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Individual metal casting nodes using 3D-Printing technique

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Abstract

In contrast to other economic sectors, the building industry and architecture have changed only slowly in recent decades. While the productivity of the entire economy in the German-speaking region recorded an increase of around 11% between 2006 and 2016, not even half of this growth was achieved in the construction sector during the same period [1]. The reasons for this cannot be found in outdated planning processes; they are mostly highly developed and are carried out using modern digital methods. Deficits or potentials, on the other hand, lie in the transfer of digital data primarily into large-format physical objects, which must meet the specific regulatory, technical, and economic requirements.

In particular, if the material composition is changed by the use of new digital manufacturing technologies, complex investigations have to be carried out in order to gain certifications. This significantly slows down the use of these new technologies such as 3D printing of structural parts.

At the same time, projects such as Ren's and Galjaard's *Topology Optimisation for Steel Structural Design with Additive Manufacturing* [2] demonstrate the potential of using additive manufacturing technologies in several respects. On the one hand they show a contemporary approach in the use of resources, and on the other hand they open up new design possibilities.

The design freedom of large girder structures is essentially determined by the manufacturing possibilities in the area of the intersection points. Not least of all, this fact is pointed out by the project *3D Printed Space Frames* [3] using 3D-printed nodes made of plastic material.

The paper describes how established manufacturing methods and certified materials are used in conjunction with 3D printed formwork for casting geometrically complex structural metal nodes. It lays out a digital process chain from design to fabrication including topology optimization cycles towards structure, material use, and casting limitations. It describes the batch production of individually shaped nodes, which are produced indirectly using a large format continuous sand printer for casting metal cores and thereby custom-made cast metal nodes with approved material properties.

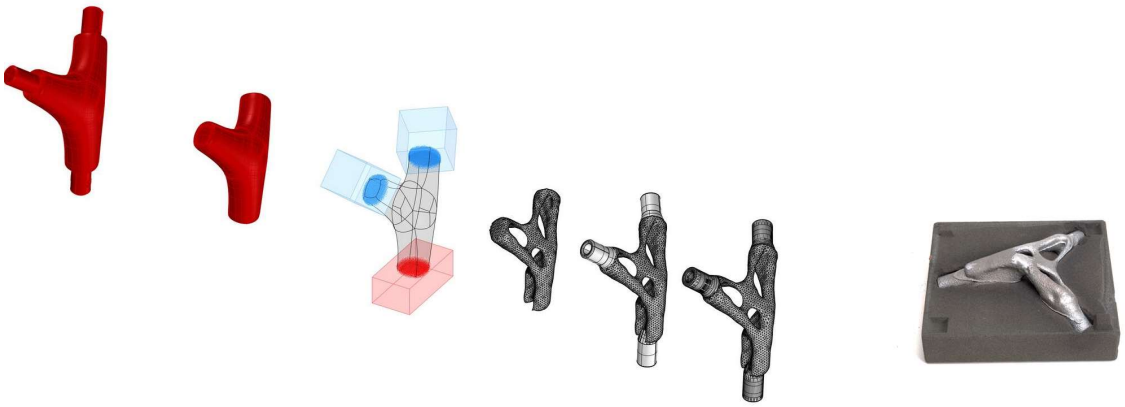

Figure 1: Example of the design process and fabrication of a custom-made cast metal node using 3D-Printing techniques [4]

References

[1] K. S. Schober, P. Hoff, and K. Nölling, *Digitalisierung der Bauwirtschaft: Der europäische Weg zu "Construction 4.0"*. [Online] Available: https://www.rolandberger.com/publications/publication_pdf/roland_berger_digitalisierung_bauwirtschaft_final.pdf.

[2] S. Ren and S. Galjaard, "Topology Optimisation for Steel Structural Design with Additive Manufacturing," in *Modelling behaviour: Design modelling symposium 2015*, M. Ramsgard Thomsen, M. Tamke, C. Gengnagel, B. Faircloth, and F. Scheurer, Eds., Cham: Springer, 2015, pp. 35–44.

[3] F. Raspall, F. Amtsberg, and C. Banon, "3D Printed Space Frames," in *"Creativity in Structural Design" Proceedings of the IASS Annual Symposium 2018: July 16-20, 2018, MIT, Boston, USA*.

[4] M. Niebler and A. Fromm, *3D-Printing cast metal core N1*.