# Generation and Simulation of Lattice Structures

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## ABSTRACT

The additive manufacturing (AM) industry continues to grow with new machines, faster processes and a large selection of materials. As design practitioners, we are excited to unleash the full potential of AM.

Lattice structures are very effective for lightweight structural panels, energy absorption devices, thermal insulation, ballistic protection and porous implants. A Taxonomy of Lattice Structures and an overview of the currently available generation techniques for on surface (i.e. triangle), 2 ½ D (i.e. honeycomb), 3D beam (i.e. Diamond, Octet) and 3D shell (i.e. Gyroid, Lidinoid) lattice structures will be presented.

Modern CAD tools can design, optimize and validate with simulation lattice structures. In addition, recently introduced CAD capabilities, introduced new lattice cells, including voxel based, stochastic, and user-defined. Since all this capability is available within the CAD environment, the designer reduces the product development time and increases confidence in the design.

For small number of the lattice structures a full geometry representation is sufficient for modeling and simulation. For medium number of lattice structures a simplified representation (beams and shells) is required. For large number of lattice structures a homogenization workflow is required. A demonstration of these techniques within the PTC CREO environment will be demonstrated. The Geometric Efficiency Index is the ratio of stiffness reduction over the mass reduction. A technique that explores the effectiveness of a typical lattice structure using the Geometric Efficiency Index will be presented. This technique uses homogenization to compute the Geometric Efficiency Index and enables the designer to select the most efficient lattice structure cell for the demand.

The Topology Optimization Process is used to reduce weight, maintain strength and improve thermal performance in 3D Printed Designs. The main bottleneck in this process is the conversion of topology optimization results back to CAD geometry. This presentation will demonstrate how to combine Sub-Divisional surface modeling, Topology Optimization and Lattice Structure generation tools to generate optimum designs. An example of weight reduction of an avionics heat exchanger without sacrificing any thermal performance will be presented. Examples of light weighting helicopter components using lattice structures and Additive Manufacturing will also be presented.

## REFERENCES

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