International Deep-Drawing Research Group Conference 2021

„Digital Technologies in Sheet Metal Forming“

21st June – 2nd July 2021
Virtual
"Digital Technologies in Sheet Metal Forming"
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Dear Colleagues, Dear Friends in Sheet Metal Forming and Modelling, Dear Researchers in Deep-Drawing Technology from all over the world!

Approximately seven months ago the Executive Committee of the International Deep-Drawing Research Group (IDDRG) accepted my proposal to take over the 40th International Deep-Drawing Research Group Conference from June 21st – July 2nd 2021 in Stuttgart, Germany. I feel deeply honored for having the pleasure to invite you today to join the 40th IDDRG Conference, which is going to be held as a fully virtual event.

As we are committed to preserving the long history and the high standards of the IDDRG Conference indeed we are grateful for having the opportunity to learn from the experience gained by our Korean colleagues having organized the 39th IDDRG Conference as a virtual venue. Such new conference styles may appear a little bit different to what we are normally are used to, but we are quite optimistic to cope successfully with rising challenges in terms of keeping the tradition of direct communication, questioning and answering on contributions of participants and guests, of inspiring keynotes, breakout sessions with friends and colleagues as well as of enjoying the flair of booths prepared by suppliers, developers and other members of the community.

Please study these web pages of conference to make you familiar with the overwhelming content of conference on the one hand. On the other hand, please find also plenty of options to meet old friends, to get in touch with them and, of course, to ask your questions concerning the pre-recorded presentations being stored available on the conference platform. You too do have the opportunity to stroll along the virtual booths of exhibitors or to click on the ads of our sponsors. Special thanks to our sponsors, though your donation allows us to realize this conference to this extent.

Please enjoy the conference IDDRG 2021 – Virtual, the huge variety of contributions and make best use of the technical options provided. Seeing you, hearing from you on June 28th on our first live session!

Sincerely

Mathias Liewald
Special Thanks to Our Sponsors!

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The annually organized IDDRG conference belongs to the most important venues being attended by the world's leading research and production specialists in the field of sheet metal processing. Members of this community from all over the world regularly meet for fruitful discussions combined with short presentations about new and challenging technical topics in sheet metal forming technology. The 40th International Deep-Drawing Research Group Conference 2021 will be held from June 21st to July 2nd 2021 as a virtual event due to the COVID-19 pandemic and is organized by the Institute for Metal Forming Technology at the University of Stuttgart in Germany.

The IDDRG 2021 - Virtual focuses on the general conference topic entitled "Digital Technologies in Sheet Metal Forming". Main aim of the 2nd conference week respectively is to bring together industry and academia in a well-managed online event though current pandemic conditions don’t allow physical meetings of individuals. During the course of conference, being subdivided into 10 mini symposia, an enlarged scope of technical aspects from the field of sheet metal forming is covered: behavior of sheet materials in manufacturing, formability of sheet metals, forming tools, tribology, advanced joining technologies, robustness of manufacturing processes and new simulation methods and experiments. The Conference also provides 10 keynotes to its participants being linked with mentioned 10 mini symposia, which are led by internationally renowned experts.
# Committee of the IDDRG 2021

## Organizing Committee

**Univ.-Prof. Dr.-Ing. Dr. h. c. Mathias Liewald MBA**, Chair  
*University of Stuttgart*

**Dr. sc. techn. Celalettin Karadogan**, Co-Chair  
*University of Stuttgart*

**Maxim Beck, M. Sc.**, Organizing Office  
*University of Stuttgart*

## Scientific Committee

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<td>Narasimhan, K.</td>
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## Program Schedule

**June 21st – July 2nd, 2021**

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<td><strong>June 21st – June 27th, 2021</strong></td>
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<tr>
<td>Mini-Symposia with pre-recorded on-demand presentations available <strong>24/7</strong></td>
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<td>132 presentations in 10 Mini-Symposia</td>
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<td><strong>June 28th – July 2nd, 2021</strong></td>
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<tr>
<td>Mini-Symposia with pre-recorded on-demand presentations available <strong>24/7</strong></td>
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<tr>
<td>132 presentations in 10 Mini-Symposia</td>
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**Live-Sessions**

Keynote presentations & Subsequent discussions linked with the keynotes and mini-symposia

Live-Sessions will be shown as a live-stream on the conference platform during given time slots below.

*Please note: All times are indicated in CEST (Central European Summer Time)*
<table>
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<tr>
<th>Time</th>
<th>Session</th>
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<tr>
<td>11:00 - 11:20</td>
<td>Opening of the Conference</td>
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| 11:20 - 12:05| “Challenges of mechanical joining technologies in versatile process chains”  
                              | By Prof. Dr.-Ing. Gerson Meschut                                          
                              | MS 01: Flexible Processes in mechanical joining                          |
| 12:05 - 12:40| Panel discussion MS 01                                                   |
| 12:40 - 12:50| Short Break                                                              |
| 12:50 - 13:25| “Hot forming of high-strength steel components - From scientific fundamentals to industrial applications”  
                              | By Prof. Dr.-Ing. Marion Merklein                                          
                              | MS 02: Press hardening, manufacturing issues                             |
| 13:25 - 14:00| Panel discussion MS 02                                                   |
| 14:00 - 14:10| Conclusion & outlook                                                    |

**Monday, June 28th**

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<td>11:00 - 11:10</td>
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| 11:10 - 11:55| “The liaison of constitutive models with structural shell models: A fruitful but limited symbiosis”  
                              | By Prof. Dr.-Ing. André Haufe                                            
                              | MS 03: Enhanced simulation using thick shells and elastic tools          |
| 11:55 - 12:30| Panel discussion MS 03                                                   |
| 12:30 - 12:40| Short Break                                                              |
                              | By Prof. Dr.-Ing. Wolfram Volk                                           
                              | MS 04: Springback simulation and compensation                           |
| 13:15 - 13:50| Panel discussion MS 04                                                   |
| 13:50 - 14:00| Conclusion & outlook                                                    |

**Tuesday, June 29th**
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<td>11:10 – 11:45</td>
<td>Panel discussion MS 05: Damage, forming limits and sheared edge formability</td>
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<td>Please make sure you have seen the lecture given by Professor Dorel Banabic on “An overview on forming limit curves determination” ID 100</td>
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<td>11:45 – 12:20</td>
<td>“Advanced Sheet Forming and Yield Surface Simulations under Consideration of Microstructure, Texture and Damage using DAMASK”</td>
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<td>By Prof. Dr.-Ing. habil. Dierk Raabe</td>
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<td>MS 06: Digital techniques in material characterization / Material models, full and small scale testing</td>
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<td>12:20 – 12:55</td>
<td>Panel discussion MS 06</td>
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<td>Short Break</td>
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<td>13:05 – 13:35</td>
<td>“Experimental and numerical challenges towards machine-learning plasticity models”</td>
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<td>By Prof. Dr. Dirk Mohr</td>
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<td>MS 06: Digital techniques in material characterization / Material models, full and small scale testing</td>
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<td>14:10 – 14:20</td>
<td>Conclusion &amp; outlook</td>
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<td>11:00 - 11:10</td>
<td>Opening of the Live-Session</td>
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<td>11:10 - 11:40</td>
<td>“Benefits of smart sensors and actuators in sheet metal forming”</td>
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<td>By Prof. Dr.-Ing. Dipl.-Wirtsch.-Ing. Peter Groche</td>
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<td>MS 07: Digitalization in tooling and intelligent tools</td>
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<td>11:40 - 12:15</td>
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<td>By Ir. Nico Langerak</td>
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<td>MS 08: Smart production technologies and machine learning</td>
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<td>Conclusion &amp; outlook</td>
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<td>11:00 - 11:10</td>
<td>Opening of the Live-Session</td>
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<td>11:10 - 11:50</td>
<td>&quot;Challenges and application fields in the digital process control of sheet metal forming processes&quot;&lt;br&gt;Prof. Dr. Pavel Hora&lt;br&gt;MS 09: Robust process design and adaptive control</td>
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<td>11:50 - 12:25</td>
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<td>12:25 - 12:35</td>
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<td>12:35 - 13:00</td>
<td>&quot;Seamless Digitalization of BIW and Stamping Processes&quot;&lt;br&gt;Dr. Bart Carleer&lt;br&gt;MS 10: Prediction and control of product and assembly properties</td>
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<td>13:00 - 13:35</td>
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Keynotes

“Challenges of mechanical joining technologies in versatile process chains”

Prof. Dr.-Ing. Gerson Meschut
Head Institute - Institute for Lightweight Design with Hybrid Systems
Paderborn University, Germany

“Hot forming of high-strength steel components - From scientific fundamentals to industrial applications”

Prof. Dr.-Ing. habil. Marion Merklein
Chair of Manufacturing Technology
Friedrich-Alexander Universität Erlangen-Nürnberg, Germany

“The liaison of constitutive models with structural shell models: A fruitful but limited symbiosis”

Prof. Dr.-Ing. André Haufe
Head of Process Simulation
DYNAmore GmbH, Germany

“Fundamental strategies of compensation for deviations in sheet metal forming”

Prof. Dr.-Ing. Wolfram Volk
Chair of Metal Forming and Casting
TU Munich, Germany
Lecture: “An overview on forming limit curves”

Prof. Dr.-Ing. Dorel Banabic
Director of the Graduate School on Engineering and Management
Director of the Research Center in Sheet Metal Forming
Technical University from Cluj-Napoca, Romania

“Advanced Sheet Forming and Yield Surface Simulations under Consideration of Microstructure, Texture and Damage using DAMASK”

Prof. Dr.-Ing. habil. Dierk Raabe
Director of the Department Microstructure Physics and Alloy Design
Max-Planck-Institut für Eisenforschung GmbH, Germany

“Experimental and numerical challenges towards machine-learning plasticity models”

Prof. Dr. Dirk Mohr
Chair of Computational Modeling of Materials in Manufacturing
ETH Zurich, Switzerland

“Benefits of smart sensors and actuators in sheet metal forming”

Prof. Dr.-Ing. Dipl.-Wirtsch.-Ing. Peter Groche
Director of the Institute for Production Engineering and Forming Machines
TU Darmstadt, Germany

“The use of big data and advanced analytics in sheet metal production and forming”

Ir. Nico Langerak
Department Manager Applications & Engineering
Tata Steel Europe, The Netherlands
“Challenges and application fields in the digital process control of sheet metal forming processes”

Prof. Dr. Pavel Hora
Institute of Virtual Manufacturing
ETH Zürich, Switzerland

“Seamless Digitalization of BIW and Stamping Processes”

Dr. Bart Carleer
Corporate Technical Director
AutoForm Engineering, Germany
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<td>Organized by Prof. Dr.-Ing. Alexander Brosius</td>
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<td>Organized by Prof. Dr.-Ing. Gerson Meschut</td>
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<td><strong>02</strong> Press hardening, manufacturing issues</td>
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<td>Organized by Prof. Dr.-Ing. habil. Verena Kräusel</td>
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<td><strong>03</strong> Enhanced simulation using thick shells and elastic tools</td>
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<td>Organized by Prof. Dr.-Ing. André Haufe</td>
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<td><strong>04</strong> Springback simulation and compensation</td>
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<td><strong>05</strong> Damage, forming limits and sheared edge formability</td>
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<td><strong>06</strong> Digital techniques in material characterization / Material models, full and small scale testing</td>
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<td>Organized by the Institute for Metal Forming Technology, University of Stuttgart</td>
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<td><strong>07</strong> Digitalization in tooling and intelligent tools</td>
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<td><strong>08</strong> Smart production technologies and machine learning</td>
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<td><strong>09</strong> Robust process design and adaptive control</td>
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<td><strong>10</strong> Prediction and control of product and assembly properties</td>
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<td>Organized by the Institute for Metal Forming Technology, University of Stuttgart</td>
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Flexible processes in mechanical joining

Organized by Prof. Dr.-Ing. Marion Merklein
Organized by Prof. Dr.-Ing. Alexander Brosius
Organized by Prof. Dr.-Ing. Gerson Meschut

ID 110  Towards an adaptable quality monitoring process for self-piercing riveting

V. Noller¹, U. Walther¹, G. Meschut² and T. Bäck³

¹Mercedes-Benz AG, Germany
²University of Paderborn, Germany
³Leiden University, Singapore

ID 115  Experimental analysis of the influence of the embossing and upsetting process on joint strength in resistance element welding with upset auxiliary joining elements

M. Meinhardt¹, M. Lechner² and M. Merklein²

¹BMW AG, München, Germany
²Lehrstuhl für Fertigungstechnologie, Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen, Germany

ID 118*  Mechanical joining technologies – An insight into further development of established joining technologies

D. Henke¹

¹Böllhoff Verbindungstechnik GmbH, Germany

ID 137  Numerical and experimental investigation of the transmission moment of clinching points

C. Steinfelder¹, J. Kalich², A. Brosius¹ and U. Füssel²

¹Chair of Forming and Machining Processes, Technische Universität Dresden, Germany
²Chair of Joining Technology and Assembly, Technische Universität Dresden, Germany
ID 151  Inverse parameter identification of an anisotropic plasticity model for sheet metal

J. Friedlein¹, S. Wituschek², M. Lechner², J. Mergheim¹ and P. Steinmann¹

¹Institute of Applied Mechanics, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany
²Institute of Manufacturing Technology, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

ID 161  Joining suitability of cast aluminium for self-piercing riveting

M. Neuser¹, F. Kappe², M. Busch³, O. Grydin¹, M. Bobbert², M. Schaper¹, G. Meschut² and T. Hausotte³

¹Department of Material Science, Paderborn University, Germany
²Laboratory for material and joining technology, Paderborn University, Germany
³Institute of Manufacturing Metrology, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

ID 168  On the uncertainty in mechanical joining

I. Lepenies¹ and A. Saharnean¹

¹SCALE GmbH, Dresden, Germany

ID 169  Safe mechanical joining processes by digital manufacturing supervision in steel coil productions

H.C. Schmale¹ and T. Geddert²

¹Salzgitter Mannesmann Forschung GmbH, Salzgitter, Germany
²Salzgitter Flachstahl GmbH, Salzgitter, Germany

ID 184  Joining with Friction Spun Joint Connectors – Manufacturing and Analysis

C. Wischer¹, C. Steinfelder², W. Homberg¹ and A. Brosius²

¹Chair of Forming and Machining Technology, Paderborn University, Germany
²Chair of Forming and Machining Processes, Technische Universität Dresden, Germany
ID 239* Numerical simulation of aluminum ski hemming process

O. Filali¹, P.-Y. Manach¹ and S. Thuillier¹

¹Université Bretagne Sud, France

ID 258* Feasibility study on electro-hydraulic clinching of carbon fiber composites and aluminum alloy sheets

H. Ghorbanimenghari¹ and J.H. Kim¹

¹Pusan National University, Republic of Korea

*Presentation Only Contributions
Press hardening, manufacturing issues

Organized by Prof. Dr.-Ing. habil. Verena Kräusel

**ID 108** The influence of coating porosity on friction and wear during hot stamping of AlSi coated ultra-high strength steel

J. Venema¹ and P. Beentjes¹

¹Tata Steel R&D, The Netherlands

**ID 114** Investigation of the impact of heat treatment on the layer formation of AlSi-coated boron-manganese steel

F. He¹ and M. Merklein¹

¹Institute of Manufacturing Technology, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

**ID 117** A Thermography-based Online Control Method for Press Hardening

E. Garcia-Llamas¹, J. Pujante¹, P. Torres² and F. Bonada²

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**ID 121** Bending behavior of a hot stamped complex phase steel with tailored properties by local carburization

A. Horn¹ and M. Merklein¹

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**ID 123** Presshardening of Aluminium – the innovative HDF-Technology

J. Hirsch¹,² and P. Amborn¹

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ID 126  Constitutive characterization of an 1800 MPa press hardening steel under hot stamping conditions

S. Lu¹, S. DiCecco¹, M. Worswick¹, C. Chiriac², G. Luckey², J. Tjong³, J. Boettger⁴ and C. Shi⁵

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⁵Promatek Research Centre, Brampton, Ontario, Canada

ID 141  Parameter study on press hardened components with tailored properties

M. Nestler¹, J. Schönherr¹, R. Haase¹, A. Albert¹, A. Stoll¹ and V. Kräusel¹

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ID 142  Effect of heat treatment conditions on the fatigue resistance of press hardened 22MnB5 steel evaluated through rapid testing technique

S. Parareda¹, D. Casellas¹,², D. Frómeta¹, E. Garcia-Llamas¹, A. Lara¹, J. Pujante¹ and A. Mateo³

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ID 155  MBW 1200 – Hot Stamping Steel with Increased Ductility

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ID 156*  Thermographic Process Monitoring in press hardening and the digitalization into an INDUSTRY 4.0 data management system

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ID 157  Investigation of Material Softening and Increase of Deep Drawing Capacity of 22MnB5 during Press Hardening using CRP Technology

P. Birnbaum¹, Y. Xu², X. Zhuang², Z. Zhao² and V. Kraeusel¹

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²Shanghai Jiao Tong University, Shanghai, China

ID 1158  Friction Characterization of Al-Si Coated Ultra-High Strength Steel under Hot Stamping Conditions

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ID 1160  Effect of heating temperatures on AlSi coating microstructure and fracture during hot-tensile tests

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ID 189  Advanced Data Acquisition for Hot Stamping and its Application

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ID 190  Application of an Advanced Friction Model in Hot Stamping Simulations: A Numerical and Experimental Investigation of an A-Pillar Reinforcement Panel from Volvo Cars

A. Güner¹, J. Hol², J. Venema³, M. Sigvant⁴, F. Dobrowolski⁵, A. Komodromos⁵ and A. E. Tekkaya⁵

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⁴Volvo Cars, Olofstrom, Sweden
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ID 195  Increasing the energy absorption of monolithic manganese boron steels in oxygen-free environment
B.-A. Behrens¹, S. Hübner¹, U. Holländer², A. Langohr², C. Pfeffer¹ and L. Albracht¹

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ID 203  Effect of strain rate on formability of 22MnB5 steel during hot stamping process
A.K. Singh¹ and K. Narasimhan¹

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ID 224  Numerical investigation of introduction of HFQ® process manufacturing of A-pillar part
Z. Lukacs¹

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ID 238  Die material properties needed for Hot Stamping of High Strength Sheet Materials
S. Sivertsen, R. Oliver

Uddeholms AB, Hagfors, Sweden

ID 256*  Effect of multi-step heat treatment on Al-Si coating of hot-formed steel
A. Bondar¹, H. Daoud¹, U. Glatzel¹,²

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ID 259*  A Study on Heat Control Technology of Transfer Stage in Hot Stamping Process for Improving Formability of Hot-Stamped Parts
J.M. Park¹, J.Y. Kong¹, S.C. Yoon¹, K.J. Park¹, J.S. Hyun¹

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*Presentation Only Contributions
Enhanced simulation using thick shells and elastic tools

Organized by Prof. Dr.-Ing. André Haufe

ID 102 Implementation of Real Contact Areas into Deep Drawing Simulations using Digital Spotting Images

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ID 129 A new machine learning based method for sampling virtual experiments and its effect on the parameter identification for anisotropic yield models

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ID 171 On appropriate Finite Element discretization in simulation of gas-based hot sheet metal forming processes

N.K. Baru¹, T. Teeuwen¹, M. Teller¹, S. Hojda¹, A. Braun¹ and G. Hirt¹

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ID 191* Roll forming simulation using higher order NURBS-based Finite Elements in LS-DYNA

S. Hartmann¹ and P. Glay²

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²DYNAmore France SAS, France
ID 211  Virtual die spotting: Advanced setup for coupling of forming and structure simulation

F. Zgoll¹, T. Götze¹ and W. Volk²

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ID 227*  Advanced 3D-Shell Elements for Sheet Metal Forming Simulation

T. Willmann¹ and M. Bischoff¹

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ID 229*  A novel substitutive press model for tool cambering prediction using sheet metal forming simulation

F. Abbasi¹, E. Saenz de Argandoña¹, A. Sarasua² and L. Galdos¹

¹Mondragon Unibertsitatea, Spain
²Matrici SCoop, Spain

ID 241*  Simulation process for Tool Design of Heat Exchanger Parts

A. Gehring¹ and A. Dolderer¹

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ID 242  Towards forming simulations by means of reduced integration-based solid-shell elements considering gradient-extended damage

O. Barfusz¹, T. van der Velden¹, T. Brepols¹ and S. Reese¹

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*Presentation Only Contributions
New sheet metal forming process for springback reduction by continuous stress superposition

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Reduction of Young's modulus for a wide range of steel sheet materials and its effect during springback simulation

L. Wagner¹, M. Wallner², P. Larour¹, K. Steineder¹ and R. Schneider²

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²University of Applied Sciences Upper Austria - Campus Wels, Austria

Development of a springback prediction for a hybrid laminate with sensor functionality

A. Graf¹, V. Kräusel¹, A.V. Rodio² and A. Lanzotti²

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²University of Naples Federico II, Department of Industrial Engineering, Italy

Enhancement of springback prediction of AHSS parts by advanced friction modelling

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³TriboForm Engineering, Enschede, The Netherlands
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ID 135  Springback Behaviour due to Die Deflection during Bending
H. Tsutamori¹, Y. Nakamoto¹ and T. Nishiwaki¹
¹Department of Mechanical Engineering, Daido University, Japan

ID 138  Parameterized data handling for forming tool tryout: reverse engineering, data consolidation and springback compensation
L. Maier¹, C. Hartmann¹ and W. Volk¹
¹Chair of Metal Forming and Casting, Technical University of Munich, Germany

ID 146  Effect of blank-holder force on springback of ultra-thin copper sheets
N. Ayachi¹,², N. Guermazi² and P.-Y. Manach¹
¹Univ. Bretagne Sud, Lorient, France,
²LGME, ENI Sfax, Tunisia

ID 153  Compensating the springback of ultra-high-strength steel parts by specific stress superposition during sheet metal forming
R. Radonjic¹ and M. Liewald¹
¹Institute for Metal Forming Technology, University of Stuttgart, Germany

ID 197  Adapted part design methods for springback minimization of stamped sheet metal car body components
A. Birkert¹, F. Dreiseitel¹, B. Hartmann², T. Held¹, O. Hetterle¹, M. Markin¹ and M. Scholle¹
¹Heilbronn University of Applied Sciences, Germany
²Inigence GmbH, Bretzfeld, Germany

ID 200  Dimensionally accurate parts made of high-strength steels - compressive stress superimposition instead of tool compensation
M. Linnepe¹, P. Sieczkarek¹, M. Kibben¹ and F. Botz¹
¹thyssenkrupp Steel Europe AG, Duisburg, Germany
ID 217  Structural springback analysis of car body closure assemblies using finite element process chain simulations

F. Schuler¹ and M. Liewald¹

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ID 225  A Numerical Study on Chain-Die Forming of the aluminium profiles with variable cross-section

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²School of Mechanical and Mining Engineering, The University of Queensland, St Lucia, Brisbane, Australia

ID 232  Experimental and numerical study of springback effect of advanced high strength steel in a V-shape bending

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²Centre for Lightweight Materials, Design and Manufacturing, King Mongkut’s University of Technology Thonburi, Thailand

ID 247  Study on the influence of the strain rate sensitivity on the springback of the AA5086 alloy under warm forming conditions

D.M. Neto¹, M.C. Oliveira¹, J.L. Alves² and L.F. Menezes¹

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²CMEMS, Department of Mechanical Engineering, University of Minho, Portugal

ID 266*  Finite element simulation of springback using homogeneous anisotropic hardening model with coupled quadratic-nonquadratic yield function

H. Choi¹, S.W. Nam², E.H. Lee³ and J.W. Yoon¹⁴

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²Daewoo Industry, South Korea
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**ID 268**  
Effect of Description of Elastic-Plastic Transition on Springback Prediction

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*Presentation Only Contributions
MS 05  
**Damage, forming limits and sheared edge formability**

Organized by Dr.-Ing. Rickmer Meya

**ID 100**  
Lecture: “An overview on forming limit curves”

D. Banabic\(^1\)

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**ID 106**  
A critical assessment of notched tensile tests for formability mapping of AHSS sheets

L. Wagner\(^1\), P. Larour\(^1\), F. Sonnleitner\(^1,2\), A. Felbinger\(^1,2\) and J. Angeli\(^1,2\)

\(^1\)voestalpine Stahl GmbH, Linz, Austria  
\(^2\)University of Applied Sciences Upper Austria - Campus Wels, Austria

**ID 109**  
Alternative characterization method for the failure behaviour of sheet metals derived from Nakajima test

D. Kohl\(^1\) and M. Merklein\(^1\)

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**ID 111**  
The Effects of Piercing Methods on Burring Formability under Practical Hole Diameter

R. Urushibata\(^1\) and Y. Ito\(^1\)

\(^1\)Nippon Steel Corporation, Japan

**ID 116**  
Comparison of different forming methods on deep drawing and springback behavior of high-strength aluminum alloys

N. Rigas\(^1\), H. Schmid\(^1\) and M. Merklein

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ID 119  Study on the impact of temperature on the warm bending of aluminium alloy sheet

A. Mauduit\textsuperscript{1} and A. Maillard\textsuperscript{2}

\textsuperscript{1}CETIM Centre Val de Loire, France
\textsuperscript{2}CETIM Senlis, France

ID 122  Influence of pass reduction in cold rolling on damage evolution in deep drawing of rotationally symmetric cups

M. Nick\textsuperscript{1}, C. Liebsch\textsuperscript{2}, M. Müller\textsuperscript{1}, I.F. Weiser\textsuperscript{1}, G. Hirt\textsuperscript{2} and T. Bergs\textsuperscript{1,3}

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\textsuperscript{2}Institute of Metal Forming (IBF), RWTH Aachen, Germany
\textsuperscript{3}Fraunhofer Institute for Production Technology IPT, Aachen, Germany

ID 128  Effect of various shearing shape conditions for the scrap-used coining method on tensile residual stress on sheared edge

Y. Honda\textsuperscript{1}, T. Yasutomi\textsuperscript{1} and M. Yamagata\textsuperscript{1}

\textsuperscript{1}Nippon Steel Corporation, Japan

ID 139  A new Device for Determination of Forming-Limit-Curves under Hot-Forming Conditions

M. Triebus\textsuperscript{1}, J. Gierse\textsuperscript{1}, T. Marten\textsuperscript{1} and T. Tröster\textsuperscript{1}

\textsuperscript{1}Chair of Automotive Lightweight Design, Paderborn University, Germany

ID 144  Cryogenic deep drawing of aluminum alloy AA6014 using macro-structured tools

M. Tulke\textsuperscript{1}, A. Wolf\textsuperscript{1}, and A. Brosius\textsuperscript{1}

\textsuperscript{1}Chair of Forming and Machining Processes, Technische Universität Dresden, Germany

ID 170  Local formability assessment of AHSS steels with shear cut tensile tests

P. Larour\textsuperscript{1}, J. Freudenthaler\textsuperscript{1}, H. Pauli\textsuperscript{1}, M. Kerschbaum\textsuperscript{1}, L. Wagner\textsuperscript{1}, A. Felbinger\textsuperscript{1,2}, F. Sonnleitner\textsuperscript{1,2} and J. Angeli\textsuperscript{1,2}

\textsuperscript{1}voestalpine Stahl GmbH, Linz, Austria
\textsuperscript{2}University of Applied Sciences Upper Austria - Campus Wels, Austria
On the mechanics of edge cracking and the reliable determination of edge formability limits

N. Manopulo¹, A. R. Chezan², E. Atzema², I. Picas Anfruns², B. Carleer³, J. Pithammar⁴,⁵ and M. Sigvant⁴,⁵

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⁴Volvo Cars, Olofström, Sweden
⁵Blekinge Institute of Technology, Sweden

Influence of synthetically generated inclusions on the stress accumulation and concentration in X65 pipeline steel

N. Fehlemann¹, Y. Sparrer¹, F. Pütz¹, M. Könemann¹ and S. Münstermann¹

¹RWTH Aachen, Germany

Experimental study on the deep-drawability of thermoplastic fibre metal laminates made of steel and glass fibre reinforced polyamide

W. Hua¹, M. Harhash¹, H. Palkowski¹

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Equivalence between Localization Criterion and Fracture Criterion as Forming Limit in Failure Evaluation for 7xxx Series Aluminum Alloy Sheets

J. H. Hong¹ and D. Kim¹

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Simplified measurement of the strain to fracture for plane strain tension; On the use of 2D DIC for dual hole plane strain tension mini Nakajima specimens with dihedral punch

M. Adlafi¹,², B. Galpin¹,², L. Mahéo¹,², C. Roth³, D. Mohr³ and V. Grolleau¹,³

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²Ecoles Saint-Cyr Coetquidan, Guer, France
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Investigation of GISSMO failure model with different specimens by numerical modelling and fracture analysis

E. Tamer¹, G. Ozgultekin¹ and B. Gürsoy²

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**ID 209**  
Comparison of different testing approaches to describe the fracture behaviour of AHSS sheets using experimental and numerical investigations  
B.-A. Behrens¹, D. Rosenbusch¹, H. Wester¹ and M. Dykiert¹  
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**ID 214**  
Effects of Pre-Existing Hydrogen to Stress Triaxiality and Damage Evolution on Ultra High Strength Steel  
H.-J. Kim¹,², M.-G. Lee², K.-J. Kim¹, S.-C. Yoon¹, J.-S. Hyun¹  
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²Department of Materials Science and Engineering & RIAM, Seoul National University, South Korea

**ID 220**  
A new specimen for investigating shear fracture strain  
V. Gál¹ and Z. Lukács¹  
¹Institute of Materials Science and Technology, University of Miskolc, Hungary

**ID 236**  
Experimental research of formability limits in different thicknesses of polycarbonate sheets  
A. Rosa-Sainz¹, JP Magrinho², M.B. Silva³, G. Centeno¹, A.J. Martínez-Donaire¹ and C. Vallellano¹  
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³IDMEC, Instituto Superior Tecnico, Universidade de Lisboa, Portugal

**ID 257**  
Characterization into the edge pre-damage within shear effect zone of punched sheet  
L. Qian¹, M. Li¹, C. Sun¹ and T. Ma¹  
¹University of Science and Technology Beijing, People’s Republic of China

**ID 261**  
Effect of damage evolution on edge crack sensitivity in dual-phase steels  
N. Habibi¹, T. Beier², H. Richter² and S. Münstermann¹  
¹Integrity of Materials and Structures, Steel Institute, RWTH Aachen University, Germany  
²Thyssenkrupp Steel Europe AG, Duisburg, Germany
ID 264* Mechanical and microstructure analysis of solution heat treated Al-Zn-Mg-Cu (7075) alloy sheet

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ID 265* Quantification and correlation of the microstructural heterogeneity and stretch-flangeability of high-strength dual-phase and complex-phase steels

Y. Chang¹, M. Lin¹, J. Lian², U. Hangen³ and W. Bleck¹

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ID 270* Scatter of material properties and its influence on stretch-flangeability of AHSS

D.J. Cruz¹, S.S. Miranda¹, R.L. Amaral¹, A.D. Santos¹², J.V. Fernandes³, L.T. Malheiro⁴

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*Presentation Only Contributions
Digital techniques in material characterization / Material models, full and small scale testing

Organized by the Institute for Metal Forming Technology, University of Stuttgart

**ID 107**  
**Influence of the strain dependent material behaviour under plane strain on the yield locus modelling**  
M. Lenzen¹ and M. Merklein¹  
¹Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

**ID 124**  
**Performance Evaluation of Planar Anisotropy Yield Criteria for Aluminum Sheet Forming Analysis**  
B. Ghoo¹, N. Ichijo², M. Selig³, N. Manopulo³, B. Carleer⁴, W. Suzuki¹ and H. Takizawa¹  
¹AutoForm Japan, Japan  
²Toyota Motor Corporation, Japan  
³AutoForm Development GmbH, Zurich, Switzerland  
⁴AutoForm Engineering Deutschland GmbH, Dortmund, Germany

**ID 132**  
**Adiabatic heating in high-strength steel sheets under crash loads – Experiments and efficient modelling**  
S. Klitschke¹ and M. Liewald²  
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²Institute for Metal Forming Technology, University of Stuttgart, Germany

**ID 150**  
**Potential use of machine learning to determine yield locus parameters**  
C. Karadogan¹, P. Cyron¹ and M. Liewald¹  
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ID 159  Effects of initial microstructure before cold rolling on microstructure evolution and mechanical behaviour of CGL-compatible Q&P steel

Y. Wang¹, Y. Xu¹ and T. Zhang¹

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ID 177  Evaluation of Simple Shear Test Geometries for Constitutive Characterization using Virtual Experiments

A. Narayanan¹, A. Abedini¹, A. Weinschenk², M. J. Worswick¹ and C. Butcher³

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³Hexagon Canada, Canada

ID 179  Potentials for material card validation using an innovative tool

M. Eder¹, M. Gruber¹, N. Manopulo² and W. Volk¹

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²AutoForm Development GmbH, Zurich, Switzerland

ID 187  Modelling continuous dynamic recrystallization of lightweight alloys by coupling polycrystal plasticity approach

S.-F. Chen¹, S.-H. Zhang¹, H.-W. Song¹ and M.-G. Lee²

¹Shi-Changxu Innovation Center of Advanced Materials, Institute of Metal Research, Chinese Academy of Sciences, China  
²Department of Materials Science and Engineering & Research Institute of Advanced Materials, Seoul National University, South Korea

ID 202  Virtual design of formability for Zircaloy-4 sheet through texture control

H. Liu¹, S. Deng¹, S. Chen¹, H. Song¹ and S. Zhang¹

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²School of Materials Science and Engineering, University of Science and Technology of China, Shenyang, China
ID 204  A novel approach to characterising the cause of disc formation by the shear cutting process in punching machines

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ID 212*  The study of surface deflection at uniaxial Tension mode using Crystal Plasticity Finite Element Method

K.J. Kim¹, S. C. Yoon¹, Y.J. Jung¹, G.H. Yim¹ and J.S. Hyun¹

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ID 221  Constitutive modelling of Usibor 1500 sheets after intercritical quenching

M. S. Dastgiri¹, R. Thakkar¹, J. Shi¹, I. Sari Sarraf¹ and D. E. Green¹

¹University of Windsor, Canada

ID 243*  Aggressive DIC testing in service of accurate material characterization: a detailed exploration of the Numisheet 2020 material dataset

K. Kannan¹, T. Toughton² and A. Devine¹

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²General Motors Corporation, USA

ID 246  Influence of the orthotropic behaviour on defects prediction in cup drawing, reverse redrawing and expansion

M.C. Oliveira¹, D.M. Neto¹, J.L. Alves² and L.F. Menezes¹,

¹CEMMPRE, Department of Mechanical Engineering, University of Coimbra, Portugal
²CMEMS, Department of Mechanical Engineering, University of Minho, Portugal
ID 267* Evaluation of transfer layers on friction and wear mechanisms in commercially coated sheet metal forming tool steels

A.F. Tavares¹, A.P. Lopes², D.T. de Almeida², E.A. Mesquita¹, J.H. Corrêa de Souza¹ and H.L. Costa¹

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ID 269* Multi-scale friction model for sheet metal forming

J. Hazrati¹, M. Shisode¹ and A.H. van den Boogaard¹

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ID 271* Different plastic flow formulations and its influence in earing prediction of cylindrical cup drawing

S.S. Miranda¹, R.L. Amaral¹, D.J. Cruz¹, A.D. Santos¹², J.C. Sá¹² and M. Parente¹²

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*Presentation Only Contributions
ID 104  Validation of Part Holder Models of Car Body Upper Line Dies for Return Stroke Loads

M. Burkart¹, M. Liewald², J. Wied¹ and C. Kaminsky¹

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ID 149  Zero-error-production through inline-quality control of press-hardened automotive parts by multi-camera systems

A. Pierer¹, T. Wiener¹, L. Gjakova¹ and J. Koziorek²

¹Fraunhofer-Institute for Machine Tool and Forming Technology, Chemnitz, Germany
²Technical University of Ostrava, Faculty of Electrical Engineering and Computer Science, Czech Republic

ID 199  Development of an automatic crack detection method for cupping tests on sheets and foils with a wall thickness below 0.1 mm

J-L. Schneider¹, D. Staupendahl¹ and L. Wahlers¹

¹Erichsen GmbH & Co. KG, Hemer, Germany
**ID 215**  New press deflection measuring methods for the creation of substitutive models for efficient die cambering

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\textsuperscript{7}Koniker S. Coop., Arrasate-Mondragon, Spain  
\textsuperscript{8}Cascade Control AB, Mölndal, Sweden

**ID 230**  Acoustic emission sensors to monitor for material necking during forming

M. Baral\textsuperscript{1}, A. Breunig\textsuperscript{2}, J. Ha\textsuperscript{1}, P. Groche\textsuperscript{2}, Y. Korkolis\textsuperscript{3} and B. Kinsey\textsuperscript{1}

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**ID 244**  Complete transparency in the press shop through seamless part tracking

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*Presentation Only Contributions*
Smart production technologies and machine learning

Organized by the Institute for Metal Forming Technology, University of Stuttgart

ID 154  Data-driven analysis of cold-formed pin structure characteristics within versatile joining processes

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ID 162  Process data-based estimation of tool wear on punching machines using TCN-Autoencoder from waveform time-series information

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ID 163  Deformation and thinning field prediction for HFQ® formed panel components using convolutional neural networks

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ID 173  Prediction of forming limit diagrams from tensile tests of automotive grade steels by a machine learning approach

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**ID 178**  Parametric Shape Optimization of Stretch Webs in a Progressive Die Process using a Neural Network Surrogate Model

S. Athreya\(^1\), A. Weinschenk\(^1\), F. Steinlehner\(^2\), D. Budnick\(^3\), M. Worswick\(^3\), W. Volk\(^2\) and S. Huhn\(^1\)

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**ID 180**  Autoencoder based Wear Assessment in Sheet Metal Forming

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**ID 192**  Melting digital technologies around sheet metal forming

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**ID 222**  Lightweight design of an automotive lower control arm using topology optimization for forming process

K. Sookchanchai\(^1\), S. Olarnrithinun\(^2\) and V. Uthaisangsuk\(^1\)

\(^1\)Centre for Lightweight Materials, King Mongkut's University of Technology Thonburi, Bangkok, Thailand
\(^2\)National Metal and Materials Technology Center (MTEC), Thailand

**ID 226**  On the use of fixed point translations as input variable for digital twins in deep drawing compared to current methods

M. Ryser\(^1\), P. Hora\(^1\) and M. Bambach\(^1\)

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**ID 262**  Schuler Connect - remote support along the machine life cycle and for process optimization

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Robust process design and adaptive control

Organized by Prof. Dr. Pavel Hora
Organized by Dr. Eisso Atzema

ID 134 Simulation of Dynamic Effects in Progressive Die Operation and Control

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ID 147 Temperature-controlled tools for multi-stage sheet metal forming of high-strength aluminium alloys

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ID 172 On thermal compensation of Hot-Form-Quench stamping die

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ID 186* Large-scale manufacturing of metallic bipolar plates for fuel cells

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ID 194 Robustness Analysis with LS-OPT and LS-DYNA for sheet metal forming simulations

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³Materials Competence Center, Dynamore GmbH, Leinfelden-Echterdingen, Germany
ID 196  Variance based sensitivity analysis of deep drawing processes based on neural networks using Sobol indices

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ID 198  Process Linearization for Closed-Loop Control of Incremental Sheet Forming

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ID 245  Approaches to analysing scatter in forming simulations: from fundamental to pragmatic

E. H. Atzema¹², M. Scholting¹ and M. Abspoel¹

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ID 249*  Applications of part-based Process Control in Deep Drawing

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ID 260*  Adaptive Rounding System

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*Presentation Only Contributions
Prediction and control of product and assembly properties

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ID 145  Predicting springback variation and process-reliable tolerance limits of outer car-body panels by stochastic sheet metal forming simulation

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ID 188  Load-specific variant generation of bead cross sections in sheet metal components by unidirectional carbon fiber reinforcement

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ID 210  A new cracking resistance index based on fracture mechanics for high strength sheet metal ranking

D. Frómeta¹, S. Parareda¹, A. Lara¹, L. Grifé¹, I. Tarhouni¹ and D. Casellas²

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ID 223  Simulation based approach for light weighting of Connecting rod by tube hydro forming process

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ID 240 Prediction and assessment of skid line formation during deep drawing of sheet metal components by using FEM simulation

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ID 253 Study on new hot stamping tool with low cost and high cooling efficiency

S. Peng\textsuperscript{1}, J. Zhou\textsuperscript{1}, M. Zhang\textsuperscript{1}, K. Zhang\textsuperscript{1}, J. Liu\textsuperscript{1} and Y. Meng\textsuperscript{1}

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