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# Abstract

**Speaker:**

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**Title:**

Superior surface integrity by knowledge-based manufacturing – Recent advances

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The surface and subsurface properties of components applied in aviation, automotive industry, and power generation strongly depend on the manufacturing process chosen to produce the parts. Based on the specific loads during the service life of a component, a characteristic combination of surface and subsurface properties such as roughness, hardness, or residual stresses is described to have a considerable impact on the functional performance and the durability of highly-stressed parts. In the last decades, the potential of manufacturing processes to generate a favorable combination of surface and subsurface properties and thus to improve the surface integrity, was identified by both, industry and science.

To gain a better understanding how these surface and subsurface properties can be achieved or even predicted, advanced understanding regarding the interrelations between the effects during manufacturing processes and the material's reaction is required. This presentation deals with recent findings and new paradigms to allow for tapping the full potential of manufacturing processes in the future. Results from mechanism-oriented research are combined with considerations regarding the need for challenging well-established and rigid structures in machining. Examples are presented, which indicate the important role of interdisciplinary research.

Until today, the choice of process parameters in many manufacturing processes is based on experience or iterative identification of suitable values. This leads to the application of parameter combinations which reliably avoid the production of scrap parts but do not generate the ideal surface and subsurface properties. In 2011, a collaborative work within the International Academy for Production Engineering showed that the so called inverse problem (the ability to produce a part with defined surface integrity in a non-iterative way) is not solved yet. This finding was the initial impulse for a new way of thinking about the impact of manufacturing processes including discussions of representatives from different relevant disciplines.

To understand the effects of manufacturing processes on the material properties, the knowledge of the exact loads within the component during the process is crucial as this is what the material reacts to. A combination of empiric and model-based investigations allows for correlating these internal material loads to the modification of the surface and subsurface properties. Furthermore, first examples for promising solutions of the inverse problem exist. The presentation will discuss these recent advances and point out, which steps have to be taken in the future.

In a second example indicating the need for knowledge-based design of manufacturing processes, the often underestimated chemical effects in machining processes will be discussed. In many manufacturing processes, metalworking fluids are applied to enable a reduction of thermal loads during the process. The cooling and lubricating ability is strongly dependent on the exact chemical composition of the metalworking fluid. In the presentation, large gap between the high potential of the chemical aspects and the lacking attention paid to this parameter will be discussed based on recent results. In interdisciplinary research, the

working mechanisms of metalworking fluids and their specific chemical substances were revealed and should be part of the prospective way of thinking about manufacturing processes.

A combination of knowledge-based choice of process-parameters in manufacturing and a better understanding regarding the relevant mechanisms might lead to a considerable contribution of engineers to meet some major challenges of the future.

- Superior surface integrity of components will allow for reduction of the weight of the parts and thus lead to lower energy consumption.
- The lifetime of the components and metalworking fluids will be increased resulting in higher resource efficiency.
- The processes themselves can be designed in a more efficient and environmentally friendly way.

However, this presentation will be able to present first steps that have been taken or should be taken in the future. Solving these challenges will still need some time, commitment of representatives from different disciplines, and close collaboration between industry, science, and research associations.