FINITE ELEMENT ANALYSIS feaINFORMATION.com

# FEA Information Engineering Solutions

Volume 1, Issue 2, March 2012

**FEA Information Engineering Solutions:**

**LS-DYNA Release Notes**

**ACP 3G Optimization Process**

**DatapointLabs Mechanical Test Capabilities**

**Total Human Model For Safety – THUMS**


October 2000, FEA Information Inc. published its first monthly newsletter, providing information and solutions related to the evolution of finite element software and current hardware.

Over the years we have expanded to e-mailing the publication to over 7,000 readers, comprised of engineering professionals, professors, consultants, students, and other interested global readers.

1. **FEA Information Inc.**
   a. FEA Information Engineering Solutions
   b. FEA Information Engineering Journal
   c. FEA Information China Engineering Solutions

**FEA Information Engineering Solutions**: February. 2000 - The first edition published of FEA Information Engineering Solutions. Initially concentrating on papers already released to the engineering community.

**FEA Information China Engineering Solutions** February 2012 - The first edition of FEA Information China Engineering Solutions, published in Simplified and Traditional Chinese.

To sign up for the Traditional or Simplifed edition write to yanhua@feainformation.com

**FEA Information Engineering Journal -** February, 2012. The first issue of our Journal publication focusing on published papers and publishing.

FEA Information Inc. is a woman owned company, small business. FEA Information Engineering Solutions and FEA Information Engineering Journal are published monthly in pdf format. 

## Platinum Participants

BETA CAE Systems SA
www.beta-cae.gr

CRAY
www.cray.com

DatapointLabs
www.datapointlabs.com

eta
www.eta.com

esi
www.esi-group.com

gns
www.gns-mbh.com/

GRIDCORE
http://gridcore.se


www.hengstar.com /

JSOL
www.jsol.co.jp/english/cae

www.lstc.com

Oasys
www.oasys-software.com/dyna/en/

## Contentss

Solutions











## ANNOUNCEMENTS

For individual, company membership or subscription contact mv@feainformation.com
Subject Line: Membership FEA

### LSTC

Julia Wolley, LSTC Technical Document Administrator – LS-DYNA release notes are available in pdf format with bookmarks.

### FEA Information Inc.

Three publications are now available:

1. FEA Information Engineering Solutions (monthly)
2. FEA Information Engineering Journal (monthly)
3. FEA Information China Engineering Solutions (bi-monthly)

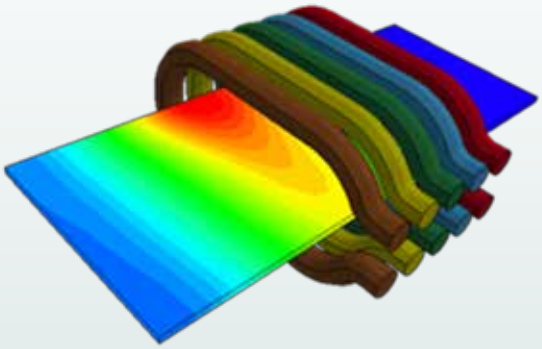
***www.feainformation.com***

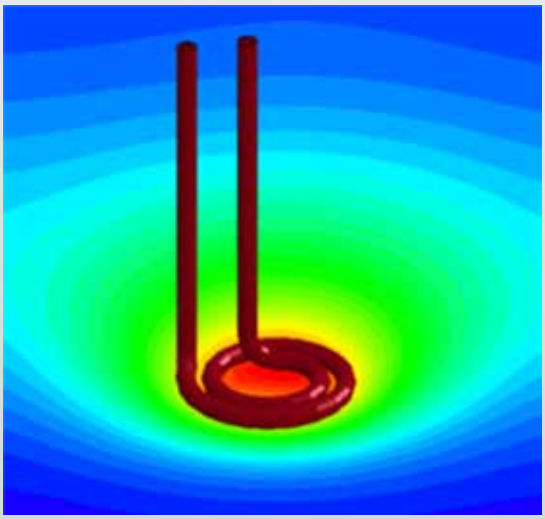
We welcome unsolicited topics, ideas, and articles. Publishing is at the sole discretion of FEA Information Inc.

For participation subscription including full page ads, articles, static listing, contact Anthony Giaccana, agiac99@aol.com

Cover & Ad Designs by Kanda Choosik

**The Electromagnetic solver** solves the Maxwell equations in the Eddy current (induction-diffusion) approximation. This is suitable for cases where the propagation of electromagnetic waves in air (or vacuum) can be considered as instantaneous. Therefore, the wave propagation is not solved. The main applications are magnetic metal forming or welding, induced heating, and so forth. The EM module allows the introduction of a source of electrical current into solid conductors and the computation of the associated magnetic field, electric field, as well as induced currents. The EM solver is coupled with the structural mechanics solver (the Lorentz forces are added to the mechanics equations of motion), and with the structural thermal solver (the ohmic heating is added to the thermal solver as an extra source of heat). The EM fields are solved using a Finite Element Method (FEM) for the conductors and a Boundary Element Method (BEM) for the surrounding air/insulators. Thus no air mesh is necessary.





## Features

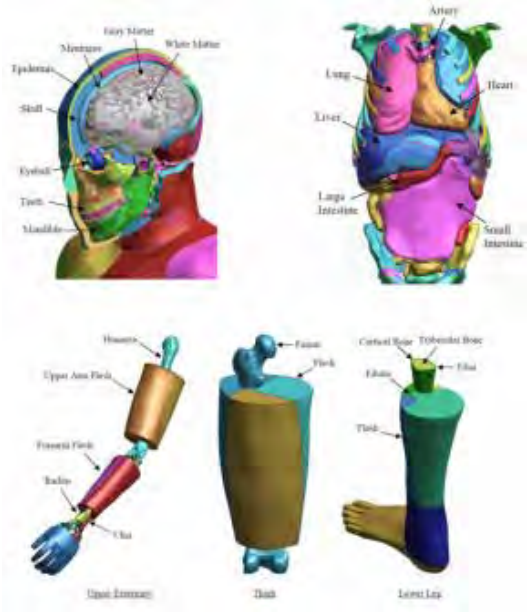
- **Eddy-current solver**
- **Induced heating solver**
- **Resistive heating solver**
- **Uniform Current in Coils**
- **Structure and Thermal coupling**
- **Axisymmetric capabilities**

**For further information contact:**

info@lstc.com

## About

The Total Human Model for Safety, or THUMS™, is a joint development of Toyota Motor Corporation and Toyota Central R&D Labs. Unlike dummy models, which are simplified representation of humans, THUMS represents actual humans in detail, including the outer shape, but also bones, muscles, ligaments, tendons, and internal organs. Therefore, THUMS can be used in automotive crash simulations to identify safety problems and find their solutions.



THUMS is limited to civilian use and may under no circumstances be used in military applications.

**Model Details: The latest Version of the THUMS model is Version 4**.

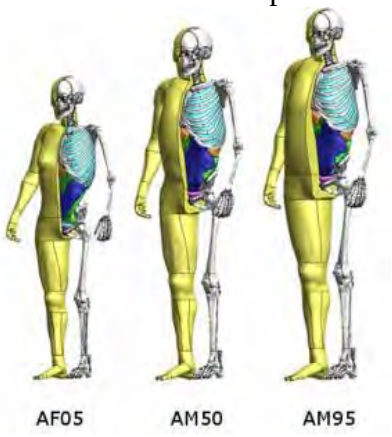
Three different sizes of the model are available:

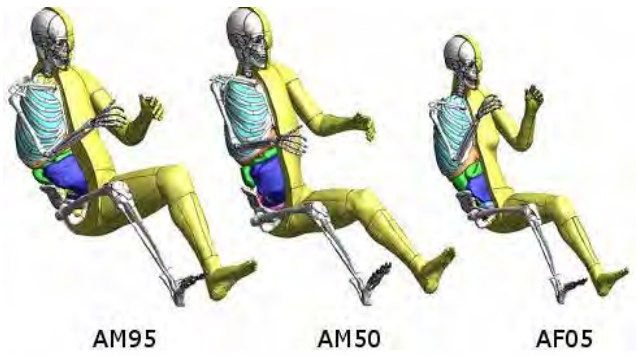
- Adult female 5th percentile
- Adult male 50th percentile
- Adult male 95th percentile

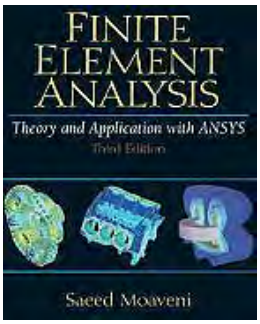
Each of the different sized models is available as sitting model to represent vehicle occupants and as standing model to represent pedestrians.

The internal organs were modeled based on high resolution CT-scans.

LSTC is the US distributor for THUMS. Commercial and academic licenses are available. For more information please contact us at THUMS@lstc.com .

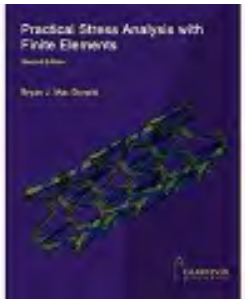




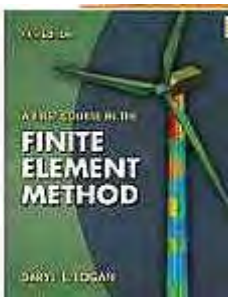

Finite Element Analysis Theory and Application with ANSYS (3rd Edition)

**Saeed Moaveni**




Practical Stress Analysis with Finite Element

**Bryan J Mac Donald**

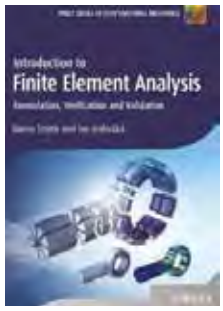



A First Course in the Finite Element Method

**Daryl L. Logan**

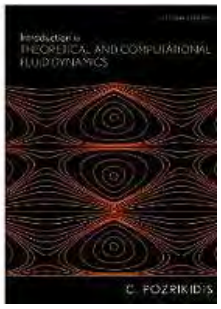

Finite Element Modelling Techniques in MSC.NASTRAN and LS/DYNA

**Sreejit Raghu**



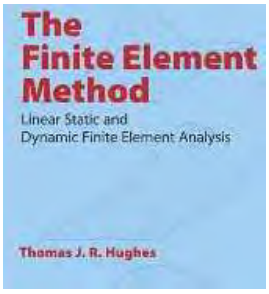

Finite Element Analysis/formulation & verification

**B. A. Szabo**



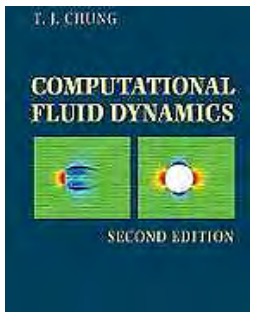

Introduction to Theoretical and Computational Fluid Dynamics

**C. Pozrikidis**




The Finite Element Method

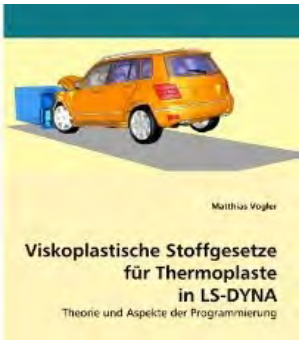
**Thomas J. R. Hughes**



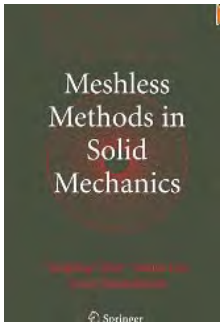

Computational Fluid Dynamics

**T. J. Chung**

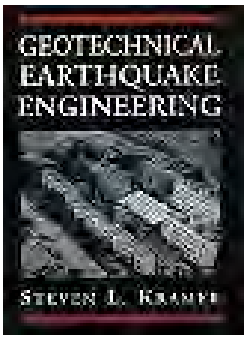
## Reference Library



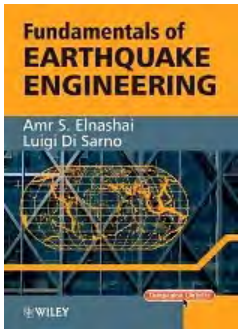

Viskoplastische Stoffgesetze für Thermoplaste in LS-DYNA: Theorie und Aspekte der Programmierung
**Matthias Vogler**



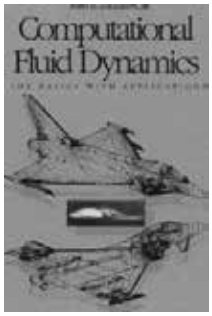

Meshless Methods in Solid Mechanics
**Youping Chen**



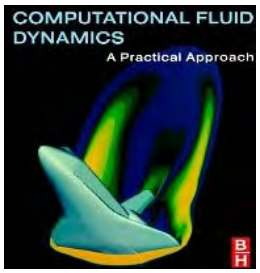

Geotechnical Earthquake Engineering
**Steven Lawrence Kramer**



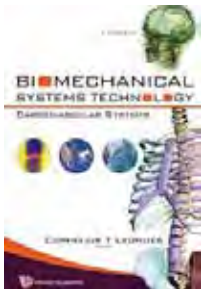

Fundamentals of Earthquake Engineering
**Amr S. Elnashai**




Computational Fluid Dynamics
**John David Anderson**




Computational Fluid Dynamics: A Practical Approach [Paperback]
**Guan Heng Yeoh**




Biomechanical Systems Technology: Computational Methods
**Cornelius T. Leondes**

# ACP 3G Optimization Process

**The following is an excerpt – the entire white paper is available at ETA:**
http://www.eta.com/images/acp-3g-whitepaper-opt.pdf

**WHITEPAPER - ACP 3G Optimization Process**

Authors: Dr. Akbar Farahani, Dir. of Engineering, Paul Dolan, Program Mgr., ETA

**Introduction:** The design of automotive body structures are driven by many competing criteria such as lower cost, weight reduction, enhanced multi-disciplinary performance, and manufacturability. In addition, the introduction of new manufacturing processes and materials (e.g., AHSS) significantly increases the available design space, or the set of all possible designs for an automotive system.

In order to explore this large design space more effectively while trying to reduce design cycle times, engineers can now take advantage of an automated design optimization process. These tools can greatly decrease the time required to identify a set of feasible, or even near-optimal, designs prior to building and testing the first prototype. Moreover, these tools can also compensate for the limitations of human intuition and provide design engineers with the freedom and power to seek creative solutions that are not obvious to even the most experienced engineer. 3G (Geometry, Grade and Gauge) optimization is the driving force behind ETA's new design process, Accelerated Concept to Product (ACP) [1]. The focus of this white paper is on 3G optimization within the ACP process as applied to a front longitudinal rail of the FutureSteelVehicle (FSV).

WorldAutoSteel's objective in the FSV program was to develop detailed design concepts and fully optimize a radically different body structure vehicle for production in the 2015-2020 timeframe utilizing the latest grades of advanced and ultra-high strength steels. FSV achieved 35 percent mass reduction at no additional cost over a conventional steel body, while achieving simulated crash test performance with a 5-star safety rating.

**Optimization Software Requirements**

The process requires an optimization software package that allows designers to automatically and concurrently explore hundreds of design parameters and their relationships in product and process design scenarios, and intelligently seeks optimal values for parameters that affect performance and cost. The software must have non-linear capability enabling interaction with non-linear software (for impact analysis, such as LS-DYNA). Optimization software can be used to improve any engineering system (structural, thermal, fluid, electrical, etc.) including multi-disciplinary scenarios.

For ACP 3G Optimization structural design applications, the HEEDS optimization code can automate the search for designs that simultaneously satisfy the objectives and targets for crashworthiness, manufacturability, mass, cost, stiffness, durability, noise and vibration, robustness and reliability [2].

**Parameterization and Design integration (CAD/FEM)**

Software with a set of design tools providing detailed parameterization capabilities is required to allow changes in the design's geometry based on optimization recommendations. The new geometry is re-meshed with all the suitably updated joints and then output as a new input deck. It can then be submitted to the appropriate solver (LS-DYNA/NASTRAN/NISA, etc). SFE-Concept offers these capabilities and is used in ACP 3G optimization.

**Load path Optimization and 3G (Geometry, Grade and Gauge) Design Optimization**

The goal of the ACP 3G Optimization process is to identify the optimal design solution within the available design space. The extent of the design space is defined by three criteria, whose relationship is illustrated in Figure 1.

1. **Design** Variables -
   The combinations design features that the ACP process is free to explore

**a. Loadpath**
The position of any given structural member [6,2,4]

**b. Geometry**
The cross-sectional shape of that structure member [3,8,9]

**c. Grade**
The choice of material that the structural member is made from[5]

**d. Gauge**
The thickness of material that the structural member is made from[5,7]

**2. Design Constraints**

Design constraints define the required performance level which the design must meet. For example under multidisciplinary loadings, a design might be required to simultaneously meet a maximum acceleration pulse for the NCAP Front Impact Loading (FMVSS 208), while maintaining a maximum passenger compartment intrusion under IIHS Front Impact Loading. This is a design requirement that places the design responses in direct conflict with each other, revealing one of the ACP's key strengths, its ability to provide a truly balanced solution [3].

**3. Design Objective**

The goal of the optimization for FSV was to obtain the greatest possible structural efficiency, hence, the lightest design solution.

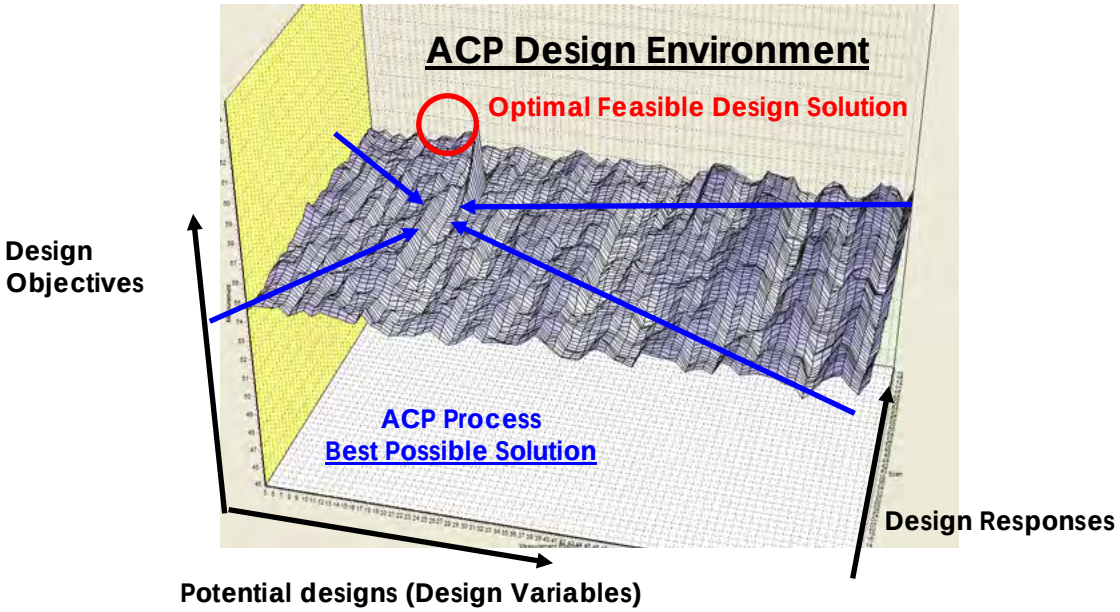



*Figure 1: The ACP Design Environment*

**Figure 1**

shows a pictorial representation of the design environment that the ACP process is working within. The first axis defines all possible combinations of the design variables as individual designs. Depending on the total design variable count, this could result in an enormous number of unique designs. The second axis represents the response of each design to the loadcases under consideration. Note that from all possible responses there is a subset of feasible designs that meet the required design constraints. This is the control on the ACP process for it is only the feasible designs that are of interest. The third axis represents how well each design meets the design objective and for FSV, this is the mass of the BIW. Thus the optimal design is the feasible design that best meets the design goal [9].

When considering the designs generated by the ACP Process it is important to consider the following.

1. **Process is a Search Engine**
   In itself the ACP 3G optimization process is unable to "invent" rather it is searching a design space that has been defined by the user for the best possible solution that meets the design constraints. [9]

2. **Enablers**
   The ACP Process considers in combination all available variables that it is given. As noted previously the ACP process is not able to invent but it does a **high level of balancing.** Therefore, when reviewing the specific design variable selections for a given design it is inappropriate to consider them in isolation. For example, the choice of a particular material grade should not be considered without first understanding the choice of cross-sectional shape and gauge of that component and its relationship to all other components within the structure affected by the same loading condition.

3. **Targets**
   The design constraints define the required performance. The process will seek to find the best possible solution with respect to the design objective, where performance is just good enough.

4. **Performance**
   Depending on the freedom that the process is given, the resulting design solutions can be very unconventional. However, it should be noted that each design's performance has been measured against the design constraints and so they can confidently be considered a valid design.

**FSV Front Longitudinal Rail 3G Sub-System Optimization**

**Background**

The entire vehicle design cycle consisted of 6 major task (T1 to T6) defined below in Figure 2. Figure 2 shows the overall flow of the design process [1].

T1 – Styling and aerodynamics
T2 – Linear static topology optimization
T3 – Non-linear dynamic topology optimization (Low Fidelity 3G (Gauge, Grade, and Geometry) optimization, aka LF3G) full vehicle level
T4 – Sub-system topography optimization (subject of this paper)
T5 – Design confirmation
T6 – Final gauge and grade optimization (full vehicle)

**FOR THE FULL WHITE PAPER**
http://www.eta.com/images/acp-3g-whitepaper-opt.pdf

**Visualization of Triaxiality Factor in LS-PrePost**

Posted on March 2, 2012 by Suri Bala

Stress Triaxiality is the ratio of Hydrostatic stress and the von-Mises stress and is known to have a great influence on the plastic deformation.

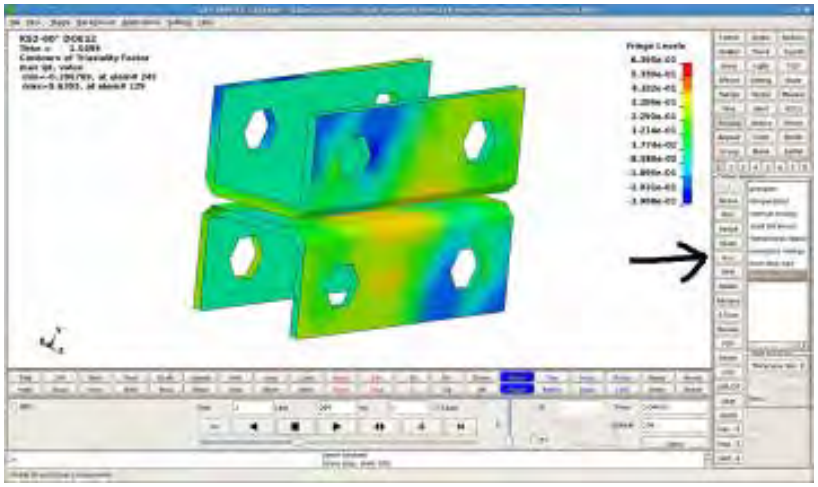
$$\frac{\sigma_h}{\sigma_{eqv}} = TF = \frac{1/3(\sigma_1+\sigma_2+\sigma_3)}{\frac{1}{\sqrt{2}}\sqrt{(\sigma_1-\sigma_2)^2+(\sigma_2-\sigma_3)^2+(\sigma_3-\sigma_1)^2}}$$

where $\sigma_1$, $\sigma_2$ and $\sigma_3$ are the first, second and third principal stresses and

$$\frac{\sigma_1+\sigma_2+\sigma_3}{3} = \text{Hydrostatic stress}$$

$$\frac{1}{\sqrt{2}}\sqrt{(\sigma_1-\sigma_2)^2+(\sigma_2-\sigma_3)^2+(\sigma_3-\sigma_1)^2} = \text{Equivalent von Mises stress}$$

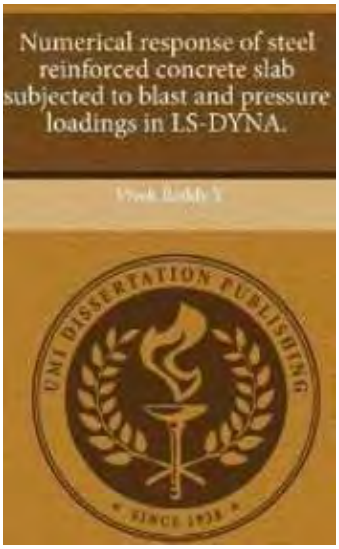
You can view this factor in LS-PrePost now as shown below at www.d3view.com



Numerical response of steel reinforced concrete slab subjected to blast and pressure loadings in LS-DYNA.

[Paperback] –

Author: Vivek Reddy




**Publication Date: September 30, 2011**

As steel reinforced concrete has got wide range of applications, this project is an attempt to study the dynamic behavior of steel reinforced concrete subjected to blast and pressure loadings using a non-linear finite element code LS-DYNA (version 971).

The aim of this project was to analyze various parameters of a steel reinforced concrete slab by validating three of the concrete material models in LS-DYNA.

The first part of the project consists of validating three concrete material models in LS-DYNA by applying boundary conditions on simple single elements. The next part consists of using these three concrete material models of LS-DYNA (version 971) for the study of blast and pressure load analysis on a steel reinforced concrete slab for two different strengths of concrete with two different mesh sizes.

The main purpose of this analysis was to provide the behavior of these concrete material models subjected to blast loads, which would be a better guide for future applications.

**Software Diagnostics**

Software Diagnostics is a German company specializing in the areas of software intelligence and software mining. The main focus of the business is on improving the transparency and control of software development and maintenance projects on the basis of their source code reality. With a foundation of over seven years' research work, Software Diagnostics was started in 2009, as a spin-off of the Hasso Plattner Institute – the German university centre of excellence for IT systems engineering.

Software Diagnostics' solutions provide all parties involved in software projects – from company management through to developers – with a valuable basis for decision making through the entire life cycle of a software system. The new software mining process automatically extracts objective information about the software project from a wide variety of sources and then brings it together. Source code parsing, dynamic run time analysis and in particular numerous repositories – such as versioning systems, bug tracking, requirements and test case management systems – are thus, for the first time, meaningfully combined.

Software Diagnostics has developed, amongst other things, an integrated software intelligence platform which creates automatic management reports (so-called software maps) of the processes within a software project. These provide managers and team leaders with objective and daily updated information on the status of the project. Decision makers thus have at their disposal a tool which can assist them in directing their own developers or external teams, efficiently and in a focused manner.

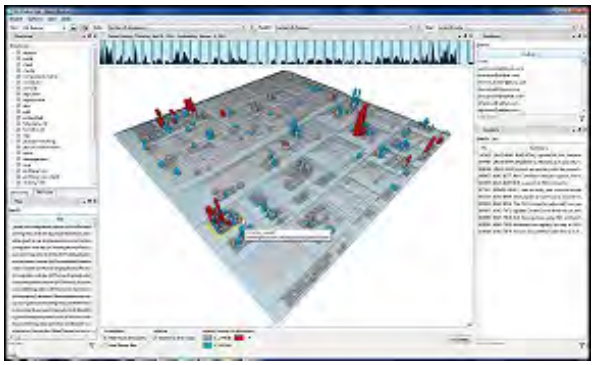


**Image 1** shows an example of a software map, revealing the current risks and costs in the source code of a software program with several million lines of code. At a glance, those in charge of the software project can see that particular parts of the source code have been programmed in a monolithic, unstructured and highly complex manner.

Each source code file is depicted on the software map as a block and positioned according to the modular structure of the software, the base area of each block corresponding to the number of lines of code in the respective file. A block's color shows its complexity whilst its height reflects how often changes are made. The quality of the sections of code identified as problematic should then be improved as quickly as possible in order to speed up the progress of a project, hampered by code which has become difficult to understand. Furthermore, the improvement in quality would reduce the existing risk of flawed changes being made within these complex code sections which could lead to considerable costs over the course of the project.

Without a suitable tool, such problematic situations are only discovered after it is too late and the budget and time frame have started to run out of control. In contrast, a software intelligence platform used as an early warning system reveals problem situations as soon as they are created.

Contact Person
Dr. Johannes Bohnet
Software Diagnostics GmbH
johannes.bohnet@softwarediagnostics.com
www.softwarediagnostics.com

## Oasys LS-DYNA 5th annual Update Meetings
## India Pune April 17th Bangalore April 19th

Agenda www.oasys-software.com/dyna/en/events/users_india_apr-12/users_india_apr-12.shtml

Oasys Ltd and nHance Engineering Solutions Pvt Ltd are pleased to announce the 5th Oasys LS-DYNA Update meetings in India for the year 2012. First meeting shall be held at **Pune** on Tuesday 17th April 2012 at The Ista Hotel and second meeting shall be held at **Bangalore** on Thursday 19th April 2012 at The Taj Vivanta, Whitefield.

Each of these is a full day free of charge event covering both LS-DYNA and Oasys software and is a perfect opportunity to find out about current and future developments and how the software is being used in the engineering community.

The presentations will mainly cover latest features of LS-DYNA software, Oasys suite and presentations from industry members specifically from OEMs like Mercedez Benz, Tata Motors & General Motors. This year's presentations also include presentation from **Mr. Yun Huang, LSTC on the capabilities of LS-DYNA for NVH and Durability.**

**Registration:** Please send your registration to this event by email to india.support@arup.com with your name, company/affiliation, telephone number and your choice for event.

**Venue:** The event in Pune will be held at The Ista Hotel, which Situated in the heart of the city, 10 minute drive from the airport and adjacent to the tranquil Aga Khan Palace.

The Ista Hotel - 88/4, Pune-Nagar Road
(Adj. Aga Khan Palace)
Yerwada Pune - 411 006,India
Tel: 91(20) 41418888

**The event in Bangalore** will be held at The Taj Vivanta, Whitefield which stands right at the main entrance to the International Tech Park, Bangalore.

The Taj vivanta, ITPB, Whitefield
Bangalore 560 066,India
Tel No.:91-80-6693-3333

If you plan to stay over before or after the event, we are pleased to confirm that we have negotiated a special rate for attendees of the Oasys LS-DYNA Update meeting. Please contact us for assistance.

**Contact Details:** If you have any queries regarding this event you can contact:

Mr. Asif Ali
nhance Engineering Solutions(P)Ltd.
Tel: +91 (0) 40 44369797/8
Email: india.support@arup.com

**Julia Wolley, LSTC, Technical Administrator, Documentation**

LS-DYNA Product Version Release Notes are compiled in text format by Lee Bindeman, and Jim Day of LSTC.

In addition to this original text format, LSTC will be publishing a compilation of these notes in pdf format, with bookmarks.

If you would like to receive the current version in pdf format and be added to the mailing list for future pdf format, please e-mail, jwolley@lstc.com subject line Release Notes.

# Release Notes

# Product: LS-DYNA®

# Version: LS-DYNA version 971 R6.0.0.

Livermore Software Technology Corp. 7374 Las Positas Road, Livermore, CA 94550

## LS-DYNA Release Notes

### Table of Contents

**Keyword: *AIRBAG_HYBRID, *AIRBAG_WANG_NEFSKE**
Added option of not applying pressure to part representing the venting hole.

**Keyword: *AIRBAG_PARTICLE**
Added BLOCK=10/11 to allow physical hole in the airbag due to eroded shells.

**Keyword: *INITIAL_AIRBAG_PARTICLE_POSITION**
New command to define initial position of airbag particles.

**Keyword: *ALE_REFINE**
Keyword to automatically refine the ALE mesh. Each element is replaced by 8 elements if a criteria is reached.

**Keyword: **BOUNDARY_RADIATION_SET_VF_CALCULATE_RESTART**
Added a new RESTART capability to the radiation view factor calculator as some viewfactor calculations may take hours to weeks (or even months) to calculate.

**Keyword: *BOUNDARY_COUPLED, *DEFINE_SPOTWELD_MULTISCALE, *INCLUDE_MULTISCALE_SPOTWELD**
Implemented loose coupling with other MPI programs. Currently only useful when linking with MPP LS-DYNA for modeling of multiscale spotwelds.

## NEW FEATURES:

**Keyword: *CONSTRAINED_LAGRANGE_IN_SOLID**
Added parameter POREINI and associated options for computing porosity for CTYPE=11 and 12.

**Keyword: *CONSTRAINED_SPR2, *CONSTRAINED_INTERPOLATION_SPOTWELD**
Added inverse distance weighting for distribution of motion, forces, and moments (INTP=2).

**Keyword: *CONSTRAINED_SPR2**
Added option for *CONSTRAINED_SPR2 which enables choice of normals computation: ALPHA3.gt.0: incremental update (default), ALPHA3.lt.0: total update (new).

**Keyword: *CONTACT_TIED_..., *CONTROL_ADAPTIVE**
Allowed for tied contacts in MPP with solid remeshing:
the interfaces are completely re-initialized after each adaptive step, which is fine for constraint type contacts, but penalty types might experience accumulated drift/creaping and force discontinuities.

**Keyword: *CONTACT_2D_AUTOMATIC_SURFACE_TO_SURFACE**
Implemented a user defined curve for the penalty stiffness like in *CONSTRAINED_LAGRANGE_IN_SOLID. If SFACT<0, abs(SFACT) is ID of the curve providing pressure-vs-penetration.

**Keyword: *CONTACT_..._ORTHO_FRICTION**
Added another method to specify orthotropic friction in contact but which is available in SMP and MPP.
See also *DEFINE_FRICTION_ORIENTATION (SMP only).

**Keyword: *CONTACT_SPOTWELD_WITH_TORSION_PENALTY**
Added penalty formulation to spotweld_with_torsion contact in both explicit and implicit.

**Keyword: *CONTROL_IMPLICIT_EIGENVALUE**
Added postprocessing of eigenforms of isogeometric elements to d3eigv for MPP.

**Keyword: *CONTROL_MPP_CONTACT_GROUPABLE**
Added control command to invoke groupable contact.

**Keyword: *CONTROL_RIGID**
Added plot element generation parameter (PLOTEL) for nodal rigid bodies.

**Keyword: *CONTROL_IMPLICIT_GENERAL**
Added geometric stiffness for type 6 beam.

**Keyword: *CONTROL_FORMING_PRE_BENDING**
Added *CONTROL_FORMING_PRE_BENDING to allow blank to be prebent prior to gravity loading.

**Keyword: *CONTROL_FORMING_ONESTEP_option**
Added new feature for one-step forming simulation that determines an unformed blank size and thickness, and also provides stress/strain/ thickness of formed part for initialization in crash analysis.
Option AUTO_CONSTRAINT allows nodal restraints to be applied automatically in implicit calculation to prevent rigid body motion.
Option DRAWBEAD is used for application of extra draw bead forces.
Option FRICTION applies friction along the periphery of the part, based on a user input “binder pressure”.

**Keyword: *CONTROL_SHELL**
Allowed the ISTUPD thickness update option to be invoked by part ID.

**Keyword: *DATABASE_BINARY_CPMFOR**
Added binary output database for *AIRBAG_PARTICLE coupling surfaces.
There are four components in the database, coupling pressure, fx, fy and fz.

## NEW FEATURES:

**Keyword: *DATABASE_FREQUENCY_BINARY_...**
Added frequency range for d3psd in *DATABASE_FREQUENCY_BINARY_D3PSD.
Added frequency range for d3ssd in *DATABASE_FREQUENCY_BINARY_D3SSD.
Added command *DATABASE_FREQUENCY_BINARY_D3RMS.
Added command *DATABASE_FREQUENCY_BINARY_D3FTG.
Added command *DATABASE_FREQUENCY_BINARY_D3SSD.
Added command *DATABASE_FREQUENCY_BINARY_D3PSD.
Added command *DATABASE_FREQUENCY_BINARY_D3ACS.
Added command *DATABASE_FREQUENCY_BINARY_D3SPCM.

**Keyword: *DATABASE_BINARY_FSIFOR**
Added three additional components to the binary fsifor database, namely, the x, y, and z components of relative tangential velocity.

**Keyword: *DATABASE_TRACER**
Added NID parameter for assigning location of tracer by a massless node ID.

**Keyword: *DATABASE_DISBOUT**
Implemented ASCII output file for discrete beams which includes relative displacements, rotations, force resultants, and orientation of the local coordinate system.

**Keyword: *DATABASE_CPM_SENSOR**
Added cylindrical shape CPM sensor to get better pressure signal.

Allowed user to select a disk region near the segment in CPM sensor to collect more particle data and get much smoother signal from CPM.

**Keyword: *DEFINE_COORDINATE_SYSTEM**
Added local coordinate system option CIDL to *DEFINE_COORDINATE_SYSTEM.

**Keyword: *DEFINE_CURVE_FUNCTION**
Implemented the Arithmetic IF conditional for *DEFINE_CURVE_FUNCTION.

**Keyword: *DEFINE_BOX_SPH**

Added a new option for DEFINE_BOX_SPH where by the box follows a node.

**Keyword: *DEFINE_CURVE_FUNCTION**

Added "sensor" to list of functions for *DEFINE_CURVE_FUNCTION so that *SENSOR_CONTROL may affect a curve.

**Keyword: *DEFINE_CPM_BAG_INTERACTION**

Added a new feature that allows the cpm particles vented from the master bag to be the input mass flow for the slave bag.

**Keyword: *ELEMENT_BEAM_PULLEY**

Added *ELEMENT_BEAM_PULLY for the definition of a pulley for truss beam elements (see *SECTION_BEAM, ELFORM=3). Currently, the beam pulley is implemented for *MAT_001 and *MAT_156. Pulleys allow continuous sliding of a string of truss beam element through a sharp change of angle.

**Keyword: *ELEMENT_MASS_MATRIX**

Added treatment of nodal mass matrices to implicit via *ELEMENT_MASS_MATRIX.

**Keyword: *ELEMENT_SEATBELT_SLIPRING**

Added normal-force-dependent slipring friction.

**Keyword: *ELEMENT_TSHELL_COMPOSITE**

Added *ELEMENT_TSHELL_COMPOSITE which allows an arbitrary number of through-thickness integration points to be defined in tshell elements that share the same part ID.

**Keyword: *HOURGLASS**

Added hourglass formulation 10. Solid element formulation 1 with hourglass formulation 10 is a Cosserat point element, see M. Jabareen and M.B. Rubin, 'A Generalized Cosserat Point Element (CPE) for Isotropic Nonlinear Elastic Materials including Irregular 3-D Brick and Thin Structures', J. Mech. and Mat. Struct., Vol 3 (2008) pp. 1465-1498.

## NEW FEATURES:

**Keyword: *INITIAL_STRESS_SPH**
Implemented initial stress command for SPH.

**Keyword: *INTERFACE_SPRINGBACK, *INITIAL_STRAIN_SHELL**
Made strain at all integration points available for MPP adaptive jobs.
Added output of strain at all integration points to dynain and dynain.bin.

**Keyword: *LOAD_THERMAL_D3PLOT**
Replaced *LOAD_THERMAL_TOPAZ with *LOAD_THERMAL_D3PLOT which allows temperatures from a thermal-only analysis to be used in a structural- only analysis.

**Keyword: *MAT_015**
Added NUMINT parameter for failure of *MAT_JOHNSON_COOK shells.

**Keyword: *MAT_036, *MAT_133**
Added heat treatment flag in *MAT_3-PARAMETER_BARLAT and *MAT_BARLAT_YLD2000.
Imposes changes in yield and hardening properties due to local or global heating to simulate enhanced formability in aluminium sheets.

**Keyword: *MAT_054**
Added new material parameter SOFTG to *MAT_ENHANCED_COMPOSITE_DAMAGE intended to soften GBC and GCA in crashfront elements.

**Keyword: *MAT_100**
Added option to fail all spotweld elements in an assemply simultaneously when one of the elements reaches the failure strain.

**Keyword: *MAT_133**
Added Gosh and Hocket-Sherby hardening to *MAT_BARLAT_YLD2000.

**Keyword: *MAT_181**
Added *MAT_SIMPLIFIED_RUBBER/FOAM for truss elements.

**Keyword: *MAT_208**
Implemented *MAT_BOLT_BEAM for discrete beams.

**Keyword: *MAT_219**
Added *MAT_CODAM2 for shell, thick shell and brick elements.

**Keyword: *MAT_220**
Implemented use of shells for *MAT_RIGID_DISCRETE.

**Keyword: *MAT_224**
Added temperature dependent Young's modulus for *MAT_TABULATED_JOHNSON_COOK. Negative value of E is now interpreted as a curve.

**Keyword: *MAT_246**
Implemented *MAT_PML_NULL - PML material for MAT_NULL with EOS_1 or 4.

**Keyword: *MAT_ADD_AIRBAG_POROSITY_LEAKAGE**
Added command to specify porosity leakage for non-fabric material in control volume modeled with *AIRBAG_HYBRID and *AIRBAG_WANG_NEFSKE.

**Keyword: *MAT_NONLOCAL**
Updated nonlocal smoothing (*MAT_NONLOCAL) to support thick shell elements in addition to shell and solid elements. Also enabled fully integrated elements to be properly smoothed. The MPP version now fully supports *MAT_NONLOCAL.

**Keyword: *MAT_ADD_EROSION**
Added new thinning strain failure criterion (EPSTHIN).

## NEW FEATURES:

**Keyword: n/a**
Added -j option to l2a so as to retain binout prefix in ASCII output files.

**Keyword: n/a**
Added check in MPP of installed memory on system and requested memory. If requested memory exceeds the real memory, the job will terminate unless command line option swapping=yes is on. This avoids some system crashes due to exhausted resources.

**Keyword: *PART_..._AVERAGED**
Added AVERAGED option for truss elements so all the elements have the same force.

**Keyword: *RIGIDWALL_PLANAR**
Added DISPLAY option to *RIGIDWALL_PLANAR as means to display the wall.

**Keyword: *SECTION_TSHELL, *CONTROL_ACCURACY**
Added support for objective stress update for all tshell formulations.

**Keyword: *SECTION_SOLID**
Added 1-point pentahedron element (ELFORM=115) with F-B hourglass control for implicit and explicit.

**Keyword: *SENSOR_DEFINE_..._SET**
Added option of "set" to *sensor_define_node and *sensor_define_element.

**Keyword: *SET_SEGMENT_ADD, *SET_SEGMENT_INTERSECT.**
Added keywords *SET_SEGMENT_ADD and *SET_SEGMENT_INTERSECT.

**Keyword: *AIRBAG_HYBRID, *AIRBAG_WANG_NEFSKE**
Allowed venting and porosity parameters to be defined using *DEFINE_CURVE_FUNCTION.

**Keyword: *AIRBAG_PARTICLE**
Removed encrypted *AIRBAG_PARTICLE data from d3hsp.

**Keyword: *AIRBAG_PARTICLE**
Assigned reference chamber ID for *AIRBAG_PARTICLE.
Fixed bug if chamber option and initial air option are both defined.

**Keyword: *AIRBAG_PARTICLE**
Improved computational efficiency of CPM chambers.

**Keyword: *AIRBAG_PARTICLE**
Enabled PPOP in *AIRBAG_PARTICLE for opening internal vent holes due to internal/external pressure differential.

**Keyword: *AIRBAG_WANG_NEFSKE**
Output airbag porosity leakage and venting hole leakage separately when CV=0.

**Keyword: *DATABASE_CPM_SENSOR**
Added option for CPM sensor to monitor rectangular box.

**Keyword: *DEFINE_CPM_BAG_INTERACTION**
Fixed bug affecting multiple definitions of CPM airbag interaction.

**Keyword: *SENSOR_CONTROL**
Fixed broken *SENSOR_CONTROL type 'AIRBAG' when airbag is defined with *AIRBAG_PARTICLE.

## *BOUNDARY - LS-DYNA version 971 R6.0.0.

**Keyword: *BOUNDARY_CYCLIC**
Added SMP and MPP support for multiple sets of cyclic boundary conditions.

Added ID option to *BOUNDARY_CYCLIC for id numbers and titles.

**Keyword: *BOUNDARY_PRESCRIBED_ACCELEROMETER**
Improved load curve parity check for *BOUNDARY_PRESCRIBED_ACCELEROMETER.

**Keyword: *BOUNDARY_PRESCRIBED_FINAL_GEOMETRY**
Added *BOUNDARY_PRESCRIBED_FINAL_GEOMETRY to implicit.

**Keyword: *BOUNDARY_PRESCRIBED_ORIENTATION_RIGID**
Fixed MPP explicit handling of subject command.

**Keyword: *BOUNDARY_PRESCRIBED_ACCELEROMETER**
Fixed acceleration output to rbdout for *BOUNDARY_PRESCRIBED_ACCELEROMETER.

**Keyword: *BOUNDARY_PRESCRIBED_MOTION_RIGID**
Fixed problem of nodal rigid bodies not moving when
*BOUNDARY_PRESCRIBED_MOTION_RIGID is used with DOF=9/10/11 or VAD=4.

**Keyword: *BOUNDARY_PRESCRIBED_MOTION_SET**
Corrected bug affecting *SENSOR when used to control
*BOUNDARY_PRESCRIBED_MOTION_SET.

**Keyword: *BOUNDARY_PRESCRIBED_ORIENTATION_RIGID**
Fixed implicit MPP implementation of *BOUNDARY_PRESCRIBED_ORIENTATION_RIGID.

**Keyword: *BOUNDARY_SPC**
Fixed bug whereby spc constraint got lost after trimming.

**Keyword: *BOUNDARY_USA_SURFACE**
Fixed bug involving USA and dynamic relaxation

**Keyword: *CONSTRAINED_COORDINATE**
Fixed bug.

**Keyword: *CONSTRAINED_COORDINATE, *DATABASE_SPCFORC**
Fixed the capturing of resultant forces for *CONSTRAINED_COORDINATE in implicit.

**Keyword: *CONSTRAINED_INTERPOLATION**
Improved error handling for when SGESVD fails for either
*CONSTRAINED_INTERPOLATION_LOCAL or _GLOBAL.

**Keyword: *CONSTRAINED_INTERPOLATION**
Fixed bug affecting *CONSTRAINED_INTERPOLATION in MPP implicit.

**Keyword: *CONSTRAINED_JOINT_STIFFNESS_GENERALIZED**
Extended the rotation angle of *CONSTRAINED_JOINT_STIFFNESS_GENERALIZED
to allow initialization to +/- 180 degrees. Previously, phi and
theta could initialize to only +/- 90. This change applies to the
incremental update option (JNTF=0 on *CONTROL_RIGID).

. **Keyword: *CONSTRAINED_JOINT_STIFFNESS_...**
Fixed problem of *CONSTRAINED_JOINT_STIFFNESS remaining in effect after joint fails.

**Keyword: *CONSTRAINED_LAGRANGE_IN_SOLID**
Added in support for thick shell parts as slave.

**Keyword: *CONSTRAINED_LINEAR_...**
Fixed bug in *CONSTRAINED_LINEAR... if rotational DOF is specified.

## *CONSTRAINED - LS-DYNA version 971 R6.0.0.

**Keyword: *CONSTRAINED_RIGID_BODY_STOPPER**
Fixed problem affecting *CONSTRAINED_RIGID_BODY_STOPPER with VID=4 or 8.

**Keyword: *CONSTRAINED_SHELL_TO_SOLID**
Fixed bug encountered when 9 solid nodes are included in NSID.

**Keyword: *CONSTRAINED_SPR2, *CONSTRAINED_INTERPOLATION_SPOTWELD**
Fixed for rare appearance of accuracy issues in single precision

**Keyword: *CONTACT**
Segment based contact (SOFT=2 on optional card A) has been observed to be slower than R4.2 and R4.2.1. The slowdown, first noticed in R5.0, occurs when there are significant numbers of shells in contact that have thicknesses that are large relative to their edge lengths. In older, faster versions, the bucket sort was sometimes not sufficiently robust to identify thick segment pairs in time to treat contact with correct thickness offsets. In R5.0 and later, this is corrected, with the side effect that the bucket sort creates longer lists and the solution time is increased. However, if SHLEDG=1 on *CONTROL_CONTACT, this slowdown does not occur and new versions should run at similar speed to R4.2.

**Keyword: *CONTACT_...**
Added option to turn off near contact stiffness option in implicit after n cycles. Set IGAP>2.

**Keyword: *CONTACT_...**
Fixed the neighbor segment checking (SFNBR>0) of segment based (SOFT=2) contact so it works when edge-edge checking is not active (DEPTH .ne. 5,25,35).

**Keyword: *CONTACT**
Excluded shell edge contact in MPP if edges are from the same segment.

**Keyword: *CONTACT**
Fixed a segment based (SOFT=2) contact bug that could allow very thick parts to penetrate before contact is detected.

## *CONTACT - LS-DYNA version 971 R6.0.0.

**Keyword: *CONTACT_...**

Replaced the check for initial penetration in segment based (SOFT=2) contact with a more accurate check that will not report nonsensical values.

Added a new optional card E for *CONTACT in order to add a new parameter for segment based (SOFT=2) contact. By default, the segment pairs that share rigid bodies, or share nodal constraints, are removed form consideration of contact. This can cause pentration because 1 or 2 nodes of a segment may belong to a constraint or rigid body, but the other nodes may be in motion, causing the segment to be penetrated. When the new parameter (ISHARE) in field one of optional card E is set to 1, the sharing of constraints is no longer used to eliminate segment pairs and contact checking is done.

**Keyword: *CONTACT_AUTOMATIC_BEAMS_TO_SURFACE**

Fixed bug whereby *CONTACT_AUTOMATIC_BEAMS_TO_SURFACE did not work correctly if it was not the first contact surface defined.

**Keyword: *CONTACT_AUTOMATIC_GENERAL**

Fixed incorrect sliding energy for beam contact.

**Keyword: *CONTACT_AUTOMATIC_GENERAL**

Computed frictional energy for sleout when using *CONTACT_AUTOMATIC_GENERAL.

**Keyword: *CONTACT_AUTOMATIC_..._TIEBREAK**

Fixed issues with MPP implementation of AUTOMATIC_TIEBREAK option 5.

**Keyword: *CONTACT_2D_AUTOMATIC_...**

Fixed 2D automatic contact for explicit solutions. When the velocity of penetration was very slow, it was failing to detect and prevent it.

**Keyword: *CONTACT_2D_AUTOMATIC_TIED_...**

For 2D adaptive problems with tied contact, now print a tied contact report after each adaptive remesh to the messag file.

**Keyword: *CONTACT_ERODING_...**
Enabled segment based (SOFT=2) eroding contact to work with a segment set for the slave or master side. In this way, eroding can be disregarded on one side or the other, thereby saving resources.

**Keyword: *CONTACT_FORCE_TRANSDUCER_PENALTY**
Fixed a bug in 2 surface force transducers when used with segment based (SOFT=2) contact.

**Keyword: *CONTACT_INTERFERENCE_...**
Increased depth of penetration allowed for *CONTACT_INTERFERENCE in MPP.

**Keyword: *CONTACT_..._MORTAR**
Fixed bugs in mortar contact.

**Keyword: *CONTACT_..._MORTAR**
Fixed bug in mortar contact.

**Keyword: *CONTACT_..._MORTAR**
Added edge treatment in mortar contact.

**Keyword: *CONTACT_NODES_TO_SURFACE,** *USER_INTERFACE_FRICTION
Fixed bug in user friction routine if *CONTACT_NODES_TO_SURFACE is used.

**Keyword: *CONTACT_..._TIEBREAK**
Issued warning about AUTOMATIC_TIEBREAK types < 0 (which are not supported in MPP) and switch to the corresponding positive type.

**Keyword: *CONTACT_TIED_...**
Enabled spot weld thinning for tied contact options OFFSET, BEAM_OFFSET, and CONSTRAINED_OFFSET in MPP. Previously, with spot weld thinning turned on via SPOTHIN in *CONTROL_CONTACT, contact thinning was based on proximity to part tied only with *CONTACT_SPOTWELD.

## *CONTACT - LS-DYNA version 971 R6.0.0.

**Keyword: *CONTACT_TIBREAK_SURFACE_TO_SURFACE**
Added warning for unsupported option TBLCID in *CONTACT_TIBREAK_SURFACE_TO_SURFACE for MPP.

**Keyword: *CONTACT_TIED_..._CONSTRAINED_OFFSET**
Fixed serious instability in MPP implementation of subject keyword and also a fix for tied contacts and adaptivity.

**Keyword: *CONTACT_TIED_SHELL_EDGE_TO_SURFACE_OFFSET**
Fixed MPP rotational stiffness of *CONTACT_TIED_SHELL_EDGE_TO_SURFACE_OFFSET i in implicit.

**Keyword: *CONTROL_CONTACT**
Added new parameter to field 8 of card 6 of *CONTROL_CONTACT to limit the number of constrained tied nodes that can be deleted before the model terminates with an error.

**Keyword: *CONTROL_DYNAMIC_RELAXATION**
Enabled IDRFLG=2 on *CONTROL_DYNAMIC_RELAXATION to be used with segment based (SOFT=2) interference contact.

**Keyword: *DATABASE_BINARY_INTFOR**
Fixed a problem of noisy output to intfor in MPP.

**Keyword: *DEFINE_FRICTION**
Fixed *DEFINE_FRICTION: DC and VC was swapped in the keyword reader in case PSET was used in PTYPEI/PTYPEJ.

**Keyword: *DEFINE_CURVE_ENTITY**
Fixed bugs affecting *DEFINE_CURVE_ENTITY when scale factors/offsets are used or the first point of the curve is not (0,0).

**Keyword: *CONTROL_ADAPTIVE, *CONTACT_DRAWBEAD**
Fixed bug in adaptivity if the input contains drawbeads.

**Keyword: *CONTROL_ADAPTIVE**
Fixed the problem of erosion of solid elements being turned off when *CONTROL_ADAPTIVE is used (excludes EFG).

**Keyword: *CONTROL_DYNAMIC_RELAXATION**
Fixed related to distortional KE when IDRFLG=3.

**Keyword: *CONTROL_FORMING_PARAMETER_READ**
Fixed problems in first adaptive step when keyword used multiple times.

**Keyword: *CONTROL_SOLID**
Extended ESORT parameter.
ESORT=1, sort tets to type 10, penta to type 15
ESORT=2, sort tets to type 10, penta to type 115
ESORT=3, sort tets to type 10, penta to type 15, print elements that have switched
ESORT=4, sort tets to type 10, penta to type 115, print elements that have switched

**Keyword: *CONTROL_TIMESTEP**
Corrected acceleration ouput for selective mass scaling.

**Keyword: *CONTROL_TIMESTEP**
Fixed bug whereby selective mass scaling did not consider deletion of rigid bodies.

**Keyword: *RIGIDWALL_GEOMETRIC_..., *CONTROL_TIMESTEP**
Supported geometric rigid walls in selective mass scaling.

## *DATABASE - LS-DYNA version 971 R6.0.0.

**Keyword: *CONTROL_OUTPUT**
Fixed broken display of tetrahedrons when TET10=1 in *CONTROL_OUTPUT.

**Keyword: *CONTROL_OUTPUT, *DAMPING_GLOBAL**
Made clear in d3hsp that whenever *DAMPING_GLOBAL is used, the nodal accelerations output to nodout are averaged over the output interval.

**Keyword: *DATABASE**
Fixed strain output for shell formulation 18.

**Keyword: *DATABASE_ABSTAT**
Output airbag interaction energy from master to slave bag to "reaction" field of abstat_cpm data written to binout.

**Keyword: *DATABASE_AVSLFT/MPGS/MOVIE**
Added error message if *DATABASE_EXTENT_AVS/MPGS/MOVIE is missing.

**Keyword: *DATABASE_BINARY_...**
Fixed SMP issue of missing d3plot states in small restart.

Fixed MPP issue of corrupt d3thdt data after second restart.

**Keyword: *DATABASE_BINARY_D3PART**
Fixed corrupt d3part database.

**Keyword: *DATABASE_BINARY_D3PLOT**
Fixed problem of MPP not properly continuing d3plot on restart.

**Keyword: *DATABASE_BINARY_D3PLOT**
Fixed bug in output of strain for 2D models.

*mat

**Keyword: *DATABASE_BINARY_BLSTFOR**
Allowed output interval to be specified with a load curve.

**Keyword: *DATABASE_BINARY_INTFOR**
Connected implicit mechanics with the intfor file.

**Keyword: *DATABASE_BINARY_INTFOR**
Automatically reset contact print flags to 0 for *CONTACT_ERODING_... if user sets either flag to 1. The intfor database is not supported for eroding contacts.

**Keyword: *DATABASE_BINARY_INTFOR**
Fixed bug in intfor for SMP version if it is a thermal problem.

**Keyword: *DATABASE_BINARY_INTFOR**
Fixed bug in intfor for SMP if thermal solver is invoked.

**Keyword: *DATABASE_BINARY_INTFOR**
Fixed broken intfor output in MPP.

**Keyword: *DATABASE_ELOUT**
Fixed miscellaneous bugs in eloutdet output.

*new

**Keyword: *DATABASE_ELOUT**
Added option for extra history variable output for all integration points to elout.

**Keyword: *DATABASE_EXTENT_BINARY, *MAT_002**
Corrected the CMPFLG output option for bricks comprised of *MAT_O02. The transformation matrix used to output in the local system was not being updated to account for element rotation.

## *DATABASE - LS-DYNA version 971 R6.0.0.

**Keyword: *DATABASE_GLSTAT**
Also write part number when writing element ID and element time step to glstat and d3hsp.

**Keyword: *DATABASE_MATSUM**
Output internal energies for each ALE2D group to matsum (like in 3D).

**Keyword: *DATABASE_PROFILE**
Upgraded *DATABASE_PROFILE for plotting distribution of an element or node component along x,y, or z-direction.

**Keyword: *DATABASE_RCFORC**
Fixed bug in output of rcforc data for implicit.

**Keyword: *DATABASE_RCFOR**
Fixed bug whereby incorrect forces were gathered by the RCFORC function of *DEFINE_CURVE_FUNCTION.

**Keyword: *DATABASE_SLEOUT**
Fixed fricitonal energy output to sleout for implicit.

**Keyword: *DATABASE_SPCFORC**
Fixed implicit's output of spcforc for linear problems.

**Keyword: *DATABASE_SWFORC**
Fixed swforc output errors for hex spotweld assembly in MPP.

**Keyword: *DATABASE_SWFORC, *MAT_100**
Fixed brick and brick assembly spot weld output to the swforc file when welds have failed after damage initiation by either plastic strain or the failure function. This was fixed for all failure options except opt 8 (DAMILER) or option 12 (user defined failure).

**Keyword: *ELEMENT_MASS_PART, *DATABASE_MATSUM**
Fixed incorrect rigid body velocity and kinetic energy in matsum file when *ELEMENT_MASS_PART is used.

**Keyword: *PART_COMPOSITE**
Fixed stress output to d3plot for *PART_COMPOSITE. Stresses for some int pts were zero.

**Keyword: *MAT_169**
Plastic strain rate (edotp) is now stored as extra history var#6 in *MAT_ARUP_ADHESIVE.

## *ELEMENT - LS-DYNA version 971 R6.0.0.

**Keyword: *CONTROL_ACCURACY, *SECTION_SOLID**
Corrected pentehedral (form 15) brick element when used with invariant node numbering. The symptom was a lack of parallel consistancy, but the real problem was an incorrect calculation of the transformation matrix so the behavior of ortho/anisotropic materials was incorrect.

**Keyword: *DAMPING_PART_STIFFNESS**
Fixed stiffness damping to work correctly for solids.

**Keyword: *EOS_USER_DEFINED**
Fixed bug associated with *EOS_USER_DEFINED in combination with ELFORM4 tetrahedrons.

**Keyword: *ELEMENT_SHELL_NURBS_PATCH,** *ELEMENT_GENERALIZED_SHELL
Renamed *ELEMENT_NURBS_PATCH_2D to *ELEMENT_SHELL_NURBS_PATCH
Activate *MAT_24 for isogeometric and generalized shells.

**Keyword: *INTIIAL_STRESS_SOLID**
Fixed reading of initial stresses for pentahedrons.

**Keyword: *SECTION_TSHELL**
Fixed problem of tshells not always eroding after reaching failure criterion.

**Keyword: *SECTION_SHELL, *SECTION_SOLID**
Fixed problem whereby 1-point 3D solid elements and 2D solid elements could generate strain during rigid body motion when using single precision.

**Keyword: *SECTION_SHELL**
Corrected bug in shell formulations 23 and 24 affecting result in pure bending.

**Keyword: *SECTION_SHELL**

Fixed stress output for triangular shell formulation 17.

Fixed output issues for shell element types 18, 23 and 24.

**Keyword: *SECTION_SHELL**
Fixed bug in output of shell element type 18 (linear DK).

**Keyword: *SECTION_SHELL**
Added output of strain for 6-node triangular shell and 8-node quad shell (shell formulations 23 and 24).
Also Fixed implicit formulation of these shells.

**Keyword: *SECTION_SHELL**
Improved load distribution in quadratic shell formulations 23 and 24.

**Keyword: *SECTION_SHELL**
Fixed for thickness update of generalized and isogeometric shells.

**Keyword: *SECTION_SHELL**
Fixed bug in rotation of fibers in shell formulationss 23 and 24, and allow mid side nodes to take part in rigid body.

**Keyword: *SECTION_SHELL, *MAT_138, *MAT_240**
Fixed bug affecting 2D cohesive elements (*SECTION_SHELL, ELFORM=46/47) comprised of *MAT_COHESIVE_MIXED_MODE or *MAT_COHESIVE_MIXED_MODE_ELASTOPLASTIC_RATE.

**Keyword: *SECTION_TSHELL, *MAT_USER_DEFINED_MATERIAL_MODELS**
Fixed thick shell forms 3 and 5 when used with user defined materials that have orthotropic properties defined (IORTHO=1). Without the fix, the strain increment, stress and deformation gradient transformations are incorrect.

## *ELEMENT - LS-DYNA version 971 R6.0.0.

**Keyword: *SECTION_TSHELL, *CONTROL_PARALLEL**
Fixed SMP parallel consistancy when PARA=1 in *CONTROL_PARALLEL for thick shell forms 3 and 5, brick form 18, tet form 13.

**Keyword: *SECTION_SOLID**
Slightly modified implicit elform3 to make it compatible with explicit elform3.

**Keyword: *SECTION_SOLID**
Fixed the deformation gradient calculation for linear solid element type 18. A test case with material 123 was calculating material failure in the first cycle.

**Keyword: *SECTION_SOLID, *DATABASE_GLSTAT**
Fixed spurious kinetic energy growth in glstat data of elform4 tets.

**Keyword: *SECTION_SOLID**
Added clean error termination when wrong solid element formulation is specified for 10-noded tetrahedrons.

**Keyword: *SECTION_SOLID**
Improved accuracy of solid element type 13 (tetrahedron).

**Keyword: *DATABASE_FREQUENCY_...**
Fixed bug in defining output frequency curve for frequency domain databases.

**Keyword: *FREQUENCY_DOMAIN_ACOUSTIC_BEM**
Fixed BEM acoustics when using set_segment for acoustic field nodes.

**Keyword: *FREQUENCY_DOMAIN_ACOUSTIC_BEM**
Added a fringe plot option to all the BEM acoustic solvers.

Updated BEM acoustics to remove the limitation on number of acoustic field nodes.

**Keyword: *FREQUENCY_DOMAIN_ACOUSTIC_BEM**
Fixed a bug in restarting bem acoustics with SSD response.

**Keyword: *FREQUENCY_DOMAIN_ACOUSTIC_FEM**
Updated frequency domain fem acoustics to introduce free pressure boundary condition.

**Keyword: *FREQUENCY_DOMAIN_ACOUSTIC_FEM**
Updated frequency domain fem acoustics, to allow using the results of i transient analysis.

**Keyword: *FREQUENCY_DOMAIN_ACOUSTIC_FEM**
Fixed frequency domain FEM acoustics for tetrahedrons.

**Keyword: *FREQUENCY_DOMAIN_ACOUSTIC_FEM**
Added Press_Pa_real and Press_Pa_imag output to frequency domain fem acoustics.

**Keyword: *FREQUENCY_DOMAIN_FRF**
Fixed a bug in FRF computation with pressure load.

**Keyword: *FREQUENCY_DOMAIN_FRF**
Extended FRF to base velocity and base displacement excitation.

## *FREQUENCY_DOMAIN - LS-DYNA version 971 R6.0.0.

**Keyword: *FREQUENCY_DOMAIN_RANDOM_VIBRATION**
Added xyplot output of psd_curve_print, converted from time history load, for random vibration LDTYP=2.

**Keyword: *FREQUENCY_DOMAIN_RANDOM_VIBRATION**
Fixed bug in reading mode information in random vibration.

**Keyword: *FREQUENCY_DOMAIN_RANDOM_VIBRATION**
Fixed bug in reading modal information and writing d3rms in random vibration analysis.

**Keyword: *FREQUENCY_DOMAIN_RANDOM_VIBRATION_FATIGUE**

Added the option to define SN fatigue curves by two equations, for random fatigue.

Implemented Dirlik method to random fatigue analysis (mode acceleration only).

**Keyword: *FREQUENCY_DOMAIN_RESPONSE_SPECTRUM**
Added Double Sum method to response spectrum analysis (MCOMB=3).

**Keyword: *FREQUENCY_DOMAIN_SSD**
Fixed bug in SSD with multiple excitations.

Fixed bug in SSD when using local damping option.

**Keyword: *FREQUENCY_DOMAIN_SSD**
Updated on SSD to allow multi-axial excitation.

**Keyword: *FREQUENCY_DOMAIN_SSD**
Added output of beam integration point values in Steady State Dynamics.

**Keyword: *FREQUENCY_DOMAIN_SSD**
Fixed a bug in writing nodout_ssd and elout_ssd files.

**Keyword: *INITIAL_STRESS_SOLID**

Added transformation of solid stresses input with *INITIAL_STRESS_SOLID when *INCLUDE_TRANSFORM rotates geometry.

## *LOAD LS-DYNA version 971 R6.0.0.

**Keyword: *CONTROL_ADAPTIVE**
Fixed problem when *CONTROL_ADAPTIVE and *LOAD_SEGMENT/*LOAD_SEGMENT_SET are used together for 2D analysis; problem was the effect of *LOAD_SEGMENT i disappearred after adaptive step.

**Keyword: *LOAD_BLAST_ENHANCED**
When BLAST=4 in *LOAD_BLAST_ENHANCED, eliminate ground encounter when determining which entity is first hit by a shock wave. Use correct time parameters and scaled distance so velocity decay is correctly computed for encounter with the ground reflected wave.

**Keyword: *LOAD_BLAST_ENHANCED**
Fixed blast wind velocity and wave index for BLAST=4.

**Keyword: *LOAD_BLAST_ENHANCED**
Reported the minimum computed arrival time.

**Keyword: *LOAD_BLAST_ENHANCED**
Fixed an index problem for the blast origin when multiple charges are defined. This problem elicited false warning messages during initialization and had no ill effect on the actual blast load.

**Keyword: *LOAD_RIGID_BODY**
Added warning message if *LOAD_RIGID_BODY part is a slave part in *CONSTRAINED_RIGID_BODIES.

**Keyword: *LOAD_SSA**
Fixed problem of incorrectly reading in explosive charge definitions.

**Keyword: *LOAD_THERMAL_VARIABLE_BEAM**
Fixed problem of *LOAD_THERMAL_VARIABLE_BEAM giving wrong temperatures for tubular sections.

**Keyword: *DEFINE_CONNECTION_PROPERTIES**

Fixed case of AREAEQ.ne.0:
The true area was not correctly used in the failure function,
if the exponents EXSN, EXSB, EXSS were not 1.0.

**Keyword: *EOS_...**
Added input check for duplication of EOS ID.

**Keyword: *MAT_...**
Fixed incorrect experimental curve data output to curveplot file for
materials 76, 77, 134, 175, 176, 178 and 276.

**Keyword: *MAT_CRUSHABLE_FOAM**
Fixed instability problem of *MAT_CRUSHABLE_FOAM for plain strain analysis.

**Keyword: *MAT_NONLOCAL**
Modified nonlocal failure for thick shells so that if elements are stacked,
averaging will not occur with elements on the top and bottom, only those
on the side.

**Keyword: *MAT_USER_DEFINED_MATERIAL_MODELS**
Fixed plane strain and axisymmetric elements when used with orthotropic
user-defined materials. This fix affects shell forms 13, 14, 15, 43,
44, 52, 53. The wrong strain and stress transformation was being done.

**Keyword: *MAT_019**
Made the strain rate the first history variable after the
plastic strain for all versions of *MAT_STRAIN_RATE_DEPENDENT_PLASTICITY.

**Keyword: *MAT_021**
Modified *MAT_ORTHOTROPIC_THERMAL so that it works with angles on the
*SECTION_SHELL or *SECTION_TSHELL card to define material directions
for layers.

## *MAT LS-DYNA version 971 R6.0.0.

**Keyword: *MAT_024**
Made beam *MAT_PIECEWISE_LINEAR_PLASTCITY plasticity iteration consistent i with *MAT_PLASTIC_KINEMATIC (*MAT_003).

**Keyword: *MAT_024 and others**
Improved user-defined failure subroutine template matusr_24 including passing of updated strain.

**Keyword: *MAT_034**
Made fabric material forms 12, 13, and 14 output global stress to the d3plot file like the other fabric forms and other materials.

**Keyword: *MAT_036**
Corrected bad output of strains and thickness reduction to d3plot for *MAT_3-PARAMETER_BARLAT.

**Keyword: *MAT_036, *MAT_190**
A bug fixed for these materials in the case of equi-biaxial stretching.

**Keyword: *MAT_058, *MAT_158**
Enabled the negative AOPT (*DEFINE_COORDINATE_NODES) option for *MAT_LAMINATED_COMPOSITE_FABRIC and *MAT_RATE_SENSITIVE_COMPOSITE_FABRIC.

**Keyword: *MAT_072R3**
Made updates to *MAT_CONCRETE_DAMAGE_REL3 per KCSE.

**Keyword: *MAT_072R3**
Implemented updates from KCSE for *MAT_CONCRETE_DAMAGE_REL3.

**Keyword: *MAT_082**
Fixed bug in *MAT_PLASTICITY_WITH_DAMAGE_ORTHO for brick elements and 2D solids which caused elements to spuriously vanish.

**Keyword: *MAT_098**
Fixed bug in *MAT_SIMPLIFIED_JOHNSON_COOK for implicit.

**Keyword: *MAT_100**
Made *MAT_SPOTWELD/SIGY<0 consistent with *MAT_SPOTWELD/SIGY>0.

**Keyword: *MAT_100**
Fixed for damage calculation in *MAT_SPOTWELD_DAMAGE-FAILURE when SIGY<0.

**Keyword: *MAT_100**
Fixed the BETA>0 option for brick or brick assembly spot welds that use DMGOPT=2, 10, 11, and 12. Weld failure was not occuring after damage initialization.

**Keyword: *MAT_107**
Fixed in Zerilli-Armstrong law in *MAT_MODIFIED_JOHNSON_COOK

**Keyword: *MAT_120, *MAT_120_JC**
Added extra history variable 16 to *MAT_GURSON and *MAT_GURSON_JC for convenience in checking against GISSMO damage model.

**Keyword: *MAT_123**
Fixed RTCL damage of *MAT_MODIFIED_PIECEWISE_LINEAR_PLASTICITY_RTCL such the input parameter EPS0 is now used correctly.

Added parameter TRIAX which is a limit on the triaxiality, beyond which damage will not grow.

**Keyword: *MAT_124**
Implemented an optional Young's modulus for compression in *MAT_PLASTICITY_COMPRESSION_TENSION.

**Keyword: *MAT_125**
Fixed energy calculation in *MAT_KINEMATIC_TRANSVERSELY_ANISOTROPIC.

## *MAT_LS-DYNA version 971 R6.0.0.

**Keyword: *MAT_156,_221,_226,_232,_233,_244,_267**
Fixed various material model bugs in
*MAT_MUSCLE (for truss elements),
*MAT_ORTHOTROPIC_SIMPLIED_DAMAGE,
*MAT_KINEMATIC_HARDENING_BARLAT89,
*MAT_BIOT_HYSTERETIC,
*MAT_CAZACU_BARLAT,
*MAT_UHS_STEEL,
*MAT_EIGHT_CHAIN_RUBBER

**Keyword: *MAT_169**
Added new option to *MAT_ARUP_ADHESIVE: If parameter BTHK<0, then do not modify time step. This helps to avoid very small time steps, but it can affect stability.

**Keyword: *MAT_172**
Modified *MAT_CONCRETE_EC2 so that when *INTEGRATION_SHELL or *PART_COMPOSITE is used, the AOPT-related angle is recalculated for each integration point.
The standard LS-DYNA treatment is to get the AOPT-related angle from the first IP made of an orthotropic material, then use the same angle for subsequent points.

**Keyword: *MAT_174**
Fixed output of curvature to "plastic strain" position in output of *MAT_RC_BEAM.

**Keyword: *MAT_181**
Fixed instability of *MAT_SIMPLIFIED_RUBBER/FOAM in full deck restart.

**Keyword: *MAT_187**
Fixed for large curve IDs in *MAT_SAMP-1.

**Keyword: *MAT_224**
Added *MAT_TABULATED_JOHNSON_COOK for type 13 tetrahedon.

**Keyword: *MAT_233**

Fixed NUMINT option of *MAT_CAZACU_BARLAT.

Added new options related to rate effects and damage.

**Keyword: *MAT_234**
Fixed calculation of sound speed for *MAT_VISCOELASTIC_LOOSE_FABRIC.
Include element number when writing out failure message.

**Keyword: *MAT_244**
Implemented *MAT_UHS_STEEL for 2D solid elements.

**Keyword: *MAT_244**

Added option to *MAT_UHS_STEEL for automatic switching between cooling and heating algorithm based on the temperature slope.

Fixed scaling of heat flow due to phase transitions in *MAT_UHS_STEEL.

Added thermal scale factor to *MAT_UHS_STEEL.

Support heating and/or reheating of *MAT_UHS_STEEL. The heat equation is taken from Oddy et al (1996) Microstructural Predictions Including Arbitrary Thermal Historic ReAustinatization And Carbon Segregation Effects.

**Keyword: *MAT_272**
Improved *MAT_RHT, including automatic parameter generation.

**Keyword: *MAT_ADD_EROSION**
Fixed GISSMO damage history output to d3hsp.

**Keyword: *MAT_ADD_EROSION**
Modified GISSMO parameters SHRF and BIAXF.

## *MAT_LS-DYNA version 971 R6.0.0.

**Keyword: *MAT_..._THERMAL**
Corrected calculation of heat flux vector for orthotropic materials.

**Keyword: *MAT_THERMAL_USER_DEFINED**
Corrected temperature in user materials in combination with 2D solids.

Corrected history variable handling in thermal user materials.

**Keyword: *PART_COMPOSITE**
Enabled *PART_COMPOSITE to work with material types 104, 108, 122, 133, 135, 137, 157, 223, 226, 229, 233, 234, 235, and 242. Previous, a keyword error was reported.

**Keyword: *SECTION_SOLID, *MAT_...**
Improved accuracy of type 13 (pressure-averaged) tetrahedron.

Modified several existing material models for type 13 tetrahedron, including *mat_015, *mat_098, *mat_106, *mat_224.

**Keyword: Various *MAT_... including *MAT_ADD_EROSION**
Fixed for NUMINT<0 in materials 120, 123, 187, 224, and GISSMO: solid elements are now deleted directly after 1st IP fails, i.e., input value of NUMINT is ignored.

**Keyword: *ALE_FAIL_SWITCH_MMG**
Supported ALE Multimaterial Group switching for failed material in MPP.

**Keyword: *ALE_FSI_PROJECTION**
Fixed bug affecting this command in MPP.

**Keyword: *ALE_AMBIENT_HYDROSTATIC, *INITIAL_HYDROSTATIC_ALE**
For these commands, add in support for *EOS_GRUNEISON but at significant cost owing to an iterative algorithm.

**Keyword: *CONTROL_ALE**
Invoked preferred multi-material ALE advection method for explosive simulations by setting DCT = -1.

**Keyword: *CONTROL_ALE, *EOS_JWLB**
Initialized the *EOS_JWLB pressure with PREF and the relative volume (ALE formulation).

**Keyword: *CONTROL_EXPLOSIVE_SHADOW_SET**
Implemented this feature for MPP.

**Keyword: *CONSTRAINED_LAGRANGE_IN_SOLID**
Fixed PFACMM=3 option.

**Keyword: *DATABASE_GLSTAT, *DATABASE_MATSUM,** *DATABASE_ALE_MAT
Improved writing of internal energy for ALE parts.

**Keyword: *DATABASE_FSI**
Corrected the computation of the mass flux.

**Keyword: *INITIAL_STRESS_DEPTH**
Initialized the stress for each ALE group.

## SPH  LS-DYNA version 971 R6.0.0.

**Keyword: *CONTROL_SPH**
Updated strain calculation (due to circumferential velocity) for SPH axisymmetry option.

**Keyword: *CONTROL_SPH, *DEFINE_SPH_TO_SPH_COUPLING**
Implemented SPH CONT=1 and SPH-to-SPH coupling for MPP.

**Keyword: *DEFINE_SPH_TO_SPH_COUPLING**
Fixed read error for multiple *DEFINE_SPH_TO_SPH_COUPLING.

**Keyword: *MAT_072, _173, _241**

Added *MAT_072 for SPH.

Added *MAT_MOHR_COULOMB for SPH but no support for material's LOCAL=1
option.

Added *MAT_JOHNSON_HOLMQUIST_JH1 for SPH.

**Keyword: *SECTION_SPH**
Output bulk viscosity energy of SPH as hourglass energy.

**Keyword:  *SECTION_SPH**
Updated bulk viscosity of SPH for MPP to conserve the total energy.

**Keyword: *..._SPH**
Fixed bugs related to SPH with thermal solver.

**Keyword: *MAT_267**

Added EFG compatibility to the *MAT_EIGHT_CHAIN rubber model.

## *IMPLICIT LS-DYNA version 971 R6.0.0.

**Keyword: *BOUNDARY_CYCLIC**
Fixed MPP implicit implementation of cyclic symmetry boundary conditions.

**Keyword: *CONTROL_IMPLICIT_AUTO**
Fixed bug in implicit auto time stepping combined with keypoints.

**Keyword: *CONTROL_IMPLICIT_AUTO**
Fixed bug when using thermal dependent materials and auto time stepping in implicit.

**Keyword: *CONSTRAINED_JOINT, *CONTROL_RIGID**
Fixed issues with the SMP and MPP implementations of the implicit (LM) joints.

**Keyword: *CONTROL_IMPLICIT_CONSISTENT_MASS**
Fixed bug in *CONTROL_IMPLICIT_CONSISTENT_MASS (MPP only).

**Keyword: *CONTROL_IMPLICIT_GENERAL**
Properly handled the switching between explicit to implicit
in the case of large rotations of rigid bodies.

**Keyword: *CONTROL_IMPLICIT_CONSISTENT_MASS**
Added consistent mass matrices for
solid types 1, 2, 10, 15; beam type 1, 2, 3, 4, 5.

**Keyword: *CONTROL_IMPLICIT_EIGENVALUE**

Fixed stress output for implicit mode shapes.

Fixed improper handling of *CASE for implicit eigenvalue analysis.

**Keyword: *CONTROL_IMPLICIT_...**

Fixed the output to implicit databases (d3eigv, d3mode, d3iter) for
10-noded tetrahedra.

Fixed MPP writing of d3eigv for large problems.

**Keyword: *CONTROL_IMPLICIT_SOLUTION**
Bug fixed in implicit nonlinear solver 12.

**Keyword: *CONTROL_IMPLICIT_STATIC_CONDENSATION**
Fixed bug of incorrectly sorted nodes for
*CONTROL_IMPLICIT_STATIC_CONDENSATION.

**Keyword: *CONSTRAINED_JOINT_...**
Fixed handling of joints in the presence of curve-based implicit
switching.

**Keyword: *DATABASE_SPCFORC**
Fixed output of spc forces in implicit.

**Keyword: *DATABASE_option**
Fixed incorrect output to spcforc for implicit.

Fixed MPP Implicit error in collecting and reporting forces
due to certain constraints.

**Keyword: *ELEMENT_DISCRETE**
Disabled velocity dependent dampers for implicit static solution.

**Keyword: *INTERFACE_LINKING_...**
Fixed MPP Implicit's treatment of *INTERFACE_LINKING_... to
match the year old changes to this feature for MPP Explicit.

**Keyword: *MAT_054, *MAT_055**
Enabled implicit solutions with solids comprised of
*MAT_ENHANCED_COMPOSITE_DAMAGE.

**Keyword: n/a**
Tuned up implicit memory requirements output.

**Keyword: *SECTION_BEAM, *CONTROL_IMPLICIT_GENERAL**
Stiffness matrix of type 2 beam was broken when IGS=1 (geometric stiffness).

## Thermal  LS-DYNA version 971 R6.0.0.

**Keyword: *CONSTRAINED_SPOTWELD**

The 2 nodes identified by this keyword will be constrained to the same temperture in a thermal only problem or in a coupled thermal mechanical problem.

**Keyword: *CONTROL_THERMAL_SOLVER, *MAT_244**

The parameter TSF (thermal speedup factor) on the *CONTROL_THERMAL_SOLVER keyword will automatically scale the kinetic rate equations used in *MAT_UHS_STEEL. TSF is used for time scaling, such as when the punch speed is  artificially increased when modeling metal stamping operations.

**Keyword: *MAT_172, *MAT_ADD_PERMEABILITY**

Fixed bug whereby *MAT_CONCRETE_EC2 beams and shells did not respond to  temperature change in a coupled thermal/structural analysis.
Pore pressure analysis thermal expansion was also failing to respond to temperature change in a coupled analysis.

**Keyword: *BOUNDARY_PRESCRIBED_MOTION_RIGID**
Fixed MPP problem related to *BOUNDARY_PRESCRIBED_MOTION_RIGID when used with relative motion.

Fixed for MPP d3plot output, which was not honoring the IEVERP flag on *DATABASE_EXTENT_BINARY.

**Keyword: *CONTROL_MPP_DECOMPOSITION**
Enhanced decomposition option to allow isolate and distribute for multiple parts or part set.

**Keyword: *CONTROL_MPP_DECOMPOSITION_SHOW, *AIRBAG_PARTICLE**
Fixed problem of viewing MPP decomposition when particle method is invoked.

**Keyword: *ELEMENT_DIRECT_STIFFNESS_MATRIX**
Enhanced MPP performance of explicit with superelements for large number of processes and small number of superelements.

**Keyword: *ELEMENT_SEATBELT_SLIPRING**
Fixed problem in MPP with sliprings having "optional orientation node".

**Keyword: *LOAD_SURFACE_STRESS**
Added MPP support of *LOAD_SURFACE_STRESS.

**Keyword: *MAT_NONLOCAL**
Added support for *MAT_NONLOCAL in MPP.

**Keyword: n/a**
Improved commonality between SMP and MPP in rigid body routines.

## Forming  LS-DYNA version 971 R6.0.0.

**Keyword: *CONTROL_FORMING_SCRAP_FALL**

Allowed displacement control of trim steel kinematics.

Fixed bug in scrap constraints release when trim steel is moving in local coordinate system

**Keyword: *DEFINE_CURVE_TRIM_3D**

Improved flanging simulation by allowing the user to control how far the elements from a defined curve can be selected for mesh refinement.

**Keyword: *DEFINE_CURVE_TRIM_NEW**

Improved 2D trimming: allow trimming curves to cross the part boundary many times.

Fixed a bug in trimming where SPC constraints could be lost.

**Keyword *INTERFACE_COMPENSATION_NEW**

Fixed bugs in springback compensation:
1)rigid tooling now can be the exact same size as the deformed blank;
2)improvement in springback compensation with undercut;
3)blank can now be bigger than the rigid tool.

*INTERFACE_COMPENSATION_NEW now allows multiple regions to be compensated at the same time, with keyword
*DEFINE_CURVE_COMPENSATION_CONSTRAINT_BEGIN
and *DEFINE_CURVE_COMPENSATION_CONSTRAINT_END.

**Keyword:**
Fixed DEM to DEM contact in MPP.

**Keyword: *CONTACT_NODES_TO_SURFACE**
Supported part/part set input in N2S contact with discrete element sphere.

**Keyword: *DEFINE_DE_TO_SURFACE_COUPLING**
Included rotational DOF for discrete element to surface coupling.

**Keyword: *ELEMENT_DISCRETE_SPHERE**

Added capillary force to simulate wet particles for Discrete Sphere Element. The particle-particle and particle-segment capillary force is calculated based on Langmuir 2005, 12, 10992-10997

Added rolling friction for discrete sphere element.

## Isogeometric Elements LS-DYNA version 971 R6.0.0.

**Keyword: *ELEMENT_SHELL_NURBS_PATCH**

Allowed degenerated nurbs-patches (multiple control-points at the same physical location) for isogeometric elements.

**Keyword: *ELEMENT_SHELL_NURBS_PATCH**

Made the transformation of parametric coordinates to physical coordinates of interpolation nodes compatible with MPP.

Fixed post-processing of stresses, ... via interpolation elements in case of multiple nurbs patches that share common edges.

**Keyword:**
Fixed interactive "cross" command in Material Model Driver.

**Keyword: *BOUNDARY_USA_SURFACE**
Added USA support for implicit.

**Keyword: *CASE**
Allowed *KEYWORD_JOBID and *CASE together.

**Keyword: *CONTROL_ADAPTIVE**
Fixed error in adaptivity restart if any elements have failed.

**Keyword: *DAMPING_FREQUENCY_RANGE**
Fixed bug whereby damping applied was much greater than the input value if FHIGH/FLOW < 3.16

**Keyword: *DAMPING_PART_STIFFNESS**
Fixed bug when damping is enabled in *DAMPING_PART_STIFFNESS and rayleigh damping energy is computed per RYLEN=2 in *CONTROL_ENERGY; shells may have had spurious stresses.

**Keyword: *DEFINE_FUNCTION**
Accommodated triangular segments in pressure loading using *DEFINE_FUNCTION.

**Keyword: *DEFINE_BOX_LOCAL**
Fixed bug affecting LOCAL option of *DEFINE_BOX.

**Keyword: *DEFINE_CURVE_FUNCTION**
Fixed a bug which gave null results for the translational velocity and acceleration functions (VX,VY,VZ,AX,AY,AZ) when the optional local coordinate system N3 was specified.

## Miscellaneous LS-DYNA version 971 R6.0.0.

**Keyword: *DEFORMABLE_TO_RIGID_AUTOMATIC**
Fixed problem of *DEFORMABLE_TO_RIGID_AUTOMATIC not switching correctly for MPP.

**Keyword: *DEFORMABLE_TO_RIGID_AUTOMATIC**
Fixed bug affecting D2R automatic switching in MPP wherein
small variations of contact forces between tire and road in a tire
rolling example were observed.

**Keyword: *INCLUDE_TRANSFORM**

Fixed *INCLUDE_TRANSFORM with *PART_CONTACT or *PART_COMPOSITE_CONTACT:
Decay constant DC was not transformed correctly.

Fixed *AIRBAG_HYBRID with *INCLUDE_TRANSFORM.

Fixed *MAT_034 (negative LCUA, LCUB, LCUAB) with *INCLUDE_TRANSFORM:
Scaling with FCTMAS, FCTTIM, and FCTLEN was not done correctly in this case.

Fixed *MAT_183 with *INCLUDE_TRANSFORM.

Fixed *CONTACT_... parameter CID_RCF (Optional Card C):
Offset IDDOFF from *INCLUDE_TRANSFORM was not accounted for.

Fixed *MAT_100 with SIGY<0: Account for offset from *INCLUDE_TRANSFORM.

Fixed *CONSTRAINED_JOINT_STIFFNESS and offsets from INCLUDE_TRANSFORM.

Fixed temperature conversion in *INCLUDE_TRANSFORM including
h conversion in *BOUNDARY_CONVECTION and adding FtoR and RtoF.

**Keyword: *INITIAL_FOAM_REFERENCE_GEOMETRY**
Calculated nodal mass and d3hsp mass properties of parts based on initial
foam reference geometry instead of deformed geometry at initial state.

## Miscellaneous LS-DYNA version 971 R6.0.0.

**Keyword: *PART_ANNEAL**
Added *PART_ANNEAL for MPP. Zeroes stress in part at specified time.

**Keyword: *..._PORE_AIR**
Corrected a bug for the retart of pore air simulation

**Keyword: *SENSOR_DEFINE_FORCE**
Corrected bug for MPP version of sensor_define_force.

**Keyword: *SENSOR_DEFINE_NODE**
Cleaned up direction specification syntax for sensor.

**Keyword: *SENSOR_DEFINE_NODE**
Fixed incorrect behaviour when VID=Y/Z in *SENSOR_DEFINE_NODE and DIR=Y/Z in *DEFINE_COORDINATE_NODES.

**Keyword: *SET_PART_LIST_GENERATE**
Fixed bug of *SET_PART_LIST_GENERATE not recognizing *PART_COMPOSITE.

**Keyword: *SET_SEGMENT_GENERAL**
Allowed *SET_SEGMENT_GENERAL for element formulations that have midside nodes.

**Keyword: *SET_PART_LIST_GENERATE**
Fixed bug affecting *SET_PART_LIST_GENERATE when *PART_MOVE is present (null
set was created).

**Keyword: *SET_..._COLLECT**
Fixed bug for *SET_SEGMENT_COLLECT and attributes of *SET_*_COLLECT. All attributes of *SET_PART_COLLECT, *SET_NODE_COLLECT and *SET_SHELL_COLLECT were not copied to the new set.

**Keyword: *TERMINATION_SENSOR**
Terminate right after sensor-switch status is changed.

**Keyword: *TERMINATION_SENSOR, *INTERFACE_SPRINGBACK_LSDYNA**
Write dynain file when termination is due to *TERMINATION_SENSOR.

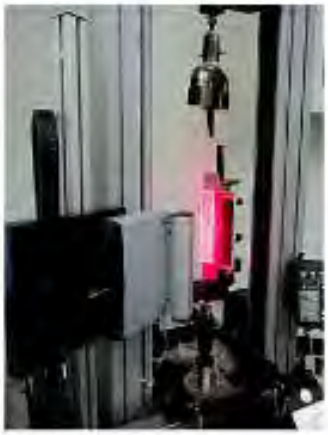
**DatapointLabs has greatly expanded its mechanical test capabilities:**

- **New Bidirectional Video Extensometer:** We have installed a new advanced video extensometer (AVE) with the capability to simultaneously measure linear and transverse strains during a stress-strain measurement. The extensometer greatly enhances our non-contact capability, making high quality measurements to large strains needed for hyperelastic rubber testing and film properties. Strains can be captured during cyclic experiments, rendering it possible to capture Mullins effects in rubber materials. The transverse strain measurement capability allows us to measure Poisson's ratio of soft materials such as rubber, foam and films. Transverse strains can also be measured in the plasticity region providing data for high end material models such as LS-DYNA's SAMP-1.

- **New Test Frames for Fatigue:** We have added two servo-hydraulic test frames to double our fatigue testing capability. At this time, we can perform fatigue measurements on a wide range of materials, from metals and plastics to weak materials such as rubber and foam. These new additions will increase our ability to provide fatigue data more efficiently.

- **New Test Frame for Rubber, Films and Fiber:** We have added an electro-mechanical test frame which allows for high extension testing suitable for rubber, films, and fibers. The test frame is coupled with a large extension environmental test chamber which permits us to greatly increase the range of measurement strains when stress-strain data are needed at elevated and low temperatures.

Keep an eye on our catalog for new tests.



**BETA CAE Systems S.A.– ANSA**

Is an advanced multidisciplinary CAE pre-processing tool that provides all the necessary functionality for full-model build up, from CAD data to ready-to-run solver input file, in a single integrated environment. ANSA is a full product modeler for LS-DYNA, with integrated Data Management and Process Automation. ANSA can also be directly coupled with LS-OPT of LSTC to provide an integrated solution in the field of optimization.

**BETA CAE Systems S.A.– μETA**

Is a multi-purpose post-processor meeting diverging needs from various CAE disciplines. It owes its success to its impressive performance, innovative features and capabilities of interaction between animations, plots, videos, reports and other objects. It offers extensive support and handling of LS-DYNA 2D and 3D results, including those compressed with SCAI's FEMZIP software

**Participant Solutions**
**CRAY**

www.cray.com

**The Cray XK6**

The Cray XK6 supercomputer combines Cray's proven Gemini interconnect, AMD's leading multi-core scalar processors and NVIDIA's powerful many-core GPU processors to create a true, productive hybrid supercomputer

**Cray XE6™ and Cray XE6m™ Supercomputers**

The Cray XE6 scalable supercomputer is engineered to meet the demanding needs of capability-class HPC applications. The Cray XE6m is optimized to support scalable workloads in the midrange market.

**Cray XMT™ System**

The Cray XMT supercomputing system is a scalable massively multithreaded platform with a shared memory architecture for large-scale data analysis and data mining. The system is purpose-built for parallel applications that are dynamically changing, require random access to shared memory and typically do not run well on conventional systems.

**Cray CX1000™ High(brid) Performance Computers**

The Cray CX1000 series is a dense, power efficient and supremely powerful rack-mounted supercomputer featuring best-of-class technologies that can be mixed-and-matched in a single rack – creating a customized hybrid computing platform to meet a variety of scientific workloads.

**Cray Sonexion 1300™ Storage System**

The Cray Sonexion 1300 system is an integrated, high performance storage system that features next-generation modular technology to maximize the performance and capacity scaling capabilities of the Lustre file system.

Cray also offers custom and third-party storage and data management solutions

Testing over 1000 materials per year for a wide range of physical properties, DatapointLabs is a center of excellence providing global support to industries engaged in new product development and R&D.

The compary meets the material property needs of CAE/FEA analysts, with a specialized product line, TestPaks®, which allow CAE analysts to easily order material testing for the calibration of over 100 different material models.

DatapointLabs maintains a world-class testing facility with expertise in physical properties of plastics, rubber, food, ceramics, and metals.

Core competencies include mechanical, thermal and flow properties of materials with a focus on precision properties for use in product development and R&D.

Engineering Design Data including material model calibrations for CAE Research Support Services, your personal expert testing laboratory Lab Facilities gives you a glimpse of our extensive test facilities Test Catalog gets you instant quotes for over 200 physical properties.

**Inventium Suite™**

Inventium Suite™ is an enterprise-level CAE software solution, enabling concept to product. Inventium's first set of tools will be released soon, in the form of an advanced Pre & Post processor, called PreSys.

Inventium's unified and streamlined product architecture will provide users access to all of the suite's software tools. By design, its products will offer a high performance modeling and post-processing system, while providing a robust path for the integration of new tools and third party applications.

**PreSys**

Inventium's core FE modeling toolset. It is the successor to ETA's VPG/PrePost and FEMB products. PreSys offers an easy to use interface, with drop-down menus and toolbars, increased graphics speed and detailed graphics capabilities. These types of capabilities are combined with powerful, robust and accurate modeling functions.

**VPG**

Advanced systems analysis package. VPG delivers a unique set of tools which allow engineers to create and visualize, through its modules--structure, safety, drop test, and blast analyses.

**DYNAFORM**

Complete Die System Simulation Solution. The most accurate die analysis solution available today. Its formability simulation creates a "virtual tryout", predicting forming problems such as cracking, wrinkling, thinning and spring-back before any physical tooling is produced

**Visual-Crash**

Visual Crash for LS-DYNA helps engineers perform crash and safety simulations in the smoothest and fastest possible way by offering an intuitive windows-based graphical interface with customizable toolbars and complete session support. Being integrated in ESI Group's Open VTOS, an open collaborative multi-disciplinary engineering framework, Visual-Crash for DYNA allows users to focus and rely on high quality digital models from start to finish. Leveraging this state of the art environment, Visual Viewer, visualization and plotting solution, helps analyze LS-DYNA results within a single user interface.

**vibro-acoustic software**

With ESI's vibro-acoustic software you no longer have to account for noise and vibration right at the design stage - no more costly delays or panic driven test-based solutions. Our vibro-acoustic software has everything you need to diagnose potential noise and vibration problems up front in your development process. Manage risk by identifying possible problem areas that may need more detailed modeling or test based development, while you still have time to make an impact on the product!

**VA One**

VA One is a complete solution for simulating the response of vibro-acoustic systems across the full frequency range. VA One seamlessly combines Finite Elements (FE), Boundary Elements (BEM) and Statistical Energy Analysis (SEA) in ONE model. It is the only simulation code on the market today that contains the complete spectrum of vibro-acoustic analysis methods within ONE common environment.

**Participant Solutions**
**GNS - Gesellschaft für Numerische Simulation mbH**

www.gns-mbh.com

**Animator4**

A general finite element post-processor and holds a leading position in its field. Animator4 is used worldwide by almost all automotive companies, a great number of aerospace companies, and within the chemical industry.

**Generator2.**

A specialized pre-processor for crashworthiness applications and has become very successful in the field of passenger safety and pedestrian protection. It is mainly used as a positioning tool for finite element component models by a great number of automobile companies throughout the world.

**Indeed**

An easy-to-use, highly accurate virtual manufacturing software that specializes in the simulation of sheet metal forming processes. Indeed is part of the GNS software suite and works concurrently with all other GNS software products.

**OpenForm**

A pre- and post-processor independently of a particular finite element forming simulation package. The software is extremely easy to handle and can be used as was designed to enable those who are not finite element experts to carry out multi-stage forming simulations with even complex multi purpose finite element codes.

Gompute is owned, developed and operated by Gridcore AB in Sweden. Founded in 2002, Gridcore is active in three areas: Systems Integration, Research & Development and HPC as a service.

Gridcore has wide experience of different industries and applications, developed a stable product portfolio to simplify an engineer/scientist's use of computers, and has established a large network of partners and collaborations, where we together solve the most demanding computing tasks for our customers. Gridcore has offices in Gothenburg (Sweden), Stuttgart (Germany), Durham NC (USA) and sales operations in The Netherlands and Norway.

The Gridcore developed E-Gompute software for internal HPC resources gives end users (the engineers) an easy-to-use and complete environment when using HPC resources in their daily work, and enables collaboration, advanced application integrations, remote pre/post, accounting/billing of multiple teams, license tracking, and more, accelerating our customers usage of virtual prototyping.

**Participant Solutions**
**JSOL Corporation**

www.jsol.co.jp/english/cae/

**HYCRASH**

Easy-to-use one step solver, for Stamping-Crash Coupled Analysis. HYCRASH only requires the panels' geometry to calculate manufacturing process effect, geometry of die are not necessary. Additionally, as this is target to usage of crash/strength analysis, even forming analysis data is not needed. If only crash/strength analysis data exists and panel ids is defined. HYCRASH extract panels to calculate it's strain, thickness, and map them to the original data.

**JSTAMP/NV**

As an integrated press forming simulation system for virtual tool shop the JSTAMP/NV meets the various industrial needs from the areas of automobile, electronics, iron and steel, etc. The JSTAMP/NV gives satisfaction to engineers, reliability to products, and robustness to tool shop via the advanced technology of the JSOL Corporation.

**JMAG**

JMAG uses the latest techniques to accurately model complex geometries, material properties, and thermal and structural phenomena associated with electromagnetic fields. With its excellent analysis capabilities, JMAG assists your manufacturing process

**LS-DYNA**

A general-purpose finite element program capable of simulating complex real world problems. It is used by the automobile, aerospace, construction, military, manufacturing, and bioengineering industries. LS-DYNA is optimized for shared and distributed memory Unix, Linux, and Windows based, platforms, and it is fully QA'd by LSTC. The code's origins lie in highly nonlinear, transient dynamic finite element analysis using explicit time integration.

**LS-PrePost**

An advanced pre and post-processor that is delivered free with LS-DYNA. The user interface is designed to be both efficient and intuitive. LS-PrePost runs on Windows, Linux, and Macs utilizing OpenGL graphics to achieve fast rendering and XY plotting.

**LS-TaSC™**

A Topology and Shape Computation tool. Developed for engineering analysts who need to optimize structures, LS-TaSC works with both the implicit and explicit solvers of LS-DYNA. LS-TaSC handles topology optimization of large non-linear problems, involving dynamic loads and contact conditions.

**LSTC Dummy Models**

Anthropomorphic Test Devices (ATDs), as known as "crash test dummies", are life-size mannequins equipped with sensors that measure forces, moments, displacements, and accelerations.

**LSTC Barrier Models**

LSTC offers several Offset Deformable Barrier (ODB) and Movable Deformable Barrier (MDB) model

**Participant Solutions**
**Oasys, Ltd**

www.oasys-software.com/dyna

**Oasys LS-DYNA® Environment**
The Oasys Suite of software, exclusively written for LS-DYNA®, is at the leading edge of the market and is used worldwide by many of the largest LS-DYNA® customers.

**Oasys PRIMER**
Oasys PRIMER is a model preparation tool that is fully compatible with the latest version of LS-DYNA®, eliminating the risk of data loss or corruption when a file is manipulated, no matter what operations are performed on it:

**Key benefits:**

- Maintains data integrity
- Finds and fixes model errors (currently over 5000 checks)
- Specialist tools for dummy positioning, seatbelt fitting, mechanisms, interior head impact etc.
- Connection manager for spotwelds, bolts, adhesive etc.
- Intelligent editing, deletion and merging of data
- Customisable with macros and JavaScript.

**Oasys D3PLOT**
Oasys D3PLOT is a powerful 3D visualization package for post-processing LS-DYNA® analyses

**Key benefits:**

- Fast, high quality graphics
- Easy, in-depth access to all LS-DYNA® results.
- User defined data components
- Customisable with JavaScript.

**Oasys T/HIS**
Oasys T/HIS is an X-Y graph plotting package for LS-DYNA®

**Key benefits:**

1. Automatically reads all LS-DYNA® results.
2. Wide range of functions and injury criteria.
3. Easy handling of data from multiple models
4. Scriptable for automatic post-processing

**Oasys REPORTER**
Oasys REPORTER is an automatic report generation tool, for use with LS-DYNA®. which allows fast automatic report creation for analyses.

**Center of Excellence**

Hengstar Technology is the first LS-DYNA training center of excellence in China. As part of its expanding commitment to helping CAE Engineers, Hengstar Technology will continue to organize high level training courses and seminars in 2012.

The lectures/training are taught by senior engineers and experts mainly from LSTC, Carhs, OEMs, and other consulting groups.

**On Site Training**

Hengstar also provides customer customized training programs on-site at the company facility. Training is tailored for company needs using LS-DYNA or the additional software products by LSTC.

**Distribution & Support**

Hengstar Distributes and supports LS-DYNA, LS-OPT, LS-PrePost, LS-TaSC. Hongsheng Lu, previously was directly employed by LSTC before opening his distributorship in China for LSTC software. He travels to LSTC often to keep current on the latest software features and support to continue to grow Hengstar as a CAE consulting group.

## Participant Solutions

## Products

| | | | |
|---|---|---|---|
| ANSA | TestPaks® | LS-PrePost | CRAY XE6m™ |
| Inventium Suite™ | CRAY XK6 | HYCRASH | LS-TaSC™ |
| Animator 4 | TOYOTA THUMS | CRAY XE6™ | PreSys |
| CRAY CX1000™ | Visual Crash | Generator 2 | VPG |
| JMAG | VA One | DYNAFORM | LSTC Dummy Models |
| LS-DYNA | CRAY Sonexion 1300™ | Indeed | Vibro-Acoustic Software |
| OpenForm | | Oasys Primer | |
| JSTAMP/NV | GOMPUTE Cloud | | LSTC Barrier Models |
| Oasys D3Plot | µETA | | Oasys T/HIS |

| | | | | |
|---|---|---|---|---|
| **Canada** | **Metal Forming Analysis Corp MFAC** galb@mfac.com<br>www.mfac.com | | | |
| | LS-DYNA | LS-OPT | LS-PrePost | LS-TaSC |
| | LSTC Dummy Models | LSTC Barrier Models | eta/VPG | |
| | eta/DYNAFORM | INVENTIUM/PreSys | | |
| **United States** | **Livermore Software Technology Corp** sales@lstc.com<br>**LSTC** www.lstc.com | | | |
| | LS-DYNA | LS-OPT | LS-PrePost | LS-TaSC |
| | LSTC Dummy Models | LSTC Barrier Models | TOYOTA THUMS | |
| **United States** | **ESI-Group N.A**<br>www.esi-group.com | | | |
| | QuikCAST | SYSWELD | PAM-RTM | PAM-CEM |
| | VA One | CFD-ACE+ | ProCAST | Visual-Process |
| | VisualDSS | Weld Planner | Visual-Environment | IC.IDO |
| **United States** | **Gompute** info@gompute.com<br>www.gompute.com | | | |
| | LS-DYNA Cloud Service | | Additional software | |
| | Additional Services | | | |
| **United States** | **Engineering Technology Associates – ETA** sales@eta.com<br>www.eta.com | | | |
| | INVENTIUM/PreSy | NISA | VPG | LS-DYNA |
| | LS-OPT | DYNAform | | |

## North America
## Distribution – Consulting

| | | | | |
|---|---|---|---|---|
| **United States** | **DYNAMAX**<br>www.dynamax-inc.com | | sales@dynamax-inc.com | |
| | LS-DYNA<br>LSTC Dummy Models | LS-OPT | LS-PrePost<br>LSTC Barrier Models | LS-TaSC |

| | | | | |
|---|---|---|---|---|
| **United States** | **CAE Associates Inc.**<br>www.caeai.com | | info@caeai.com | |
| | ANSYS Products | CivilFem | Consulting ANSYS<br>Consulting LS-DYNA | |

| | | | | |
|---|---|---|---|---|
| **United States** | **Predictive Engineering**<br>www.predictiveengineering.com | | george.laird@predictiveengineering.com | |
| | FEMAP<br>LS-PrePost | NX Nastran<br>LS-TaSC | LS-DYNA<br>LSTC Dummy Models<br>LSTC Barrier Models | LS-OPT |

## Europe
## Distribution – Consulting

| | | | | |
|---|---|---|---|---|
| **France** | **Alliance Svce. Plus - AS+** | | v.lapoujade@asplus.fr | |
| | www.asplus.fr/ls-dyna | | | |
| | LS-DYNA | LS-OPT | LS-PrePost | LS-TaSC |
| | DYNAFORM | VPG | MEDINA | |
| | LSTC Dummy Models | | LSTC Barrier Models | |
| **France** | **ALYOTECH** | | nima.edjtemai@alyotech.fr | |
| | www.alyotech.fr | | | |
| | ANSYS | LS-DYNA | MOLDEX3D | FEMZIP |
| | Primer | PreSys | DYNAFORM | SKYGEN |
| | MERCUDA | MOCEM | | |
| **Germany** | **CADFEM GmbH** | | lsdyna@cadfem.de | |
| | www.cadfem.de | | | |
| | ANSYS | LS-DYNA | optiSLang | DIGIMAT |
| | ESAComp | AnyBody | VPS | |
| | FTI FormingSuite | | | |
| **Germany** | **DYNAmore GmbH** | | uli.franz@dynamore.de | |
| | www.dynamore.de | | | |
| | ANSYS | LS-DYNA | optiSLang | DIGIMAT |
| | LS-OPT | LS-PrePost | LS-TaSC | DYNAFORM |
| | Primer | D-Spex | GENESIS | FEMZIP |
| | VisualDoc | | LSTC Dummy & Barrier Models | |
| | | | TOYOTA THUMS | |
| **Germany** | **GNS** | | mbox@gns-mbh.com | |
| | www.gns-mbh.com | | | |
| | Animator | Generator | Indeed | OpenForm |
| **Netherland** | **Infinte** | | j.mathijssen@infinite.nl | |
| | www.infinite.nl | | | |
| | ANSYS Products | CivilFem | CFX | Fluent |
| | LS-DYNA | LS-PrePost | LS-OPT | LS-TaSC |

## Europe

## Distribution – Consulting

| | | | | |
|---|---|---|---|---|
| **Italy** | **EnginSoft SpA** | | info@enginsoft.it | |
| | www.enginsoft.it | | | |
| | ANSYS | MAGMA | Flowmaster | FORGE |
| | CADfix | LS-DYNA | Dynaform | Sculptor |
| | ESAComp | AnyBody | FTI Software | |
| | AdvantEdge | Straus7 | LMS Virtual.Lab | ModeFRONTIER |
| **Russia** | **STRELA** | | info@dynarussia.com | |
| | LS-DYNA | LS-TaSC | LS-OPT | LS-PrePost |
| | LSTC Dummy Models | | LSTC Barrier Models | |
| **Sweden** | **DYNAmore Nordic** | | marcus.redhe@dynamore.se | |
| | www.dynamore.se | | | |
| | ANSA | µETA | LS-DYNA | LS-OPT |
| | LS-PrePost | LS-TaSC | FastFORM | DYNAform |
| | FormingSuite | | LSTC Dummy Models | |
| | | | LSTC Barrier Models | |
| **Sweden** | **GRIDCORE** | | info@gridcore.com | |
| | www.gridcore.se | | | |
| | LS-DYNA Cloud Service | | Additional software | |
| | | | Additional Services | |
| **Switzerland** | **DYNAmoreSwiss GmbH** | | info@dynamore.ch | |
| | www.dynamore.ch | | | |
| | LS-DYNA | | LS-OPT | LS-PrePost |
| | LS-TaSC | | LSTC Dummy Models | |
| | | | LSTC Barrier Models | |
| **UK** | **Ove Arup & Partners** | | dyna.sales@arup.com | |
| | www.oasys-software.com/dyna | | | |
| | LS-DYNA | | LS-OPT | LS-PrePost |
| | LS-TaSC | PRIMER | D3PLOT | T/HIS |
| | REPORTER | SHELL | FEMZIP | HYCRASH |
| | DIGIMAT | Simpleware | LSTC Dummy Models | |
| | | | LSTC Barrier Models | |

| | | | | |
|---|---|---|---|---|
| **China** | **ETA – China**<br>www.eta.com/cn | | lma@eta.com.cn | |
| | Inventium | VPG | DYNAFORM | NISA |
| | LS-DYNA | LS-OPT | LSTC Dummy Models | LS-PrePost |
| | | | LSTC Barrier Models | LS-TaSC |
| **China** | **Oasys Ltd. China**<br>www.oasys-software.com/dyna | | Stephen.zhao@arup.com | |
| | PRIMER D3PLOT | HYCRASH | T/HIS REPORTER | SHELL |
| | LS-DYNA | LS-OPT | LSTC Dummy Models | LS-PrePost |
| | DIGIMAT | FEMZIP | LSTC Barrier Models | LS-TaSC |
| **China** | **Shanghai Hengstar Technology**<br>www.hengstar.com | | info@hengstar.com | |
| | LS-DYNA | LS-TaSC | LSTC Barrier Models | |
| | LS-DYNA Courses | LS-OPT | LSTC Dummy Models | LS-PrePost |

## Asia Pacific
## Distribution – Consulting

**India** **Oasys Ltd. India** lavendra.singh@arup.com

www.oasys-software.com/dyna

| | | | | |
|---|---|---|---|---|
| PRIMER | D3PLOT | T/HIS | | |
| | | LS-OPT | LSTC Dummy Models | LS-PrePost |
| | | LS-DYNA | LSTC Barrier Models | LS-TaSC |

---

**India** **EASI Engineering** rvenkate@easi.com

www.easi.com

| | | | | |
|---|---|---|---|---|
| ANSA | | | | |
| LS-DYNA | | LS-OPT | LSTC Dummy Models | LS-PrePost |
| | | | LSTC Barrier Models | LS-TaSC |

---

**India** **CADFEM Eng. Svce** info@cadfem.in

www.cadfem.in

| | | | | |
|---|---|---|---|---|
| ANSYS | VPS | optiSLang | ESAComp | DIGIMAT |
| LS-DYNA | | LS-OPT | LSTC Dummy Models | LS-PrePost |
| FTI FormingSuite | | AnyBody | LSTC Barrier Models | LS-TaSC |

---

| | | | | |
|---|---|---|---|---|
| Japan | **ITOCHU**<br>www.engineering-eye.com | Ls-dyna@ctc-g.co.jp | | |
| | LS-DYNA<br>LSTC Dummy Models | LS-OPT<br>LSTC Barrier Models | LS-PrePost<br>CmWAVE | LS-TaSC |
| Japan | **JSOL**<br>www.jsol.co.jp/english/cae | | | |
| | JSTAMP<br>LS-DYNA<br>LSTC Dummy Models | HYCRASH<br>LS-OPT<br>LSTC Barrier Models | JMAG<br>LS-PrePost | LS-TaSC |
| Japan | **FUJITSU**<br>http://jp.fujitsu.com/solutions/hpc/app/lsdyna | | | |
| | LS-DYNA<br>LSTC Dummy Models | LS-OPT<br>LSTC Barrier Models | LS-PrePost<br>CLOUD Services | LS-TaSC |

## Asia Pacific
## Distribution – Consulting

Korea **THEME** wschung@kornet.com
www.lsdyna.co.kr

| | | | |
|---|---|---|---|
| LS-DYNA | LS-OPT | LS-PrePost | LS-TaSC |
| LSTC Dummy Models | LSTC Barrier Models | eta/VPG | Planets |
| eta/DYNAFORM | FormingSuite | Simblow | TrueGRID |
| JSTAMP/NV | Scan IP | Scan FE | Scan CAD |
| FEMZIP | | | |

---

Korea **KOSTECH** young@kostech.co.kr
www.kostech.co.kr

| | | | |
|---|---|---|---|
| LS-DYNA | LS-OPT | LS-PrePost | LS-TaSC |
| LSTC Dummy Models | LSTC Barrier Models | eta/VPG | FCM |
| eta/DYNAFORM | DIGIMAT | Simuform | Simpack |
| AxStream | TrueGrid | FEMZIP | |

---

Taiwan **Flotrend** gary@flotrend.tw
www.flotrend.com.tw

| | | | |
|---|---|---|---|
| LS-DYNA | LS-OPT | LS-PrePost | LS-TaSC |
| LSTC Dummy Models | LSTC Barrier Models | eta/VPG | FCM |

---

## Cloud Services including LS-DYNA

| | |
|---|---|
| Japan | Fujitsu www.fujitsu.com |
| Germany | Gridcore www.gridcore.se |
| Sweden | Gridcore www.gridcore.se |
| United States | Gompute www.gompute.com |

## To Join FEA Distribution/Consultants

PARTICIPATION

Participation is available in this section, for only this section or for full participation.

.

Contact Anthony agiac99@aol.com for further information.

The Complete Courses Offered Can Be Found At: www.cadfem.de
Please check the site for accuracy and changes. Among the many course offered:

Introduction to simulation with ANSYS Workbench
03/13/12

Introduction to explicit structural mechanics with ANSYS-LS-DYNA and LSTC's LS-DYNA
02/08/12 05/09/12
08/29/12 09/05/12
11/06/12 12/19/12

Material Modeling with LS-DYNA
03/06/12 10/16/12

Simulation of composites with ANSYS Composites PrepPost and LS-DYNA
05/08/12 08/21/12

Contact modeling with LS-DYNA
05/22/12 11/06/12

Modeling joints with LS-DYNA
03/02/12 10/12/12

Crash simulation with LS-DYNA
09/25/12

Introduction to simulation with Diffpack
03/22/12 11/06/12

Working efficiently with Diffpack in ANSYS Workbench
03/23/12 11/07/12

Introduction to simulation of joint- and muscle-forces with AnyBody
04/25/12 09/19/12

Efficient coupling of AnyBody with ANSYS Workbench
04/27/12 09/21/12

Additional Courses are offered – please check the website for upcoming dates for: FTI Forming Suite - DIGIMAT DIFFPACK and others.

Individual Training: Take advantage of the expertise of our specialists and get to know how simulation processes in your company can be arranged in an optimal way.

## Germany

## DYNAmore

The Complete Courses Offered Can Be Found At: www.dynamore.de/en

Intro LS-DYNA
03/12/12 04/19/12 04/25/12 06/18/12
09/20/12 10/15/12 10/30/12 12/10/12

Contact Definitions
03/16/12 10/18/12

Element types
07/04/12

Plasticity
10/24/12

Users Interfaces
11/19/12

Crash Analysis
04/17/12 12/04/12

Spot Welds
03/19/12 09/27/12

Dummy Modeling
06/14/12

Airbag Modeling
06/14/12

eta/DYNAFORM
03/17/12 09/17/12

Metal Forming
03/29/12

ALE
10/11/12

Meshless Methods
10/11/12

The Complete Courses Offered Can Be Found At: www.lstc.com

Please check the site for accuracy and changes.
Among the many course offering are the following:

Smoothed Particle Hydrodynamics (SPH) in LS-DYNA and Element-Free Galerkin (EFG) CA
February 23-24, 2012

Contact in LS-DYNA CA
March 15-16, 2012

Introduction to LS-PrePost (no charge) MI
March 19, 2012

Introduction to LS-DYNA MI
March 20-23, 2012

Advanced Options in LS-DYNA CA
March 20-21, 2012

Implicit Analysis with LS-DYNA CA
March 22-23, 2012

Advanced Impact Using LS-DYNA MI
April 24-26, 2012

Introduction to LS-PrePost (no charge) CA
April 30, 2012

Introduction to LS-DYNA CA
May 1-4, 2012

## Sweden

## DYNAmore Nordic

The Complete Courses Offered Can Be Found At: www.dynamore.se

Please check the site for accuracy and changes.
Among the many course offering are the following:

LS-PrePost 3, introduction
March 12, 2012
Anders Jernberg Fars Hatt,
Kungälv

LS-DYNA, introductory course
March 13, 2012
Dr. Jimmy Forsberg Fars Hatt,
Kungälv

ANSA & Metapost, Introductory course
March 20, 2012
David Karlsson
Linköping

ANSA CFD Meshing
March 22, 2012
David Karlsson
Linköping

LS-DYNA, implicit analysis
March 27, 2012
Dr. Thomas Borrvall
Linköping

LS-DYNA, Simulation of sheet metal forming processes
April 17, 2012
Dr. Mikael Schill
Linköping

LS-DYNA, Material modelling
April 24, 2012
Dr. Thomas Borrvall
Linköping

## France

## Alliance Plus (AS+)

The complete Training Courses offered can be found at www.asplus.fr/ls-dyna
Please check the site for accuracy and changes.

LS-DYNA Explicit/Implicit solver – Special University Training session (to be held in Toulouse)
15-18/02 – Special University Price
(date to be confirmed)

Other regular courses (in Paris) …

LS-DYNA Introduction Explicit Solver
10-12/09

LS-DYNA Introduction Implicit Solver
24/09

LS-DYNA Unified Introduction Implicit & Explicit Solver
16-19/01, 18-21/06 & 12-15/11

LS-OPT & LS-TaSC Introduction
21-22/03 & 24-25/10

Switch to LS-DYNA
2-3/04 & 10-11/10

Switch from Ls-PrePost 2.X to 3.X
4/04 & 26/09 & 28/11

LS-DYNA Advanced Implicit Solver
25/09

LS-DYNA ALE / FSI
19-20/03 & 22-23/10

LS-DYNA SPH
21-22/05 & 8-9/10

LS-PrePost 3.0 – Advanced meshing capabilities
5/04 & 27/09 & 29/11

LS-DYNA User Options
23-24/05

LS-DYNA – Plasticity, Damage & Failure – By Paul DU BOIS
26-27/11
(date may be changed in Q1)

LS-DYNA – Polymeric materials – By Paul DU BOIS
12-13/12

LS-DYNA – Geo-material modeling
14-15/12

## United States

## Engineering Technology Associates

The Complete Courses Offered Can Be Found At: www.eta.com

Please check the site for accuracy and changes.
Among the many course offering are the following:

Introduction to DYNAFORM

- 03/06-07/2012
- 04/03-04/2012
- 05/01-02/2012

Introduction to PreSys

- 03/13/2012
- 04/10/2012
- 05/08/2012

Introduction to LS-DYNA

- 03/20-21/2012
- 04/17-18/2012
- 05/15-16/2012

The Complete Courses Offered Can Be Found At: www.caeai.com

Please check the site for accuracy and changes. Among the many course offering are the following:

ANSYS Training, CFD and FEA Consultants Serving CT, NJ, NY, MA, NH , VT

Apr 12, 2012 2 days
Introduction to CivilFEM
Middlebury, CT

Apr 16, 2012 3 days
Introduction to ANSYS Mechanical APDL Part I (Traditional GUI
Middlebury, CT

Apr 19, 2012 2 days
Introduction to ANSYS Mechanical APDL Part II (Traditional GUI)
Middlebury, CT

May 14, 2012 1 day
ANSYS Workbench Meshing for CFD
Middlebury, CT

May 15, 2012 2 days
Introduction to CFX
Middlebury, CT

Jun 11, 2012 1 day
ANSYS DesignModeler
Middlebury, CT

Jun 16, 2012 2 days
Introduction to ANSYS Mechanical (Workbench)
Middlebury, CT

## United States

## Paul Du Bois & Len Schwer

**PAUL DU BOIS & LEN SCHWER**

**Announce their annual LS-DYNA® training class schedule**

May 2012 - Somerset Inn - Troy Michigan

These popular LS-DYNA training classes have been offered since 2006, in North America and Europe. The classes continuously evolve, reflecting the ongoing additions and improvements in LS-DYNA's simulation capabilities.

**Paul du Bois and Len Schwer, Co-Instructors:**

| | |
|---|---|
| *Penetration Modeling with LS-DYNA* | May 1 - 2 (Tuesday – Wednesday) |
| *Blast Modeling with LS-DYNA* | May 3 - 4 (Thursday – Friday) |
| *Modeling and Simulation with LS-DYNA* | May 7 - 8 (Monday - Tuesday) |

**Len Schwer, Instructor:**

| | |
|---|---|
| *Concrete & Geomaterial Modeling* | May 9 - 10 (Wednesday - Thursday) |

Class descriptions available on the LSTC web site: **www.lstc.com/training**

To request Registration Form, please send email to: **schwerdubois@yahoo.com**

The Complete Courses Offered Can Be Found at www.hengstar.com

| 2012 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| An Introduction to LS-DYNA(High Level) | | | | | | | | | | | |
| Concrete & Geomaterial Modeling with LS-DYNA | ■ | | | | | | | | | | |
| Pedestrian Safety and Bonnet Design with LS-DYNA | | | ■ | ■ | | | | | | | |
| Crashworthiness Theory and Technology | | | ■ | ■ | | | | | | | |
| LS-DYNA MPP, Airbag Simulation with LS-DYNA | | | | | ■ | ■ | | | | | |
| Introduction of LS-OPT which is Based on LS-DYNA | | | | | | ■ | ■ | | | | |
| Passive Safety and Restraint Systems Design | | | | | | | | ■ | ■ | | |
| Crashworthiness Simulation with LS-DYNA | | | | | ■ | ■ | ■ | | | | |
| Passive Safety Simulation with LS-DYNA | | | | | | | | | | ■ | ■ |
| Crashworthy Car Body Development - Design, Simulation and Optimization | | | | | | | | ■ | ■ | | |

## France

## Alyotech Technologies

For course location visit www.alyotech.fr

LS-DYNA Introduction
- April 03-05
- June 04-06
- Sept 10-12
- Oct 01-03
- Nov 12-14
- Dec 03-05

LS-DYNA Thermal
- Sept 13-14

LS-DYNA Implicit
- May 21-23
- Sept 17-19
- Nov 19-21

LS-PrePost – Meshing
- May 24
- Sept 27
- Nov 26

LS-PrePost – New Interface
- May 25
- Sept 28
- Nov 27

LS-OPT Introduction
- June 18-19
- Dec 10-11

LS-TaSC – Topology Optimization
- June 20
- Dec 12

Material Modeling & User Defined Material in LS-DYNA
- July 10-11

Crash & Impact Modeling
- April 02-05

FSI & ALE in LS-DYNA
- March 15-16

LS-DYNA Composite
- July 12-13

# Oasys LS-DYNA 5th
# Annual Update Meetings India

## April 17th & 19th 2012

**Pune – Tuesday, 17th April 2012**
The Ista Hotel, 88 Nagar Road, Adjacent to Aga Khan Palace Pune.
**Bangalore – Thursday, 19th April 2012** – The Taj Vivanta, Whitefield, Bangalore.

Oasys Ltd and nHance Engineering Solutions Pvt Ltd are pleased to announce the 5th Oasys LS-DYNA Update meetings in India for the year 2012. First meeting shall be held at Pune on Tuesday 17th April 2012 at The Ista Hotel and second meeting shall be held at Bangalore on Thursday 19th April 2012 at The Taj Vivanta, Whitefield.

Each of these is a full day free of charge event covering both LS-DYNA and Oasys software and is a perfect opportunity to find out about current and future developments and how the software is being used in the engineering community.

The presentations will mainly cover latest features of LS-DYNA software, Oasys suite and presentations from industry members specifically from OEMs. This year's presentations also include presentation from Mr. Yun Huang, LSTC on the implicit capabilities of LS-DYNA for NVH and Durability. Detailed agenda shall be published next month.

Presentations of the last year Update Meeting can be seen at http://www.oasys-software.com/dyna/en/events/users_india_apr-11/users_india_apr-11.shtml .

**Registration:** Please send your registration to this event by email to india.support@arup.com with your name, company/affiliation, telephone number and your choice for event.

**Venue:** If you plan to stay over before or after the event, we are pleased to confirm that we have negotiated a special rate for attendees of the Oasys LS-DYNA Update meeting. Please contact us for assistance.

**Contact Details:** If you have any queries regarding this event you can contact:

Mr. Asif Ali:
nhance Engineering Solutions(P)Ltd (Part of the ARUP Group)
Plot No. 39, Ananth Info Park, HiTec City-Phase 2
Madhapur, Hyderabad-500081,India
Tel: +91 (0) 40 44369797/8 Email:
india.support@arup.com

## Gompute User Group Meeting
## (7th Edition)

## May 08 & 09, 2012

http://www.simdi.se/

**Location**:

Scandic Crown Hotel
Gothenburg (Sweden)

**About the Gompute User Meeting**

The Gompute User Meeting, formerly called SIMDI (Simulation and Data intensive Fair), is an event that gathers different actors of the Simulation Industry

Primarly GUM11 gathers users of Gompute® software suite and the Gompute on Demand™ service but it is open to any other person interested in the application of numerical simulation on their daily work.

This year meeting is the sixth one all of them has been celebrated in Gothenburg Sweden.

Gompute on Demand delivers HPC on demand for technical and scientific applications, it is owned and operated by Gridcore AB, a Swedish System integrator specialized in technical and scientific computing.

You may get more information about gompute and Gridcore at www.gompute.com and www.gridcore.se .

**GUM11's Agenda Manager**

Iago Fernandez
Phone: +46 704 19 39 76
Mail: iago.fernadez@se.gompute.com

**GUM11's Event Manager**

Anne-Marie Ohlsson
Phone: +46 31 18 21 60
Mail: amo@gridcore.se

# 12th International LS-DYNA Users Conference

## June 03-05, 2012

**Conference website:** **www.ls-dynaconferences.com**

**12th' Int'l LS-DYNA Users Conference**
**June 3rd, 4th & 5th**

**Training 6th & 7th**

**Conference Plenary/Keynote Addresses**
June 4th
Professor Thomas J.R. Hughes
The University of Texas
Professor David J. Benson
University of California
Mr. Kenji Takada
Honda Japan
Mr. Paul A. Du Bois
Consulting

**FEA Information Participants**
**Sponsoring and/or exhibiting:**

- ARUP
- CRAY
- BETA CAE Systems, S.A.
- DatapointLabs
- ESI North America
- ETA
- Gompute Inc.
- GNS mbH
- D3View
- FEA Information
- JSOL

**Hotel - Venue - Reservations**

Hyatt Regency Dearborn
Fairlane Town Center, Dearborn, MI 48126

**Please inform reservations that you're attending the LS-DYNA Conference**

**For booth, sponsorships or any conference questions contact:** **info@lst.com**

**TRAINING OFFERED:**

- Pre- Conference LS-PrePost
- Pre- Conference User Material Dev. In LS-DYNA
- Advanced ALE Applications
- ALE/Eulerian & FSI
- Blast & Penetration Using LS-DYNA
- Heat Transfer with Warm Forming and Hot Stamping Applications
- Introduction to LS-OPT
- NVH & Frequency Domain Analysis w/ LS-DYNA
- Occupant Restraint: Dummies/Barriers
- Polymeric Material With LS-DYNA
- Probabilistic Design Using LS-OPT & LS-DYNA
- SPH & Element-Free Galerkin

## GNS – 7th OpenFoam® Workshop

## June 25th 2012

http://www.openfoamworkshop.org/2012/OFW7.html

**7th OpenFOAM® Workshop**

The 7th OpenFOAM® Workshop will be held in Darmstadt (next to Frankfurt, Germany) from June 25-28, 2012 - hosted by the Center of Smart Interfaces (CSI) and the Graduate School of Computational Engineering (GSCE) of the Technische Universität Darmstadt.

The OpenFOAM® Workshop intends to bring together OpenFOAM®'s developers and users, to promote collaborative activities, exchange information and share experiences in similar areas of interest. The 7th OpenFOAM® Workshop is

- a community forum and open discussion platform for OpenFOAM® users and developers,
- the largest OpenFOAM® community event of the world (expected 400 participants),
- since 2006: sustainable, community-driven and non-profit.

The 7th OpenFOAM® Workshop is organized using the Community Portal of the Extend Project.

Please visit for abstract submission, registration and progam schedule.

**Your OpenFOAM®-Workshop Organizing Committee**

committee@openfoamworkshop.org

## DYNAmore German LS-DYNA Forum

### October 09, 2012

http://www.dynamore.de/en/training/conferences/upcoming/ls-dyna-forum-2012/ls-dyna-update-forum-2011

**German LS-DYNA Forum 2012**
LS-DYNA Forum, 9 - 10 October 2012, Ulm, Germany

On the 9th and 10th October 2012, our 11th LS-DYNA Forum will be taking place at the Maritim Hotel in Ulm, Germany. We cordially invite you not only to attend the event but submit a paper. In your presentation, you can talk about your experiences with LS-DYNA or LS-OPT and you can discuss and exchange these experiences with other users.

User presentations will form the core of the event. General lectures given by renowned speakers are also planned as well as talks on the latest LS-DYNA und LS-OPT .

Comprehensive information all about LS-DYNA software can be obtained from the accompanying exhibition.

The Forum will be accompanied by seminars which will be held during the week of the conference on the subjects of CPM Airbag OoP, ALE and fluid-structure inter-action, meshless methods and on concrete and geomaterial modeling.

**Your presentation:** You are cordially invited to contribute towards the program plan by submitting a paper. Contributions from the various areas of application of LS-DYNA/LS-OPT are planned

**To Submit your papers:** Please send us the title, authors and a short summary (approx. 300 words).

**Dates:** Submission of proposed paper:
25th May 2012
Author notification: 11th June 2012
Submission of two-page summary for proceedings:
7th Sept. 2012

**Location:** Maritim Hotel Ulm
Basteistraße 40, 89073 Ulm

**Registration and contact**
DYNAmore GmbH
Tel. +49 (0) 7 11 - 45 96 00 - 0
Fax +49 (0) 7 11 - 45 96 00 - 29
E-Mail: forum@dynamore.de
www.dynamore.de/forum12

## ANSYS Conference
## & 30. CADFEM Users´ Meeting
## October 24-26, 2012

**Location: Kassel Germany**

Environmental protection and economic aspects make electric mobility one of the great challenges of the coming years. Step-by-step it will replace traditional forms of mobility in everyday life. Therefore, a number of projects have been defined in so-called ‘model regions’ in order to better understand and optimize this process.

For a better understanding of electric mobility and its optimization, simulation specialist ANSYS has extended its portfolio with a set of simulation applications that can serve as models in the development and implementation of innovative drive concepts. Structural and fluid mechanics and electromagnetic simulation models of the individual components are modeled in a consistent environment both individually and interacting, considering the drive as a complete multi-physical system – Engineering the System!

The ANSYS Conference & the 30th CADFEM Users’ Meeting focus on the many simulation options in electric mobility and several other current application fields where structural mechanics, fluid mechanics and electro magnetics issues are important.

CADFEM GmbH and ANSYS Germany GmbH cordially invite you to join the conference

We look forward to your participation

The CADFEM & ANSYS Germany Team

| start date | Conference - Event |
|---|---|
| 04/03<br>Germany | Automotive CAE Grand Challenge 2012<br>www.carhs.de/grand-challenge |
| 04/16<br>Belgium | 11th Int'l Conf. - Computer Applications/Information Tech. -Maritime Ind.<br>www.compit.info/ |
| 05/15<br>US | 2012 SIMULIA Customer Conference<br>www.3ds.com/company/events/scc-2012/overview/ |
| 05/21<br>Germany | Nastran Users Meeting<br>http://pages.mscsoftware.com/NastranUserMeeting2012-Home.html |
| 06/11<br>USA | AMD Fusion12 Developer Summit<br>http://www.amd.com |
| 06/12<br>US | Seventh M.I.T. Conference<br>www.seventhmitconference.org/ |

**ESI-group**

http://www.esi-group.com/corporate/news-media/press-releases/2012-english-pr/esi-releases-the-latest-version-of-ace-plus-suite-multiphysics-and-cfd-software

ESI releases the latest version of ACE+ Suite, the Multiphysics and Advanced CFD software improves product development processes for Automotive to Semiconductor industries

**CRAY**

http://investors.cray.com/phoenix.zhtml?c=98390&p=irol-newsArticle&ID=1667153&highlight=

Cray's YarcData Division Launches New Big Data Graph Appliance

The uRiKA graph appliance fills an unmet need in the rapidly-growing Big Data market.

**BETA CAE Systems S.A**.

announces the release of ANSA v13.2.2 with new features and known problems resolved

http://www.beta-cae.gr/news/20120222_announcement_ansa_v13.2.2.htm

The official software release is comprised by the latest ansa_v13.2.2 files that reside in the server at the time of this announcement. These replace any pre-releases and files downloaded prior to March 22nd, 2012.

**BETA CAE Systems S.A**.

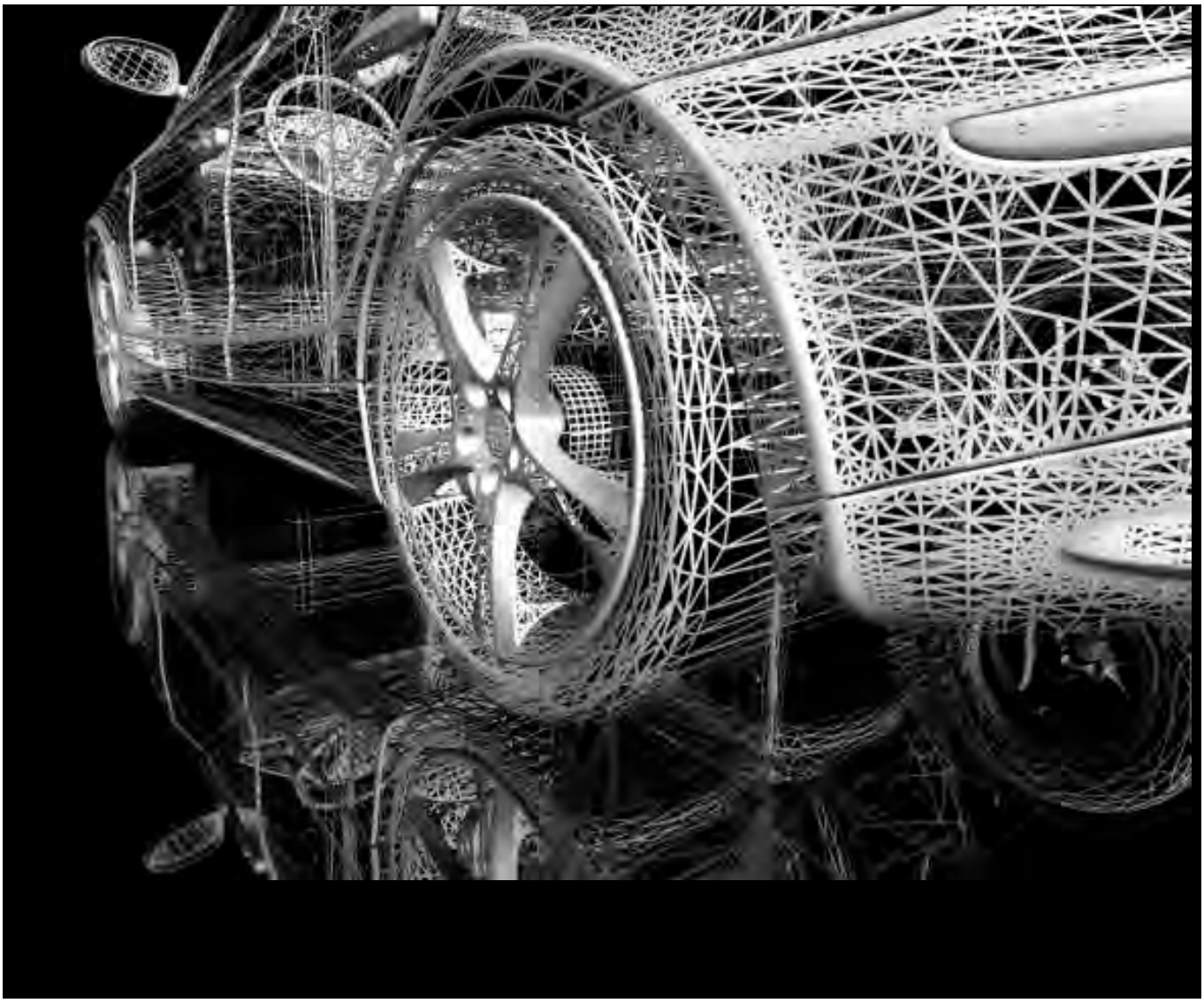
announces the release of μETA v6.8.0 with new important features and code corrections

http://www.beta-cae.gr/news/20120222_announcement_meta_v6.8.0.htm

The official software release is comprised by the latest meta_post_v6.8.0 files dated March 20th, 2012. These replace any pre-releases and files downloaded prior to this date.

# FEA Information Engineering Journal

**Volume 1, Issue 2, March 2012**





**FEA Information Engineering Journal Publications**
www.feapublications.com

**Prediction of Springback in CNC Tube Bending Process Based on Forming Parameters**
Levent Sözen, Mehmet A. Guler, Recep M. Görgülüarslan, Engin M. Kaplan
- University of Economics and Technology

**Process Modeling of Freeform Incremental Forming Using LS-DYNA®**
Feng Ren, Zhen Cui, and Z. Cedric Zia Ford Motor Company

Numerical Simulation and Experimental Study of Electromagnetic Forming
**Kianhui Shang, Larry Wilkerson, Steve Hatkevich; American Trim LLC**
Pierre L'Eplattenier,, LCTC

Published in the 11th International LS-DYNA® Users Conference 2010 Proceeding.

**Publications at this time are internet available.**
www.feapublications.com

**Publications focus on a set of criteria, among them being:**

- FEA Analysis focusing on LS-DYNA®.
  - (LS-DYNA is a registered trademark of Livermore Software Technology Corp.)
- Information, or papers not previously published, that are of technical interest.
- Published papers from alternative publications, that we have authorization to showcase.

**For Information on publishing a paper contact mv@feainformation.com**
**Subject Line Should Be: Journal Publication**

FEA Information Engineering Journal is published monthly in pdf format by FEA Information Inc.  FEA Information Journal welcomes unsolicited topics, ideas, and articles