INTELLIGENT-CONTROLLED ADDITIVE MANUFACTURING PROCESS CHAIN USING SIMULATIVE AND EXPERIMENTALLY DETERMINED COMPONENT, MATERIAL AND PROCESS DATA (ReAddi)

The automotive industry is a key industry in Germany and one of the country's largest employers. To withstand international competition and meet increasing customer requirements, innovative, flexible and versatile types of production are in demand. Particularly, electric mobility is greatly interested in lightweight and low vibration parts with a high degree of function integration. Additive manufacturing can make a significant contribution towards realizing such requirements. Within this project, a prototype additive series production will be implemented for the automotive industry.

PROJECT OVERVIEW

DURATION

10/2019 – 09/2022

PARTNER

- Daimler AG
- DMG Mori/ Realizer GmbH
- EDAG Engineering GmbH
- FAU Erlangen-Nürnberg (Institute of Photonic Technologies)
- Heraeus Noblelight GmbH
- Indutherm Gießtechnologie GmbH
- INTES GmbH
- Karlsruhe Institute of Technology (Institute of Production Science)
- Paderborn University (Chair of Design and Drive Technology)
- Protiq GmbH
- QASS GmbH
- Robert Bosch GmbH
- Rosswag GmbH
- Simufact GmbH
- USU Software AG

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In additive manufacturing, laser powder bed fusion (LPBF) is on the threshold of being installed in industrial series production. Having been used in prototype production for many years, it has become a more and more established process for small series production of motor sports components and spare parts. A wide range of applications in the series production of the automotive industry is becoming relevant, especially in the premium segment and for specific components in derivatives. However, LPBF should not be seen as an isolated process, but rather as an important step in a whole process chain extending from part design, powder supply, and the actual LPBF process to post-processing. A major obstacle in further expanding such process chains is the lack of vertical and horizontal data integration and the insufficient coordination of design parameters along the process chain. Nevertheless, data integration must be seen as an exigence for safe production, opening further optimization potentials in the hybrid additive process chain, so that the requirements of automotive series production can be met.

Project overview

Regarding the implementation of a series production of additive manufactured parts in the automotive industry, one aim of this project is the realization of a prototypical line integration. This will allow to gain general knowledge and help in planning of future lines. Threrefore, suitable in-line and in-process measurement technologies will provide feedback from the individual steps of the process. Thereby, in conjunction with suitable algorithms, a control of the individual process parameters in the LPBF process chain can be implemented. For example, information of the LPBF process about geometrical accuracy or part status can be used in the final machining process to ensure optimal and reproducible technical functionality of the finished part by defining appropriate process parameters. The materials used in series production will be specifically attuned to the needs of the applications. To ensure the robust and safe processing of different material, a new type of heating system is developed and integrated into the machine. For an economical production, the system technology is automated at the key points. Therefore, appropriate system and factory concepts will be designed and implemented for partial automation. In order to realize control of the whole process chain and configuration of all parameters, a data integration will be implemented in the planned serial production. For this purpose, all parts of the process chain including the part design, the powder, the LPBF process itself and the post-process are connected and a vertical and horizontal data integration will be achieved.

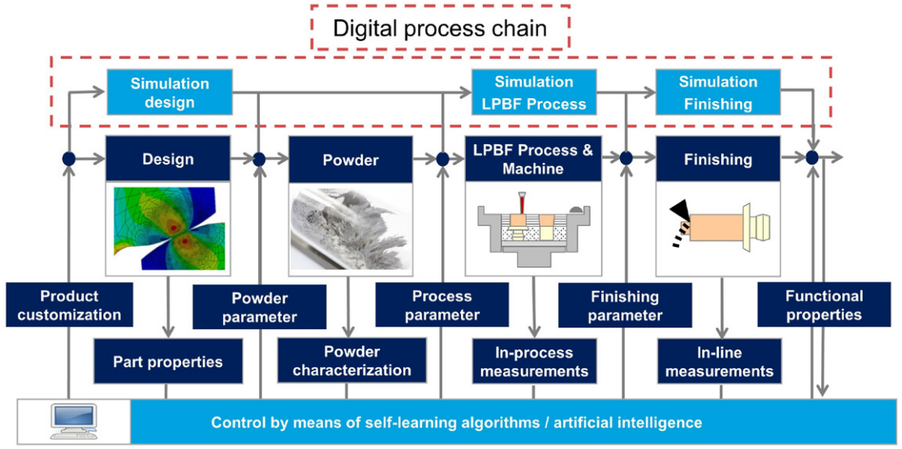

FIGURE 1 Digital process chain and possible control loops

Part design

Especially, in part design for additive manufacturing, the conception and design phases can be digitized for line integration. Within the conception of parts, vibration damping through additively manufactured structures can be improved significantly, whereby the parts have achieved a high level of function integration and function density. These potentials are quantified by experimental investigations, thus enabling the designer to improve the performance of parts. Thereby, additively and conventionally manufactured parts can be compared at an early stage in the design process. As a result of this research, design guidelines for using particle impact damping as an active principle will be derived. The part design is further extended by design guidelines for a manufacturing-oriented support design, which will be digitized in design catalogues. With regard to post-processing, it is indispensable to evolve geometric deviations experimentally and evaluate these results with machine learning methods. Recommendations for a design of the parts suitable for measuring must also be drawn up. The aim is to optimize the part design based on their function and the necessary tolerance values and thus enable a robust process chain. The process parameters and their influence on the part quality will be examined by differnt project partners. Results at the end of the process chain can be given back into the part design in order to iteratively analyze and improve either the parts or the process parameters. The experimentally determined results in particle impact damping, manufacturing-oriented support design and geometric deviations are converted into digital active principles, design guidelines and tolerance catalogues and thus serve the line integration in software tools within the project. Using artificial intelligence and machine learning will help create a universally applicable and general digital process chain as an addition to the actual process chain