Sheet Metal Project

CM: *949*

Team name: Team #4 Section 02

To: *Dr. McCormack*

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Due date: *January 17,2020*

Re: Sheet Metal Project

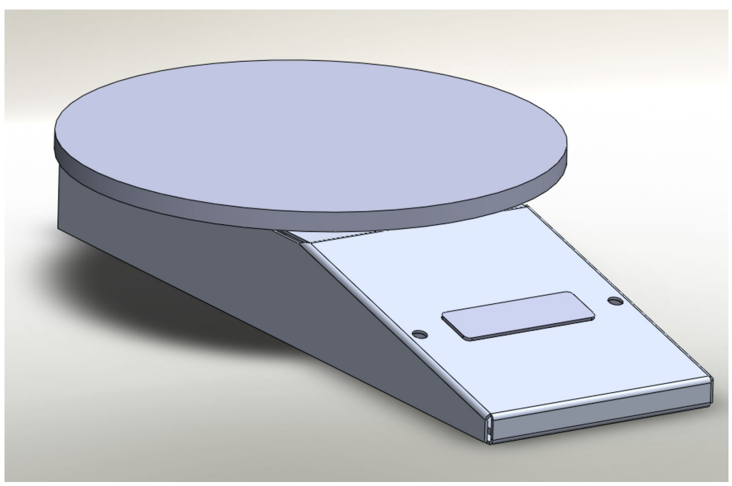


Figure 1.

This product is a scale that is used in the kitchen when weighing food for cooking or baking.

Benchmarking:

We were given a benchmark spreadsheet to measure the performance of our scale compared with other products on the market. The spreadsheet we filled out is shown below in Figure 2.

	angle of display (measured from flat surface)	total length of seams visible from a top or side view (in)	total length of seams visible from a bottom view (in)	gap area visible from the top and side views (in^2)	gap area visible from the bottom view (in^2)	coefficient of static friction between scale and granite surface	weight of scale (lb)	max height of scale (inches)	bounding box footprint area (in^2)	material cost ($)	manufacturing cost ($)	assembly cost ($)	other hardware cost ($)	total cost ($)
The sheet metal digital scale...														
1. displays the weight of common food items i	x													
2. is easy to clean.		x	x	x	x									
3. is competitively priced.										x	x	x	x	x
4. is easy to use.	x					x								
5. is easily stored.							x	x	x					
Benchmarked performance of each team														
2_3														
2_4	15	0.7	5	0	12	0	0	1	38	$308,052.99	$17,435.70	$202,083.33	$1,980,000.00	$2,507,572.02

Figure 2.

The benchmarking values were taken straight from our solidworks model, found from research, or calculated as shown below. We assumed that a "gap" is an open hole in our product that reaches to the PCB or inside wiring. A seam is any place in our product where two parts meet or one part slightly separates due to a bend.

Coefficient of static friction between scale and granite surface:

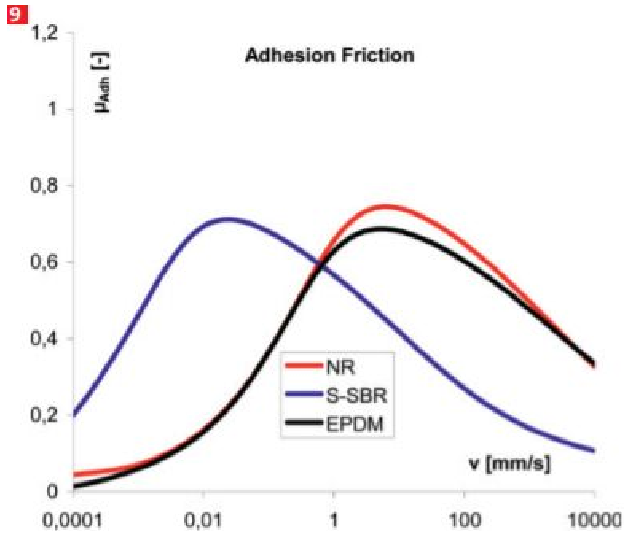


Figure 3.

TPE Rubber feet are attached to the bottom of the scale in order to increase the friction between the scale and the granite countertop. Adhesion friction at a very low speed would be the most comparable to static friction. According to an article written by Manfred Klueppel, the coefficient of adhesion friction for SBR rubber at the extremely low speed of 0.0001 mm/s is approximately 0.2. This is seen in Figure 3. This value can be used as an estimate as some SBR rubbers are made from TPE rubbers. This can be seen on page 24 of the article written by Kalle Hanhi, Minna Poikelispää, Hanna-Mari Tirilä on elastomeric materials.

Material cost:

Figure 4 shown below is the die layout of our part. It was laid out with the intention of saving on costs by wasting as little material as possible.

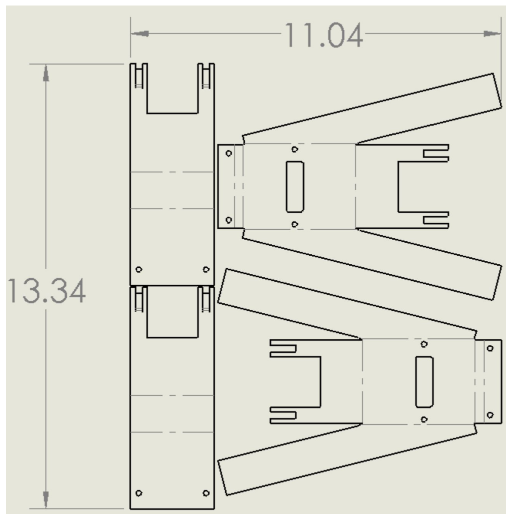


Figure 4.

The material cost is found by arranging the parts into the pattern shown in Figure 4 and then calculating the area it takes to make each product. To calculate the volume of material used, we used the following formula: V = total area of material cut by one blanking die*sheet metal thickness. We then found the density of Aluminum 3003 by multiplying its specific gravity by the density of water. Next, the volume of material used to make one scale was multiplied by the density of the Aluminum to find the total mass of material used to make one scale. This total mass of material is then multiplied by the cost of Aluminum 3003 per kilogram to determine the cost of material used to produce one scale. Table 1 summarizes all the calculations below.

Table 1:

Material:	Aluminum, 3003 hard
W: width of pattern to produce a product	30.48 cm
L: length of pattern to produce a product	33.88 cm
A: area of material it takes to make one product	1032.62 cm
T: thickness of sheet metal	0.074 cm
V: volume of material used to produce one product	38.03 cm^3
Cost of Material: cost of material used to produce one product	$ 0.31
Cost of Material: cost of material used to produce 1,000,000 products	$ 308,052.99

Manufacturing costs:

Blanking die cost:

The blanking die is shown in the image above. As given in the project instructions,

Blanking die cost = Rtm x (Mds + Mp0 x flw), where:

Mds = 3+ 0.009 x L x W = time in hrs needed to produce the die plate

Mp0 = 28 + 1.03 x Xp = time in hrs needed to produce die features associated with the perimeter complexity.

Xp = P / (L x W)$^{1/2}$ = profile complexity index

P = perimeter length to be sheared in cm

flw = area correction factor found from the graph below

Table 2:

Rtm:	$40/hr
W:	30.48 cm
L:	33.88 cm
P:	398.42 cm
Xp:	12.4
Mds:	12.3 hrs
Mp0:	40.8 hrs
flw:	7.3
Blanking Die Cost:	$12,400

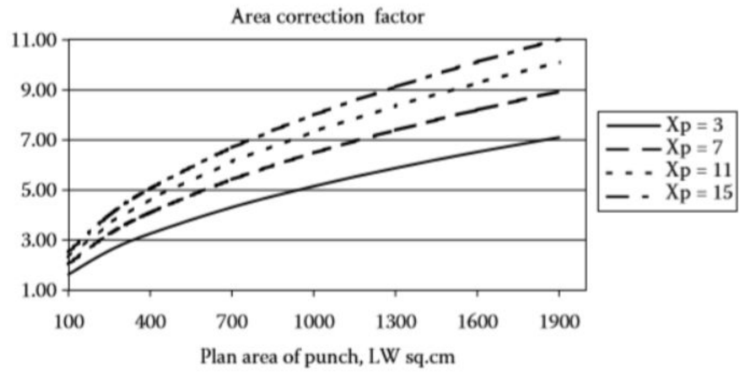


Figure 5.

Bending die cost:

As given in the project instructions,

Bending die cost = Rtm x (21 + 0.032 x L x W + 0.68 x Lb + 0.58 x Nb)

Where Lb is the total length of bend lines and Nb is the number of different bends to form the product.

Table 3:

	Front Part	Back Part
Lb: total length of bend lines	14.27 cm	6.35 cm
Nb: number of different bends to be formed	5	3
Bending Die Cost:	$2665.9	$2372.8

Operator wages:

As given in the project instructions,

operator wages per product = (tblanking + tbending + tdrawing) x Rop

Where Rop is the wage rate of the operator in $/second and tblanking is the cycle time of the blanking operation, and is found by

tblanking = (3.8 + 0.11 x (L x W)) / number of products in one pattern.

Tbending is the cycle time of the bending operation, and is found by

tbending = $\Sigma\,(3.8\ +\ 0.11\ \times\ (Lpartn\ \times\ Wpartn))$ for each n part in the product that has bends

Where Lpartn and Wpartn are the length and width of the bounding box for the nth part of the product.

Table 4:

Rop:	Assume 15/3600 ($/second)
Tblanking	58.69 seconds
Tbending front part:	44.53 seconds
Tbending back part:	15.58 seconds
Operator wages per product:	$ 0.50
Operator wages to produce 1,000,000 product:	$ 495,017.91

Assembly cost:

As given in the project instructions,

assembler wages = total assembly time x Ra, where:

Ra is the wage rate of the assembler in $/second

We assumed for the assembly that the rubber feet pictured in the appendix took the same amount of time to assemble as rivets.

Total assemble time: (6 rivet**s) *(7s** / rivet**)** + 6.5s for assembling with two hands

Table 5:

Ra: wage rate of assembler	15/3600 ($/second)
Total assembly time:	48.5 s
Total assembly cost for one product:	$ 0.20
Total assembly cost to produce 1,000,000 products	$ 202,083.33

Total cost:

Table 6:

Material Cost to produce 1,000,000 products:	$ 308,052.99
Manufacturing Cost to produce 1,000,000 products:	$17435.7
Assembly Cost to produce 1,000,000 products:	$ 202,083.33
Other costs to produce 1,000,000 products:	$ 1,980,000
Total Cost to produce 1,000,000 products:	$ 2,507,572.02

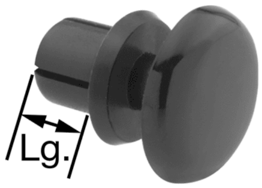
Weight of scale:

The weight of scales was assumed to only include the weight of our housing. This was found by finding the total volume of the product on solidworks, and multiplying it by the density of the part we found above.

Table 7:

Volume of product:	$1.9975*10^{-5}m^3$
Density of Aluminum, 3003 hard	2700 kg/m^3
Weight of scale:	.054 kg

Appendix:



Sources:

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