Boeing Drone: Frame Concepts and Budget

Project 03

Team Hi-Jacks

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Project Description

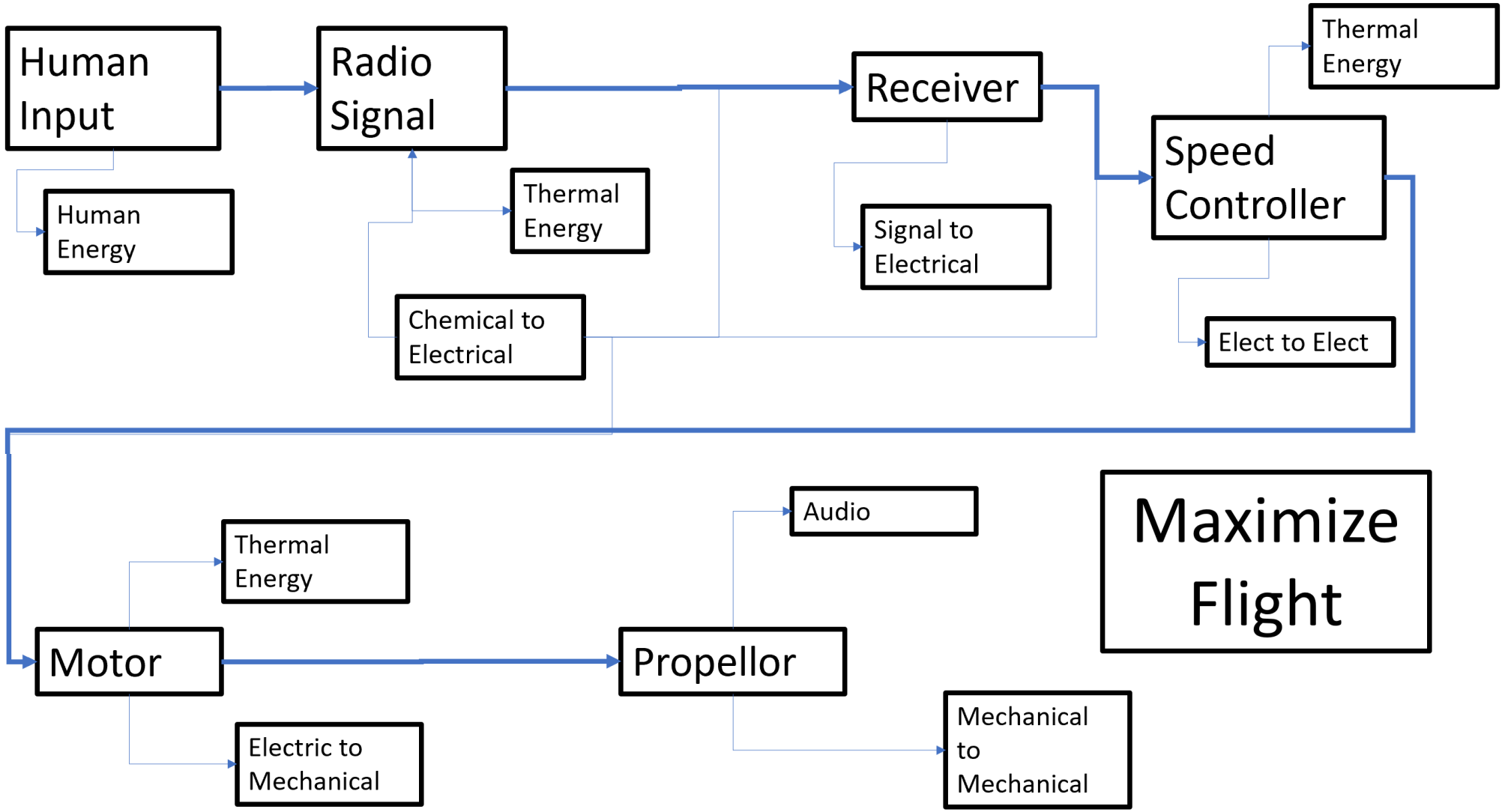
Design, analyze, and manufacture a 3D printed drone frame that minimizes weight and maximizes flight time using set commercially available components.

- Sponsor: Boeing
- Gain insight into team's academic processes.
- Seek innovative solutions from another perspective.

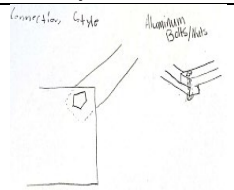
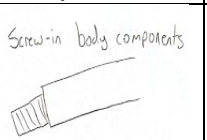
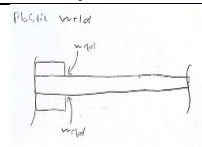
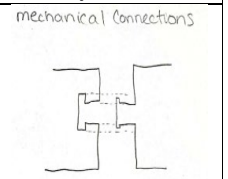
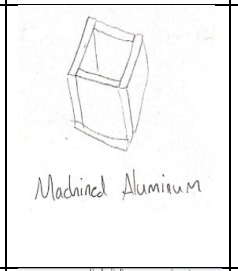
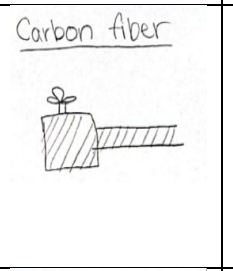
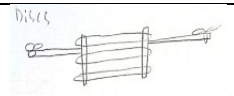
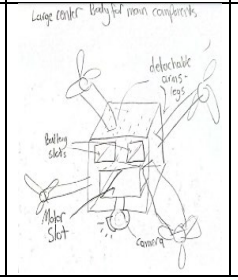
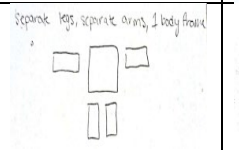
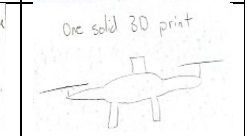
Black Box Model

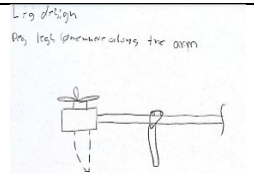
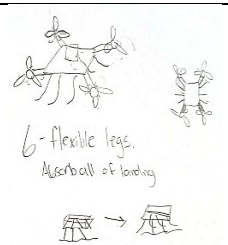
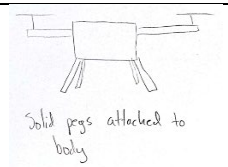
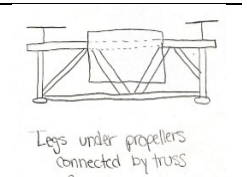
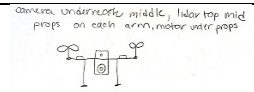
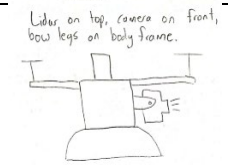
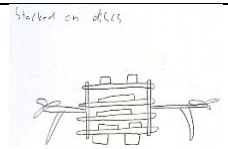
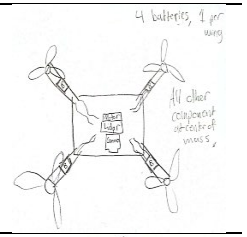
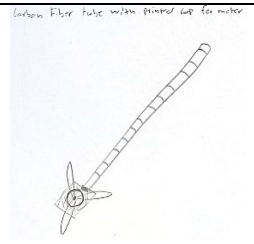
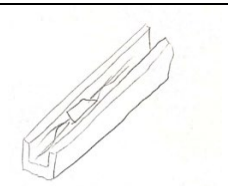
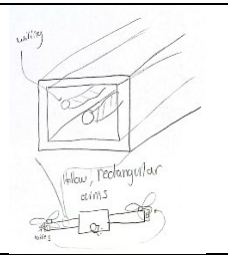
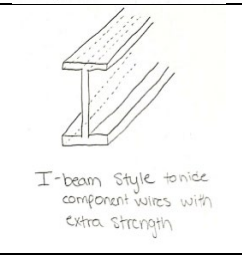
- Inputs/Outputs:
  - Material
  - Energy
  - Signals

Functionality Diagram



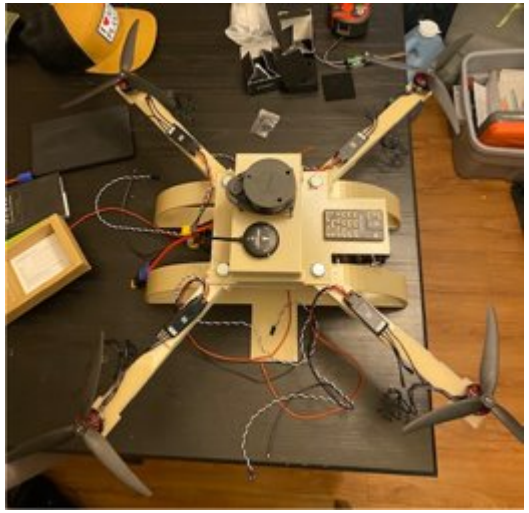
Morph Matrix

Subcategories	Concept 1	Concept 2	Concept 3	Concept 4
Arm Connection Style				
Material				
Body Configuration				

Subcategories	Concept 1	Concept 2	Concept 3	Concept 4
Leg Style				
Component Configuration				
Arm Style				

Concept Evaluation: Pugh Chart

- Criteria was customer and engineering requirements
- All designs were compared to the datum
- Received scores of better (+), worse (-), or Same (S) as datum.



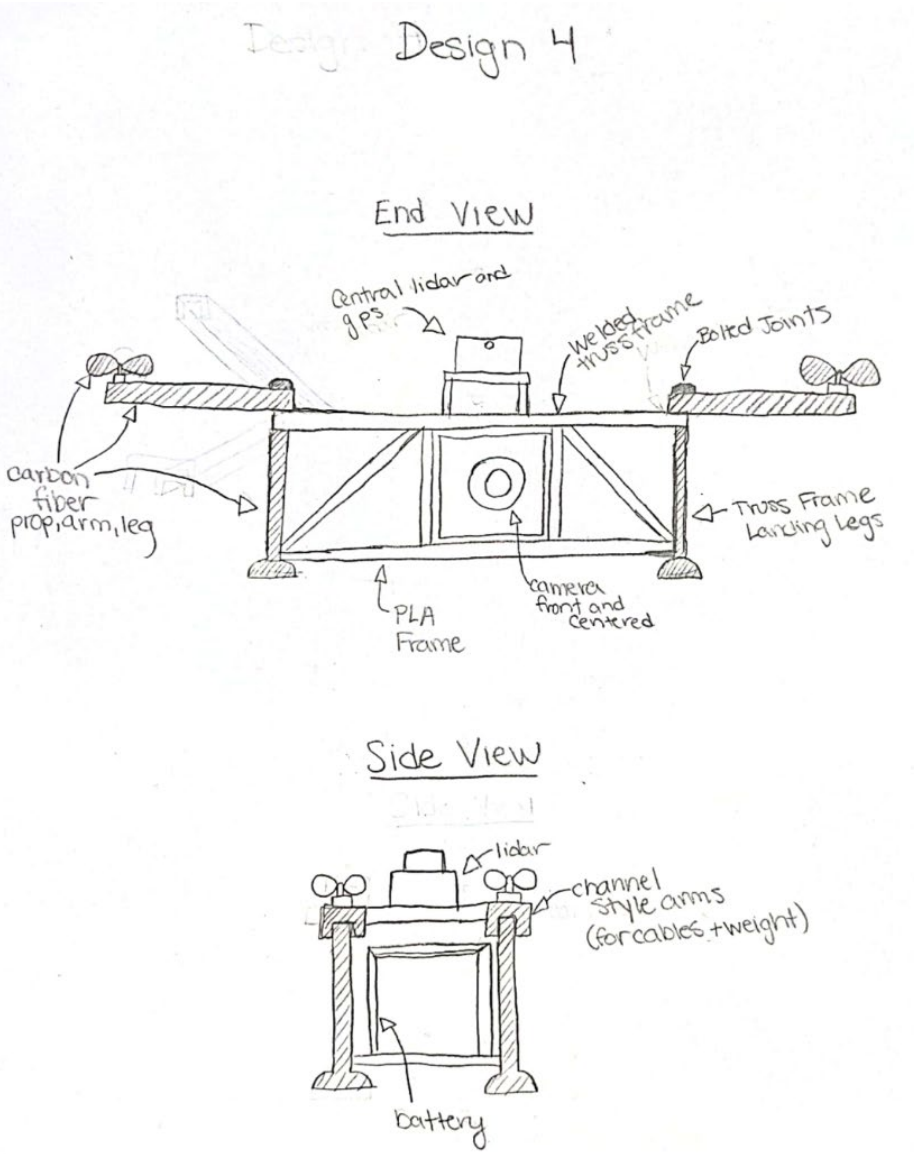
Datum

Concept/ Criteria	Datum – Boeing	Design 1	Design 2	Design 3	Design 4	Design 5
Lightweight		+	+	-	+	+
Component FOV		-	S	-	S	S
Ease of Manufacturing		S	+	-	+	+
Frame Strength		+	+	S	+	+
Cost		-	-	-	-	-
Minimized Hardware		S	S	+	-	S
Σ +	N/A	2	3	1	3	3
Σ -	N/A	2	1	4	2	1
Σ S	N/A	0	2	-3	1	2

Design 4

Concepts

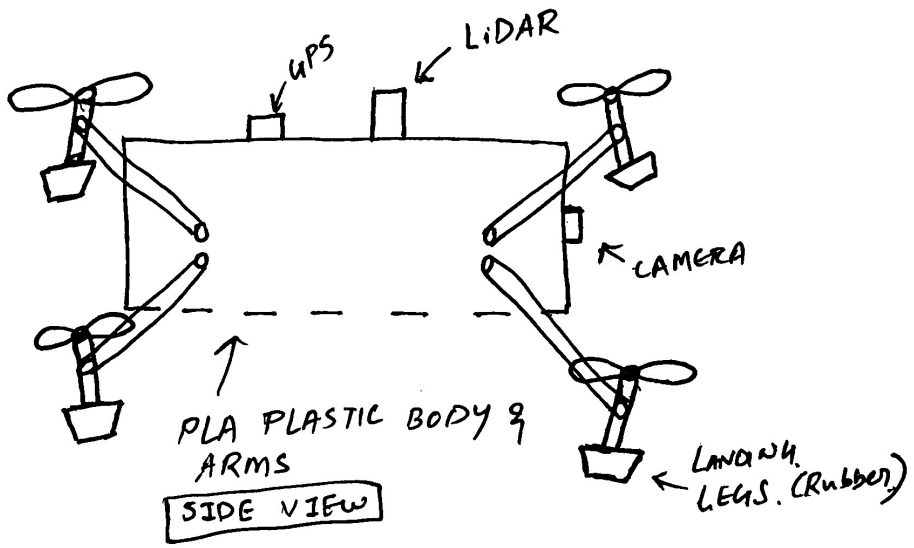
- Truss Frame w/PLA Material and welded sections
- Legs w/Carbon Fiber Material
- Channel Frame Arms w/Carbon Fiber Material
- Centralized Components
- Bolted Joints

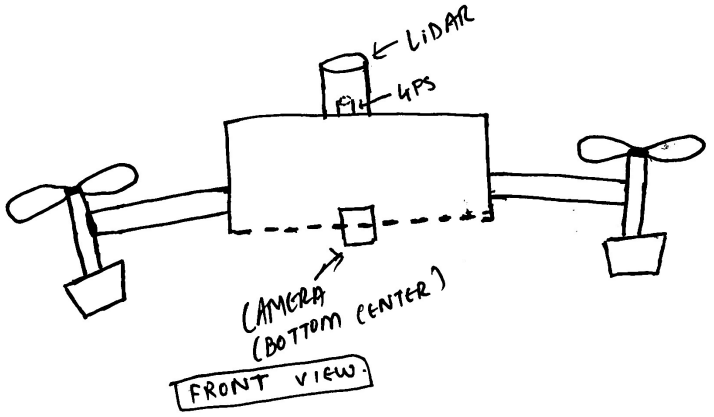


Design 5

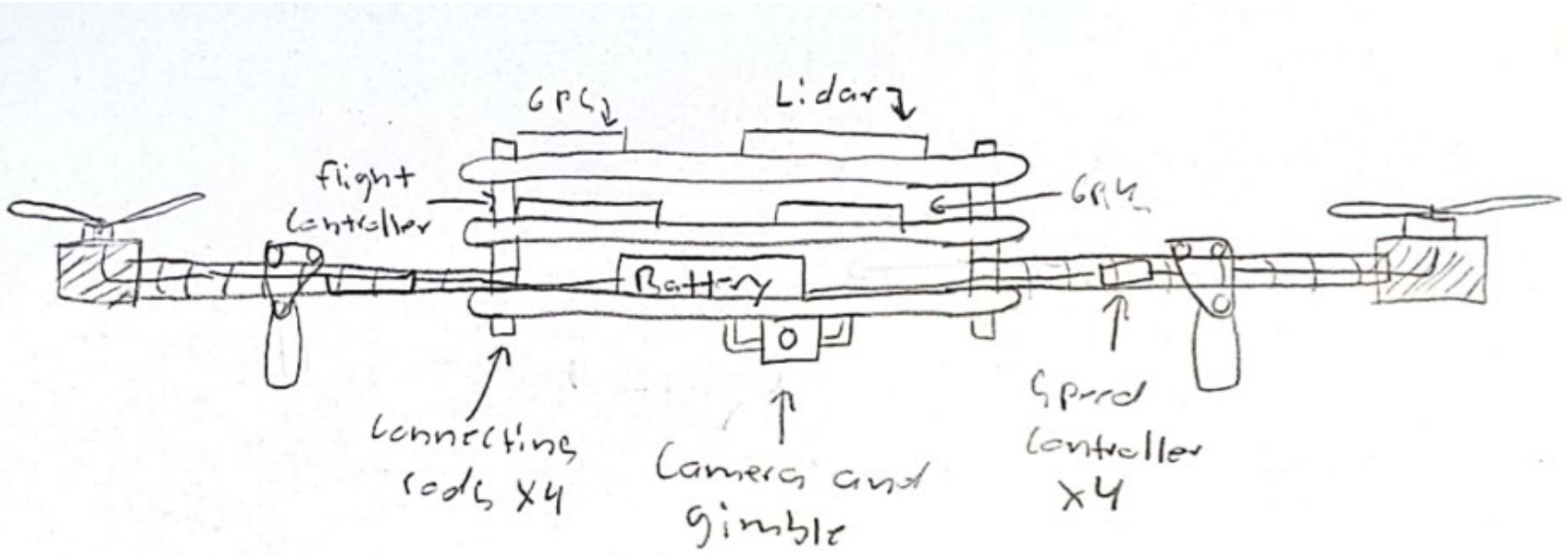
Concepts

- Full PLA Plastic body
- No welding and bolts for body to arm connection. 3D printed altogether in one design.
- Specially designed legs with reverse triangular design and flat top which helps smooth landing on any surface.

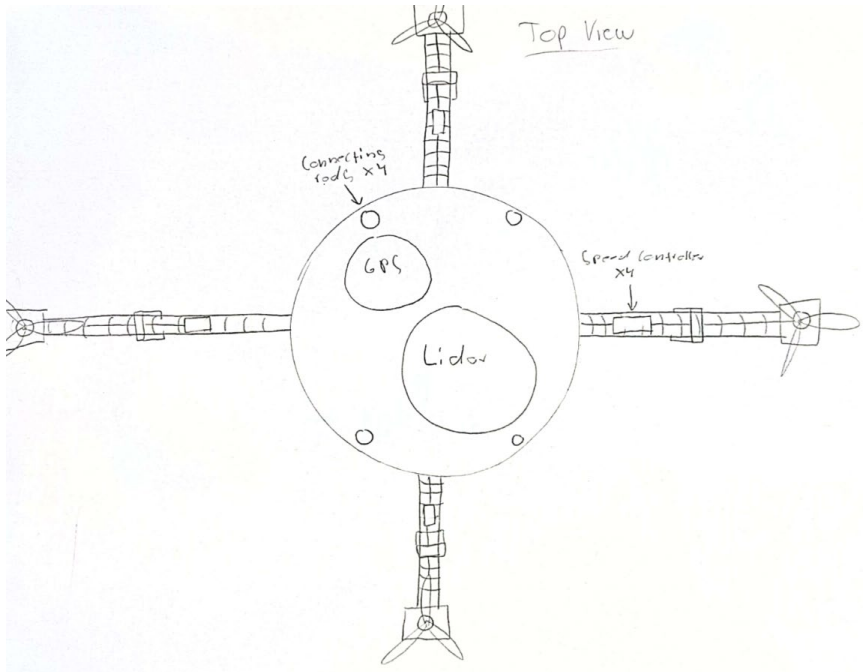




Design 2



- Circular disc body
- Creates a more central COG
- Carbon fiber arms
- Adjustable landing struts

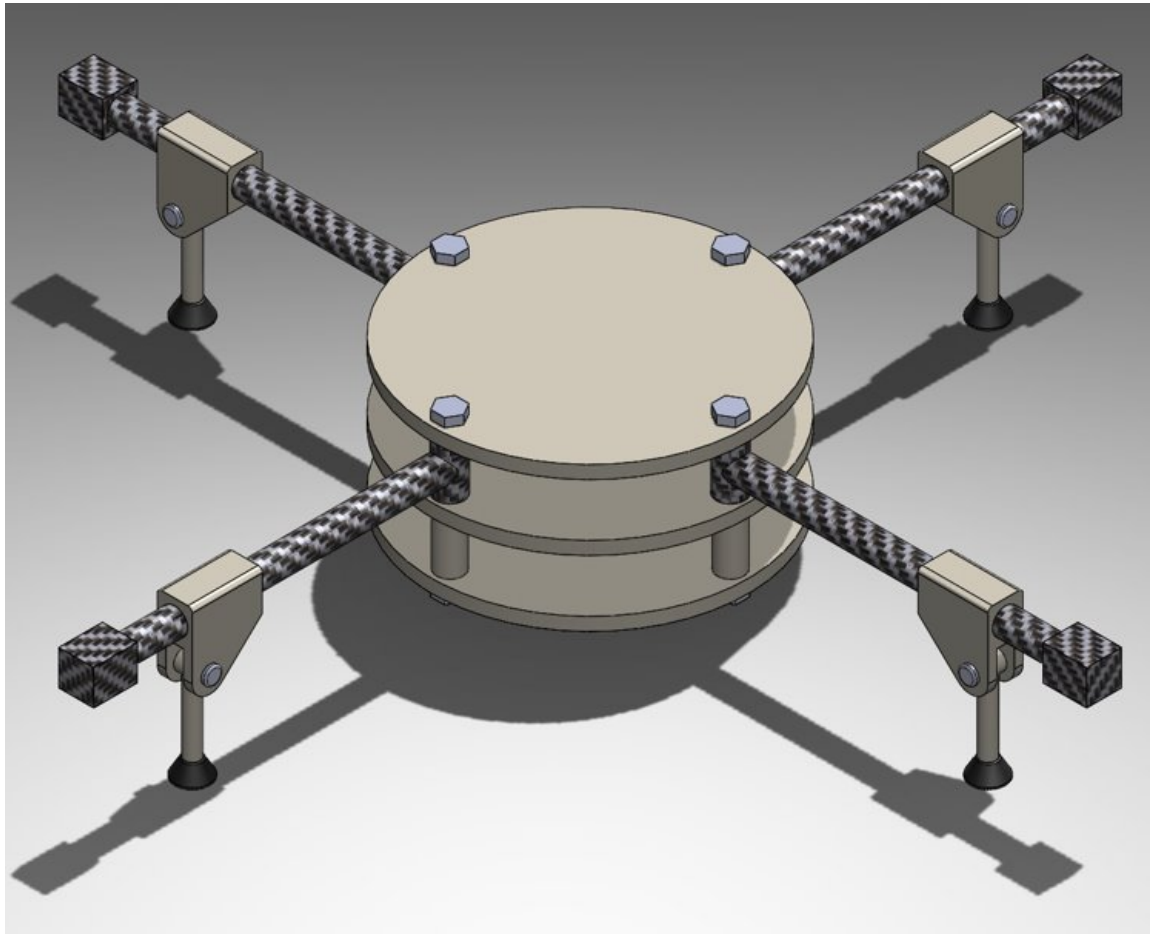


Concept Evaluation: Decision Matrix

- Top 3 designs made the cut
- Weighted criteria based on importance of customer needs
- Highest weighted score solidifies our final design (for now)

		Design 2		**Design 4**		**Design 5**	
Criteria	**Weight (%)**	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Lightweight	25	7	1.75	6	1.5	7	1.75
Component FOV	20	8	1.6	7	1.4	7	1.4
Ease of Manufacturing	15	9	1.35	9	1.35	8	1.2
Frame Strength	20	7	1.4	8	1.6	7	1.4
Cost	10	6	.6	5	.5	8	.8
Minimized Hardware	10	5	.5	4	.4	5	.5
Total	100		7.2		6.75		7.05

Simple CAD Design



Bill of Materials

Bill of Materials							
Team							
Part #	Part Name	Qty	Description	Functions	Material	Dimensions (in)	Cost ($)
1	Body	1	Body	Body	PLA		340
2	Hobbytown 40A ESC	4	Speed Controller	Control motor speed			55.99
3	Gemfan 9045 3-Blade Prop	4	Propeller	Provide lift	Glass Fiber Nylon	9	15.98
4	Battery Charger	1	Battery Charger	Charge battery			47.97
5	Battery Connector	1	Batter Connector	Connect battery to electronics			8.99
6	Socokin 6S Lipo Battery	1	LiPo Battery	Provide power	Lithium Polymer	6.06 x 2.03 x 1.89	73.99
7	iFlight XING 2814 880KV Motor	4	Motor	Spin propeller	Copper	Stator L: 0.551 Stator D: 0.787 Shaft D: 0.197	154.4
8	Flysky FS-i6X 2.4GHz RC Trans/Receiver	1	Remote Control	Control drone		6.85 x 3.5 x 7.48	72.99
9	Slamtec RPLIDAR	1	LIDAR Unit	Light detection and ranging		5.1 x 3.9 x 3.1	99.99
10	Arducam PTZ Camera	1	Camera Unit	First person control and recording			124.99
11	2-Axis Brushless Gimbal	1	Camera Gimbal	Stabilize camera		3.15 x 3.15 x 3.15	69.99
12	NVIDIA Jetson Nano GPU	1	GPU	Process visual data			129.00
Total Cost Estimate:							1194.28
					Cost of Manual Flight Parts		770.31
	Required component for footprint on design, cannot be altered (not required to purchase)						
	Required for manual flight, can be altered with similar component if unavailable						

- Cost of body is assuming 100% PLA and a goal of 3 pounds
- Manual flight components are parts required to get off the ground
- Boeing is responsible for other parts and setup

- Budget remaining after 1 manual flight prototype will be around $4229.69
- Enough budget for 6 manual flight prototypes
- The leftover $378.14 can be used for surprise expenses and travel costs

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