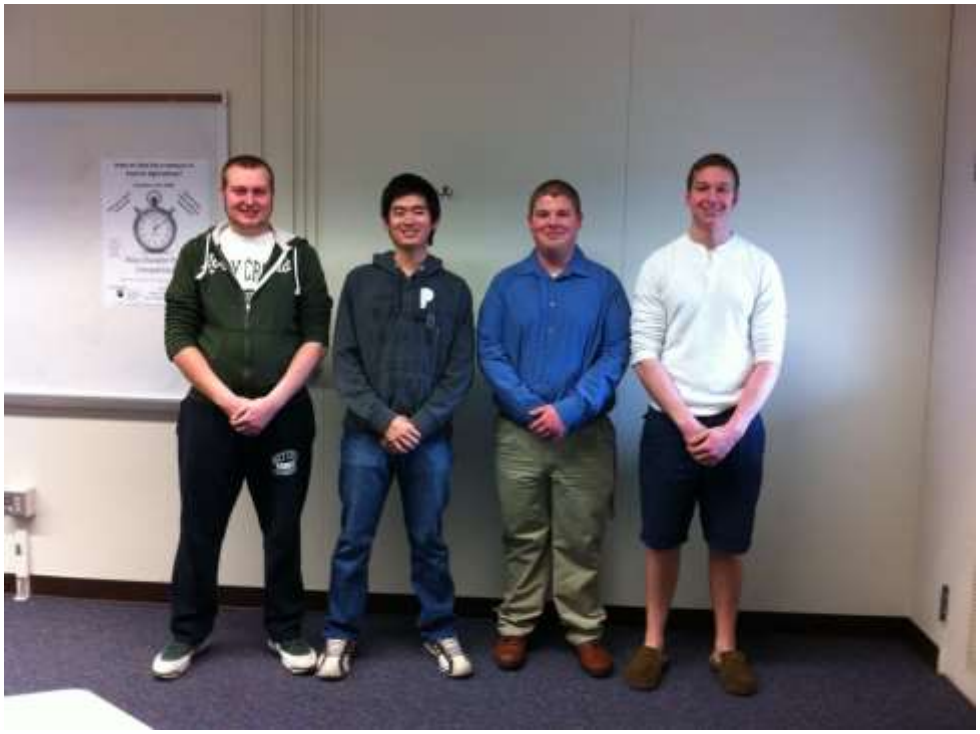
Guttertron 5000

Suavé Nation
Jake Bashore, Mark Kennedy, Nick Kneier, Rico Polim
EDSGN 100 Section 20 Spring 2013
Dr. Kissenwether

Jake Bashore—builder, tester, research, front page, concept development, testing prototype 1
Mark Kennedy—builder, tester, research, spokesperson, final editor/continuity checker
Nick Kneier—builder, sketching, tester, research, design refinement and testing, lessons learned
Rico Polim—tester, writer, matrix, AHP, research, problem statement, costing



Problem Statement: Rico Polim

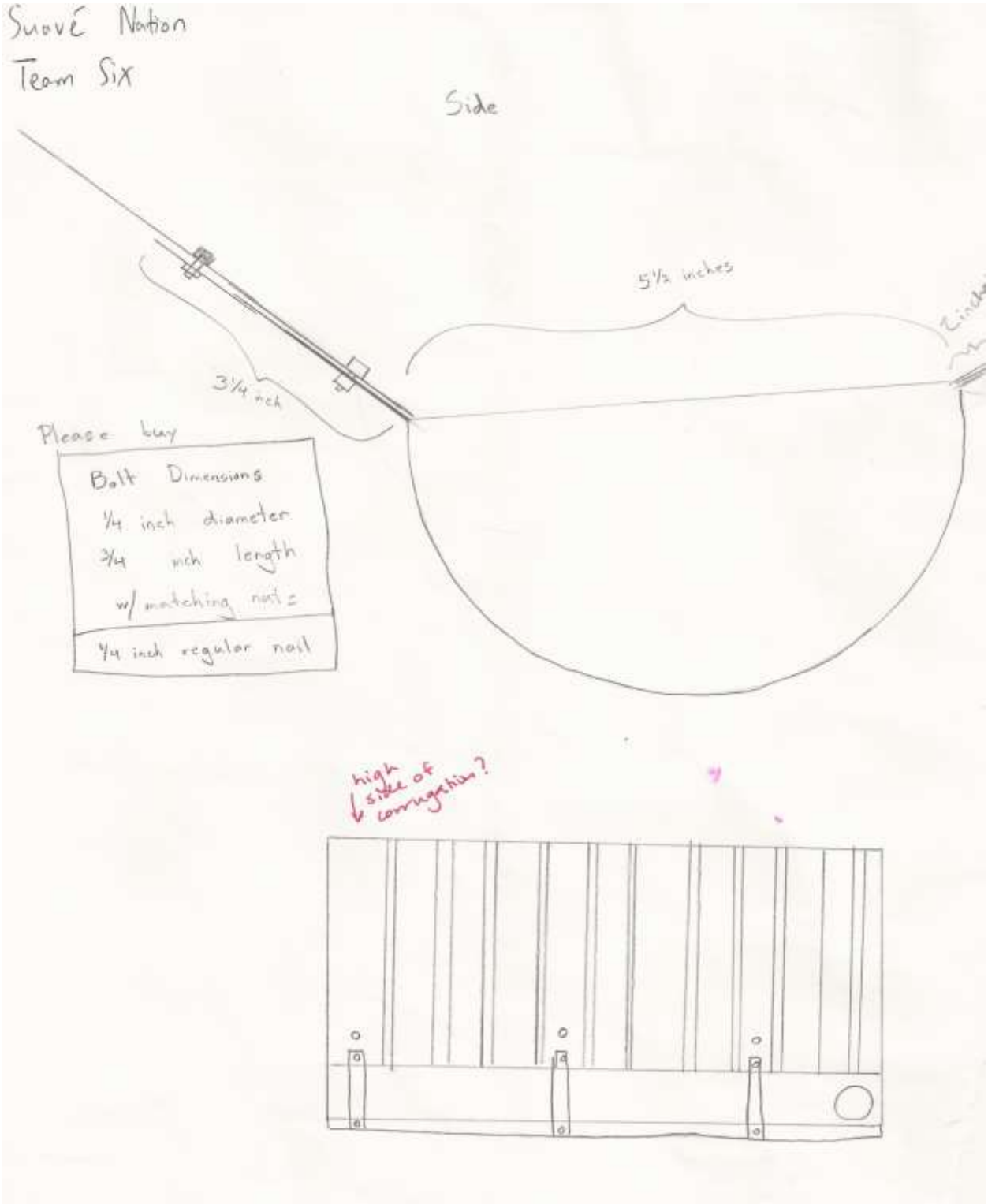
As rural Kenya is desperate for water, the need to harvest rainwater is an urgency that must not be undermined. The shortage of water in Kenya has led to undesirable sanitary and agricultural problems such as diseases and crop failures. Houses in Kenya, currently and sadly, are inefficient in collecting water for domestic use. Tin roofed houses in rural Kenya are currently incapable of collecting rainwater. Suavé Nation, henceforth, under the supervision of Dr. Elizabeth Kisenwether, sees the need to design an affordable yet versatile gutter for Kenya.

Concept Development: Jake Bashore

We researched weather patterns in Kenya, and discovered that Kenya receives much more rain than we are accustomed to here in Pennsylvania. We had to keep the cost of the gutter as low as possible. We wanted our gutter to be capable to capture large amounts of water. Our gutter also had to be strong to withstand heavy downpours and hold large amounts of water. We designed our gutter to be easily modified and repaired if necessary. Lastly, we felt it was important that our gutter was aesthetically pleasing. With that in mind, we designed our gutter accordingly (Figure 1).

	Cost	Easy to Repair	Aesthetics	Easy to Modify	Safe to Install	Water Capacity	Easy to Install	Withstand Downpours	Total	Weight
Manufacturing Cost	1.00	3.00	5.00	3.00	2.00	1.00	2.00	1.00	18.00	0.21
Easy to Repair	0.33	1.00	2.50	1.00	1.00	0.50	1.00	0.50	7.83	0.09
Aesthetics	0.20	0.40	1.00	0.33	0.33	0.20	0.33	0.20	2.99	0.03
Easy to Modify	0.33	1.00	3.00	1.00	0.75	1.50	1.00	0.75	9.33	0.11
Safe to Install	0.50	1.00	3.00	1.33	1.00	1.50	0.50	0.50	9.33	0.11
Water Capacity	1.00	2.00	5.00	0.67	0.67	1.00	2.00	1.00	13.34	0.16
Easy to Install	0.50	1.00	3.00	1.00	2.00	0.50	1.00	2.00	11.00	0.13
Withstand Downpours	1.00	2.00	5.00	1.33	2.00	1.00	0.50	1.00	13.83	0.16
									86.65	

Figure1: **Prototype #1: Concept Drawing**



We named our gutter The Guttertron 5000. We wanted our gutter to have a futuristic type name. We thought that the Kenyans would like our gutter more with a name like this.

Testing of Prototype #1: Jake Bashore

Overall, our gutter performed as expected. There was a slight spill over on the side opposite the roof. The water did not flow in the gutter as we had anticipated. The holes in the gutter experienced slight leakage after a while (Figure 3). While we were building the gutter we discovered that the holes were difficult to put in the gutter.

The test results were very influential in our second prototype. We will add a lip on the side opposite the gutter to prevent water from spilling. We will also design a slant in the gutter to direct the water to flow in one direction. We will water proof the gutter holes with small pieces of rubber. Lastly, we need to find an easier way to puncture the gutter. We are considering using a nail to start the hole, and then using progressively larger nails to widen the hole until it is large enough for the bolt.

Figure 2(Left) Gutter look from right side view

Figure 3(Right) We can see minor spillage from the left and front side because some water ran through the strip and some spilled from the back, showing that we need to slant the gutter more.

Design Refinement (Prototype #2) and Testing: Nick Kneier

As we had shown in our AHP, our top priority was the price of the gutter as a whole. After completing prototype #1, we realized that we used too much material in our design and that there was a decent amount of material that could be omitted. However, our two biggest concerns when designing the second gutter were the loss of water

through the bolt holes where the gutter was secured to the roof and the loss of water over the outer edge of the gutter. Both of these concerns were addressed in our concept selection matrices. For the water leakage through the bolt holes, we decided the best way to fix this problem was to put small pieces of rubber tubing on the bolts to form a seal to prevent water from leaking through. For the water spillage at the outer edge of the gutter, we added a high lip that would prevent water from going down the roof and going over the edge of the gutter. With the addition of these two parts, we were able to successfully fix the mistakes we had made in our first prototype. The new concept can be seen below

Figure 4: **Prototype #2: Concept Drawing**

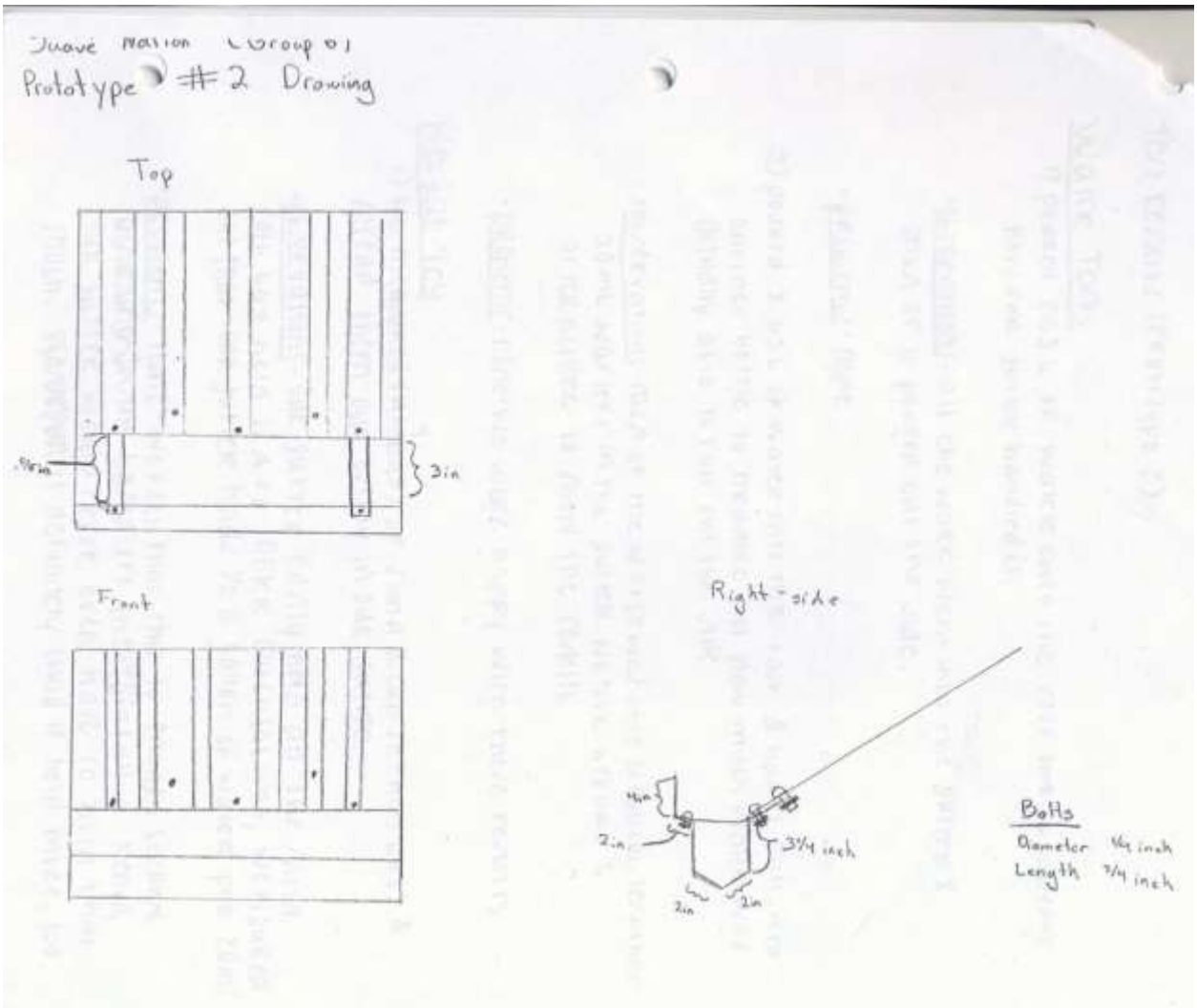


Figure 5(Left) Sand bags placed in the gutter to test strength, flexibility, and durability

Figure 6(Right) The high lip on the prevents water spillage over the edge and the rubber stoppers prevent water from seeping through the screw holes.

In our prototype #2 experiments, we reported success in every test that we conducted. With the new lip on the outer edge (Figure 6), almost all the water traveling down the roof was contained in the gutter and was successfully transported to the outer openings in our gutter, collecting in the tub below. The new rubber pieces added prevented all water leakage through the bolt holes, making a simple and cheap way to avoid roof leakage. We also conducted an experiment of how much water that can be held by the gutter. We placed 4 bags of sand in the gutter in order to test this as seen in Figure 5. The gutter did bend under this pressure, but still remained at a position that would still collect water. Also, when these bags were removed, the gutter was able to naturally return to his standard position without any signs of permanent damage or bending.

Costing: Rico Polim

In Prototype #2, we create our gutter with 8 bolts, 8 nuts, and 0.46 meter^2 28-gauge tin sheet for one meter of our gutter. The bolts and nuts are 1½ inch in length and ¾ inch in diameter. We refer to the information given by our supervisor, Dr. Liz., 1 bolt, along with its nut will cost 20 Kenyan Shilling/.23$ (1 US$ = 86 KES, as in March 1 2013). We refer the price of tin sheet to a lower Kasturi Hardware store in Nyeri Town.

Referring to the price of tin sheets sold in Kenya Hardware store, we know that it cost 1500 KES/17.44 US$ (1 US$ = 86 KES, as in March 1 2013) for 32 meter^2. Using ratio, we found that it cost .25$ for 0.46 meter^2.

The team also realizes that labor costs must also be included. From the first prototype, we recorded that it took the team 20 minutes to assemble one meter of our gutter. It took us 20 minutes to bend the gutter, punch the holes, and tighten the bolts and nuts. Knowing that the gutter will be bent before being attached by Kenyan labor and understanding that 20 minutes is the time it took for the team to assemble the whole thing the first time, we are assuming that specialized Kenyan labor can attach one meter of our gutter in 15 minutes. We are also provided with average Kenyan labor cost of 400 KES (4.65 US$) per 10 hours of work. Therefore, multiplying 15 minutes per meter by 32 meters, we have 480 minutes or 8 hour. As a whole it will take 3.72 US$ for attaching 32 meters of our gutter.

The following are all the bill of materials for our second prototype:

1. 0.46 meter^2 tin sheet, **25 US cents**
2. Eight bolts and nuts, **23 US cents each, 1.84 US$ for 8 of them.**
3. Kenyan labor cost, **11.36 US cents for 1 meter gutter attachment**

Adding up expenditure 1 and 2, our **material cost** will be **2.09 US$** for 1 meter of our gutter.
With expenditure 3 added, we will have our **total project cost** of **2.20 US$** for 1 meter of our gutter.

If we were to be given another prototype, changes are ought to be made in tin sheet dimension and length of bolts. We believe that we can cut down up to 7 inch of our tin sheet's width such that we only need 0.29 m^2 28 gauge tin sheet. Maintaining the same number of bolts and nuts used, the team saw that the length of our bolt, 1½ inch, as too long. Therefore, we expect that we can change our bolt to a cheaper 1-inch bolt, keeping the diameter as constant. We assume that we can calculate the price of an inch bolt by ratio in comparison to the price of 1½-inch bolt. Knowing that 1½-inch bolt and nut cost us 23 US cents, we get 15.3 US cents for each 1-inch bolt and nut. The change in gutter dimension and bolt length was not considered as a factor that will affect labor's assembly time.

The projected bill of materials for will be:

1. 0.29 meter^2 tin sheet, **16 US cents**
2. Eight bolts and nuts, **15.3 US cents each, 1.22 USD for 8 of them**
3. Kenyan labor cost, **11.36 US cents for 1 meter gutter attachment**

Adding up expenditure 1 and 2, our **material cost** will be **1.38 US$** for 1 meter of our gutter.

With expenditure 3 added, we will have our **total project cost** of **1.50 US$** for 1 meter of our gutter.

The result shows that the constrain of 1 $/meter is a challenging constrain for Suavé Nation. We are currently $1 too high from the constrain. To get close to 1$ means that we need to give up some of our current features, the team has thought of decreasing the bolt length and tin sheet dimension. Referring to our projection, it will still not go under 1$. Learning from this projected cost, we observed the possibility of reducing the amount of bolts and nuts used while in the same time decreasing the length of bolts and tin width. The alternative of decreasing the number of bolts, though, will create a decrease in the gutter's durability and ability to withstand heavy downpour. Due to the constrain of prototype attempts, the team was not able to convey much about this complex trade-off alternative.

Lessons Learned: Nick Kneier

If we were to have a prototype #3, we would try to reduce the amount of material used to drive down the cost. Since our gutter was able to hold a substantial amount of water, withstand a large of amount of water, and avoid major water spillage, these areas would not need improving with another prototype. We found that the gutter that we had made was substantially bigger than the amount of water that actually stands in the gutter at one time. With this in mind, for our next prototype we propose decreasing the height of the gutter by 3 inches and keeping the lip that we have on the gutter which catches any water spillage. By reducing the height of the gutter, we instead use the roof as part of the gutter which will be able to hold excess water. By doing this, we reduce the amount of material used, while at the same time reducing the price of the product of

the goal. Also, if we made another prototype, we would try to do an actual meter of gutter so we can figure out exactly how many bolts we would need to secure our gutter to the roof. If we can reduce the amount of bolts used, we can drastically decrease the price since the price of one bolt with a nut can be very high in Kenya. With a prototype #3, we could have a much better idea of what our final product would look like.

For our team, we were able to work together very well. We communicated our ideas to each other in a decent manner so that everyone's ideas for our gutter would be able to be taken into consideration. We each were given our specific jobs and completed them to the best of our abilities. Overall, as a group, we were able to effectively complete the task at hand in a mannerly and efficient way. However, sometimes our ability to complete tasks on time was a bit off. We were sometimes rushed with some of the jobs that needed to be finished, but in the end we were able to complete them.

The DEM project could be improved by making a clearer list of important dates ahead of time so we know went everything needs to be completed by. There were many times that we did not realize a certain part of our project was due, and we needed to finish it up so we could meet the deadline that was set for us. Otherwise, the DEM project did run smoothly. We knew the project that needed to be completed and the goals that needed to be achieved.