

PRESS RELEASE

October 14, 2025 || Page 1 | 3

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Efficiently 3D-printing tools for the highest component quality: Fraunhofer IWU shows how it's done

Additive manufacturing, particularly the Laser Powder Bed Fusion (LPBF) process, offers new possibilities in toolmaking due to its considerable design freedom. Fraunhofer IWU is unlocking this potential in two research projects, "AdTopoTool" and "EWAM." The goal is to accelerate the development and production of more efficient tools for sheet metal forming and injection molding. This also improves the quality of the components, which can be produced more efficiently using such tools.

AdTopoTool: Efficient material distribution in tools reduces weight by around 30%

Many toolmaking companies still rely on conventional manufacturing methods and designs based on experience. This often results in geometric limitations and heavy tool weights. Consequently, production times and component quality are frequently impacted by insufficient temperature management. In the AdTopoTool research project, the partners Fraunhofer IWU, Werkzeugbau Winkelmühle GmbH, and H+E Produktentwicklung GmbH demonstrated that additively manufactured tools with topology- and cooling-channel-optimized geometries offer significant advantages—despite high demands on the tool's thermomechanical resilience and temperature management. Using topology optimization, the tool achieves an ideal balance of low weight and high stiffness through a smart material layout and enhanced cooling channel design. Using injection molding and press hardening as examples, a numerical method was developed to reliably predict the load and structural behavior of thermally stressed tools. This method was used for the topology optimization and design of cooling channels for one demonstrator tool, each for injection molding and press hardening. The researchers also validated the optimized, additively manufactured tool geometries at a lab scale.

The result: A weight reduction of approximately 34% for the injection molding tool and around 28% for the press hardening tool segment, without compromising form stability.

By implementing more efficient temperature control systems, cycle times for injection-molded components can be reduced by 60%, and heat treatment times for press-hardened components can be almost halved. In some cases, the quality and dimensional accuracy of the end products can even be improved.

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EWAM: Automatic temperature channel design for additively manufactured tools

October 14, 2025 || Page 2 | 3

A lack of experience with additive manufacturing, complex temperature system design, and incomplete construction guidelines have so far hindered the widespread adoption of this technology. To overcome these barriers, Fraunhofer IWU is developing a script-based, automated temperature design in the current EWAM (Efficient Toolmaking with Additive Manufacturing) project. Less manual effort and reduced development time for the tools are expected to significantly increase efficiency. The **EWAM** project aims to develop a software plug-in for the automated design of additive temperature systems. This sophisticated design process intrinsically incorporates both the requirements of **additive manufacturing** and the critical insights derived from **thermal, flow, and stress analyses**. To ensure quick adoption after the market launch, the plug-in will be created in a universal programming language and be compatible with various 3D CAD programs.

The combination of the Laser Powder Bed Fusion process, an optimized tool geometry that accounts for actual process loads, and intelligent tool cooling systems creates real value for medium-sized tool manufacturers. Fraunhofer IWU aims to set new standards for quickly implementable, resource-efficient, and high-quality tool solutions.

Funding note: AdTopoTool – Additively manufactured, topology-optimized tools with added value.

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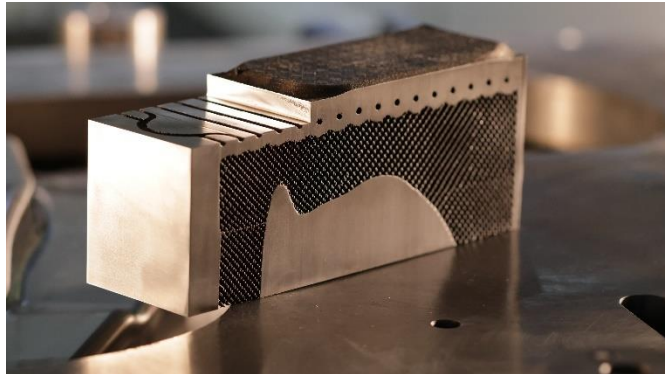


Fig. 1 Additively manufactured, topology-optimized segment of a press hardening tool.
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October 14, 2025 || Page 3 | 3

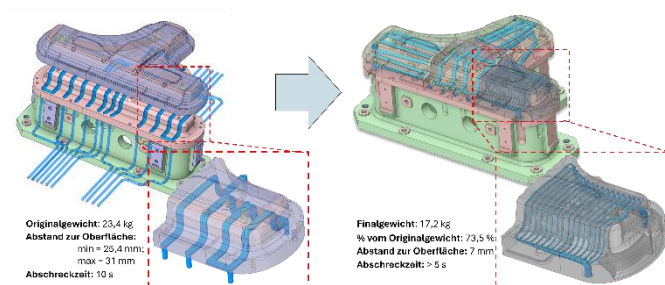


Fig. 2 Left: Original tool; right: the topology-optimized segment has been additively manufactured. The cooling channels are evenly distributed across the tool surface and positioned closer to the surface for better temperature management.
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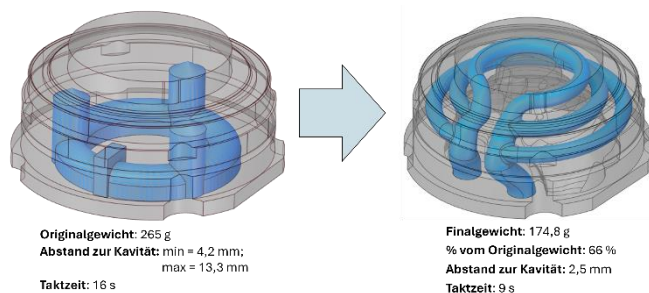


Fig. 3 Significant weight reduction, from 265g to 174.8g, thanks to AdTopoTool. Example of an injection molding tool (left: original tool, right: topology optimized tool).
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