# Industrial Scale Multi-Material, Coupled Thermo-Structural Optimization (Sim-AM 2019)

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## ABSTRACT

With recent advances in additive manufacturing technology, there has been a renewed interested in the application and development of topology optimization [1] based design tools to exploit the benefits of these advances for aerospace applications. In particular, the ability to fabricate lattice structures at length scales relative to component sizes that are appropriate for homogenization-based continuum analysis offers the potential to enable performance that cannot be achieved with conventional manufacturing processes. In order to unlock this potential, an industrial scale topology optimization tool is being developed for multi-material, coupled thermo-structural optimization. The tool exploits established multi-material topology optimization algorithms for lattice design by treating optimal collections of lattice unit cells as sperate materials, viz., at a given density for a given material the optimal material distribution of stiffness differs from the optimal distribution for conductivity. This approach enables a computationally practical method for local insertion of either a structurally and thermally optimal lattice architecture in a design space to meet global performance objectives. The presentation will cover: 1) optimization of lattice unit cells for thermo-structural performance and development of corresponding material interpolation models for thermo-elastic properties based on homogenization methods that are density and temperature dependent; 2) development of an industrial scale framework for obtaining sensitives from a finite element implementation of nonlinear thermo-elasticity [2]; 3) industrial scale verification examples.

## REFERENCES

1. Bendsoe, M. P., Sigmund, O., “Topology Optimization: Theory, Methods and Applications”, Springer-Verlag, Berlin Heidelberg New York, 2003.
2. Putanowicz, R., et. al., “Finite Element Implementation of Nonlinear Thermo-elasticity as Typical Coupling of Diffusion and Momentum Balance”, Mechanical and Control, vol. 32, 2013