



IMEPRIAL COLLEGE SPACE SOCIETY:
HPR Project Team

Project Mach One: Materials and Part List

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Abstract:

This document contains our most up to date materials and parts list. It holds all body dimensions, ISO screw and specific part sizes. Where required, specific manufacturing notes are included to elaborate any multistage processes that are required to make a specific component. Drawings and figures are included in sections where there may be a possible loss of context or ambiguity in any of the parts labelled. This is to ensure that a clear understanding of the design is maintained.

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1 External Components

1.1 Body Tube/Airframes

Body Tube Section	Material	External Diameter (mm)	Internal Diameter (mm)	Length (m)	Weight (g)	Supplier	Notes:
Upper Stage	Carbon Fibre	57	55	0.9	237	Black Cat Rocketry	"woven fabric wrapped carbon fibre airframe tubing is provided in gloss finished form and requires no surface preparation."
Lower Stage	Carbon Fibre	57	55	0.7	187	Black Cat Rocketry	

Table 1: Air frame Specifications

1.2 Fins

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Fins	Material	Shape	Cross - Section	Thickness (mm)	Span (mm)	Root Chord (mm)	Tip Chord (mm)	Weight/fin (g)	QTY	Notes:
Upper Stage	Aluminium	$\frac{5e^{0.5x}}{1+e^{0.5x}}$ $-6 \leq x \leq 6$	Rectngular	1.0	49.6	12.8	-	29.9	3	Laser Cut by ESSEX Lasers
Lower Stage	Aluminium	Trapeziodal	Rectangular	1.0	42.5	114	55	29.4	3	Cut on Sheet Metal Cutter: Sweep length is 52mm

Table 2: Fin Characteristics

CAD Designs of the fins are placed on the following page.

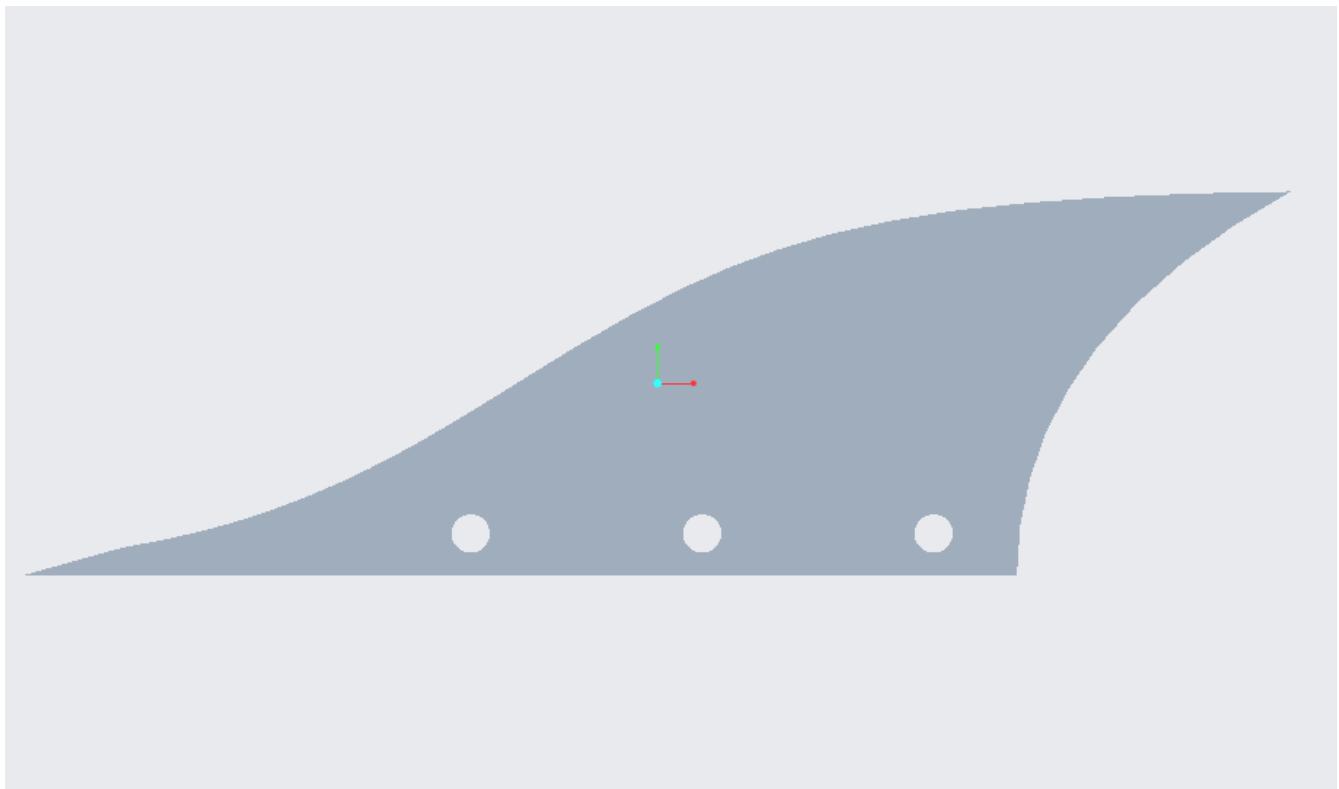


Figure 1: Supersonic Fin

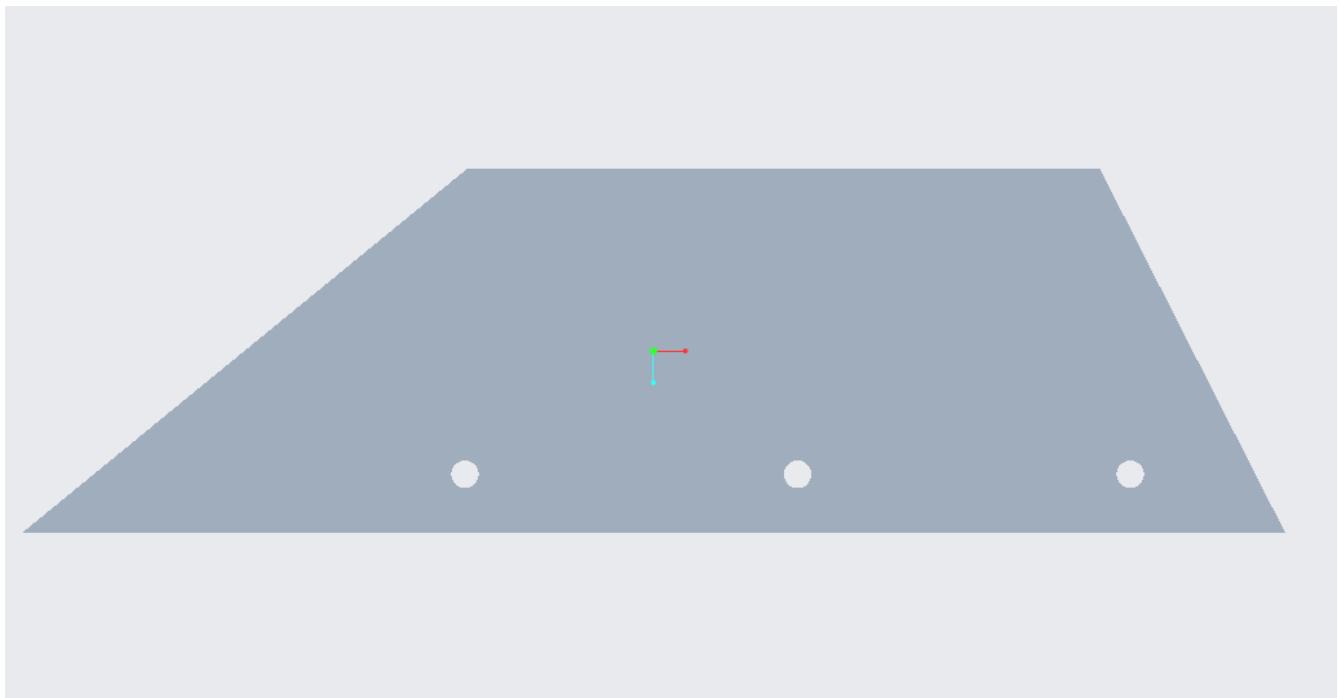


Figure 2: Subsonic Fin

1.3 Fin Mount

Fin Mount	Material	Thickness (mm)	Internal Diameter (mm)	External Diameter (mm)	Effective Diameter (mm)	External Diameter (mm)	Weight (g)	QTY	Notes:
Upper Stage	ABS - reinforced with Carbon Fibre	3	57	63		73	124.8	1	3D printed in house. Careful considerations have been made to the Tg (glass transition temperature) of the upper stage fin mount to ensure that this material will not soften during flight.
Lower Stage	ABS	3	57	63		73	98.8	1	

Table 3: Outline of Fin Characteristics

Each mount has 9x3mm holes to allow the fins to be bolted on. Nylon nuts will be placed in the 3D printed recess and will secure the fins to the mount. This can be seen in the image below.



Figure 3: Finmount

1.4 Motor Retainers

Part	Material	Internal Diameter (mm)	External Diameter (mm)	Length (mm)	QTY	Supplier	Notes
Motor Retainer	Aluminium	41.2	45.0	34.0	2	Black Cat Rocketry	Streamlined with internal threaded retention ring To be used on both stages

Table 4: Motor Retainer

1.5 Nosecone

Part	Material	Shoulder Diameter (mm)	Shoulder Height (mm)	External Lip Diameter (mm)	Internal Diameter (mm)	Total Height (mm)	Shape	Internal thread Pitch and length (mm)	Weight (g)	QTY	Supplier
Nose Cone	ePLA	54.5	80	57	45	330	Von Karman Hack series	Pitch: 4.0 Length:35	244	1	RENND 3D Manufacturers

Table 5: Nose Cone Specifications

The Nosecone has an internal thread. This is so we can place electronics in the nose cone and seal them in with a screwed cap.

1.6 Threaded Nose Cap

Part	Material	Internal Diameter (mm)	External Diameter (mm)	Base Diameter (mm)	Base Height (mm)	Total Height (mm)	External thread Pitch and length (mm)	Weight (g)	QTY
Nose Cap	ABS	40	44.7	54.5	5	41.5	Pitch: 4.0 Length:35	28.3	1

Table 6: Nose Cap Specifications



Figure 4: Nosecone



Figure 5: Nose Cap

2 Internal Components

2.1 Motors

Motor (comes with igniter, nozzle, Motor tube and ejection charge)	Name	Manufacturer	Supplier	Diameter (mm)	No. of Grains
Upper Stage	Pro38-J357	Cesaroni	Rocketry and Things	38	5
Bottom Stage	Pro38-I540WT	Cesaroni	Rocketry and Things	38	5

Table 7: Motors

2.2 Motor Casings

Motor Casings	Name	Manufacturer	Supplier	Diameter (mm)	QTY
Both Stages	Cesaroni- 5G casings	Cesaroni	Rocketry and Things	38	2

Table 8: Motor Casings

2.3 Motor Mount Tubes

Motor Mount Tubes	Material	Internal diameter (mm)	External Diameter (mm)	Length (mm)	Supplier	Diameter (mm)	QTY
Both Stages	Phenolic Tubing	38.6	41.1	36.7	Black Cat Rocketry	38	2

Table 9: Motor Mount Tubes

2.4 Centering Rings

Centering Rings	Material	Internal Diameter (mm)	External Diameter (mm)	Thickness (mm)	QTY	Weight/ring (g)
Upper Stage	Birch Plywood (laser cut)	41.5	54.7	9.0	4	5.8
Bottom Stage	Birch Plywood (laser cut)	41.9	54.7	9.0	4	5.8

Table 10: Centering Rings

2.5 Bulkheads and Fixture Plates

The eye bolts for the shock chords will be attached to a modified version of a centering ring (fixture plates) that will be placed at the tail end of the motor mount tubes. The modification is that the internal diameter is smaller, providing more space for the eye bolts and a locking nut.

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Bulk Heads	Material	Location	Diameter (mm)	Thickness (mm)	Weight/bulkhead (g)	QTY
Bottom Stage	Birch Plywood	Top and Bottom of Ignition electronics Housing	41.9	6.0	9.0	2

Table 11: Bulk Heads

Fixture Plates	Material	Location	Internal Diameter (mm)	External Diameter (mm)	Thickness (mm)	Weight/bulkhead (g)	QTY (i.e per stage)
Both Stages	Birch Plywood	Top of motor mount Tube	32.0	54.7	12	11.9	1

Table 12: Modified centring rings (fixture plates)

2.6 Parachutes

Upperstage

Parachutes	Material	Name	Diameter (in)	Cd	Manufacturer	Weight (g)
Main Chute	Enhanced-Rip Stop Nylon	IFC-30-SL	30	2.2	Fruity Chutes	46
Drogue Chute	Rip-stop Nylon	BCC-24	24	1.5	Black Cat Rocketry	72

Table 13: Upper stage Parachutes

Bottom Stage

Parachutes	Material	Name	Diameter (in)	Cd	Manufacturer	Weight (g)
Main Chute	Rip-Stop Nylon	CFC-30-S	30	1.6	Fruity Chutes	56

Table 14: Bottom stage Parachute

2.7 Shock Chords

Shock Chords	Material	Thickness (mm)	Length (m)	Manufacturer	Weight (g)
Upper Stage: Drogue	Kevlar (fire resistant)	5.0	5.0	Black Cat Rocketry	20
Upper Stage: Main	Nylon	15.9	5.0	Black Cat Rocketry	-
Bottom Stage Main	Kevlar (fire resistant)	5.0	10.0	Black Cat Rocketry	40

Table 15: shock chords

2.8 Inter-stage Coupler/Support

Part	Material	Total Length (mm)	Internal Diameter (Bottom stage half) (mm)	External Diameter (Bottom stage half) (mm)	Internal Diameter (top stage half) (mm)	External Diameter (top stage half) (mm)	Weight (g)
Inter-stage Coupler Support	Onyx Reinforced with 30% Carbon Fiber	200	42.0	54.8	48.5	54.8	196.7

Table 16: Interstage Coupler

The inter-stage coupler is subset 100mm into the top stage and 100 mm into the bottom stage. It has 4 cut slits in the top stage so it can conform with a special cut centring ring that allows for the slit to pass through.

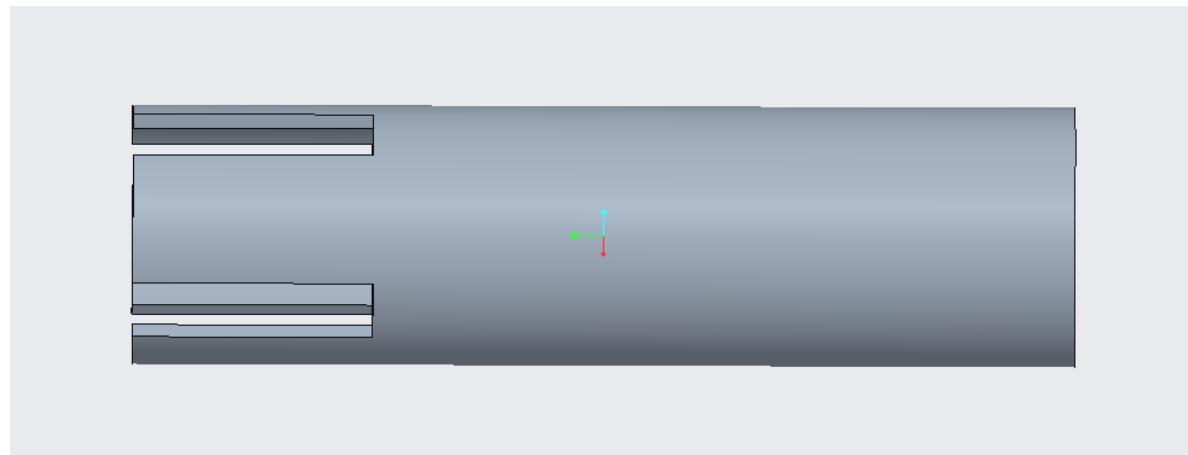


Figure 6: Inter-stage

2.9 Hardware

Overview

Hardware	Qty	Bespoke or Standard	Weight/unit (g)
Quick links : (5mm diameter)	3	Standard	63
Eye Bolts (M4×10)	5	Standard	18
Nyloc Nut (M4)	5	Standard	3
Washer (M4)	5	Standard	1
Chute Release	1	Bespoke	98
Nose Cone Payload Bay and Electronics	1	Bespoke	max(220)
Second Stage Ignition Electronics System and Bay	1	Bespoke	max(110)
Nomex Sheets cut to size	-	Standard	-

Table 17: Hardware Overview

The max weight allocated has been given. Currently the designs are less than this; but we have added contingency's in-case extra redundancies and components are needed.

Chute Release

QTY	Part
1	50gf Pull Stroke Linear Actuator
1	Solderable Bread Board
3	3V Lithium Coin Cell
1	Coin Cell Casing
1	BMP180 Pressure and Altitude Sensor
1	3D printed casing
1	Elastic Chord
1	Metallic Loop (3mm Thick)
1	Elegoo Nano Micro-Controller

Table 18: Chute Release Components

Second Stage Ignition System

QTY	Part
1	Bulk Head - (42mm x 3mm) (covered in Nomex heat shield)
1	Bulk Head - (42mm x 6mm)
1	Arduino Nano Micro Controller
1	High G Accelerometer
1	DS3231 Precision Timer
1	Linear shift switch
1	850 mAh Battery with JST
1	MakerHawk GPS Module 51
1	Acrylic Backing (40 x 3 x 50mm)
1	(Igniter) - Placed in system before launch

Table 19: Staging Components

Nose Cone Payload

QTY	Part
1	Payload Mount
1	Arduino Nano Micro Controller
1	HiLetgo 5pcs Micro SD TF Card Adapter Reader Module 6Pin
1	DS3231 Precision Timer
1	MakerHawk GPS Module 51
1	Charging circuit and transformer to 5V
1	850mah battery with JST
1	BMP180 Pressure and Altitude Sensor
1	MPU6050 3 Axis Accelerometer Gyroscope
1	High G accelerometer

Table 20: Staging Components

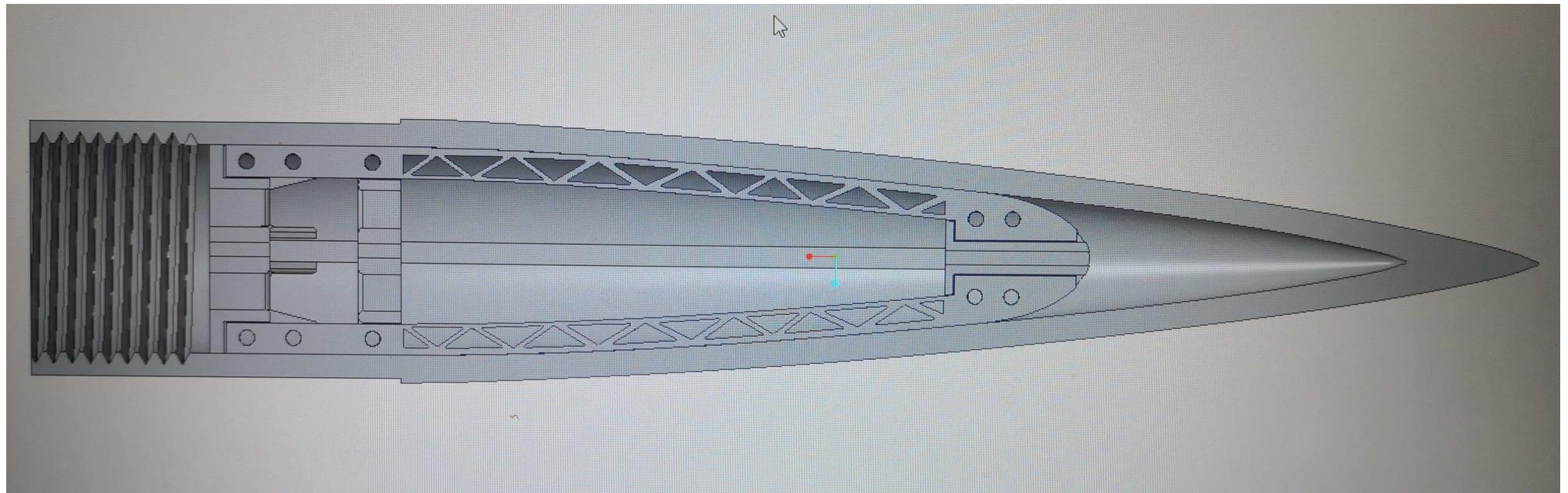


Figure 7: Payload Bay Inside Nose Cone



Figure 8: Payload Bay and Mount

3 Adhesives and Fittings

Part A	Part B	Fitting	Adhesive	QTY (fitting only)	Additional Components (fittings only)
Supersonic fin	Supersonic fin mount	M3 × 6 mm Countersunk Cross-head Screw	-	9 (3 for each fin)	3mm Nyloc Nut
Subsonic fin	Subsonic fin mount	M3 × 6 mm Countersunk Cross-head Screw	-	9 (3 for each fin)	3mm Nyloc Nut
Centring Rings	Motor Mount Tube	-	JB Weld Epoxy Adhesive	-	-
Centering Rings	Interior of Airframe	-	JB Weld Epoxy Adhesive	-	-
Centering Ring	Modified Centring Ring	-	JB Weld Epoxy Adhesive	-	-
Supersonic Fin Mount	Exterior Surface Air Frame	-	JB Weld Epoxy Adhesive	-	-
Subsonic Fin Mount	Exterior Surface Air Frame	-	JB Weld Epoxy Adhesive	-	-
Motor Retainers	Motor Mount Tube	-	JB Weld Epoxy Adhesive	-	-
Acrylic Backing	Plywood Bulk Heads	-	JB Weld Epoxy Adhesive	-	-

Table 21: Adhesives and Fittings