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LSTC & INTEL®
One Day Training Course

The 19th Annual
HP CAE Symposium

LS-DYNA® on Windows®
Compute Cluster Server
Executive Breakfast

FEA INFORMATION RESOURCE MAGAZINE

FEA Information Announcements

LSTC's 10th Int'l LS-DYNA® Users Conference:
Registration and Hotel **registration now available** on line at:
www.ls-dynaconferences.com

LSTC & Intel® One Day Training Course Agenda
For times and locations - contact Dr. Wayne Mindle, wlm@lstc.com

LS-DYNA® on Windows® Compute Cluster Server Executive Breakfast
March 4th

Oasys LS-DYNA® Update Meeting in India
April 2nd

The 19th Annual HP CAE Symposium
April 8th

Sincerely,

Art Shapiro art@feainformation.com – Editor
Marsha Victory mv@feainformation.com - President
Anthony Giaccana feaanswer@aol.com - Business Manager
Wayne Mindle – Graphic Design

Table of Contents –January 2008

LSTC & INTEL® One Day Training Course

Intel® Cluster Ready – Cluster Support Training

This one-day course provides cluster administrators and support technicians with the latest information about the Intel® Cluster Ready program. Using exercises and hands-on labs, attendees will discover how the Intel® Cluster Ready program makes it easier to purchase, deploy, and maintain clusters built with Intel components. Attendees will learn how Intel works with platform vendors, solution integrators, and software developers to create solutions for the end user that are ready-to-use. A comprehensive tool to check and troubleshoot a cluster is provided with every Intel Cluster Ready cluster, and this will be reviewed in detail.

Agenda

Module 1: Intel® Cluster Ready Program Overview

This module will discuss the Intel® Cluster Ready program and how it applies to different program members.

At the end of this module, students will be able to

- Describe the purpose of the Intel Cluster Ready program
- List the tools and resources provided by the program
- Describe what is an Intel Cluster Ready reference implementation
- Explain how to obtain Intel Cluster Ready support

Module 2: Certification & Registration Program

Intel® Cluster Ready certification and registration procedures provide a common, proven method to identify compliance with the Intel® Cluster Ready specification. Documented steps are required to achieve application registration or platform certification.

At the end of this module, students will be able to

- Explain the purpose of the certification and registration program
- List the steps necessary to complete a platform certification
- List the steps necessary to complete an application registration

Module 3: Cluster Design

The Intel® Cluster Ready specification defines the minimum and recommended components and design required for a certified cluster. This module identifies important components of the specification.

At the end of this module, students will be able to

- Defined common cluster terminology
- Identify important requirements and recommendations given in the Intel® Cluster Ready specification

Module 4: Intel® Cluster Tools

Intel® Cluster Tools provide a leading development environment for cluster applications. This module describes these development tools and how they integrate into the Intel® Cluster Ready program.

At the end of this module, students will be able to

- Describe the Intel® development tools in the Intel® Cluster Ready SDK
- Describe how to use installed tools or their runtime libraries

Module 5: Intel® Cluster Checker: Introduction

Intel® Cluster Checker provides an automated utility for analyzing the configuration and performance of Linux clusters. This module describes the architecture and operation of Intel® Cluster Checker.

At the end of this module, students will be able to

- Explain how Intel® Cluster Checker works
- Create a basic cluster configuration file
- Execute Cluster Checker

Module 6: Intel® Cluster Checker: Advanced Configuration

Intel Cluster Checker includes options to customize operation to meet requirements for all certified clusters. It also provides features to automate operation and analyze output. This module explores many of those options.

At the end of this module, students will be able to

- Customize configuration options for different performance metrics and messaging fabrics
- Add and remove modules
- Integrate Cluster Checker into a job scheduler (PBS)
- Create node groups with different configurations

Module 7: Intel® Cluster Checker: Troubleshooting

In addition to analyzing the health and compliance of clusters, Intel® Cluster Checker provides an invaluable tool for locating problems on clusters. In the module, features of Intel® Cluster Checker for debugging and troubleshooting are reviewed.

At the end of this module, students will be able to

- Explain the effects of verbosity on Cluster Checker operation
- Activate debugging on individual modules
- Create custom tests using generic modules

For Information Contact:

Dr. Wayne Mindle,
LSTC – 925-449-2500
wlm@lstc.com

The 19th Annual HP CAE Symposium

Advancing Innovations with High-Productivity Computing

HP and Livermore Software Technology Corporation invite you to a free, one-day CAE Symposium.

Tuesday April 8th, 2008
8:00 a.m. – 4:00 p.m.
Long Beach Mariott,
4700 Airport Plaza Drive
Long Beach, CA 90815

Complete symposium details, agenda and registration

For Questions contact:
Christine Fronczak
408-447-7783

Keynote Presentations

"The unexpected Challenges of an Evolving Enterprise – New Demands on CAE"
John S. Hurley, PhD.,
Sr. Manager Distributed Computing, Networked Systems Technology,
The Boeing Company

"HPC and CAE: Trends and Paradoxes"
Knute Christiansen, Worldwide HPC Solutions Marketing Manager
Hewlett-Packard

LSTC Presentation

"LS-DYNA – It's Applications and Potentials"
Ian Do, PH.D., Senior Scientist
Livermore Software Technology Corp.

This popular one-day symposium will include over 20 of the industry's leading CAE applications experts, industry speakers and more then 200 engineers and managers to discuss current technology trends in computational engineering.

Among the Industry Experts attending are:

- ANSYS
- ESI Group
  Intelligent Light
- Livermore Software Technology Corp.
- MSC Software
- The Boeing Company

Symposium Tracks

- Impact analysis
- Structural analysis
- Computational fluid dynamics
- Visualization
- Engineering IT technologies

February Featured Paper

ALE Modeling of Surface Waves

Author: Nicolas Aquelet – Livermore Software Technology Corporation
Complete Paper can be read at DYNALOOK

http://www.dynalook.com/documents/6th_European_ls-dyna/4.1.3.pdf

ABSTRACT

An Arbitrary Langrange Euler formulation for the propagation of surface waves is developed in LS-DYNA®. The ALE computational time step in this code is divided in two cycles: A Langrangian cycle in which the mesh follows the material deformation and an advection cycle in which the users through remappping algorithms control the mesh motion. The new feature presented in this paper is one of these remapping algorithms. It enables a Lagrangian behavior of *free* ALE mesh boundaries whereas, in the direction of the wave propagation, the ALE mesh is Eulerian to avoid distortions. Nodes on the ALE mesh borders moves with the surface waves during the Lagrangian cycle. During the advection cycle, the remap positions of these nodes are computed by interpolating the Langrangian positions of their neighbors with biquadratic polynomials. If the wave amplitudes are too important, ALE smoothing can be used for the internal nodes and a specific smoothing is applied on the mesh surfaces.

The "1st International Conference on Hot Sheet Metal Forming of High performance Steel, October 22-24, 2008, Kassel, Germany"

The ongoing demand towards the application of high-performance steel and, beyond that, towards steel parts with tailored properties leads inevitably to a demand for improved metal forming technologies. Among these technologies hot sheet metal forming is gaining increasing importance. The technological reason for that can be seen in the ability not only to improve formability at elevated temperatures but especially in the potential of simultaneous control of complex micro structures during thermo-mechanical processing. This of course involves challenges in terms of tailored properties through optimisation of varying microstructure over the overall part geometry. As the first in a series of international conferences, to be alternatively held in Kassel and in Luleå, will highlight these multiple aspects from a scientific as well as from an industrial viewpoint

Website Conference Invitation - pdf

Conference Secretary Contact Information

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SGI® Acquires Assets of Linux Networx

SUNNYVALE, Calif., Feb. 14 -- SGI demonstrated continued momentum in the HPC market today with the announcement of its acquisition of the core assets of Linux Networx, Inc. and an investment in SGI by Oak Investment Partners and Lehman Brothers.

In exchange for the issuance of SGI common stock, SGI has acquired key Linux Networx software, patents, technology and expertise. Linux Networx is a recognized technology leader in the clustered HPC space and boasts a significant customer base. The acquisition is expected to advance SGI leadership in production-ready high performance computing solutions.

"This is another significant step in the growth of SGI," said Bo Ewald, SGI Chief Executive Officer. "We've grown orders more than 30 percent in each of the last two quarters. We're in a position to acquire key technology and expertise to further power our growth. This represents the first of such key technology acquisitions and will help further the development of our software environment and support for our clustered systems. In addition, we are very pleased that Oak and Lehman Brothers have provided additional financing to the company to help speed our growth."

As part of the transaction, SGI has acquired software and several patents in the areas of cluster design, power and cooling and overall cluster optimization. SGI will also add key personnel and expertise in the areas of software design, system optimization, application performance tuning and cluster management.

The purchase of the Linux Networx assets closed today. For additional information refer to SGI SEC reports.

About SGI

SGI (Nasdaq: SGIC) is a leader in high-performance computing. SGI delivers a complete range of high-performance server, visualization and storage solutions along with industry-leading professional services and support that enable its customers to overcome the challenges of complex data-intensive workflows and accelerate breakthrough discoveries, innovation and information transformation. SGI helps customers solve significant challenges whether it's enhancing the quality of life through drug research, designing and manufacturing safer and more efficient cars and airplanes, studying global climate change, providing technologies for homeland security and defense, or helping enterprises manage large data. With offices worldwide, the company is headquartered in Sunnyvale, Calif., and can be found on the Web at www.sgi.com.

Seminars From carhs.training gmbh

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trainingcenter@carhs.de
http://www.carhs.de/en

Training Center: Alzenau – A few of the many 2008 classes starting at 9:00 am

Advanced Complexity-based Robust Design	Wed, 23 Apr
Introduction to Passive Safety of Motor Vehicles	Wed, 28 May
Euro NCAP and global Tests for Consumer Protection through Active and Passive Safety	Mon, 23 Jun
Frontal-Restraint Systems according to FMVSS 208 and Euro NCAP	Wed, 25 Jun
Side Impact - Requirements and Development Strategies	Thurs, 03 Jul

Intelligent Light – FieldView

Intelligent Light Website

Bringing FieldView products to Windows Compute Cluster Server 2003 and Windows HPC Server 2008 systems, expanding access to large data post-processing capability for CFD and CAE.

Rutherford, NJ (January 9, 2008) — With the goal of expanding access to high-performance computing resources for CFD and CAE practitioners worldwide, Intelligent Light is working with Microsoft to deliver new capabilities for the mid-range technical computing market. The collaboration will bring expertise and accessibility together as a part of a turnkey end-to-end solution stack for simulation driven organizations.

"Engineers' appetite for improving their understanding and their design solutions is insatiable. Our customers continue to increase their reliance on simulation and high performance workflow. Windows Compute Cluster Server and Windows HPC Server 2008 bring the power of high-performance computing to wholly new segments of our markets while promising to decrease the operational cost in many well established environments," said Steve M. Legensky, General Manager at Intelligent Light. "The availability of FieldView products running on Windows Compute Cluster Server will bring large data capabilities to many engineers and organizations who have previously been unable to effectively deploy HPC solutions."

"By accelerating how real-world phenomena are simulated, high-performance computing has become an essential tool of modern engineering," said Shawn Hansen, Director of HPC Marketing at Microsoft. "Through accelerating simulations on easy-to-deploy HPC clusters, design engineers can amplify productivity by conducting more accurate simulations, exploring more design candidates, and speeding fundamental research. Also, by offering FieldView on clusters that integrate seamlessly with existing Windows infrastructure, Intelligent Light enables engineers to focus more on their core research, and less on IT management."

Engineering HPC solutions for small to midsize companies and departments has traditionally been cost prohibitive. However, Windows Compute Cluster Server 2003 and Windows HPC Server 2008 clusters - which are built to integrate seamlessly with the company's existing Windows-based environment - are cost effective to deploy, integrate with existing infrastructures, and easy to manage and use.

"Both Windows and FieldView product families share a long tradition of making technology accessible to the people who use it. FieldView products running on Windows Compute Cluster Server 2003 will enhance the simulation capability, productivity, and impact of our joint customers. This also directly contributes to the simultaneous achievement of organizational goals for improving product and research quality, decreasing time to market, and decreasing the costs of product and knowledge development," noted Roger R. Rintala, strategic marketing manager at Intelligent Light.

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FieldView and LS-DYNA

FieldView now supports post-processing of structural analysis data. With FieldView Version 12, LS-DYNA simulation data can be easily read into and post-processed bringing powerful

analysis, animation, and large data capabilities to this community. This is an ideal joint solution for Fluid-Structure Interaction (FSI) simulations. The structural analysis support will expand as additional data readers are made available as plug-ins to the initial release.

Dr. Godo added, "We've added the ability to read FSI and crash simulation data from LS-DYNA and we are proud to deliver the results of our collaboration with LSTC to our customers."

"Many LS-DYNA customer organizations are already FieldView users for CFD. LSTC engineers have worked closely with Intelligent Light to support the development of CAE post-processing capabilities for LS-DYNA data within FieldView. We welcome FieldView as a tool to increase productivity and enhance both the interrogation of and presentation of simulation results," said Wayne L. Mindle, Ph. D., technical sales engineer at Livermore Software Technology Corporation (LSTC). "Customers with large simulations will benefit from the rich heritage and capabilities for handling large, transient data that have been a part of FieldView for many years."

Users in all industries will benefit from the simplicity of the new one-click animation capability. It is now simple to create animations of simulation results with the click of a single button. The linking of surfaces and datasets allows this to be done for multiple transient datasets as required for FSI and other multi-physics applications.

"It is exciting to simultaneously extend the capabilities of FieldView while bringing its culture, reliability, and well known ease of use to new analyst communities," Dr. Godo concludes. "Our commitment to user productivity is reflected in this release with new automation functions in FieldView FVX and the ability to capture available hardware resources for optimal performance and multitasking."

Many analysts have used FieldView over the years and have moved into other roles where FieldView is not available to them. The tremendous changes to FieldView capabilities are causing analysts and managers to consider FieldView again. When they do, they find the same simple, efficient, reliable environment they appreciate and are familiar with along with new functionality including the ability to handle their FSI and CAE data, different solvers, arbitrary polyhedral elements, and 2-D plotting needs. FieldView has become the most comprehensive post-processing and visualization tool on the market today.

About Intelligent Light

Intelligent Light, located in Rutherford, New Jersey, was founded in 1984 with a mission to provide the scientific and engineering community with the best possible tools for understanding data and communicating results. The company provides CFD and CAE post-processing and big data visualization capability, under the industry leading FIELDVIEW brand, to thousands of HPC users in the aerospace, automotive and general manufacturing industries. Their unique development team is composed of CFD leaders, computer scientists, and visualization experts focused on listening to clients and delivering products that meet their needs.

APTEK - MMCD LS-OPT® Interface

APTEK Website

The basic fitting procedure is to use the MMCD GUI to select the material model parameters that the user wants to fit to test data, define a range in values for these parameters, and then perform numerous MMCD calculations over the range in values. LS-OPT creates multi-dimensional surfaces of the computed response versus parameter values. Then LS-OPT finds the parameter values that minimize the difference between each computed response surface and each test data point using an iterative optimization routine. Multiple response surfaces are created, and the differences are summed up, if multiple data points are analyzed.

Obtaining an LS-OPT license

LS-OPT is developed by LSTC. Contact LSTC for your local distributor.

MMCD Steps for Performing an Optimization using LS-OPT

- Optimization Setup
  - Optimization Title
  - Material Model
  - Point Selection
  - LS-OPT Iterations
- Variable Selection
- Dependent Variable Definition
- Test Data Selection
- MMCD Solver Definitions
- Objective Definitions
- MMCD Iteration Specification

Yahoo Group Yammerings

LS-DYNA® Yahoo Group is neither owned/operated by LSTC, LSTC has no control over the content.

Jim Kennedy	Len Schwer
KBS2 Inc.	Schwer Engineering & Consulting Services
jmk@kbs2.com	Len@Schwer.net

The LS-DYNA Yahoo Group archive contains a wealth of information that can be helpful to any LS-DYNA user. We suggest you 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.*

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

1. *Limitations of Shell Type 17 Fully Integrated DKT Triangular?*
2. *Multiple forming simulations?*
3. *Rayleigh Wave Prediction?*

Limitations of Shell Type 17 Fully Integrated DKT Triangular?

Are there known limitations of the triangular DKT Shell Element Type 17? How about the accuracy in bending and plasticity? Is the speed the only drawback?

Reply by Jim Kennedy

Some comments are given in the following note:

"A List of New Capabilities in Version 960 of LS-DYNA," Livermore Software Technology Corporation, 2000. http://www.dynalook.com/documents/Feainformation/feb_2001.pdf

It is stated there, "A discrete Kirchhoff triangular shell element (DKT) for explicit analysis with three in plane integration points is flagged as a type 17 shell element. This element has much better bending behavior than the cotriangular element."

I believe that I read somewhere that the DKT formulation gives more accurate solutions for coarser mesh densities. A nice description and discussion of the element is given here: Wu, S., Li, G., and Belytschko, T., "A DKT Shell element for Dynamic Large Deformation Analysis", Communications in Numerical Methods in Engineering, Vol. 21, pp. 651-674, 2005.

Perhaps the following paper might offer some discussion which may be of interest:

Zheng, Q., Gu, R., Song, J. "Finite Element Method in Assessing Springback of Stamped Parts - A DKT Shell Model", SAE Paper 2005-01-0519, CAD/CAM/CAE Technology - Analysis, SAE 2005 World Congress & Exhibition, Detroit, Michigan, April, 2005.

Multiple forming simulations?

I am looking for the best way to simulate multiple bends and forming on a part without having one HUGE model. In other words I need to take the results of one problem and use them in a new problem. I have tried importing the results from LS-Pre-Post into the new model but receive several errors when it tries to read initial stresses. I have used

interface spring back keywords before, but I need to specify additional constraints on the work piece, radiator, etc., entered in to LS-DYNA?

Reply by Chris Galbraith

In my experience, the best way to handle multiple forming simulations is to dump out a DYNAIN file for the work piece after each stage. You don't need to include any constraints. Then read the DYNAIN file into a pre-processor that handles the initial stresses and strains. DYNAFORM works really well for this, and I am sure there are others as well. The most important thing for the pre-processor to do is to be able to do a tensor rotation. The initial stresses and initial strains are output in global coordinates. If you rotate the part at all in the pre-processor (i.e. to make it fit in between the new tools) then your pre-processor must map the tensors between the original and new coordinate systems. For example, rotating the part by 90 degrees about the z-axis will transform the global x-strains into global y-strains, and vice versa. Nothing needs to be done to the tensor for translations.

Rayleigh Wave Prediction?

After an impact event with an elastic surface, I see that LS-DYNA predicts the compression and shear wave fronts. What I don't see is the Rayleigh wave that should appear as a displacement on the surface radiating outward and decaying as a function of distance from the impact site.

Does anyone know if the equation for predicting these phenomena is built into LS_DYNA? Has anyone studied this behavior? For particular materials such as brittle ceramics, it can be the primary failure mode.

Reply by Len Schwer

LS-DYNA has NO built in phenomena. It solves the discrete non-linear continuum equations of motion. Thus, if you observe P (compressive) and S (shear) waves, then the Rayleigh wave should also be present.

This part of the answer is more intuition than knowledge. Since the Rayleigh wave produces circular or elliptical surface motion, it may require significantly more mesh refinement to observe than the P & S body waves.

LS-DYNA Yahoo Groups: You can subscribe to the group by sending an email request to LS-DYNA-subscribe@yahoogroups.com or by visiting the Yahoo Groups web site http://groups.yahoo.com

LS-DYNA® on Windows® Compute Cluster Server

Executive Breakfast, Tuesday, March 4, 2008

Presented by LSTC – ETA – Microsoft

Benefits of the Compute Cluster for LS-DYNA applications.

Invitation:

Tuesday, March 4th, 2008
Breakfast beginning at 8:30 am
Program 9:00 am to 11:30 am
Microsoft Southfield Campus
1000 Town Center,
Suite 1930, Southfield,
Michigan 48075

Join us for the latest on:

- Bringing the power and flexibility of the Microsoft platform and technologies to the Compute Cluster Server with LS-DYNA.
- The benefits of the Compute Cluster for LS-DYNA applications.
- Technical information regarding LS-DYNA, eta/VPG and eta/DYNAFORM
- Deploying and developing high performance solutions leveraging Windows Compute Cluster Server
- Experience how the server is simple to deploy, operate, and integrate with existing CAE applications and other advanced tools.

Program Topics:

High Performance Computing Applications of LS-DYNA – Virtual Tests and Beyond.

- How LS-DYNA combined with HPC and Cluster Computing has changed the way we do simulations.
- The need for tools to efficiently handle these models.
- Improved fidelity of FE models and more realistic simulations.
- Trends in simulation that take advantage of cluster computing environments.

Cluster Computing with LS-DYNA:

Applications and Scaling - Overview of LS-DYNA Scaling on Clusters

Experience how the server is simple to deploy, operate, and integrate with LS-DYNA and other advanced CAE tools.

Registration made simple – e-mail Dr. Wayne Mindle of LSTC with your name and phone number, company name, and that you would like to attend

For information:
Dr. Wayne Mindle
wlm@lstc.com
925-449-2500

nHance Oasys ARUP

The software house of ARUP

Oasys LS-DYNA® Update Meeting in India - Wed 2nd April 2008

Oasys Ltd. and nHance Engineering Solutions Pvt. Ltd. are pleased to announce Oasys LS-DYNA Update Meeting in India

Oasys Ltd and nHance Engineering Solutions Pvt Ltd are pleased to announce the forthcoming Oasys LS-DYNA Update meeting being held on Wednesday 2nd April 2008 at Le Meridien hotel in Pune, India.

This full day free of charge event covers 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.
Presentations will also include developments in FE dummy and barrier models.

We are pleased to welcome Mr. Sarang Kshirsagar - Project Manager(Crash) of TATA Motors who will be speaking at this event

Registration

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

Venue

The event will be held at Le Meridien Hotel in Pune which is situated in the heart of the business district.

Raja Bahadur Mill Road, Pune 41001, India
+91 (20) 26050505

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:

Ms Rafia Sultana, nhance Engineering Solutions(P)Ltd (Part of the ARUP Group)
Plot No. 39, Ananth Info Park, Opposite Oracle Campus
HiTec City-Phase II, Madhapur, Hyderabad-500081, India
Tel: +91 (0) 40 44369797/8 - Email: india.support@arup.com

Provisional Agenda for Oasys LS-DYNA India Update Meeting
Date: 2nd April 2008 - Place: Le Meridien Hotel, Pune

Time	Session	Length of Presentation	Presenter
09:30AM-10:00AM	*Registration with tea & coffee*		
10:00AM-10:10AM	Welcome Address	10 minutes	Prasad Nadipalli & Lavendra Singh
10:10AM-11:10AM	Session 1: LS-DYNA-1 Oasys PRIMER Introduction	 30 minutes 30 minutes	 Brian Walker Miles Thornton
11:10AM-11:40AM	*Tea & Coffee*		
11:40AM-1:00PM	Session 2: Oasys Post-processing Introduction Arup Car Project (SLC) FE Models: FAT dummies & Arup Cellbond Barriers	 30 minutes 30 minutes 20 minutes	 Roger Hollamby Neil Butcher/Neil Ridley Brian Walker/Lavendra Singh
1:00PM-2:00PM	*Lunch*		
2:00PM-3:30PM	Session 3: Oasys PRIMER Advanced Oasys Post-processing Advanced Oasys REPORTER	 40 minutes 30 minutes 20 minutes	 Miles Thornton Roger Hollamby Miles Thornton
3:30PM-4:00PM	*Tea & Coffee*		
4:00PM-5:10PM	Session 4: Invited Speaker 1 Invited Speaker 2 LS-DYNA-2	 20 minutes 20 minutes 30 minutes	 Mr.Sarang Kshirsagar, Tata Motors TBC Brian Walker
5:10PM-5:20PM	Closing Address & Raffle		
5:20PM-5:50PM	Time for networking and Oasys LS-DYNA Team available for discussion, questions & software demonstrations		

Leading Engineering Application Providers – LEAP

Leading Engineering Analysis Providers

LEAP stands for Leading Engineering Application Providers. Our area of expertise is the application of technology to enable efficient product development, manufacturing, and management of the whole process throughout the entire lifecycle

Among the Products distributred: ANSYS Products – LSTC Products – ETA Products

For complete Course Locations and Contact visit

ANSYS Vibration seminar
Mar 5, 2008

Pro/ENGINEER Seminar
Mar 6, 2008

ANSYS & Pro/ENGINEER Educational Hands-On Workshop
March 2008, TBA

What's New in Pro/ENGINEER Seminar
Mar 19, 2008

Pro/ENGINEER Pro/PROCESS Seminar
Mar 20, 2008

EDEM Hands-On Workshop
Mar 28, 2008

ANSYS & Pro/ENGINEER Educational Hands-On Workshop
Mar 27, 2008

JRI Solutions, Ltd. (JRI-SOL)

JRI Solutions Ltd Website

Japan LS-DYNA® Users Conference 2008

Date : Tuesday, October 7 - Wednesday, October 8, 2008
Organizer: JRI Solutions, Ltd.
Venue: Grand Prince Hotel Akasaka (Tokyo, Japan)

JRI Solutions, Ltd. (JRI-SOL) offer following services as a distributor of LS-DYNA in Japan and a developer of CAE package software:

- Consulting of software application to fit user's environment and purposes
- Manuals and original reference books (both in Japanese)
- Technical support for the users by experienced staff
- Regular training classes

Products
(#) originally developed by JRI -Sol

LS-DYNA
Impact and structural analysis program

JVISION (#)
Multipurpose pre/post-processor

Oasys Software
Pre/post-processor for crashworthiness, occupant safety, and related application

JSTAMP/NV (#)
Integrated Forming Simulation System for Virtual Tool Shop

JMAG (#)
Electromagnetic field analysis software package

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LS-DYNA® Support Site Recent Change – February 02, 2008

Hourglass

Preface

See the User's Manual (*HOURGLASS) and sections 3.2 and 6.4 of the Theory Manual.

Hourglass (HG) modes are nonphysical, zero-energy modes of deformation that produce zero strain and no stress. Hourglass modes occur only in under-intetgrated (single integration point) solid, shell, and thick shell elements. LS-DYNA has various algorithms for inhibiting hourglass modes. The default algorithm (type 1), while the cheapest, is generally not the most effective algorithm.

A way to entirely eliminate hourglass concerns is to switch to element formulations with fully-integrated or selectively reduced (S/R) integration. There can be a downside to this approach. For example, type 2 solids are much more expensive than the single point default solid. Secondly, they are much more unstable in large deformation applications (negative volumes much more likely). Third, type 2 solids have some tendency to 'shear-lock' and thus behave too stiffly in applications where the element shape is poor.

Notice

Triangular shells and tetrahedral solid elements do not have hourglassing modes but have drawbacks with regard to overly stiff behavior in some applications.

A good way to reduce hourglassing is to refine your mesh.

The method of loading can affect the degree of hourglassing. A pressure loading is preferred over loading individual nodes as the latter approach is more likely to excite hourglassing modes.

To evaluate hourglass energy, set HGEN to 2 in *CONTROL_ENERGY and use *DATABASE_GLSTAT and *DATABASE_MATSUM to report the HG energy for the system and for each part, respectively. The point is to confirm that the nonphysical HG energy is small relative to peak internal energy for each part (<10% as a rule-of-thumb). For shells only, you can fringe hourglass energy density by first setting SHGE=2 in the LS-DYNA input deck (*DATABASE_EXTENT_BINARY). Then, in LS-Prepost, choose Fcomp >> Misc >> hourglass energy.

For fluid parts, the default HG coefficient is generally inappropriate (too high). Thus for fluids, the hourglass coefficient should generally be scaled back several orders of magnitude. Use only viscosity-based HG control for fluids. The default HG formulation (type 1) is generally ok for fluids. Please note that in 971 R3, the default hourglass coefficient for ALE parts (ELFORM 11) is 1.e-6. To override that default, as might be appropriate for non-fluid materials, use *HOURGLASS and HGID in *PART. Check the hourglass energy via MATSUM.

Hourglass types

Stiffness-based HG control (types 4,5) is generally more effective than viscous HG control for structural

parts. Usually, when stiffness-based HG control is invoked, I like to reduce the HG coefficient, usually in the range of .03 to .05, soas to minimize nonphysical stiffening of the response and at the same time effectively inhibiting hourglass modes. For high velocity impacts, viscosity-based HG control (types 1,2,3) is recommended even for solid/structural parts.

Type 8 HG control applies only to shell formulation 16. This HG type activates warping stiffness in type 16 shells so that warping of the element does not degrade the solution. Type 16 shells will solve the so-called Twisted Beam problem correctly if HG type 8 is invoked.

Type 6 HG control invokes an assumed-strain co-rotational formulation for type 1 solid elements and under-integrated 2D solids (shell types 13 and 15). With the HG type set to 6 and the hourglass coefficient set to 1.0, an elastic part need only be modeled with a single type 1 solid through its thickness to achieve the exact bending stiffness. Type 6 HG control should always be used for type 1 solids in implicit simulations (in fact, this is done automatically in v. 970).

The hourglass coefficient for type 6 HG control will typically range from 0.1 (default) to 1.0. For elastic material, use 1.0. For other materials, the choice of HG coefficient is not obvious. Even looking at results, it may be difficult to quantify the 'goodness' of the hourglass coefficient used. Too low a value may result in visible hourglass modes of deformation (unlikely). Too high a value may result in overly stiff behavior. It may be necessary to run the model twice to see if the results exhibit any sensitivity to the hourglass coefficient. Checking the hourglass energy is a good idea.

The default hourglass coefficient of 0.1 is superseded by any nonzero value given for QH in *CONTROL_HOURGLASS. I see nothing in the manual to contradict this interpretation. The manual does say that the default hourglass type in *HOURGLASS is 1 regardless of what's given in *CONTROL_HOURGLASS. Unless I missed something, no such note appears with regard to hourglass coefficient. The lesson here is that users should specify a nonzero hourglass coefficient wherever *HOURGLASS is used. Otherwise, the user may, as you did, inadvertently change the intended coefficient by use of *CONTROL_HOURGLASS.

Comments regarding these notes can be directed to jday@lstc.com

Participant LS-DYNA® Resource Page (alpha order)

Fully QA'd by Livermore Software Technology Corporation

SMP and MPP Hardware and OS

FUJITSU

FUJITSU Prime Power	SUN OS 5.8
FUJITSU VPP	Unix_System_V

HP

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

IBM 4/5	AIX 5.1, 5.2 5.3
IBM Power 5	SUSE 9.0

INTEL

INTEL IA32	Linux, Windows
INTEL IA64	Linux
INTEL Xeon EMT64	Linux, Windows 64

NEC

NEX SX6	Super-UX

SGI

SGI Mips	IRIX 6.5X
SGI IA64	SUSE 9 w/Propack 4 Red Hat w/ Propak 3

SUN

SUN Sparc	5.8 and above
SUN Opteron	5.8 and above

Participant LS-DYNA® Resource Page (alpha order)

Fully QA'd by Livermore Software Technology Corporation

MPP and Interconnect MPI

FUJITSU

	O/S	HPC Interconnect	MPI Software
FUJITSU Prime Power	SUN OS 5.8		
FUJITSU VPP	Unix_System_V		

HP

	O/S	HPC Interconnect	MPI Software
HP PA8000	HPUX		
HPIA64	HPUX		
HP Alpha	True 64		

IBM

	O/S	HPC Interconnect	MPI Software
IBM Power 4/5	AIX 5,1, 5.2, 5.3		
IBM Power 5	SUSE 9.0		LAM/MPI

INTEL

	O/S	HPC Interconnect	MPI Software
INTEL IA32	Linux, Windows	InfiniBand (Voltaire), MyriCom	LAM/MPI, MPICH, HP MPI, SCALI
INTEL IA64	Linux		LAM/MPI, MPICH, HP MPI
INTEL Xeon EMT 64	Linux	InfiniBand(Topspin, Voltaire), MyriCom, PathScale InfiniPath	LAM/NPI, MPICH, HP MPI, INTEL MPI, SCALI

NEC

	O/S	HPC Interconnect	MPI Software
NEX SX6	Super-UX		

SGI

SGI Mips	IRIX 6.5 X	NUMAlink	MPT
SGI IA 64	SUSE 9 w/Propack 4 RedHat w/Propack 3	Numalink, InfiniBand(Voltaire)	MPT, Intel MPI, MPICH

SUN

Sun Sparc	5.8 and above		
Sun Opteron	5.8 and above		LAM/MPI

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.

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 Ltd.: Specializing in Research & Consulting; System Consulting, Frontier Business, System Integration and Science Consulting.

Hewelett 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.

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

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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

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.

FEA Information Participants –

Company name takes you directly to Website

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).

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

Intelligent Light: A a world leader in the development and delivery of software for computational fluid dynamics (CFD) users. We help the world's best engineering and research organizations maximize the productivity and impact of their CFD capabilities

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LS-DYNA® Software Distributors - Alphabetical order by Country

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

Consulting and Engineering Services

Australia Manly, NSW	Leading Engineering Analysis Providers (LEAP) Greg Horner info@leapaust.com.au 02 8966 7888
Canada Kingston, Ontario	Metal Forming Analysis Corp. - (613) 547-5395 Chris Galbraith galb@mfac.com
Germany Alzenau	CARHS - 49 6023 96 40 60 info@carhs.de
Italy Firenze	EnginSoft Spa - 39 055 432010 info@enginsoft.it
UK Solihull, West Midlands	ARUP - 44 (0) 121 213 3317 Brian Walker brian.walker@arup.com
USA Austin, TX	KBEC L.C - (512) 363-2739 Khanh Bui kdbui@sbcglobal.net
USA Windsor, CA	SE&CS - (707) 837-0559 Len Schwer len@schwer.net
USA Troy, MI	Engineering Technology Associates, Inc: (248) 729-3010
USA Corvallis, OR	Predictive Engineering - (1-800) 345-4671 George Laird george.laird@predictiveengineering.com
USA Troy, MI	Detroit Engineered Products
USA Troy, MI	Engineering Technology Associates, Inc. (248) 729-3010 sales@eta.com
USA Austin, TX	Friedman Research Corporation - (512) 247-2277

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

LS-DYNA Support Site	FEA Informationwebsites
LS-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	

LSTC Training Classes in California & Michigan

	California	Michigan
Advanced Impact	Aug 5-8	
Advanced Option	June 23-24	Dec 15-16
ALE/Eulerian & FSI	Feb 13-15	
Blast & Penetration	Aug 18-19	
Composite Materials	June 25-26	
Concrete & Geomaterial Modeling	Sept 25-26	
Contact	Aug 14-15	March 27-28 Sept 16-17
Heat Transfer & Thermal-Stress		
Implicit	Aug 12-13	
Intro to LS-DYNA	May 06-09 July 22-25 Nov 11-14	March 18-21 June 17-20 Sept 09-12 Dec 09-12
Intro to LS-OPT	Sept 09-14	Apr 08-11
Material Modeling Using User Defined Options	June 30-July01	
Mesh Free Methods (SPH & EFG)		

RESUME: Mark Greer

2516 W. Country Bend Drive • South Jordan, UT 84095 • (801) 254-9354 •
mlgreer@msn.com

MANAGEMENT: Product Marketing, Business Development, Alliance Marketing, Pre-Sales

PROFILE

Talented and accomplished Marketing professional, with over 15 years of experience directing departments, programs, and projects. Consistent record of achieving dramatic increases in revenue. Expertise in facilitating business growth, directing product development and launches, and supporting corporate sales efforts. Adept at managing effective teams.

Product Marketing • Strategic Planning • Brand Management • Process Improvement
Budget Administration • Pricing • Distribution • Promotions • Problem Solving •
Consultative Sales • Competitive Analysis • Product Positioning • Negotiations •
Relationship Management

PROFESSIONAL EXPERIENCE

Linux Networx, Bluffdale, UT 2007 - Present
Corporate Marketing / MarCOM Manager

Linux Networx, Bluffdale, UT 2004 - 2006
Alliance Marketing Manager

Coordinated partnership marketing efforts at global level and led market research efforts.

- Developed and managed partnerships and joint marketing programs with major software companies to enhance revenue growth by marketing vendor software with Linux O/S supercomputer systems.
- Analyzed partner solution offerings and developed relationships with application vendors to achieve business goals. Investigated and resolved technical issues with partners applications.
- Worked with partners to develop, position, and market value-added solutions for product lines.
- Communicated with field sales to coordinate joint sales efforts and business development opportunities with vendor partners.
- Developed value propositions for product collateral, promotional material, and sales programs.
- **Played key role in company's ability to penetrate commercial market with new product offerings.** Oversaw market research and configuration development for turnkey, desk-side cluster optimized for finite element analysis (FEA) software applications.
- Assisted with creation of reseller agreement used to recruit application partners and resellers.

Novell, Inc., Provo, UT 1999 - 2003
Product Marketing Manager
Managed marketing functions for company's highest-selling products, valued at $45 million.

- Carried out complete project management of products, from initial launch planning through ongoing promotional and marketing efforts.
- **Grew Novell Identity Manager (Novell DirXML) from launch to $25 million in sales, exceeding revenue projects by 34% and becoming market leader.** Developed messaging, managed analyst relations, and created channel messaging.
- **Increased sales 37%** for Novell eDirectory product, by creating aggressive Internet-based promotional offer [targeting SUN and Microsoft directory users] that quadrupled license revenue and received extensive media attention.
- Prepared training materials, oversaw pricing and packaging, performed staff training, developed collateral and web content, and defined positioning strategies.
- **Improved brand recognition 32%** as measured through outside analysts and customer surveys. Supervised team of six for two major launch initiatives.

NCR, Inc., Dayton, OH 1997 - 1999
Pre-Sales Consultant

- Carried out consultative technical sales / sales support of data mining, business intelligence, and scalable data warehouse solutions. Delivered presentations and demonstrations.
- Supported sales for Western region, including 25 sales representatives and accounts such as Sears, Meijer, Home Depot, Wal-Mart, and other nationally recognized retail accounts.
- Prepared RFP responses, proof-of-concept documentation, competitive analyses, and other various pre-sales activities to drive the sales process.
- **Managed projects from business discovery to deployment.** Performed account planning and strategic analyses, customer service, and training.
- Oversaw retail data mining solution support, including affinity and market basket analyses, customer segmentation, site selection, and other functions.
- **Played major role in growing data mining practice from initial launch to viable business unit that delivered several million dollars in new business after second year.**
- **Improved sales process, solution development, and customer satisfaction.** Established retail data mining Community of Interest and associated Intranet site to educate sales and pre-sales staff on data mining technology. Arranged seminars with vendor representatives.
- **Awarded multi-million dollar data mining/business intelligence agreement from Meijer**.

Unisys, Inc., Salt Lake City, UT 1995 - 1997
Partner Marketing Manager

- Established and managed new business unit for company and initiated first relationships with data warehouse/business intelligence software partners, such as Brio, Cognos, and SAS.
- Determined market and customer requirements and carried out complete product life cycle management, including development, positioning, marketing,

vendor selection, contract negotiations, business case development, pricing, life cycle planning, and knowledge transfer.

- **Implemented data mining sales program with projected six-month ROI of $4 million.**
- **Delivered $100 million in sales leads, with 89% conversion rate**, for company. Arranged joint, 10-city seminar with Red Brick on business intelligence and data mining.

Century Software, Murray, UT 1994 - 1995
Channel Marketing Manager

- Developed ISV, VAR, and channel partner relationships to support business goals.
- Managed channel audits and mappings for new software releases. Tracked performance of channel partner programs and worked with distributors to increase sales.
- **Facilitated 15% growth.** Administered budget. Created training materials and collateral.

PREVIOUS EMPLOYMENT

Regional Account Manager, Spire Technologies, Orem, UT 1993 - 1993
Marketing Manager, ZZ Software Systems, Orem, UT 1991 - 1993

EDUCATION

MBA, Finance emphasis, National University, San Diego, CA (1990)
BS in Business Management, Marketing emphasis, Brigham Young University, Provo, UT (1987)

PROFESSIONAL DEVELOPMENT

Project Mgmt., Mgmt., Marketing, Sales Support, RDBMS Modeling, Teradata Factory, SQL

ADDITIONAL INFORMATION

Computers: MS Office, PowerPoint, Project, Adobe Contribute CS3, SQL, MessageReach
Affiliations: Past Member, National Marketing Association

Smooth Contact

© Xinhai Zhu, Livermore Software Technology Corp.

Abstract

This paper introduces a new type of contact called Smooth Contact. Traditional contact is based on nodes and elements, whereas smooth contact fits a surface to the rigid body mesh, and calculates penetrations based on the newly fitted surface. This new contact option can result in more accurate contact force calculations and improved springback predictions.

Introduction

The treatment of sliding and impact along interfaces has always been an important capability in LS-DYNA®. Interfaces can be defined in three dimensions by listing in arbitrary order all triangular and quadrilateral surface segments that comprise each side of the interface. One side of the interface is designed as the slave side, and the other is designated as the master side. Nodes lying on those surfaces are referred to as slave and master nodes, respectively.

Conventional Forming Contact

LS-DYNA offers the *CONTACT_FORMING option for sheet metal stamping simulation which is implemented using a penalty method.This type of contact This method consists of placing normal interface springs between all penetrating nodes and the contact surface. The interface stiffness is chosen to be approximately the same order of magnitude as the stiffness of the interface element normal to the interface. Consequently, the computed time step size is unaffected by the existence of the interface. However, if interface pressure becomes large, unacceptable penetration may occur. We may still solve such problems using the penalty approach by increasing the stiffness and reducing the time step size.

The traditional penalty method is based on using triangular or quadrilateral surface elements, rather than a smooth surface. This may result in some obvious numerical noise when the curvature is large. Figure 1 is an exaggerated example showing the penetration problem in associated with the conventional contact method. In this figure, the smooth curve representing the master side is discretized by three straight line segments. Node A is a slave node located at the end of a slave segment. It is seen that node A should be in contact with the smooth curve representing the master surface. However, the conventional method will not find this contact. Contact will only be detected when the slave node moves closer to the line segment representing the master surface, such as near the position of point B. If node A moves to A', the penetration is detected, but it can be very large. As a result, a huge contact force will be applied to node A', which in turn causes a significant jump in the contact force. When the contact force is too large, the simulation can become unstable.

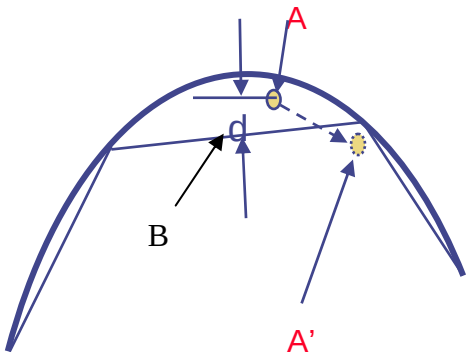


Figure 1. Illustrations of penetration calculation with the conventional contact

Another problem associated with the conventional contact algorithm involves the that calculation of the direction of reaction force between slave nodes and the master elemcontact normal calculationents. In the conventional method, each master segment (element) is treated separately It , and the neighboring element information is ignored. Accordingly, the contact force is always assumed to be in the normal direction of the master element. This is not a serious problem if the curvature is small. If the curvature is large and the slave node is near a vertex, then a small change in location may cause the slave node to find a different (neighboring) master element. This is illustrated in Figure 2. The normal of the contact force will be calculated based on the new master element. This can cause a significant perturbation to the resultant contact force.

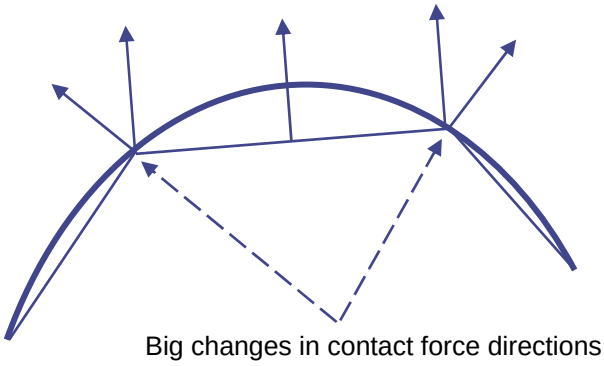


Figure 2 The calculation of contact force orientation in conventional method

Therefore, with conventional contact method, it is expected that the contact force calculation will have many oscillations, which will affect contact force calculations and the springback predictionsFrom the above analysis, it is seen that conventional contact has some obvious disadvantages. It can result in large errors in the calculations of the penetration and contact normal. As a result, the stress distribution and springback predictions will be adversely affected..

Smooth Contact

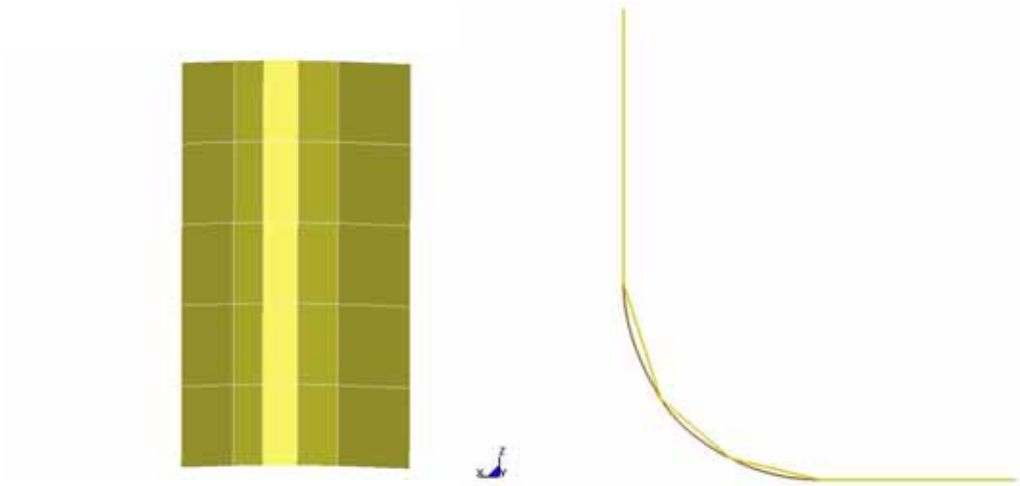
In the 1990s, people began to pay attention to the non-smoothness associated with conventional contact. At first, smooth contact based on CAD surface (IGES and VDA format) was implemented in LS-DYNA. With this method, CAD surfaces as the inputdefine the contact interfaces.

This approach has many problemsits limitations. The CAD surfaces are usually not clean; which means that in other words, there are many gaps, small patches, overlaps, etc. The accuracy and robustness of the contact search algorithm is adversely impacted by these 'dirty' CAD surfaces. The computation is much slower than the conventional contact. It is common for six times the CPU time to be required for simulations. Finally, there are many different entities in a typical CAD surface. It is extremely difficult to support all of these entities. As a result, the contact based on CAD surfaces has only been used for small lab validations.

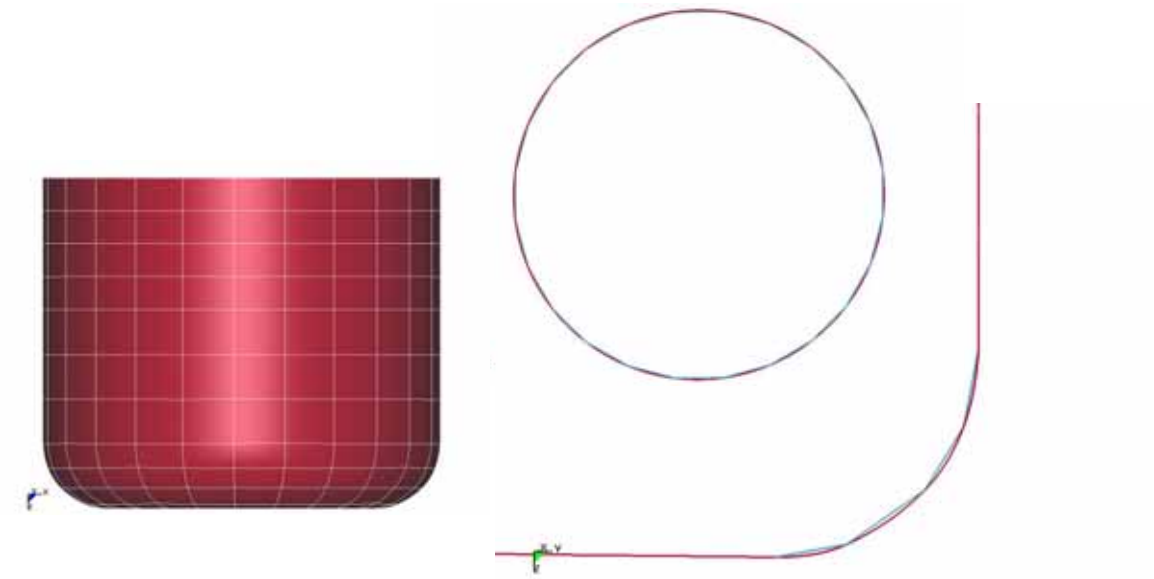
Recently, LSTC developed a new approach that can meet the team's requirements. In this approach, surface patches are fit based on the element for the master sidesby considering the neighboring information. Between the patches, the boundary will have G1 continuityThe surface patches will have G1 continuity among the patch boundaries. The penetration calculations are based on the fitted surface patches.

Surface-fitting

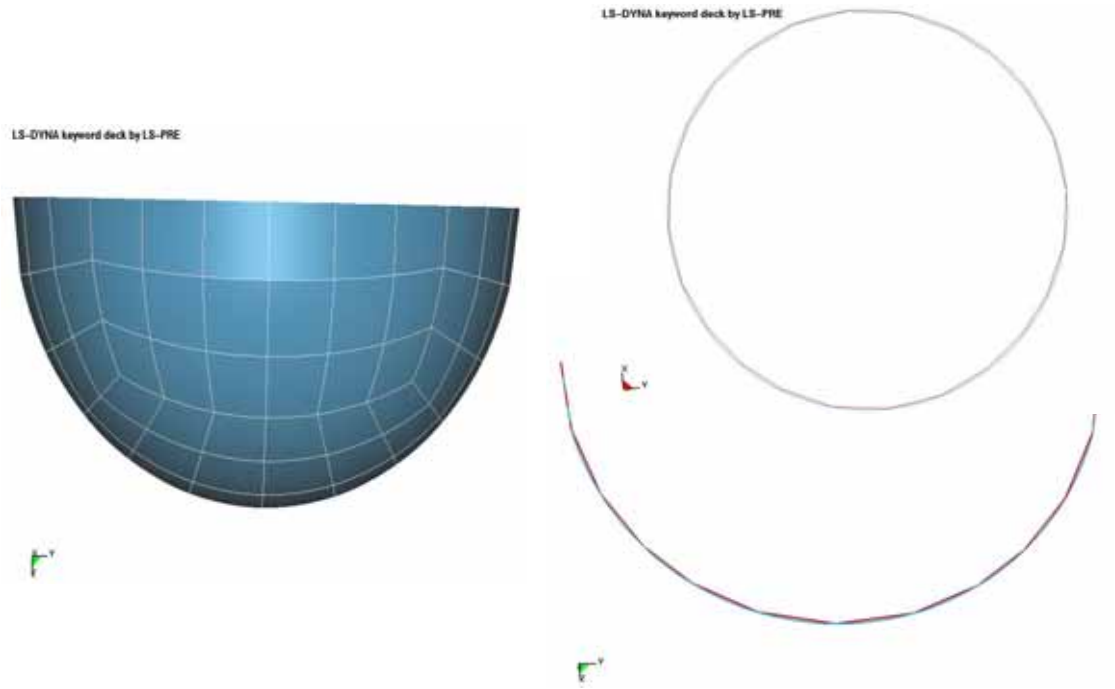
Surface fitting (creating surfaces to fit the mesh geometry) methods must be reliable in order to achieve robust contact methods, since any surface defects can affect the contact force calculation. LSTC has developed an edge-detection algorithm, which is critical to the surface fitting. B-Splines are used to describe the surface patches. Many numerical tests have been performed to validate the robustness of this surface fitting algorithm. Figure 3 shows some of the surface-fitting results, from which it clearly shows that new surface can accurately represent the true smooth surface.



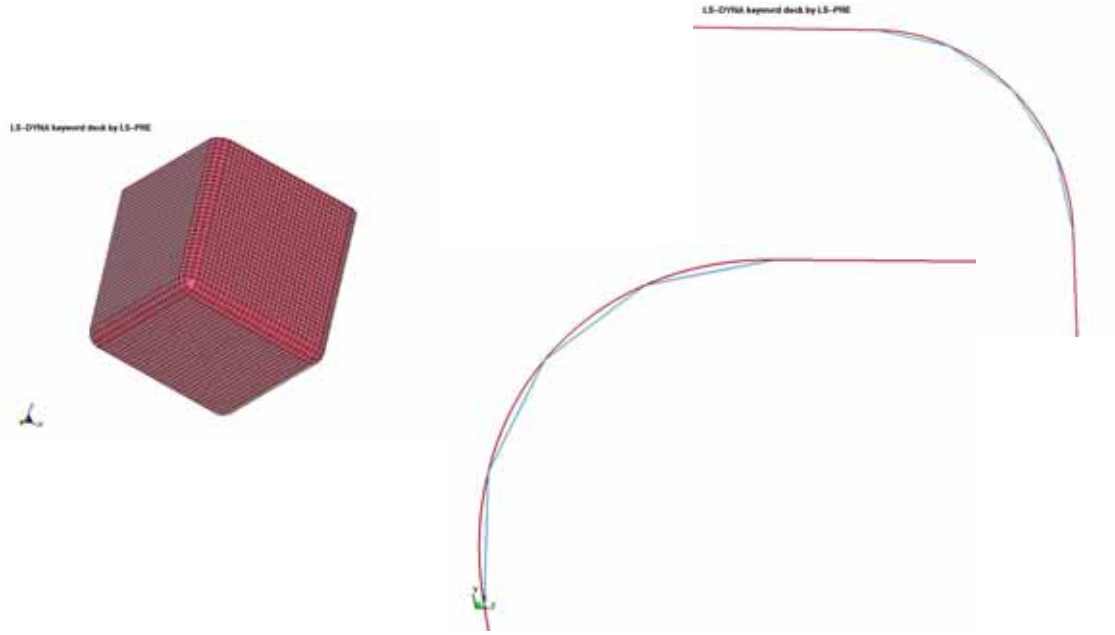
a) surface fitting of a corner



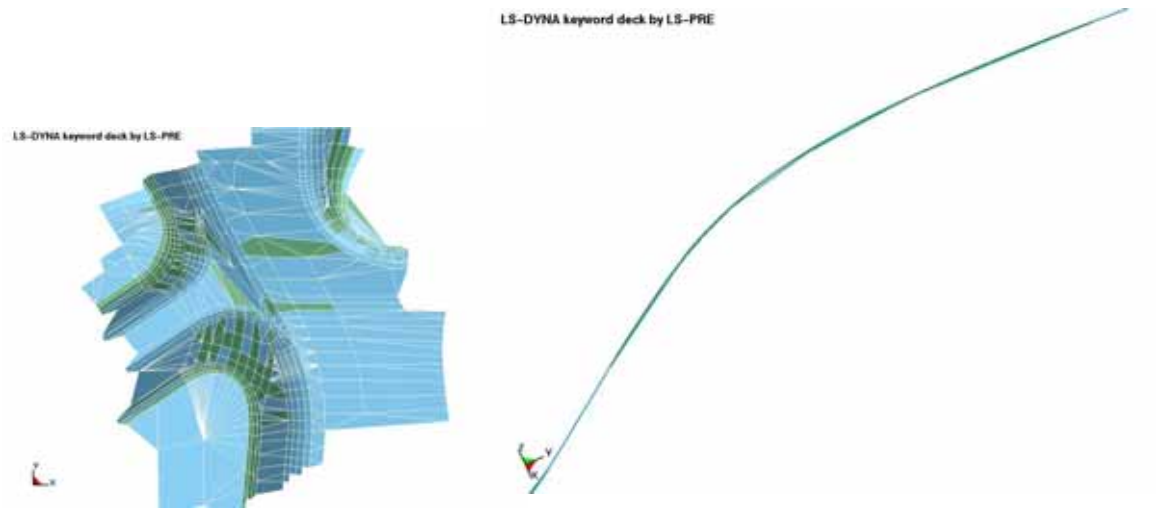
b) Surface fitting of a cylinder



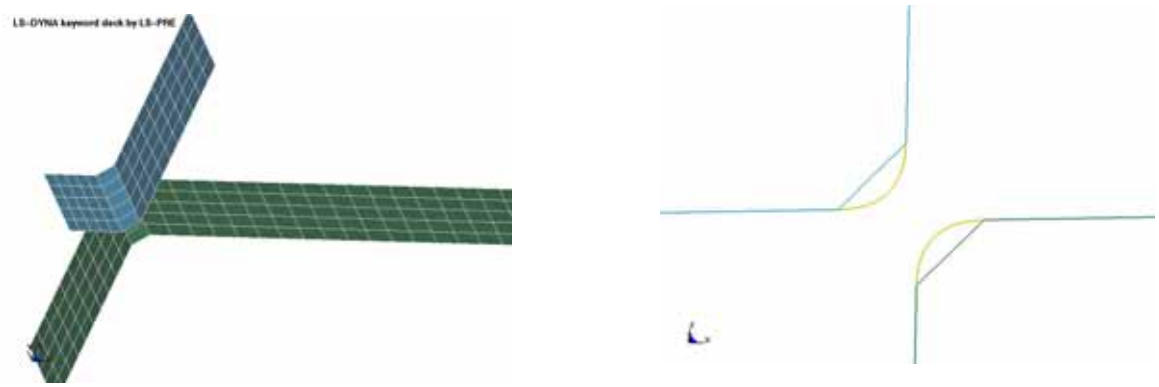
c) Surface-fitting for a half-ball



d) Surface-fitting for a cubic box



e) Surface-fitting for hood-inner (local view)



f)

Figure 3 Surface fitting for different kind of mesh

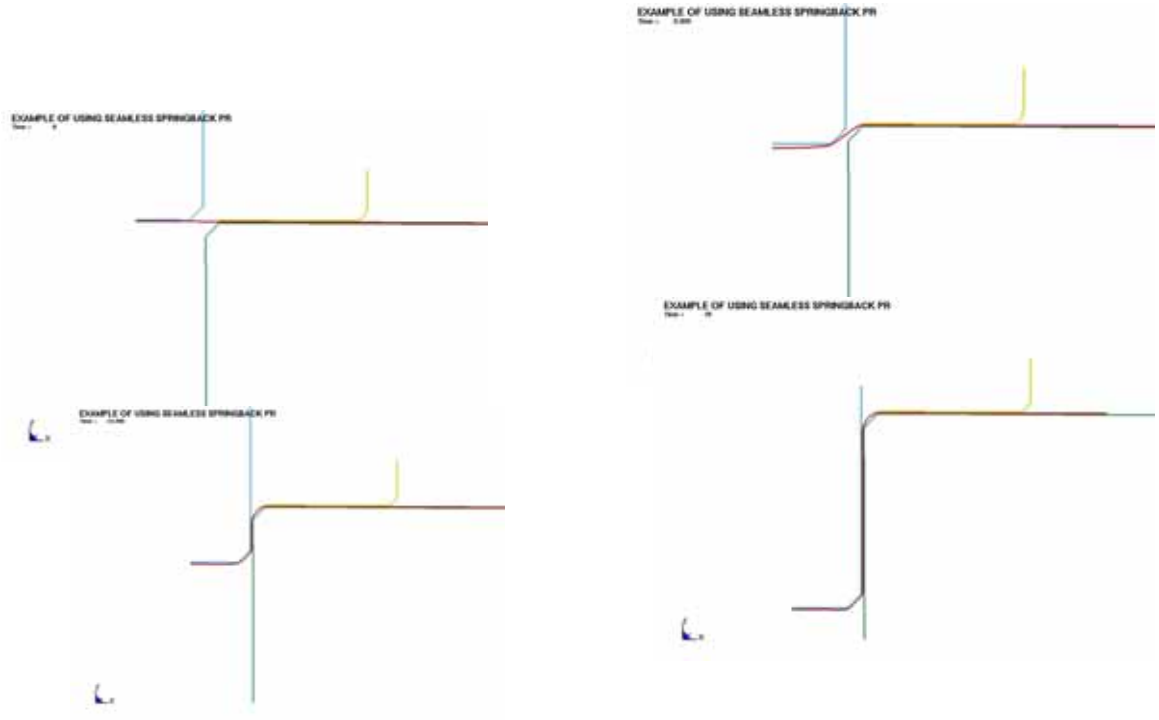
Validations of smooth contact

After the surface-fitting algorithm was fully tested, LSTC developed a new contact searching algorithm based on the surface patch. With the new algorithm, the smooth contact becomes robust and efficient (only 10%~20% overhead).

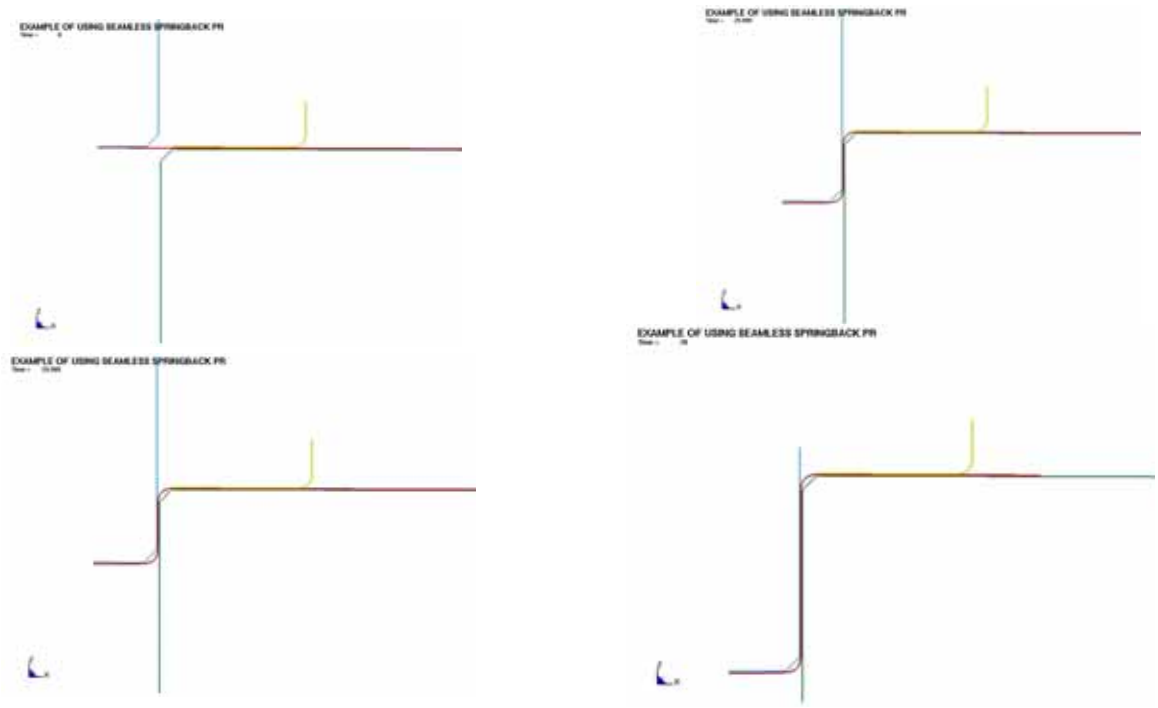
Smooth contact has been implemented in LS-DYNA for both SMP and MPP versions. LSTC has spent lots of efforts in making it user-friendly . To activate smooth contact, only an oprtion, 'SMOOTH', should be added to the conventional contact definition keyword. All the other keywords remain the same.
It is also easy for people to use. The user do not need to worry about the surface, they simply need to use the conventional mesh as contact, and add a '_SMOOTH' option to the contact keyword, such as *CONTACT_FORMING…_SMOOTH.

To use the smooth contact, there are some requirements on the mesh quality for the master sides. First, elements must be non-overlapping. Second, element normals must be consistent. Finally, the mesh must be fully connected. With any current commercial preprocessor, it is very easy to generate a mesh to satisfy the above requirements.

Many tests have been designed to test the code implementation. To test the implementation, a simple test was usIn this test, oOnly one element is put in the 90-degree angle region for NUMISHEET'93 U-Channel. Figure 4a shows the results when the "SMOOTH" option is not used. It is seen that blank forms a sharp angle by following the master elements. Figure 4b shows the results when using the "SMOOTH" option. It is seen that the blank in the corner region does not follow the mesh of the rigid bodies, but follows the smooth internal contact surface instead.



a) Without smooth option



b) With smooth option

Figure 4 Contacts with and without smooth contact option

Some user-dependent results

One of the most important parameters is SLSFAC, which defines the contact stiffness. The contact might be too stiff and the predicted springback might be too small if a large value is used. On the other hand, a small value of SLSFAC can result in large penetrations and also affect the springback prediction. Figure 5 shows the spring back angle prediction of Numisheet'93 U-channel with different value of SLSFAC. It is seen that predicted springback depends on the value of SLSFAC.

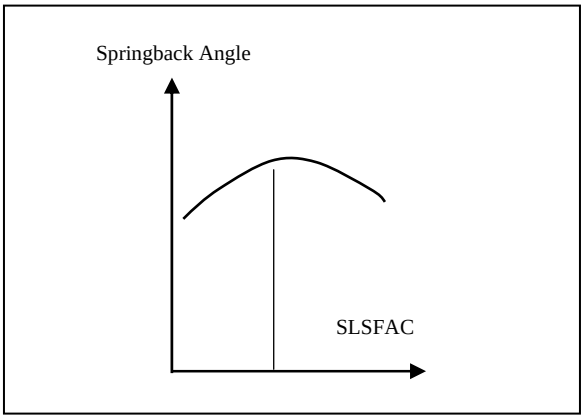


Figure 5 Effect of SLSFAC on springback prediction Material: high-strength steel; binder pressure: 19.6 KN
Initial coarse mesh, with 3 levels of adaptivity

Another important factor affecting springback prediction is the quality of the rigid body mesh. The number of elements in the radius regions can have an obvious effect on springback prediction. It is found that more than six elements are needed to cover a 90 degree angle for the rigid bodies.

With the implementation of smooth contact, smooth surface patches were used for the contact force calculation. As a result, it is expected that the element size of the rigid bodies should have less effect on the springback predictions, and the noise for contact force calculations can be significantly reduced. For validation purposes, a simple test, Numisheet'93 U-channel, was used. In this model, the size of the rigid body elements was changed for each case. The number of elements covering a 90-degree angle ranges from 1 to 10. Table 1 shows that with only one element covering the 90-degree angle, the predicted springback angle is 19.9, while the predicted angles for the other cases are all around 21 degree. It is obvious that smooth contact has significantly reduced the dependence of the size of rigid body elements.

Table 1 The effect of element size on springback predictions

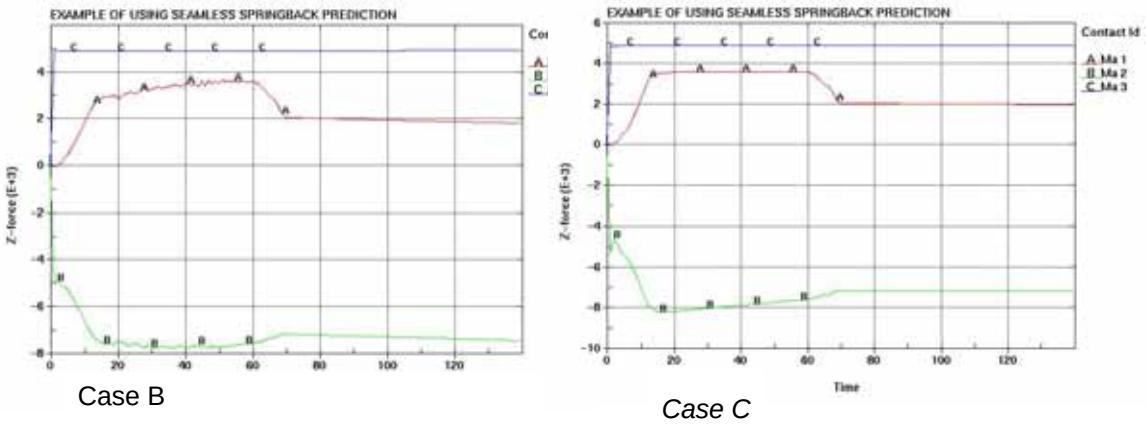
# of Element	1	2	4	10
Angle	19.9	21.2	20.8	21.5

With the smooth contact, the shortcomings associated with conventional contact can be significantly reducedovercome. It is expected that there will be a much smaller change in the calculation of both contact force and reaction direction with the new contact. In addition, a penetrating slave node can be found early. Therefore, large penetration can be avoided. Accordingly, the stiffness of contactthe contact stiffness, or SLSFAC, should have less effect on the contact force calculations. Numisheet'93 u-channel was used again to demonstrate this advantage of smooth contact. In this study, three cases were used. Case A uses the conventional contact with initial

coarse blank mesh and mesh adaptive option; Case case B uses smooth contact, initial coarse blank mesh and mesh adaptive option; and Case case C uses smooth contact and initial fine mesh without mesh adaptivity. Three values of SLSFAC were used: 0.1, 0.05, and 0.01. The results are shown in Table 2. It is seen that, with conventional contact, the predicted springback angle changes significantly from 4.4 degree to 11.0 degree. The prediction for the cases using smooth contact, as shown in cases B and C, is more stable. From this study, it is seen that the springback predictions have become much more stable and depend much less dependent on SLSFAC. The predicted contact force (punch force) also becomes very smooth with the use of smooth contact, which can is shown in Figure 6. Some small oscillations still exist when mesh adaptivity is used, as seen in Case B.

Table 2 Effect of SLSFAC with smooth contact on springback predictions

SLSFAC	0.1	0.05	0.01
Case A	4.4	5.4	11.0
Case B	16.4	17.0	19.4
Case C	21.3	20.9	20.6



Case B

Case C

Figure 6 Effect of smooth contact on contact force

To further validate smooth contact, an industrial production part was studied: Numisheet'05 Automotive Underbody Cross Member, as shown in Figure 7. Two calculations were performed: with and without smooth contacts. It is seen that with smooth contact, the contact force is much smoother than that by using conventional contact, as shown in Figure 8.

Figure 7 Numisheet'05 Automotive Underbody Cross Member

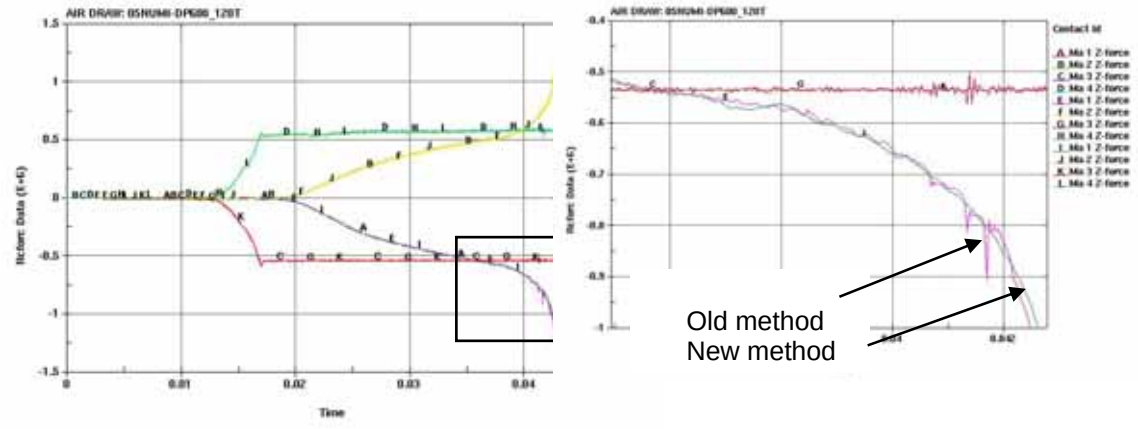


Figure 8 Contact force with and without smooth contact (Automotive Underbody Cross Member

From the above calculations, it is validated that the new calculations with smooth can give improved contact force calculation. Accordingly, the calculation will be less depends on user's experience.smooth contact has been shownproven to be more accurate and can reduceovercome user-dependent predictions. Due to the extra calculations required for smooth contact, it usually takesusually ten to two twenty percent more CPU time to perform a forming simulation.

Conclusions

The proposed surface fitting algorithm is robust; it can nicely fit surfaces from different kinds of rigid body meshes. With smooth contact, the noise in a penetration calculation can be significantly reduced, and the predicted contact force becomes more accurate. As a result, the contact stiffness has much less effect and springback prediction accuracy can be improved. It is expected that user-dependent error can be minimized with this new option.