



1 *More efficient process chains by combining innovative manufacturing technologies and intelligent data and resource management*

ULTRA-SHORT PROCESS CHAINS FOR GEARBOX HOLLOW SHAFT MANUFACTURING

Fraunhofer Institute for Machine Tools and Forming Technology IWU

Reichenhainer Strasse 88
09126 Chemnitz, Germany

Department Cold and Precision Forming

Dr.-Ing. Udo Hellfritsch
Phone +49 371 5397-1334
udo.hellfritsch@iwu.fraunhofer.de

Department Corporate Management

Dr.-Ing. Andreas Schlegel
Phone +49 371 5397-1177
andreas.schlegel@iwu.fraunhofer.de

www.iwu.fraunhofer.de
www.e3-fabrik.de

The E³ concept puts the view of interactions among the levels of technologies and equipment, logistics and factory processes, and the integration of the human being into production in a new analytical-methodological context. This change in perspective opens up new opportunities for specific solutions to address key manufacturing engineering requirements by using and implementing synergy effects.

The challenge

The Fraunhofer IWU has become a leader in the production of rotary parts by forming. Gear tooth forming by means of gear tooth rolling and the manufacturing of the hollow shafts by means of spin extrusion are two technologies that have been engineered and can be employed to optimize production engineering process in terms of resource efficiency. However, when implementing these methods in an industrial setting, the challenge is that the upstream and downstream process steps have to be modified to suit these new,

more efficient technologies and processes in industry. The focus is on the development of holistic process chains based on forming, beginning with component design tailored to this technology, including performing the component analysis in comparison with conventional techniques, and concluding with the introduction of series manufacturing by the final customer. The technical preconditions to test these new, ultra-short process chains under factory conditions were created in the "Powertrain" competence area of the "E³ Research Factory for Resource-efficient Production".



2

The overall process chain also must be monitored as thoroughly as possible in order to synchronize the individual processes according to the interaction of the pre- and post-process steps and to react early on errors.

The approach

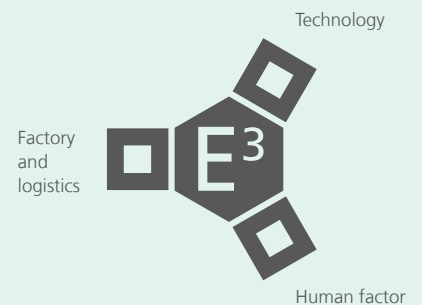
Within the scope of the Fraunhofer E³ production lead project, a complete process chain for the manufacturing of hollow gear shafts has been researched and developed as a demonstrator for the first time. These car gearbox hollow shafts are responsible for torque transmission in the powertrain. The conventional process chain includes the steps of forging, turning and drilling, hobbing, heat treatment, grinding, and shot peening. In the new process chain, expensive, material- and time-consuming machining processes, such as gun drilling and hobbing, are replaced by resource-efficient forming processes, such as spin extrusion and gear tooth rolling. In addition to the optimization of the individual technologies and the production planning, new information management and factory planning tools are integrated into the process chain at the factory level and refined. The objective is to tailor a process chain that is cross-linked with the factory environment, completely supervised and optimized in terms of energy.

Sensors in the machines and building services management capture the data and feed them into a central energy- and resource-management system, the “Linked Factory” platform developed at the Fraunhofer IWU. Following advanced approaches to information processing, such as linked data and semantic web technologies, the machine data collected are to be brought together here with the characteristic values from building services management, logistics and relevant economic parameters and compressed into useful information. Mobile IT technologies enable the machine operator to directly affect process variations and to initiate the optimization measures required. The process time to produce the component can be reduced by 20 percent and material consumption by 30 percent. The weight reduction potential in terms of lightweight construction amounts to 10 percent.

E³ effect

A process chain demonstrator for the manufacturing of gearbox hollow shafts was created and evaluated under factory conditions. This extremely short process chain is both based on forming and considers the three levels of the technology, the factory and the human being. The overall process chain was designed and refined by optimization. New approaches to monitoring these procedures in terms of the data flow by the human being were tested.

2 The demonstrator of the shortened process chain illustrates all necessary manufacturing steps.



The E³ concept Forming-based process chains

Energy and resource-efficient production

Integration of information and communication technologies | Efficient production systems | Innovative technologies and materials | Individualized products

Emissions neutral factory

Process monitoring | Energy and material cycles | Zero error production | Energy management | Quality cycles

Embedding of the human factor into the production

Knowledge and information | Human factor as creative problem solver