

Mobile Computer Cart

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Progress Report

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1. Project Summary

A Northern Arizona University Capstone instructor is looking for one mobile computer cart 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. The computer cart 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, "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 preform 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).

Table 1: Objectives

Objectives	Measurement Basis	Criteria	Units
1. Inexpensive	Cost 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

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
 - support two screen monitors.
 - hold a CPU, keyboard, and a mouse.
 - move through rough terrain.
 - easily transported with only one individual.
 - weather resistant.
- One-sided inequality constraints
 - cart must be less than \$500.00.
 - storage space must accommodate 2 ft³.
 - width of the cart must be less than 3 ft.
 - 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 analyses will be completed during this test:

1. The client must be able to roll 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 roll 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. Concept

4.1 Two Wheeled Dolly Style

The two wheeled dolly style cart is designed to be completely portable and weather proof. It incorporates telescoping tubing which will allow the dual monitors to extrude out of the cart when the operator wants to perform experiments. The design consists of an inter frame created from steel square tubing, while sheet metal lines the exterior. All the experimental components, monitors, keyboard and CPU can be stored inside. The walls will consist of two Plexiglas windows to allow for the operator to watch the monitors when the cart sits in a closed position. Further description of the design and analysis is presented below.

4.1.1 CAD / Drawings

The CAD drawings below are an accurate representation of the design for the two wheeled model. The inner framing of the cart consists of 0.75'' x 0.065'' A513 hot rolled steel square tubing. This frame will give the cart its main structure and stay together during transportation. To prevent the outside elements from damaging any of the interior components .03'' thick steel sheet metal will be welded to the frame. The monitor mounts will be mounted to telescoping tubing with holes drilled at every inch. A pin can be inserted into these holes to position the monitors at the preferred height. There will be two 10'' wheels that will allow for the cart to be leaned back and pushed around. The cart will be 24'' x 24'' x 48'', which will allow for plenty of storage space. The 48'' height is a comfortable position to place your hands and maneuver the cart around. The three Plexiglas windows are made from UV resistant and scratch resistant polycarbonate. This will allow for the operator to look inside when the unit is closed.

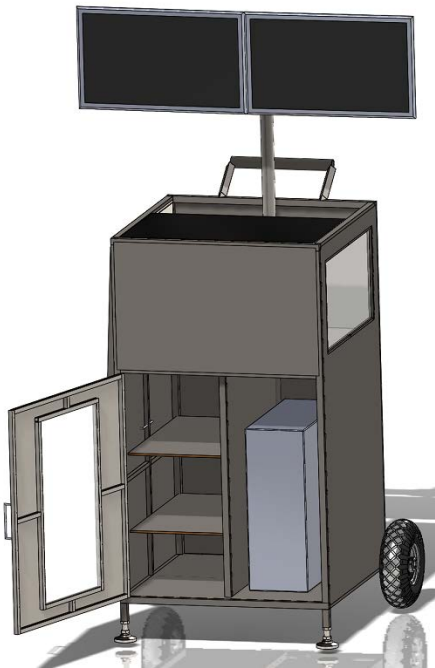


Figure 1: Computer Cart Isometric Vi

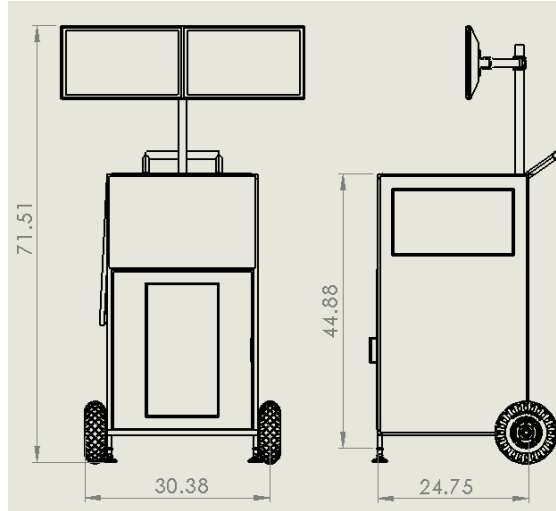


Figure 2 : Drawing Dimensions

5. Parts ordered

In order to manufacture the mobile computer cart material must be ordered from outside vendors. By ordering raw material it allows for the cart to be assembled from the ground up, which in the long run will cut down on costs. Currently most of the material being ordered has come from Online Metals and McMaster Carr. About 80% of the material has been ordered and currently resides in the Northern Arizona Machine shop. A list of the current parts ordered can be seen below in Table 2. Items that still need to order include: the wheels, second part of the telescoping tubing, paint, upper hinges, and weather stripping. The goal is to visit local stores around Flagstaff to find these supplies. Once all the material has arrived the project will be closer to completion.

Table 2: Parts Ordered

Parts Ordered				
No.	Parts	QTY.	Vendor	Description
1	8ft Frame Tubing 1	6	Online Metals	0.75" x 0.75" x 0.065" square tubing A513 HOT ROLLED MILD STEEL
2	8ft Frame Tubing 2	7	Online Metals	0.5" x 0.5" x 0.065" square tubing A513 HOT ROLLED MILD STEEL
3	Sheet Metal	6	Online Metals	24" x 48" x 0.03" steel
4	Plexiglass 1	1	Mc Master Carr	12" x 24" x 1/8" Polycarbonate
5	Plexiglass 2	1	Mc Master Carr	12" x 48" x 1/8" Polycarbonate
6	Telescope Tubing	1	Mc Master Carr	1.5" x 1.5" x 4ft Telescoping tubing
7	Hinge	1	Mc Master Carr	2 ft long piano hinge
8	Monitor Mount	1	Amazon	Tyke Supply Dual LCD Monitor Stand
9	Leveling Mounts	2	Machine Shop	Swivel Leveling Mounts
10	Latches	2	Mc Master Carr	Draw latches
11	Door latch	2	Mc Master Carr	Magnet latches
12	Door Handles	2	Machine Shop	Door Handles

6. Manufacturing Process

The large component to the mobile computer cart project consists of manufacturing the design together into one functioning component. This involves a lot of hands on work assembling the ordered parts together in the Northern Arizona University machine shop. Over winter break the frame section of the cart was about 90% assembled, taking about 40 hours of time. Measuring, cutting, welding, grinding, and sanding are just some of the components that have gone into the assembly process so far.

Manufacturing the cart ourselves allows us to keep cost down, and spend more on parts. It is a time consuming process to make the project look professional, but will pay off in the end. The beginning stages of the manufacturing process can be seen in the figures below.

Figure 3 represents the beginning stages of cutting the square tubing in preparation for welding. Lengths were taken from SolidWorks, and then transferred onto the tubing using tap measures. Once marked a horizontal ban saw was used to cut through the steel. The edges and burrs were further ground down and sanded so it could be easily welded together. This allows for no contaminates, including rust or oil, to weaken the welds.



Figure 3 : Cutting Stage

Figure 4 represents the tubing being laid up on a welding table in preparation to be welded together. Leaves and squares were used to get the desired dimensions for each of the tubing members. The frame was also clamped down to the table to make sure no warping occurred due to the intense heat. Welding tacks were first put down, and then each section was welded. After welding the frame sections with protruding weld beads were ground down.

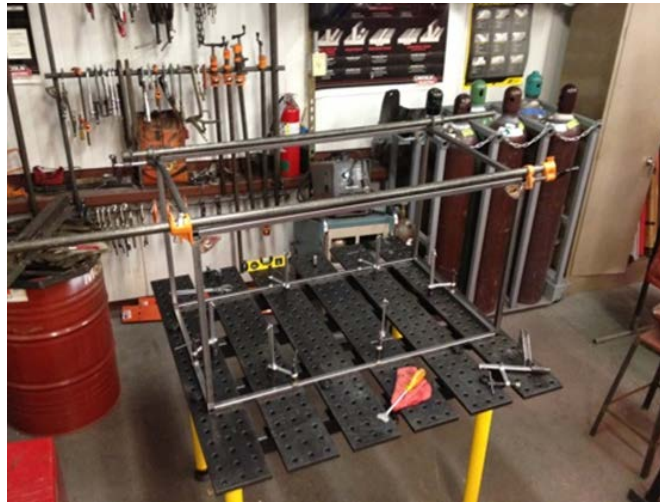


Figure 4 : Welding Table

Figure 5 represents the welding of the frame taking place. The mobile cart was all MIG welded in the NAU machine shop.

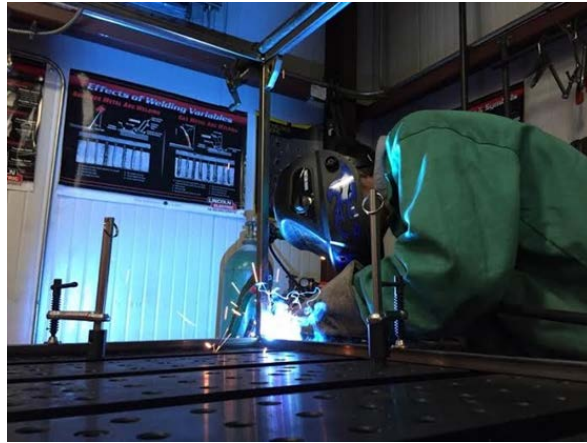


Figure 5 : MIG Welding

Figure 6 represents the process of welding the sheet metal onto the computer cart. The sheet metal was clamped down to the welding table the same was the frame was. The sheet metal was initially tacked down at multiple stops, to prevent warping of the metal to occur due to the heat. It was very important to allow time for the metal to cool enough before continuing. Much care was taken to not allowing the welds to burn through the time metal, which would create holes. Once welds were applied around the entire surface edges the metal was ground down to a smooth finish.



Figure 6 : Welding Sheet Metal

8. Project Progression

A Gantt chart is used to give our team a rough estimate of the progression of the project, deliverables and designs goals. It serves as an outline of the milestones that we will encounter during the manufacturing and project review steps. Over winter break the team has started assembling the frame, door, and lid. This has given us a head start on the overall goal of finishing the project by the middle of March. This will allow for adequate testing that needs to be done outside. As well as is any problems arise, they can be resolved before the end of the semester. All of the parts are expected be ordered by the beginning of February. The schedule is subjected to minor changes when it comes to the painting process. The team is currently putting in a lot of hours into the project at the machine shop, preparing to show the best product possible at UGRADS on April 24th. The spring 2015 Gantt chart progression plan can be seen below in Figure 7.

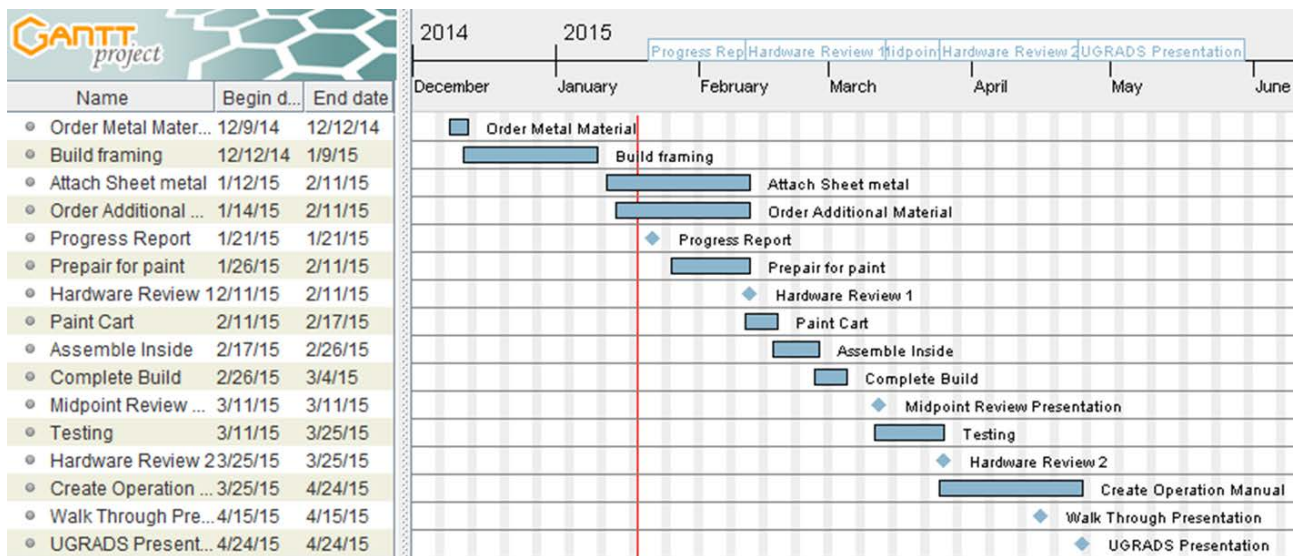


Figure 7 : Gantt Chart

9. Conclusion

The project has progressed as planned, however a specific build part timeline will be beneficial in ensuring that end product is completed in a timely manner. Since the hardware review 1 is due on February 11th the expectation is that half or more of the project will be completed. All team members contributed and collaborated as expected making this project manageable and of good quality.

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