Written Design Review - Team XXX
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The project for Team 16 is to design and fabricate a digital postal scale that accurately measures the weight of any object that is placed on its platform and adheres to the given requirements (see Table 1). The following discussion will focus on the technical details regarding our group's scale and discuss our overall advancement.

CHARACTERISTIC	SPECIFICATION
Capacity	250 pounds force
Resolution	At least 0.5 ounce
Accuracy	0.5% (0-4 pounds)
Readability	At 2 ft.
Platform Size	Supports a standard envelope
Power	9V batteries (2)
Assembly/Disassembly time	50/25 minutes
Kit size	One shoe box

Table 1—Design Requirements

Our scale is composed of three integral systems: 1) Platform and Casing; 2) Frame Support and Support Rod; 3) Strain Beam; 4) Electrical Circuitry.

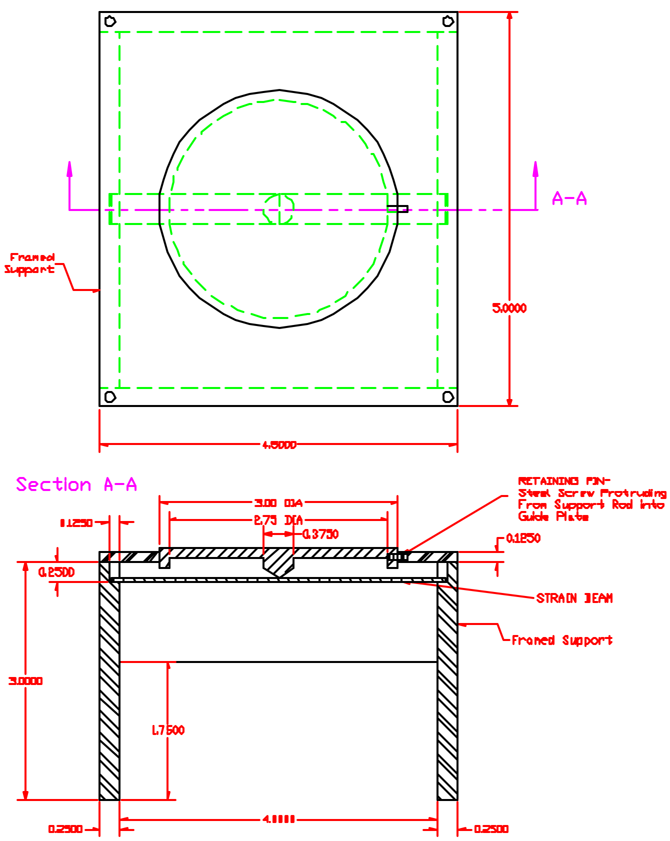

Figure 2 - Internal Frame and Support Rod Detail

I. Platform and Casing

Our first system, the platform and casing, is what will be in view to the user while performing its specific task. The casing will be constructed out of a prefabricated aluminum box, which is sturdy and fairly inexpensive. The platform will be constructed from 1/16 inch aluminum plating, which will allow for an overall aesthetically appealing design. The area of the platform will allow for a standard size envelope to be placed easily onto the scale. Problems involving this system fall behind the sizing of every component to allow it to fit within the casing. Already having purchased the box at Sandy's and researching the price for aluminum plate at Reno Salvage, we budgeted $25.00 towards this system.

II. Internal Frame and Support Rod

After an object is placed on the platform, its weight must be distributed downward to the strain bar in order to allow the transfer to the circuitry. This is all solved for in this system. The platform, upon which the object sits, will be connected to a support rod. This object is designed to distribute the weight along an imaginary line perpendicular to the span of the strain beam (see Figure 2). Knowing that our strain beam would bend most easily with a line of force, this lateral point distribution will allow for an accurate replication of weight directly along the beam. Also, a plastic guide plate is what supports and directs the support rod as it exerts force downward. Having a 3 inch diameter hole bored from the center, this guide plate works in conjunction with the large diameter of the support rod and allows for maximum stability. Although both of these element will undergo friction with one another as the support rod moves, the finely machined surfaces and lubricants will allow for all force to be contained within the support rod. A simple internal frame holds every one of these components together. Constructed from four, specifically sized ¼ inch aluminum plates and formed into a box with only two sides connected to the bottom of the casing, this frame allows room for our circuitry and supports every mechanical element in place (See Figure 2). Problems involving this system are mostly regarding with the complexity of the support rod and the connection of the four aluminum plates to make the frame. After researching Reno Salvage and contacting Tripp Plastics, we budgeted 50.00 towards this system.

III. Strain Beam

This system allows us to transfer weight of an object into strain. Team 16 decided that our strain beam would adhere to a three-point bending system because it allows for an efficient and simple method of accepting weight and outputting strain. Our beam is supported within the internal framing of our scale (see Figure 2). Two notches cut out of the sides of the plate support the beam on both sides. As these two sides interact with the lateral point applied by the support rod, the system undergoes an accurate three point bending. With a strain gage located on the middle underside of our beam, it will experience the maximum amount of gain. Our strain beam will be constructed from aluminum 2024-T4 because is a common and lightweight material. Designing our strain beam to fit into our casing we found that 4-5/16 inches sufficed. Although the actual distance of the part of the beam undergoing strain was 4 inches we were able to find that a 1/16-inch height combined with a 3/8 inch base allows our strain to be .00193 at 5 pounds (see Table 2). This base magnitude was chosen because it produces an acceptable strain and is a more common size than the others. Problems involving this system mostly revolve around finding the correct sizing of the strain beam and the best method of holding the bar in place. Lengthy investigations at Reno Salvage forced us to budget $10.00 towards this system.

	BASE (in.)		
WEIGHT (lbs)	5/16	3/8	7/16
0	0	0	0
2.5	.00115925	.0009660	.000828
5	.00231819	.0019321	.001656

Table 2- Strain at different Base magnitudes (Span = 4 in. & Height = 1.16 in.)

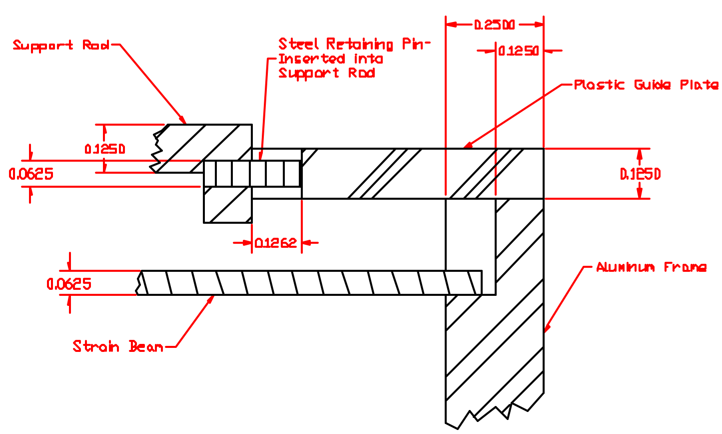

Figure 3 - Cross-section of strain gage and supports (all dimensions in inches)

IV. Electrical Circuitry

The final system of Group 16's digital scale is the electronics, which performs the conversions of strain, supplied from the strain bar, into readout on a digital scale. The first component of the circuit is the strain gage, a device that converts strain to resistance. This is located on the underside of the center of the strain beam and is attached there with glue. The strain gage used has a resistance of 120Ω and a gage factor of 2.05, as defined by the makers. Here, as the beam strains to the weight applied, so does the gage, allowing it to change resistance. The strain gage acts as one of four 120Ω resistors in a Wheatstone bridge in the position R_g (see Figure 4). The Wheatstone bridge allows us to convert the change in resistance of the strain gage into a voltage. As long as (R_g x R_3) = (R_2 x R_4) no voltage leaves the Wheatstone Bridge; however, as the strain gage (R_g) changes the resistance within the bridge, voltage is output. Because the strain gage will not be exactly 120Ω, R_3 will be a potentiometer, which allows us to be able to zero the scale. When 5 pounds of force is applied to the scale, the Wheatstone bridge outputs merely 8.9021 mV. This amount is very small and must be increased, so the voltage is run through an LM741 op-amp (see figure 4 – labeled G) and four resistors, which are, R_a, R_b, R_c, R_d. Gain in voltage is equal to the ratio of R_c / R_a. Therefore, based on the voltage output from the Wheatstone Bridge the gain in our team's scale is 44.6 which allows our voltage output to be 5V for 5 pounds. After researching Sandy's we have decided to budget $40.00 towards this system.

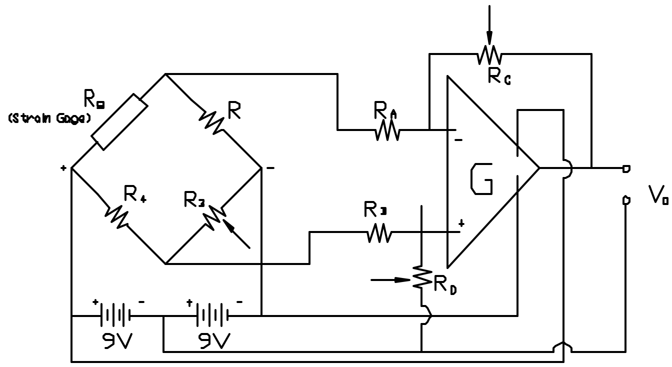

Figure 4 - Electronics Schematic

Group 16's parts list includes many different items (see Table 3). Most of these items are prefabricated except for the platform, guide plate support rod, and framing. This will help reduce our cost.

Name	Description	Qty.
Platform	Al sheet	1
Guide Plate	1/8 in platic sheet	1
Support Rod	Al plate	1
Casing	Al box(pre-fab)	1
Strain Bar	1/16 in. Al sheet	1
Internal Framing	¼ in. Al Plating	1
Display	Digital Multimeter	1
Circutry	Board, op-amp, wires, reisistors	1
Power Supply	9 Volt	2
Strain Gage	120 Ω, 2.05 GF	1

Table 3 - Parts List

We will now discuss our project status. At the beginning of the semester, we laid out a timeline that we have been trying to adhering to (see Table 4). The main operational issue at this time is getting the prototype built and testing for final review. We have great confidence in the design of our project.

Sept. 13	Sept. 27	Oct. 18	Nov. 15	Nov. 29	Dec. 6
Proposal	Written Report	Oral & Written Design Review	Prototype Due	Performance Testing	Final Presentation
		Design			
			Fabrication, Testing and Revision of Scale		

Table 4 – Timeline.