EWI Forming Center Workshop:
Advanced Sheet Metal Forming Technology

A Virtual Workshop | October 21-22, 2020

Speaker Abstracts and Biographies:

Hyunok Kim, EWI

Applications of the Machine-learning Based Process Control for Sheet Metal Forming

ABSTRACT

The first-time quality of stamping with reduced scrap rates is a primary goal of the metal stamping industry. Machine learning (ML) and inline monitoring sensors have recently been applied in sheet metal forming production. This presentation will introduce industrial case studies with the applications of the inline monitoring sensors and the ML-based process control for sheet metal forming. Real-time monitoring tools can provide both inline and statistical data to help the forming process more robust against the production variations.

The presentation will also provide a brief update on new technical capabilities developed by EWI Forming Center on:

- Wedge bend testing for AHSS and GEN3 steel with Digital Image Correlation (DIC) tool
- New stamping test to evaluate edge cracking
- Application of the DIC to characterize the local formability of the laser-welded blank

BIO

Hyunok Kim is the Director of EWI Forming Center. He has more than 15 years of technical expertise in sheet metal forming, tribology, formability analysis, and process simulations for industrial application. Hyunok received his M.S. at the University of Michigan and Ph.D. at The Ohio State University in metal forming and manufacturing. He is also an Ohio-certified Professional Engineer (PE) of Mechanical Engineering. He is actively involved in teaching manufacturing/metal forming courses to undergraduate and graduate students as an instructor at OSU's College of Engineering. Hyunok has authored and co-authored more than 50 technical papers and articles on topics related to metal forming.

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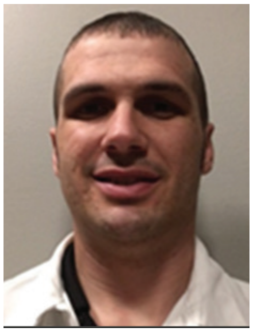
Speaker Abstracts and Biographies:



Ben Hoffman

Ryan Hahnlen

Ben Hoffman and Ryan Hahnlen, Honda

Additively Manufactured Forming Tools for Low Volume Production

ABSTRACT

In order to provide design verification and guidance, prototype components for vehicle development must have the same shape and performance as the ultimate mass production parts they represent. To accomplish this, the components need to be made with similar manufacturing processes. In the context of automotive development, the body-in-white consists primarily of stamped sheet metal parts made with hard tooling. Currently, prototype tooling is essentially identical to mass production tooling: large metal dies that can form 10,000's of parts, even though the useful life for such tooling is often only 100's or parts. Furthermore, prototype metal forming tools require long lead-times and come with high costs. This can cause schedule delays and increased spending during the development process. The lead time and costs are associated with manual programming of CNC and milling operations, along with multiple tooling set ups for complex geometries. Additive manufacturing allows for producing highly complex parts with minimal programming time and lights-out manufacturing, however printed parts do not have the same mechanical properties or performance as mass production parts, and print costs are much higher per volume than bulk materials. Utilizing plastic additive manufacturing to print metal forming tool shells and backfilling them with less expensive bulk materials is a novel way to reduce lead times and tool costs, while maintaining final part properties and performance.

This presentation will discuss ongoing research into the development, design, and testing of Low-Cost Agile Tooling (LCAT) enabled by additive manufacturing and how they perform against current low volume tooling methods.

BIOS

Ben Hoffman is an Engineering Coordinator in the Manufacturing Tech Division of Honda of America Manufacturing, and currently on assignment in the Strategic Research Operations division of Honda R&D Americas, LLC. His responsibilities include working with universities, tier 1,2, and 3 suppliers, third party companies, non-government, and government institutions to identify and develop new technologies in tooling development in forming and injection molding applications, as well as additive manufacturing. Ben received his A.S. in Mechanical Engineering at Marion Technical College and is currently pursuing his B.S. and M.S. in Industrial Systems Engineering at The Ohio State University. Ben has two patents granted with several more pending in the area of additive manufacturing applications.

Ryan Hahnlen is a Senior Engineer in the Strategic Research Operations division of Honda R&D Americas, LLC. His responsibilities include third-party outreach, working with universities, non-government, and government institutions to identify and develop new technologies in lightweighting, high performance structures, additive manufacturing, and multi-material joining. Ryan received his B.S., M.S., and Ph.D. degrees in Mechanical Engineering at The Ohio State University with his graduate research focusing on modeling and characterizing metal matrix composites made via additive manufacturing. Ryan has co-authored over 17 technical papers and articles and has four patents granted with several more pending in the area of advanced manufacturing.

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Speaker Abstracts and Biographies:

Tom Feister, EWI

GISSMO Damage Modeling in Forming Simulation

ABSTRACT

The forming limit diagram (FLD) has become the standard tool for predicting failure when simulating sheet forming processes. However, this tool is not always able to predict failures that are showing up in production using advanced high strength steels, aluminum, and magnesium alloys. An unchecked error in the formability model can result in the need to redesign the die, causing major delays and added costs. Limited ductility in advanced materials leads to non-necking material failures that require an additional prediction tool. The solution to accurately predict failure for these new materials comes in the form of GISSMO (Generalized Incremental Stress-State independent damage MOdel) that is implemented in LSDYNA.

The primary objectives of this presentation are to:

- Introduce triaxiality stress state failure limits
- Demonstrate how the triaxiality based damage model can be obtained an applied

BIO

Tom Feister, Applications Engineer, came to the EWI Forming Center in 2017 with a broad background in sheet metal forming, materials testing, lightweight materials evaluation, stamping, forging, and metal forming software. He honed his expertise in finite element analysis (FEA) in previous positions at KTH Parts, Scientific Forming Technologies Corporation (SFTC), and AutoForm Engineering. Tom specializes in developing forming processes through simulation and optimizing these processes through DOE studies. He is also an Ohio-certified Professional Engineer (PE) in the metallurgical and materials field.

Andrei Burnosenka, Magna

The Challenges of Material Characterization for Production Environment

ABSTRACT

No simulation tool can be used effectively without a robust material model. That is why material characterization remains crucial for sheet metal forming.

USCAR/USAMP Low-cost Mg project is a good example of that. A new alloy called E-Form+ targets warm-form performance of ZEK100 at fraction of the cost. The end goal of the material evaluation is stamping door inner and outer panels, but before that is done, a correlation study is being performed using EWI cross-die test data.

Another topic of the presentation is applying GISSMO damage model to evaluate AHSS performance. Several Gen3-980 production parts were identified during die engineering and home-line trials that showed splits despite having safe FLC status. Simulations will be performed for these parts to check if there is any improvement in crack prediction with the GISSMO model.

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Speaker Abstracts and Biographies:

Andrei Burnosenka, Magna

Statistical analysis of production material properties indicates pitfalls of using “one fits all” material cards for die engineering. Using regression methods to test against the property range is one viable solution. Creating mill-specific material cards for faster die engineering is another one.

BIO

Andrei Burnosenka is employed by CDT (Magna International) as R&D Application Manager. He has been working with Magna since 2011 where he has been heavily involved in sheet metal forming and other CAE projects to support Magna manufacturing divisions. His education and previous work experience include Engineer’s Diploma and M.S. in Mechanical Engineering from BNTU (Belarus) and 8 years of work in automotive engineering.

Lu Huang, US Steel

Global Forming Capacity Index to Depict Global Formability of Sheet Metals

ABSTRACT

While forming limit curve (FLC) has been widely used to characterize the global formability sheet metal, the formability window during stamping depends not only on the material’s forming limit, but also on its strain distribution ability. To account for both essential aspects of global forming, a new index named global forming capacity (GFC) index was developed. This index is constructed by integrating the instantaneous n-value from zero to the effective strain limit of the material. An explicit relationship was established between the calculated index and experimental limiting dome height test results. In this talk, previous work will be reviewed on the development, validation, and application of the GFC index via experimental approaches and computer simulations. The use of the GFC indices provides a straightforward way to assess the overall global formability for material comparison and selection purposes. It also serves as an effective tool to evaluate down-gauging opportunities of automotive components from global forming perspective.

BIO

Lu Huang is an Industry Research Engineer at the Automotive Solutions Center of United States Steel Corporation. Her research interests in this position include sheet metal formability and fracture analysis of advanced high strength steels with specialties in advanced nondestructive characterization techniques. Lu earned her Ph.D. degree in Materials Science from the University of Tennessee in Knoxville, Tennessee.

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Speaker Abstracts and Biographies:

Laura Zoller, EWI

Effects of Edge Quality in Creating Reliable Forming Limit Diagrams

ABSTRACT

Forming limit diagrams (FLDs) are widely accepted in sheet metal forming for predicting a material's formability and understanding the failure strains. FLDs are commonly used in sheet metal forming simulations to be able to accurately predict the results of a given part prior to production. FLDs can also be used during production to make engineering decisions on how to solve quality issues such a wrinkling or cracking. EWI has experienced edge cracking and sample distortion with nickel-based super alloys and materials less than 0.5-mm thick.

This presentation will explore ISO-12004 recommendations on:

- Sample geometry
- Sample edge preparation
- Various methods to calculate the FLD

The major findings from this presentation are:

- If edge cracking is an issue, reducing sharp corners of the samples and the amount of material where the blank holder makes contact can eliminate the edge cracking
- There is no difference in formability between waterjet cut or milled samples
- The ISO-12004 can provide reliable data

BIO

Laura Zoller is an Applications Engineering in the EWI Forming Center. She specializes in processing, measuring and analyzing sheet metal forming. Laura operates EWI's stamping presses and leads quality inspection testing. In addition, she conducts material formability tests and research. Prior to EWI, Laura was a Quality Engineer at Honda of America Mfg., Inc. She has her B.S. in Materials Science and Engineering from The Ohio State University.

Justin Nardone, Figur

Advancements in Dual Sided Incremental Sheet Forming

ABSTRACT

Figur is a hardware technology company changing the way industries manufacture sheet metal components. Our goal is to eliminate centuries-old metal forming processes and replace them with digitally driven tools. We have developed proprietary, leading-edge technology that enables manufacturers to produce complex parts without tooling or dies. The elimination of metal forming dies will give manufacturers a competitive advantage in supplying their customers with unique metal products quickly and without the high startup and development costs normally associated with sheet metal fabrication. Our technology has the potential to disrupt current manufacturing markets and uncover entirely new markets that were not feasible with existing technologies.

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Justin Nardone, Figur

This presentation will outline several tests done with a series of sample parts to test the accuracy and repeatability of Figur's unique dual-sided forming process. All parts were fabricated using our current demo machine. We will show test done for accuracy and repeatability across a range of materials, speeds, and resolutions.

BIO

Justin Nardone is the Founder and CEO of Figur. He has over 15 years of experience in design and fabrication of supertall towers, kinetic buildings, digital fabrication and 3D printed structures. Early in his career he founded a company centered around designing human interfaces to technology for commercial and residential spaces. Following that he worked for Gehry Technologies – the software spinoff from architect Frank Gehry. He went on to work in Skidmore Owings and Merrill and then Thornton Tomasetti. At both firms he led several technology initiatives implementing custom developed software, advanced manufacturing processes, and even drone technology. His expertise in the use of digital fabrication technologies as allowed him to bridge the gap between digital design and advanced manufacturing.

Clare Gu, EWI

Evaluation and Prediction of Laser Welded Blank (LWB) Formability with GEN3 Steel

ABSTRACT

The automotive industry has extensively used the laser-welded blanks (LWB) to improve crashworthiness and light-weighting for three decades. However, the automotive industry needs prediction capability of strain distribution on the weld zone and heat-affected zone (HAZ) using commercial FEM software. The current practice does not consider any weld material properties or safety margin on the weld and HAZ. This can result in a significant mismatch between FEM-predicted results and production trials for the LWB. To improve the accuracy in TWB formability prediction, reliable material testing methods and analysis are also very critical. To address this industrial challenge, EWI started an internal project with industry partners. This presentation will focus on:

- Evaluation of the formability of the LWB materials with a 980GEN-3 steel using biaxial and plane-strain conditions
- Prediction of the failure of the LWB materials using AutoForm
- Feasibility to improve the sheared edge quality and weld quality for the LWB using a high-speed shearing process

BIO

Clare Gu is a graduate fellow in the EWI Forming Center. She is currently pursuing a Ph.D. degree in Industrial Systems Engineering at the Ohio State University. Her research focuses on sheet metal manufacturing development, especially in formability prediction and evaluation influenced by the blanking process. Her technical skills include sheet metal finite element analysis, materials characterization and modeling, and metallurgical analysis. She had her B.S. in Material Science and Engineering from OSU.