Guidelines for a post processing oriented design of additive manufactured parts for use in topology optimization

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ABSTRACT

By breaking down complex three-dimensional structures into a sequence of comparatively simple two-dimensional layers, additive manufacturing processes offer a multitude of advantages over conventional manufacturing processes. These include the saving of a forming tool, the manufacturability of complex, topologically optimized components and the feasibility of increased functionality by function integration. However, process-specific restrictions, such as the need for support structures and the associated limitation of overhang lengths, must be taken into account.

In order to be able to use the entire potential of additive manufacturing, it is necessary to know the advantages and restrictions and to consider them already during the product development process. For this reason, design guidelines for additive manufacturing processes have been developed and made available to users [1,2,3].

However, a manual check of the design guidelines for topologically optimized components, proves to be highly complex. For this reason, there is a growing need for software tools that perform fully automated verification of design guidelines during topology optimization to enable a robust, cost-effective, additive manufacturing. These software tools have to be based on quantifiable design guidelines for different manufacturing boundary conditions. There are already approaches for an automated design check for production ready, topologically optimized components which should be build with additive manufacturing [4,5].

With regard to a post processing process like milling or turning of additive manufactured components, the dissemination of design guidelines is largely inadequate and the knowledge required for successful component design is still limited. For example, the design of the component must take into account a manufacturing allowance or a chucking possibility. Espacially for freeformed or topologically optimized components this is not a trivial task.

This paper deals with a method for the development of quantifiable, post processing oriented design guidelines. For this purpose, the experimental investigations and quantitative results of design guidelines for laser-beam-melted (SLM) and subsequent machined components made of AlSi10Mg are presented. The resulting design guidelines enable a first time right production and machining of additive manufactured components. As the design guidelines are drawn up in a quantifiable form, an integration into automatic design checking software tools is possible. This allows to check the machinability of complex shaped or topology optimized components during the design process or the topology optimization. Thereby costs and time can be saved and the possibility is given to optimize the component design automatically regarding to a post processing oriented shape.

REFERENCES

[1] D. Thomas: The Development of Design Rules for Selective Laser Melting. Phd Thesis, University of Wales Institute, 2009.
[2] J. Kranz; D. Herzog; C. Emmelmann: Design guidelines for laser additive manufacturing of lightweight structures in TiAl6V4. Journal of Laser Applications, Vol 27 S14001, 2015
[3] G. Adam: Systematische Erarbeitung von Konstruktionsregeln für die additiven Fertigungsverfahren Lasersintern, Laserschmelzen und Fused Deposition Modeling,

Dissertation, Aachen: Shaker Verlag GmbH (Forschungsberichte des Direct Manufacturing Research Centers, 1), ISBN: 978-3-8440-3474-5, 2015

[4] J. Tominski; S. Lammers; C. Wulf; D. Zimmer: “Method for a Software-Based Design Check of Additively Manufactured Components”. 29th Annual International Solid Freeform Fabrication (SFF) Symposium – An Additive Manufacturing Conference. S. 69-79, 2018

[5] S. Lammers; J. Tominski; S. Magerkohl; T. Künneke; T. Lieneke; D. Zimmer: „Design Guidelines for a Software-Supported Adaptation of Additively Manufactured Components with Regard to a Robust Production”. 29th Annual International Solid Freeform Fabrication (SFF) Symposium – An Additive Manufacturing Conference, pp. 527-540, 2018