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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Welcome Message

Univ.-Prof. Dr.-Ing. Dr. h. c. Mathias Liewald MBA

Head of Institute
Institute for Metal Forming Technology
University of Stuttgart

Chair of the IDDRG 2021 – Virtual

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 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!

Main Sponsor of the IDDRG 2021 – Virtual

Gold Sponsor

Silver Sponsors

Exhibitors
About the Conference

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

Asnafi, N. (Sweden) Li, D. (China)
Atzema, E. (Netherlands) Liewald, M. (Germany)
Banabic, D. (Romania) Manach, PY. (France)
Barlat, F. (South Korea) Martins, P. (Portugal)
Behrens, B.-A. (Germany) Merklein, M. (Germany)
Brosius, A. (Germany) Meschut, G. (Germany)
Bruschi, S. (Italy) Meya, R. (Germany)
Chen, F-K (Taiwan) Mohr, D. (Switzerland)
Deng, Z. (USA) Music, O. (Turkey)
Gantar, G. (Slovenia) Narasimhan, K. (India)
Ghiotti, A. (Italy) Peura, P. (Finland)
Golovashchenko, S. (USA) Rolfe, B. (Australia)
Green, D. (Canada) Saenz de Argandoña, E. (Spain)
Groche, P. (Germany) Santos, A. D. (Portugal)
Hama, T. (Japan) Sigvant, M. (Sweden)
Hance, B. (USA) Steglich, D. (Germany)
Haufe, A. (Germany) Stoughton, T. (USA)
Havinga, J. (Netherlands) Tekkaya, A. E. (Germany)
Hazrati, J. (Netherlands) Thuillier, S. (France)
Hirt, G. (Germany) Tisza, M. (Hungary)
Huh, H. (South Korea) Uthaisangsuks, V. (Thailand)
Hora, P. (Switzerland) van den Boogaard, A.H. (Netherlands)
Karadogan, C. (Germany) van Tyne, C. (USA)
Kim, H. (USA) Volk, W. (Germany)
Kim, J.H. (Korea) Wagner, L. (Austria)
Kinsey, B. (USA) Worswick, M. (Canada)
Korkolis, Y. (USA) Yoon, JW (Korea/Australia)
Kräusel, V. (Germany) Yoshida, F. (Japan)
Kuwabara, T. (Japan) Yoshida, Y. (Japan)
Langerak, N. (Netherlands) Zhang, S.H. (China)
Lee, M. G. (South Korea)
# Program Schedule

**June 21st – July 2nd, 2021**

<table>
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<th>1st Conference Week</th>
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<tbody>
<tr>
<td>June 21st – June 27th, 2021</td>
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<tr>
<td>Mini-Symposia with pre-recorded on-demand presentations available 24/7</td>
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<tr>
<td>132 presentations in 10 Mini-Symposia</td>
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<tr>
<th>2nd Conference Week</th>
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<tr>
<td>June 28th – July 2nd, 2021</td>
</tr>
<tr>
<td>Mini-Symposia with pre-recorded on-demand presentations available 24/7</td>
</tr>
<tr>
<td>132 presentations in 10 Mini-Symposia</td>
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</tbody>
</table>

**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>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>11:00 - 11:20</td>
<td>Opening of the Conference</td>
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</table>
| 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 - 13:35 | “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                         |
| 13:35 - 14:10 | Panel discussion MS 02                                               |
| 14:10 - 14:20 | Conclusion & outlook                                                |

**Monday, June 28th**

<table>
<thead>
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<tr>
<td>11:00 - 11:10</td>
<td>Opening of the Live-Session</td>
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</table>
| 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                                       
<pre><code>           | MS 04: Springback simulation and compensation                        |
</code></pre>
<p>| 13:25 - 14:00 | Panel discussion MS 04                                               |
| 14:00 - 14:10 | Conclusion &amp; outlook                                                |</p>
<table>
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<tr>
<td>11:00 - 11:10</td>
<td>Opening of the Live-Session</td>
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<tr>
<td>11:10 - 11:45</td>
<td>Panel discussion MS 05: Damage, forming limits and sheared edge formability</td>
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<tr>
<td></td>
<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>
</tr>
<tr>
<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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<tr>
<td></td>
<td>By Prof. Dr.-Ing. habil. Dierk Raabe</td>
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<tr>
<td>12:20 – 12:55</td>
<td>Panel discussion MS 06</td>
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<tr>
<td>12:55 – 13:05</td>
<td>Short Break</td>
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<tr>
<td>13:05 – 13:50</td>
<td>“Experimental and numerical challenges towards machine-learning plasticity models”</td>
</tr>
<tr>
<td></td>
<td>By Prof. Dr. Dirk Mohr</td>
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<tr>
<td>13:50 – 14:25</td>
<td>Panel discussion MS 06</td>
</tr>
<tr>
<td>14:25 – 14:35</td>
<td>Conclusion &amp; outlook</td>
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<tr>
<td>11:10 - 11:55</td>
<td>“Benefits of smart sensors and actuators in sheet metal forming”</td>
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<tr>
<td></td>
<td>By Prof. Dr.-Ing. Dipl.-Wirtsch.-Ing. Peter Groche</td>
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<tr>
<td>11:55 - 12:30</td>
<td>Panel discussion MS 07</td>
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<tr>
<td>12:30 - 12:40</td>
<td>Short Break</td>
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<tr>
<td></td>
<td>By Ir. Nico Langerak</td>
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<tr>
<td>13:25 - 14:00</td>
<td>Panel discussion MS 08</td>
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<tr>
<td>14:00 - 14:10</td>
<td>Conclusion &amp; outlook</td>
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<td>Time</td>
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<td>11:00 - 11:10</td>
<td>Opening of the Live-Session</td>
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<tr>
<td>11:10 - 11:55</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>
</tr>
<tr>
<td>11:55 - 12:30</td>
<td>Panel discussion MS 09</td>
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<tr>
<td>12:30 - 12:40</td>
<td>Short Break</td>
</tr>
<tr>
<td>12:40 - 13:25</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>
</tr>
<tr>
<td>13:25 - 14:00</td>
<td>Panel discussion MS 10</td>
</tr>
<tr>
<td>14:00 - 14:30</td>
<td>Conclusion &amp; closing of the conference</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
## Mini-Symposia

<table>
<thead>
<tr>
<th>#</th>
<th>Title</th>
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<tbody>
<tr>
<td>01</td>
<td>Flexible processes in mechanical joining</td>
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<tr>
<td></td>
<td>Organized by Prof. Dr.-Ing. Marion Merklein</td>
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<tr>
<td></td>
<td>Organized by Prof. Dr.-Ing. Alexander Brosius</td>
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<td></td>
<td>Organized by Prof. Dr.-Ing. Gerson Meschut</td>
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<tr>
<td>02</td>
<td>Press hardening, manufacturing issues</td>
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<tr>
<td></td>
<td>Organized by Prof. Dr.-Ing. habil. Verena Kräusel</td>
</tr>
<tr>
<td>03</td>
<td>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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<tr>
<td>04</td>
<td>Springback simulation and compensation</td>
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<tr>
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<td>Organized by Prof. Dr.-Ing. Wolfram Volk</td>
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<tr>
<td>05</td>
<td>Damage, forming limits and sheared edge formability</td>
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<td></td>
<td>Organized by Dr.-Ing. Rickmer Meya</td>
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<tr>
<td>06</td>
<td>Digital techniques in material characterization / Material models, full and small scale testing</td>
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<td></td>
<td>Organized by the Institute for Metal Forming Technology, University of Stuttgart</td>
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<tr>
<td>07</td>
<td>Digitalization in tooling and intelligent tools</td>
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<tr>
<td></td>
<td>Organized by Prof. Dr.-Ing. Dipl.-Wirtsch.-Ing. Peter Groche</td>
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<tr>
<td>08</td>
<td>Smart production technologies and machine learning</td>
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<tr>
<td>09</td>
<td>Robust process design and adaptive control</td>
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<td>Organized by Prof. Dr. Pavel Hora</td>
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<td>Organized by Dr. Eisso Atzema</td>
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<tr>
<td>10</td>
<td>Prediction and control of product and assembly properties</td>
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<td></td>
<td>Organized by the Institute for Metal Forming Technology, University of Stuttgart</td>
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</table>
Towards an adaptable quality monitoring process for self-piercing riveting

V. Noller\textsuperscript{1}, U. Walther\textsuperscript{1}, G. Meschut\textsuperscript{2} and T. Bäck\textsuperscript{3}

\textsuperscript{1}Mercedes-Benz AG, Germany
\textsuperscript{2}University of Paderborn, Germany
\textsuperscript{3}Leiden University, Singapore

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

M. Meinhardt\textsuperscript{1}, M. Lechner\textsuperscript{2} and M. Merklein\textsuperscript{2}

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

Mechanical joining technologies – An insight into further development of established joining technologies

D. Henke\textsuperscript{1}

\textsuperscript{1}Böllhoff Verbindungstechnik GmbH, Germany

Numerical and experimental investigation of the transmission moment of clinching points

C. Steinfelder\textsuperscript{1}, J. Kalich\textsuperscript{2}, A. Brosius\textsuperscript{1} and U. Füssel\textsuperscript{2}

\textsuperscript{1}Chair of Forming and Machining Processes, Technische Universität Dresden, Germany
\textsuperscript{2}Chair 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. Thuiller¹

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

¹Eurecat, Centre Tecnològic de Catalunya, Unit of Metallic and Ceramic Materials, Spain
²Eurecat, Centre Tecnològic de Catalunya, Smart Management Systems, Spain

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

A. Horn¹ and M. Merklein¹

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

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

J. Hirsch¹,² and P. Amborn¹

¹Hodforming GmbH, Königswinter, Germany
²Aluminium Consulting Königswinter, Germany
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

¹University of Waterloo, Waterloo, Ontario Canada
²Ford Motor Company, Dearborn, Michigan, USA
³Ford Motor Company, Windsor, Ontario, Canada
⁴Magna International, Troy, Michigan USA
⁵Promatek Research Centre, Brampton, Ontario, Canada

Parameter study on press hardened components with tailored properties

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

¹Fraunhofer Institute for Machine Tools and Forming Technology, Chemnitz, Germany

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

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

¹Eurecat, Centre Tecnològic de Catalunya, Unit of Metallic and Ceramic Materials Spain
²Luleå University of Technology, Division of Mechanics of Solid Materials Sweden
³Universitat Politècnica de Catalunya, Spain

MBW 1200 – Hot Stamping Steel with Increased Ductility

D. Rosenstock¹, J. Banik¹, R.P. Röttger², S. Graff¹ and T. Gerber¹

¹thyssenkrupp Steel Europe AG, Dortmund, Germany
²thyssenkrupp Steel Europe AG, Duisburg, Germany

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

S. Sturm¹

¹InfraTec GmbH, Germany
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

¹Chemnitz University of Technology, Chemnitz, Germany  
²Shanghai Jiao Tong University, Shanghai, China

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

R. He¹, S. DiCecco¹, R. George¹, M. Worswick¹, C. Chiriac², G. Luckey², J. Tjong³, C. Shi⁴ and J. Boettger⁵

¹University of Waterloo, Canada,  
²Ford Motor Company, USA,  
³Ford Canada, Canada;  
⁴Magna International, USA  
⁵Promatek Research Centre, Canada

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

S. B. Zaman¹, J. Hazrati¹, M. Rooij² and T. Boogaard¹

¹Nonlinear Solid Mechanics, Faculty of Engineering Technology, University of Twente, Enschede, The Netherlands  
²Surface Technology & Tribology, Faculty of Engineering Technology, University of Twente, Enschede, The Netherlands

ID 189  Advanced Data Acquisition for Hot Stamping and its Application

C. Rouet¹ and G. Trattnig¹

¹voestalpine Stahl GmbH, Linz, Austria

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

¹AutoForm Engineering Deutschland, Dortmund, Germany  
²TriboForm Engineering B.V., Enschede, The Netherlands  
³Tata Steel, Research & Development, Ijmuiden, The Netherlands  
⁴Volvo Cars, Olofstrom, Sweden  
⁵Institute for Forming Technology and Lightweight Components, TU Dortmund University, Germany
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

¹Institute of Forming Technology and Machines, Garbsen, Germany
²Institute of Materials Science, Garbsen, Germany

ID 203  Effect of strain rate on formability of 22MnB5 steel during hot stamping process

A.K. Singh¹ and K. Narasimhan¹

¹IIT Bombay, India

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

Z. Lukacs¹

¹University of Miskolc, Miskolc, Hungary

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

¹Neue Materialien Bayreuth GmbH, Bayreuth, Germany
²University of Bayreuth, Bayreuth, Germany

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

¹DYNAmore GmbH, Stuttgart, Germany
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

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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

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*Presentation Only Contributions
ID 103  New sheet metal forming process for springback reduction by continuous stress superposition

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ID 105  Reduction of Young's modulus for a wide range of steel sheet materials and its effect during springback simulation

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ID 120  Development of a springback prediction for a hybrid laminate with sensor functionality

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ID 130  Enhancement of springback prediction of AHSS parts by advanced friction modelling

U. Durmaz¹, S. Heibel¹, T. Schweiker¹, M. Merklein², S. Berahmani³, J. Höf² and P. Nägele⁴

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⁴AutoForm Engineering Deutschland GmbH, Esslingen am Neckar, Germany
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

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ID 146  Effect of blank-holder force on springback of ultra-thin copper sheets
N. Ayachi¹,², N. Guermazi² and P.-Y. Manach¹

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ID 153  Compensating the springback of ultra-high-strength steel parts by specific stress superposition during sheet metal forming
R. Radonjic¹ and M. Liewald¹

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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

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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

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ID 217  Structural springback analysis of car body closure assemblies using finite element process chain simulations

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\textsuperscript{1}Roto Frank Fenster- und Türtechnologie GmbH, Leinfelden-Echterdingen, Germany
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ID 225  A Numerical Study on Chain-Die Forming of the aluminium profiles with variable cross-section

K. Lu\textsuperscript{1}, Z. Liang\textsuperscript{1}, Y. Liu\textsuperscript{1}, T. Zou, D. Li\textsuperscript{1} and S. Ding\textsuperscript{2}
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ID 232  Experimental and numerical study of springback effect of advanced high strength steel in a V-shape bending

W. Julsri\textsuperscript{1}, A. Sanrutsadakorn\textsuperscript{1} and V. Uthaisangsuk\textsuperscript{2}
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\textsuperscript{2}Centre 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. Neto\textsuperscript{1}, M.C. Oliveira\textsuperscript{1}, J.L. Alves\textsuperscript{2} and L.F. Menezes\textsuperscript{1}
\textsuperscript{1}CEMMPRE, Department of Mechanical Engineering, University of Coimbra, Portugal
\textsuperscript{2}CMEMS, 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. Choi\textsuperscript{1}, S.W. Nam\textsuperscript{2}, E.H. Lee\textsuperscript{3} and J.W. Yoon\textsuperscript{1,4}
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\textsuperscript{2}Daewoo Industry, South Korea
\textsuperscript{3}Department of Mechanical Engineering, Sungkyunkwan University, Republic of Korea
\textsuperscript{4}School of Engineering, Deakin University, Australia
ID 268* Effect of Description of Elastic-Plastic Transition on Springback Prediction

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

Organized by Dr.-Ing. Rickmer Meya

ID 100  Lecture: “An overview on forming limit curves”
D. Banabic¹

¹Technical University of Cluj Napoca, Romania

ID 106  A critical assessment of notched tensile tests for formability mapping of AHSS sheets
L. Wagner¹, P. Larour¹, F. Sonnleitner¹,², A. Felbinger¹,² and J. Angeli¹,²

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²University 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. Kohl¹ and M. Merklein¹

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ID 111  The Effects of Piercing Methods on Burring Formability under Practical Hole Diameter
R. Urushibata¹ and Y. Ito¹

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ID 116  Comparison of different forming methods on deep drawing and springback behavior of high-strength aluminum alloys
N. Rigas¹, H. Schmid¹ and M. Merklein

¹Institute of Manufacturing Technology, Friedrich-Alexander-University Erlangen-Nürnberg, Germany
ID 119  Study on the impact of temperature on the warm bending of aluminium alloy sheet
A. Mauduit¹ and A. Maillard²
¹CETIM Centre Val de Loire, France
²CETIM Senlis, France

ID 122  Influence of pass reduction in cold rolling on damage evolution in deep drawing of rotationally symmetric cups
M. Nick¹, C. Liebsch², M. Müller¹, I.F. Weiser¹, G. Hirt² and T. Bergs¹,³
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³Fraunhofer 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. Honda¹, T. Yasutomi¹ and M. Yamagata¹
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ID 139  A new Device for Determination of Forming-Limit-Curves under Hot-Forming Conditions
M. Triebus¹, J. Gierse¹, T. Marten¹ and T. Tröster¹
¹Chair of Automotive Lightweight Design, Paderborn University, Germany

ID 144  Cryogenic deep drawing of aluminum alloy AA6014 using macro-structured tools
M. Tulke¹, A. Wolf¹, and A. Brosius¹
¹Chair of Forming and Machining Processes, Technische Universität Dresden, Germany

ID 170  Local formability assessment of AHSS steels with shear cut tensile tests
P. Larour¹, J. Freudenthaler¹, H. Pauli¹, M. Kerschbaum¹, L. Wagner¹, A. Felbinger¹,², F. Sonnleitner¹,² and J. Angeli¹,²
¹voestalpine Stahl GmbH, Linz, Austria
²University of Applied Sciences Upper Austria - Campus Wels, Austria
ID 176  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

ID 183  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

ID 185*  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

¹Institute of Metallurgy, Clausthal University of Technology, Germany

ID 205  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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ID 207  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
³ETH Zurich, Switzerland

ID 208*  Investigation of GISSMO failure model with different specimens by numerical modelling and fracture analysis

E. Tamer¹, G. Ozgultekin¹ and B. Gürsoy²

¹Borcelik Celik Sanayi, Bursa, Turkey
²Bias Mühendislik, Turkey
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. Kim¹², 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

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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

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²Thyssenkrupp Steel Europe AG, Duisburg, Germany
ID 264*  Mechanical and microstructure analysis of solution heat treated Al-Zn-Mg-Cu (7075) alloy sheet

C. Moon¹, S. Thuillier², J. Lee³, M.-G. Lee¹

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²Univ. Bretagne Sud, Lorient, France
³Korea Institute of Materials Science, Changwon, South Korea

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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²Advanced Manufacturing and Materials, Department of Mechanical Engineering, Aalto University, Finland
³Bruker Nano Surfaces, Aachen, Germany

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. Santos¹,², J.V. Fernandes³, L.T. Malheiro³

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*Presentation Only Contributions
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. Lenzen\(^1\) and M. Merklein\(^1\)  
\(^1\)Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

**ID 124**  
Performance Evaluation of Planar Anisotropy Yield Criteria for Aluminum Sheet Forming Analysis  
B. Ghoo\(^1\), N. Ichijo\(^2\), M. Selig\(^3\), N. Manopulo\(^3\), B. Carleer\(^4\), W. Suzuki\(^1\) and H. Takizawa\(^1\)  
\(^1\)AutoForm Japan, Japan  
\(^2\)Toyota Motor Corporation, Japan  
\(^3\)AutoForm Development GmbH, Zurich, Switzerland  
\(^4\)AutoForm Engineering Deutschland GmbH, Dortmund, Germany

**ID 132**  
Adiabatic heating in high-strength steel sheets under crash loads – Experiments and efficient modelling  
S. Klitschke\(^1\) and M. Liewald\(^2\)  
\(^1\)Fraunhofer Institute for Mechanics of Materials IWM, Germany  
\(^2\)Institute for Metal Forming Technology, University of Stuttgart, Germany

**ID 150**  
Potential use of machine learning to determine yield locus parameters  
C. Karadogan\(^1\), P. Cyron\(^1\) and M. Liewald\(^1\)  
\(^1\)Institute for Metal Forming Technology, University of Stuttgart, Germany
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

¹The State Key Laboratory of Rolling and Automation, Northeastern University, China

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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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

S. Nießner¹ and M. Liewald²

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²Institute for Metal Forming Technology, University of Stuttgart, Germany

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

¹Automotive Steel Application Engineering Team, Hyundai-Steel, South Korea

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

¹AutoForm Engineering USA Inc., USA
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

¹ Federal University of Rio Grande, Brazil
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ID 269* Multi-scale friction model for sheet metal forming

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

¹ Nonlinear Solid Mechanics, University of Twente, Enschede, The Netherlands

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. Santos¹,², J.C. Sá¹,² and M. Parente¹,²

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*Presentation Only Contributions
ID 104 Validation of Part Holder Models of Car Body Upper Line Dies for Return Stroke Loads
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\textsuperscript{2}Institute for Metal Forming Technology, University of Stuttgart, Germany

ID 149 Zero-error-production through inline-quality control of press-hardened automotive parts by multi-camera systems
A. Pierer\textsuperscript{1}, T. Wiener\textsuperscript{1}, L. Gjakova\textsuperscript{1} and J. Koziorek\textsuperscript{2}
\textsuperscript{1}Fraunhofer-Institute for Machine Tool and Forming Technology, Chemnitz, Germany
\textsuperscript{2}Technical 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. Schneider\textsuperscript{1}, D. Staupendahl\textsuperscript{1} and L. Wahlers\textsuperscript{1}
\textsuperscript{1}Erichsen GmbH & Co. KG, Hemer, Germany
**ID 215**  
New press deflection measuring methods for the creation of substitutive models for efficient die cambering

J. Pilthammar\textsuperscript{1,2}, T. Skåre\textsuperscript{3}, L. Galdos\textsuperscript{4}, K. Fröjd\textsuperscript{5}, P. Ottosson\textsuperscript{3}, D. Wiklund\textsuperscript{3}, J. Carlholmer\textsuperscript{3}, M. Sigvam\textsuperscript{1,2}, M. Ohlsson\textsuperscript{3}, E. Sáens de Argandoña\textsuperscript{4}, F. Abbasi\textsuperscript{4}, O. Sarasua\textsuperscript{6}, A. Garro\textsuperscript{7} and W. Rutgersson\textsuperscript{8}

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**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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\textsuperscript{2}Technische Universität Darmstadt, Germany  
\textsuperscript{3}The Ohio State University, USA

**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

S. Asahi¹, C. Karadogan², S. Tamura¹, S. Hayamizu¹ and M. Liewald²

¹Faculty of Engineering, Gifu University, Japan
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ID 163  Deformation and thinning field prediction for HFQ® formed panel components using convolutional neural networks

H.R. Attar¹, H. Zhou¹ and N. Li¹

¹Dyson School of Design Engineering, Imperial College London, UK

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

F.P. Finamor¹, M.A. Wolff¹ and V. S. Lage¹

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

S. Athreya¹, A. Weinschenk¹, F. Steinlehner², D. Budnick³, M. Worswick³, W. Volk² and S. Huhn¹

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Autoencoder based Wear Assessment in Sheet Metal Forming

P. Niemietz¹, M. Unterberg¹, D. Trauth¹ and T. Bergs¹,²

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Melting digital technologies around sheet metal forming

J. Stahlmann¹ and M. Brenneis¹

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

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

M. Ryser¹, P. Hora¹ and M. Bambach¹

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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**  
D. Budnick¹, F. Steinlehner², A. Weinschenk³, W. Volk², W. Melek¹, M. Worswick¹ and S. Huhn³

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³Forming Technologies, Hexagon Manufacturing Intelligence, Canada

**ID 147**  
**Temperature-controlled tools for multi-stage sheet metal forming of high-strength aluminium alloys**  
J. Günzel¹², J. Hauß² and P. Groche¹

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**ID 172**  
**On thermal compensation of Hot-Form-Quench stamping die**  
D. Szegda¹, M. Mohamed¹ and M. Ziane²

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²ESI Group, Paris, France

**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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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

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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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Soudronic AG, Switzerland

*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

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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

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