



# A.E.R.O.

Arduinos  
Engineering  
Rockets  
Observations

Kids Did Built Rockets!  
<https://rocket.schnitter.net>

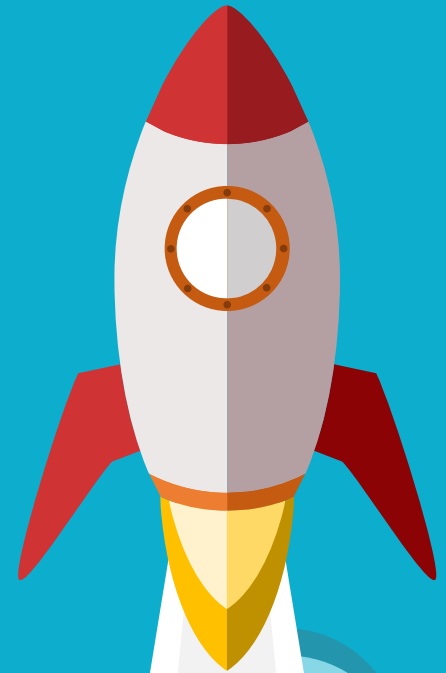
Presented By: Benny Penote  
David Schnitter  
Sam Parker  
Ryan Schnitter  
Mark Schnitter (helped a little too)



“We choose to do these things not because they are easy, but because they are hard.”  
- President John F. Kennedy

# Overview of Project

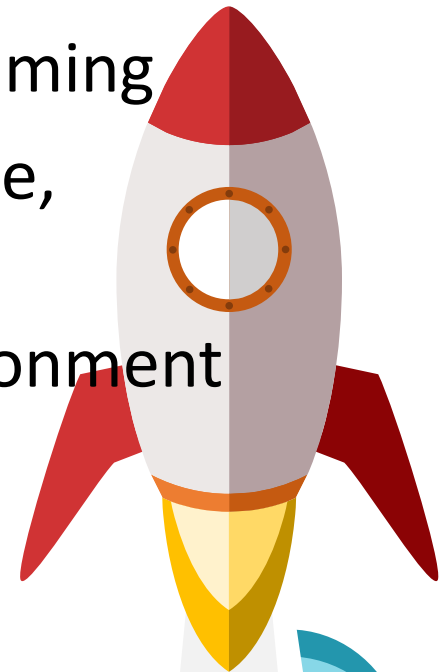
- Purpose / Why do this
- A Little About Rocket Physics
- The Arduino
- Building and Testing Rockets
- Results
- What We Learned



“Do not fear mistakes. You will know failure. Continue to reach out.”  
- Benjamin Franklin

# Purpose

- Rockets Are Cool!
- Learn About Rocket Physics and Programming
- Arduino as a Telemetry Collector (Altitude, Acceleration, and Temperature)
- Running an Arduino in a Real-Time Environment
- Doing Fun Summer Project



*"Success consists of going from failure to failure without loss of enthusiasm."*  
- Winston Churchill

# But First... Some Rockets...

Play LaunchSlides

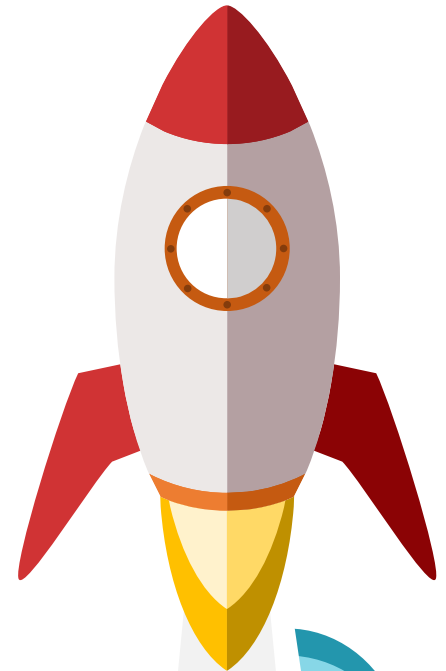


LaunchSlides-WEB.mp4

Play Launches



Launches-WEB.mp4



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# Rocket Physics

- Newton's Three Laws

1. Objects at rest will stay at rest, or objects in motion will stay in motion unless acted upon by an unbalanced force.
2. The acceleration of an object is directly related to the force exerted on the object and oppositely related to the mass of that object. ( $A = F/m$ )
3. For every action there is always an opposite and equal reaction.

- How they apply to us

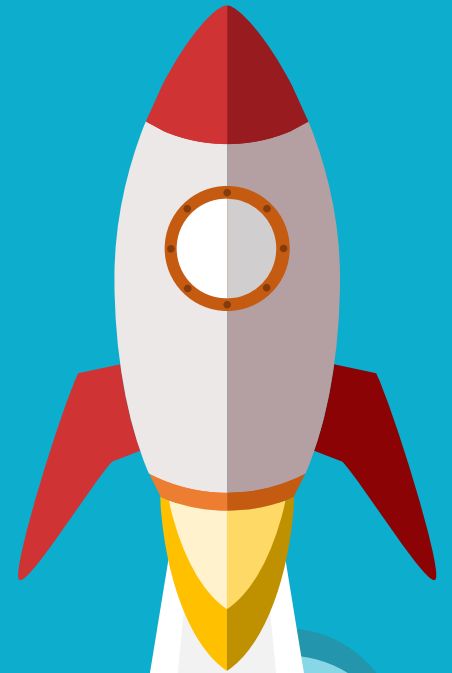
1. **1<sup>st</sup> Law** - A rocket will remain on the launch pad until a force is exerted, propelling the rocket upward.
2. **2<sup>nd</sup> Law** - The amount of force depends upon how much air is pumped inside the rocket. You can increase the force further by adding a small amount of water, which increases the mass expelled by the air pressure in the rocket.
3. **3<sup>rd</sup> Law** – The action force of the air (and water) as it rushes out of the nozzle creates an equal and opposite reaction force propelling the rocket upward.

“Success is the result of perfection, hard work,  
learning from failure, loyalty, and persistence.”

- Colin Powell

# Basic Rocket Flight Principals

- Nose Cones
  - Reduce drag of rocket while in flight
- Fins
  - Provides stability for rocket while in flight

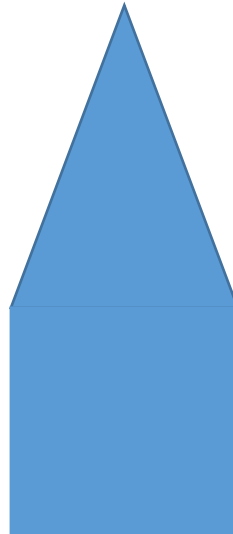


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# Nose Cones



Bullet or Parabolic



Cone



Blunt or Solid Cylinder



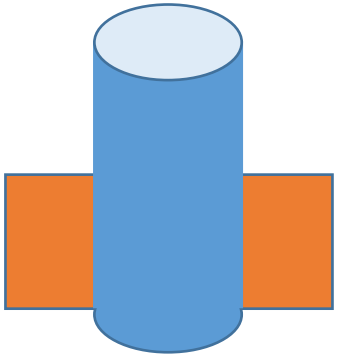
Low Drag

High Drag

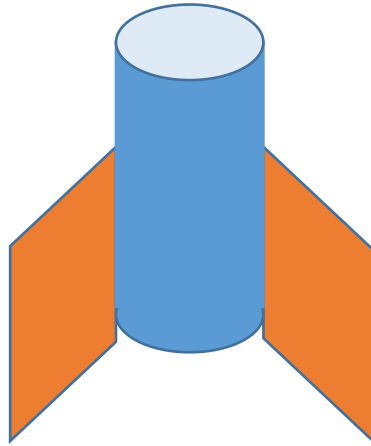
*"A house divided against itself cannot stand."*  
President Abraham Lincoln, June 16, 1858



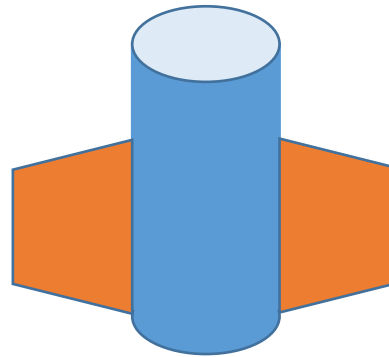
# Fins



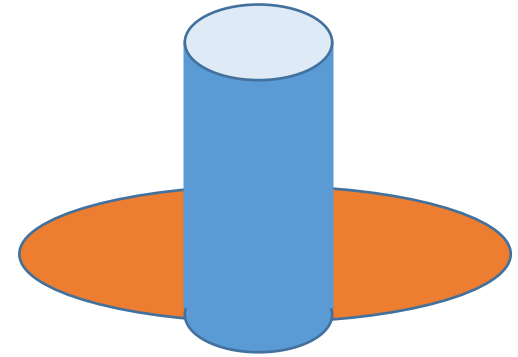
Straight



Swept



Trapezoidal



Rounded



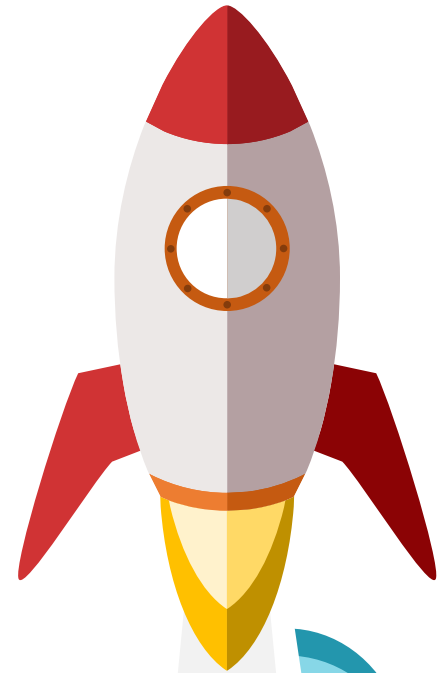
Very Stable  
High Drag

Less Stable  
Low Drag

"A house divided against itself cannot stand."  
President Abraham Lincoln, June 16, 1858

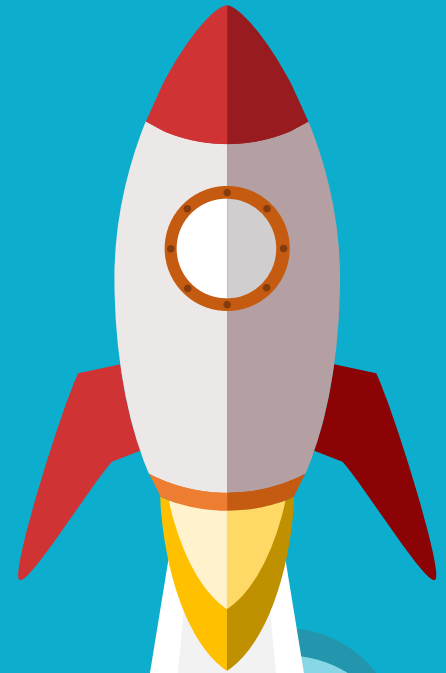
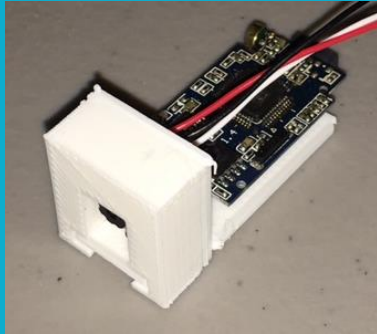
# AERO Teams

- Parachute Design and Construction
- Arduino Programming
  - Parachute Deployment
  - Data Collection (Altitude and Acceleration)
- Launch Pad and Rocket Construction
  - Nose Cone Testing
  - Fin Testing
  - Bottle Splice Testing
  - Electronics Testing
- Launching Rockets



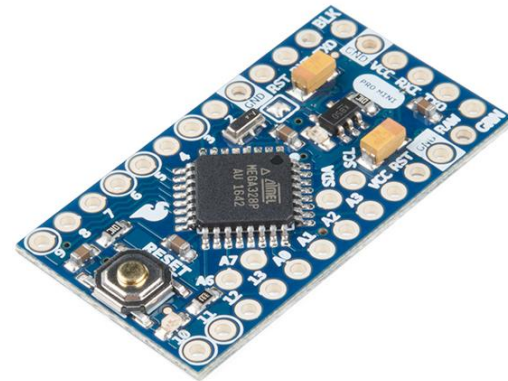
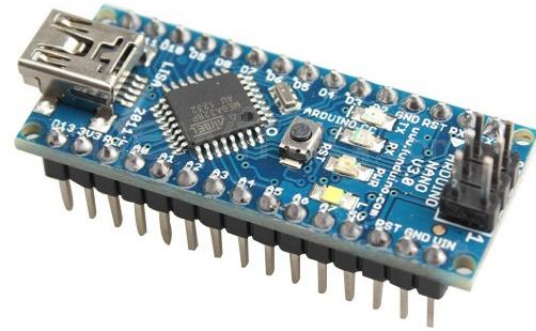
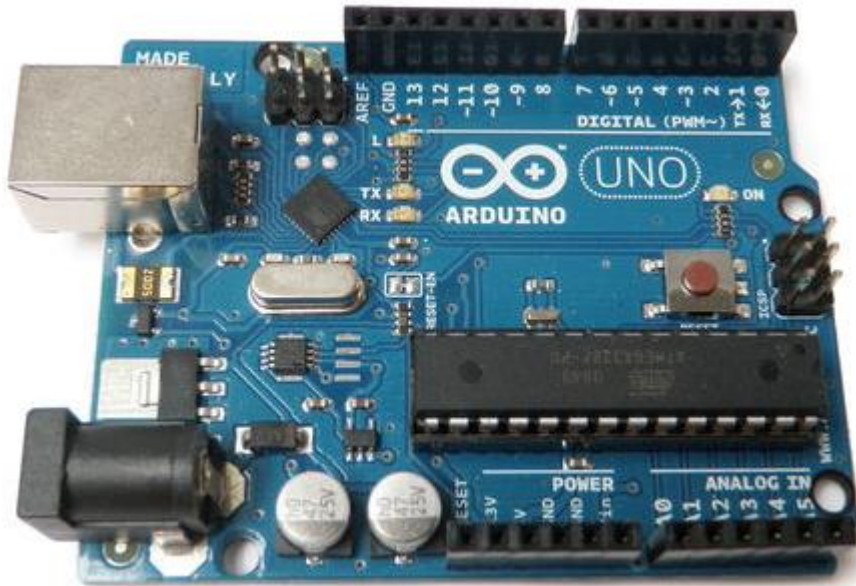
*"A house divided against itself cannot stand."  
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# Tools and Equipment



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Benjamin Franklin

# Arduinos

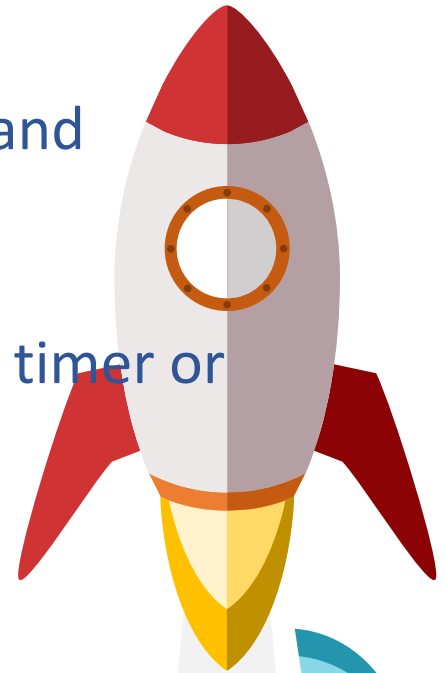


"It's fine to celebrate success but it is more important to heed the lessons of failure."

- Bill Gates

# Software Development

- Develop Software for Arduino to perform the following functions:
  - Capture and Record Altitude, Acceleration, and Temperature on SD Card
  - Detect Launch
  - Determine Parachute Deployment either by timer or detecting drop in altitude
  - Deploy Parachute
  - Alert Recovery Team of Rocket Location
  - Turn Onboard Camera On and Off
  - Reset Rocket for Next Launch



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# System Flow

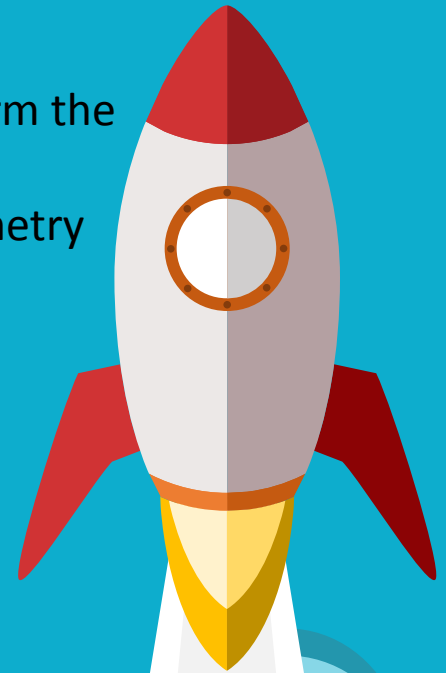
## Stages of Rocket Flight

1. **Ready**
2. Fueling – Water
3. Add Launch Clamp
4. **Ready for Launch / Arm the Rocket**
5. **Start Recording Telemetry**
6. Pressurize
7. Countdown
8. **Launch**
9. Ascent
10. **Deploy Parachute**
11. Descent
12. **Recover / Land**
13. **Reset**

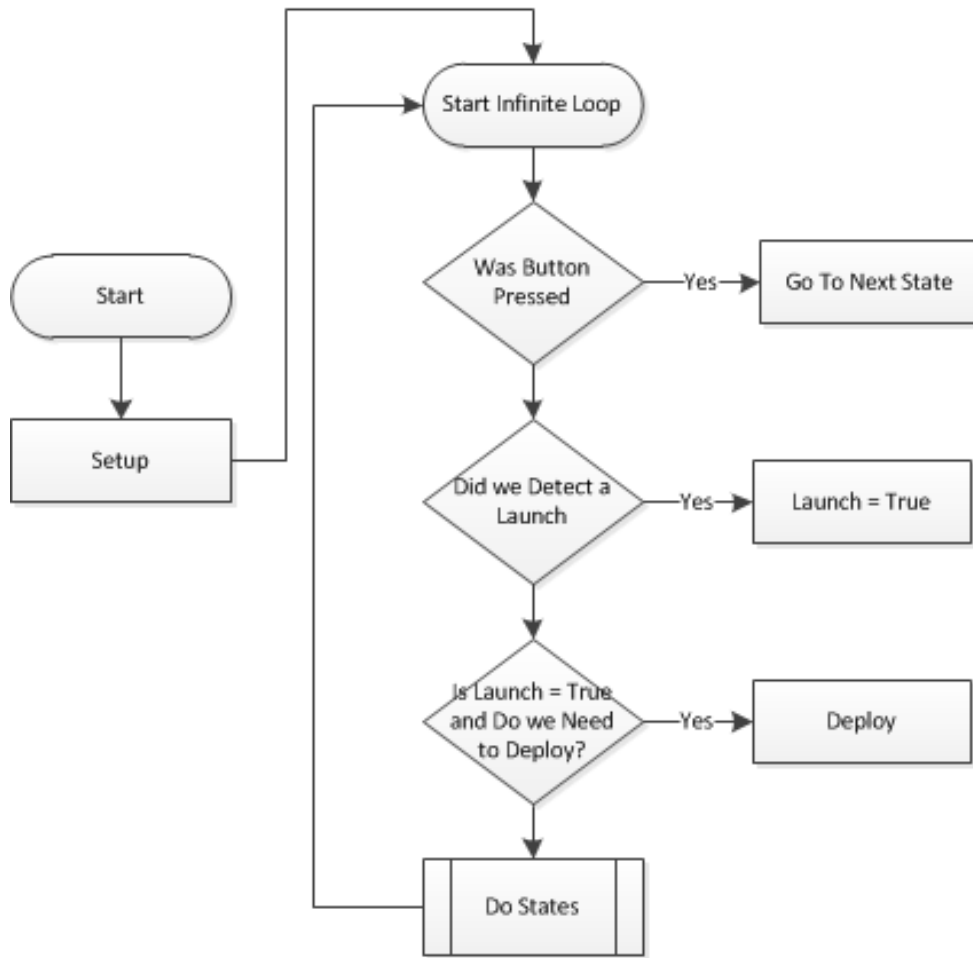
## Functions of Arduino

1. Ready
2. Ready for Launch / Arm the Rocket
3. Start Recording Telemetry
4. Detect Launch
5. Deploy Parachute
6. Recover / Land
7. Reset

- **The Stages of Rocket Flight were mapped to Functions of the Arduino**
- **The Functions of the Arduino became our programs**



# Program Flow



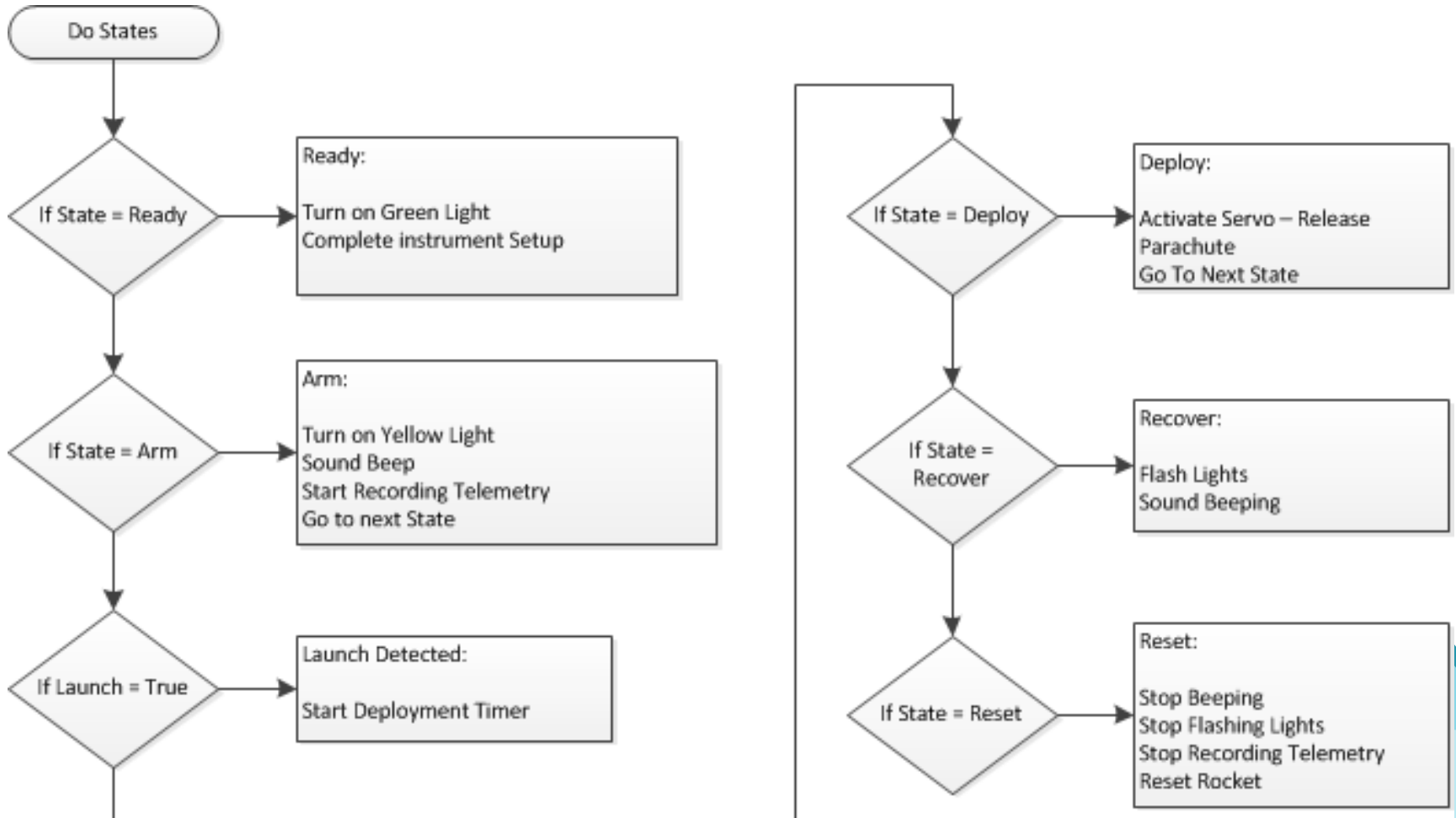
## Functions of Arduino

1. Ready
2. Ready for Launch / Arm the Rocket
3. Start Recording Telemetry
4. Detect Launch
5. Deploy Parachute
6. Recover / Land
7. Reset

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# Program Flow (cont.)



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# Arduino Programming

**pinMode(<pin number>, <OUTPUT / INPUT>);**

- Tell the Arduino how individual pins will behave, put voltage on a pin or detect voltage of a pin

**digitalWrite(<pin number>, <HIGH / LOW>);**

- Turns a pin either on (HIGH) or off (LOW)

**digitalRead(<pin number>);**

- Detect if a pin has voltage on it, returns either HIGH (ON) or LOW (OFF)

**delay(<milli seconds>);**

- Tells the Arduino to wait for x milliseconds

**tone(<pin number>, <frequency>);**

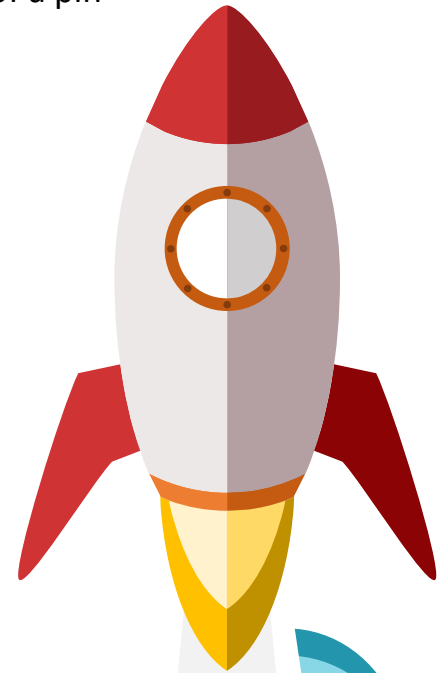
- Generates a specific frequency on the given pin

**noTone(<pin number>);**

- Turns off frequencies on the given pin

**servo.write(<position>);**

- Positions a Servo Motor to a specific position in degrees



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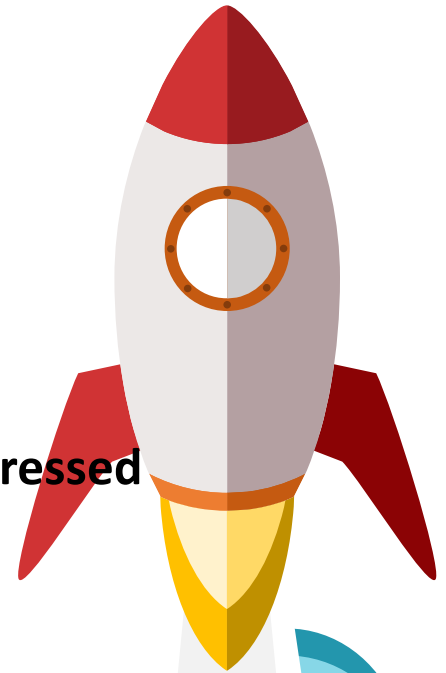
# Arduino Programming (cont.)

## Rocket Code Library:

- initRocket()** – Initialize the sensors on the rocket
- camera()** – Toggle camera on and off
- logdata()** – Retrieve and write data to SD Card
- deploy()** – Deploy Parachute
- recovery()** – Start beeping to find rocket
- resetToLaunch()** – Reset rocket back to “ready” state
- buttonPressed()** – Returns true if the command button was pressed

## Key Variables:

- STATE** – The current state of the rocket
- LAUNCHED** – Was the rocket launched



# Arduino Programming (cont.)

```
void loop() {  
  if ( buttonPress() ) STATE++;
```

```
  switch (STATE) {  
  case 0: // Programming Mode  
    CheckComm();  
    break;
```

```
  case 1: // Setup for Launch  
    ReadyLaunch();  
    break;
```

```
  case 2: // Ready for Launch  
    ArmRocket();  
    break;
```

```
  case 3: // Accent Stage  
    logdata();  
    break;
```

```
  case 4: // Deploy  
    deploy();  
    logdata();  
    break;
```

```
  case 5: // Recovery  
    logdata();  
    recovery();  
    break;
```

```
  case 6: // Reset to Ready  
    noTone(piezoPin);  
    camera();  
    resetToLaunch();  
    STATE=0;  
    break;  
  }
```

```
  if (LAUNCHED && millis() - deploytimer >= TimeDeployDelay && (STATE  
  == 2 || STATE==3)) {  
    STATE=4;  
    deploytimer = 0;  
  }
```

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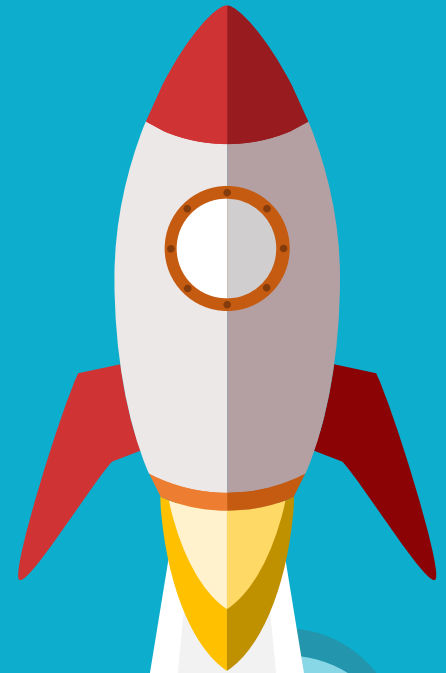
- Bill Gates

# Building and Testing Rockets

Play Build Video



Build Video-WEB.mp4



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# What We Learned

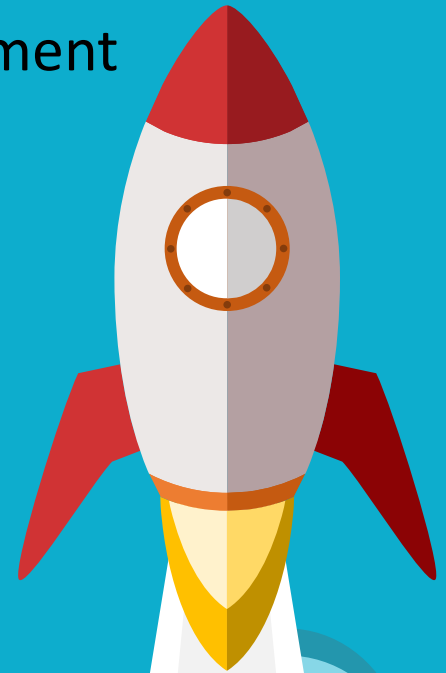
- How Rockets Work
- Basic Electronics
- Software Development Techniques
- Programming in 'C'
- Problem analysis using video, audio, and good note taking
- Through Failures we find Success



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# Challenges

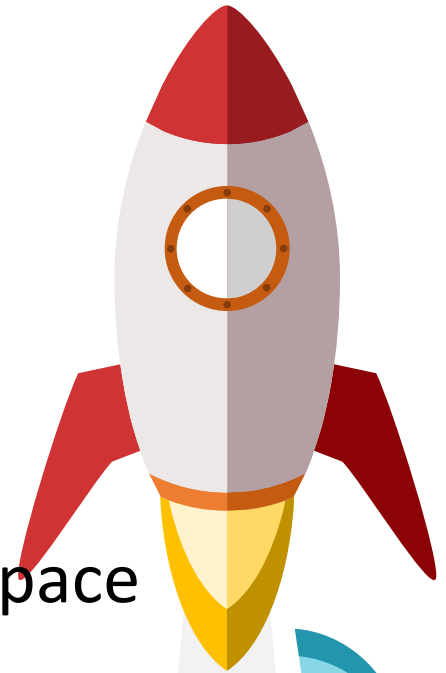
- Exploding bottle splices
- Powering the Arduino, failed Parachute Deployment
- Finding a Workable Altitude Precision
- Parachute Deployment
- Nose Cone Fitting Rocket
- Loose Cables Causing Rockets to Crash
- Running out of memory in the Arduino
- Time and Availability
- Learning Complex Concepts



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# Applications

- Prototyping
- Smart Devices
  - Self Driving Cars - Smart Cars
- Aeronautics – Guidance Systems
- Biomedical – Prosthetic Limbs
- Robotics - Virtual Surgery
- Data Collection – Weather, Biomedical, Space Exploration, Underwater Exploration



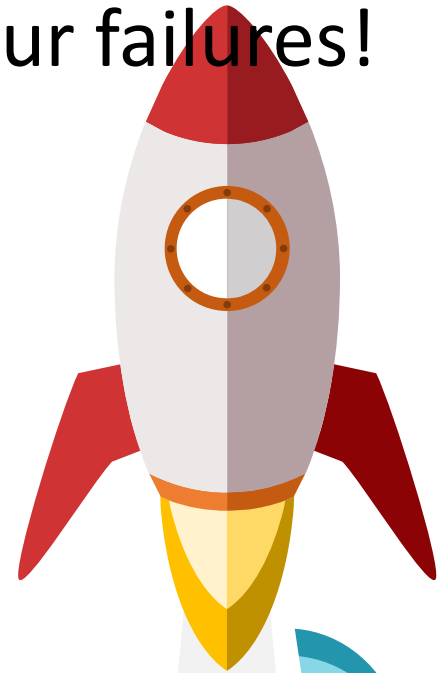
# BOOM

For your enjoyment, a collection of our failures!

Play Boom



Boom-WEB.mp4



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- Colin Powell



# Thank You !!

- Bruce Smith for 3D Printing and Camera Mount Design
- Thanks to our Moms and Dads for supporting us throughout this project!
- Thanks to my wife Lori, AERO Team Mom!

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# References / Credits

- PowerPoint Template: Designed by Showeet.com
- Rocket Information: NASA Education
- Rocket Builds: US Water Rockets and Air Command Water Rockets

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