Structures Mark II

Project Website:
http://projects.eng.uci.edu/projects/2020-2021/structures-mark-ii
Team: Vincent Tran, Gabriel Cruz, Kevin Luu, Allana Ilagan
Sponsor: Prof. David Copp

Introduction:

- AUVSI SUAS is a yearly competition utilizing a UAV and UGV
- UAV is required to do several tasks:
  - Map predetermined waypoints
  - Follow a course while avoiding obstacles
  - Deploy UGV
  - Image capture
- UGV must descent safely and drop off an object at a location

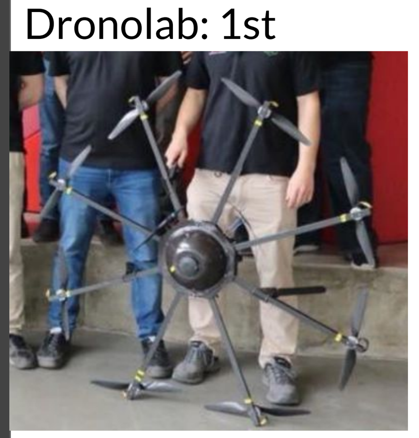
Objective

This subteam, Structures Mark II, was gathered for the purpose of creating an optimized airframe. It is tasked with closely researching structural allowables, requirements, constraints, material and design choices for a new and better frame. The team will then sketch and model a possible airframe for the rest of UAV Forge to build in the upcoming year. For now the overall design will be a prototype and can be adjusted to fit any new needs or new design choices when the time comes.

Existing Solutions:

Past years' competition placers:

Dronolab: 1st



- Octorotor
- Upside Down motors to allow them to be closer to the center of gravity of the drone.
- Arms are hollow and squares
  - Easier to produce and bolt together
- Motors mounted directly onto arms

UCAV: 4th

- Chose Octoroter that is co-axial:
- X8 configuration can stay airborne in the event of a motor failure and has enough control to be landed safely.

Animus Ferus: 2nd

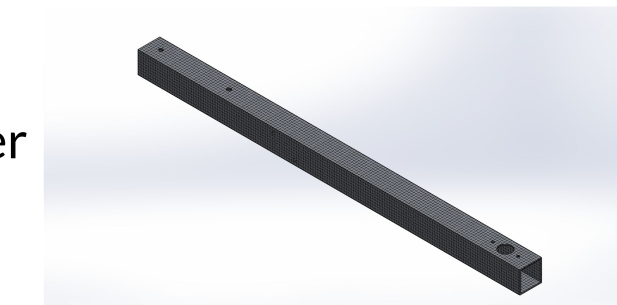
- Hexrotor
- Bottom and top plate are carbon fiber
- Square spars
- Hexa can stay in the air even if a motor fails unlike a quad
- Says octo can consume too much battery power

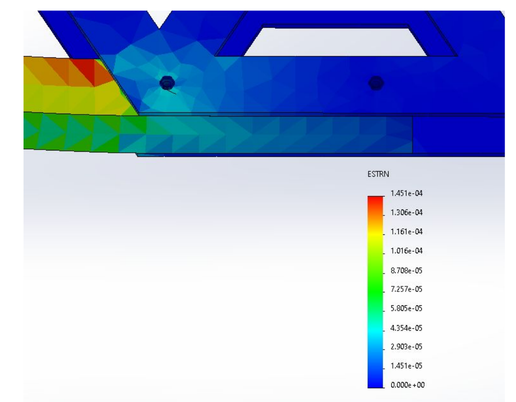
Design Requirements

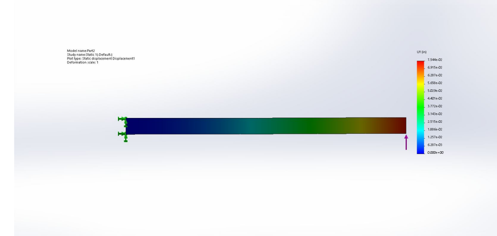
Temperature	Operate up to 110 Fahrenheit and not flammable
Cost	Less than $1300
Modular	< 10 minutes for assembly and disassembly
Weight	< 25 pounds
Sturdy	Able to re-fly after a crash with minimal repairs
Easy Access	Avionic components must be easy to access
Simple	Few fasteners as possible

Arms

- Roll Wrapped Twill Carbon Fiber Arms
  - Strong and Light
- Square shape
  - Stronger joint connections
  - Quick assembly/disassembly



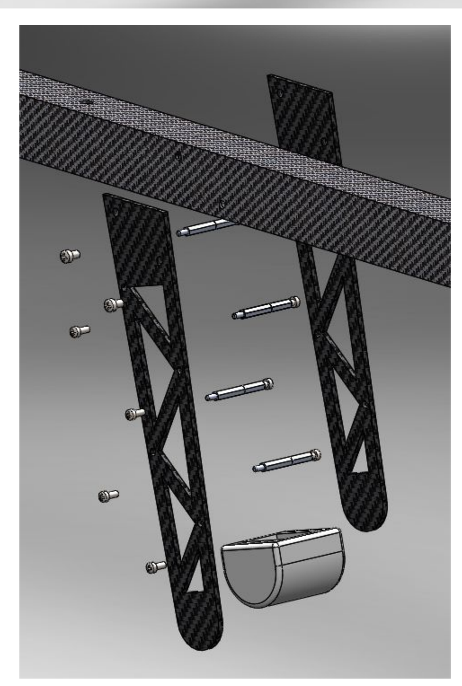




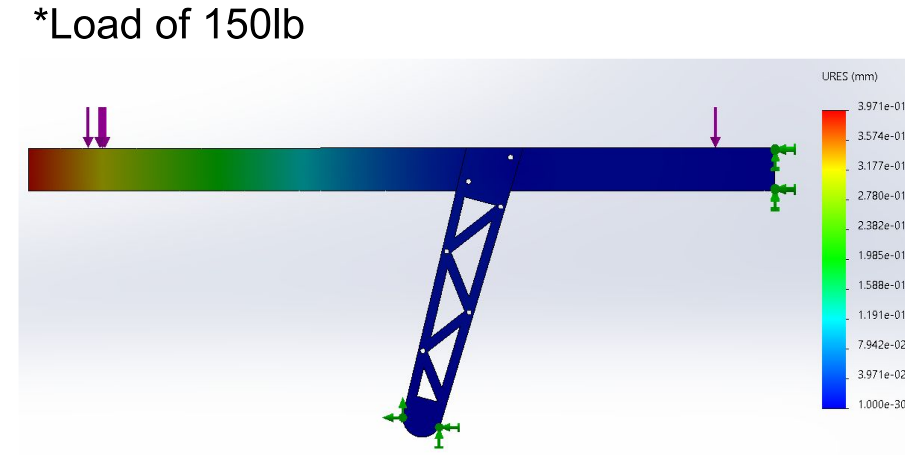
- Force tests to analyze:
  - Force on bolt
  - Displacement on arms

Landing Gear

- Pieces cut out from the same carbon fiber sheet used on the base plates, held together by spacers and screws
- 3D printed tip made of TPU, glued to the bottom

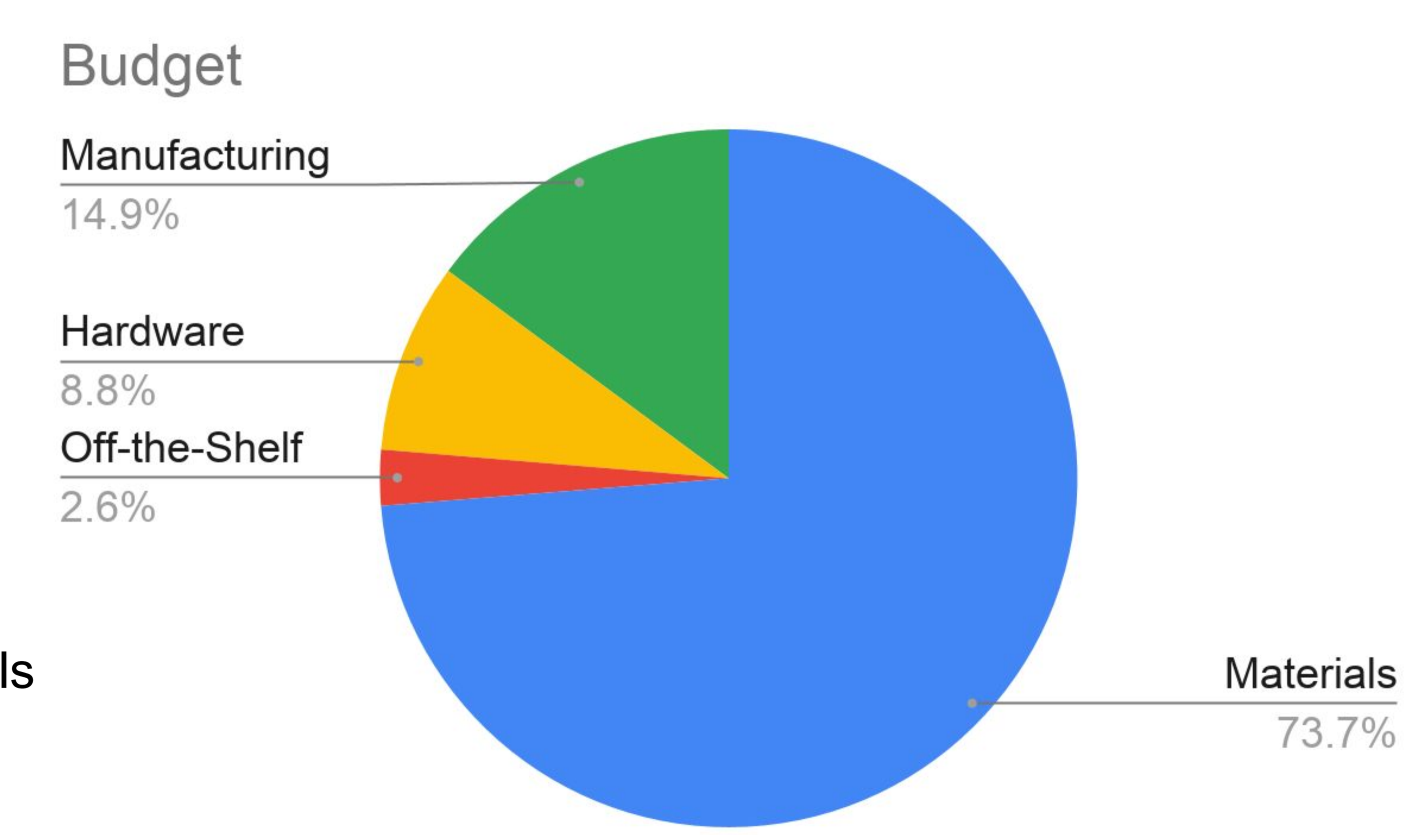


*Load of 150lb



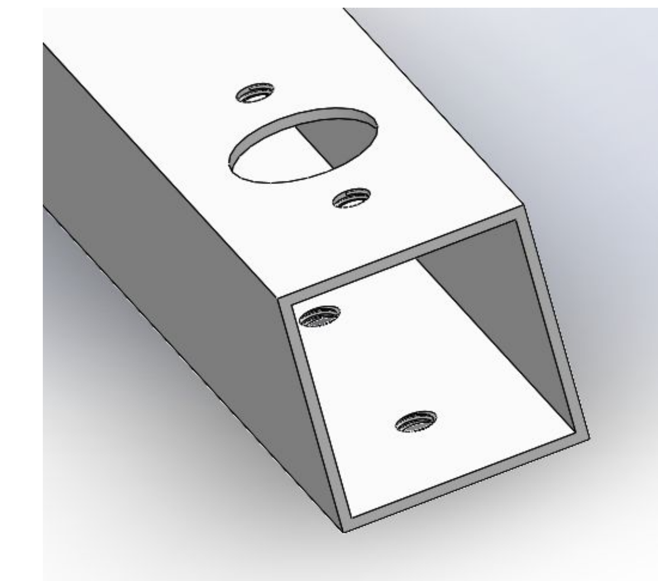
Timeline

Week 1-3	Problem Definition
Week 4-5	Concept Generation
Week 6-7	Concept Selection
Week 8-9	Solidworks Models + Assembly
Week 10	Presentation



Motor Mounts

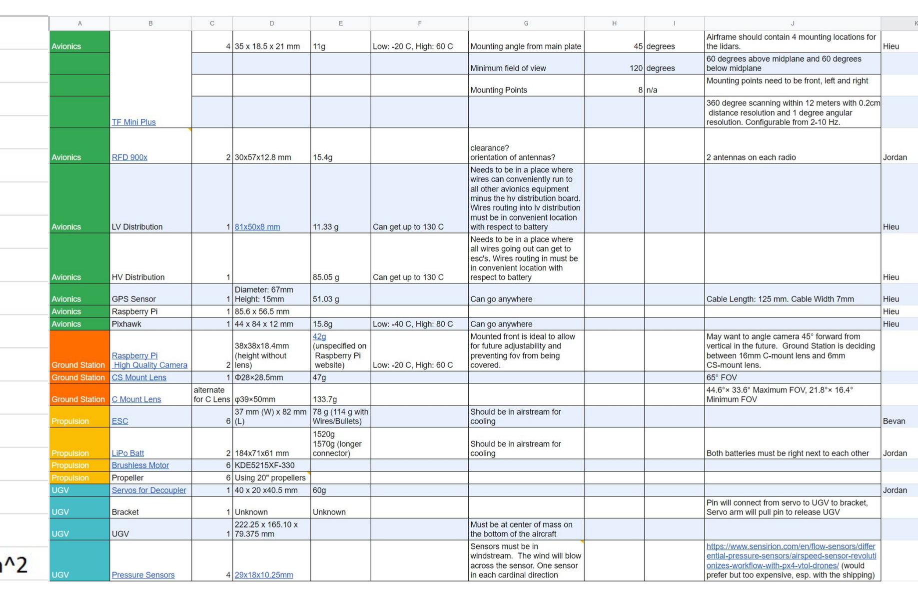
- Fastening motors directly onto arms
  - Reduces cost, weight, and number of fasteners
- Reduce vibration from motors with rubber washers/electrical tape
  - Clear imaging leads to better mapping



Central Hub + Avionics Placement

Surface Area Calculaitons (in^2)					
Component	Length (in)	Width (in)	Quantity (#)	Surface Area	
RFD 900x	1.181103	2.244096	1	2.65050816	
Pixhawk	1.7322844	3.307088	1	5.72881764	
HV Distribution	3.1889781	1.968505	1	6.27751933	
LV Distribution	3.1889781	1.968505	1	6.27751933	
Rasberry Pi	3.3700806	2.224411	1	7.49644309	
TF Mini Plus - Lidar	1.3779535	0.728347	4	4.01451236	
Camera	1.4960638	1.496064	1	2.23820689	
UGV Chassis	8.7500047	6.500004	1	56.8750614	
Servos	1.574804	0.787402	2	2.48000764	
Battery	7.2440984	2.795277	2	40.4985247	
Pressure Sensor	1.1417329	0.708662	4	3.23640997	
ESC	3.2283482	1.456694	6	28.2162869	
GPS Sensor	Diameter	2.637797	1	5.46200757	
Wings	5.86	1.38	6	48.5208	
			Total Area	219.972625	in^2

Surface Area Calculations



Structures System Requirements table

The Approach:

- Began with evaluating the UAV Forge Structures team's Component placement chart and then proceeded to calculate surface area of the components to get a rough idea of the base plate size to go with.

The Build:

- Base plate side = 8.08 inches -> which grants more than enough surface area for components and allow strategic cut outs for air flow and easier wiring.
- Three stack: Two hexagonal plates (Area = 118.76 in^2) and one rectangular plate (Area = 26.69 in^2).
- Priority placement:
  - HV and LV distribution -> top for best exposure to airflow and allow better natural cooling.
  - Lidar sensors on a mount with 45 degree

Conclusions

Overall, the design's priority was ease of manufacturing and quicker assembly. Square arms provide an effortless way for attachments due to its horizontal surfaces. Using the same material sheet for the base plates and landing gear provides a cost effective solution for the production of multiple parts. The base plates were made to have strategic cutouts for the fastening of components and airflow through the electronics to prevent overheating. Using simple designs and the same material for multiple parts is efficient in a time where access to machines might not be readily available.

Future Improvements:

- Connections between base plates and arms can be improved
  - Find weakness in bolt connections
  - Experiment with bolt placement and bolt sizes
- Motor mount design that allows fastening with four screws for firmer attachment and to account for torque
- Consider different forms of attachment methods for components