**Project #11MATS01**

Pranav Addepalli

**Title: Effect of infill parameters on spatiotemporal temperature distribution in fused deposition modeling**

**Abstract:**

Three-dimensional (3D) printing has grown into a widely used technology for consumer and industrial use. Most commercial 3D printers use fused deposition modeling (FDM), a printing technique where a solid thermoplastic filament is repeatedly melted and extruded onto a two-dimensional layer to produce a 3D object. In FDM printing, thermal stresses between layers due to variable thermal conduction during cycles of heating and cooling creates distortions, known as warpage. Various parameters, especially infill percentage, cause thermal properties to become anisotropic because of thermal conduction through plastic, natural convection in air gaps, and the discontinuous nature of plastic. The effect of infill percentage on spatiotemporal temperature distribution and on thermal conductivity was investigated, and a strong, positive association was hypothesized between infill percentage and thermal conductivity due to plastic’s more effective means of heat transfer of plastic when compared to air. Polylactic Acid (PLA) discs of 10%, 20%, and 30% infills were printed and negative temperature coefficient thermistors were embedded to collect spatiotemporal temperature distribution data. The center of temperature and mean temperature at the center was calculated for all times and the temperature gradient was calculated between an equilibrium steady-state point and the centers. The mean gradient for 30% was greater than the mean gradient for 20% (p < 0.0001) and the mean gradient for 20% was greater than the mean gradient for 10% (p < 0.0001), showing a positive relationship between infill percentage and net heat flow.

**References:**

Deng, C., Kang, J., Shangguan, H., Hu, Y., Huang, T., & Liu, Z. (2018). Effects of hollow structures in sand mold manufactured using 3D printing technology. Journal of Materials Processing Technology, 255, 516-523. doi:10.1016/j.jmatprotec.2017.12.031

Mathur, D. S. (1970). Fundamentals of Heat. Amir Chand Marg (Nai Sarak), Delhi-6: Sultan Chand and Sons.

Trhlíková, L., Zmeskal, O., Psencik, P., & Florian, P. (2016). Study of the thermal properties of filaments for 3D printing. AIP Conference Proceedings, 1752. doi:10.1063/1.495525