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ADVANCES AND COMPUTATIONAL CHALLENGES IN THE INTEGRATION OF ADDITIVE MANUFACTURING AND TOPOLOGY OPTIMIZATION

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ABSTRACT

Additive Manufacturing (AM) and Topology Optimization (TO) are cornerstones of the fourth industrial revolution, both carrying the promise of minimizing materials and resources consumption. The interplay between AM, which allows nearly unlimited geometrical freedom, and TO, fully leveraging AM by complex, multiscale designs with extreme performance, has been opening new design paradigms.

To date, the contact point between the two disciplines mainly consisted in the simplified modelling of geometrical uncertainties, the implementation of the AM design rules as constraints for the TO problem. However, the susceptibility of a design to process-induced stresses (e.g., overheating, or thermo-mechanical stresses) may cause flaws in the final products, crippling the performance or even leading to failure.

Thus, the interdependence between the design geometry and the associated performance in the AM process calls for a more thorough design workflow, integrating performance- and process-design optimization. This is a major task, involving the most advanced techniques available from the two fields, as process physics simulations and sensitivity analyses which are extremely expensive.

This session aims at bringing together researchers working on computational methods from both AM and TO fields. Topics of this session include, but are not limited to:

- modelling of process-physics induced restrictions, and their inclusion in optimization;
- optimization under stochastic geometrical and material imperfections;
- large-scale optimization with many constraints;

- effective multiscale TO solutions;
- AI-based advanced computational methodologies;
- industrial applications showcasing the integrated use of AM and TO.

REFERENCES

[1] J. Liu, A.T. Gaynor, S. Chen, Z. Kang, K. Suresh, A. Takezawa, L. Li, J. Kato, J. Tang, C.C.L. Wang, L. Cheng, X. Liang, A.C. To. *Current and future trends in topology optimization for additive manufacturing*. Structural and Multidisciplinary Optimization (2018) 57:2457–2483

[2] Liang Meng, W. Zhang, D. Quan, G. Shi, L. Tang, Y. Hou, P. Breitkopf, J. Zhu, T. Gao. *From Topology Optimization Design to Additive Manufacturing: Today's Success and Tomorrow's Roadmap*. Archives of Computational Methods in Engineering (2020) 27:805–830