What is the project?

- A projectile that falls from a high altitude and lands in a very accurate radius, slowing down from a high speed to 0 m/s

Use Case:

- Deliver vaccines and essential materials to the most remote places in the world
- This is how vaccines are delivered to remote areas
    - People have to travel over rivers and mountains all alone under bad conditions
        - The medicine denatures because of the conditions such as temperature gradients they've been through during transportation
        - Countries that need this most don't have the infrastructure to deliver
        - Up to 40% or more of vaccines denature during transportation
    - Impossibly difficult to deliver
    - No work being done in this sector
    - Because of this inefficient process
        - 20% of the world's children grow up unvaccinated, and vaccine-preventable diseases kill 2.4 million children annually because of outdated and inefficient supply chains
        - We invest billions in healthcare but the money is funneling in because we haven't improved our infrastructure
- Solve this through using a 1-time use drone
    - Brings vaccines (Dropped from an aircraft - without the first mile last mile problem)
    - Motors double as a generator so that the vaccines can be kept cool (cold chain)

Vision:

Vision

- We are developing a more effective way to deliver medicine - Unit cost ~$20 per airdrop of 1000 vaccines with the aim of eventually delivering other low cost medical materials.
    - Hyper low cost due to low cost of materials used in the process
        - Cardboard
        - Small plastic parts
        - Budget motor
        - Small computer
    - The delivery unit will contain a computer initially for computer vision (Raspberry Pi), and we will load it with educational/instructional content
    -
- Cheap, scalable, and functional
- Stabilization and platform detection algorithms will be developed and open-sourced
    - This can be used for future applications
    - Will advance how we think about delivering not only medicine, but products in general
- 10km package radius, dropped of any plane, and lands at a target accurately

Software:

- Raspberry Pi will use OpenCV to detect where the projectile should land
  - We will train it with different images of the platform so that it is able to detect the platform and continue the landing sequence
  - This will control the grid fins and be a factor in the thrust of the projectile
- The Arduino will be connected to all other sensors: servos, altimeter, gyroscope, and the electronic speed controller
  - This will send data to the Raspberry Pi and will control the projectile's orientation and throttle based on its tilt and altitude
  - Constant communication with a GPS satellite to determine an approximate landing location
- The general software flow is as follows:
  1. The projectile is thrown off a height
  2. The Arduino orients the projectile using grid fins for stabilization
  3. The Raspberry Pi is constantly searching for the platform to land on
  4. The GPS module and physical sensors will detect when the projectile apply thrust
  5. Grid fins along with thrust will land the projectile on the platform

Prototype Plan (experimental vs evolutionary):

- Vertical because we will create the function of each component separately and combine them at the end
  - This will enable us to have a modular workflow and get a thorough understanding of the responsibility of the individual components
  - Ultimately we will be combining each of the smaller components and make them work together with each other
- Evolutionary
  - We will start development on the platforms we'll be using
  - Each stage will be used as a seed to continue to the next stage
    - Should apply a new or fixed feature to the software and hardware
  - Because of the nature of our project, it must be evolutionary because we are going to be prototyping in sequence with the previous prototype

Hardware:

- Servos
- Brushless Motor (X2)
- Propeller and Coupler (x2)
- 30A Electronic Speed Controller (X2)
- Servos (x4)
- Data Downlink
- Raspberry Pi (x2)
- Arduino Uno
- Jumpers
- Breadboard
- Gyroscope/Accelerometer
- Altimeter

- Raspberry Pi Screen
- Rasberry Pi Camera (x2)
- Stepper Motor
- Stepper motor controller
- Peltier tiles

Challenges Anticipated:
- 3-D printing is really expensive and we need to prototype different models so that we can develop a final, sustainable model that's optimized and uses cheap resources
- Asynchronous communication between the Arduino Uno and the Raspberry Pi
- Experimenting with the thrust needed to propel to projectile to
- Stabilizing the projectile in real-time
- Calibrating the different sensors to ensure the projectile does not burn through battery unnecessarily

Why Not Drones (if you're curious):
- Inefficient because they are really expensive (require quadcopter)
- Low range as compared to conventional aircraft
- Can't deliver as much load
- High chance of being wafted by air or being destroyed during delivery
- Higher infrastructure cost (charging stations and launch facilities)
- Requiring a return trip decreases usable range (which needs to be high to deliver)