Rocketcam Air Cannon

Rapid Fire Air Mortar System for the Really Cool Engineering Co.

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MET 400 Mechanical Design CAPSTONE, Fall 2019
Professor Tim R. Cooley, PE, "CEO"

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Overview

Build an improved pneumatic air cannon to launch a 3D printed rocket containing a GoPro camera.

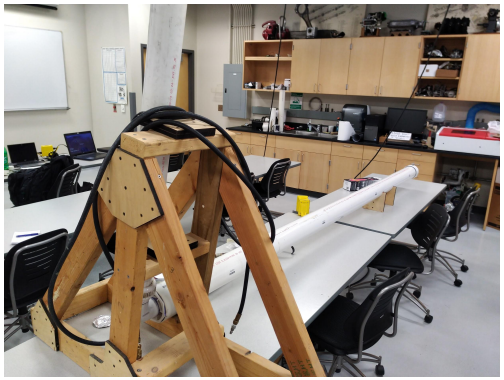
- MAKE IT PORTABLE
- MAKE FIRING MECHANISM PREDICTABLE
- RELOAD FASTER
- DESIGN FOR MASS PRODUCTION

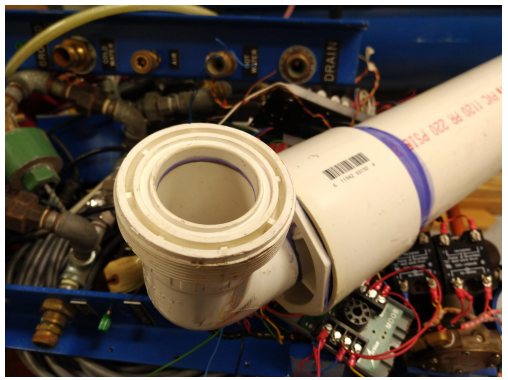
Project Constraints

- **SCOPE**
  - make portable
  - make firing predictable
  - make firing faster
  - design for mass production
- **COST**
  - Budget $1000
- **SCHEDULE**
  - Normal semester 16 weeks.
  - First project "killed" after only 6 weeks by "CEO".
  - **Leaving only 8 weeks (1/2 the time)** to Design, Prototype, Test, Build, and Refine.

OLD Pneumatic Cannon

- **NOT PORTABLE**
  Two people needed to move, heavy, and length of a small car.
- **UNPREDICTABLE FIRING MECHANISM**
  Aluminum foil discs fail at unpredictable pressures.
- **SLOW RELOAD**
  Takes 5 to 10 minutes.
- **NOT DESIGNED FOR MASS PRODUCTION**





NEW Rocketcam Air Cannon

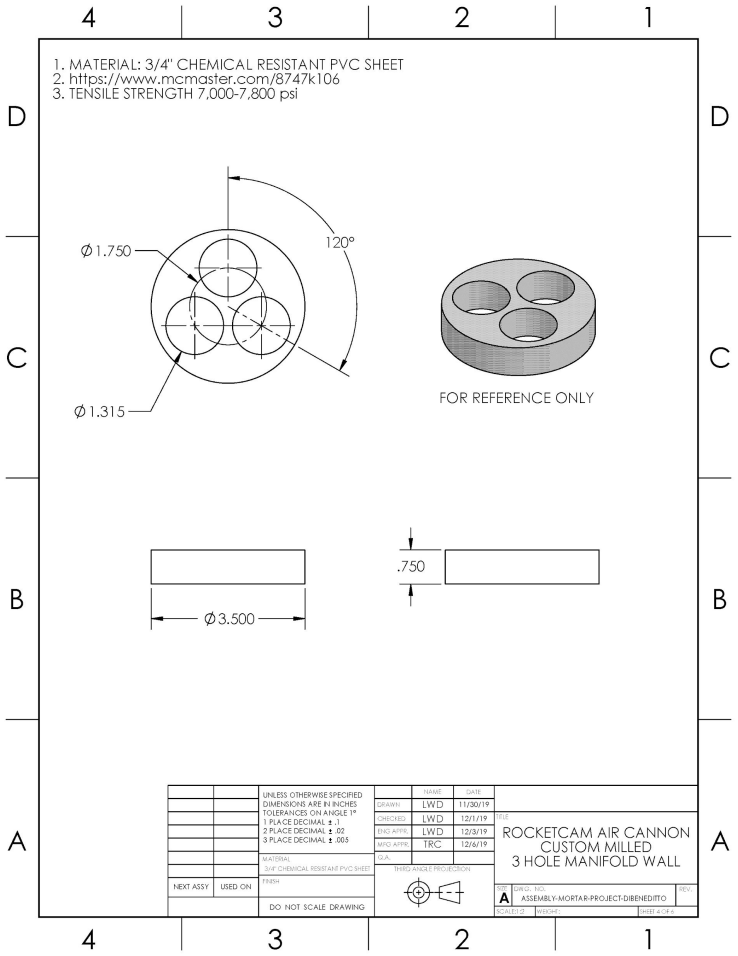
Designed, Prototyped, Tested, Built, Refined

- ✓ **PORTABLE**
  - ✓ 1 person carry
  - ✓ 1/4 the **weight**
    75% improvement
  - ✓ 2 ft² **footprint**
    80% improvement
- ✓ **REDICTABLE FIRING MECHANISM**
  - ✓ Will not fire until trigger is pulled
  - ✓ **Adjustable pressure**
- ✓ **RAPID FIRE**
  - ✓ Reload and fire in under 15 seconds
    98.5% improvement
- ✓ **DESIGNED FOR MASS PRODUCTION**

NEW Rocketcam Air Cannon Design for Mass Production

Designed, Prototyped, Tested, Built, Refined

- Sell machined part online
- CAD Drawing Package "Plans to Build" can be sold online to mitigate liability with pressure vessel certification.
- .75 in Chemical Resistant PVC
- 1000 psi tensile strength
- 1.5 Hours Machine Shop time Setup $112.50
- 10 Minutes per part
- Volume Pricing <$15/part total
- Sell for >$40/part total



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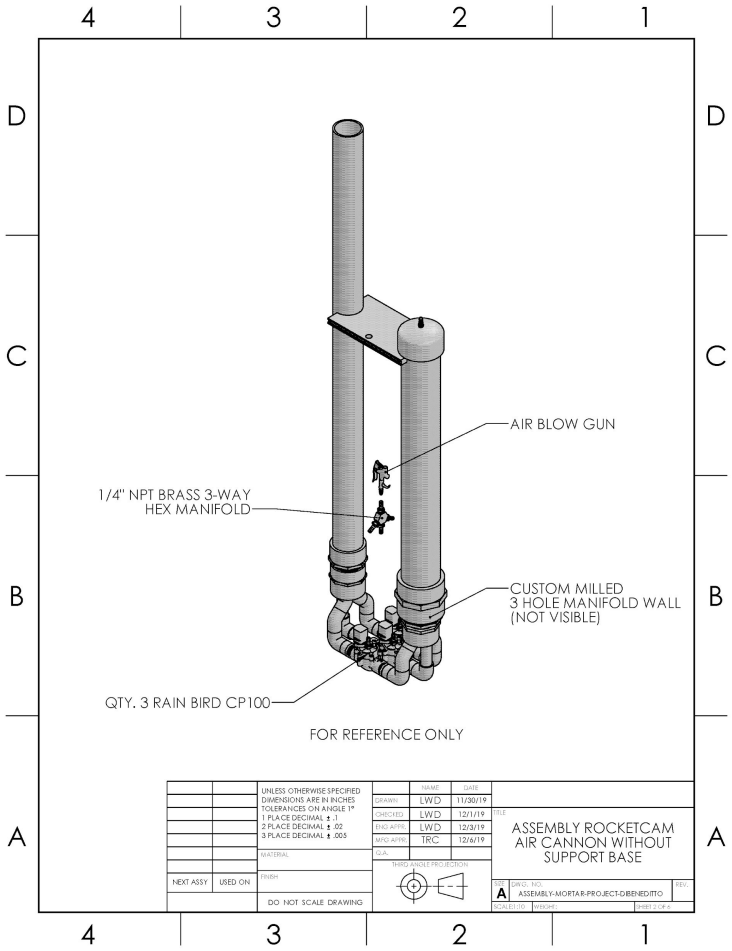
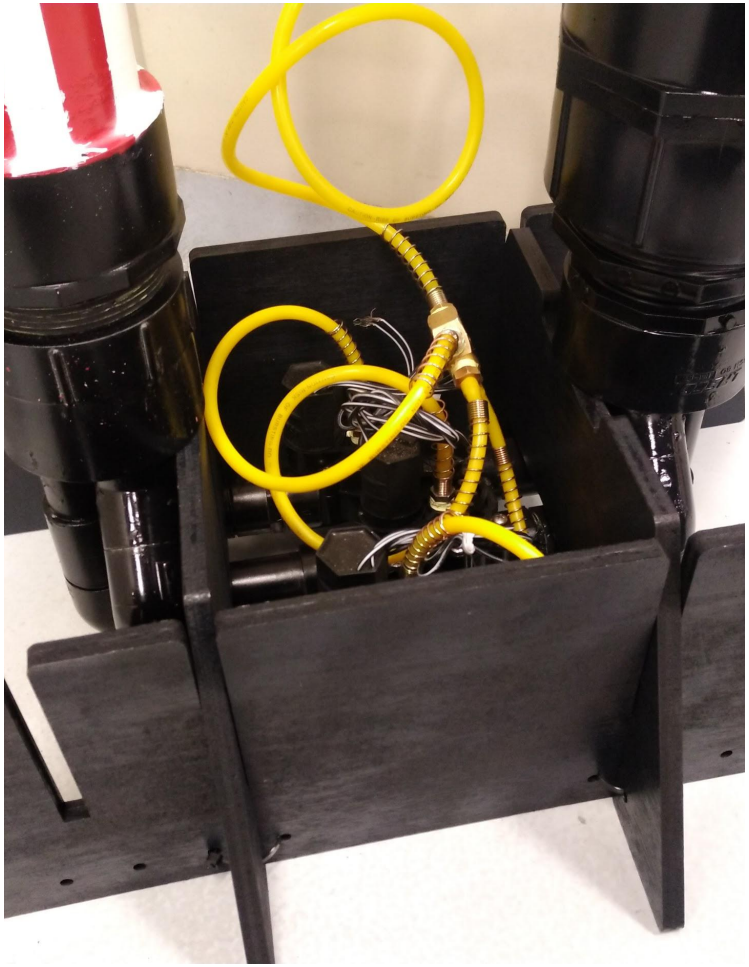
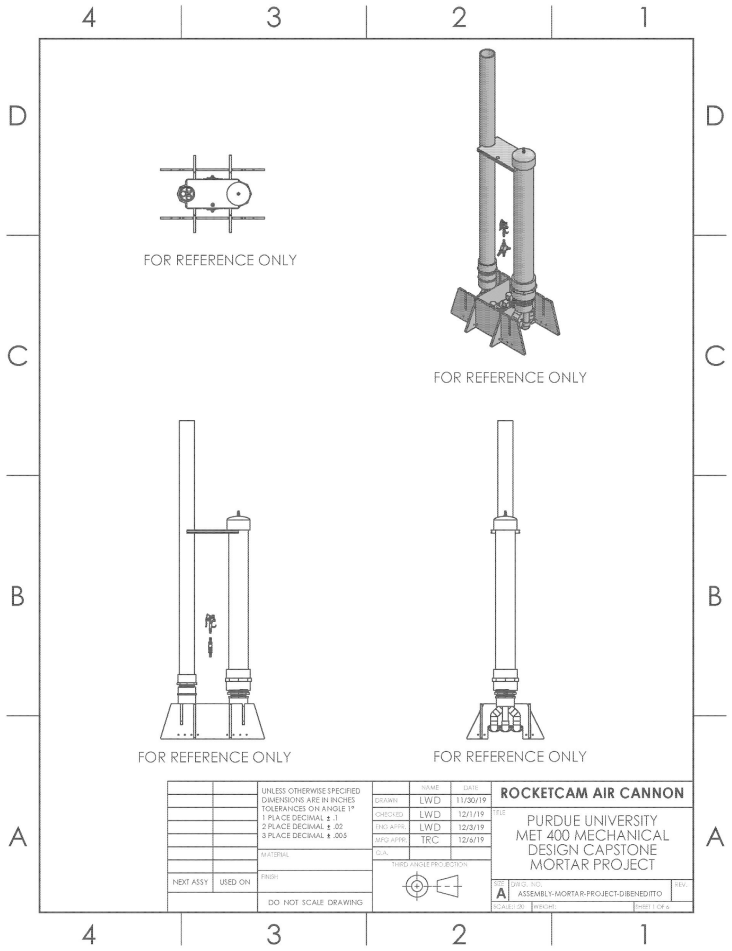
NEW Rocketcam Air Cannon Photos

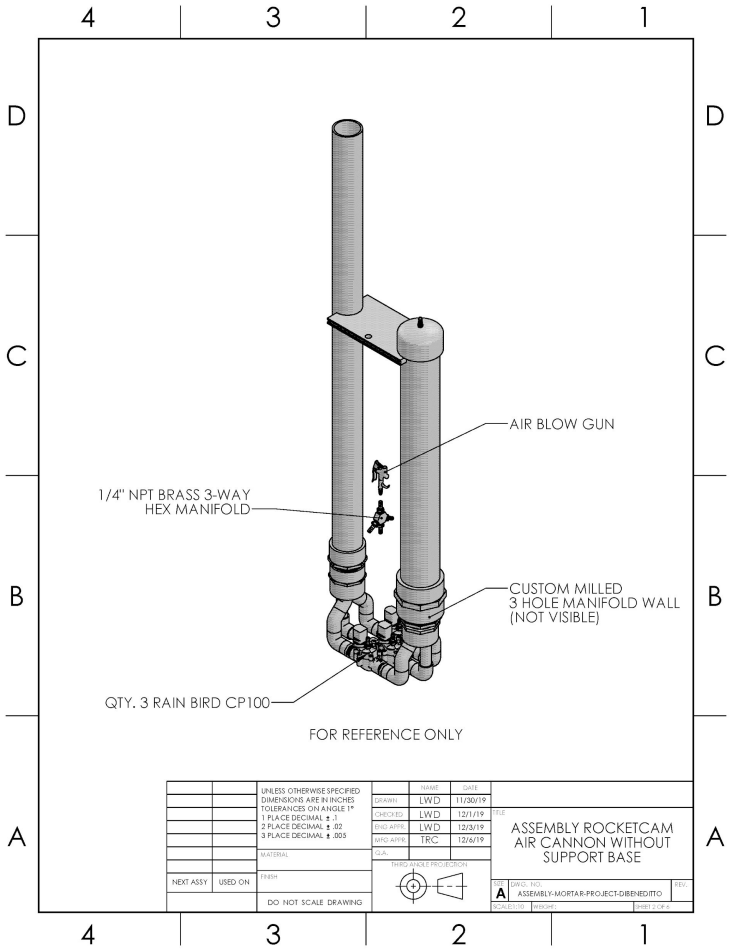


NEW Rocketcam Air Cannon Photos



NEW Rocketcam Air Cannon CAD Drawings





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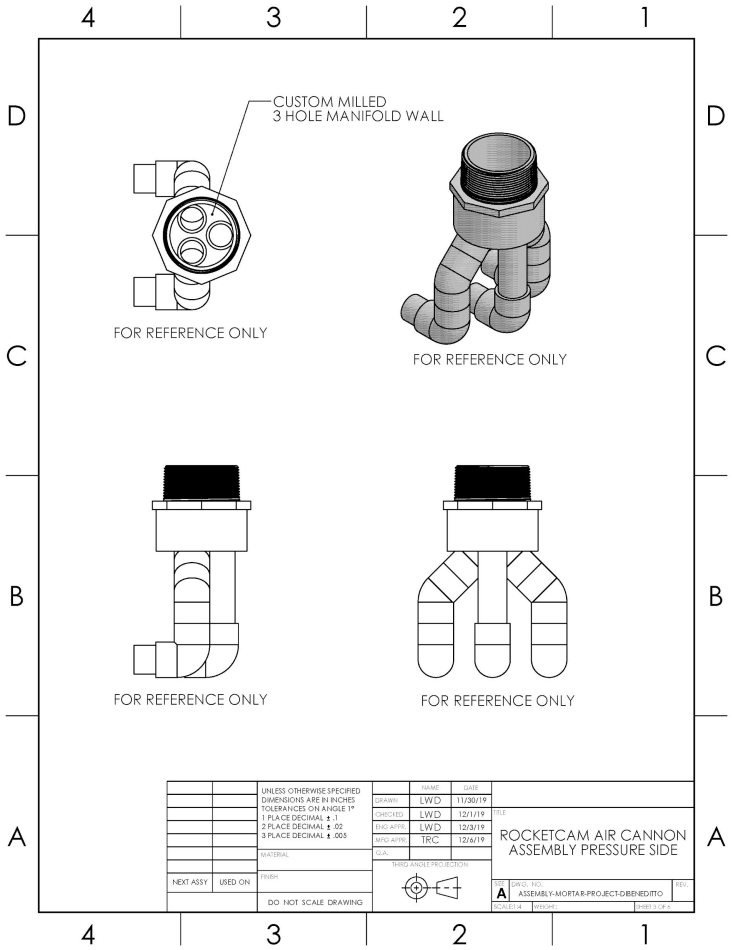

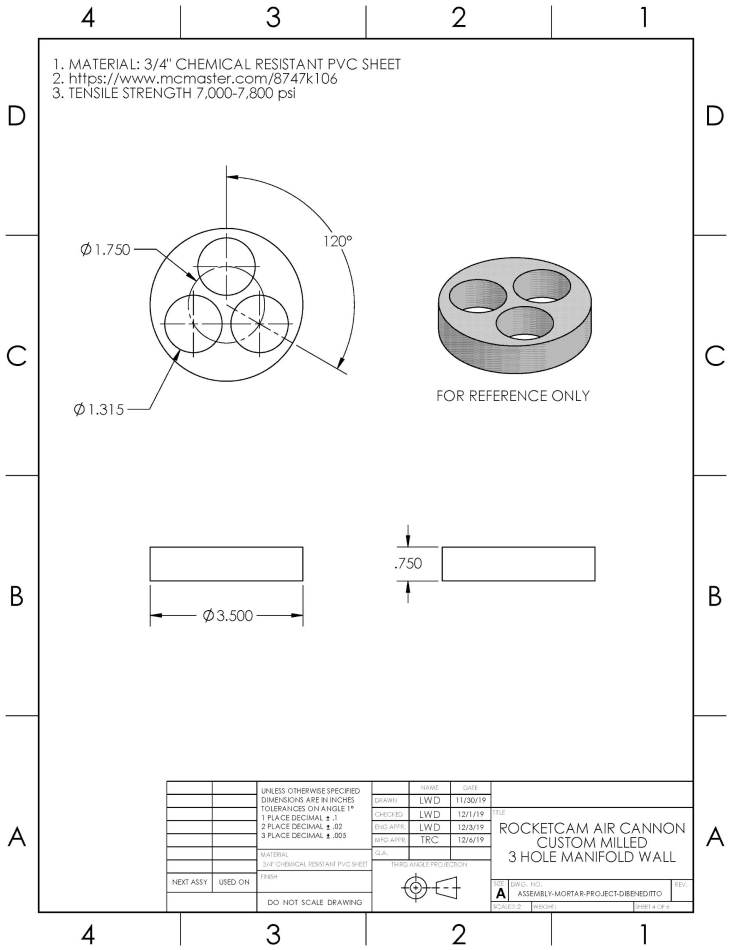

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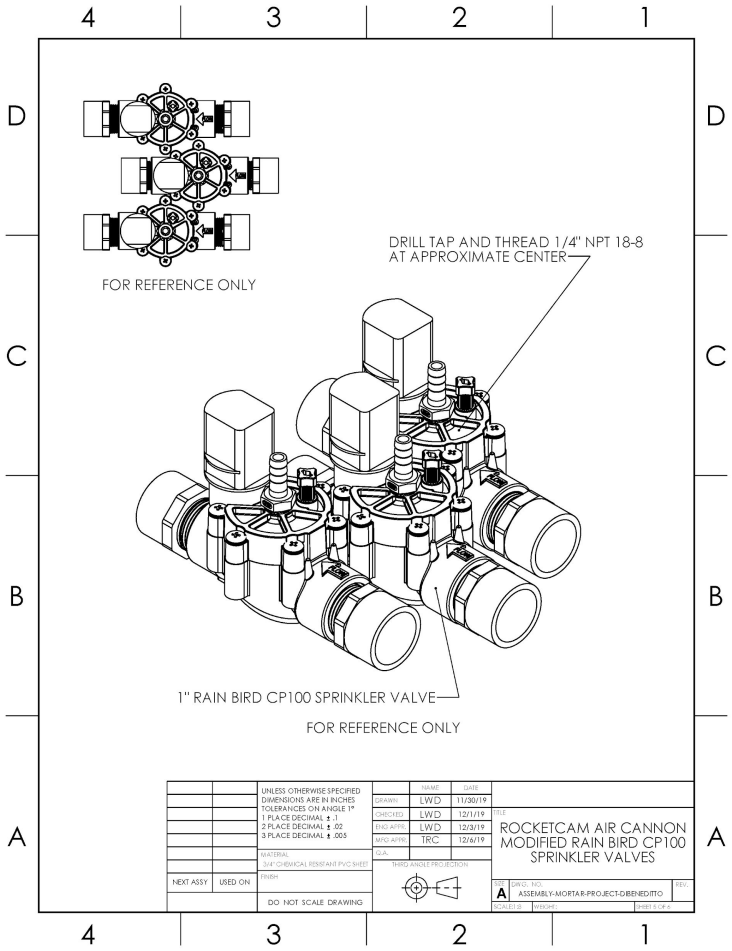

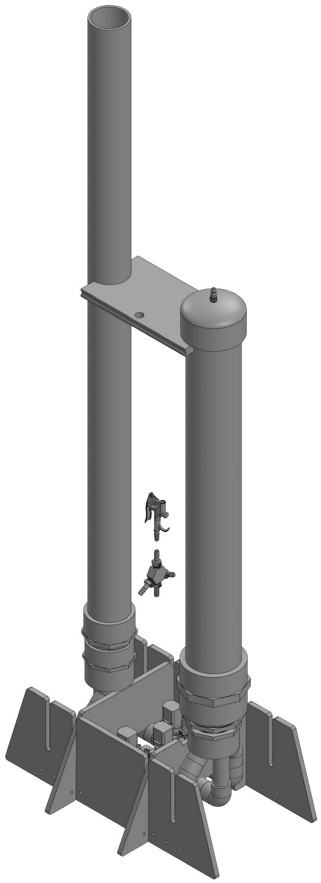

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Team Members & Responsibilities

LUKAS – Research, Experimental Design, Testing, Computer Networking, After Hours Lab Key Card Access, Arduino Intra-Team Consultation, Arduino C++ Programming, Soldering, Electronic Circuit Design, Pressure Sensor System Implementation, Financial Procurement, Purchasing, Accounts Reconciliation, Safety Validation, Welding, Laser Operation, Machine Shop Coordination, Pressure Vessel Validation, Manifold System Design, AutoCAD 2D CAD, SOLIDWORKS 3D CAD, Graphic Design, Paint Prep, Paint, Hardware Assembly, Video editing, 7 Prototypes, and Project Management

JOE – Research, Experimental Design, Testing, Pressure Sensor System Implementation, Financial Procurement, Purchasing, Financial Accounts Reconciliation, Lathe Operation, Hardware Assembly, Pressure Vessel Validation, Piston Valve System, Launch Angle Device Prototype, 7 Prototypes, and Project Management

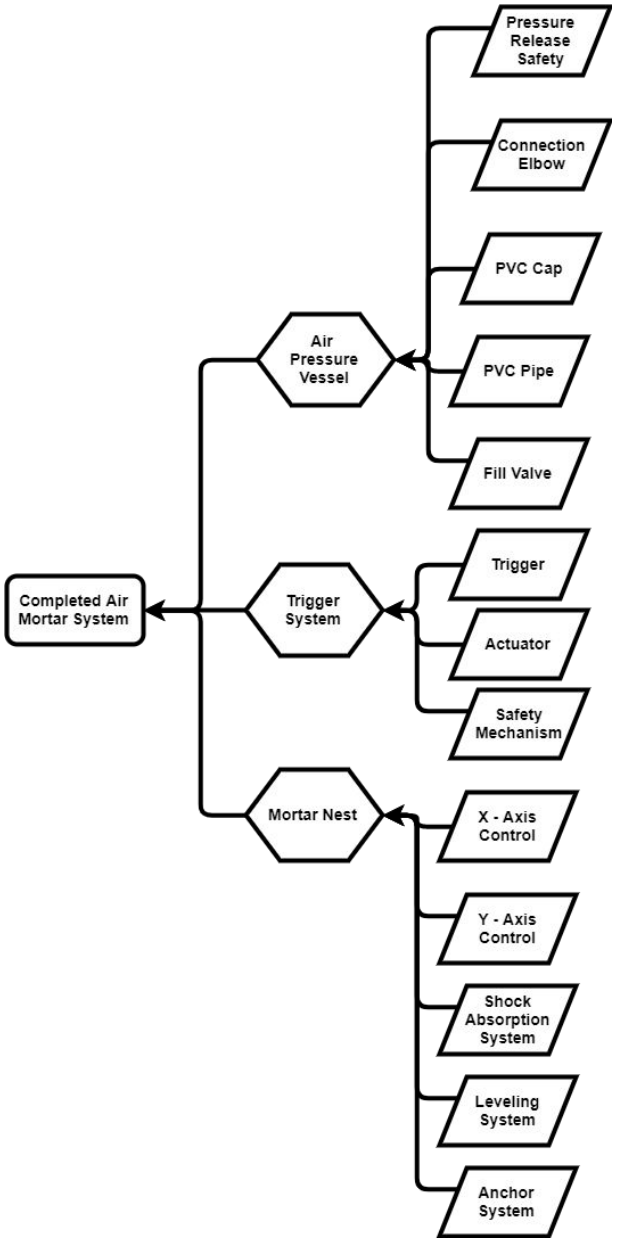
Major Project Deliverables

- System design with smaller footprint
- Trigger system that offers faster reload time
- Package system for quick setup & disassembly
- Launching base to provide support against recoil

Major Issues Encountered ➜ Resolutions

- Lack of accurate pressure test
  - ➜ Arduino pressure test system
- Sprinkler valve restriction
  - ➜ Shift to manifold system & piston valve
- Piston valve malfunction
  - ➜ Smaller system trial
- Parts order and procurement
  - ➜ Understand intercompany ordering process

Original Product Breakdown Structure



Final Costs

- Testing Subtotal: $246.42
- Build Subtotal: $636.11
- Total Cost: $882.53
- **11.75% Under Budget**

Lots and lots of paperwork!!!

Sprinkler Valve Speed

1 inch black rain bird valve electrically actuated	
Test	Time (ms)
30	288.408
31	273.872
32	200.256
34	178.328
35	178.248
Sample size (n)	5
Sample mean (average, x bar)	223.8224
Median	200.256
Sample standard deviation	53.33480047
	223 ± 53 ms

1 inch green orbit valve electrically actuated	
Test	Time (ms)
26	114.832
27	208.928
28	134.552
29	122.232
Sample size (n)	4
Sample mean (average, x bar)	145.136
Median	128.392
Sample standard deviation	43.29882967
	145 ± 43 ms

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Pneumatically Actuated Sprinkler Valves (**without flow control**) are Fast! 51 ± 3 ms (51/1000th of a second)

1 inch black rain bird valve pneumatically actuated	
Test	Time (ms)
36	46.576
37	51.344
38	54.736
39	51.344
40	51.344
41	51.512
42	53.216
Sample mean (average, x bar)	51.0688
Median	51.344
Sample standard deviation	2.909502225
	51 ± 3 ms

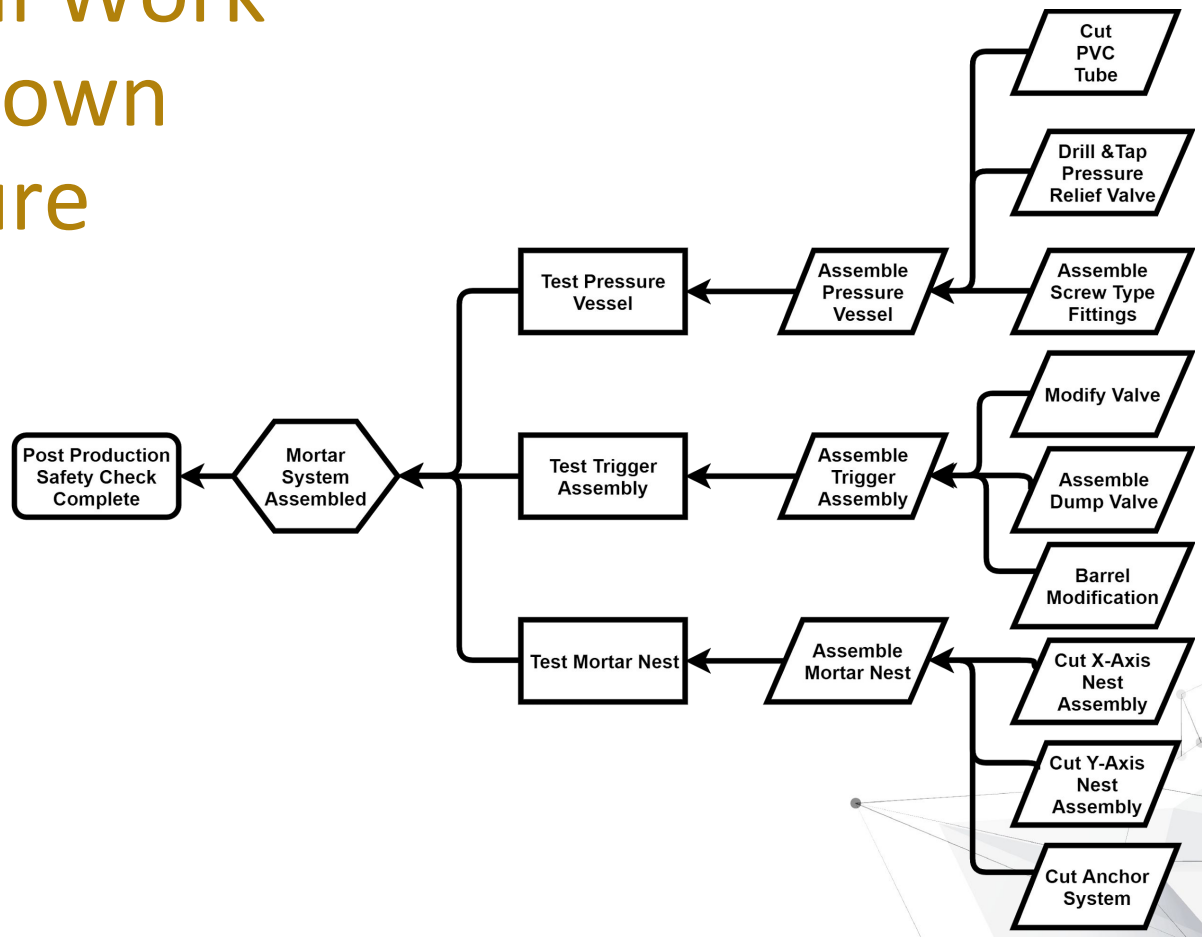
Performance Test Results

Test	1	2	3	4
Projectile	Water Bottle	Water Bottle	Water Bottle	Rocketcam
Wadding	Paper Towels	Paper Towels	Shop Rag	None
Weight (oz)	16.9	16.9	16.9	8
Pressure Vessel (PSIG)	35	85	95	95
Time of Flight (s)	7.040	9.481	7.513	11.108
Angle of Launch	85	85	85	85
Initial Velocity (mph)	77.5127	104.3889	82.7206	122.3027
Initial Velocity (ft/s)	113.685	153.104	121.324	179.377
Maximum Height (ft)	199.3	361.5	227	496
Distance (ft)	69.8	126.5	79.4	173.7

Pressure Vessel	
Inside Diameter (in)	3.786
Inside Diameter (ft)	0.3155
Length (in)	36
Length (ft)	3
Volume (ft^2) = π * h* $(D/2)^2$	0.2345

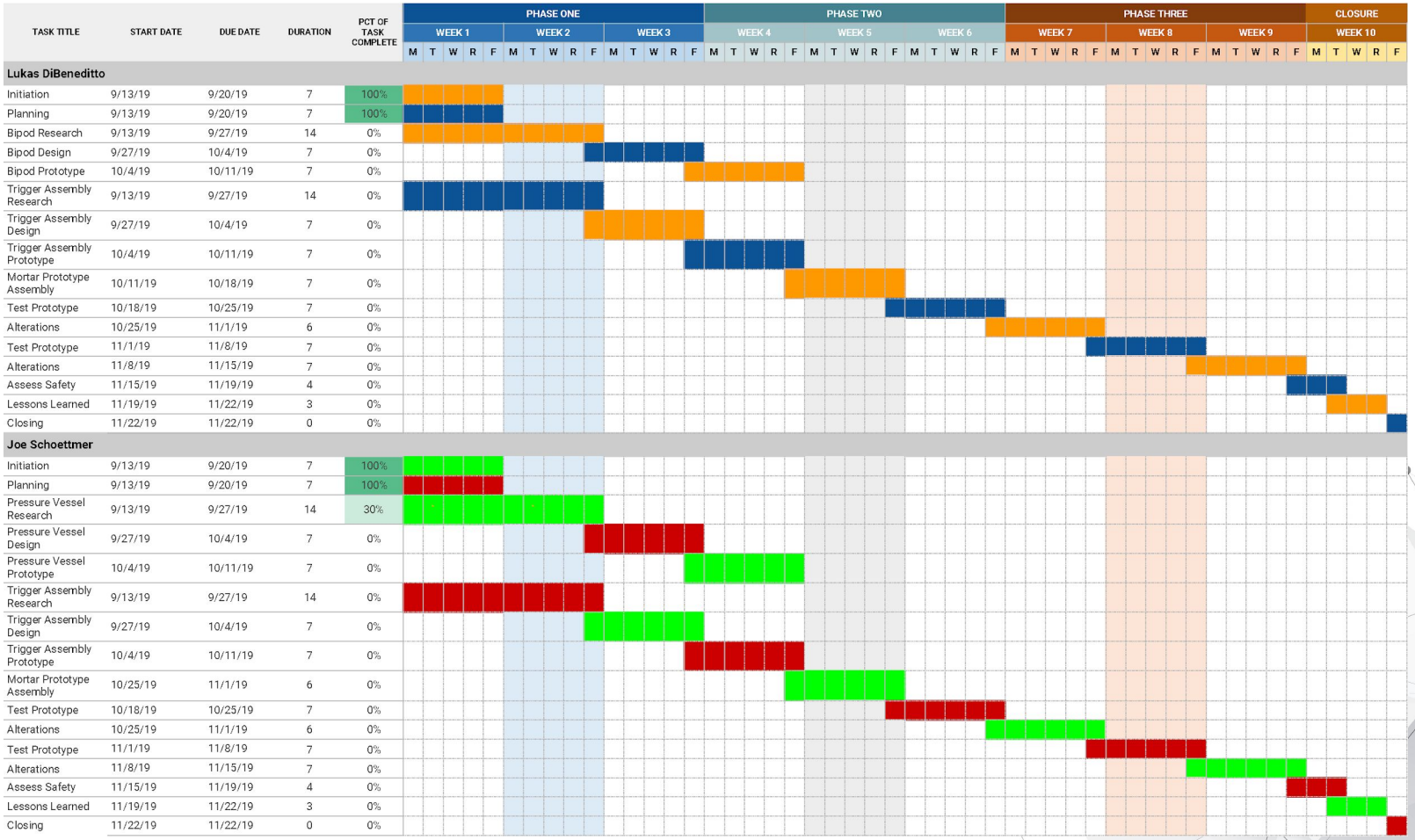
Cannon (PSIG)	
Cannon Length (in)	60
Cannon Length (ft)	5

Original Work Breakdown Structure



Gantt Chart

PROJECT NAME	Better Air Mortar System	**COMPANY NAME**	The Really Cool Company
PROJECT MANAGER	Tim Cooley	**DATE**	9/13/19



TASK TITLE	START DATE	DUE DATE	DURATION	PCT OF TASK COMPLETE
Lukas DiBeneditto				
Initiation	9/13/19	9/20/19	7	100%
Planning	9/13/19	9/20/19	7	100%
Bipod Research	9/13/19	9/27/19	14	0%
Bipod Design	9/27/19	10/4/19	7	0%
Bipod Prototype	10/4/19	10/11/19	7	0%
Trigger Assembly Research	9/13/19	9/27/19	14	0%
Trigger Assembly Design	9/27/19	10/4/19	7	0%
Trigger Assembly Prototype	10/4/19	10/11/19	7	0%
Mortar Prototype Assembly	10/11/19	10/18/19	7	0%
Test Prototype	10/18/19	10/25/19	7	0%
Alterations	10/25/19	11/1/19	6	0%
Test Prototype	11/1/19	11/8/19	7	0%
Alterations	11/8/19	11/15/19	7	0%
Assess Safety	11/15/19	11/19/19	4	0%
Lessons Learned	11/19/19	11/22/19	3	0%
Closing	11/22/19	11/22/19	0	0%
Joe Schoettmer				
Initiation	9/13/19	9/20/19	7	100%
Planning	9/13/19	9/20/19	7	100%
Pressure Vessel Research	9/13/19	9/27/19	14	30%
Pressure Vessel Design	9/27/19	10/4/19	7	0%
Pressure Vessel Prototype	10/4/19	10/11/19	7	0%
Trigger Assembly Research	9/13/19	9/27/19	14	0%
Trigger Assembly Design	9/27/19	10/4/19	7	0%
Trigger Assembly Prototype	10/4/19	10/11/19	7	0%
Mortar Prototype Assembly	10/25/19	11/1/19	6	0%
Test Prototype	10/18/19	10/25/19	7	0%
Alterations	10/25/19	11/1/19	6	0%
Test Prototype	11/1/19	11/8/19	7	0%
Alterations	11/8/19	11/15/19	7	0%
Assess Safety	11/15/19	11/19/19	4	0%
Lessons Learned	11/19/19	11/22/19	3	0%
Closing	11/22/19	11/22/19	0	0%

PHASE ONE: WEEK 1, WEEK 2, WEEK 3
PHASE TWO: WEEK 4, WEEK 5, WEEK 6
PHASE THREE: WEEK 7, WEEK 8, WEEK 9
CLOSURE: WEEK 10
M T W R F M T W R F M T W R F M T W R F M T W R F M T W R F M T W R F M T W R F M T W R F M T W R F

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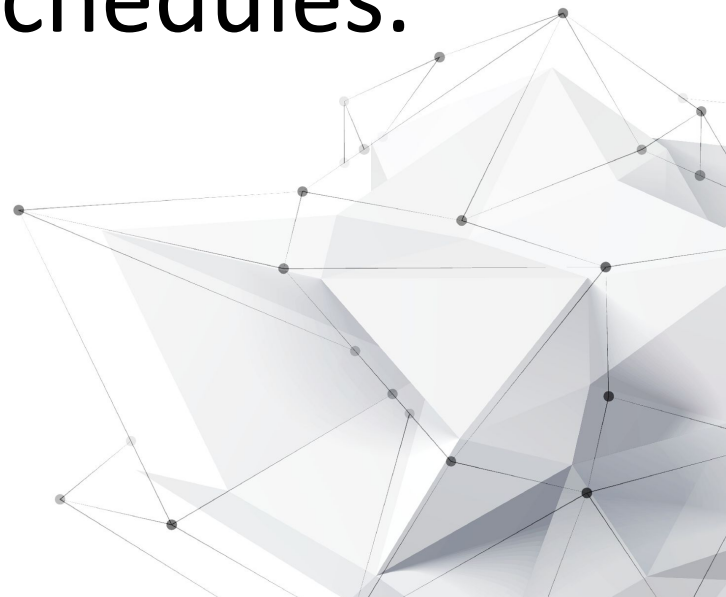
Risk Matrix

Priority	Symptoms	Triggers	Responses
1	Unsuccessful Test of Trigger Mechanism	Missed Deadline	Team Discussion, Present Manager With Alternatives
2	Leaks Between Joints	Unable to Maintain Pressure	Disassemble, Inspect and Add Teflon or Other Components, Discuss with Team, Add In Manager If Necessary
3	Quickly Draining Budget	Budget Depleted to 25%	Team Discussion, Present Manager w/ Alternative Funding
4	Slow Reaction Time for Evacuation	Mortar Unable to Achieve Acceptable Lift	Redesign Trigger in Parallel with Team Discussion, Followed By Discussion With Manager
5	Launch Recoil Support Ineffective	Damage Noted to System	Team Discussion, Followed By Discussion With Manager

The Following Images and Photographs...

Represent all the design, testing, fabrication, and refinement we did with **7 prototypes each, in 1/2 the time** of a normal semester even with full time Engineering school class schedules.



NEW Rocketcam Air Cannon

Designed, Prototyped, Tested, Built, Refined

- ✓ TURNED IN EARLY
- ✓ UNDER BUDGET
- ✓ SOLVED ALL DESIGN CHALLENGES
- ✓ EXCEEDED ALL EXPECTATIONS

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