



**CALIFORNIA STATE SCIENCE FAIR  
2016 PROJECT SUMMARY**

<b>Name(s)</b> <b>Alexander Woodside</b>	<b>Project Number</b> <b>S0334</b>
<b>Project Title</b> <b>Finding a Strong Affordable Material to Construct a Simple Quadcopter Frame</b>	
<b>Objectives/Goals</b> The goal of my project was to find what affordable material would be best to build a simple quadcopter frame.	
<b>Abstract</b> <b>Methods/Materials</b> In my project I tested the strength of materials available in common hardware stores. To test the strength of these materials, I dropped 5, 10, 20 pound exercise weights from a height of 46 inches from the material. This gave me corresponding energy levels of 26.5, 52.2, 104.5 joules. All tests were recorded with a camera to ensure the weights impacted the materials at the desired angle and location. The materials I have chosen to test are Polyvinyl Chloride (PVC) foam, High Density Polyethylene (HDPE), Plywood, Medium Density Fiber (MDF) board, 3/4" wood, Birch, Poplar, Craft Pine and Red Oak. The dimensions of the materials were kept at store bought dimensions for two reasons; a hobbyist new to quadcopters will most likely keep them at these dimensions and the goal of the project was to keep engineering of the frame as simple as possible.	
<b>Results</b> My mount in trial 1 was not as secure as I would have liked. As a result the mount absorbed a portion of the energy of the impact. In trials 2 and 3 a new satisfactory mount was used. Plywood, MDF board, and Craft Pine never survived the 5 lbs. tests with any of the mounting techniques in all the trials. Poplar was damaged once and broke twice at 5 lbs. In trial 1, Red Oak, HDPE, PVC foam and Birch all survived the 10 lbs. tests. In contrast, only Birch survived the 10 lbs. tests in trial 2 and only Red Oak and Birch survived in trial 3 at 10 lbs. PVC foam broke at 5 lbs. once and twice at 10 lbs. The two "finalists" were Red Oak and Birch. Birch broke twice at 20 lbs and Red Oak broke only once.	
<b>Conclusions/Discussion</b> Red Oak is the best material to construct a simple quadcopter frame of the materials I have tested. Red Oak is an open grain wood and has a density of $0.733 \text{ g/cm}^3$ . In comparison, Birch is a closed grain wood and fast growing. These factors lead to it not surviving as well as Red Oak. HDPE had the highest density but it is heat sensitive. As a result all the KE made it bend. PVC foam is a bendable foamed plastic. I believed this would help create a shock absorbing frame. It turns out the weight easily pushed the PVC foam past its maximum bending point. Poplar also had a similar density as Birch but its brittle nature caused it to fracture. I must conclude Red Oak is the best material to build a simple quadcopter frame.	
<b>Summary Statement</b> This project will allow first time quadcopter builders to learn how to fly without needing to worry about rebuilding their frame after many inevitable crashes.	
<b>Help Received</b> I received help in conducting this experiment from many people. Mom and Dad funded this project. My Mom and Jim Bock gave me Physics advice. My Dad gave his help and advice during the fabrication of my material mounts.	