

Select a Material for a Drone Arm

Difficulty Advanced	Time 1-2 class periods	Type Aerospace Mission
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Background

A small inspection drone needs a replacement arm. The material must be light, stiff enough, manufacturable, and affordable.

Engineering Problem

Compare candidate materials and recommend the best choice for a defined drone-arm scenario.

Learning Objectives

- Use material properties in a trade study
- Distinguish strength, stiffness, density, and toughness
- Apply weighted decision criteria
- Defend an engineering recommendation

Materials

- Candidate material data sheets
- Decision matrix template
- Calculator or spreadsheet
- Engineering notebook

Procedure

1. Review the mission profile, arm dimensions, expected load, and available manufacturing processes.
2. Compare aluminum, PLA, ABS, nylon, and carbon-fiber composite using density, stiffness, strength, toughness, cost, and manufacturability.
3. Choose weighting factors that total 100%.
4. Normalize or score each material consistently.
5. Complete the weighted decision matrix.
6. Perform one simple mass comparison using equal part volume.
7. Identify one property not captured well by the numerical matrix.
8. Write a recommendation with one risk and one verification test.

Engineering Requirements

- Compare at least five candidate materials
- Use at least six criteria
- Explain all weighting choices
- Include one quantitative mass comparison
- Identify a verification test before flight use

Constraints & Safety

- Use provided or credible property data

- Do not treat all composites as identical
- Recommendation applies only to the stated mission and geometry
- No physical load testing beyond approved classroom limits

Deliverables

- Material-property comparison table
- Weighted decision matrix
- Mass calculation
- Recommendation memo
- Risk and test plan

Reflection Questions

1. Which criterion controlled the result?
2. How would a crash-resistance requirement change the choice?
3. Why might the lightest material not be best?
4. What data would you verify with a supplier?

Engineering Tip

Strength and stiffness are different. A material may resist breaking but still bend too much.

Common Mistake

A decision matrix does not replace judgment. Poor data or arbitrary weights can produce a misleading winner.

Stretch Goal

Recalculate the matrix for a cold-weather mission or a low-cost training drone.

Career Connection

Materials and aerospace engineers select materials by balancing performance, environment, manufacturing, cost, and risk.