Requirements Document

**1.0 Introduction**

1.1 We have been asked by the SCE (Society of Cedarcrest Engineering) to design a marshmallow launching system. It must include drawings of the launcher, testing plans and results, scale models, and a prototype system. Written requirements must be turned in by January 21, 2002. We will be testing our prototype on January 28, 2002. We will be presenting our plans on January 18, 2002.

* + 1. Katie Williams: Katie helped designing the initial marshmallow launcher. She worked on the drawing for the first design. She typed the write-up for our test plans. Katie also worked on the power-point presentation for 6 hours and 10 minutes. She helped test our MLS for 4 hours and 30 minutes.
    2. Sunni Beaman: Sunni helped in testing our marshmallow launcher for 4 hours and 30 minutes. She also typed up the parts list. She helped write and think of the motto/song for the group. Sunni also edited the requirements document for 4 hours. She also helped work on the power-point presentation.
    3. Diane McKenney: Diane built our marshmallow launching system that was tested, and helped in testing it. Katie and her both wrote the conclusion. She also worked on the final design drawings. Diane also worked on the power-point presentation for 6 hours and 10 minutes.
    4. The total number of hours put into this project was 34 hours 54 minutes.

**2.0 Design Features**

2.1 Our marshmallow launcher is designed to efficiently launch five consecutive marshmallows, in an economical way. It resembles a large-scale slingshot-like mechanism. Our marshmallow launcher requires an operator to reload it, but is lever operated.

**3.0 Design Process**

* + 1. One idea we had resembled a catapult, bending back a metal arm containing a marshmallow and releasing it. However, finding a metal that was malleable enough to endure stress of bending back was hard to find. It also didn’t supply enough force to launch a marshmallow 10 yards.
    2. The second design idea was putting a marshmallow down a large pipe and pulling back a spring and this would shoot the marshmallow out of the tube. But this design didn’t meet the requirements of having it be push button/ lever operated.

3.2 One problem our group faced, was misinterpretation of the rules. We felt that there was no rule prohibiting us from launching all five marshmallows at once. We learned we had to launch each of the five, one at a time. Also, finding time when we could all get together was a problem our group had. We found that our launcher wasn’t as stable as we had wanted, so we added spiked bolts into the four legs to stake into the ground. In addition, we found that the tubing needed some sort of cover to prevent the shock cord from tearing as the marshmallow was launched through the “Y”.

3.3 Initial Computations

None of our angles for our launcher were mathematically derived, but we mainly figured them out by trial and error.

**4.0 Description of Parts**

|  |  |  |  |
| --- | --- | --- | --- |
| parts list | | | |
| Part # | Item | Manufacturing | Qty. |
| N101-162 | Gate Latch |  | 1 |
| BMW-012 | 6’ Shock Cord |  | 1 |
| BMW-001 | 10” 5/16 OD Stainless Steel Tubing | Cut to length | 1 |
| BMW-002 | 1’4” 1x1/8 Wall Square Tubing | Cut to length | 2 |
| BMW-003 | 4’ 2x2x1/8 Wall Square Tubing | Cut to length | 1 |
| BMW-004 | 10” 1 ¼ SCH 80 Black Tube ASME-4-53 Grade b | Cut to length | 1 |
| BMW-005 | 10”x ¾” SCH 40 Black Tube ASME-A-53 Grade B | Cut to length | 2 |
| BMW-006 | 5’x5’x3/8” Steel Plate |  | 1 |
| BMW-007 | 2’x2’x1/8” Angle Iron |  | 1 |
| BMW-008 | 2’x6” PVC Plastic | Cut to length | 1 |
| BMW-009 | ¼”NCx½ Cap Screws w/ Locking Nuts |  | 4 |
| BMW-009 | 1/8”x4” Nylon Tie Straps |  | 4 |
| BMW-010 | 1’of 2” Duck Tape | Cut to length  KM | 1 ft. |
| BMW-011 | Stabilizer Pins (feet) 3/8” | Grind bolts to sharpen | 4 |
| BMW-013 | 10”, 6” Pipe Insulation | Cut to length | 2 |

The tools we used to build our Marshmallow Launcher consisted of:

* Drill Press
* Port-A-Band Saw (Milwaukee)
* MIG Welding Machine
* Ridge Tubing Bender
* Ridge Tubing Cutter
* Reamer
* Tape Measure
* Combination Square
* Grinder

**5.0 Assembly**

* 1. The 4 foot square tubing piece is the base of our marshmallow launcher. The two one foot-4inch square tubing pieces are where welded to the base to stabilize it. They were welded about 6 inches from each end of the base. We welded the 10” x ¼” SCH 80 black tube 2 inches from one end of the base. In that tube the 2-10” x 3/4” SCH40 black tubes we welded 8 inches apart forming a “Y” shape. The 2-10”x 3/4” black tubes had holes drilled about 4” down, through these holes the shock cord was inserted and tied on the backside, holding it in place. But before it was tied we bent the10” of stainless steel tubing to form a “V” shape and slipped it on the shock cord, inside the “V” shape we bend the 2”x 6” PVC plastic and placed it. This would be the part that held the marshmallow in place before it was launched. We then tied the shock cord, pulled it through the holes while giving it enough slack so it was tight. At the other end of the base we welded the 5’x 5’ x 3/8” steel plate at about a 35 degree angle from the base. This is the “launching pad”, to this we welded the 2”x2”x1/8”angel iron, which we had drilled 4 holes about ½” from the four corners of the angle iron. We used the ¼” NCx1/2” cap screws with locking bolts to bolt the gate latch to the angle iron.

**6.0 Operation of Equipment**

6.1 Describe how the equipment works.

The “V” stainless steel tubing on the shock cord latches into the gate latch, which is then released, pulling back the gate lever. The marshmallow is then launched through the “Y” that is formed by the two black pipes.

**7.0 Cost Accounting**

* 1. How much did it cost?

Our Marshmallow launching system costs a total of $58.94 w/o tax.

7.2 How much time was spent (doing what)?

Designing- 8 hours 20 minutes

Building- 6 hours

Testing- 6 hours 30 minutes

Time doing write-ups: 8 hours 15 minutes

Presentation: 6 hours 10 minutes

Advertising: 1 hour

Total hours: 36 hours 15 minutes

**Appendix A** (Tests)

Test 1

**Purpose/Problem**: What is the average distance our Marshmallow Launching System (MLS) will launch 5 marshmallows?

**Hypothesis**: If we run 3 tests of launching 5 marshmallows for a maximum of one minute each, then the average distance of the three tests combined will be less than or equal to 10 yards.

**Procedures**: Step 1: Diane handed Sunni 1 marshmallow, and began to time the

marshmallow launching process.

Step 2: Sunni pulled back the sling and hooked it onto the lever.

Step 3: Sunni then placed the marshmallow onto the platform

and pressed down on the lever to release the marshmallow launcher.

Step 4: Sunni and Diane repeated the process 4 more times.

Step 5: After finishing the launching procedure, Sunni and

Diane took measurements from the start line (front of

MLS) to the place of landing.

\* Diane, Sunni, and Katie each operated the marshmallow launcher 1 of the three tests\*

**Data**: Date: January 17, 2002

-Test 1- -Test 2- -Test 3-

1. 35’ 1. 39’-2” 1. 42’-5”

2. 39’-1” 2. 37’-3” 2. 46’

3. 44’-4” 3. 43’-9” 3. 47’

4. 45’ 4. 43’-9” 4. 50’

5. 49’-6” 5. 43’-9” 5. 52’

-Avg. distance-

42’-7” 41’-6” 47’-6”

**Analysis**: Our marshmallow launcher launched 5 marshmallows on average better than we expected, and it was fairly consistent. We think because we made sure our launcher was consistent during the entire procedure that our results were accurate. We also noticed that each time we launched the marshmallow, it got further each time. Test three was the best of all three tests by far launching a total average distance of 47’-6”, and test two the worst launching only 41’-6” on average.

**Conclusion**: From the test we were able to judge how far our launcher would be able to launch, and we exceeded our minimal expectations in this test.

Test 2

**Purpose/Problem**: What is the average time that it takes for the MLS to launch 5 consecutive marshmallows at a time?

**Hypothesis**: If we run three tests of launching 5 consecutive marshmallows, then the average time of all the tests will be less than or equal to 1 minute.

**Procedures**: Step 1: Sunni handed Diane 1 marshmallow, and began to time the

marshmallow launching process.

Step 2: Diane pulled back the sling and hooked it onto the lever.

Step 3: Diane then placed the marshmallow onto the platform

and pressed down on the lever to release the marshmallow

launcher.

Step 4: Diane and Sunni repeated the process 4 more times.

Step 5: After finishing the launching procedure, Diane,

Sunni, and Katie took measurements from the start line (front of MLS) to the place of landing.

**Data**: Date: January 17, 2002

-Test 1- -Test 2- -Test 3-

45 sec. 55 sec. 55 sec.

Average time of three tests combined- 52 seconds

\* Diane, Sunni, and Katie each operated the marshmallow launcher 1 of the three tests \*

**Analysis**: The time it took to launch a single marshmallow 5 times on average was 52 seconds, therefore our hypothesis was correct. We rushed our first test, so for the second and third tests we took more time to launch the marshmallows.

**Conclusion**: From the tests we took we got an idea of how long it would take to launch 5 marshmallows in less than a minute. We learned that we can take more time and we don’t need to rush the launching process, as long as it is under a minute we will be alright.

Test 3

**Purpose/Problem**: How accurate is the MLS after launching 5 marshmallows consecutively in one minute?

**Hypothesis**: If we run three tests of launching 5 consecutive marshmallows each in a minute, then all of the marshmallows launched by the MLS will be within 1 foot of the centerline.

**Procedures**: Step 1: Diane handed Katie 1 marshmallow, and began to time the

marshmallow launching process.

Step 2: Katie pulled back the sling and hooked it onto the lever.

Step 3: Katie then placed the marshmallow onto the platform

and pressed down on the lever to release the marshmallow

launcher.

Step 4: Katie and Diane repeated the process 4 more times.

Step 5: After finishing the launching procedure, Diane,

Sunni, and Katie took measurements from the start line

(front of MLS) to the place of landing.

\* Diane, Sunni, and Katie each operated the marshmallow launcher 1 of the three tests \*

**Data**: Date: January 15, 2002

-Test 1- -Test 2- -Test 3-

1. 1’-11” 1. 2’-5” 1. 7.5”

2. 2’-9” 2. 4’-7” 2. 8”

3. 11” 3. 1’-7” 3. 2’

4. 2’-7” 4. 3’-11” 4. 2’-2”

5. 9” 5. 4’-8” 5. 2’-3”

-Avg. accuracy-

1’-7” 3’-4” 1’-6.5”

**Analysis**: We need to work on accuracy but distance and time meet the requirements. Test two was definitely where we were hurt the most. Test three was the best test for accuracy, and test two was the worst.

**Conclusion**: From the tests we found the more of the above variables we can eliminate the more accurate our launcher will be. Time also has something to do with it. The more rushed we were the more off-center it was.

**Appendix B** (Accounting)

|  |  |  |
| --- | --- | --- |
| parts list | | |
| Part # | Item | Quantity/Cost |
| N101-162 | Gate Latch | 1/ $5.59 |
| BMW-012 | 6’ Shock Cord | 1/ $3.54 |
| BMW-001 | 10” 5/16 OD Stainless Steel Tubing | 1/ $4 |
| BMW-002 | 1’4” 1x1/8 Wall Square Tubing | 2/ $4.50 |
| BMW-003 | 4’ 2x2x1/8 Wall Square Tubing | 1/ $12 |
| BMW-004 | 10” 1 ¼ SCH 80 Black Pipe ASME-4-53 Grade b | 1/$2.00 |
| BMW-005 | 10” ¾ in SCH 40 Black Pipe ASME-A-53 Grade B | 2/$1.35ea. = 2.70 |
| BMW-006 | 5x5x3/8” Steel Plate | 1/$3.12 |
| BMW-007 | 2x2x1/8 Angle Iron | 1/$1.70 |
| BMW-008 | 2’x6” PVC Plastic | 1/$1.00 |
| BMW-009 | ¼”NCx½ Cap Screws w/ Locking Nuts | 4/$2.00 |
| BMW-009 | 1/8”x4” Nylon Tie Straps | 4/ 10 for $5.00 |
| BMW-010 | 1’of 2” Duck Tape | 1 ft./ roll for $7.00 |
| BMW-011 | Stabilizer Pins (feet) 3/8” | 4/ bolts=. 79 ea.,  nuts = .29ea.  Combined =$4.00 |
| BMW-013 | 10X6” | 2/ 6’=$.79 |

Labor Hours:

Katie Williams- Testing- 4 hours 30 minutes

Building- 0 hours

Designing- 2 hours

Presentation- 6 hours 10 minutes

Advertising- 1 hour

Typing- 2 hours

Total time- 15 hours 40 minutes

Sunni Beaman- Testing- 4 hours 30 minutes

Building- 0 hours

Designing- 0 hours

Presentation- 3 hours

Advertising- 30 minutes

Typing- 4 hours 45 minutes

Total time- 12 hours 45 minutes

Diane McKenney- Testing- 6 hours 30 minutes

Building- 6 hours

Designing- 6 hours 20 minutes

Presentation- 6 hours 10 minutes

Advertising-1 hour

Typing- 1.5 hours

Total time- 28 hours 30 minutes

Skill Levels:

Katie- Designing, powerpoint, typing, etc…

Sunni- Launching, testing, typing, etc…

Diane- Designing, building, testing, etc…