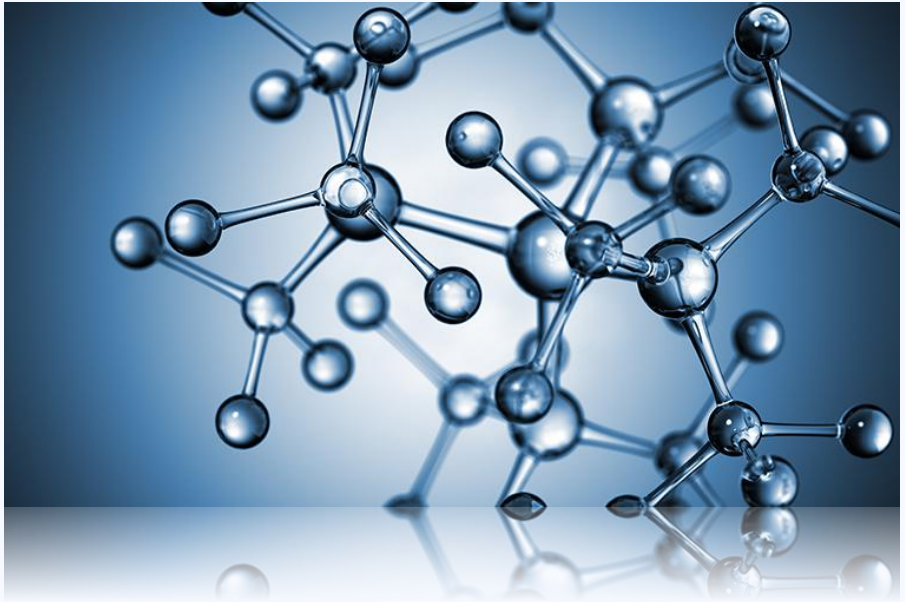
Material Selection and Analysis



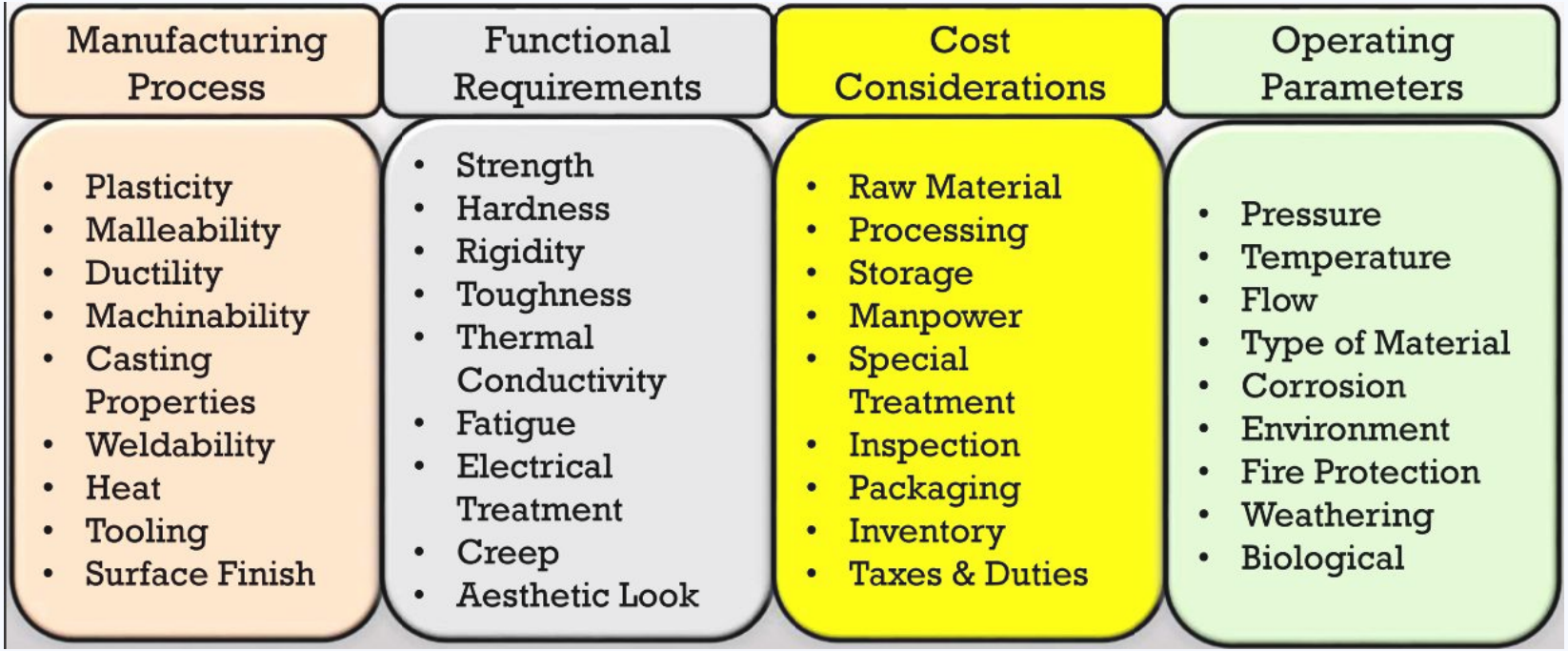
- After your last lecture on parachutes and descent control mechanisms, we will now be telling you how to select appropriate materials and manufacture your SATCAN!

Material Selection

There are several types of materials available to us for manufacturing various CANSAT components, such as:

- Thermoplastics - ABS, PVC
- Composites - Glass Fiber, Carbon Fiber
- Metals and Metal alloys
- Balsa wood
- Monokote

Factors Affecting Material Selection

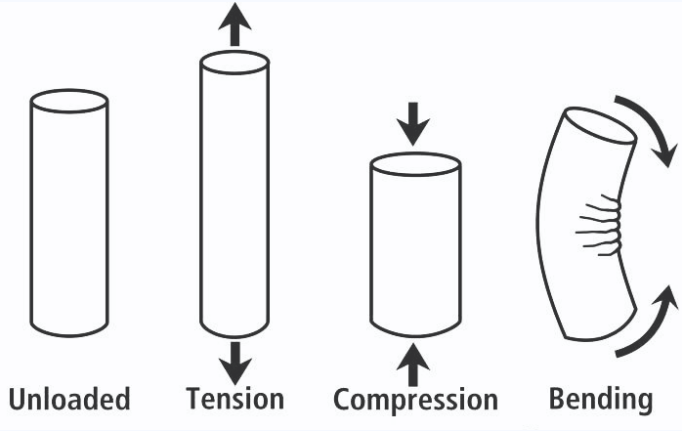


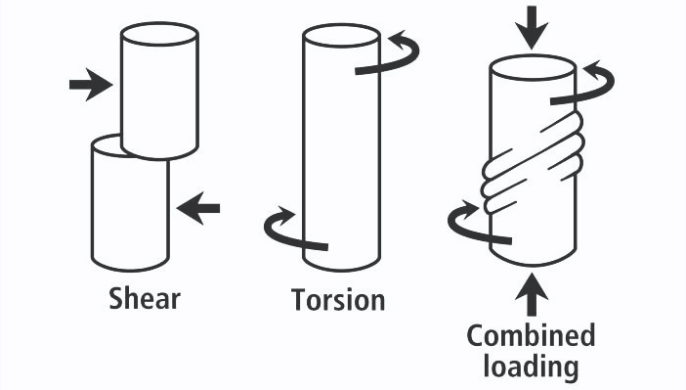
Things to evaluate in a material:

- Processing and manufacturing requirements
- Applicability of material in problem statement
- Technical properties (Mechanical, electrical, chemical, thermal, etc.)
- Availability and cost of material

Steps for the Material Selection Process:

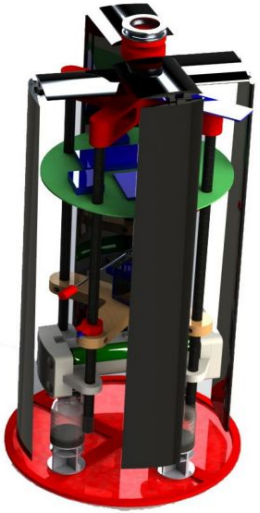
- Identify the design requirements
- Identify the materials selection criteria
- Identify candidate materials
- Evaluate candidate materials
- Select suitable material


Unloaded
Tension
Compression
Bending

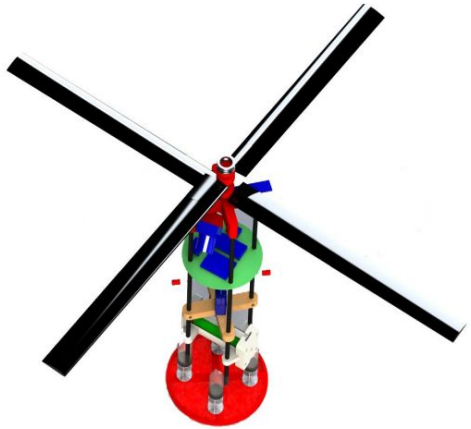

Shear
Torsion
Combined loading

Previous Year Example: Payload

STOWED CONFIGURATION



DEPLOYED CONFIGURATION



Key trade issues and materials considered for Payload mechanical layout

S. NO	COMPONENT	TRADE ISSUES	MATERIAL CONSIDERED
1	Auto-gyro blades	• Strength • Smoothness • Weight • Fabrication capability • Cost	• Balsa • ABS • PLA
2	Mounting rods	• Weight • Fabrication capability • Structural strength • Cost	• Carbon fibre • Glass fibre
3	Battery case	• Weight • Structural strength • Fabrication capability • Ease of assembly and disassembly • Cost	• ABS • PLA

S. NO	COMPONENT	TRADE ISSUES	MATERIAL CONSIDERED
4	Shaft	• Structural Strength • Weight • Fabrication capability • Cost	• Balsa • ABS • PLA
5	Suspension mechanism	• Weight • Shock absorption • Cost	• Carbon fibre • Glass fibre
6	Servo base	• Weight • Structural strength • Fabrication capability • Ease of assembly and disassembly • Cost	• ABS • PLA

1. Auto-gyro blades:

MATERIAL	PROS	CONS
ABS	• **High resistance** • **More durable** • **Lighter than PLA**	• **Weaker than PLA** • **Expensive**
Balsa	• Light weight	• Fabrication • Low strength
PLA	• High strength and stiffness • Cheap	• Low melting temperature • Poor impact resistance • Susceptible to moisture

2. Mounting rods:

MATERIAL	PROS	CONS
Carbon fibre	• **High stiffness** • **High tensile strength** • **Light**	• **Expensive**
Glass fibre	• Better durability • Cheaper	• Low stiffness • Heavier than carbon fibre

3. Battery case:

MATERIAL	PROS	CONS
ABS	• **High impact and heat resistance** • **More durable** • **Lighter than PLA**	• **Less rigid than PLA** • **Expensive**
PLA	• High strength and stiffness • Cheap	• Low melting temperature • Poor impact resistance • Poor durability

4. Shaft:

MATERIAL	PROS	CONS
Carbon fibre	• **High stiffness** • **High tensile strength** • **Light**	• **Expensive**
Balsa	• Light weight	• Low stiffness and strength
ABS	• High impact resistance	• Less strength than carbon fibre • Heavier

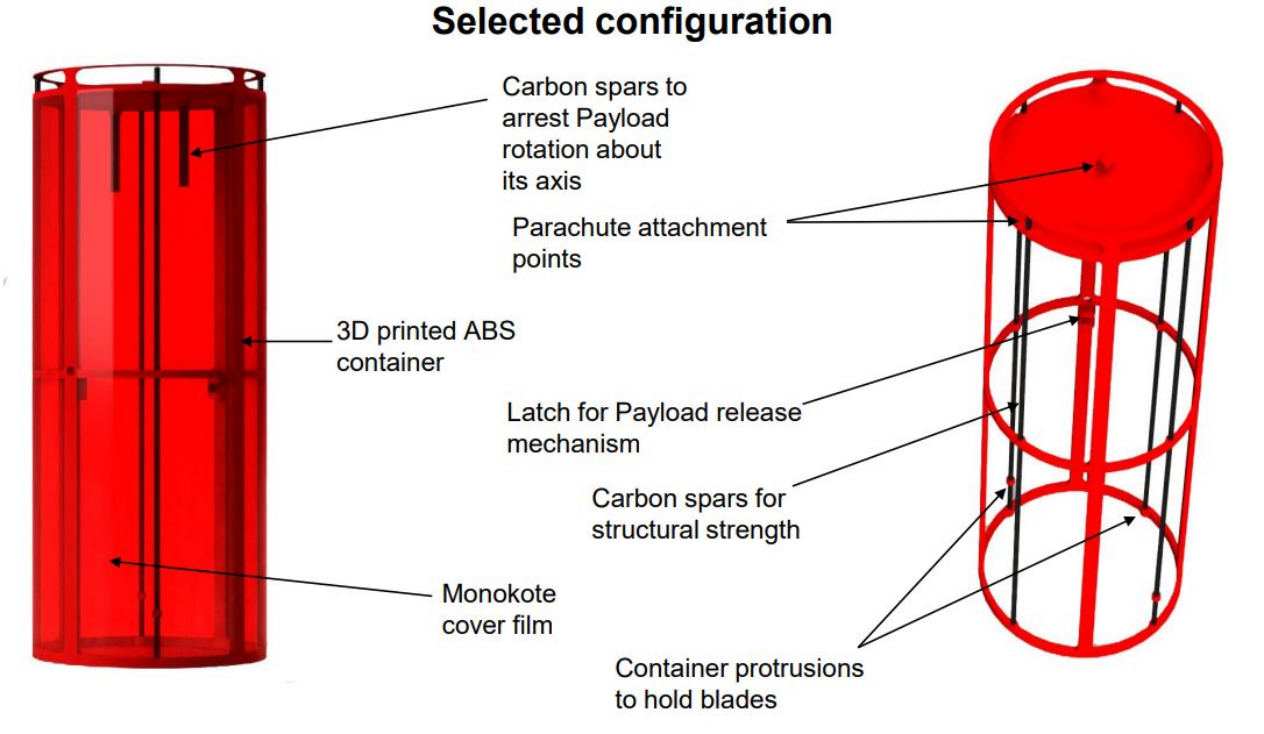
5. Suspension mechanism:

COMPONENT	PROS	CONS
Syringe	• **Convert shock energy to work done by friction and rubber cap** • **Some energy is utilized to compress air** • **Light weight** • **Commercially available**	• **Integration**
Polyurethane foam	• Cheap • Easily available • Damping effect • Shock absorption	• Heavier • Requires more space
Bent PVC pipes	• Easy to fabricate	• Transmit some of the shock to the Payload
Springs	• Commercially available	• Heavy • The Payload can rebound after landing

6. Servo base (X-plate):

MATERIAL	PROS	CONS
ABS	• **Can be hard mounted** • **More fabrication freedom** • **Ease of fabrication**	• **Heavier than Balsa** • **Expensive**
PLA	• Can be hard mounted • More fabrication freedom	• Heavier than Balsa or ABS
Balsa	• High strength to weight ratio • Easily available	• Fabrication • Need to use external mechanism to mount it as super glue weakens the structure

Previous Year Example: Container



Trade selection for container mechanical layout

1. Container:

MATERIAL	PROS	CONS
ABS	• **High impact and heat resistance** • **More durable** • **Lighter than PLA**	• **Weaker than PLA** • **Expensive** • **Susceptible to moisture**
Nylon	• Light • More durable • Less expensive	• Susceptible to moisture
PLA	• High strength and stiffness • Cheap	• Low melting temperature • Poor impact resistance • Susceptible to moisture

2. Supporting rods:

MATERIAL	PROS	CONS
Carbon fibre	• **High stiffness** • **High tensile strength** • **Light**	• **Expensive**
Glass fibre	• Better durability • Cheaper	• Low stiffness • Heavier than carbon fibre

3. Covering film:

MATERIAL	PROS	CONS
Solite	• **Light weight**	• **Low tear strength**
PLA	• High tear strength	• High shrink rate • Heavier • Requires more heat

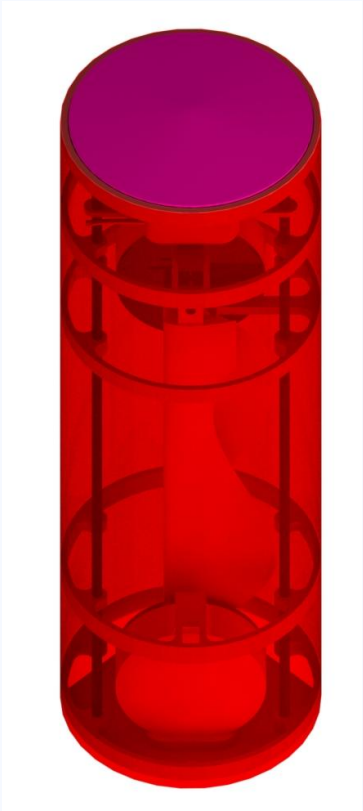
4. Container protrusions:

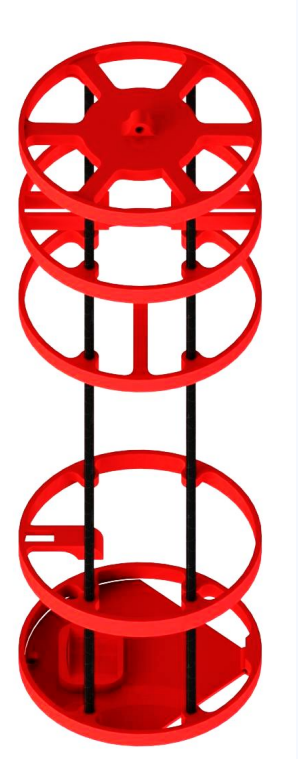
MATERIAL	PROS	CONS
ABS	• **High impact and heat resistance** • **More durable** • **Can be incorporated with the container**	• **Weaker than PLA** • **Expensive** • **Susceptible to moisture**
Carbon fibre	• High stiffness • High tensile strength • Light	• Expensive
Balsa	• Lightest	• May not able to handle the stress exerted by the blades

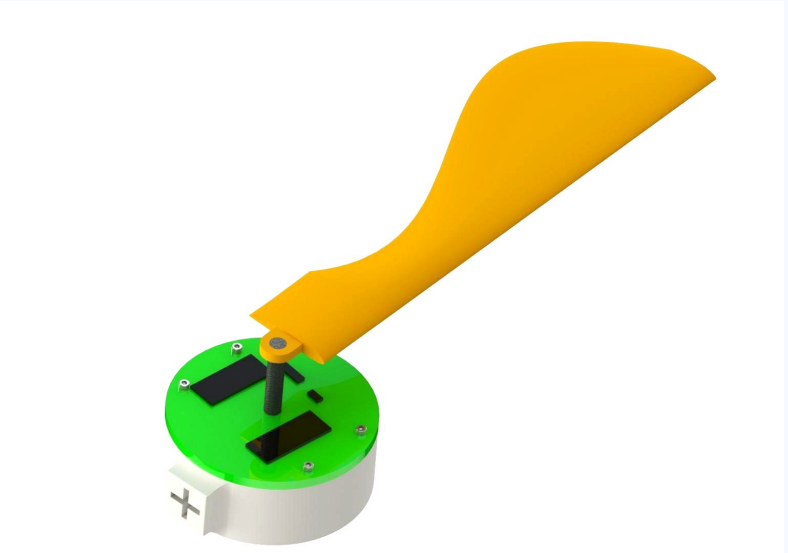
5. Supports to prevent payload rotation:

MATERIAL	PROS	CONS
Carbon fibre	• **High stiffness** • **High tensile strength** • **Light**	• **Expensive**
ABS	• High impact and heat resistance • Less expensive	• Difficult to integrate • Structurally weaker • Susceptible to moisture

Another Example







THANK YOU