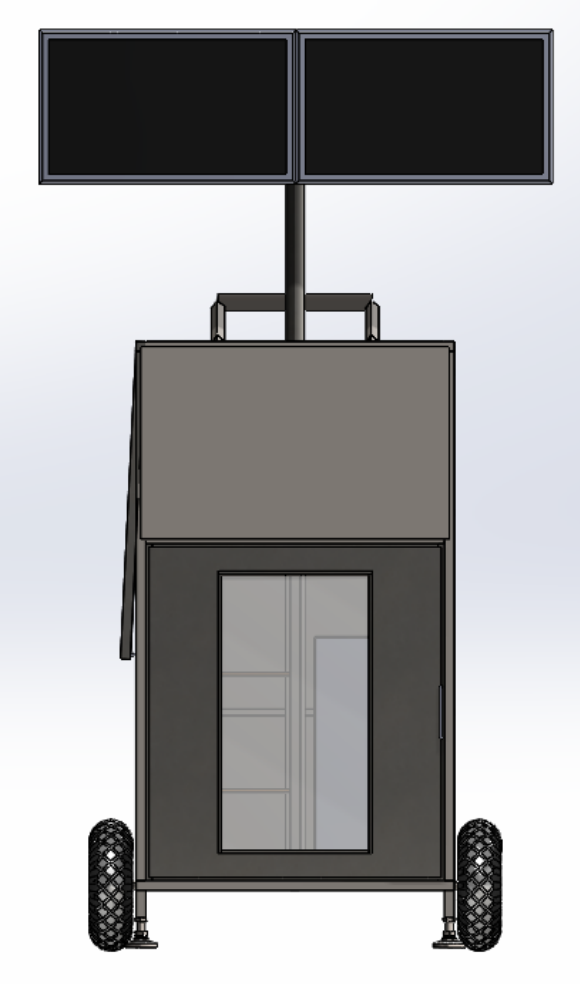
Table 4 : Decision Matrix 2

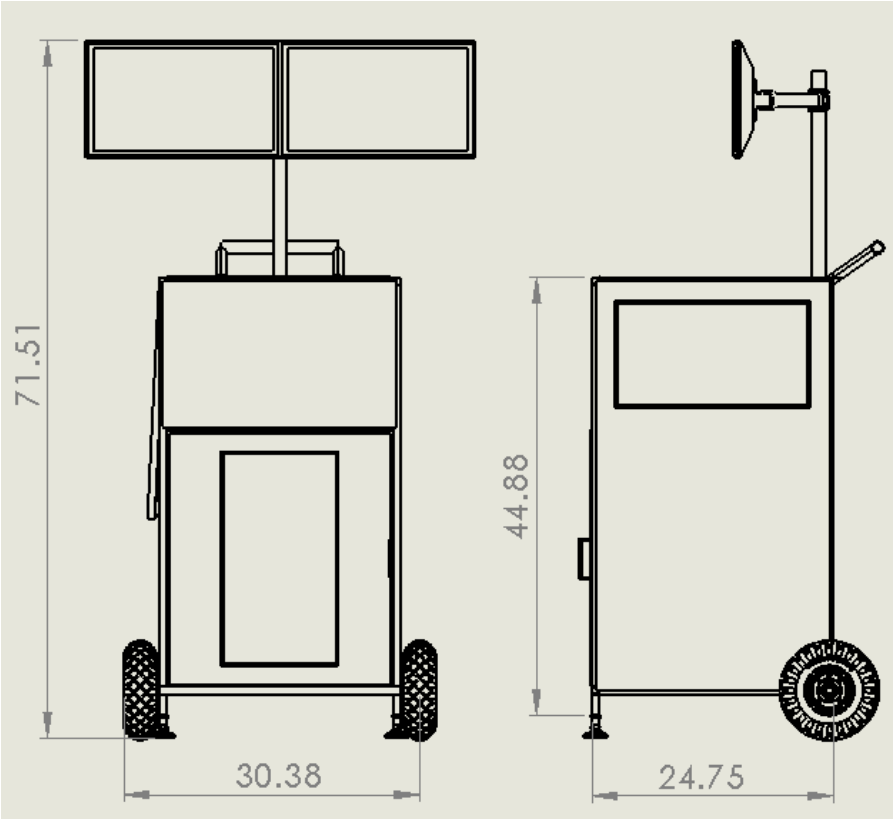
Concept 1

- **Two wheeled dolly Design**
  - Adjustable monitors
  - Large wheels for rough terrain
  - Interior storage space
  - Weather proof
    - Retractable lid
    - Collapse everything inside
    - Windows
  - Fits through doors
  - Handle for easy maneuverability

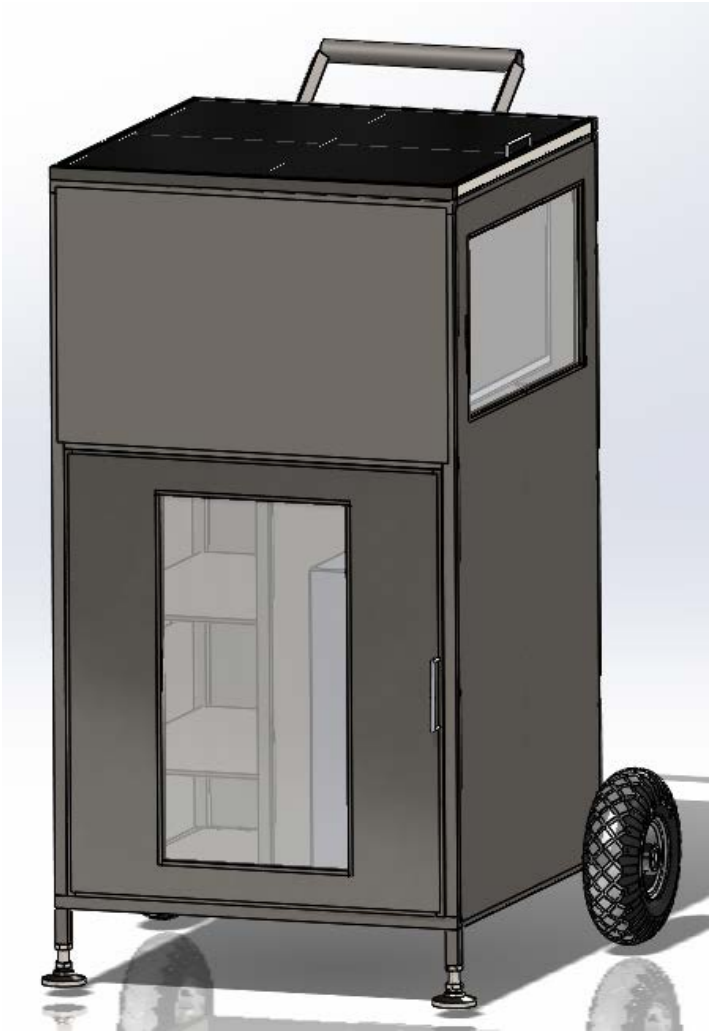


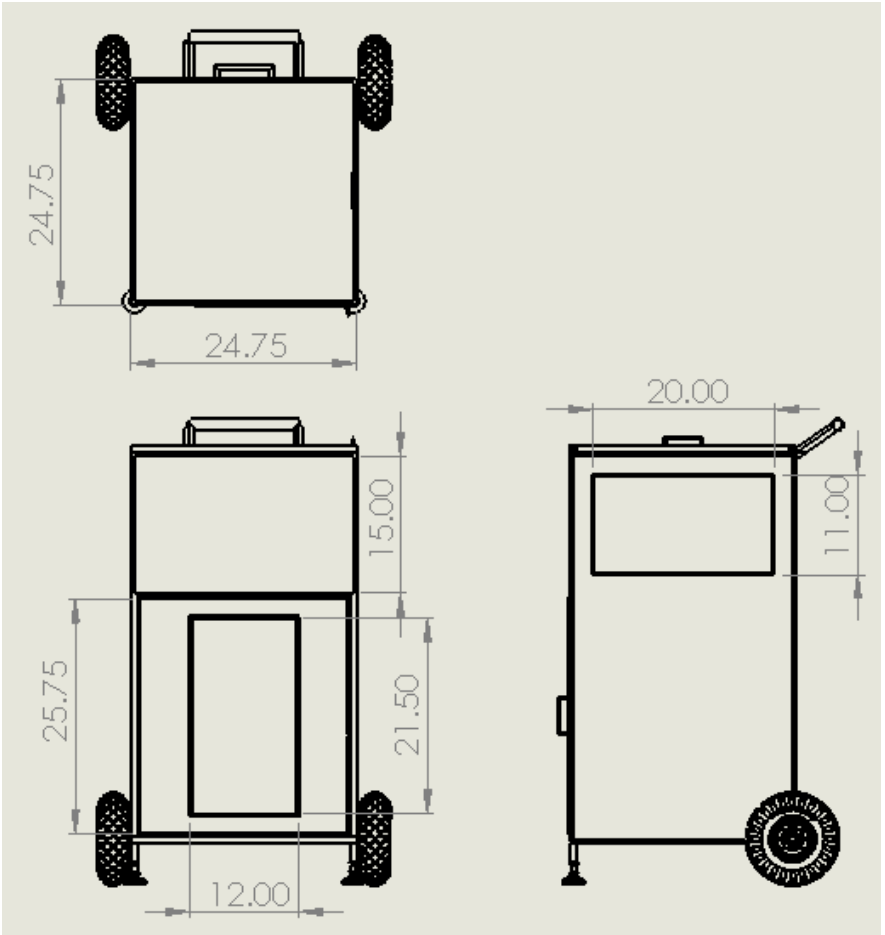
Dimensions / CAD





Dimensions / CAD





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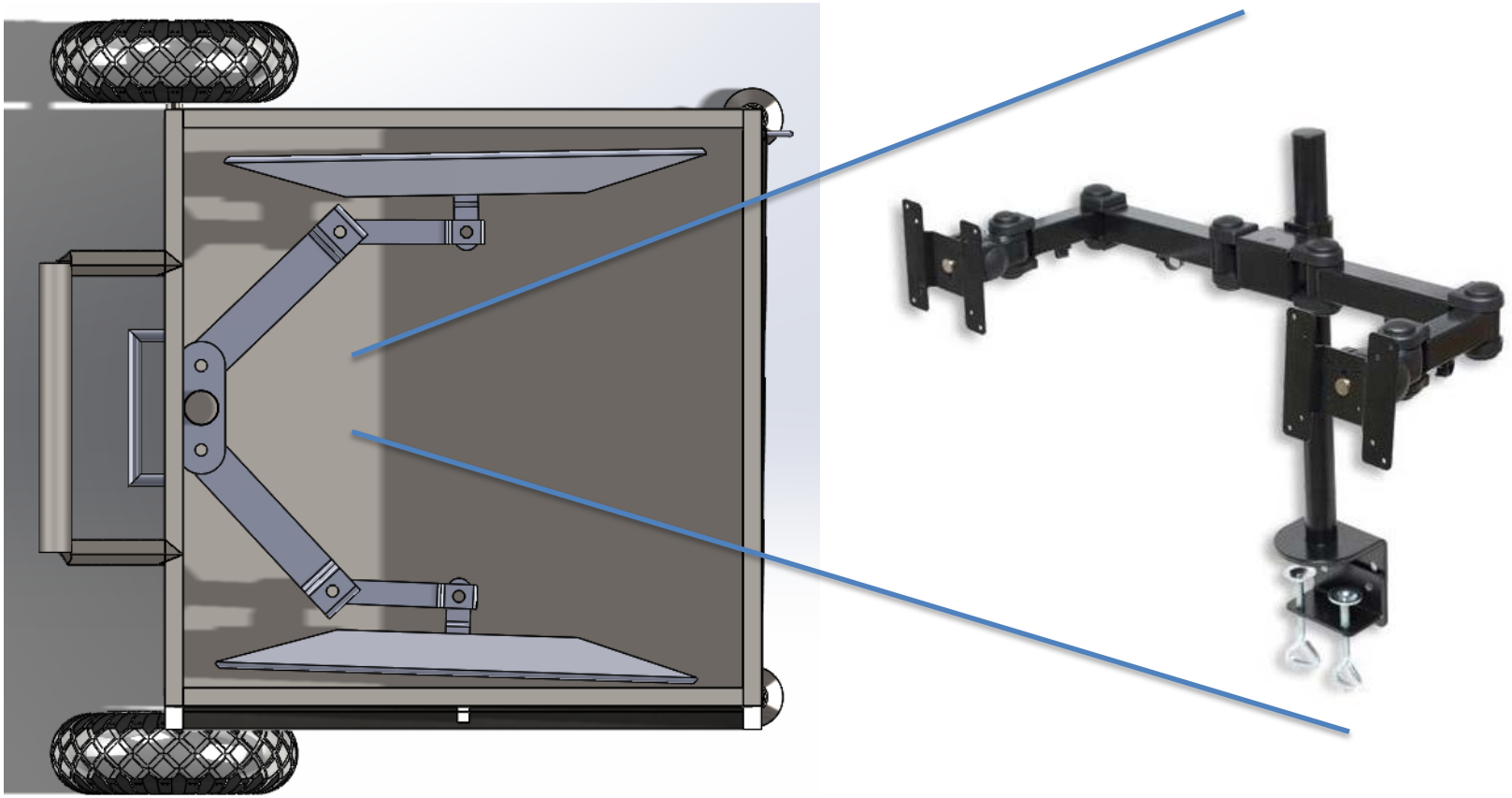


Analysis

- Omitted analysis for bought Materials:
  - 10’’ wheel – rated 300lbs per tire
  - Tyke Supply dual monitor mount – holds up to two 16 lb. monitors

- Weight of frame before components added inside

Frame weight					
Material	Description	QTY.	Length (ft)	Weight/ft (lbs)	Weight (lbs)
0.75'' x 0.065'' thick	A513 steel Square tubing	7	8	0.6054	33.90
0.5'' x 0.065'' thick	A513 steel Square tubing	7	8	0.3845	21.53
24'' x 48'' x .03'' thick	Steel sheet metal	5	n/a	9.7804	48.90
				Total	104.34

Table 5 : Frame Weight

Analysis

- Static Forces Equations
  - Compressive Stress : $\sigma = f/a$
  - Shear stress : $\tau = f/a$

- Material

Material Specifications			
Parts	Material	Cross-section (in^2)	Yield Strength (Psi)
Pins	A513 Hot rolled steel	.0767	72,000
Telescoping Fixture	A513 Hot rolled steel	.1656	72,000
Frame Tubing	A513 Hot rolled steel	.3869	72,000

Calculations

- Frame tubing compressive stress
  - $\sigma = f/a = (105 \text{ lbs.})/(0.1656 \text{ in}^2)$
    $= 634.06 \text{ psi} < 72{,}000 \text{ psi}$

- Telescoping tube compressive stress
  - $\sigma = f/a = (16 \text{ lbs.})(2)/(0.3869 \text{ in}^2)$
    $= 82.708 \text{ psi} < 72{,}000 \text{ psi}$

- Shear stress of pin
  - $\tau = f/a = (16 \text{ lbs./monitor})(2 \text{ monitors})/(2)(0.0767 \text{ in}^2)$
    $= 208.604 \text{ psi} < 72{,}000 \text{ psi}$ (only 1 pin needed)

Bill of Materials

Bill of Materials					
No.	Parts	QTY.	Vendor	Description	Cost
1	8ft Frame Tubing 1	7	Online Metals	0.75'' x 0.75'' x 0.065'' square tubing A513 HOT ROLLED MILD STEEL	$78.68
2	8ft Frame Tubing 2	7	Online Metals	0.5'' x 0.5'' x 0.065'' square tubing A513 HOT ROLLED MILD STEEL	$49.49
3	Sheet Metal	6	Mc Master Carr	24'' x 48'' x 0.03'' steel	$108.80
4	Plexiglass 1	1	Mc Master Carr	12'' x 24'' x .025'' Tinted Polycarbonate	$16.66
5	Plexiglass 2	1	Mc Master Carr	24'' x 24'' x 1/8'' UV Resistant Polycarbonate	$21.53
6	Air Tires	2	Amazon	Double bearing , Dia 10'' x Width 3''	$23.38
7	Telescope Tubing	1	Mc Master Carr	2'' x 2'' x 4ft Telescoping tubing	$50.00
8	Pins	1	Mc Master Carr	5/16'' Locking pins	$2.16
9	Hinges 1	1	Mc Master Carr	12'' long x 1 1/16 wide x .05'' thich piano hinge	$1.93
10	Hinges 2	1	Mc Master Carr	12'' long x 1 1/16 wide x .05'' thich piano hinge	$2.48
11	Hinges 3	2	Mc Master Carr	270 Degree Hinge	$6.60
12	Monitor Mount	1	Amazon	Tyke Supply Dual LCD Monitor Stand	$43.99
13	Leveling Mounts	2	Mc Master Carr	1/4 - 20 Swivel Leveling Mounts	$3.62
14	Weather Stripping	2	Homedepot	3/8 '' x 5/16 '' x 10'' High-Density Rubber Foam Weatherstrip Tape	$5.14
15	Wood	1	Homedepot	11/32 '' x 4 '' x 8 '' Yellow Pine Plywood Sheathing	$17.43
16	Latches	2	Mc Master Carr	Draw latches	$9.00
17	Door latch	2	Mc Master Carr	Magnet latches	$2.60
				Total:	$443.49

Table 7 : Bill of Material

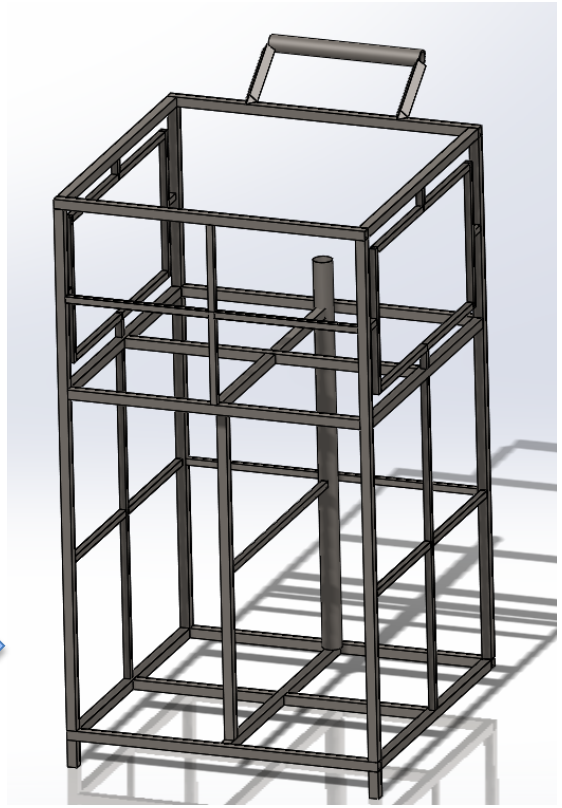
Initial Steps

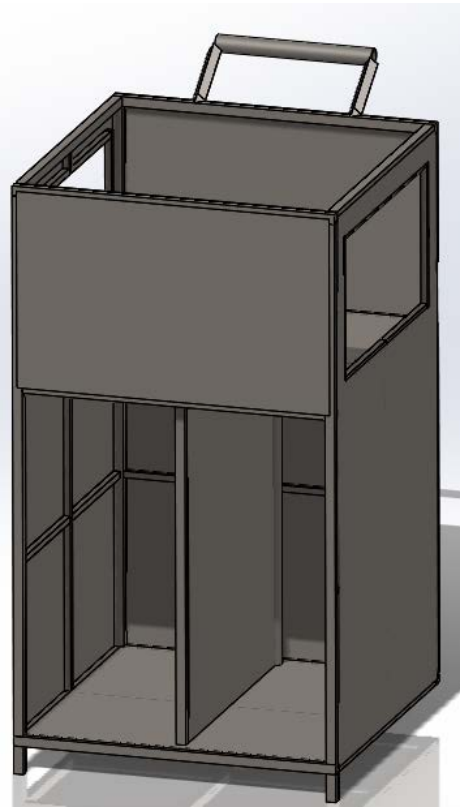
- Goal over winter break
  - Order materials
    - square tubing
    - sheet metal
    - monitor mount
  - Construct
    - frame
    - doors / lid
    - install sheet metal
  - Improve overall design

Initial Steps

NAU machine shop

- Cut tubing to length
- Use jig to hold tubing
- MIG weld frame together
- Cut sheet metal to size
- MIG weld sheet metal on to frame





Project Progression

Name	Begin date	End date
Client Contact	9/10/14	9/10/14
Needs Identification	9/10/14	9/16/14
Product Specification	9/10/14	9/16/14
QFD	9/10/14	9/22/14
State of the Art	9/10/14	9/22/14
1st Presentation	9/22/14	9/22/14
Market Research	9/22/14	10/1/14
Concept Generation	9/22/14	10/10/14
Selection	10/10/14	10/13/14
2nd Presentation	10/14/14	10/14/14
2 Designs	10/14/14	11/11/14
Analysis	10/20/14	11/11/14
3rd Presentation	11/14/14	11/14/14
Final Designs	11/13/14	12/1/14
Final Analysis	11/13/14	12/1/14
Cost Analysis	11/13/14	12/1/14
Final Proposal	12/2/14	12/2/14

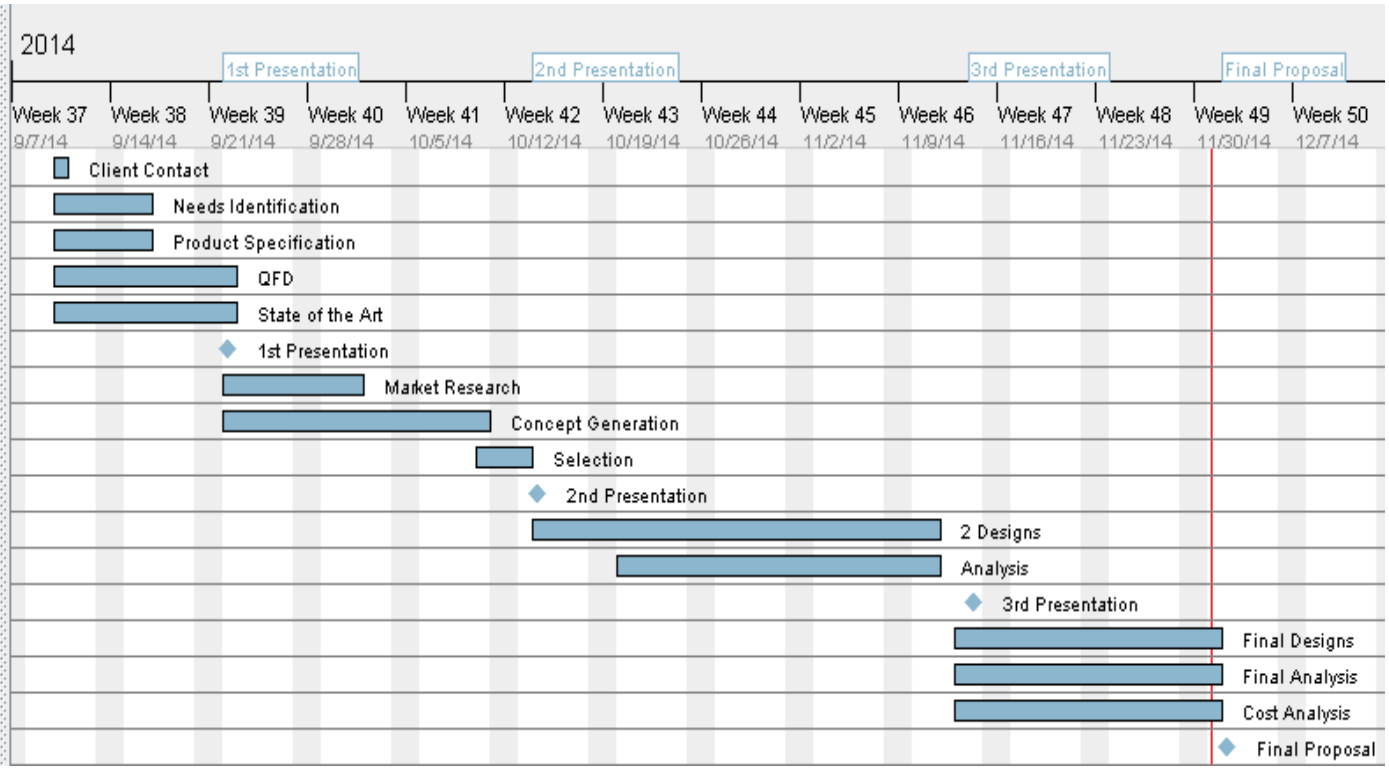


Table 8 : Gantt Chart

Summary

- Need: The current available mobile computer carts are too expensive and are not designed for outside use.
- Objectives and Constraints: The ideal cart is inexpensive, maneuverable, weather proof, and has ample storage.
- Benchmarks: The benchmark carts do not contain the desired benefits and are expensive.
- Concepts: Ten initial designs were created.
- Decision Matrices: Narrowed the original ten designs down to two best options.
- Final Design: Analysis, Calculations, Bill of Materials for the stresses, forces, and production cost.
- Project Progression: The next step is to build a prototype.

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