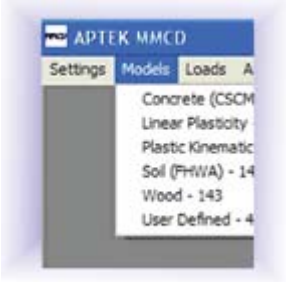
AUGUST
2007

feaINFORMATION

WWW.FEAINFORMATION.COM

APTEK, Incorporated

The Mixed Mode
Constitutive Driver
(MMCD)



PANASAS

ActiveStor Parallel
Storage Cluster
Solution

The 10th International LS-DYNA® Users Conference

June 8-10, 2008

Call for Papers

FEA INFORMATION RESOURCE MAGAZINE

Announcements:

Welcome FEA Information Participants:

APTEK - a Colorado based applied R&D company. APTEK has performed R&D studies primarily for the US government-DOD, DOE, NASA and the Federal Highway Administration (FHWA). Among the software developed APTEK develops and licenses an interactive program for driving LS-DYNA material models called the Mixed Mode Constitutive Driver (MMCD).

PANASAS - is a leader in high performing Parallel Storage for scalable Linux clusters. Panasas delivers exceptional scaling in capacity and performance while extending appliance-like ease of management to a virtually boundless storage system for High Performance Computing (HPC) organizations around the world

LSTC ANNOUNCEMENT:

The 10th International LS-DYNA® Users Conference Call for Papers

ETA-China

Will be a sponsor for "The 4th China High-level Seminar on Automobile Body Development and Mold Manufacture Technique", which will be held on Sep. 15-16 in Shanghai.

Sincerely,

Art Shapiro **art@feainformation.com**

Marsha Victory **mv@feainformation.com**

www.feainformation.com - **www.ls-dynaconferences.com**

Table of Contents – August

Editor: **Arthur Shapiro**
Graphic Designer: **Wayne L. Mindle**
Business Mgr: **Anthony Giaccana**
President: **Marsha J. Victory**

Technical Writers: **Dr. David Benson**, **Dr. Ala Tabiei**, **Uli Franz**, **Suri Bala**

Writing Consultants:
Steve Pilz
Reza Sadeghi

August Featured Paper

LS-DYNA Data Management Using Visual-Environment (pdf)

6th European LS-DYNA Users' Conference

Authors:

- Shivakumara H Shetty,
- Velayudham Ganesan,
- Suthy C Sivalingam,
- Etienne De Pommery,
- Jean Louis Duval ESI Group

Correspondence:

ESI Group
36800 Woodward Avenue,
Suite 200
Bloomfield Hills, MI 48304 .

Excerpt from Abstract:

Realistic Simulation is considered to be the most important part of Simulation based Design (SBD) in the product development cycle. Realistic simulations can not be achieved just by using currently available CAE pre and post processing functionalities alone. Many of the complex requirements of CAE modeling need to be addressed by having a synchronized CAD and CAE environment. CAE analsts need a tool, which will allow them to control variables, manage data, adapt the changes and transport across different discipines of analysis such as Crash, Safety, NVH and Durability. ESI's Open VTOS™ application called "Visual-Environment (VE)" provides such capabilities as a complete solution to SBD.

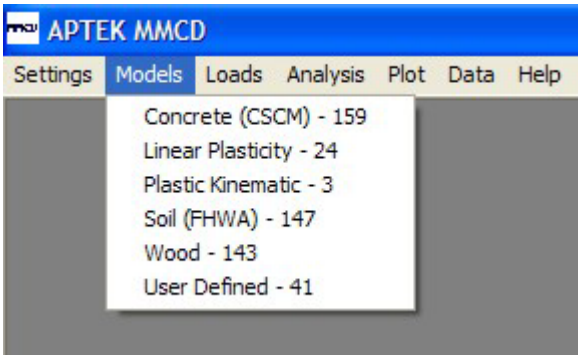
VE is an interated suite of pre-post, CAE data management tools synchronizing CAD and CAE. It also provides several contexts based on individual FE solvers. Visual-Crash DYNA (VCD) is for LS-DYNA model setup, Visual-Composer (VCO) is for model assembling and data management by linking CAD (Geometry) and FE (Physics). VCO and VCD will allow managing LS-DYNA model data linking to corresponding CAD assemblies. It helps to adapt fast design changes, communicate the engineering changes back to design, and to track the models and solution of multiple iterations.

Visual-Safe is an advanced pre-processor for safety features, Visual-Mesh a general pupose meshing took, Visual-Viewer(VVI) a general purpose plotting and simulation application, Visual-Life Nastran (VLN) a general purpose pre processor for NASTRAN, Visual-Process Executive -an application for process customization and automation are the other contexts to name a few.

This paper describes the LS-DYNA data management functionalities of Visual-Environment in Crash and Safety Simulation with productivity examples and process automation.

APTEK, Incorporated

Mixed Mode Constitutive Driver (MMCD) (For full Information Visit APTEK



APTEK develops and licenses an interactive program for driving LS-DYNA material models called the Mixed Mode Constitutive Driver (MMCD).

The driver helps the analysts to:

- Quickly evaluate the stress-strain behavior of LS-DYNA material models to gain an understanding of their applicability and limitations.
- Develop and evaluate new or user-proprietary material models (called user defined material models).
- Fit the material model parameters to test data. Parameter identification is accomplished either manually through visual comparison of the model's stress-strain behavior with test data or automatically via use of the LS-OPT optimization program.
- Prepare the material model portion of the LS-DYNA input file (*MAT).
- Prepare report-quality graphs from stored and retrieved computed results and test data.

The driver complements the performance of finite element codes like LS-DYNA. Its intended use is to help analysts efficiently fit and evaluate material models prior to performing large-scale finite element analyses. Material response may include elastic, plastic, damage, and high strain rate behaviors.

Overview

The MMCD is a graphics-based and menu-driven program that interfaces with the LS-DYNA library of material models and the LS-OPT optimization code. The core of the MMCD is the driver, which calculates the stress-strain behavior of material models driven by combinations of strain increments and stress boundary conditions, i.e. pure shear stress, and combinations of uniaxial, biaxial, and triaxial compression and tension. MMCD input and output is accessed via pre- and post-processors; graphical user interfaces (GUIs) for easily selecting the material model parameters and load histories, and for plotting the output in both two (stress-strain curves) and three (yield surfaces) dimensions. The pre-processor, driver, and post-processor are combined into a web downloadable software package that operates seamlessly as a single code.

The MMCD may be used in conjunction with LS-OPT optimization software for automating the fitting procedure. The MMCD prepares the LS-OPT and MMCD

input files from information supplied by the user via the MMCD GUI, executes LS-OPT and the model driver, and then gathers and plots the optimized results. Results include graphs of computed stress-strain curves fit to test data and values of fitted parameters versus LS-OPT iteration number.

Features

- Web downloadable software package providing all functionality under a single, easy to use, user interface.
- A select library of LS-DYNA material models including the user-defined material model. More models will be added as the MMCD continues to develop.
- A database of experimental results for materials such as concrete, wood, and soil. More data will be added as the MMCD continues to develop. Users wishing to contribute additional data may contact the authors.
- A read/write curve capability for incorporating and saving user-defined experimental data. This feature is useful for plotting new data or for data that is proprietary.
- An automated procedure for fitting each material model by interfacing the MMCD with the LS-OPT code.
- A library of predefined mixed-mode load histories that simulate common laboratory tests.
- An optional method for inputting user-specified load histories.
- The capability to plot 2D stress-strain (or stress-invariant) curves with and without experimental data.
- The capability to plot 3D yield surfaces, and to rotate and translate those surfaces about various axes.
- The capability to create report-quality graphics via a large selection of fonts, curve line types, symbol styles, and curve manipulations (scaling, swapping, integrating, cross-plotting, and shifting).

Advantages

- Dedicated Software Package. The MMCD is dedicated to the efficient development, evaluation, and parameter identification (fitting) of material models used in finite element codes. It is not cluttered with extraneous features that the user has to learn and sort through. Although many software programs focus on helping the user develop geometric model input (mesh generators for nodes and elements), the MMCD's unique focus is on material model input via parameter identification and material model evaluation.
- More Accurate and Consistent Fits to Data**.** The automated LS-OPT fitting procedure provides consistent fits from user to user that are less dependent upon the analysts experience and judgment than a manual fitting procedure.
- Ease of Use. Pre- and post-processing and code execution are interactive and GUI-menu driven. The MMCD creates the input files, executes the driver and LS-OPT, gathers the stress-strain output, and then plots the data. Thus the MMCD is easy to use, even for a beginning analyst. Little knowledge of optimization theory or the LS-OPT code is required.
- Variety of Loading Simulations. Unlike strain-based drivers, the MMCD will analyze both strain-

based and mixed-mode behaviors. Fits to typical test data, like those conducted under uniaxial or biaxial stress, require mixed mode capabilities (see theory).

- Fast Turn-Around Time. APTEK has determined that the time it takes an experienced analyst to set-up, run, and plot model output with the driver is approximately one-fifteenth that needed to perform a single element simulation. For less experienced analysts, the savings would be even greater. A number of features contribute to the fast turn-around time. First, driving a material model is quick computationally and requires less input (set-up) than a single element simulation that analysts typically use to evaluate material models. Second, the point and click features of the pre- and post-processors are extremely efficient. Additionally, the material models and experimental data are all incorporated into the same piece of software, allowing for rapid visualization. Having data readily available also saves the analyst time in searching for, and gathering experimental data. In addition, plotting yield surfaces in three dimensions is not available with most finite element post-processors. The MMCD saves time by eliminating the switch to 3D graphics plotting routines.

Benefits

- **Cost Effectiveness.** All of the above advantages result in savings in cost (time) associated with selecting and fitting material models for use in finite element applications.
- **Better Finite Element Simulations.** Dedicated material model evaluation and accurate and consistent fits to test data will result in improved finite element simulations.
- **Educated Analysts.** Use of the MMCD will improve the analysts understanding of material model behavior.

Theory

Constitutive material models accept strain rate increments as input and output the resulting stresses. The MMCD driver passes strain rate increments directly to the material model, by-passing all the finite element coding associated with the nodal displacements, element forces, and the dynamic equations of motion. The MMCD calculates material response under both mixed-mode and strain-mode loading conditions. The term mixed mode indicates that the driver can load the material with a mixture of strain rate increments and stress-boundary conditions and then solve for the stresses through an iterative procedure. Examples of mixed-mode simulations are uniaxial and biaxial stress. Strain-mode simulations are those in which all strain components are specified, such that no free stress boundary conditions exist. In this case, no iteration is required, and the specified strain increments are the final strain increments. Examples of strain-controlled simulations are uniaxial strain and simple shear.

LS-DYNA and LS-OPT

LS-DYNA is a general purpose transient dynamic finite element program capable of simulating complex real world problems. It is developed and leased by the Livermore Software Technology Corporation (LSTC) (www.lstc.com). LS-OPT is LSTC's standalone design optimization and probabilistic analysis package. Click here for more info

.

Digital planetarium soars to new heights with HP

HP Workstations power visually intensive 3D displays at Gates Planetarium

Complete Article can be found at the HP News Room

The quality of visual effects in our planetarium is absolutely crucial to the overall visitor experience. With Intel multi-core technology running on HP workstations, we can reach new heights in visualization, making the planetarium a true launch pad for visitors to gain new vistas and perspectives about the universe. — Dan Neafus, operations manager, Gates Planetarium

Visitors to the Charles C. Gates Planetarium in Denver, Colorado have never been wowed like this. Three-dimensional exhibits and short films, such as B*lack Holes: The Other Side of Infinity*, transport visitors to new and unseen places, enabling them to experience and virtually touch the universe in ways they never could before.

Creating these remarkable images is no easy task. It requires hundreds and even thousands of hours of programming and editing to produce the sensation of soaring through space, with planets and solar systems all around.

It also requires the highest-performance computer hardware to render and power these exhibits.

"The quality of visual effects in our planetarium is absolutely crucial to the overall visitor experience," says Dan Neafus, operations manager, Gates Planetarium. "With multi-core technology running on HP workstations, we can reach new heights in visualization, making the planetarium a true launch pad for visitors to gain new vistas and perspectives about the universe."

The challenges of 3D exhibits

As Zachary Zager, the planetarium's system administrator notes, the Gates Planetarium no longer produces just dots on an overhead screen.

"We can have you fly anywhere in outer space and the solar system, have you floating with the planets and observing the universe from any point," he says. "We can even turn 180 degrees and dive to the micro-organic level, and show cells and organisms in three dimensions. Our only limit is our imagination."

The planetarium opened four years ago, and its design made use of a very large supercomputer that, at the time, was the only technology capable of rendering exhibit-class visualization, according to Neafus.

"What we realized very quickly is that sustaining supercomputer architecture is expensive, time-consuming and painstaking," says Neafus. "Even more troubling was the fact that it required an extremely high-level skill set for both operators and computer scientists to manage the architecture. It was

extremely complex and challenging, just too rigid and demanding to work realistically as a long-term solution."

Neafus met with administrators at the Denver Museum of Nature & Science, the planetarium's parent body, and laid out a plan for preserving long-term quality and improving efficiency by looking at emerging technologies in computer hardware and software that could make life easier at the planetarium.

"We needed a more flexible and sustainable platform, pure and simple," says Neafus. "In terms of software we recognized that a dual approach was needed — Linux for research-based and specialized scientific applications, and Windows to port to our system for digital rendering and image-based tasks.

"In terms of hardware, we needed to identify and build a relationship that could help sustain our operations long-term by supporting an ongoing update of capabilities, hardware and software. HP proved to be the right solution."

Building a 3D experience with HP

HP xw8400 Workstation, with an HP LP2465 LCD monitor, plus a mouse and keyboard.

Equipped with Quad-Core Intel Xeon® processors and the new Intel Core 2 Extreme® QX6700 quad-core processors running on the new Intel 5000P chipset, HP xw8400 Workstations offer benchmark computing power and speed. The 5000P chipset provides 33-67 percent improvement in throughput over previous Intel chipset technology.

As the planetarium's programmers quickly discovered, these workstations, when processing in tandem, can deliver visual output to rival and surpass even the most robust supercomputing platforms.

The planetarium linked its HP workstations with digital projectors across the interior of the domed viewing room to create a region of virtual space, enabling visitors to explore the universe in a seamless, real-time environment that looks and feels like a real nighttime sky, with perspectives from the earth, from various stars and other fixed points across a virtual universe.

"Each HP workstation is dedicated to a different projector inside the planetarium," Zager explains. "Working together, they create a seamless image across the dome."

The planetarium has a core workstation that serves as the "master unit," creating the sense of space and processing images within the 3D software. It then sends images to the other computers, which in turn relay the data to the projectors, creating a real-time image of the universe from a specific point at a specific time.

As Neafus points out, the robust capabilities of the HP workstations help support the planetarium's technology and scientific learning goals.

"Staying ahead of the audience, per se, is not a competition. It's not about trying to outdo someone else. When we do our job by staying ahead of the technology curve, the cool factor is more than enough to get our audience excited about coming to the planetarium," says Neafus. "Our goal is to improve scientific literacy, to maintain programming that gets our audience motivated to learn more, to experience more.

"And we want to be as efficient as possible, from an operations perspective,

about getting new, fresh content in front of the audience."

Faster image development, better displays

The HP workstations aren't used just for showcasing 3D displays. They are also used to develop and edit images for each exhibit.

As media systems developer Matt Brownell notes, the horsepower needed to render complex 3D images for the planetarium's displays is comparable to what's seen with cutting-edge computer games, where the finished products inch ever closer to the look and feel of real-life experiences.

"The way our real-time systems work is very similar to the gaming industry," says Brownell. "Our texture mapping and post-editing are very similar. We use a lot of the same technologies and the same three-dimensional libraries that high-end game developers use."

The planetarium's programmers and developers turn to HP workstations to accelerate the development process. The most dramatic improvement is in rendering time. According to Neafus, using its previous hardware the planetarium's staff would require up to 60 hours of editing and rendering with Adobe® After Effects® imaging software in order to develop a 10-second scene. Using HP Workstations, which are developed and tested with multiple software vendors including Adobe, this has been reduced to just a few hours.

"With the new equipment, it feels like we're about 50 times faster," Brownell comments. "It's so much easier to see frame rates and properties in real-time. We can access frames in about ten seconds. It used to take more than 60 seconds for them to load, and we could never really observe the frames in a real-time scenario."

The planetarium's on-site show development team includes only two developers, placing great emphasis on fast, efficient work. If projects fall behind or the team encounters unexpected complications, the results can force exhibits to be postponed and overextend project budgets and timelines.

"HP workstations have allowed us to process all of our imagery much, much faster, with a far quicker turnaround. We can do our work in much more timely fashion. It's a great relief," says Brownell.

SUMMARY

Industry: Non-profit

Objective: Gates Planetarium needed powerful computers capable of efficiently running complex three-dimensional displays

Approach: Planetarium installed HP workstations

Business benefits:

- HP workstations efficiently run complex, computing-intensive operations
- Attractive, 3D displays draw more visitors
- Reduction in time-intensive display support
- Increased efficiency — less time to render and edit images, more time spent enhancing innovative displays

IT benefits:

- Reliable, high-performance hardware leads to reduced service and support issues

This customer's results depended upon its unique business and IT environment, the way it used HP products and services and other factors. These results may not be typical; your results may vary.

Among the MSC.Software Corporation's 2007 VPD Conferences

October 2007 – **US**, **Europe, Middle-East, & Africa**

MSC.Software Corporation's 2007 Americas VPD Conference: Gaining Competitive Advantage through Engineering Productivity

For Complete Information

Americas Conference Information:
Marriott at the Renaissance Center
Detroit, Michigan
October 11-12, 2007

MSC.Software's driving mission is to help you and your company improve your product development process. This conference is dedicated to providing you with the latest information on the strategies and technologies that you can use immediately to enhance concept development, design, simulation, testing, manufacturing, and business performance.

This is the only industry conference that explores all aspects of virtual product development. Join nearly 700 engineers and senior executives from industries including automotive, aerospace, bio-medical, civil engineering, defense, and general machinery. You'll discover how other industry leaders are improving communication and collaboration in their product design and manufacturing processes to accelerate time and right to market. MSC.Software management and experts will also be available to discuss your requirements in relation to your current and future product development needs. They'll provide insight into how you can improve product performance and reliability by enhancing product simulation, testing, and manufacturing.

Attend the 2007 VPD Conference and you'll have the opportunity to network with colleagues in your field, hear from industry leaders such as Whirlpool, Chrysler North America, Dura Automotive Systems, Eaton Corporation, Embraer, Energizer Battery, Ford Motor Company, General Dynamics Land Systems, General Motors, Kimberly-Clark Corporation, L-3 Communications Integrated Systems, Lockheed Martin and Spirit AeroSystems on the evolution of simulation in the enterprise, and learn how MSC.Software's new enterprise solution strategy will help you meet the ever-increasing pressures of time, cost, quality, and performance.

Join us and you'll be better equipped to:

Maximize the return on your Enterprise Simulation investment

Ensure right-to-market for your products

Minimize time-to-market for your products

MSC Software Virtual Product Development (VPD) Conference, 2007

Europe, Middle-East, & Africa (EMEA)
17-18 October, 2007 *(arrival 16-October)*
The Radisson SAS Hotel, Frankfurt Germany

Complete Information

Why Attend

Today's manufacturing landscape is intensely shaped by competition, and achieving or maintaining competitive advantage is typically reported as the #1 challenge facing engineering organisations. Success may include bringing products to market more quickly, at lower cost, or by gaining greater acceptance through enhanced product performance or new levels of included innovation.

Conference Objectives

MSC.Software's Virtual Product Development Conference 2007 is the premier gathering for all executives, managers, engineers and designers who are actively seeking Gaining Competitive Advantage through Engineering Productivity.

Our agenda is dedicated to the Technologies and Processes of Virtual Product Development, providing a consolidated review of the simulation environments available today, and a perspective of trends and developments over the next 12 months. Our aim is to celebrate the best in industrial applications, simulation process management, and design innovation from the VPD community.

Participants Benchmarks on TopCrunch

TopCrunch.org for complete Vendor submitted benchmarks

SGI / Applications Engineering – Intel Woodcrest

Computer/ Interconnect	Processor	#Nodes x #Processors per Node x #Cores Per Processor = Total #CPU	Time (Sec)	Benchmark Problem	Submission Date
Altix 1200/ Voltaire HCA 410Ex InfiniHost III Lx SDR, OFED v1.2	Intel 5160 Woodcrest DC 3.0GHz	16 x 2 x 2 = **64**	336	neon_refined_revised	08/01/2007
Altix 1200/Voltaire HCA 410Ex InfiniHost III Lx DDR, OFED v1.2	Intel 5160 Woodcrest DC 3.0GHz	32 x 2 x 2 = **128**	327	neon_refined_revised	08/04/2007

Participants Benchmarks on TopCrunch

TopCrunch.org for complete Vendor submitted benchmarks

IBM / IBM – Intel Xeon

Computer/Interconnect	Processor	#Nodes x #Processors per Node x #Cores Per Processor = Total #CPU	Time (Sec)	Benchmark Problem	Submission Date
HS21XM BladeCenter/InfiniBand	Intel Xeon 5160	8 x 2 x 2 = **32**	5900	3 Vehicle Collision	08/14/2007
HS21XM BladeCenter/InfiniBand	Intel Xeon 5160	4 x 2 x 2 = **16**	10852	3 Vehicle Collision	08/14/2007
HS21XM BladeCenter/InfiniBand	Intel Xeon 5160	2 x 2 x 2 = **8**	20237	3 Vehicle Collision	08/14/2007
HS21XM BladeCenter/InfiniBand	Intel Xeon 5160	1 x 2 x 2 = **4**	39416	3 Vehicle Collision	08/14/2007

LS-DYNA® at the 25th CADFEM Users´ Meeting

November 21 – 23, 2007, Dresden, Germany - www.usersmeeting.com

CADFEM has announced the preliminary LS-DYNA program at this year´s CADFEM Users´ Meeting. The CADFEM Users´ Meeting will be held simultaneously to the German ANSYS Conference. In 2007, the ANSYS Conference & 25th CADFEM Users' Meeting will be one of the most comprehensive expert conferences on numerical simulation in product development in Europe.

LS-DYNA at the 25th CADFEM Users´ Meeting – preliminary agenda:

Wednesday, November 21, 2007

Keynote:

Future Technology Outlook

J. Hallquist (Livermore Software Technology Corporation, Livermore, CA, USA)

LS-DYNA Session:

Technical Remarks Part I

J. Hallquist (Livermore Software Technology Corporation, Livermore, CA, USA)

ALE and FSI Capabilities in LS-DYNA - New Corpuscular Method for Airbag Deployment Simulations

L. Olovsson (Livermore Software Technology Corp., Livermore, CA, USA, IMPETUS Afea, Huddinge, Sveden)

Neuigkeiten zu LS-DYNA bei CADFEM

U. Stelzmann (CADFEM GmbH, Chemnitz), M. Hörmann (CADFEM GmbH, Grafing)

SPH - New Developments and Applications

J. Lacome (Livermore Software Technology Corporation, Livermore, CA, USA)

Thursday, November 22, 2007

LS-DYNA Session:

Aktueller Stand und neue Trends aus Anwendersicht

U. Stelzmann (CADFEM GmbH, Chemnitz), M. Hörmann (CADFEM GmbH, Grafing)

Simulation von Klebeverbindungen zwischen Stahlblechen unter Crashbeanspruchung im Automobilbau mit der Methode der Finiten Elemente

M. Brede (Fraunhofer-Institut für Fertigungstechnik und Angewandte Materialforschung, Bremen)

Auslegung eines Crashdeformationselementes einer Sicherheitslenksäule mittels numerischer Simulation

K. Plangger (ThyssenKrupp Presta AG, Eschen, Liechtenstein)

FAT-Richtlinie: Dynamische Werkstoffkennwerte für die Crashsimulation

W. Böhme (Fraunhofer Institut für Werkstoffmechanik, Freiburg)

Parameter Identification for the Simulation of Debonding in Honeycomb Sandwich using LS-DYNA

M. Hörmann (CADFEM GmbH, Grafing)

ANSYS & LS-DYNA Simulation of Electronic Modules Subjected to Free Drop Test

P. Gromala (Qimonda Dresden GmbH & Co. oHG, Dresden)

Johnson-Cook Model Parameter Identification: Some Observations Illustrated with Aluminium 6063-T6

L. Schwer (Schwer Engineering & Consulting Services, Windsor CA, USA)

Technical Remarks Part II

J. Hallquist (Livermore Software Technology Corp., Livermore, CA, USA)

N.N.

T. Dutton (Dutton Simulation Ltd., Warks, United Kingdom)

Übertragung von Umformergebnissen in die Crashsimulation zur Verbesserung der Vorhersagequalität

U. Scholl (Fraunhofer Gesellschaft SCAI, Sankt Augustin)

Simulation eines zellularen Verbundwerkstoffes für Crashanwendung

F. Bartl, R. Dallner (Fachhochschule Ingolstadt)

Test Verification Techniques in LS-DYNA

U. Jankowsi, M. Müller-Bechtel, J. Martinez (TECOSIM GmbH, Rüsselsheim)

LS-OPT based Identification of a User Defined Material Model for Distortional Hardening with Application to Sheet Forming Processes with Complex Strain Path Changes

V. Levkovitch, B. Svendsen (Universität Dortmund)

Robustheitsbewertungen von Crashberechnungen mit LS-DYNA und optiSLang

J. Will (Dynardo GmbH, Weimar), U. Stelzmann (CADFEM GmbH, Chemnitz)

An Overview of the ASME Guide for Verification and Validation in Computational Solid Mechanics

L. Schwer (Schwer Engineering & Consulting Services, Windsor CA, USA)

Simulation des Druckanstiegs in der Tür beim Seitencrash mittels Fluid-Struktur-Interaktion

M. Machens (Wilhelm Karmann GmbH, Osnabrück)

Friday, November 23, 2007

Technical Workshop I

New Features in LS-DYNA 971 & Tips and tricks for contacts and composites

U. Stelzmann (CADFEM GmbH, Cemnitz), M. Hörmann (CADFEM GmbH, Grafing)

Technical Workshop II

Optimization and robustness using LS-OPT & Simulation of bonded joints

W. Lietz (CADFEM GmbH, Dortmund), A. Matzenmiller (Universität Kassel)

The program dedicated to LS-DYNA will be embedded in one of this year´s most comprehensive expert conferences. 800 or even more engineers are expected to attend the event with a special emphasis on structural mechanics, computational fluid mechanics and fluid-structure-interaction. It will be accompanied by a large CAE exhibition with probably more than 40 companies.

So LS-DYNA users benefit twice from attending the conference: They take advantage of an effective and detailed technical content on LS-DYNA, AND additionally, they have access to a broad variety of complementary CAE information!

More information:
www.usersmeeting.com

The LS-DYNA® Italian Users' Meeting

Direct participation by LSTC

For Complete Conference Information and products: EnginSoft S.p.A

modeFRONTIER™ - ANSYS Workbench - ANSYS CFX - ANSYS ICEM CFD Magmasoft - LMS Virtual.Lab - Moldflow's Design Analysis Solutions – AdvantEdge - FORGE2 and FORGE3

LS-DYNA®, LS-OPT®, LS-PrePost®

EnginSoft's annual Meeting will be hosted in the elegant Villa Caroli-Zanchi, near Stezzano/Bergamo, on 25th and 26th October 2007.

The next edition of the LS–DYNA Italian Users' Meeting will adopt a totally new spirit. "Priority and Challenges" viewpoint and motto by EnginSoft will characterize this year's LS-DYNA Italian Users' Meeting. The leading principle will be shaped in the many presentations by the LS–DYNA users.

Last year's edition of the LS–DYNA Italian Users' Meeting had been a successful one, in terms of both interest and attendance. The success built upon the rich programme of technical presentations and agenda. The agenda and direct participation of LSTC allowed users attending the meeting to acquire information, knowledge and innovative experiences from many different industry, educational and research sectors.

This year's edition of the LS–DYNA Italian Users' Meeting, aims at repeating its past success. This year users will find a broader presentation agenda and support for the growing technical interest in LS-DYNA, the foremost numerical code, specifically developed for the resolution of complex non-linear dynamic problems of real phenomena.

The 2007 programme, besides several contributions about application examples and industrial cases, will offer a technical update seminar on specific methodologies and software tools regarding LS-DYNA applications. The event will be the ideal occasion to convey an overview of the state-of-the-art and in depth study of solutions and analysis routines.

This event targets knowledge and routine transfer. Therefore, the present invitation is addressed, besides LS-DYNA Italian users, to anyone dealing with rapid dynamics problems, involving deformations, sophisticated material models and complex contact conditions, which are typical of impact problems and metal forming

LS-DYNA® Discussion Group at 78th Shock & Vibration Symposium

November 6th, 2007

An informal LS-DYNA Discussion Group will be held on Tuesday 6 November from 17:30 to 19:00 in conjunction with the 78th Shock & Vibration Symposium. (www.saviac.org)

The Discussion Group will feature a presentation by Dr. Tom Littlewood on new and improved under water explosion (UNDEX) capabilities of LS-DYNA.

This meeting is an opportunity for engineers to meet with Livermore Software Technology Corporation (LSTC) personnel, learn of recent developments in LS-DYNA and LS-PrePost, discuss application of LS-DYNA to their problems, share best practices, and make requests for new features.

The meeting is hosted by Livermore Software and Technology Corporation (LSTC) and moderated by Dr. Len Schwer of Schwer Engineering & Consulting Services. You may contact Len (Len@Schwer.net) for more information, comments, or suggestions.

About The annual Shock and Vibration Symposium:

The annual Shock and Vibration Symposium is the leading forum for the structural dynamics and vibration community to present and discuss new developments and on-going research. The Symposium was established in 1947 and includes both classified and unclassified sessions. The classified sessions allow critical technology and classified (up to secret level) research to be presented in closed forums of cleared US Government and government-contractor researchers. Topics covered at the symposium include shock-ship testing, water shock, weapons effects (air blast, ground shock, cratering, penetration) shock physics, earthquake engineering, structural dynamics, and shock and vibration instrumentation and experiment techniques. Over 200 technical papers are typically presented. Panel discussions address topics such as new software developments or accelerometer isolation problems. Tutorials provide up-to-date technology overviews by leading specialists

DYNALOOK – New Addition

www.dynalook.com **780+ papers ready to download**

The latest addition to the DYNALOOK website is the 6th European LS-DYNA Users Conference held in Gothenburg 2007.

The European LS-DYNA Users Conferences on DYNALOOK

6th European LS-DYNA Users Conference in 2007 (Gothenburg)

5th European LS-DYNA Users Conference in 2005 (Birmingham)

4th European LS-DYNA Users Conference in 2003 (Ulm)

3rd European LS-DYNA Users Conference in 2001 (Paris)

The International LS-DYNA Users Conferences on DYNALOOK

9th International LS-DYNA Users Conference in 2006 (Detroit)

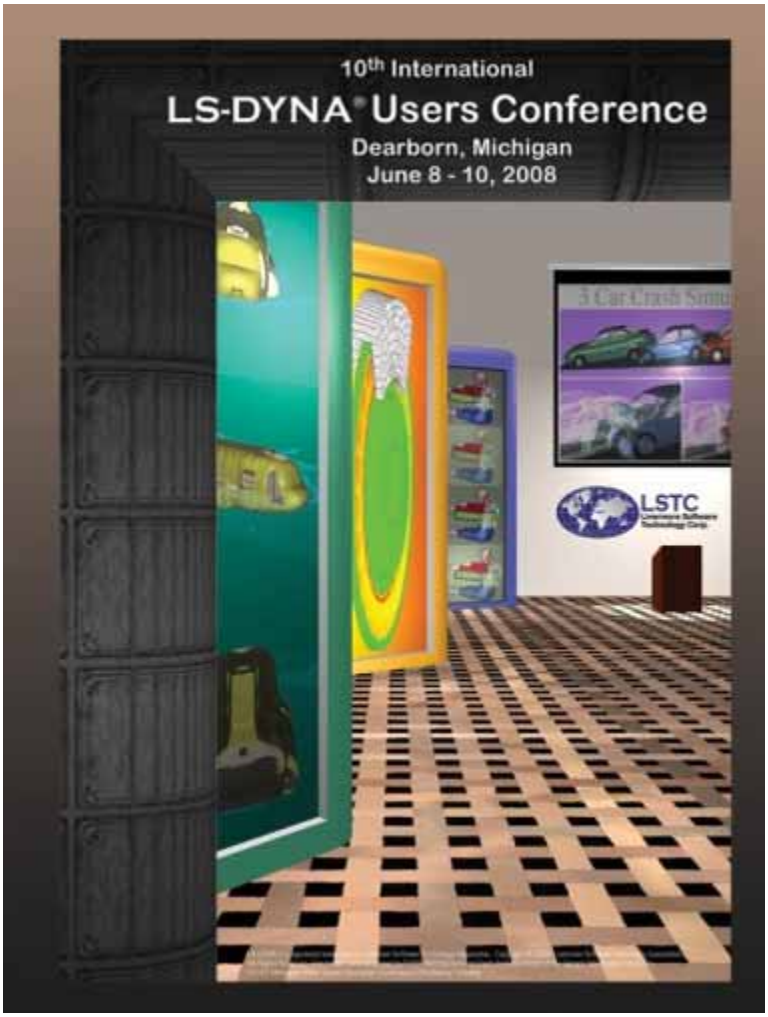
8th International LS-DYNA Users Conference in 2004 (Detroit)

7th International LS-DYNA Users Conference in 2002 (Detroit)

6th International LS-DYNA Users Conference in 2000 (Detroit)

The 2007 6th German LS-DYNA Forum

October 11-12, 2007 Frankenthal, Germany



The 10th International

LS-DYNA® Users Conference

June 8-10, 2008

Hosted by Livermore SoftwareTechnology Corp. (LSTC)

To be held at The Hyatt Regency Dearborn, MI

Abstract Deadline: Dec. 5, 2007

email your abstract to:
papers@lstc.com

Notification: 01/27/08

Paper Deadline: 03/07/08

Conference Papers: The presenter of each accepted paper will receive free admission to the conference, provided that the presenter registers for a room at the Hyatt Regency Dearborn under LSTC Conference

Application Areas Being Accepted for Paper Submission:

- Aerospace
- Automotive Crashworthiness
- Ballistic and Penetration
- Biomechanics
- Civil Engineering
- Compressible Fluid Dynamics
- Electro Magnetics
- Heat Transfer
- Impact and Drop Testing
- Manufacturing Processes
- Metal Forming
- Modeling Techniques
- Nuclear Applications
- Occupant Safety
- Seismic Engineering
- Ship Building
- Transportation
- Virtual Proving Ground

Abstract Length: Approximately 300 words, please include figures, if possible

Paper Length: Maximum of 3000 words, single-spaced, on 8-1/2" x 11" paper

Format: A MS Word template will be provided

Contact: papers@lstc.com

Livermore Software Technology Corp.
(925) 449-2500
www.lstc.com
www.ls-dynaconferences.com

LSTC California & Michigan Training Classes

A complete list of dates can be found on the LSTC website

Class Registration Form (PDF Format)

Sept		
11-14	MI	Introduction to LS-DYNA
18-21	CA	Advanced – Impact Analysis
24-25	CA	Blast & Penetration
October		
18-19	CA	Concrete and Geomaterial Modeling
22-25	MI	Introduction to LS-DYNA
November		
12-15	CA	Introduction to LS-DYNA
27-30	CA	Introduction to LS-OPT
December		
10-11	MI	Contact
12-13	MI	Implicit

For Complete Class Details:

www.lstc.com

LS-DYNA® Yahoo Group – Yahoo Yammerings

Note: LS-DYNA Yahoo Group is neither owned nor operated by LSTC, and LSTC has no control over the content.

Jim Kennedy
KBS2 Inc.
jmk@kbs2.com

Len Schwer
Schwer Engineering & Consulting Services
Len@Schwer.net

This installment of "Yahoo Yammerings" features several questions, with responses, from the past month of postings to the LS-DYNA Yahoo Group.

This installment of "Yahoo Yammerings" features two questions and responses from the past month of postings to the LS-DYNA Yahoo Group:

1. *Contact?*
2. *Time step calculation in non linear material?*

Contact?

I am trying to model contact between the ground and concrete debris after an explosion such that the debris will stay on the ground surface and not penetrate the ground surface. I have tried automatic surface to surface, automatic node to surface, and rigid wall contact. However, I have had no success. I would like to know if there are other parameters I have to define other than the master and slave part.

Reply by Nick Harle

If my understanding is correct, in a Lagrangian analysis you have 2 types of contact, kinematic and penalty based.

Penalty Based For soft = 0 or 1 in your automatic contacts, the penetration of slave nodes through a 4 node contact segment is resisted by a penalty force. This penalty force pushes the node back out of the segment. You can either:

1) alter the magnitude of the penalty force (through parameters such as SFS and SFM) or

2) increase the segment thickness (giving the contact more time to work), e.g. using SST, MST or *PART_CONTACT.

I understand soft = 2 to be segment to segment based contact, and have found this able to handle contact situations where soft = 1 or 0 have failed. However it is more computationally expensive than either soft = 0 or 1.

Kinematic Based I believe (and I may be corrected on this) that for contacts such as rigid walls, LS-DYNA simply sets to zero the component of the node's velocity that is perpendicular to the rigid wall. This is in fact simple linear algebra. Hence contact is automatically preserved, but some kinetic energy is removed from the simulation, and of course this type of contact cannot be used with any other kinematic type constraints.

Additional Considerations If beam elements or shell edge to shell contact is involved this may further fool the automatic contact algorithms you have mentioned. Beams (you may have used these to reinforce the concrete), as 2 node elements, do not have a segment

to check penetration against. Also for shell edge to shell edge contacts this is not your classic penetrating node situation. These latter situations often require use of the automatic general contact card.

Also if the contact does not spot the penetrating node / segment in time then no or little action will be taken. This can happen if a node is traveling so fast that in 1 time step it moves largely through the contact segment thickness.

Returning To Your Problem Hence to finally return to your contact problem, automatic contacts can fail if:

1) The contact is not spotted in time - possible solution reduce time step / increase contact thickness

2) Insufficient contact force - possible solution either increase contact force (beware of instability) or use soft = 1 or 2

3) Insufficient time for contact force - possible solution increase contact segment thickness

4) Node penetrates element without segments (such as beam) or shell edge penetrates shell edge - possible solution use automatic general contact or automatic general contact interior if interior shell edge checking required (note these are very computationally expensive contacts)

Time step calculation in non linear material?

The element time step is calculated based on the Young's modulus of the material and the density. But when the material crosses the yield point and the modulus value starts decreasing, what does LS-DYNA do? Does it recalculate the time step and reduce it? Does it add mass for maintaining the time step? Or are all time step calculations based only on the initial modulus value?

Reply by James Campbell

I would suggest that you read the time step control chapter in the theoretical manual as a starter. An understanding of this issue is important when using an explicit code.

In your question you seem to be talking about a simple elastic-plastic model such as *MAT_PLASTIC_KINEMATIC. This is a material model with a fixed bulk modulus and so lets us ignore the equation-of-state and bulk viscosity effects in this discussion.

The critical time step is calculated from a wave speed and an element characteristic length. The wave speed used for solid elements is the elastic wave speed under uniaxial strain, calculated from the density and elastic material parameters. This is effectively a fixed parameter for an element using *MAT_PLASTIC_KINEMATIC as the Elastic modulus and Poisson's ratio are fixed, and if there is significant change in density you are using an inappropriate material model anyway. The element length is calculated from the current element geometry and so can change for an element using *MAT_PLASTIC_KINEMATIC, governing the element critical time step.

You are confused between the Elastic (Young's) modulus and the tangent (local slope of the stress-strain curve) modulus. When the material crosses the yield point the elastic modulus does not change, and it is the elastic modulus that governs the wave speed.

Reply by Len Schwer

Two more points to add to James' nice response:

#1 - While the plastic modulus could be used in the time step calculation, this would INCREASE the time step as the plastic wave speed is slower than the elastic wave speed (E_plastic < E_elastic).

#2 - Since the overall time step is controlled by the smallest time step in the model, accounting for the plastic time step would not typically benefit the overall time step.

LS-DYNA Yahoo Groups

About The LS-DYNA Yahoo Group

- The archives contains a wealth of information that can be helpful to any LS-DYNA user.
- There are over 2240 subscribers from all over the world, and grows by a hundred new subscribers ever few months. The group currently averages about 300 message per month, i.e. about 10 message per day.

How To Subscribe:

- Send an email request to
- LS-DYNA-subscribe@yahoogroups.com
- Visit the Yahoo Groups web site http://groups.yahoo.com This group is LS-DYNA (you must use the hyphen in LS-DYNA or you will join the wrong group)

How To Benefit from the Group

- Review the archives when you are seeking help on any topic related to LS-DYNA. NOTE: Questions and responses may have been edited for clarity & brevity.
- Generally, the quickest/best responses are to those questions posed with the most specifics.

General questions such as “How do I use XXX feature?” either go unanswered, or are answered by Jim Kennedy with links to appropriate references in the growing LS-DYNA related literature, e.g. see the archive of LS-DYNA Conference proceedings at www.dynalook.com

2007/2008 Worldwide Events

Oct 11-12	**German LS-DYNA Forum** **Frankenthal, Germany, hosted by DYNAmore Call for papers (pdf)**
Oct 25-26	**LS-DYNA Italian Users' Meeting will take place next October during the Annual EnginSoft Users' Meeting**
Oct 30-31	**Japan LS-DYNA Users Conference** **hosted by JRI**
Nov 05	**12th Korean LS-DYNA Users Conference** **hosted by THEME**
Nov 21 - 23	**CADFEM Users´ Meeting 2007** **Dresden, Germany, hosted by CADFEM**
Dec 5-7	**China International Simulation Industry Exhibition & Conference – Shanghai, China**
Events 2008	
June 8-10	**10th International LS-DYNA Users' Conference -The Hyatt Regency, Dearborn, MI, US -hosted by LSTC**
May, 28-30	**The 4th International Conference on Advances in Structural Engeering and Mechanics(AWAS'08)** **in Jeju, Korea**

FEA Information China Participants

Arup China: LS-DYNA sales, support, training	Name: Li YuQiang Email: Yu-qiang.li@arup.com Tel 021 5396 6633 extn 151
Tsinghua University	Qing Zhou, PhD. – Professor Department of Automotive Engineering Beijing, 100084, China
Engineering Technology Associates (China) Inc.	Martin Ma Tel: + 86-21-64385725 Contact: support@eta.com.cn

China Company Listings

Ansys-China, Inc.	Tel: 86-10-84085558 Website: www.ansys.com.cn Contact: China@ansys.com.cn
Hewlett-Packard Asia Pacific Ltd.	Jerry Huang Tel: +86-10-65645261 Contact: J.Huang@hp.com
IBM China	Ms. Ling WANG - Tel: +86-10-6539-1188 x4463 (T/L:901-4463) Website: http://www.ibm.com/cn/ Contact: wangling@cn.ibm.com
MSC. Software Corp.	Tel: +86-10-6849-2777 Website: www.mscsoftware.com.cn Contact: mscprc.contact@mscsoftware.com
SGI China	Carl Zhang Tel: +86 -10 - 65228868 Ext. 3362 Contact: carl@sgi.com
Zhong Guo ESI Co., Ltd	Yang Xiaojum Phone: +86 (020) 8235 6272 Contact : Yang Xiaojun

Engineer's Market Place

BOOKS Available at Amazon

The Finite Element Method: Linear Static and Dynamic Finite Element Analysis -Thomas J.R. Hughes (Sept. 2000)

Vibration Simulation Using MATLAB and ANSYS - Michael R. Hatch -(Sept. 2000)

Nonlinear Finite Element Analysis for Continua and Structures
Ted Belytschko, et al/Hardcover/Published 2000

Nonlinear Finite Element Analysis for Continua and Structures
Ted Belytschko, et al/Paperback/Published 2000

LS-DYNA Resource Page - MPP Interconnect and MPI

FEA Information Inc. Participant's (alphabetical order)

Fully QA'd by Livermore Software Technology Corporation

TABLE 1: SMP - Fully QA'd by LSTC	
AMD Opteron	Linux
FUJITSU Prime Power	SUN OS 5.8
FUJITSU VPP	Unix_System_V
HP PA-8x00	HP-UX 11.11 and above
HP IA-64	HP-UX 11.22 and above
HP Opteron	Linux CP4000/XC
HP Alpha	True 64
IBM Power 4/5	AIX 5.1, 5.2, 5.3
IBM Power 5	SUSE 9.0
INTEL IA32	Linux, Windows
INTEL IA64	Linux
INTEL Xeon EMT64	Linux
NEC SX6	Super-UX
SGI Mips	IRIX 6.5 X
SGI IA64	SUSE 9 with ProPack 4 Red Hat 3 with ProPack 3
SUN Sparc	5.8 and above
SUN Opteron	5.8 and above

TABLE 2: MPP Interconnect and MPI

Vendor	O/S	HPC Intereconnect	MPI Software
AMD Opteron	Linux	InfiniBand (SilverStorm), MyriCom, QLogic InfiniPath	LAM/MPI, MPICH, HP MPI, SCALI
FUJITSU Prime Power	SUN OS 5.8		
FUJITSU VPP	Unix_System_V		
HP PA8000	HPUX		
HPIA64	HPUX		
HP Alpha	True 64		
IBM Power 4/5	AIX 5.1, 5.2, 5.3		
IBM Power 5	SUSE 9.0		LAM/MPI
INTEL IA32	Linux, Windows	InfiniBand (Voltaire), MyriCom	LAM/MPI, MPICH, HP MPI, SCALI
INTEL IA64	Linux		LAM/MPI, MPICH, HP MPI
INTEL Xeon EMT64	Linux	InfiniBand (Topspin, Voltaire), MyriCom, QLogic InfiniPath	LAM/MPI, MPICH, HP MPI, INTEL MPI, SCALI
NEC SX6	Super-UX		
SGI Mips	IRIX 6.5	NUMAlink	MPT
SGI IA64	SUSE 9 w/ProPack 4 RedHat 3 w/ProPack 3	NUMAlink, InfiniBand, (Voltaire)	MPT, Intel MPI, MPICH
SUN Sparc	5.8 and above		LAM/MPI
SUN Opteron	5.8 and above		

LS-DYNA Resource Page - Participant Software

Interfacing or Embedding LS-DYNA - Each software program can interface to all, or a very specific and limited segment of the other software program. The following list are software programs interfacing to or having the LS-DYNA solver embedded within their product. For complete information on the software products visit the corporate website.

ANSYS - ANSYS/LS-DYNA

ANSYS/LS-DYNA - Built upon the successful ANSYS interface, ANSYS/LS-DYNA is an integrated pre and postprocessor for the worlds most respected explicit dynamics solver, LS-DYNA. The combination makes it possible to solve combined explicit/implicit simulations in a very efficient manner, as well as perform extensive coupled simulations in Robust Design by using mature structural, thermal, electromagnetic and CFD technologies.

AI*Environment: A high end pre and post processor for LS-DYNA, AI*Environment is a powerful tool for advanced modeling of complex structures found in automotive, aerospace, electronic and medical fields. Solid, Shell, Beam, Fluid and Electromagnetic meshing and mesh editing tools are included under a single interface, making AI*Environement highly capable, yet easy to use for advanced modeling needs.

ETA – DYNAFORM

Includes a complete CAD interface capable of importing, modeling and analyzing, any die design. Available for PC, LINUX and UNIX, DYNAFORM couples affordable software with today's high-end, low-cost hardware for a complete and affordable metal forming solution.

ETA – VPG

Streamlined CAE software package provides an event-based simulation solution of nonlinear, dynamic problems. eta/VPG's single software package overcomes the limitations of existing CAE analysis methods. It is designed to analyze the behavior of mechanical and structural systems as simple as linkages, and as complex as full vehicles

MSC.Software - MSC.Dytran LS-DYNA

Tightly-integrated solution that combines MSC.Dytran's advanced fluid-structure interaction capabilities with LS-DYNA's high-performance structural DMP within a common simulation environment. Innovative explicit nonlinear technology enables extreme, short-duration dynamic events to be simulated for a variety of industrial and commercial applications on UNIX, Linux, and Windows platforms. Joint solution can also be used in conjunction with a full suite of Virtual Product Development tools via a flexible, cost-effective MSC.MasterKey License System.

MSC.Software - MSC.Nastran/SOL 700

The MSC.NastranTM Explicit Nonlinear product module (SOL 700) provides MSC.Nastran users the ability access the explicit nonlinear structural simulation capabilities of the MSC.Dytran LS-DYNA solver using the MSC.Nastran Bulk Data input format. This product module offers unprecedented capabilities to analyze a variety of problems involving short duration, highly dynamic events with severe geometric and material nonlinearities.

MSC.Nastran Explicit Nonlinear will allow users to work within one common modeling environment using the same Bulk Data interface. NVH, linear, and nonlinear models can be used for explicit applications such as crash, crush, and drop test simulations. This reduces the time required to build additional models for another analysis programs, lowers risk due to information transfer or translation issues, and eliminates the need for additional software training.

MSC.Software – Gateway for LS-DYNA

Gateway for LS-DYNA provides you with the ability to access basic LS-DYNA simulation capabilities in a fully integrated and generative way. Accessed via a specific Crash workbench on the GPS workspace, the application enhances CATIA V5 to allow finite element analysis models to be output to LS-DYNA and then results to be displayed back in CATIA. Gateway for LS-DYNA supports explicit nonlinear analysis such as crash, drop test, and rigid wall analysis.

Gateway products provide CATIA V5 users with the ability to directly interface with their existing corporate simulation resources, and exchange and archive associated simulation data.

Oasys software for LS-DYNA

Oasys software is custom-written for 100% compatibility with LS-DYNA. Oasys PRIMER offers model creation, editing and error removal, together with many specialist functions for rapid generation of error-free models. Oasys also offers post-processing software for in-depth analysis of results and automatic report generation.

EASi-CRASH DYNA

EASi-CRASH DYNA is the first fully integrated environment for crashworthiness and occupant safety simulations with LS-DYNA, and covers the complete CAE-process from model building and dataset preparation to result evaluation and design comparisons.

EASi-CRASH DYNA can be used for concept crash, FE crash and coupled rigid body/FE crash simulations in conjunction with MADYMO.

Full capability to handle IGES, CATIA V4, CATIA V5, UG and NASTRAN files

APTEK

The MMCD is a graphics-based and menu-driven program that interfaces with the LS-DYNA library of material models and the LS-OPT optimization code. The core of the MMCD is the driver, which calculates the stress-strain behavior of material models driven by combinations of strain increments and stress boundary conditions, i.e. pure shear stress, and combinations of uniaxial, biaxial, and triaxial compression and tension. MMCD input and output is accessed via pre- and post-processors; graphical user interfaces (GUIs) for easily selecting the material model parameters and load histories, and for plotting the output in both two (stress-strain curves) and three (yield surfaces) dimensions. The pre-processor, driver, and post-processor are combined into a web downloadable software package that operates seamlessly as a single code.

FEA Information Participants – Company name takes you directly to Website

Oasys, Ltd: Markets engineering software products. Consulting engineers, planners and project managers working in all areas of the built environment.

JRI Solutions Limited: Specializing in Research & Consulting; System Consulting, Frontier Business, System Integration and Science Consulting.

Hewlett Packard: Personal computing, mobile computing, network management, 3-D graphics and information storage.

ANSYS, Inc.: Develops, markets, supports and delivers collaborative analysis optimization software tools.

SGI: Silicon Graphics, Inc., is a leader in high-performance computing, visualization, and storage.

MSC.Software: Information technology software and services provider.. Products & services used to enhance & automate the product design/manufacturing process.

Fujitsu Limited: Internet-focused information technology solutions.

AMD: Supplier of integrated circuits for the personal and networked computer and communications markets.

NEC Corporation A history of more than 100 years of leadership/innovation in the core high-technology sectors of communications, computers/electronic components

---

Intel: For more than three decades, Intel Corporation has developed technology enabling the computer and Internet revolution that has changed the world.

Engineering Technology Associates, Inc: Provides engineering & IT services & has

created the streamlined simulation software packages DYNAFORM and VPG

IBM: Invention, development & manufacture of advanced information technologies, including computer systems, software, storage systems & microelectronics

---

ESI Group: A software editor for the numerical simulation of prototype and manufacturing process engineering in applied mechanics.

Microsoft: For customers solving complex computational problems, Microsoft Windows Compute Cluster Server 2003 accelerates time-to-insight.

BETA CAE Systems S.A., Specialized in the development of state of the art CAE pre- and post-processing software systems.

LNXI - Linux Networx. Blending the price performance advantage of Linux clusters with real-world supercomputing expertise and innovation

---

Sun Microsystems Inc.,provides network computing infrastructure solutions that include computer systems, software, storage, and services.

Detroit Engineered Products: a Michigan based engineering consulting and software products firm specializing in the area of Product Development products and solutions.

APTEK Among the software developed APTEK develops and licenses an interactive program for driving LS-DYNA material models - the Mixed Mode Constitutive Driver (MMCD).

PANASAS High performing Parallel Storage for scalable Linux clusters. Delivering exceptional scaling in capacity and performance for High Performance Computing (HPC) organizations.

Software Distributors

Alphabetical order by Country

Australia	Leading Engineering Analysis Providers
Canada	Metal Forming Analysis Corporation
China	ANSYS China
China	Arup
China	MSC. Software – China
Germany	CAD-FEM
Germany	DynaMore
India	Oasys, Ltd.
India	Altair Engineering India
India	Cranes Software International Limited (CSIL),
Italy	EnginSoft Spa
Japan	Fujitsu Limited
Japan	The Japan Research Institute
Japan	ITOCHU Techno-Solutions Corporation
Korea	Korean Simulation Technologies
Korea	Theme Engineering

Software Distributors (cont.)

Alphabetical order by Country

Netherlands	Infinite Simulations Systems B.V.
Russia	State Unitary Enterprise - STRELA
Sweden	Engineering Research AB
Taiwan	Flotrend Corporation
USA	Engineering Technology Associates, Inc.
USA	Dynamax
USA	Livermore Software Technology Corp.
USA	APTEK
UK	ARUP

International Consulting and Engineering Services

(continued on next page)

Alphabetical Order By Country

Australia Manly, NSW	Leading Engineering Analysis Providers (LEAP) Greg Horner info@leapaust.com.au 02 8966 7888
Canada Kingston, Ontario	Metal Forming Analysis Corp. Chris Galbraith galb@mfac.com (613) 547-5395
Germany Alzenau	CARHS. 49 6023 96 40 60 info@carhs.de
India Bangalore	Altair Engineering India Nelson Dias info-in@altair.com 91 (0)80 2658-8540
Italy Firenze	EnginSoft Spa info@enginsoft.it 39 055 432010
UK Solihull, West Midlands	ARUP Brian Walker brian.walker@arup.com 44 (0) 121 213 3317

USA Consulting and Engineering Services

(continued)

USA Austin, TX	KBEC L.C Khanh Bui kdbui@sbcglobal.net (512) 363-2739
USA Windsor, CA	SE&CS Len Schwer len@schwer.net (707) 837-0559
USA Troy, MI	Engineering Technology Associates, Inc: (248) 729-3010
USA Corvallis, OR	Predictive Engineering George Laird (1-800) 345-4671 george.laird@predictiveengineering.com
USA Troy, MI	Detroit Engineered Products
ETA Troy, MI	Engineering Technology Associates, Inc. (248) 729-3010 sales@eta.com

Educational & Contributing Participants

Alphabetical Order By Country

China	Dr. Qing Zhou	Tsinghua University
India	Dr. Anindya Deb	Indian Institute of Science
Italy	Professor Gennaro Monacelli	Prode – Elasis & Univ. of Napoli, Frederico II
Russia	Dr. Alexey I. Borovkov	St. Petersburg State Tech. University
USA	Dr. Ted Belytschko	Northwestern University
USA	Dr. David Benson	University of California – San Diego
USA	Dr. Bhavin V. Mehta	Ohio University
USA	Dr. Taylan Altan	The Ohio State U – ERC/NSM
USA	Dr. Ala Tabiei	University of Cincinnati

Informational Websites

The LSTC LS-DYNA Support site: www.dynasupport.com

LSTC/DYNAmore LS-DYNA Support Site	FEA Informationwebsites
LSTC/DYNAmore S-DYNA Examples (more than 100 Examples)	LS-DYNA Conference Site
TopCrunch – Benchmarks	LS-DYNA Publications to Download On Line
LS-DYNA Publications	LSTC LS-PrePost Tutorials
CADFEM GmbH Portal	