

**PhD Dissertation Defense Announcement**  
**Mechanical and Aerospace Engineering Department**  
**University of Texas at Arlington**

**Experimental Analysis and Characterization of In-situ Heating Method for Fused Filament  
Fabrication of Tall Thin-walled Structures Using Poly Lactic Acid (PLA)**

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1:00 PM, Wednesday, September 3<sup>rd</sup>, 2025

Woolf Hall, Room 200

**Abstract**

Tall thin-walled structures often play a critical role in aerospace, automotive and other applications. Fused filament fabrication of such structures faces challenges due to inherent voids and poor layer-to-layer adhesion, as tall thin-walled structures are printed vertically up to avoid stair-stepping effect. In this work, a previously demonstrated technique of improving layer-to-layer bonding by providing additional thermal energy during printing is utilized to print thin-walled structures that are much taller than standard specimens. Mechanical characterization of parts printed with Polylactic Acid (PLA) is carried out along with characterization including geometric deviation, surface roughness, interlayer bond potential, thermography, and microscopic analysis.

Research demonstrates that providing additional in situ thermal energy more than doubles the bending strength and significantly increases the bonding potential while maintaining or exceeding geometric accuracy and surface finish. Such results are found to be valid for a tall structure with both single bead and multi bead walls, compared to a standard specimen. Several key parameters influencing tensile strength are identified, including print speed, temperature and alignment of the heater block, and filament's condition. While the print speed has a minor effect, the others have a significant effect on the tensile strength of these structures.

Further, a detailed design of experiments (DOEs) is carried out to evaluate the statistical effects of aforementioned key parameters at different levels on mechanical and geometric accuracy of a double bead, tall thin-walled structure printed using in situ heating method. The statistical analysis indicates that all the key parameters are significant in influencing bending strength while the average deviation in length, width or height does not exceed more than 2 mm. Furthermore, the highest bending strength of 53.3 MPa, a 33.5% increase from a standard specimen, is achieved through a combination of aligned heater block at 245 °C using dried filament printed at a speed of 1200 mm/min. The increase in strength is attributed to improved layer-to-layer bonding, change of shape of voids from sharp edge to circular, and reduction in overall void percentage, all while maintaining the geometric accuracy. In overall, this research work brings in situ heating method closer to printing tall thin-walled structures for practical strength requirements.