Topology Optimization – Design Tool for Additive Manufacturing

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Introduction
Additive manufacturing (AM), also called 3D printing, enables the manufacture of nearly any geometry without the constraints imposed by traditional manufacturing techniques. As this technology advances and the costs of 3D printed parts continue to fall, AM will become a more prevalent and viable engineering and business solution. In order to take full advantage of this technology, new approaches to design need to be implemented in order to facilitate innovation and lightweight design.

What is topology optimization?
Finite element based topology optimization is a process of finding the optimal distribution of material and voids in a given design space, dependent on loading and boundary conditions, such that the resulting structure meets prescribed performance targets.

What is the connection between topology optimization and AM?
Although topology optimization has been an available design tool for a few decades, restrictions imposed by traditional manufacturing techniques have severely limited its usefulness. This is changing now with the continuous development and increased use of AM in industry. With AM, it is possible to print almost any geometry – meaning that there are no longer harsh manufacturing restrictions limiting the potential for optimized design. Now design is limited by imagination and available design tools.

Additional Considerations
While topology optimization can help determine the optimal placement of material in order to meet design requirements, there are additional factors to consider when designing for AM. Successfully printing a part necessitates knowledge of the specific requirements for a given AM technology, material being printed, build direction, build orientation, supporting structures and their removal, and post-processing procedures. VTT has experts in advanced manufacturing techniques, structural design and analysis, and material science all under one roof. Knowledge sharing within these areas of expertise can help ensure successful design and creation of additive manufactured parts.

Why use topology optimization?
Used in the early stages of the design process for concept generation, this technique can automate and expedite the traditional design process by reducing necessary design iterations. Find a truly optimal design, not just a design improvement.

So many reasons to use AM…
- Lower component weight
- Reduce time to market
- Customization of parts
- Design freedom
- Product complexity and flexibility
- Parts consolidation
- Reduce complexity of manufacturing processes
- Reduce stock
- Enable leaner logistics processes

Design outside the box
Top: Nurmi Hydraulics Oy valve block
Bottom: Competition racing kart sprocket connecting joint