FDM Design Specifications

GUIDELINES FOR ADDITIVE MANUFACTURING OPTIMIZATION

To ensure optimal manufacturing outcomes, part fidelity, and structural integrity, please adhere to the following design specifications. Our production facility utilizes Fused Deposition Modeling (FDM) technology, equipped with an industry-standard **0.4mm nozzle** and high-grade **Polylactic Acid (PLA)** polymer. Designing your models in accordance with these parameters will maximize dimensional accuracy and surface quality while minimizing production costs.

1. Dimensional Tolerances & Nozzle Specifications

FDM processes construct geometry via precise extrusion paths. Designing part features as multiples of the hardware's extrusion width ensures solid structures and avoids unstable algorithmic gap-fill patterns.

Feature	Required Dimension	Engineering Rationale
Minimum Wall Thickness	**0.8mm** (2 perimeters) **1.2mm** (3 perimeters)	Standard extrusion widths range from 0.40mm to 0.45mm. Utilizing multiples of these dimensions prevents internal voids and ensures optimal perimeter bonding.
Surface Embossing & Debossing	Min. **0.4mm** width Min. **0.3mm** depth	Features narrower than the nozzle diameter cannot be resolved by slicing algorithms. Excessively shallow features will be obscured by standard layer topography.

Internal Bores & Holes	**+0.2mm to 0.3mm** diametric offset	Thermal contraction during polymer cooling naturally reduces internal diameters. Mechanical holes for fasteners or pins must be oversized to account for this shrinkage.

2. Overhangs, Bridging, and Support Structures

FDM relies on sequential layer deposition. While our specific PLA cooling configurations are highly optimized, structural design must account for gravitational limitations during extrusion.

- **The 45° Threshold:** Overhangs angled up to 45° from the vertical axis can be successfully manufactured without sacrificial support material. Angles steeper than this require generated supports, which may impact surface finish upon removal.
- **Base Transitions (Chamfers vs. Fillets):** For angled transitions at the base of the model (contacting the build plate), utilize flat 45° chamfers instead of rounded fillets. Fillets initiate at a severe angle relative to the build platform, resulting in unsupported extrusion and geometric deformation.
- **Bridging Capabilities:** Our parameters allow for unsupported horizontal spans (bridges) between **10mm and 30mm**. Design spans to traverse direct linear paths rather than employing sweeping, unsupported arches mid-air.

3. Build Volume Orientation and Plate Adhesion

The FDM process involves dynamic movement of the build platform along the Y-axis. To mitigate vibrational artifacts and prevent part detachment, structural anchoring to the build plate is critical.

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Planar Base Requirement: Orient the model to provide a substantial, flat base for build plate contact. This anchors the part securely during rapid direction changes.

- **Avoiding Pointed Bases:** Designs culminating in a single vertex or minimal contact area at the base should be avoided, or mechanically split into multiple assemblies with flat mating surfaces for later adhesion.
- **Mitigating Base Layer Expansion:** To counteract the intentional first-layer compression required for adhesion (commonly termed "elephant's foot"), integrate a **0.5mm × 45° chamfer** along the bottom exterior edges of the part if strict base dimensional accuracy is required.

4. Z-Axis Resolution and Surface Curvature

Additive manufacturing inherently features lower vertical (Z-axis) resolution compared to planar (X/Y axis) resolution. Gradual, shallow curves on top horizontal surfaces will result in pronounced topographical stepping, reducing aesthetic quality.

- **Geometric Alternatives:** Replace shallow, dome-like top structures with steeper geometries or flat planes transitioning via chamfers. This drastically reduces visible stepping across the uppermost layers.
- **Curvature Orientation:** Where structurally permissible, orient organic or flowing curves vertically. The precision of the printer's X/Y kinematics yields exceptionally smooth surfaces on the vertical plane, bypassing the limitations of Z-axis layer height.

Note on Design Optimization: Adhering to these specifications during the initial CAD phase eliminates the need for excessive secondary support generation, accelerates production time, and ensures the final manufactured component directly correlates with your digital tolerances.