Popular science summary of the PhD thesis

PhD student	Peter Dørffler Ladegaard Jensen
Title of the PhD thesis	High Fidelity Multi-scale Topology Optimization
PhD school/Department	Department of Civil and Mechanical Engineering

Science summary

This Ph.D. thesis marks a major leap in the field of multi-scale topology optimization, an area crucial for designing complex engineering structures with high efficiency and structural performance. The research focuses on creating high-fidelity optimization methods that can handle large-scale, real-world engineering challenges using powerful but still commonly available computers.

At the core of the thesis are new techniques in multi-scale topology optimization aimed at designing structures with maximized stiffness. These structures are unique in their internal structure, featuring specific hierarchical lamellar patterns.
Different strategies are presented in the thesis to control the structure of the lamellar patterns and local porosity of the internal structure, to facilitate indirect stability and manufacturability of these structures.

One of the innovative areas explored is feature-mapping-based topology optimization, a type of optimization where strict geometric features are used to design structure. This led to the creation of a new multi-scale feature mapping method, adept at handling issues like overlapping features and space constraints. Additionally, the thesis puts forward advanced techniques for converting theoretical designs into practical designs through processes known as ``de-homogenization methods'', with an emphasis on design structures under multiple loads and with irregular shapes.

The research showcases its value through several examples, proving its computational efficiency and the superior performance of the structures designed using these methods. This positions the work as a significant stride towards developing an interactive, high-fidelity tool for multi-scale topology optimization capable of tackling complex engineering problems.

Finally, the thesis concludes with a preliminary study of a high-fidelity multi-scale wing, highlighting the primary challenges and suggesting directions for future research in this field. This study sets the stage for further advancements in designing more efficient and effective engineering structures through topology optimization.

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Please email the summary to the PhD secretary at the department