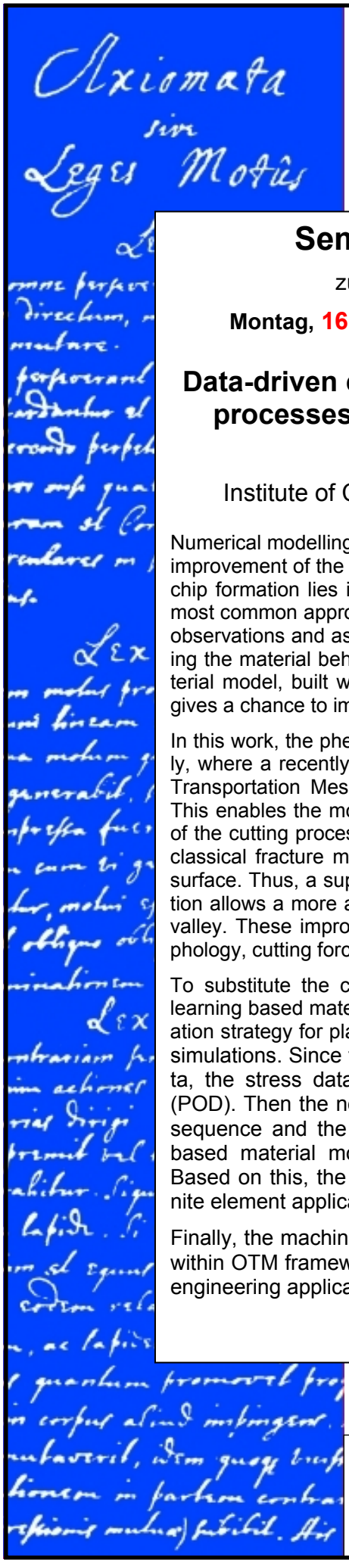

Seminar über Fragen der Mechanik

zu folgendem Vortrag wird herzlich eingeladen

Montag, 16.09.2019, 13:00 Uhr, Immerwahrstr. 1, Raum 01.025

Data-driven computational modelling of metal machining processes using machine learning and OTM method

Dengpeng Huang
Institute of Continuum Mechanics, Leibniz Universität Hannover

Numerical modelling of chip formation is important for a better understanding thus for an improvement of the high speed metal cutting process. The challenge in the modelling of chip formation lies in the material model applied to capture the complex physics. The most common approach is to develop a material model based on the phenomenological observations and assumptions. However, this kind of model shows limitations in capturing the material behaviors. As a new material modelling approach, the data-driven material model, built with the experimental data directly by machine learning technology, gives a chance to improve the model accuracy continuously.

In this work, the phenomenological model is applied to the metal cutting simulation firstly, where a recently developed Galerkin type meshfree scheme, the stabilized Optimal Transportation Meshfree (OTM) method, is applied as a numerical solution method. This enables the modelling of material separation and serrated morphology generation of the cutting process in a more realistical and convenient way. It can be seen that the classical fracture model shows limitations in capturing the fracture on the chip upper surface. Thus, a supplementary condition for the stress triaxiality is applied. This condition allows a more accurate measurement of the chip size, like chip spacing, peak and valley. These improvements are demonstrated by comparing the calculated chip morphology, cutting force and chip formation process with experimental results.

To substitute the classical material model with the data-driven model, the machine learning based material modelling framework is developed in this work. The data generation strategy for plasticity is proposed to guide the data collection from experiments or simulations. Since the strain stress data of plasticity is a time/history dependent data, the stress data is pre-processed with the Proper Orthogonal Decomposition (POD). Then the neural networks is applied to learn the pattern between the strain sequence and the stress sequence. The tangent matrix of the machine learning based material model is derived by the automatic differentiation tool AceGen. Based on this, the developed machine learning based model is validated in the finite element applications.

Finally, the machine learning based model is applied in the metal cutting simulation within OTM framework, which shows the availability of data-driven approach for the engineering application.

Prof. Dr.-Ing. P. Steinmann
Prof. Dr.-Ing. K. Willner
Lehrstuhl für Technische Mechanik
Egerlandstraße 5, 91058 Erlangen

Prof. Dr.-Ing. S. Leyendecker
Lehrstuhl für Technische Dynamik
Immerwahrstraße 1, 91058 Erlangen