

# **10<sup>th</sup> International LS-DYNA<sup>®</sup> Users Conference 2008**

Sponsored by  
Livermore Software Technology Corporation (LSTC)

Editor  
Wayne L. Mindle

June 8-10, 2008  
Dearborn, Michigan USA

Livermore Software Technology Corporation  
7374 Las Positas Road  
Livermore, California 94551

Tel: 925-449-2500  
Fax: 925-449-2507  
Email: [sales@lstc.com](mailto:sales@lstc.com)  
Website: [www.lstc.com](http://www.lstc.com)

Copyright © 2008 Livermore Software Technology Corporation. LS-DYNA<sup>®</sup>, LS-OPT<sup>®</sup> and LS-PrePost<sup>®</sup> are registered trademarks of Livermore Software Technology Corporation.

ISBN 0-9778540-4-3

Permission to reproduce any papers contained herein is granted provided that credit is given to LSTC, the author and his/her company. Authors retain their respective copyrights.

**Table of Contents**

**Welcome Remarks** *Dr. Wayne L. Mindle, LSTC*  
**Introduction of Keynote Speakers** *Dr. John O. Hallquist, LSTC*

**Plenary Session (1) - Keynote Presentations ..... P-1**

*“Lessons Learned from Crash Analysis by the Earth Simulator”*

**Mr. Tsuyoshi Yasuki**  
*Toyota Motor Corporation*

*“Advancements of Safety CAE within Ford”*

**Mr. Stephen T. Kozak / Mr. Nand K. Kochhar**  
*Ford Motor Company*

*“Developments in Computational Science and Engineering”*

**Dr. Ted Belytschko**  
*Northwestern University*

*“Autobody Manufacturing CAE – The Business Needs and Technical Challenges”*

**Dr. Chuan-Tao Wang**  
*General Motors Corporation*

*“Evolving Technology: Multi-Phase, Multi-Material,  
ALE Approach for Buried Blast Simulation”*

**Dr. Rahul Gupta**  
*Army Research Laboratory*

*“Simulation of Polymeric Materials in LS-DYNA®”*

**Mr. Paul A. Du Bois**  
*Consulting Engineer*

**Plenary Session (2) ..... P-2**

Technology Today

*Presentation by Conference Sponsors*

Final Keynote Presentation

*“LS-DYNA Development”*  
**Dr. John O. Hallquist, LSTC**

Closing Remarks

Dr. Wayne L. Mindle, LSTC

**Session 1 - Crash/Safety (1)**

<i>Kang, S., Xiao, P.,</i> <b>Comparison of Hybrid III Rigid Body Dummy Models .....</b>	<b>1-1</b>
<i>Franz, U., Gromer, A., Walz, M., Zschieschack, J., Huang, Y.,</i> <b>Ideas on Applying Very Fine Models in Dummy Model Development .....</b>	<b>1-11</b>
<i>Kapoor, T., Altenhof, W., Howard, A.,</i> <b>The Effect of using Rigid ISOFIX on the Injury Potential of Toddlers in Near-side Impact Crashes .....</b>	<b>1-27</b>
<i>Gromer, A., Stahlschmidt, S., Schuster, P.,</i> <b>WorldSID Dummy Model Development in Cooperation with German Automotive Industry .....</b>	<b>1-49</b>

**Session 2 – Metal Forming (1)**

<i>Xu, D., Kosek, J.,</i> <b>Application of Scrap Shedding Simulation in Stamping Manufacturing .....</b>	<b>2-1</b>
<i>Tang, A., He, J.,</i> <b>Visions and Latest Developments in Dynaform .....</b>	<b>2-13</b>
<i>Haufe, A., Lorenz, D., Roll, K., Bogon, P.,</i> <b>Concepts to take Elastic Tool Deformation in Sheet Metal Forming into Account .....</b>	<b>2-19</b>
<i>Clarke, M., He, J.,</i> <b>Sheet Metal Forming Simulation and Real World Tooling .....</b>	<b>2-27</b>

**Session 3 – Simulation Technology (1)**

<i>Bhatti, A.Q., Kishi, N., Shad, K.U.R.,</i> <b>A Numerical Investigation for Rock Fall Impact Behavior of Pithead of Tunnel with Falling Weight Impact Loading .....</b>	<b>3-1</b>
<i>Abu-Odeh, A.,</i> <b>Modeling and Simulation of Bogie Impacts on Concrete Bridge Rails using LS-DYNA® .....</b>	<b>3-9</b>
<i>Mahapatra, A., Chatterjee, A.,</i> <b>Comparison of Analytical and Numerical Results in Modal Analysis of Multispan Continuous Beams with LS-DYNA® .....</b>	<b>3-21</b>
<i>Huang, Y., Schellenberg, A., Mahin, S., Fenves, G.,</i> <b>Coupling FE Software through Adapter Elements: A Novel Use of User-Defined Elements .....</b>	<b>3-31</b>

**Session 4 – Optimization (1)**

<i>Müllerschön, H., Liebscher, M., Roux, W., Stander, N., Reuter, U.,</i> <b>Statistics and Non-Linear Sensitivity Analysis with LS-OPT<sup>®</sup> and D-SPEX .....</b>	<b>4-1</b>
<i>Stander, N., Goel, T.,</i> <b>Metamodel Sensitivity to Sampling Strategies: A Crashworthiness Design Study .....</b>	<b>4-15</b>
<i>Li, G., Goel, T., Stander, N.,</i> <b>Assessing the Convergence Properties of NSGA-II for Direct Crashworthiness Optimization .....</b>	<b>4-31</b>
<i>Witowski, K., Thiele, M., Goel, T.,</i> <b>Visualization of Pareto Optimal Fronts for Multiple Objectives with D-SPEX .....</b>	<b>4-39</b>

**Session 5 – Computing Technology**

<i>Posey, S.,</i> <b>Novel HPC Technologies for Scalable CAE: The Case for Parallel I/O and File Systems .....</b>	<b>5-1</b>
<i>Makino, M.,</i> <b>The Performance of 10-Million Element Car Model by MPP Version of LS-DYNA<sup>®</sup> on Fujitsu PRIMEPOWER .....</b>	<b>5-7</b>
<i>Shainer, G., Kher, S.,</i> <b>Optimizing LS-DYNA<sup>®</sup> Productivity in Cluster Environments .....</b>	<b>5-11</b>
<i>Prince, T.,</i> <b>Intel<sup>®</sup> Cluster Ready Support for LS-DYNA<sup>®</sup>/MPP .....</b>	<b>5-17</b>
<i>Schreiber, O., Raymond, M., Kodiyalam, S.,</i> <b>LS-DYNA<sup>®</sup> Performance Improvements with Multi-Rail MPI on SGI<sup>®</sup> Altix<sup>®</sup> ICE Clusters .....</b>	<b>5-21</b>

**Session 6 – Crash/Safety (2)**

<i>Park, C.K., Hong, S.W., Mohan, P., Morgan, R.M., Kan, C.D., Lee, K., Park, S., Bae, H.,</i> <b>Simulation of Progressive Deformable Barrier (PDB) Tests .....</b>	<b>6-1</b>
<i>Asadi, M., Walker, B., Shirvani, H.,</i> <b>New Finite Element Model for NHTSA Impact Barrier .....</b>	<b>6-17</b>
<i>Wood, P.K.C., Schley, C.A., Buckley, M., Walker, B., Dutton, T.,</i> <b>Modeling Self-Piercing Riveted Joint Failures in Automotive Crash Structures .....</b>	<b>6-23</b>
<i>Reid, J.D., Bielenberg, R.W.,</i> <b>Modeling Rebound of Foam Backed Racetrack Barriers .....</b>	<b>6-43</b>
<i>Boria, S., Forasassi, G.,</i> <b>Impact Analysis of a Crash-box for Racing Car in Sandwich Material .....</b>	<b>6-51</b>

**Session 7 – Metal Forming (2)**

- Hu, Y., Du, C., Kariat, S., Zhang, L.,*  
**A Review of Sixteen Years of LS-DYNA<sup>®</sup> Application in Stamping  
 Manufacturing Engineering at Chrysler, LCC .....7-1**
- Grimes, R.G., Zhu, X.,*  
**Metal Forming Applications using Implicit Mechanics Features  
 in LS-DYNA<sup>®</sup> .....7-11**
- Borrvall, T.,*  
**Mortar Contact Algorithm for Implicit Stamping Analyses in LS-DYNA<sup>®</sup> .....7-19**
- Benson D.J., Bazilevs, Y., Hughes, T.J.R.,*  
**Preliminary Results for an Isogeometric Shell .....7-29**

**Session 8 – Simulation Technology (2)**

- Le Blanc, G., Chanal, P.Y., Hereil, P.L., LaPorte, P., Avrillaud, G., Vincent, P.,  
 L'eplattenier, P.,*  
**Ramp Wave Compression in a Copper Strip Line: Comparison Between  
 MHD Numerical Simulations (LS-DYNA<sup>®</sup>) and Experimental  
 Results (GEPI device) .....8-1**
- Zhang, Y., L'eplattenier, P., Taber, G., Vivek, A., Daehn, G., Babu, S.,*  
**Numerical Simulation and Experimental Study for Magnetic Pulse  
 Welding Process on AA6061-T6 and Cu 101 Sheet ..... 8-13**
- Medvedev, S.V., Petrushina, M.V., Tchij, O.P.,*  
**Influence of the Residual Welding Phenomena on the Dynamic Properties  
 of a Two-Meter Long Tube with 64 Non-Symmetrical Brackets Welded  
 on a Helical Path.....8-25**
- Huang, Y., Souli, M.,*  
**Simulations of Acoustic and Vibro-Acoustic Problems in LS-DYNA<sup>®</sup> using  
 Boundary Element Method .....8-37**
- Rassian, M., Huang, Y., Lee, J.C., Arakawa, T.T.,*  
**Structural Analysis with Vibro-Acoustic Loads in LS-DYNA<sup>®</sup> .....8-45**

**Session 9 – Impact Analysis**

- Loikkanen, M., Praveen, G., Powell, D.,*  
**Simulation of Ballistic Impact on Composite Panels ..... 9-1**
- Deka, L.J., Vaidya, U.K.,*  
**LS-DYNA<sup>®</sup> Impact Simulation of Composite Sandwich Structures with  
 Balsa Wood Core ..... 9-13**
- Stamper, E., Hale, S.,*  
**The Use of LS-DYNA<sup>®</sup> Models to Predict Containment of Disk Burst  
 Fragments .....9-25**

<i>Lavoie, M-A., Gakwaya, A., Ensan, M.N.,</i> <b>Application of the SPH Method for Simulation of Aerospace Structures under Impact Loading .....</b>	<b>9-35</b>
<i>Thatte, B.S., Chandekar, G.S., Kelkar, A.D., Chaphalkar, P.,</i> <b>Studies on Behavior of Carbon and Fiberglass Epoxy Composite Laminates under Low Velocity Impact Loading using LS-DYNA® .....</b>	<b>9-43</b>
<i>Rao, M.P., Keefe, M., Powers, B.M., Bogetti, T.A.,</i> <b>A Simple Global/Local Approach to Modeling Ballistic Impact onto Woven Fabrics .....</b>	<b>9-55</b>

## Session 10 – Pre/Post and Data Management

<i>Makropoulou, I., Kolokythas, Y., Rorris, L.,</i> <b>LS-DYNA® Impact Model Build-up: Process Automation with ANSA Data Management and Task Manager .....</b>	<b>10-1</b>
<i>Walker, B., Young, P., Said, R.,</i> <b>Use of Simpleware Software for LS-DYNA® Analyses .....</b>	<b>10-17</b>
<i>Shetty, S.H., Ganesan, V., Sivalingam, S.C.,</i> <b>Visual-Environment Integrated Pre and Post Environment for LS-DYNA® .....</b>	<b>10-33</b>
<i>Hörmann, M.,</i> <b>Using LS-DYNA® from ANSYS Workbench Environment ... ..</b>	<b>10-39</b>
<i>Thornton, M.,</i> <b>Automating Oasys PRIMER and Oasys D3PLOT using JavaScript .....</b>	<b>10-49</b>
<i>Ganesan, V., Sivalingam, S.C., Shetty, S.H., Dooge, D.,</i> <b>VisualDSS CAE Data Management and Decision Support System for Simulation Life Cycle Management .....</b>	<b>10-53</b>

## Session 11 - Crash/Safety (3)

<i>Feng, B., Coleman, D.,</i> <b>Gas Dynamic Simulation of Curtain Airbag Deployment through Interior Trims .....</b>	<b>11-1</b>
<i>Lian, W., Bhalsod, D., Olovsson, L.,</i> <b>Benchmark Study on the AIRBAG_PARTICLE Method for Out-Of-Position Applications .....</b>	<b>11-11</b>
<i>Fukushima, S., Kumagai, K., Yasuki, T.,</i> <b>Development of Finite Element Models of Restraint System for Injury Analysis in Side Impact .....</b>	<b>11-23</b>
<i>Shin, J., Untaroiu, C.D., Crandall, J.R.,</i> <b>Pelvic Response Investigation of Lateral Loading Conditions using Finite Element Models .....</b>	<b>11-37</b>

**Session 12 – Metal Forming (3)**

- Akarca, S.S., Altenhof, W.J., Alpas, A.T.,*  
**A Smoothed-Particle Hydrodynamics (SPH) Model for Machining  
of 1100 Aluminum .....12-1**
- Espinosa, C., Lacome, J.L., Limido, J., Salaun, M., Mabru, C., Chieragatti, R.,*  
**Modeling High Speed Machining with the SPH Method .....12-9**
- Neukamm, F., Feucht, M., Haufe, A, Roll, K.,*  
**On Closing the Constitutive Gap Between Forming and Crash Simulation .....12-21**
- Imbert, J., L'eplattenier, P., Worswick, M.,*  
**Comparison Between Experimental and Numerical Results  
of Electromagnetic Forming Processes .....12-33**

**Session 13 – Simulation Technology (3)**

- Untaroiu, C., Genovese, D., Ivarsson, J., Crandall, J.,*  
**A Finite Element Analysis of Mid-Shaft Femoral Tolerance under Combined  
Axial-Bending Loading ..... 13-1**
- Kulkarni, H., Eidt, J.M., Podhaturi, D., Farahani, A.,*  
**Assessment of Automotive Panel to Meet Handling Load  
Requirements: CAE Simulation .....13-11**
- Perillo, M., Primavera, V., Bonello, G., Cavedoni, M.,*  
**Structural Dynamic Response of a Track Chain Complete Undercarriage  
System using Virtual Proving Ground Approach ..... 13-13**
- Edara, R., Shih, S., Tamini, N., Palmer, T., Tang, A.,*  
**18 Wheel Truck Dynamic and Durability Analysis using Virtual  
Proving Ground ..... 13-25**

**Session 14 – Optimization (2)**

- Henchi, I., L'eplattenier, P., Daehn, G., Zhang, Y., Vivek, A., Stander, N.,*  
**Material Constitutive Parameter Identification using an Electromagnetic  
Ring Expansion Experiment Coupled with LS-DYNA<sup>®</sup> and LS-OPT<sup>®</sup> ..... 14-1**
- Van den Bergh, G., Lemmens, Y.,*  
**Multi-Disciplinary Design Optimization for Occupant Safety: Leveraging  
Your LS-DYNA<sup>®</sup> Simulations .....14-11**
- Goel, T., Stander, N.,*  
**Influence of Selection Criterion on the RBF Topology Selection  
for Crashworthiness Optimization .....14-19**
- Goel, T., Lin, Y.Y., Stander, N.,*  
**Direct Multi-objective Optimization through LS-OPT<sup>®</sup> using Small Number  
of Crashworthiness Simulations .....14-35**

**Session 15 – Fluid/Structure**

<i>Jackson, K.E., Fuchs, Y.T.,</i> <b>Comparison of ALE and SPH Simulations of Vertical Drop Tests of a Composite Fuselage Section into Water .....</b>	<b>15-1</b>
<i>Del Pin, F.,</i> <b>An Implicit Incompressible CFD Solver in LS-DYNA<sup>®</sup> for Fluid-Structure Interaction Problems .....</b>	<b>15-21</b>
<i>Aquelet, N., Souli, M.,</i> <b>2D to 3D ALE Mapping .....</b>	<b>15-23</b>
<i>Zhang, Z.C.,</i> <b>Using the New Compressible Fluid Solver in LS-DYNA<sup>®</sup> – CESE Solver and the Input File Setup .....</b>	<b>15-35</b>

**Session 16 – Simulation Technology (4)**

<i>Turton, N., Majumder, A., Altenhof, W., Green, D., Vijayan, V., An, H., Jin, S.Y.,</i> <b>Numerical and Experimental Determination of Strains in the Vicinity of a Centrally Located Circular Discontinuity in AA6061-T6 Square Extrusions during Axial Crushing .....</b>	<b>16-1</b>
<i>Tarigopula, V., Langseth, M., Hopperstad, O.S.,</i> <b>Influence of Element Formulation on the Axial Crushing of Thin-walled Dual-phase Steel Square Sections .....</b>	<b>16-13</b>
<i>Sakakibara, T., Tsuda, T., Ohtagaki, R.,</i> <b>A Study of Quasi-static Problem by SPH Method .....</b>	<b>16-21</b>
<i>Hörmann, M.,</i> <b>FE-Applications in Aircraft Structure Analysis .....</b>	<b>16-27</b>

**Session 17 – Metal Forming (4)**

<i>Dick, R.E., Yoon, J.W.,</i> <b>Effect of Material Characteristics on Wrinkling During Dome Forming of a Beverage Can using LS-DYNA<sup>®</sup> .....</b>	<b>17-1</b>
<i>An, H., Green, D.E.,</i> <b>Optimization and Sensitivity Analysis of Numerical Simulation of Tubular Hydroforming .....</b>	<b>17-9</b>
<i>Lu, H.S., Wu, C.T., Xu, J.X.,</i> <b>Forging and Extrusion Analysis with LS-DYNA<sup>®</sup> using 3D Adaptive EFG Method .....</b>	<b>17-21</b>
<i>Ulacia, I., Hurtado, I., Imbert, J., Worswick, M.J., L'eplattenier, P.,</i> <b>Influence of the Coupling Strategy in the Numerical Simulation of Electromagnetic Sheet Metal Forming .....</b>	<b>17-25</b>

**Session 18 – Simulation Technology (5)**

- Tabiei, A., Lawrence, C., Fasanella, E.L.,*  
**Validation of Finite Element Crash Test Dummy Models for the Prediction  
of Orion Crew Member Injuries during a Simulated Vehicle Landing ..... 18-1**
- Fasanella, E.L., Jackson, K.E., Kellas, S.,*  
**Soft Soil Impact Testing and Simulation of Aerospace Structures .....18-29**
- Tutt, B., Johnson, R.K., Lyle, K.,*  
**Development of an Airbag Landing System for the Orion Crew Module .....18-43**
- Babu, S., Biswas, J.,*  
**Drop Analysis of Waste Transfer Flask .....18-57**
- Makino, M.,*  
**Tippe Top Simulation by LS-DYNA® .....18-65**

**Session 19 – Material Modeling**

- Carney, K.S., Goldberg, R.K., Pereira, J.M., Lee, R.S., Albert, J.J.,*  
**A Heterogeneous Constitutive Model for Reinforced Carbon-Carbon  
using LS-DYNA® ..... 19-1**
- Huang, Y., Mahin, S.A.,*  
**A Cyclic Damaged Plasticity Model: Implementation and Applications .....19-21**
- Du Bois, P.A., Kolling, S., Feucht, M., Haufe, A.,*  
**The Influence of Permanent Volumetric Deformation on the Reduction  
of the Load Bearing Capability of Plastic Components .....19-35**
- Xiao, X.,*  
**Simulation of Composite Tubes Axial Impact with a Damage Mechanics  
Based Composite Material Model ..... 19-43**
- McGregor, C., Vaziri, R., Xiao, X.,*  
**Simulation of Energy Absorption in Braided Composite Tubes through  
Axial Crushing ..... 19-55**

**Session 20 – Penetration/Blast**

- Lou, K.A., Perciballi, W.,*  
**Finite Element Modeling of Preloaded Bolt under Static Three-Point  
Bending Load ..... 20-1**
- Toussaint, G., Durocher, R.,*  
**Finite Element Simulation using SPH Particles as Loading on Typical Light  
Armoured Vehicles ..... 20-11**
- Nilakantan, G., Keefe, M., Gillespie, J.W.,Bogetti, T.A.,*  
**Novel Multi-scale Modeling of Woven Fabric Composites for use  
in Impact Studies ..... 20-19**
- Schwer, L.E.,*  
**Simple Input Concrete Constitutive Models: An Illustration of Brick Wall  
& Concrete Cylinder Perforation .....20-39**

**Keynote  
Presentations**

*Lessons Learned from Crash Analysis by the Earth Simulator*

**Mr. Tsuyoshi Yasuki**

*General Manager of CAE Research  
Development and Application  
Toyota Motor Corporation*

*Advancements of Safety CAE within Ford*

**Mr. Stephen T. Kozak**

*Chief Engineer, North America Safety  
Ford Motor Company*

**Mr. Nand K. Kochhar**

*Executive Technical Leader, CAE  
Ford Motor Company*

*Developments in Computational Science and Engineering*

**Dr. Ted Belytschko**

*Walter P. Murphy Professor  
Northwestern University*

*Autobody Manufacturing CAE – The Business Needs and Technical Challenges*

**Dr. Chuan-Tao Wang**

*Chief Die Engineer  
GM Technical Fellow  
Global Die Center  
GM Manufacturing Engineering  
General Motors Corporation*

*Evolving Technology:*

*Multi-Phase, Multi-Material, ALE Approach for Buried Blast Simulation*

**Dr. Rahul Gupta**

*Army Research Laboratory  
Aberdeen Proving Ground*

*Simulation of Polymeric Materials in LS-DYNA<sup>®</sup>*

**Mr. Paul A. Du Bois**

*Consulting Engineer*

**Technology Today – Conference Sponsors**

Arup

Engineering Technology Associates, Inc.

Evergrid, Inc.

Hewlett-Packard Company

IBM

Intel Corporation

Microsoft Corporation

NEC Corporation of America

SGI

Sun Microsystems

TASS Americas

**Final Presentation**

*“LS-DYNA Development”*

Dr. John O. Hallquist, LSTC

**Closing Remarks**

Dr. Wayne L. Mindle, LSTC