TECHNISCHE UNIVERSITÄT DRESDEN

FLUID-MECHATRONISCHE SYSTEMTECHNIK DRESDEN

PROFESSUR FÜR WERKZEUGMASCHINENENTWICKLUNG UND ADAPTIVE STEUERUNGEN

Institut für Mechatronischen Maschinenbau IMD

DRESDEN concept

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Institute of Mechatronic Engineering, TU Dresden

Method for the Co-Simulation of Machine and Process on the Example of Sheet Metal Forming

ČSVZP seminar

„Sheet metal processing“

10.09.2020 Liberec, CZ

Institute of Mechatronic Engineering at TU Dresden

Chair of Fluid-Mechatronic Systems (Fluidtronics)

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Endowed Chair of Construction Machines

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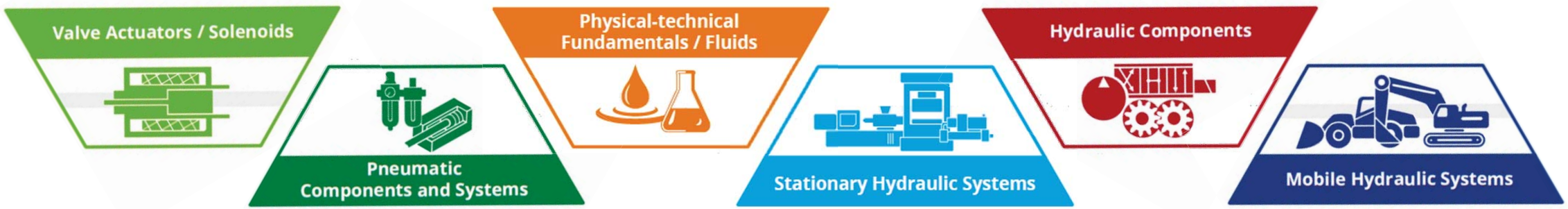
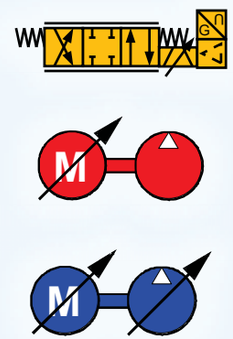
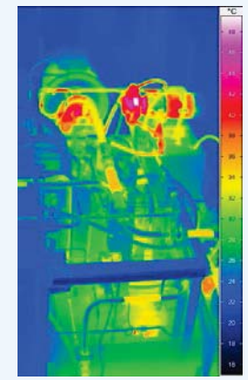


Research activities on Hydraulic Deep Drawing Presses

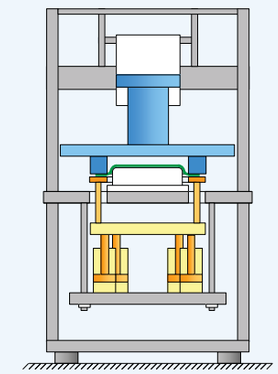
Drive structure



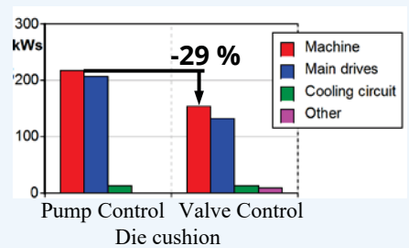
Thermal analysis



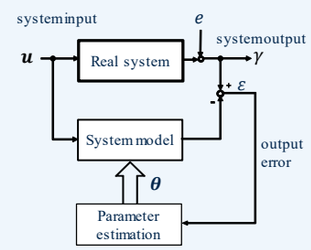
System Model



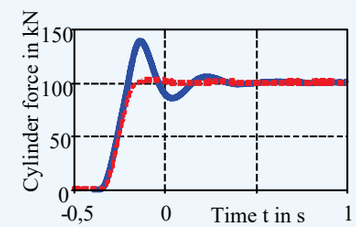
Energy consumption



System Identification

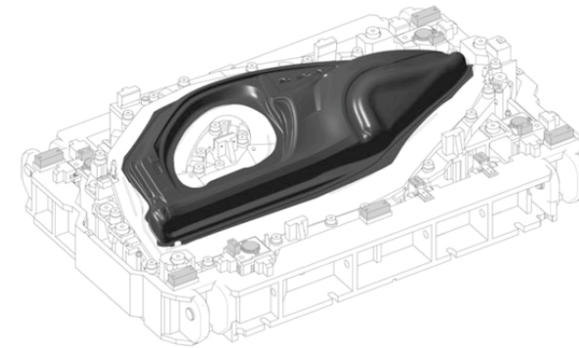


Control

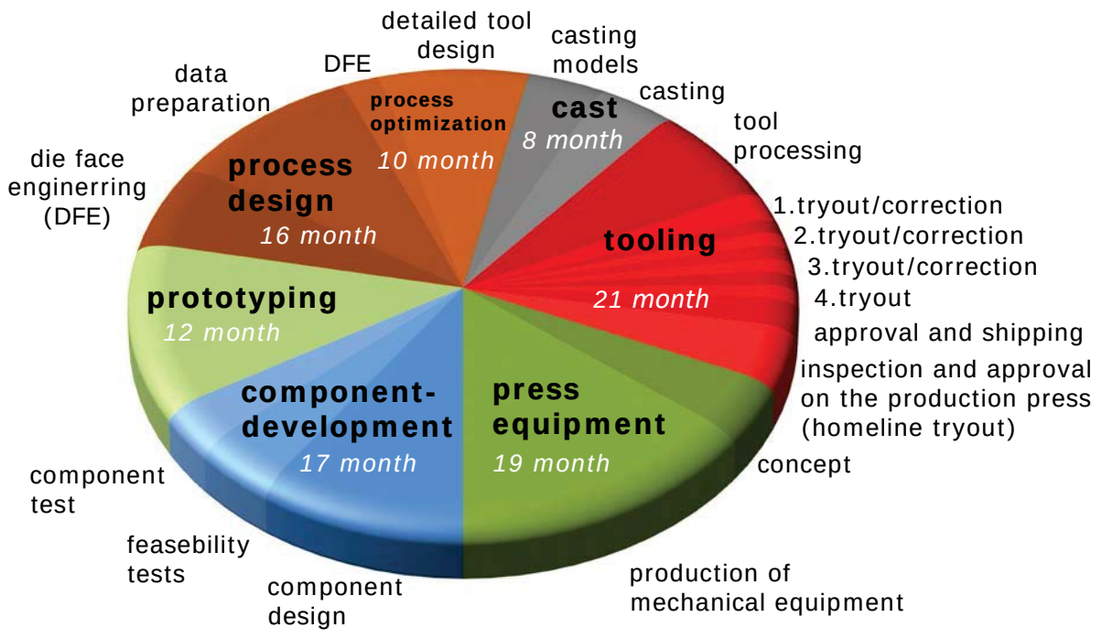


Motivation

Production of deep drawing tools on the example of a car body side wall

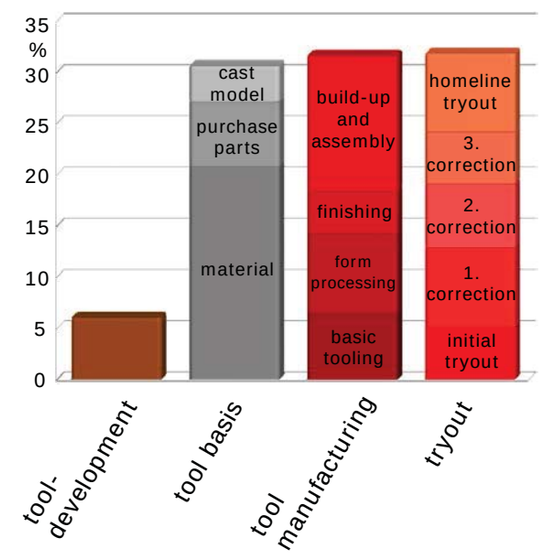


Distribution of working time



source: *Umformtechnische Herstellung komplexer Karosserieteile*, Birkert et.al., Springer, 2013

Allocation of costs



Motivation - properties influencing the drawing quality

elasto-static behaviour of the tool

- deflection of die, punch and blankholder

tribology

- friction
- lubrication

elasto-static behaviour of the press

- deflection of slide, press table and the die cushion‘s pressure box
- tilting elasticity of the slide and the die cushion

material behaviour

- flow–stress curve
- anisotropy

dynamic performance of the press

- stiffness of the drives
- control performance
- performance of electric and hydraulic components

Deep Drawing Press and Tool - Video

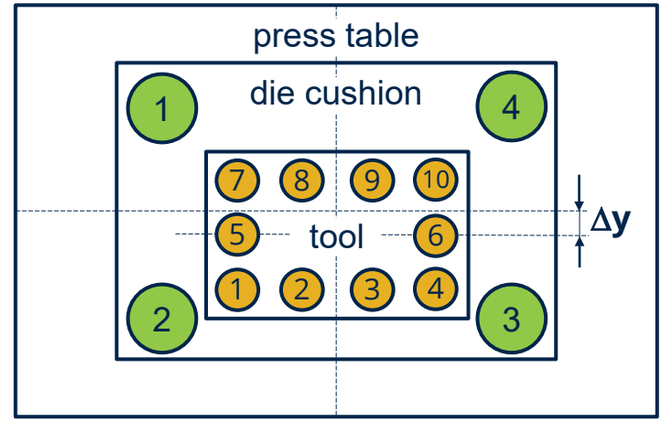
Technology application – rectangular pan with draw beads

Slide
elastic tilting

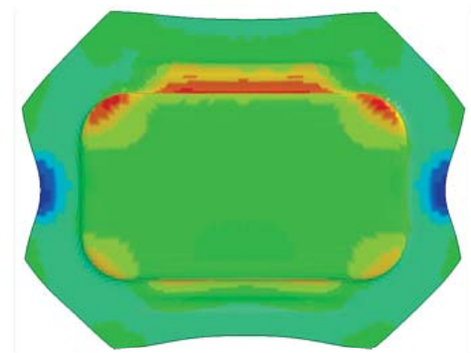
tool
blankholder
pins

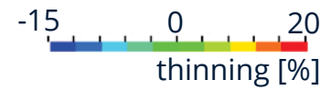
press table

Eccentric position of the tool



pin
die cushion cylinder





- slide tilting
- uneven pin loads
- unsymmetrical part
- unsymmetrical thinning and flange draw-in

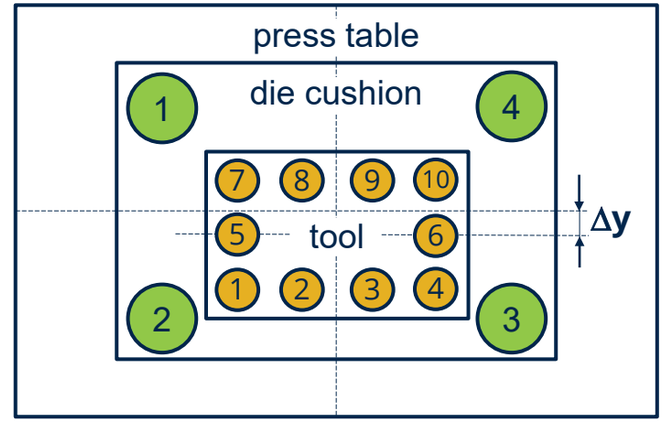
Technology application – rectangular pan with draw beads

Slide
elastic tilting

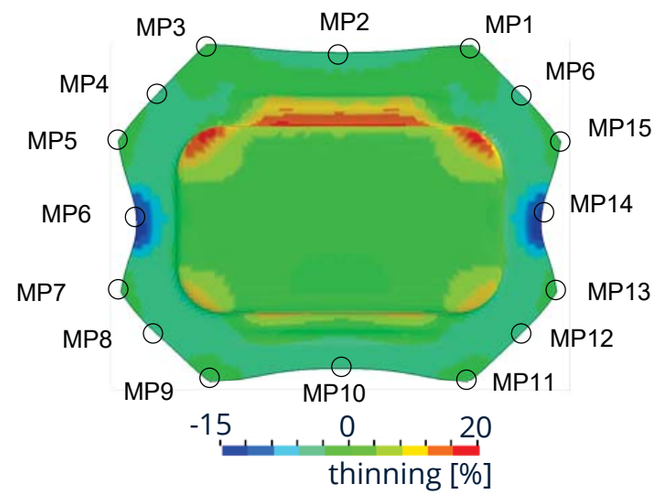
tool
blankholder
pins

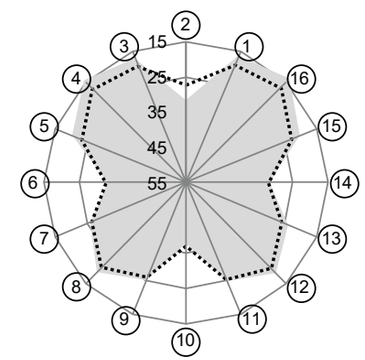
press table

Eccentric position of the tool



pin
die cushion cylinder

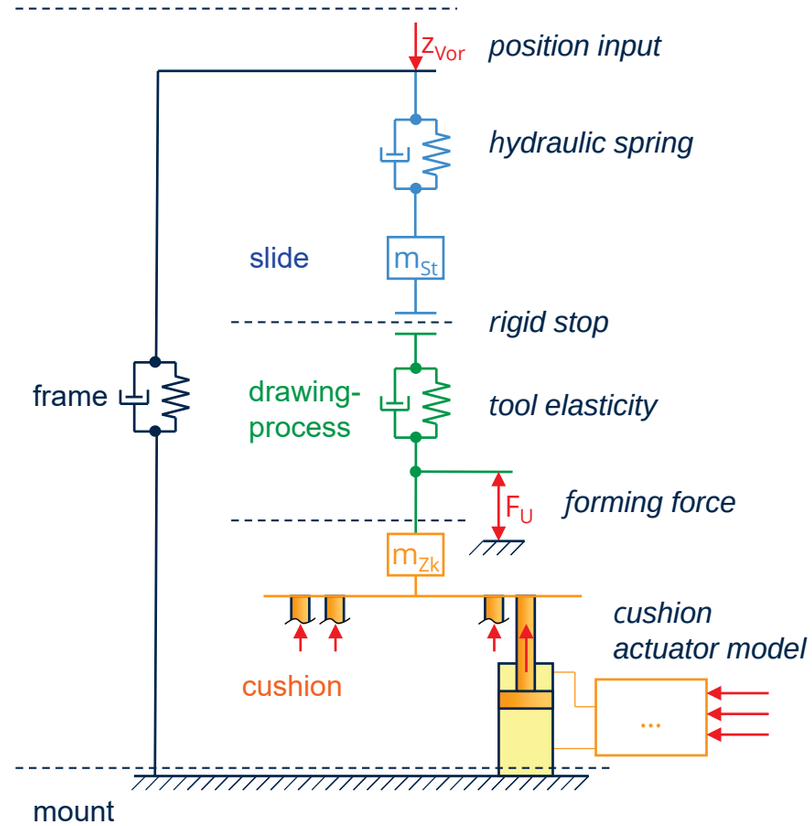




MP… measuring point

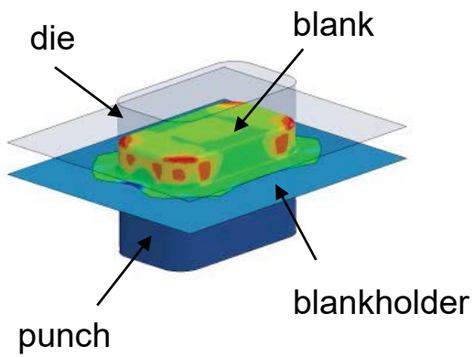
Model of the press (SimulationX)

System simulation model (schematic)

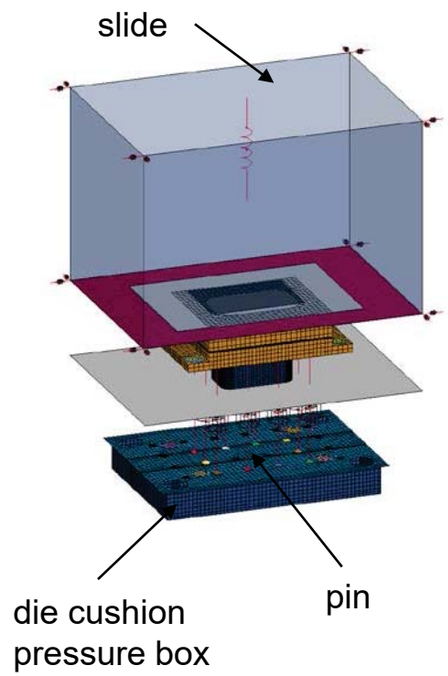


Process-model and implementations of machine behavior

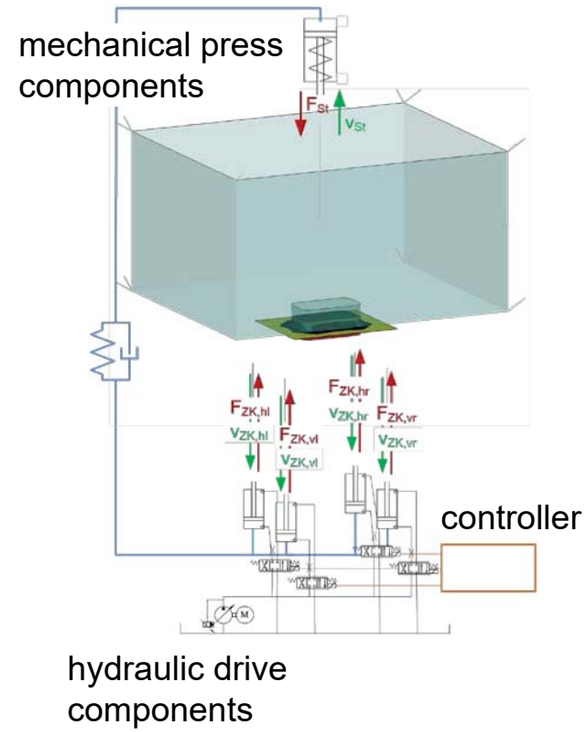
FE base model



Advanced FE model

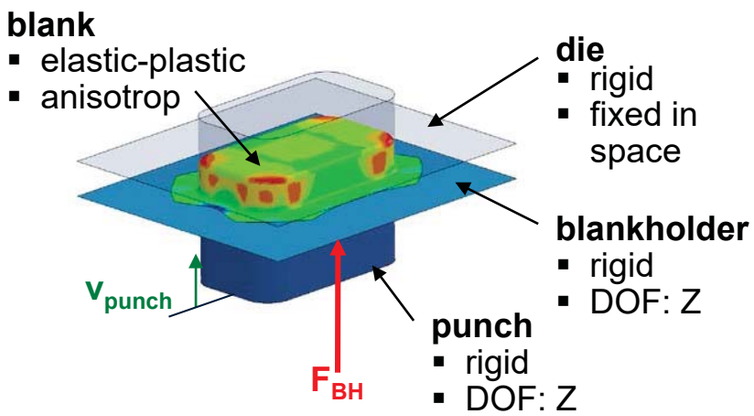


Co-Simulation

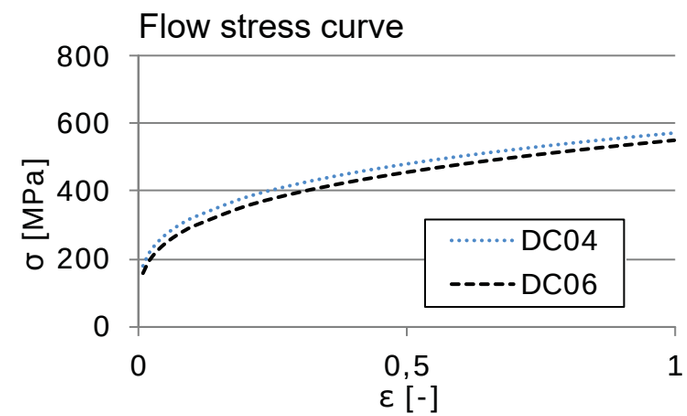


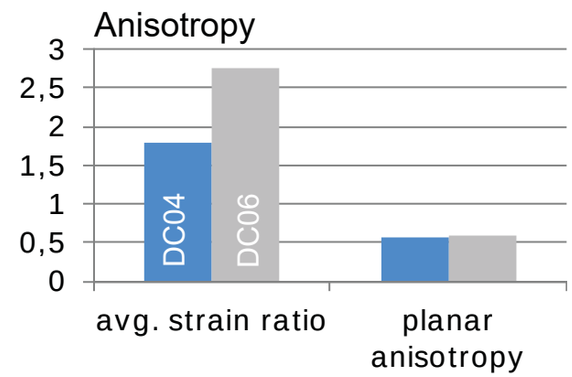
Standard process model with rigid tool (3rd party tool)

FE base model



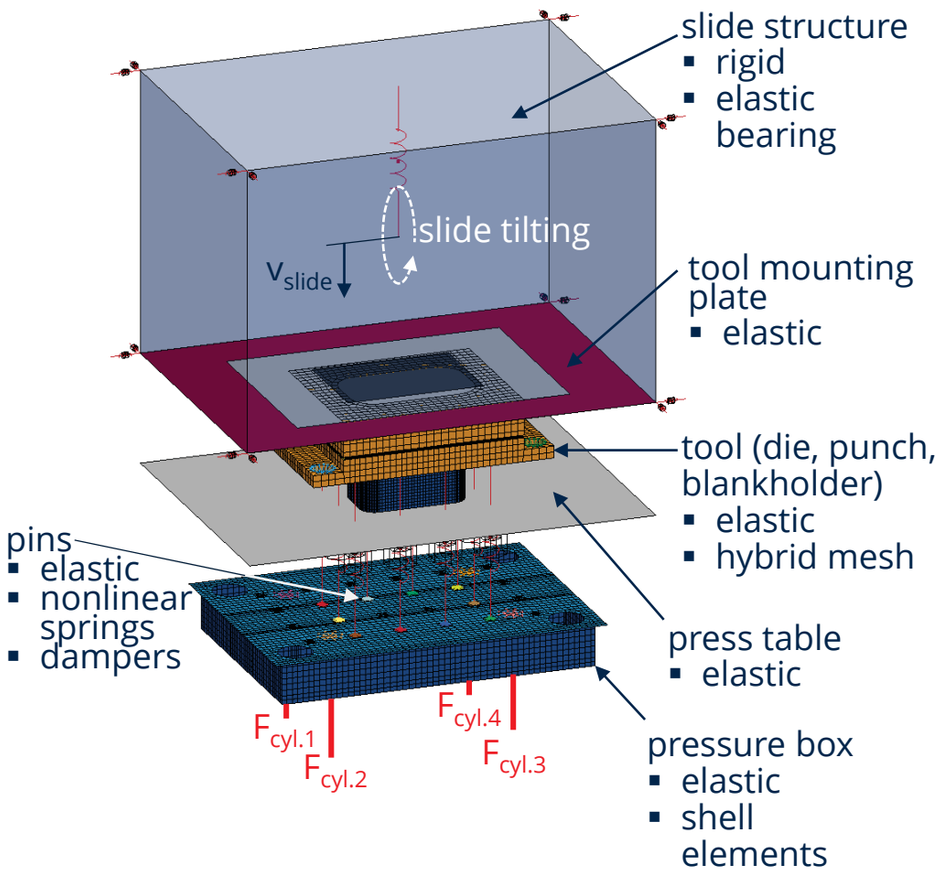
contact	
type	penalty based
Friction law	Coulomb
F_R	$= \mu \cdot F_N$
$\mu_{DC04/tool}$	0.155
$\mu_{DC06/tool}$	0.100



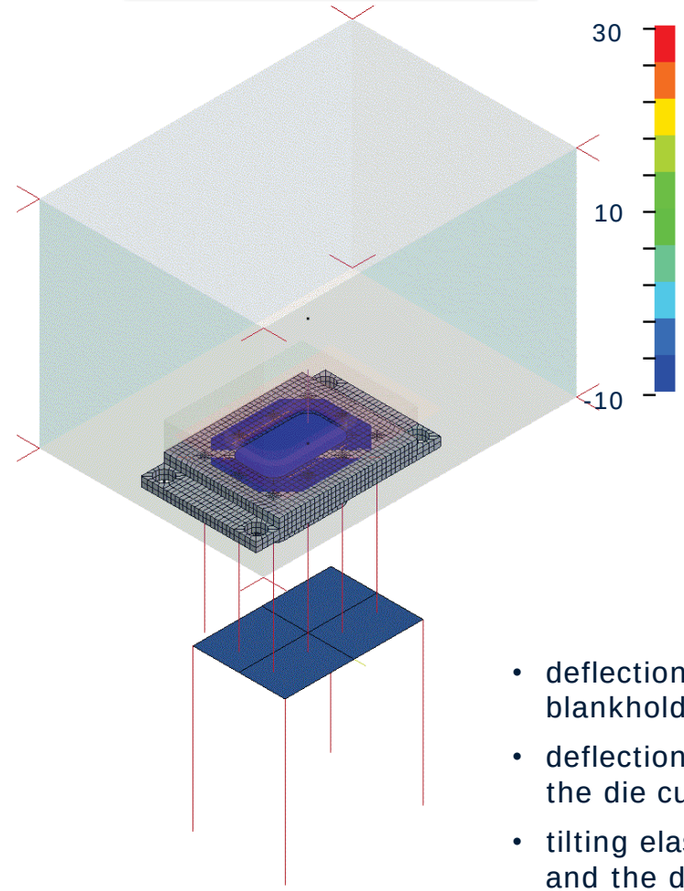


Advanced forming process model with elastic press and tool properties (3rd party tool)

Advanced FE model

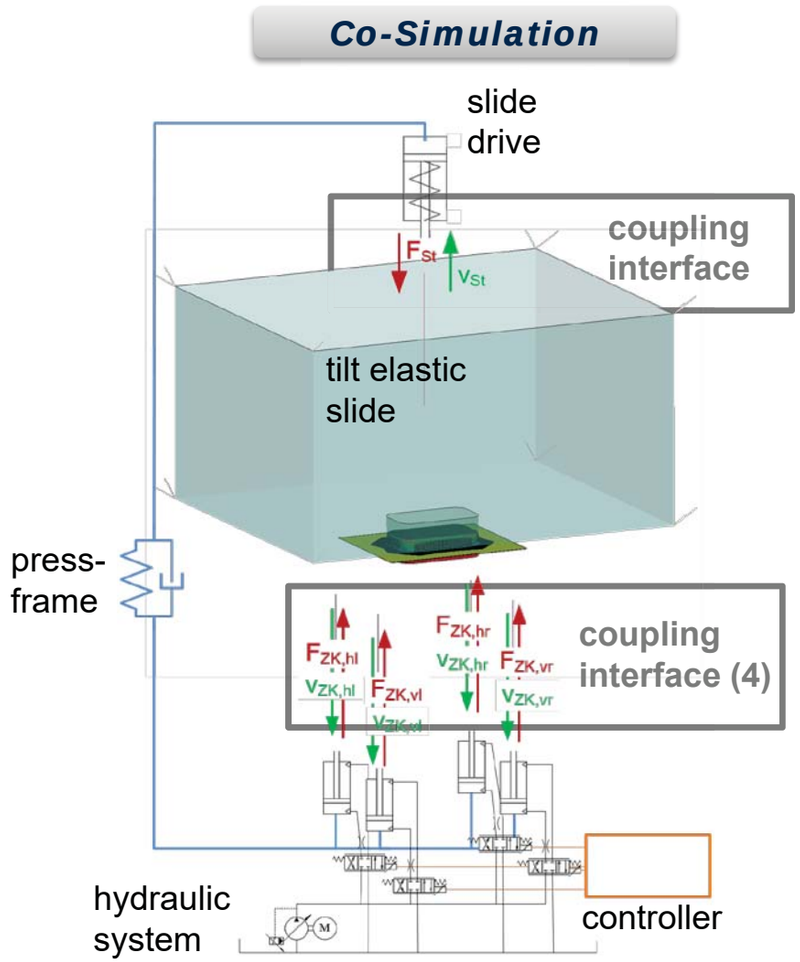


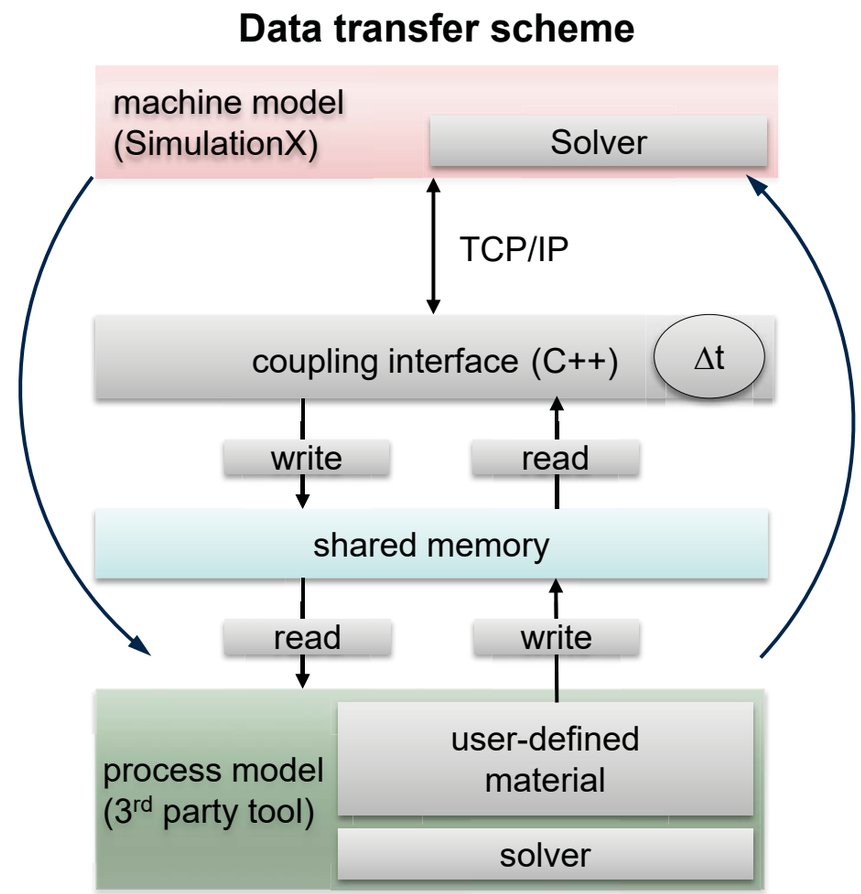
Drawing simulation



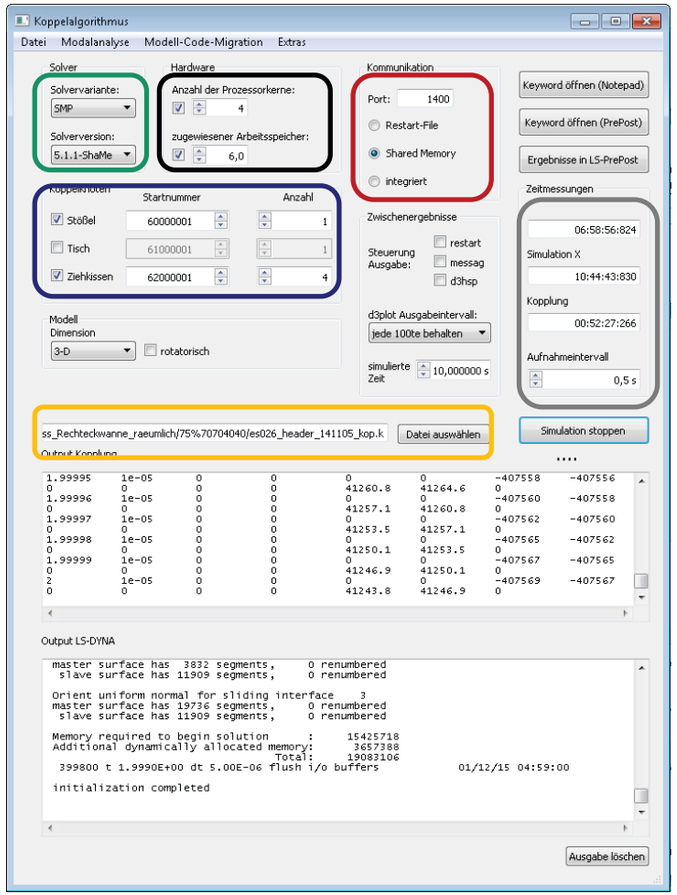
- deflection of die, punch and blankholder
- deflection of slide, press table and the die cushion‘s pressure box
- tilting elasticity of the slide and the die cushion

Over-all-System-Model and coupled simulation





User interface of the coupling program



type of FE-solver

hardware

interface for communication between process- and machine model

number of coupling nodes

file-dialog for the FE model

time measurement

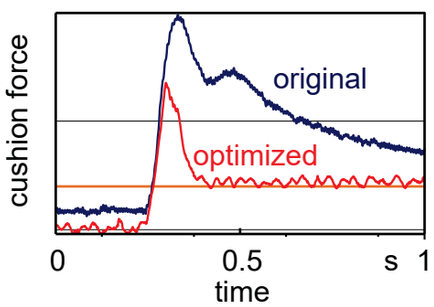
- easy handling of coupled simulation models
- different types of FE-solver possible
- communication over shared memory reduces simulation time for the over-all system modell

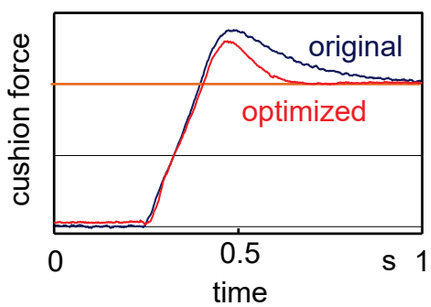
Use case – grading of optimized control parameters for the die cushion cylinders

Operating point dependence of the control parameters

round cup

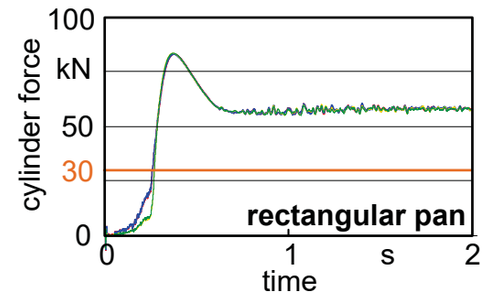
rectangular pan



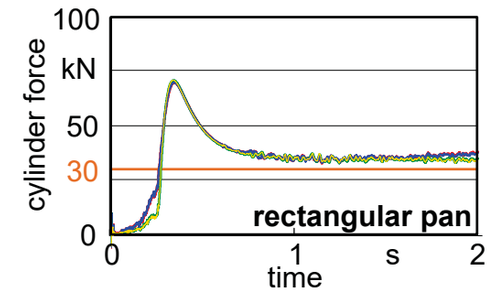


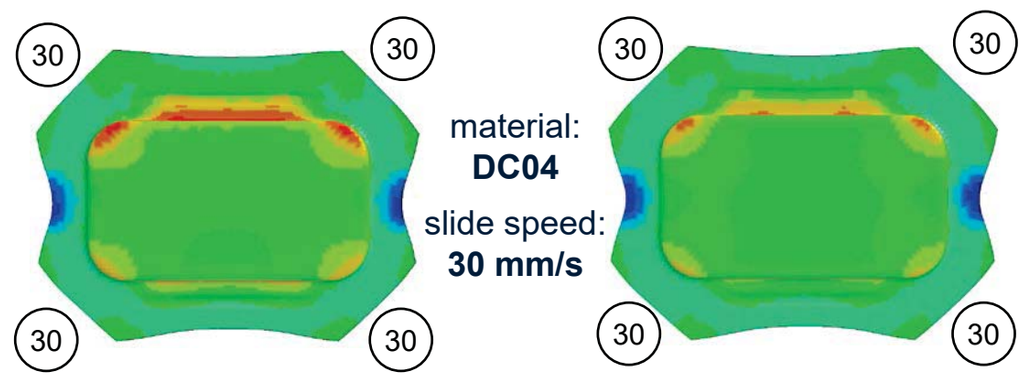
Influence of the control parameters on the part quality

original control parameter



optimized control parameter



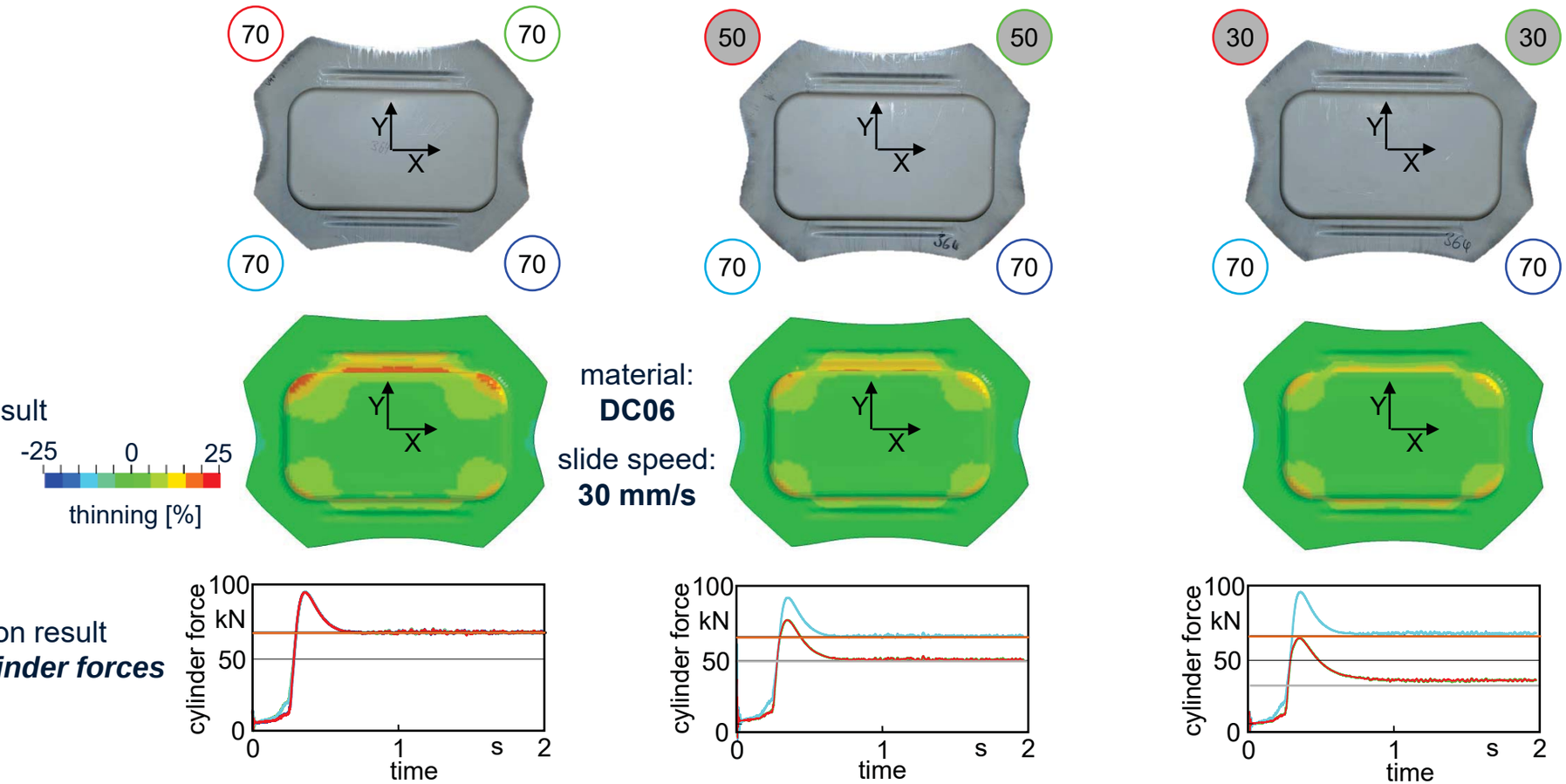


Co-simulation: rectangular pan with draw beads – required cylinder forces

Drawing part
(experiment)

FE-Simulation result
blank thinning
(3rd party tool)

System Simulation result
die cushion-cylinder forces
(SimulationX)

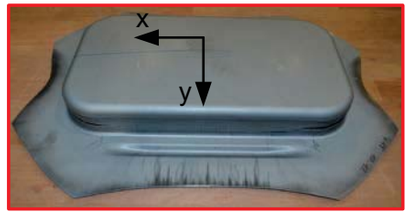


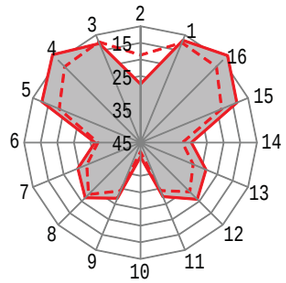
Co-simulation: rectangular pan with draw beads - results

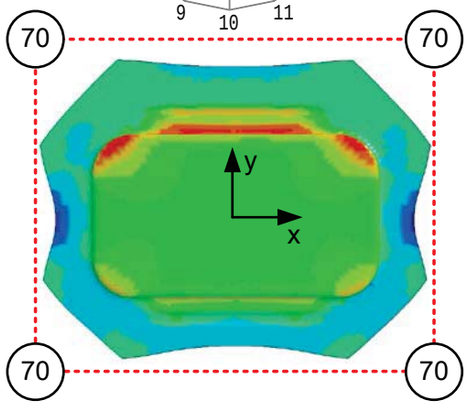
Drawing part
(experiment)

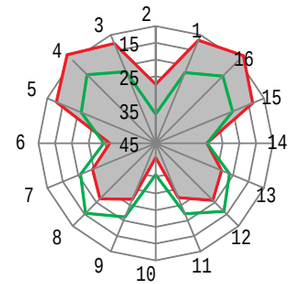
FE-Simulation result
blank thinning
(3rd party tool)

original control parameter



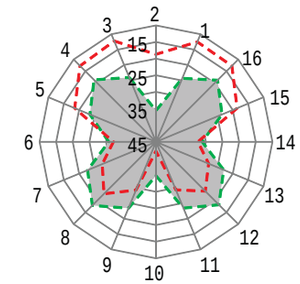




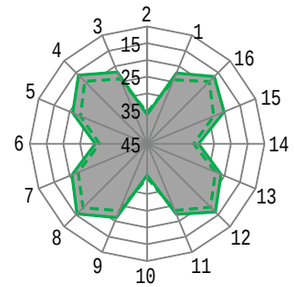


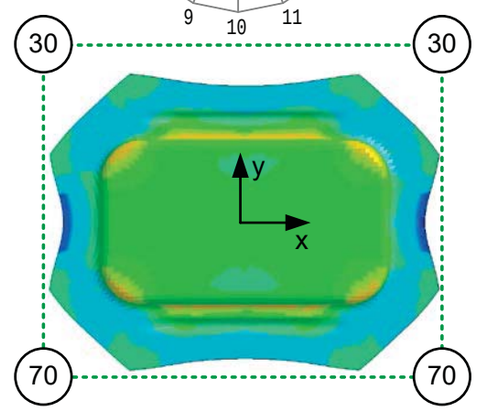
material:
DC06

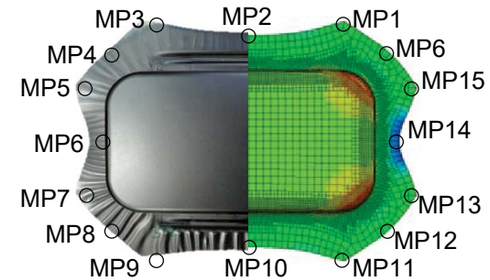
slide speed:
30 mm/s



optimized control parameter

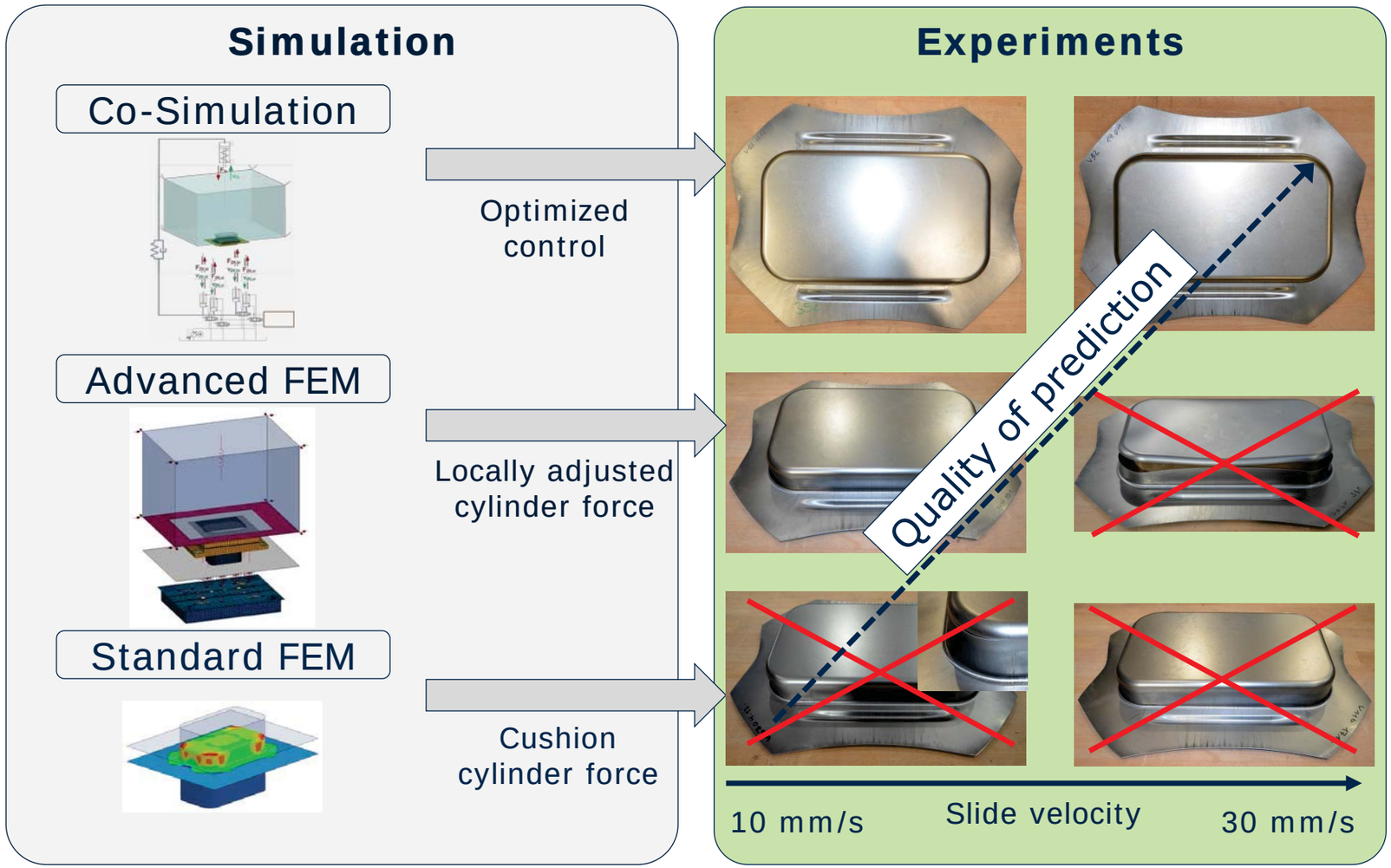






MP… measuring point

The effect of the model depth on the prediction quality



Invitation

12th International Fluid Power Conference
October 12-14, 2020

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Chair of Fluid-Mechatronic Systems
Prof. Dr.-Ing. J. Weber | Tel. +49351- 463 33559 | fluidtronik@mailbox.tu-dresden.de

www.ifk2020.com

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