

Mobile Computer Cart

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Needs Identification and Product Specification Document

*Submitted towards partial fulfillment of the requirements for
Mechanical Engineering Design I – Fall 2014*



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1. Project Summary

A Northern Arizona University Capstone instructor is looking for two mobile computer carts designed and fabricated by students. The team will work directly with the client Dr. Srinivas Kosaraju to verify if the design meets his needs. The primary objective of these carts is to accommodate a data acquisition computer that can be taken easily outside the engineering building for outdoor experiments. Current available market designs are very expensive and are made to be used indoors only. Two computer carts must be fabricated to carry a CPU, data acquisition equipment, two widescreen monitors, attachment to position keyboard and mouse at adjustable height. It must also have some storage space for user to keep additional cables, manuals of equipment. Neither design must exceed the cost of more than \$500.00 apiece.

2. The Problem Statement

This section will include all necessary problem formulation information such as needs and goals statements as well as the project's objectives and constraints.

2.1. The Clients Need Statement

Dr. Srinivas Kosaraju's need statement is as follows, "The current available mobile computer carts are too expensive and are not designed for outside use."

2.2. The Problem Definition

2.2.1. Goal Statement

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

2.2.2. Design Objectives

Team 12 determined the objectives based off the client's quantifiable expectation on how the computer cart should perform. These objectives will drive the design process and help the team formulate each part of the design in the future. The objective is as follows "Design two inexpensive mobile computer stations that can easily be taken outside to perform experiments, while resisting the outside elements. In addition the cart must hold dual monitors, CPU, testing equipment, reasonably sized, and be adjustable for different users." The following objectives are listed on (Table 1) in the appendix.

2.2.3. Design Constraints

The design constraints are based off the permissible conditions of design features, the permissible range of the design and performance parameters our client tasked us with. There are multiple constraints our

team needs to abide by in order to create two successful mobile computer station prototypes. The constraints are broken into two categories, which include yes-no constraints and one sided inequality 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 ft³.
 - The width of the cart must be less than 3 ft.
 - The height of the cart must be less than 7 ft.

3. Testing Environment

When evaluating the objectives it is necessary to have an ambiguous description of the testing environment. The goal of this environment is to test multiple aspects of our design to conclude whether or not we have met all the project's objectives. In terms of the mobile computer station the test will be an outside field test, which is where our product is meant to operate. The following the analyses that will be completed during this test:

1. The client must be able to role the mobile computer cart outside with no assistance required
 - a. Fit through door
 - b. Weight
 - c. Maneuverability
 - d. Time it takes to transport
2. The computer station must move over multiple terrains
 - a. Rocky, grass, dirt
3. The computer station must role outside and function properly once stationary
4. Testing components must remain undamaged during transportation
5. There must be no water accumulation inside storage compartment
 - a. Simulate rain
6. Must be adjustable once in outside environment

- a. Test any adjustable components once at destination

4. Quality Function Development (QFD)

This section contains information describing the Quality Function Deployment (QFD) stage of the team's design process. This section includes engineering and customer requirements, benchmarking research, and the final QFD table that resulted relates everything together. The QFD can be found on (Table 3) of the appendix.

4.1 Customer Requirements

This section contains the requirements specified by the client. The client is going to be using this mobile computer cart when performing engineering tests and the prototype must meet all his requirements. The relationship to engineering requirements can be seen in (Table 3) of the appendix.

1. Holds dual monitors: The mobile computer cart must be able to hold two computer monitors that both operate in parallel.
2. Aesthetics: The mobile computer station must be aesthetical pleasing.
3. Inexpensive: Each station must cost less than \$500.00.
4. Adjustable Height: The monitor's height must adjust for multiple users.
5. Storage Space: There must be enough storage space for engineering test equipment.
6. Mouse and Keyboard platform: A platform should be provided for a mouse and keyboard.
7. Hold CPU: There should be a compartment to put a CPU.
8. Portable: The station must be able to move from one location to another.
9. Light Weight: The station must be light enough to be operated by one person.
10. Easy to transport: The station must move in and out of a building with ease.
11. Weather resistant: The weather station should not be affected by rainy weather.
12. Durable: The station must be able to withstand bumps and other outside elements.
13. Move through rough terrain: The station should be able to move through grass, rocks, dirt, and uneven terrain.

4.2 Engineering Requirements

The engineering requirements were created based off taking the customer requirements and finding how they would be analyzed. Each requirement has a mathematical unit associated with it letting us translate the customer requirements in to units of measurement. The engineering requirements will be used later on when the design and testing takes place. The only exact value know for the requirements is in the cost category, which is \$500.00 each per cart. The rest will be specified later on in the process. All engineering requirements can be seen in the appendix on (Table 3).

4.3 Benchmarking

This section contains two different mobile computer carts that are currently out on the market. Both these carts have some design components our client is looking for, but neither fully meets the customer requirements. This is represented in (Table 3) of the appendix.

4.3.1 Deluxe Diagnostic Fusion Cart

The Deluxe Diagnostic Fusion Cart is a mobile computer cart sold by Versa Tables for \$459.00. Although this would meet the cost criteria, other aspects would not qualify. The cart only holds one monitor and space for a CPU. There would be no space for testing equipment and other storage room. The wheels would hinder the cart from moving around outside with ease. All the electronics are exposed to the outside elements as well, making it not weather resistant. Although this mobile computer cart has some of the client's requirements, all are not met. [7]

4.3.2 Ergotron WorkFit-C

The Ergotron WorkFit-C is a mobile computer cart sold by CompSource for \$854.99. Its features include dual monitor attachments, a CPU holder, a platform for a mouse and keyboard, and a platform to write on. It also includes four small wheels that allow it to move when pushed. Additional features include 25" total height adjustment, a small footprint and advanced cable management. This particular cart also does not meet all the customer requirements specified. The cost is out of budget and it is not weather proof. The smaller wheels would also hinder it from moving through rough terrain. [8]

4.4 QFD Results

After relating all customer and engineering requirements the QFD concluded that the most important area of focus will be on the cost, material thickness, and weight. Based on the QFD these need to be part of the main focus when designing the cart. Research needs to be done to find out the most cost effective way of designing the cart. By doing this the cost will stay below \$500.00 per cart. The weight comes in to play when any customer requirement needs to be added to the cart. If material is added it obviously will add some sort of weight. The QFD shows that the existing products will not meet all the clients' expectations and proves the necessity for students to create a new design. Although some areas need more attention than others, every customer requirement needs to be analyzed in order to have a successful product. All results can be seen in (Table 3) of the appendix.

5. State of the Art (SOTA)

When designing a new product it is essential to research existing designs and products that are already developed. By researching different books and journals it allows your product to reach its full potential.

Also it cuts down on wasted time trying to re-invent the wheel, when you could of taken already existing product and improving on it. The following section is a summary of relevant State of the Art (SOTA) complied in the efforts of designing components for the mobile computer station.

5.1 Mobile storage and computer cart patent

The mobile storage and computer cart patent has a wheeled base on the bottom. On top of that is a lockable storage area with drawers and then a mounting location for a computer. This design contains many of the desired objectives for the project. It contains a storage area that is completely enclosed and it has mounting for a computer. The design is lacking in some areas, the location where the computer goes is not weatherproof so the computer could be easily damaged by the elements. The wheels on the base do not appear to be large enough to handle outdoor travel and they do not appear to have any locking mechanism to prevent the cart from rolling if left on an incline. This patent can be seen in (Figure 1) of the appendix. [1]

5.2 Engineering Mechanics Statics

The design of the cart is going to need to be able to handle many stresses and strains because of the computer and the monitors and the desire for it to be able to travel through rough terrain. An engineering statics book contains many useful equations and data about designs and how forces from different directions affect them. The information contained in this book will be helpful in calculating the strength of the design and simulating the stresses it will endure. [2]

5.3 Wheel design

The patent illustrates the structure of an axel rod, brackets, and caster wheel that allow the wheels to swivel. The axle rod will be mounted to the base. The Fabricated brackets swivel to adapt to the swivel cavities providing an accurate disposition of the wheels. This patent wheel structure should provide smooth rotating wheels to ease the cart movement. [3]

5.4 Braking System

The patent illustrates a braking system which can be activated by foot pressure to hold shopping cart from rolling downhill while unloading the cart. The way this braking system work is by an activated wedge pressing on the cart wheels and not released unless the wedge is pulled. This patent could benefit our project to keep the mobile cart from rolling downhill when conducting an experiment. This patent can be seen in (Figure 2) of the appendix. [4]

5.5 Large Monitor computer cart

This patent talks about the design of a **mobile** flat panel monitor and computer cart. The cart has a wheeled base, a support structure coupled to and extending above the base, a shelf coupled to the support structure above the base for supporting a computer, and a bracket coupled to the support structure above the shelf. This support structure is adapted to have mounted to it a flat-panel monitor. This patent helps us with the structure of our mobile cart where we intend to add a wheeled base and a support structure for the monitors. This patent can be seen in (Figure 3) of the appendix. [5]

5.6 Multiple Wheel bases

This patent talks about a multi-wheeled base for a **mobile** cart that includes one or more swiveling, optionally locking, caster wheels and one or more non-swiveling traction wheels. This design improves the maneuverability of the cart by making it easier to steer and stop. The traction wheels may be manually engaged, which may be operated by a cam and lever. The traction wheels may be automatically engaged, operated by a motor and a threaded shaft. Or activated by a motion-sensitive sensor and by an on/off electrical switch or button. The traction wheels are preferably in contact with the floor when the **mobile** cart is moving, and rise above the surface of the floor when the cart is stationary. This patent helps us with improving the maneuverability of the mobile cart as it describes a working design of the multi-wheeled base and the functions of each of its parts with their benefits to the base structure. [6]

6. Project Planning

6.1 Gantt Chart

A Gantt chart is a type of bar chart that illustrates a project schedule. The left side of the chart tells us the task and the beginning and ending dates. The right side shows us a visual timeline of when everything needs to be accomplished. We have attached Gantt chart as (Table 3) in the appendix which covers the first semester's timeline of the mobile computer cart design. We have eight major tasks that needs to be accomplished by the end of the semester, which include doing more market research, Concept generation, selection, 2 designs, analysis, final designs , final analysis and final cost analysis. Market research will allow us to have a better understanding of the designs that are already in the market. By knowing the designs that are already marketed we can come up with unique and different designs that will meet our client's specifications. We plan on breaking the mobile computer cart into sections (desk, storage, dual monitor mounts, wheels, and frame) where each member in the group will have to design each part. Doing this will allow us to have 5 different designs where we can mix and match to create two different products. Cost and material analysis will be done on both designs to make sure it meets our client's requirements. With that information we can finalize or change the design. After the final designs are

selected we will focus on enhancing whatever we can to the designs and making sure that the material and cost analysis will meet our client's needs.

References

- [1] A. Rossini, "Mobile storage and computer cart," US20050178298, 8/15/2005, 2005.
- [2] R. C. Hibbeler, *Engineering Mechanics Statics*. Upper Saddle River, New Jersey: Pearson Prentice Hall, 2013.
- [3] R. T. Raw, "Cart Wheel structure," U.S. Patent 4 749 204 A, June 6, 1988.
- [4] M. S. Hargett, "Foot pressure activated braking wedge, shopping cart wheel restraint," U.S. Patent 6 223 864 B1, May 1, 2001.
- [5] A. P. Rossini, "Mobile flat panel monitor and computer cart," 11/24/ 2009.
- [6] A. P. Rossini, L. Halio, J. M. Silverman, D. Maloney, D. Leiter and T. Bagley, "Mobile cart base with traction wheel," 10/29, 2013.
- [7] <http://www.versatables.com/products/deluxe-diagnostic-fusion-cart/>
- [8] <http://www.cdw.com/shop/products/Ergotron-WorkFit-C-Dual-Sit-Stand-Workstation/2478618.aspx>

Appendices

Table 1 : 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 space	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 2 : Gantt chart

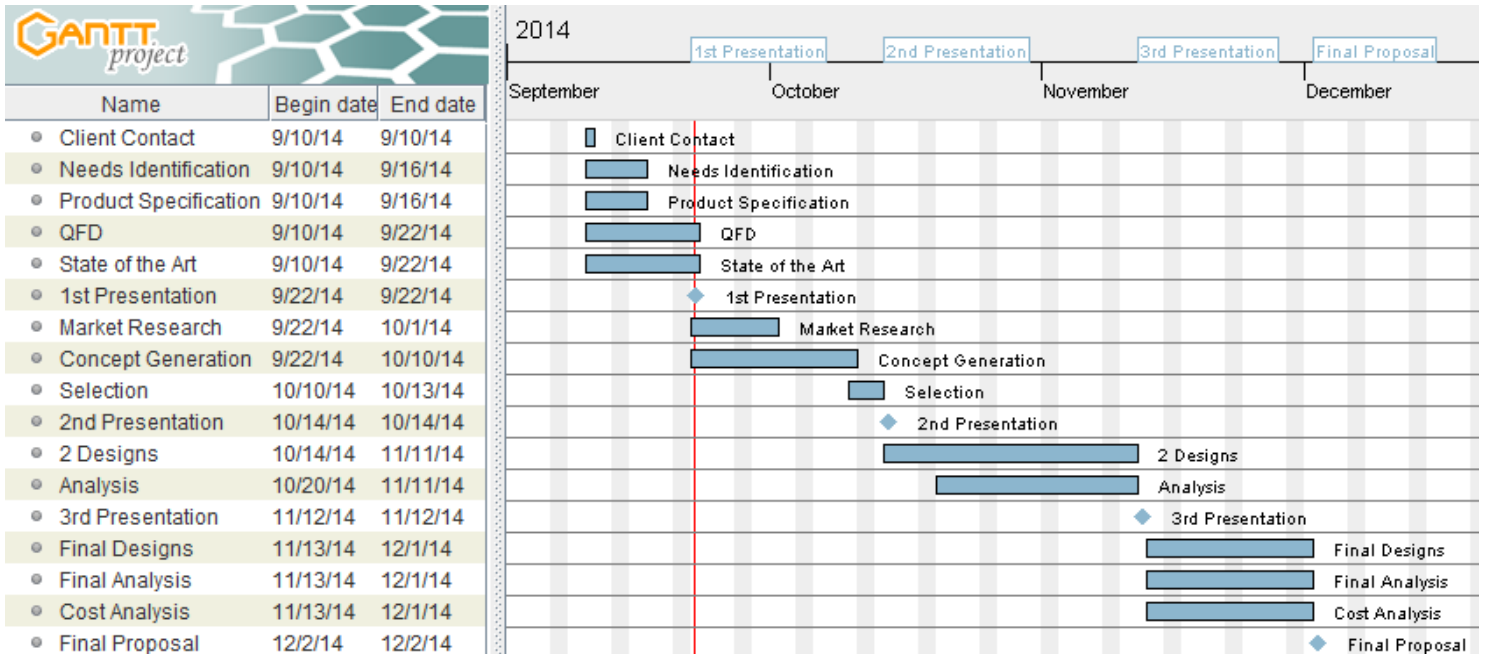


Table 3: QFD

		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													

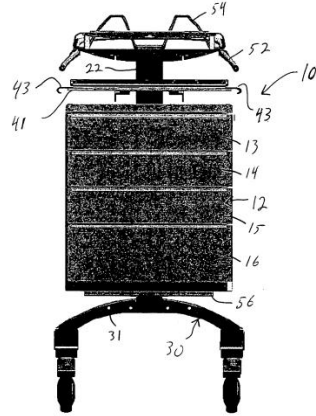


Figure 1: Mobile storage and computer cart patent

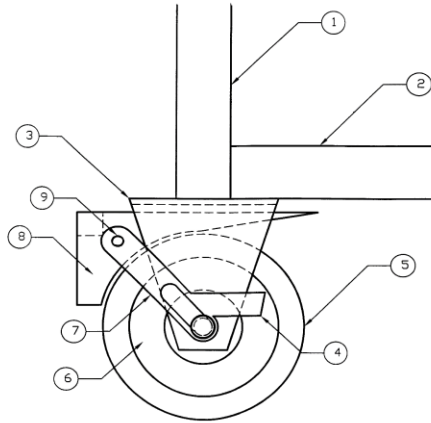


Figure 2: Breaking System

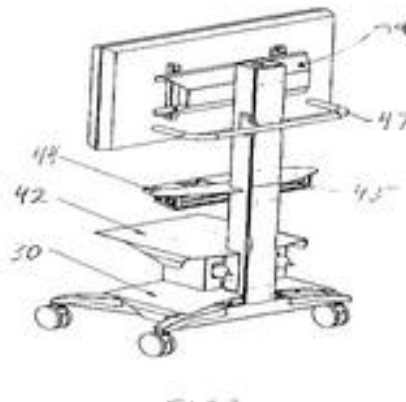


Figure 3: Large Monitor computer cart