

## W14 Element D 7.0 & 8.0 Materials & Fabrication Research

Team Members Full Name:

Project Name/Topic :

Date:

Problem Statement:

### Material Research

- Research THREE materials that your project can be constructed from.
- Briefly describe each method
- List a minimum of 3 PROS and a minimum of 3 CONS for each method
- Proper citation is made for all research materials
- This is research only, not a material decision yet.

### Fabrication Research

- Research THREE materials that your project can be constructed from.
- Briefly describe each method
- List a minimum of 3 PROS and a minimum of 3 CONS for each method
- Proper citation is made for all research materials
- This is research only, not a fabrication decision yet.

### Material Research

(Each person must research a different material type)

#### Material Type

PLA (Polylactic Acid) - Thermoplastic Polymer for FDM 3D Printing

**Material Description-** Use STEM Principles to describe the properties of the material selected.

Science: Biodegradable thermoplastic made from corn starch. Glass transition temp: 60-65°C, melting point: 150-160°C.

Engineering: Tensile strength: 50-70 MPa, impact strength: 2-5 kJ/m<sup>2</sup>, good layer adhesion, ±0.1mm dimensional accuracy.

Math: Density: 1.24 g/cm<sup>3</sup>, cost: \$18-25/kg, ~\$1 per rover chassis (50g part), print time: 2-4 hours.

Technology: Prints at 190-220°C, no heated bed needed, minimal warping, works on all school 3D printers.

#### PROS and CONS for each Material

PROS	CONS
Easy to print (low warping, no heated bed)	Brittle - may fail 0.8m drop test requirement
Cost-effective (~\$1/chassis, fits \$70 budget)	Heat-sensitive (deforms above 60°C in hot cars)

Child-safe, non-toxic, no harmful fumes	UV exposure causes outdoor degradation
Fast prototyping (2-4 hrs) for quick iteration	Cannot handle soldering heat during assembly
Available in multiple colors for neutral design	Creep under sustained load (motor mounts may loosen)

### APA or MLA Citation

Citation:	Simplify3D. (2024). PLA material specifications. <a href="https://www.simplify3d.com/resources/materials-guide/pla/">https://www.simplify3d.com/resources/materials-guide/pla/</a>
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### Fabrication Research (Each person must research a different material type).

#### Fabrication Type/Style:

FDM (Fused Deposition Modeling) or FFF (Fused Filament Fabrication)

**Fabrication Description-** Use STEM Principles to describe the properties of the material selected.

Technology: Additive manufacturing process where thermoplastic filament is heated to 190-220°C and extruded layer-by-layer through a moving nozzle (0.4mm typical diameter) to build 3D objects.  
 Engineering: Layer height: 0.1-0.3mm, build volume: 200x200x200mm (typical school printer), tolerance: ±0.1-0.5mm depending on calibration and geometry.  
 Math: Print speed: 40-60 mm/s, infill density: 10-100% (affects strength vs. material use), support material waste: 5-15% for complex geometries.  
 Science: Controlled heating/cooling cycle creates thermoplastic bonding between layers. Extrusion multiplier and flow rate determine material deposition accuracy.

#### PROS and CONS for each Fabrication method

PROS	CONS
Low setup cost - School already has printers, no tooling investment needed for prototyping	Slow production - 2-4 hours per chassis, can't scale to mass production
Design iteration speed - Change CAD file and reprint same day	Layer lines visible - Anisotropic strength (weaker between layers), may affect durability and aesthetics
Complex geometries - Can print undercuts, internal channels, modular snap-fit connectors without assembly	Manual post-processing - Support removal, surface finishing required, adds time and inconsistency

Material flexibility - Easy to test PLA vs. ABS vs. PETG without changing equipment	Size limitations - Build volume restricts part size, may need to split large components
No minimum order - Print one prototype or 100 parts, no economic penalty for small batches	Mechanical weakness - Layer adhesion creates failure points under impact/stress compared to molded parts

**APA or MLA Citation**

Citation:	Formlabs. (2024). FDM 3D printing: How it works, materials, and applications. <a href="https://formlabs.com/blog/fdm-3d-printing/">https://formlabs.com/blog/fdm-3d-printing/</a> All3DP. (2024). FDM vs. other 3D printing technologies: Complete comparison guide. <a href="https://all3dp.com/1/fdm-fff-3d-printing-technology/">https://all3dp.com/1/fdm-fff-3d-printing-technology/</a>
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