W14 Element D 7.0 & 8.0 Materials & Fabrication Research #2

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Project Name/Topic : Open STEM Project
Date: 1/31/26
Problem Statement: How can we design an affordable, gender-neutral STEM construction kit that promotes authentic inquiry-based learning and guardian-child co-play for children ages 6-13?

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

PETG (Polyethylene Terephthalate Glycol) — Thermoplastic Polymer for FDM 3D Printing

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

Science: PETG is a glycol-modified polyester that is tougher and less brittle than PLA. Typical glass transition temperature is ~80°C, meaning PETG holds shape better than PLA in warm environments (e.g., hot classroom storage, car heat).
Engineering: PETG is commonly used for functional parts because it has higher impact resistance and better flexibility than PLA. It also has low shrink/warping compared to ABS, making it practical for school printers when a heated bed is available. Recommended nozzle temps often fall around 230–250°C, with bed temps around 75–90°C depending on printer and filament brand.
Math: Density is typically ~1.23–1.27 g/cm³. Filament costs commonly land in a similar range to PLA depending on brand; using the same mass estimate as the chassis example (≈50g) keeps per-part cost low (roughly "a few dollars or less," depending on spool price).
Technology: PETG prints similarly to PLA but requires more tuning to avoid stringing and surface "hairs." Many guides describe PETG as beginner-friendly but more sensitive to settings than PLA (especially retraction/temperature).

PROS and CONS for each Material

PROS	CONS
Better heat resistance than PLA (less softening around hot environments)	More stringing/"hairing" than PLA; needs tuning (retraction/temp)
Tougher and less brittle than PLA; good for functional parts and impacts	Heated bed is typically required for best adhesion and consistency
Low warping compared to ABS; suitable for larger prints on school printers	Can be "sticky" during printing and may bond too strongly to some build surfaces (risk of surface damage if not managed)
Better outdoor/UV/environment tolerance than PLA in many use cases (less rapid degradation)	Higher printing temperatures than PLA increase risk of heat-related mistakes (poor cooling can reduce detail/bridging)
More suitable than PLA for load-bearing parts like motor mounts/housings (reduced brittle failure)	Bridging can be worse than PLA; geometry may need design adjustments for clean prints

APA or MLA Citation

Citation:	Simplify3D. (n.d.). Tips for 3D Printing with PETG (Ultimate Materials Guide). https://www.simplify3d.com/resources/materials-guide/petg/

Fabrication Research

(Each person must research a different material type).

Fabrication Type/Style:

Laser Cutting (CO_2 Laser) — 2D Sheet Cutting for Acrylic/Plywood/Hardboard Components

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

Technology: Laser cutting uses a focused CO_2 laser beam to cut sheet materials by melting/vaporizing material along a toolpath. This method is commonly used to produce high-precision 2D parts quickly (plates, brackets, structural panels, spacers), which can then be assembled using fasteners or tabs/slots.
Engineering: Laser cutting supports high repeatability for flat parts and enables clean slot/tab assemblies for modular designs. A key design consideration is kerf (material removed by the laser), which varies by material and thickness; kerf is typically small but must be accounted for when designing tight-fit slots. Math: Part cost is driven by sheet size, cut length, and machine time. Geometry can be "nested" efficiently on a sheet to reduce waste. Dimensional fit is controlled by adjusting slot widths based on kerf and desired clearance (tight friction fit vs. slip

fit). Science: Laser cutting works by transferring energy into the material via light absorption, causing rapid localized heating and phase change (melting/vaporization). Different materials respond differently: acrylic often produces clean edges and is widely used for laser cutting applications.

PROS and CONS for each Fabrication method

PROS	CONS
Fast production for flat parts (plates/brackets) compared to multi-hour 3D prints; supports rapid iteration for chassis panels and mounting plates.	Limited to 2D sheet geometry; complex 3D shapes (motor housings, enclosed electronics) still require 3D printing or multi-part assembly.
High precision and clean edges for many sheet materials; supports accurate slot/tab assembly and repeatable kits.	Kerf and fit tuning required; slot widths may need iteration depending on material/thickness to avoid loose joints or burning away thin features.
No tooling cost (unlike injection molds); ideal for prototypes and small batches.	Material and safety limits: not all plastics/foams are safe to laser cut; school lab rules may restrict materials and supervision requirements.
Efficient material use through nesting, enabling multiple rover parts per sheet at low cost.	Assembly labor increases if many laser-cut pieces are required (fasteners, alignment, stacking), which can reduce "under 30 minutes" assembly goals if overused.
Good for modularity: flat "universal" interfaces can be standardized (mounting hole patterns, plates, brackets).	Edge effects: some materials can show discoloration/charring (notably wood products), which can affect aesthetics for a consumer-facing kit.

APA or MLA Citation

Citation:	Xometry. (2022, November 18). Advantages and Disadvantages of Laser Cutting. https://www.xometry.com/resources/sheet/laser-cutting-advantages/ Ponoko. (2024, June 12). How to Laser Cut Acrylic (The Right Way). https://www.ponoko.com/blog/digital-manufacturing/laser-cutting/how-to-laser-cut-acrylic/