Minisymposium *Interactions between Structure and Process in Manufacturing Systems*

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The goal of this mini-symposium was to shed light on the interactions between processes and structures in modern production facilities. The knowledge of these interactions will enable a reliable and reproducible process control including ramp-up and the systematic design of production equipment – tasks that currently involve a high amount of empirical knowledge. The reason for this is the close connection of the properties of the (machine) structure and the (manufacturing) process with regard to the result of the manufacturing process. This connection has not yet been investigated in detail.

The applications considered in the minisymposium range from metal chipping, milling, and grinding to robot-guided laser material treatments. The mathematical tasks covered are important modelling issues arising in the coupling of process and structure, including mechanical interactions and the role of heat production and release, numerical methods for an efficient simulation of the arising coupled systems and, last but not least, their optimal control.

The talk by Matthias Maischak from Brunel University dealt with the simulation of metal chipping. Here, the focus lay on the efficient numerical simulation using a boundary element and finite element coupling procedure for the elastoplastic thermo-mechanical contact problem with a linear elastic work tool and an elastoplastic work piece. Unfortunately, Matthias' presentation is not included in the proceedings. Further information about his research can be found on his webpage.[1]

Oliver Rott from the Weierstrass Institute, Berlin, studies the influence of machine and structure on the stability of milling processes. The model consists of a harmonic oscillator equation for the dynamics of the cutter and a linear viscoelastic workpiece model. The coupling through the cutting force adds delay terms and further nonlinear effects. Numerical results show that the model is capable of predicting instabilities due to a lack of workpiece stiffness.

[1] www.brunel.ac.uk/about/acad/siscm/maths/people/acad/matthiasmaischak

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In the long run this work may lead to a more precise prediction of stability charts.

The contribution by Heribert Blum and Andreas Rademacher from Technische Universität Dortmund is related to the NC-shape grinding process. They use an empiric force model in conjunction with a geometric kinematical simulation to model the process. The machine model is based on a finite element simulation, in which the spindle and the grinding wheel are explicitly considered. The remaining parts of the grinding machine are modelled by elastic bearings. The simulations are coupled by the exchange of the predicted grinding force, which is used as Neumann type boundary condition in the finite element simulation, and of the displacement of the grinding wheel, which changes the contact conditions in the geometric-kinematical simulation. Because of the varying length scales, the diameter of the grinding wheel is about 100 mm and the depth of cut is less than 1 mm, adaptive finite element algorithms are an appropriate tool to obtain an efficient simulation. The main focus of their paper is the derivation of a goal-oriented error estimation for the linear wave equation and a corresponding adaptive refinement algorithm.

Andreas Steinbrecher from Weierstrass Institute, Berlin, considers robot-guided laser material treatments. Up to now, mathematical models for laser treatments usually assume the path of the laser on the workpiece to be known. However, depending on the workpiece geometry and the desired production goal the necessary laser path can not always be realized. To this end Andreas studies different strategies of coupling the optimal control of the laser heat treatment with the path-planning of the laser-guiding industrial robot.