



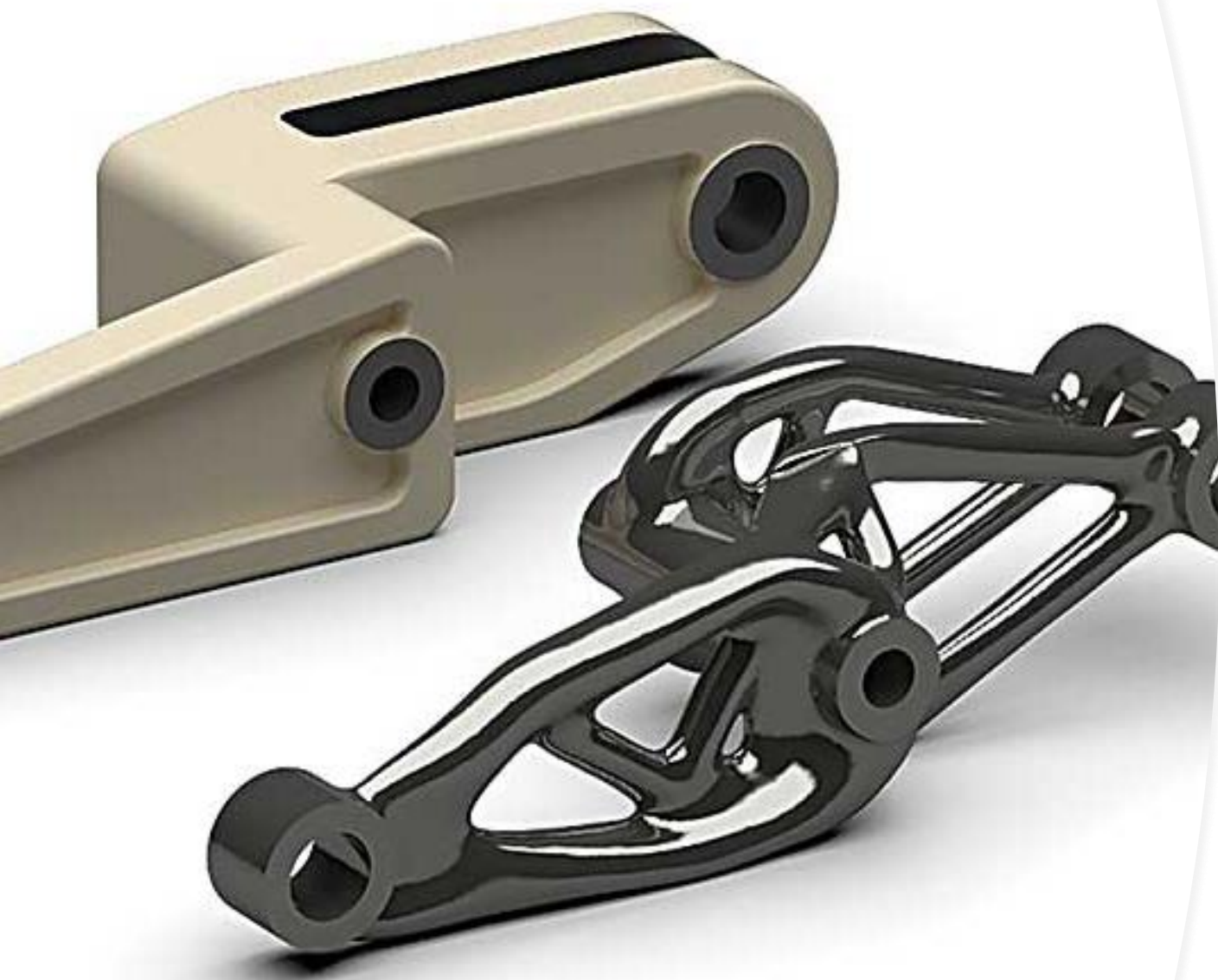
# Optimization of Quadcopter Frame using Generative Design and Comparison with DJI F450 Drone Frame

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# What is Generative Designing?



Iterative Design  
exploration process



Uses AI to generate  
multiple Design in a  
single computation



GAN is used to  
generate surfaces  
between constraints



Mainly used for  
mass reduction and  
structural  
optimization

# Steps involved in Generative Design



## Define

Define preserved boundaries



Define obstacle boundaries



Define fixed Geometry



Define material



Define AM technique



## Generate

Define the loading conditions



Generate all possible outcomes



Remove all under defined outcomes



## Explore

Check for the best possible design with optimized properties



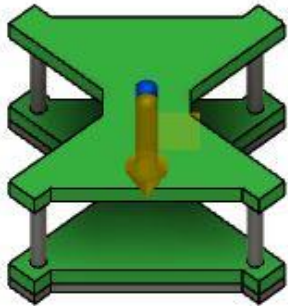
Smoothen the surface using form tools

# Loading conditions

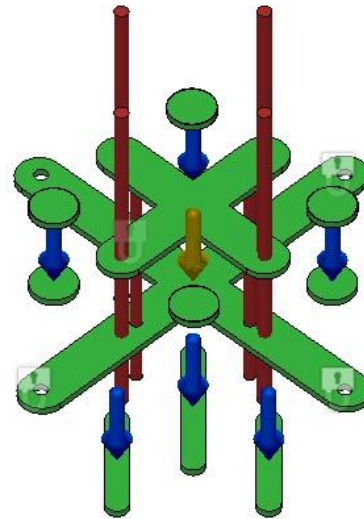
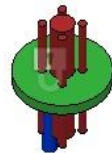
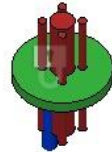
Component	Number of individual components	Weight of individual component (g)	Net Weight of individual component (g)
RS2205S Motor	4	28.8	115.2
Pixhawk FC	1	73	73
M8N GPS	1	32	32
5" Propeller	4	4	16
BL Heli ESC	4	14	56
PC Hub PDB	1	8.5	8.5
Camera	1	12	12
Telemetry	1	15	15
IA6B Receiver	1	14.6	14.6
LIPO Battery	1	200	200
TOTAL	19		542.3

- Approx. weight of frame = 250 g
- 15% buffer in tot. mass = 1000 g
- $M = 1000\text{g} = 1\text{ Kg}$
- $F = M * g = 10\text{ N}$
- So for hovering,
- A minimum of 10 N thrust from all 4 motors is required.

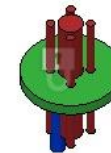
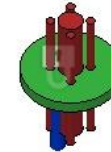
# Defining of our Generative Design Models



MODEL-1



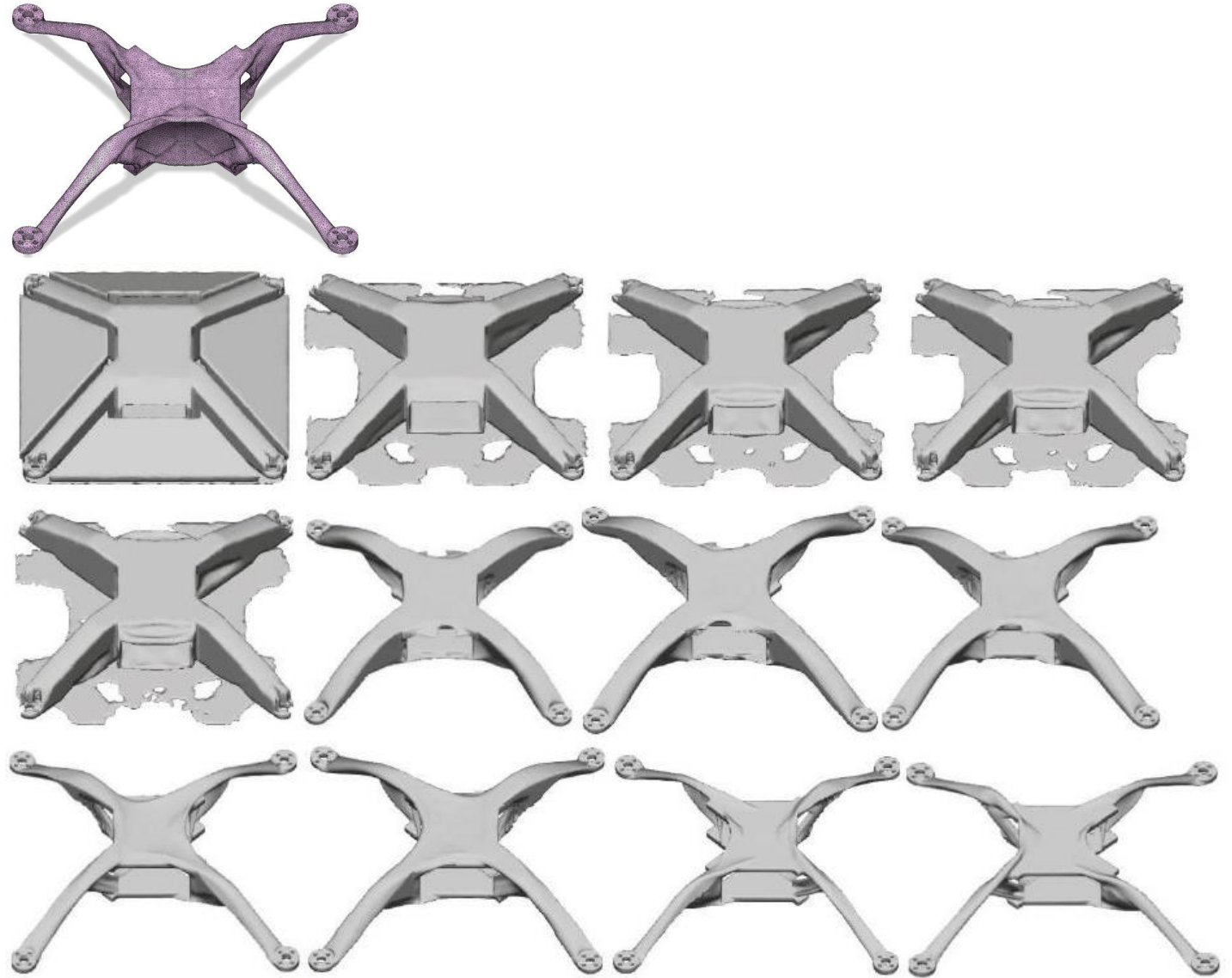
MODEL-2



- QUAD SPECS:
- 450 mm size.
  - True X shape.
  - Centre of mass. maintained at the center of Quad.
  - Symmetric in nature.

# ITERATIONS

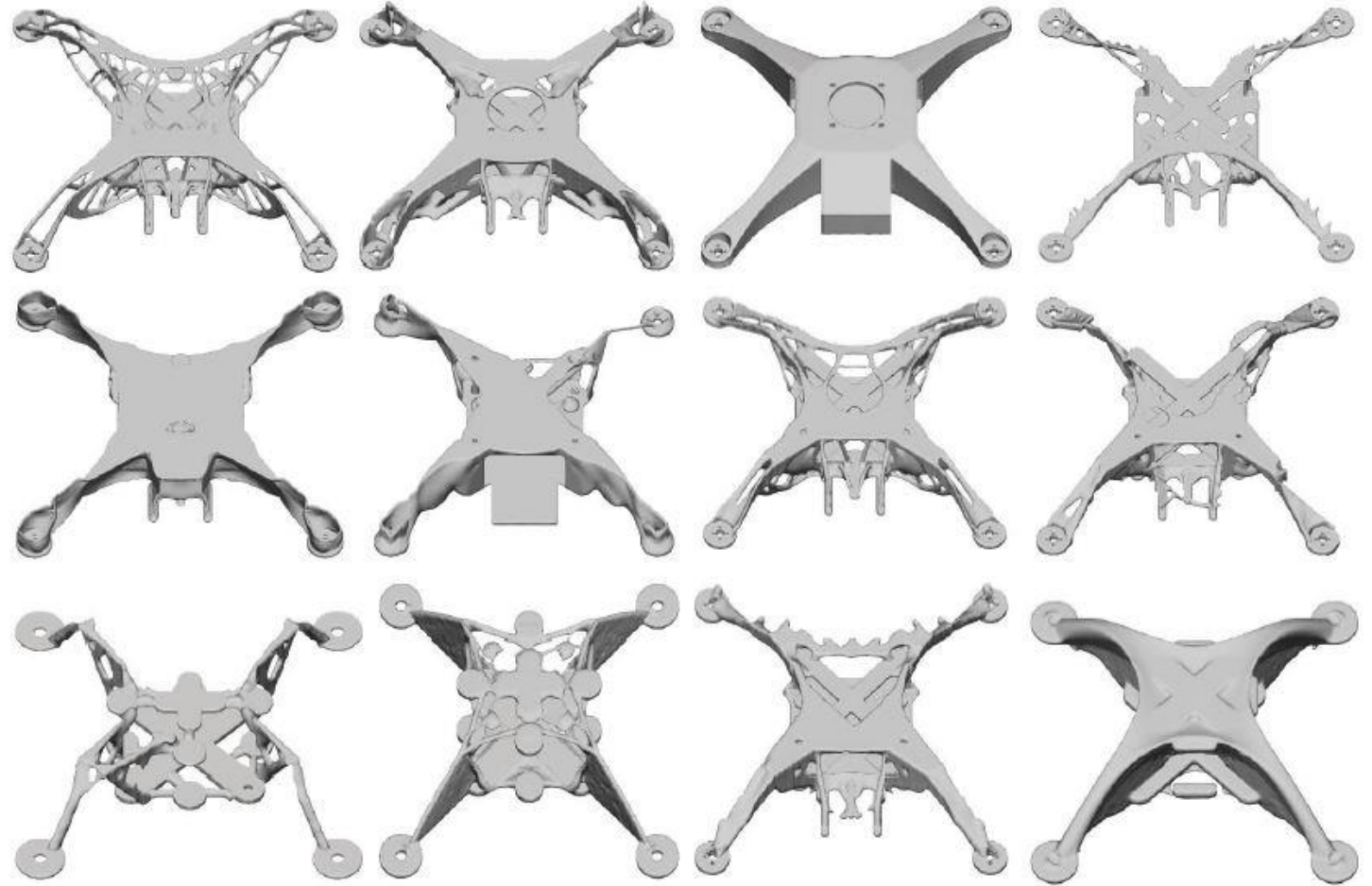
- GAN creates surfaces and overhangs.
- The iterative mechanism removes mass from the surfaces while optimizing mechanical properties.
- Final model is converged, that is, no mass can be removed while having maximum mechanical strength at that particular iteration.





# OUTCOMES

- A total of 74 designs were generated throughout the experimentation.
- Fusion 360 autonomously classifies the models based upon Mass, FOS, Von Misses Stress, etc.
- The best model is chosen based upon its mechanical properties.

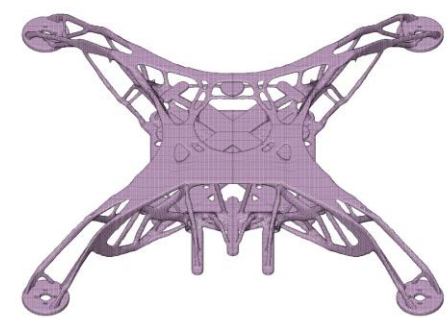


# RESULTS

- Mechanical properties of generatively designed frame in comparison with DJI F450 Drone frame
- ABS plastic is used for Additive manufactured Drone frame



Model 1



Model 2

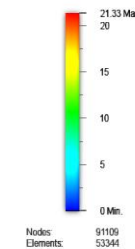
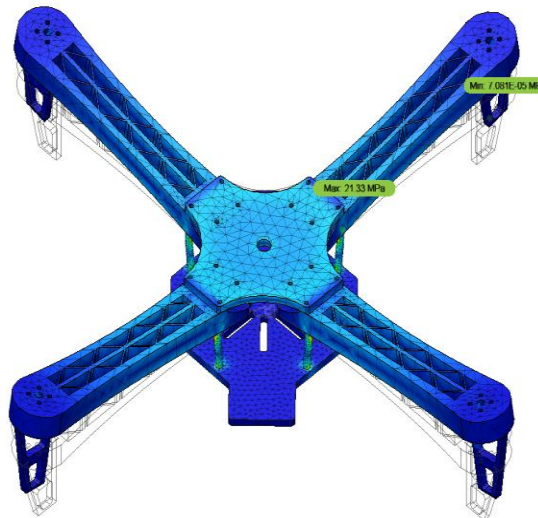
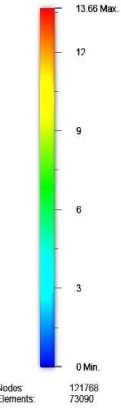
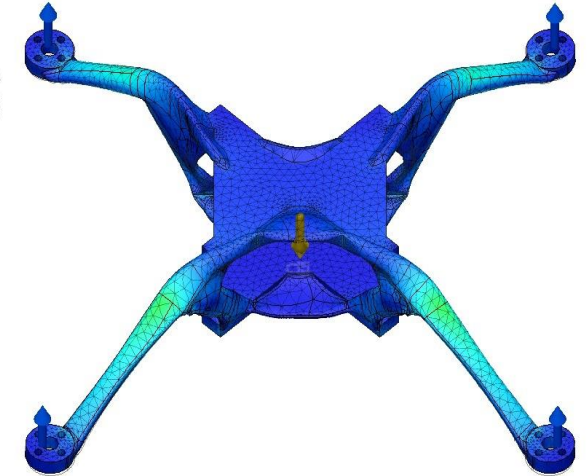
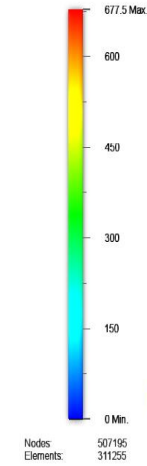
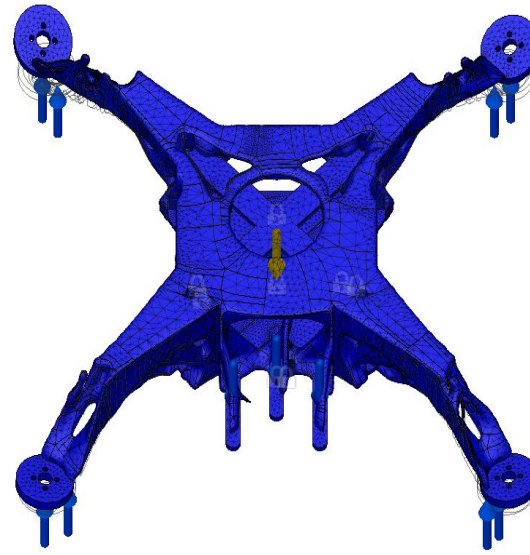


DJI F450 FRAME

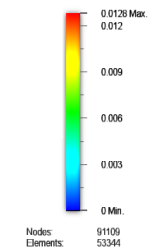
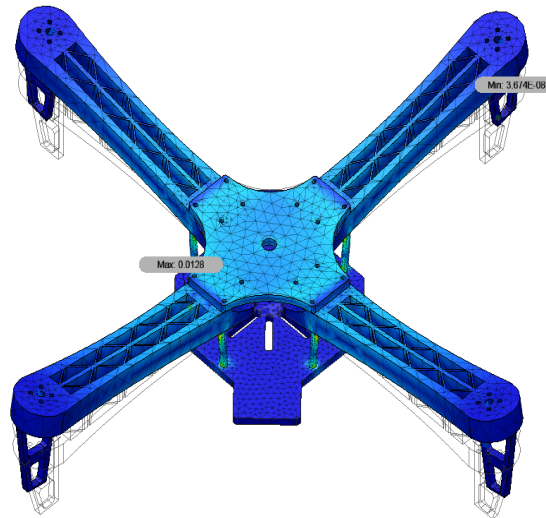
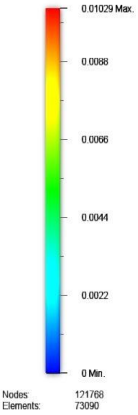
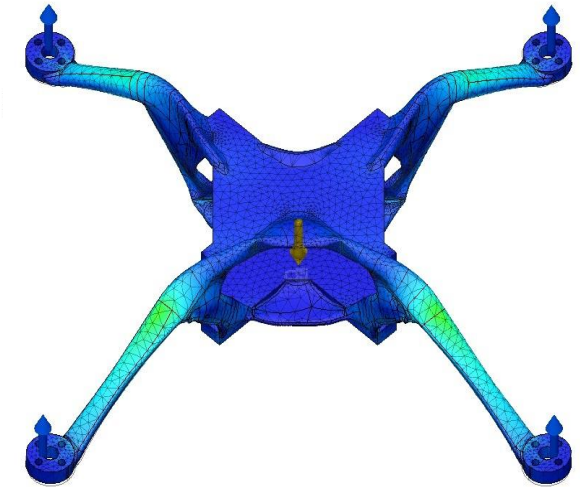
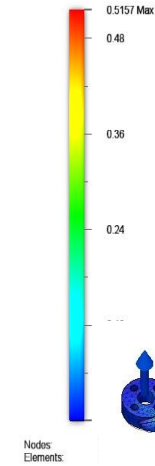
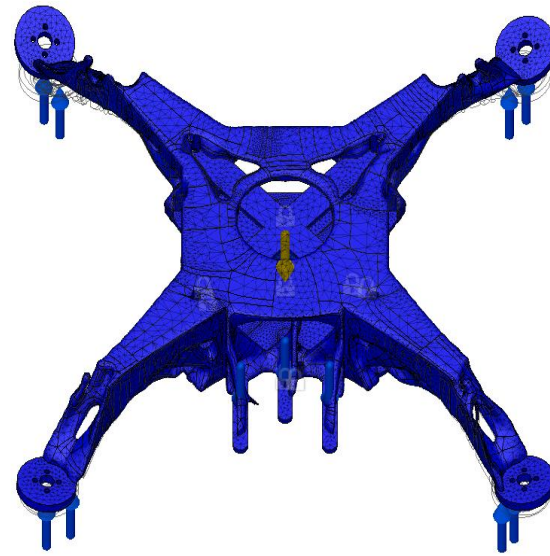
FACTORS	MODEL 1	MODEL 2	DJI F450
Mass of the frame(g)	267	227	330
Minimum FOS	133	13.3	3.301
Manufacturing Method	Additive Manufacturing	Additive Manufacturing	Advanced Manufacturing
Maximum Von Mises stress(MPa)	17.11	1.5	21.33
Maximum Displacement Global(mm)	0.01	6.22	4.016
Material used	ABS	ABS	Polyamide Nylon



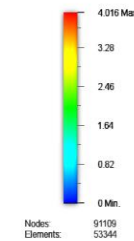
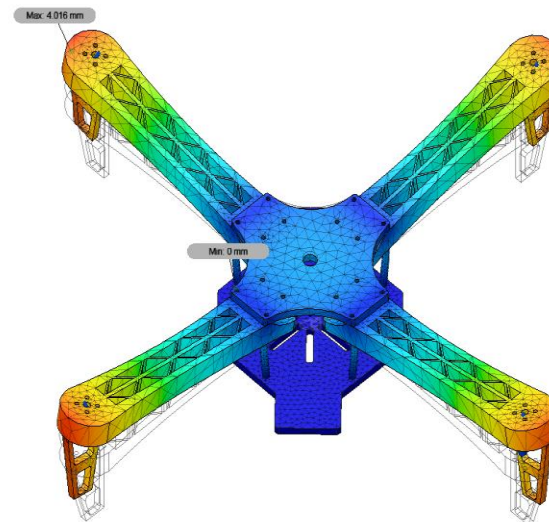
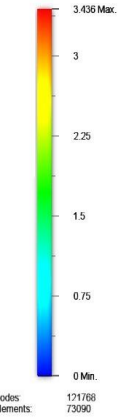
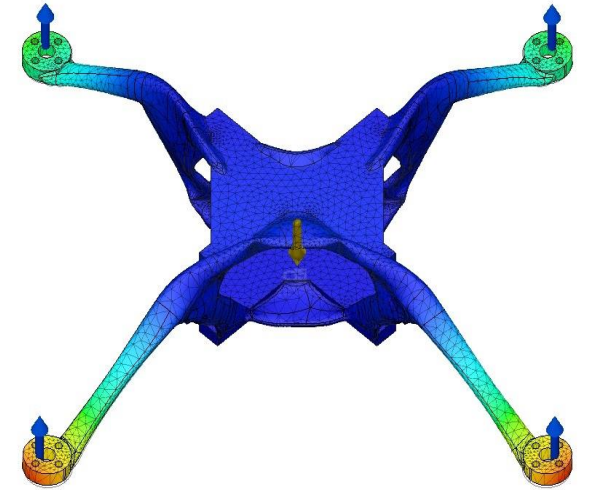
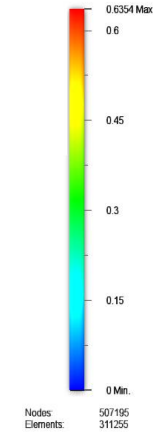
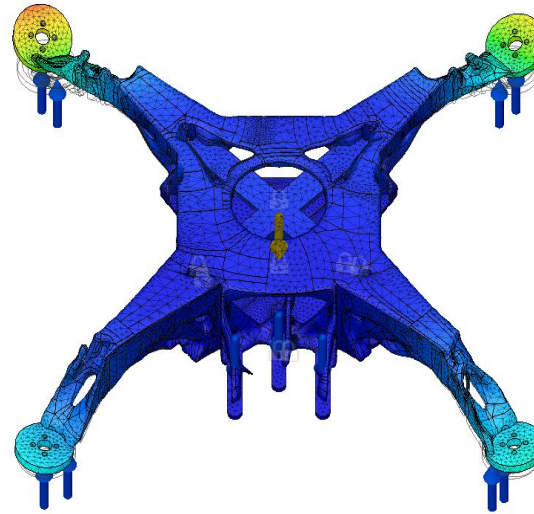
# STRESS ANALYSIS



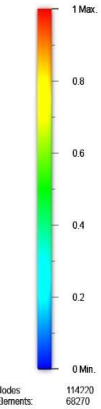
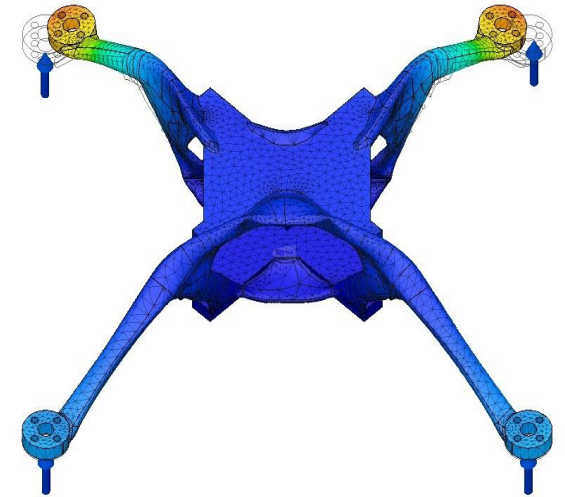
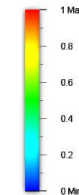
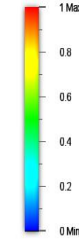
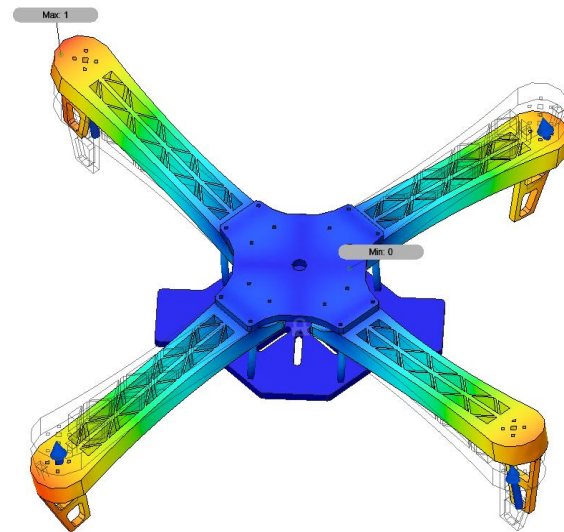
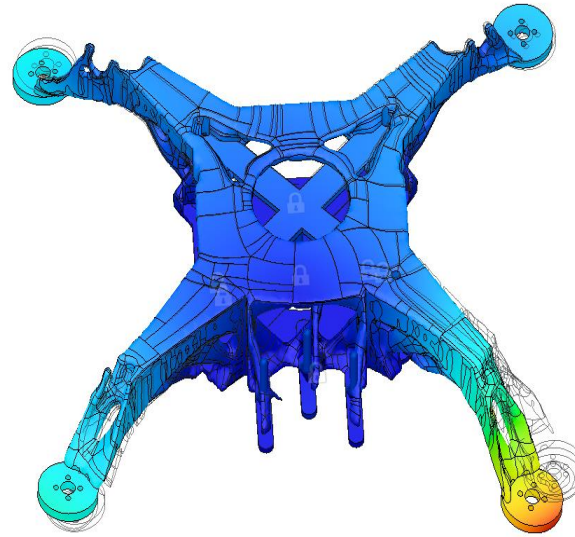
# STRAIN ANALYSIS



# DISPLACEMENT ANALYSIS



# FREQUENCY ANALYSIS AT 300 Hz



# CONCLUSION

All the designs generated are within the safety limits.

Mass is significantly less for generatively designed frames when compared to traditionally designed UAV frame.

Factor of Safety of model 1 is almost 40 times of DJI F450 frame.

Maximum displacement of model 2 is just about 0.1 mm under the loading conditions which is 400 times when compared to DJI frame.

Von Misses Stress is 11.4 times less for the model 2 frame in comparison to DJI F450 frame.

Model 1 and 2 can withstand cyclic load and can survive from failure for a longer period of time when compared to the F450 frame.

# **Thank you**

