APRIL
2006

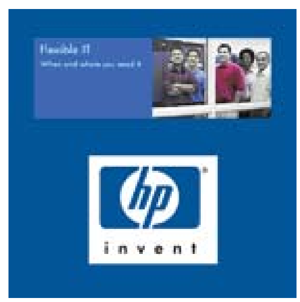
fea INFORMATION

WWW.FEAINFORMATION.COM

COVER STORY

HP

LS-DYNA® Compute Power by the Hour



PRODUCT SPOTLIGHT

AMD

Opteron Processors

for Servers

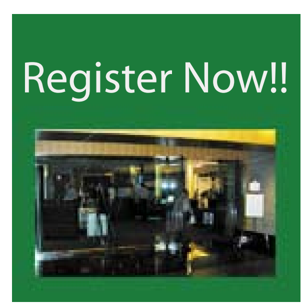
CONFERENCE SPOTLIGHT

LSTC

9th International

LS-DYNA Users Conference

June 4-6, 2006 Dearborn, MI



FEA INFORMATION RESOURCE MAGAZINE

FEA Information Worldwide Participants

Contents

FEA Information Announcements

Addition to our LS-DYNA® Resource Page

Pathscale PathSacle InfiniPath has been added to the LS-DYNA Resource Page Table 2 – MPP Interconnect and MPI, under HPC Interconnet.

Be sure to note our technical writer Suri Bala's article Airbag Modeling in LS-DYNA®

LS-DYNA® Theory Manual Edition 2006 is now available

Registration is now under way at www.ls-dynaconferences.com

Sincerely,
Trent Eggleston & Marsha Victory

Airbag Leakage Modeling in LSDYNA®

Suri Bala

Introduction:

In the area of numerical simulations involving the use of airbags to absorb impact energy, passively or actively, accurate definitions of airbag leakage parameters play a crucial role in predicting the response of impacting objects (ex. occupants). LSDYNA® provides various options for airbag leakage modeling that may appear overwhelming at first but are actually quite simple to use. This article discusses these various methods and options that are applicable to leakage modeling in airbags for control-volume and ALE inflation schemes.

Types of Leakage

There are two broad classifications of leakages that occur during and after airbag deployment as shown in Figure 1. In the first type, called *Venting,* the gas is discharged by means of "openings/vents/orifices" which are located on the airbag surface. The amount of gas that is discharged is a function of the vent area and its dependence on the airbag internal pressure. The second type, called *Porosity*, the leakage is attributed to porous nature of the airbag fabric. The amount of porosity leakage is a function of the airbag internal pressure and the characteristics of the bag material. Other types of leakages that could be potentially seen are through seams and inflator attachments which are usually grouped into *Venting*. For any given airbag, the total leakage is thus the summation of the leakages due to both venting and porosity. Both types of leakage are usually part of the design variables to "cushion" the impacting occupant.

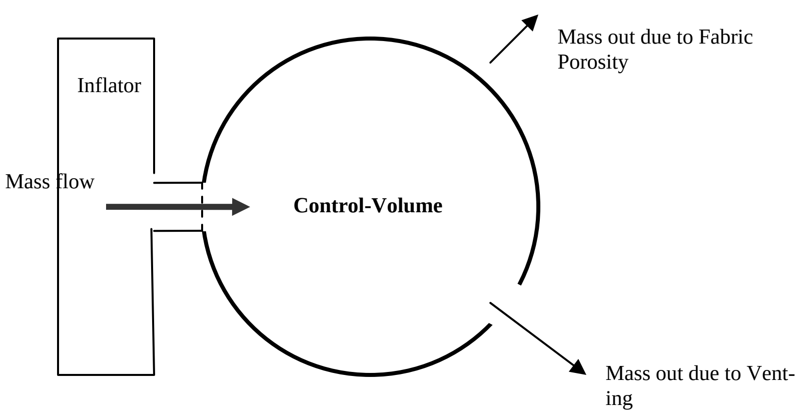


Figure 1: Airbag Setup

Leakage Formulations in LS-DYNA for Control Volume Airbags

Numerical treatment of leakage for control volume based airbag (EOS, WANG-NEFSKE, HYBRID, etc) involves computing the mass that needs to be removed from the incoming gas mass prior to computing the energy and the resulting uniform pressure. Besides formulation dependent parameters, the calculation of the outgoing mass, for both forms of leakage, primarily depends on three criteria: the area of the leakage, its dependence on some form of pressure (relative, absolute, gauge) and simulation time. Additional considerations include potential blockage of the leakage area due to contact-impact interactions. Since WANF-NEFSKE, HYBRID and ALE methods are most widely used inflation models, leakage options that apply to them are discussed in this article.

LSDYNA offers 1 type of venting formulation and 5 different types of porosity-based leakage formulation types. The choice of the porosity-based leakage formulations can be invoked using the parameter ***OPT*** in ***AIRBAG** keyword. Another variable that controls the porosity leakage formulation type is the parameter ***FVOPT*** option in ***MAT_FABRIC** which inherits its definition from *OPT* in *AIRBAG keyword. In other words, if *OPT*=0 then *FVOPT* is completely ignored. If *OPT* & *FVOPT* is greater than 0, then *FVOPT* determines the type of porosity leakage formulation. For more information, please refer to Remark #8 under *MAT_FABRIC keyword. Each of the porosity based leakage formulations optionally allow the user to consider blockage that may occur during or after deployment due to the interaction of the airbag surface with external entities. Wang-Nefske formulation (*OPT*=0) using leakage parameters defined in the *AIRBAG keyword is the default formulation.

Modeling Leakage due to Venting

The default method of modeling venting follows the original Wang-Nefske implementation. This approach uses two constants, ***C23*** and ***A23*.** The descriptor "23" is number inherited from the original paper as described by the formulation authors. *C23* is the venting-coefficient while *A23* is the venting-area. To enable more flexibility, the venting coefficient can be defined as a function of simulation time using ***LCC23*** (Load Curve Coefficient 23). Similarly, the venting-area can be defined as a function of absolute pressure using ***LCA23***(Load Curve Area 23). It must be noted that the load-curve based definitions of coefficient and area (*LCC23* and *LCA23*) will be ignored if its constant counterparts (*C23* and *A23*) are non-zero. When defining area as a function of absolute pressure, it is important that the definition covers the working range of the bag pressure.

In practice, it is not recommended to remove a portion of the airbag segments to physically model the vents using the control-volume approach. This is due to the fact that the airbag volume calculation in LS-DYNA, based on Green's theorem, requires a closed surface. If there are any open sections on the airbag surface, LS-DYNA detects them using its internal edge-location algorithm and closes them by projecting the n-sized polygon onto a two dimensional surface which is included as a separate airbag surface so a closed surface condition is met prior to the volume calculations. Consequently, the presence of any intentional physical holes on the airbag will not contribute to any leakage area and thus results in no gas discharge.

To model any open sections present in the airbag material, it is either recommended to fill the hole using null elements (this helps in preventing LS-DYNA spend any time in trying to close the open-sections) and refer its **PID** using *A23* variable (more in the next paragraph) OR use any one of porosity based leakage formulations using *MAT_FABRIC described later in this paper. For the non-control-volume airbag inflation schemes such as Euler/ALE, it is perfectly valid to include physical vent holes to allow the incoming gas to flow out of the airbag chamber skipping the fluid-structure-interaction. In the case of **ALE**, LS-DYNA performs an internal PID switch for the outgoing gas to enable easy measurement of the time-dependent mass and other related properties.

In LS-DYNA 970 revision 58xx and higher, negative inputs are permitted for *LCC23* and *A23* which invokes different definitions. When *LCC23* is less than zero, then abs(*LCC23*) is interpreted as the definition of the venting leakage coefficient as a function of relative pressure (P_{air}/P_{bag}) instead of simulation time. When *A23* is less than zero, then abs(*A23*) refers to a *PID* rather than to constant area. This allows LS-DYNA to dynamically compute the leakage area from summing up its individual element area of *PID* on every compute cycle. Using this approach allows the original Wang-Nefske venting implementation to use actual geometry for area calculations which was not available in earlier versions of LS-DYNA. This approach also provides an alternative way of defining the vent-holes in the airbag where the hole can be first filled using null elements (*MAT_NULL with shell elform type 9) and refer its *PID* using a negative value for *A23*. Since the actual airbag surface will not have any material in the vent-hole, it is recommended to define the part representing the vent-hole using negligible density and stiffness values so realistic stress can be computed around the vent hole.

Wang-Nefske Venting = [C23 (if >0) or LCC23] * [A23(if>0 or <0) or LCA23] * [OPT dependent properties]

Modeling Leakage Due to Porosity

There are five different formulations that are available in LS-DYNA to define porosity based leakage as shown in Table 1. These five different formulations can be further categorized as fabric-independent (default *OPT*=0) and fabric-dependent (*OPT* = 1 thru 8). Fabric independent formulation is the Wang-Nefske (Original) implementation for porous leakage using two constants ***CP23*** (Coefficient Porosity 23) and ***AP23*** (Area Porosity 23). *CP23* can be optionally defined as a function of time using ***LCCP23*** (LoadCurveCoefficientPorosity23) and *AP23* can be defined as a function of absolute pressure using ***LCAP23*** (LoadCurveAreaPorosity23). As in venting, load-curve based definitions for porosity coefficient and area (*LCCP23* and *LCAP23*) will be ignored if their constant counterparts are non-zero.

Fabric independent implementations of porous leakage formulations use the actual area of the fabric and use the *MAT_FABRIC constitutive model along with non-zero *OPT/FVOPT* values. Material constants ***FLC*** and ***FAC*** in *MAT_FABRIC also allow additional flexibility to define the porous leakage. The actual fabric area for a given part is computed by summing each element's area and is performed every cycle. *FLC* (Fabric Leakage Coefficient) allows the user to specify a leakage coefficient. If *FLC*>0, then it is assumed to be a constant value whereas if *FLC*<0, the abs (*FLC*) refers to a load curve (*DEFINE_CURVE) which defines the fabric leakage coefficient as a function of simulation time. *FAC* (Fabric Area Coefficient) allows the user to specify an area coefficient. Similar to *FLC*, when *FAC*>0, it is assumed to be a constant value while *FAC*<0, abs *(FAC)* refers to a load curve which defines the fabric area coefficient as a function of absolute pressure. It must be noted that the default value for both FLC and FAC is zero which will result in no discharge irrespective OPT/FVOPT parameters. To invoke the leakage, both must be non-zero and could be defined as unity which then removes the dependence of the leakage area on any form of pressure.

Porosity Based Leakage Formulations	FVOPT / OPT Values	Equation
Wang-Nefske (Original)	0	$\dot{m}'_{23} = C'_{23} A'_{23} \frac{p}{R\sqrt{T_2}} Q^{1/\gamma} \sqrt{2 g_c \left(\frac{\gamma R}{\gamma - 1}\right)\left(1 - Q^{y-1/\gamma}\right)}$
Wang-Nefske (Fabric)	1 or 2	$\dot{m}_{out} = \sqrt{g_c} \cdot \left[\sum_{n=1}^{nairmats} \left(FLC(t)_n \cdot FAC(p)_n \cdot Area_n\right)\right] \cdot \sqrt{2 p \rho} \sqrt{\frac{\gamma (Q^{\frac{2}{k}} - Q^{\frac{\gamma-1}{\gamma}})}{\gamma - 1}}$
Graefe, et al	3 or 4	$\dot{m}_{out} = \left[\sum_{n=1}^{nairmats} \left(FLC(t)_n \cdot FAC(p)_n \cdot Area_n\right)\right] \cdot \sqrt{2(p - p_{ext})\rho}$
Porous Media	5 or 6	$\dot{m}_{out} = \left[\sum_{n=1}^{nairmats} \left(FLC(t)_n \cdot FAC(p)_n \cdot Area_n\right)\right] \cdot (p - p_{ext})$
Gas Volume Outflow vs Pressure	7 or 8	Not available at the time of publication

Table 1: Porosity Based Leakage Formulations

In LS-DYNA version 970 and higher, a new option is available to compute the effective leakage area. This method, invoked by setting ***X0***=1 in *AIRBAG keyword, scales the original airbag surface area using *FLC* and *FAC* which have a different meaning. When *X0*=1 and *FLC* <0, abs (*FLC*) refers to a load curve definition defining leakage coefficient as function of the area stretch ratio ($A_{current}/A_{original}$) instead of simulation time. Similarly, when *FAC*<0, abs (*FAC*) is refers to a load curve that defines the area coefficient as a function of pressure ratio (P_{air}/P_{bag}) instead of absolute pressure.

Choice of the leakage formulations depends entirely on the available test data. Irrespective of the formulation type, it is however important to choose its variables such that they are not problem-dependent. For example, choosing a leakage coefficient that is a function of simulation time may be heavily dependent on the problem. Pressure-dependent leakage parameters are recommended since they have greater flexibility.

Note: For *OPT/FVOPT* = 7/8, *FAC* always expect the dependent variable to be leakage volume rate instead of area coefficient

The combined contributions of the porosity-based parameters are shown below.

Fabric-Independent Porosity Area (Default) = [CP23 or LCCP23 (if defined)] * [AP23 or LCAP23 (if defined)]

Fabric-Dependent Porosity Area (for X0=0) = [FLC or FLC (time)] * [FAC or FAC(pressure) (if defined)] * FabricArea(time)

Blockage Considerations

When any part of airbag surface interacts with other entities through contact, it is possible that they prevent the local outflow of gas as shown in Figure 2. To model this in LS-DYNA the parameters *OPT/FVOPT* must be set to any non-zero even number (2, 4, 6, or 8). Invoking blockage treatment allows LS-DYNA to check if the airbag segments are involved in contact and remove its area contribution from the total effective leakage area prior to the actual leakage calculations. The amount of blocked area from each segment is dependent on the number of nodes that are in contact at the time of checking. If only one node of a 4-noded segment is in contact then 25% of its area is treated as blocked, while 2-node in contact would result in 50% of blocked area and so on. When blocking is considered in leakage formulations, the mass-flow rate is usually noisy since the bag could be in and out of contact between a small number of compute cycles due to airbag oscillations. This can be generally reduced by using a mass-weighted-damping, ***MWD*** in ****AIRBAG***. When a non-zero MWD is defined, LS-DYNA computes the damping force that is proportional to the relative velocity between the bag and the surface-point (node). The bag-velocity is determined by taking the average mass-weighted velocity of all the nodes used to define the bag. *It must be noted that airbag's interaction with Rigidwalls **(*RIGIDWALL)** does not account for any blockage in the leakage area. The blockage calculations in LS-DYNA are limited to only contact-impact interfaces defined using any of *CONTACT keywords.*

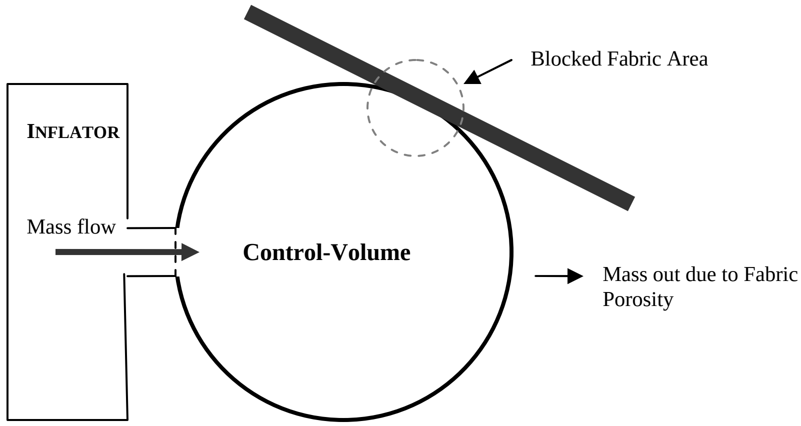


Figure 2: Fabric Blockage Due to Contact

Determining Leakage Coefficients

Measuring leakage coefficients, for both venting and porosity, can be a difficult task. Several tests, namely, Textest and Tube-flow, can be performed to determine the fabric's leakage properties for use in simulation. However, in some instances, such as non-porous venting, measuring the venting time-history could be extremely difficult. In such instances, the coefficients are best determined using an optimizer such as **LS-OPT®.** Assuming we have confidence in all other data, we can set up a simple problem, such as a free-falling object onto the airbag (after deployment for Control-Volume approach and during deployment for ALE/Euler approach) and monitor the objects behavior under no-venting and venting+porosity conditions for independent tuning of leakage parameters. Within LS-OPT®, one can define the leakage coefficients as design variables and relevant time-history information of the free-falling body as the response(s). Using either constants or load-curve based parameters, LS-OPT® can drive the simulations until we find the optimum leakage parameters such that the response of the object matches measured test values.

Special Considerations for Leakage in ALE/Euler Simulations

When modeling the airbag inflation process using ALE/Euler method, the process of venting is a relatively simple approach where the physical hole is incorporated in the airbag geometry. For modeling the porosity leakage, only two formulations, types 7/8, in *FVOPT/OPT* are supported. This requires the definition of volume rate as a function of absolute pressure using the parameter *FLC* in *MAT_FABRIC keyword. Alternatively, if experiment data is available one can use the parameter ***LCIDPOR*** in ***CONSTRAINED_LAGRANGE_IN_SOLID** to define a non-linear relationship between relative pressure and relative velocity between the Lagrangian structure and the gas. LS-DYNA allows the switching of inflation schemes between a control-volume and ALE using the SWITCH parameter in *AIRBAG_ALE. When the inflation scheme switch is used, the leakage formulations and parameters are also switched so as to achieve identical leakages irrespective of the scheme choice. This is limited to fabric-based porosity formulations and excludes *CONSTRAINED based porosity formulation.

Measuring Leakage in Output Files

Total leakage from the airbag control volume can be measured using the component "Output dm/dt" from ***ABSTAT*** output file which gives the rate at which the mass is flowing out of the airbag. The component can be used for both control-volume and ALE/Euler based airbag inflation models. To monitor blocked areas, LS-DYNA reports the unblocked and blocked areas for each fabric PID as a function of time to the ABSTAT ascii output. LS-PREPOST, a generic pre-and-post processor for LS-DYNA, allows the plotting of all the various components output to ABSTAT.

Acknowledgements

I would like to thank Dr. John Hallquist, Dr. Art Shapiro, Dilip Bhalsod, Jim Day and Dr. Ian Do for their help at various stages when leakage methods were investigated to help the users which consequently lead to writing this article. Finally to Marsha Victory for doing a wonderful job of keeping all the users informed about LS-DYNA through these newsletters.

References

1. LS-DYNA Theory Manual, 2006
2. LS-DYNA Keyword Manual, 2006
3. LS-OPT Manual, 2006
4. Advanced LS-DYNA Notes
   Dr. John Hallquist
5. Optimization of Nonlinear Dynamical Problems Using Successive Linear Approximations in LS-OPT
   Nielen Stander, Rudolf Reichert and Thomas Frank

LS-DYNA® Support Site
www.dynasupport.com/
Posted 04/06

What do the ANOVA bars mean?

What do the ANOVA bars mean? How does the coloring of the plots work? What is the difference between "b" and "b*b"?

The ANOVA bars indicates which variables are important for the computation of the response. The statistical evidence is weak for the portion of the bar shown in red. If the whole bar is red, then you cannot trust the value computed, and you may be better of believing that that variable does not contribute to the response. Conversely, if most of the bar is gray, then the contribution of that variable is significant. Note that the ANOVA value is the gray and red part together; the red part is therefore half of the confidence interval and the other half of the confidence interval extending to the right of the ANOVA value is not shown.

The underlying technology considers b and b*b to be two different variables in the case of response surfaces. So, if you have y = 1.0 * b + 0.0 * b*b, then you will only see a bar for b and the b*b bar should be of length zero. Conversely for y = 0.0*b + 1.0*b*b, you will see a bar for b*b and the bar for "b" will be of length zero. So if b*b does not contribute much, you can change the order of your response surface from quadratic to linear. Note that you only have b together with b*b for response surfaces; for neural networks, you will only have b.

LS-DYNA® Compute Power by the Hour

Offer is for North America Based LS-DYNA Customers

Chris Smith-Hewlett Packard - c.smith@hp.com

The LS-DYNA HP Flexible Computing Services allow LS-DYNA users to get access to as much compute resource as they need

- **LS-DYNA Flexible Computing Service is a pay-as-you go service**
- **No long-term financial commitment - pay for the cpu-hour's of hardware and LS-DYNA software you reserved**
- **Designed to extend and complement your in-house LS-DYNA resources.**

LS-DYNA Utility Computing Service Solution

Hewlett-Packard has recently released a new end-to-end LS-DYNA Utility Computing Service as a solution offering under their HP Flexible Computing Services portfolio. This unique utility computing service offers LS-DYNA customers servers, networking, storage and LS-DYNA licensing, all hosted at an HP-owned data center. The service is available now on a "per cpu-hour" basis to run LS-DYNA jobs.

Everyday, critical LS-DYNA jobs are pushed out or canceled altogether because of budget, IT, and project deadline constraints. There can be very significant opportunity costs as a result. A slip in project schedule for the design of a new product isn't an option. In the past, there was no opportunity to work around limited capital asset budgets, resources, and deadline constraints, but compromises had to be made in deciding which LS-DYNA jobs would get run and which jobs would have to be sacrificed. The problem with this scenario is that the development teams could have provided additional confidence in the product design, performance, and quality. More LS-DYNA analysis would have provided such benefits.

Financial Impact

The long-term financial impact to the overall business can be huge. Product problems could have been identified early on so they are much less likely to manifest themselves when the product goes to production. The cost to find a problem with a product design grows exponentially the farther you get into the product design/production lifecycle. The end result can affect product quality ratings, increase warranty costs, and even increase potential for product-driven injury and create corporate liability issues.

Continuing to increase the amount of analysis to support product design, early on, is essential to ensuring that companies and their products remain competitive. The LS-DYNA HP Flexible

Computing Services allow LS-DYNA users to get access to as much compute resource as they need, when they need it, and still meet critical project deadlines and budget constraints.

HP helps customers change the opportunity cost equation by enabling LS-DYNA customers to get more work done in less time, at a lower cost, while increasing end-product performance and quality. Other key benefits that accrue to the LS-DYNA user include:

- No expensive hardware, application or infrastructure assets to own
- Optimum scheduling flexibility
- Ability to pay for cycles out of a department's operating budget
- Avoid the requirement to justify with senior management the need for hard-to-get capital asset budget dollars

LS-DYNA users can now realize these benefits as they reserve time on a complete LS-DYNA "public" utility infrastructure with as little as 48 hours notice. The LS-DYNA HP Flexible Computing Service fills the need for the LS-DYNA analysis resources required. Users can now properly evaluate all potential designs while meeting critical project deadlines with higher product performance, quality, and improved competitiveness.

Pay As You Go:

The LS-DYNA Flexible Computing Service is a pay-as-you go service. There is no long-term financial commitment needed to use the service. You can use it once and only pay for the cpu-hour's of hardware and LS-DYNA software you reserved. It is designed to extend and complement your in-house LS-DYNA resources.

Configuration:

HP configures for you the exact LS-DYNA and operating system version you require. There is no worry about having to use a "standard" setup, which could lead to inconsistent answers when comparing to in-house runs. Everything you need to run your LS-DYNA jobs is included: head nodes, compute nodes, networking interconnect, operating systems, systems configuration, LS-DYNA licenses, and even batch job queuing software if needed. All you need to do is log on and submit your jobs. Access to the resources is via SSH, VPN or dedicated leased line, at the customer's choosing.

Customers typically pay out of operating expense budgets, preserving critical capital dollars. This also allows users and their IT departments to directly tie work from a specific project to an IT cost.

HP configures and maintains the latest high-performance Opteron, Xeon, and Itanium infrastructure that is specifically designed to run LS-DYNA jobs. HP keeps the environment refreshed with the fastest technology available, so users can expect to have access to the highest performance LS-DYNA environment, year after year. This is in contrast to in-house resources that quickly age from a technology perspective once they are procured. HP's infrastructure enables clients to continue "pushing the envelope" on product analysis, with larger LS-DYNA models at finer resolution, and over increased time horizons.

The Flexible Computing resources are 100% dedicated to a client during an LS-DYNA utility computing engagement. This provides a high-level of security, and it helps to ensure that all of the potential computing power is available to the client during the engagement period.

Security:

Security is best-in-class, run from HP's Tier-3 HP Data Centers. Access to these centers is tightly controlled with procedures and policies in place to ensure both logical and physical security of the environment and of customers' data. And when a client is done using the service, all customer data and scratch space is "scrubbed" clean using the best techniques available to ensure there is no trace of data left. HP even turns over root password control to the client, so they have total control of the environment to further ensure the security of their company's confidential data that gets submitted to the LS-DYNA HP Flexible Computing Service. HP is industry recognized for running highly secure IT environments for our clients and our own company. We protect and guard the client's intellectual property using the same processes and procedures we use to guard HP's sensitive data.

For more Information:

Visit http://www.hp.com/go/utility and click on HP Flexible Computing Services for more information and to request a consultation with one of our Flexible Computing Services experts.

Visit the HP Booth at the LS-DYNA International Users Conference June 4-6, 2006 at the Hyatt Regency Dearborn, MI.

HP is proud to sponsor Monday's lunch on June 5th.

WEBPAGE SHOWCASE
AMD Opteron Processors for Servers

www.amd.com - Product Information – Server Processors

Introducing Models 885, 285, and 185 to the AMD Opteron™ Processor Family -- The World's Highest Performing Processors for 1-8P x86 Servers and Workstations

AMD Opteron processors with Direct Connect Architecture and HyperTransport™ Technology deliver leading-edge 32-bit performance today and enable you to transition to 64-bit computing at your own pace, without sacrificing your x86 technology investment.

At AMD, we understand it's critical that technology should migrate on your terms to help you realize your unique vision. It's one of the reasons why leading OEMs offer enterprise class solutions powered by AMD Opteron processors, and why business entities like Microsoft Treasury and Sabre Holdings have adopted AMD Opteron processor-based solutions to power their enterprises.

Investigate Processor Performance

- Multi-Core Processor Overview
  Learn about the multi-core advantage, the evolution of multi-core technology, the availability of multi-core products and more.
- AMD PowerNow!™ Technology
  Learn how AMD PowerNow!™ Technology can help optimize performance and maximize IT budget dollars.
- Competitive comparison
  See how the AMD Opteron processor compares to the competition.
- Benchmarks
  Examine performance in a variety of enterprise

HP, Novell and AMD take the guesswork—and extra costs—out of Linux® deployment

Now, with just one price and one license, you can do it all!

HP, in conjunction with Novell/SUSE and AMD, is offering an Enterprise Linux eight-License Value Pack - use it on any combination of AMD Opteron™ processor-based HP BladeSystems and ProLiant Servers (ML and DL) applications.

- Model number comparison
  Compare features of current models.
- Key architectural features
  Explore Direct Connect Architecture, Hyper-Transport™ Technology and other features.
- Compare Processor Specifications
  Customize your overview of processor specifications.
- Development tools
  Access AMD technical documentation, processor utilities, source code and links to Web sites supporting development for AMD Opteron processors.
- The powerful combination of the Solaris OS and the AMD Opteron processors is shattering benchmark records and delivering break-through price/performance for databases, application servers, Web servers, compilers, and more

AMD is proud to sponsor Tuesday's Breakfast on June 6th at the LS-DYNA International Users Conference June 4-6, 2006 at the Hyatt Regency Dearborn, MI.. Visit the AMD Booth.

ARUP China Distributor of LS-DYNA®, LS-OPT®, LS-PrePost® & Oasys LS-DYNA Environment

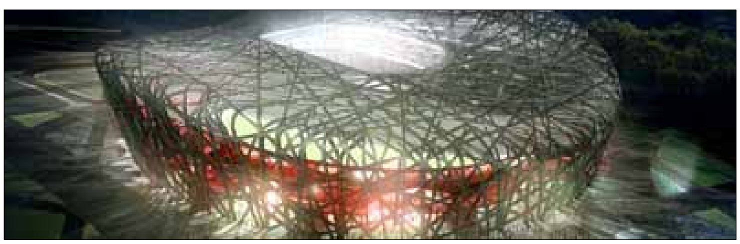
As of 1st April 2006, Arup's services in China additionally include full distribution of LS-DYNA, LS-OPT, LS-PrePost, as well as continued consulting and technical training. Arup has been involved with LSTC for over 20 years and has been the UK distributor of LS-DYNA since 1989. This article introduces Arup to FEA Information readers and explains what we have to offer to our Chinese customers.

Arup is one of the world's largest and most respected consulting engineering firms. The firm was formed 60 years and has grown rapidly since then, currently employing over 7000 people in 30 countries. Our skills are diverse, ranging from the design of buildings and bridges, to automotive engineering and business consulting.

Arup in China

With 40 years in East Asia we have been involved in many of the region's largest and most prestigious projects. We continue to grow and develop our expertise within the region and are able to offer a vast global network of skills. Our approach ensures that we deliver the best team, solutions and outcomes for our clients.

Some of Arup's recent China projects



A new stadium for the 2008 Beijing Olympics

Vehicle development for Chinese client

Dongtan City Masterplan

Beijing CCTV Headquarters

Arup has over 1200 staff working in China from our offices in Hong Kong, Shanghai, Beijing and Shenzhen. In all these offices we have LS-DYNA experts, with experience applying LS-DYNA in many different industries, including automotive, building design and transport. Our team is able to supply a local service to companies looking for support in China.

Arup does not act as an agent for any other software company; our focus is on providing expert advice on LS-DYNA alone.

Contact information:

Arup Shanghai
Kimbal Virdi
+86(0)21-5396-6633 Email
kimbal.virdi@arup.com

Arup Beijing
Baiqian Wan
+86(0)10-6597-3788
Email: baiqian.wan@arup.com

Arup Shenzhen
Yang Wang
+86(0)755 8203 1619
Email: y.wang@arup.com

Arup Hong Kong
Goman Ho
+852 22683154
Email: goman.ho@arup.com

Please visit www.arup.com/dyna for more information

Visit The ARUP booth at the 9th International LS-DYNA Users Conference
June 4-6, 2006

Interest Story Chosen by FEA Information News:

Jet Propulsion Laboratory – California Institute of Technology

http://www.jpl.nasa.gov/news/features.cfm?feature=1062

Forty Years of Space Talk

March 28, 2006

"That's one small step for man. One giant leap for mankind." That famous communique from Apollo 11 during the historic first-ever moon walk was brought to you by the 64-meter antenna at NASA's Deep Space Network in Goldstone, Calif.

The antenna has accumulated a rich legacy during its 40 years of supporting space exploration. In addition to capturing the words of astronauts on all the Apollo moon missions, the dish has communicated with the computers and equipment on every one of NASA's major robotic solar system explorers. The "Big Dish" enabled the world to see the first-ever close-up images of Jupiter, Saturn, Uranus and Neptune, their rings and their myriad moons, by the Pioneer, Voyager, Galileo and Cassini missions. The antenna has also communicated with NASA's Mars missions, including the currently-operating fleet of five: Mars Global Surveyor, Mars Odyssey, the Mars Exploration Rovers and Mars Reconnaissance Orbiter.

The antenna's history stretches back to 1963, when the United States and Russia were engaged in a high-stakes space race. Engineers were relying on smaller antennas to keep tabs on NASA's earliest missions, which ventured only as far as orbit around Earth. With the development of the Mariner Mars missions, more powerful communications tools were needed.

The plan was to build a 64-meter antenna at Goldstone, one of three sites of the Deep Space Network. In 1963, Rohr Corporation was awarded a $12 million contract to design and build the big dish.

After two years of construction, a testing phase began to determine how well the antenna would receive signals. In March 1966, engineers pointed the dish toward Mariner 4, which had been lost by smaller antennas after its historic Mars flyby in 1965. Eureka! Mariner 4 sent a signal, and the Goldstone antenna picked it up.

To commemorate this historic event, the 64-meter antenna was named "Mars," or more technically, Deep Space Station 14. After three months of calibrations and personnel training, the Mars antenna became the first operational 64-meter antenna of the Deep Space Network in June 1966.

The Network includes communications facilities placed about 120 degrees apart around the world -- at Goldstone; near Madrid, Spain; and Canberra, Australia. As Earth rotates, this strategic placement permits ground controllers to maintain constant observation of robotic spacecraft exploring the solar system and beyond.

The pioneering Mars antenna was later to expand its repertoire - and its size. In the late 1960s, the antenna was called on to support all the American lunar missions, including Apollo 11, and the nerve-wracking "Houston, we have a problem" Apollo 13 mission. During the critical re-entry of that space capsule, it was more essential then ever for engineers on the ground to maintain contact with the astronauts. The craft's minimal power was needed for re-entry, with little left over for transmitted communications. The antenna was able to capture the "whispers from space," and helped bring the astronauts home safely.

As the years passed, NASA pushed the boundaries of space travel farther and farther. The transmitting capability of the 64-meter antenna was expanded for the Viking Mars landers in the mid-1970s. In 1988, the antenna was enlarged to 70 meters (230 feet) to support the Voyager 2 flyby of the distant planet Neptune.

Today's 70-meter antenna can do much more than track spacecraft. It's also used for solar system radar, imaging nearby planets, asteroids and comets. It does this by transmitting a 500,000-watt signal to "bounce" off the object and return the resulting signal to Earth. Radar allows us to figure out the paths of asteroids and comets and determine whether any might be a possible future threat to earth. The antenna is also used for Very Long Baseline Interferometry, in conjunction with a radio telescope at one of the other Deep Space Network Stations, to precisely measure Earth's orientation. This information helps with spacecraft navigation.

With a fleet of NASA missions already flying and many more planned for the future, the 70-meter Goldstone antenna and the other dishes of the Deep Space Network have a busy lifetime ahead of them.

Yahoo Group Yammerings

Jim Kennedy
KBS2 Inc.
jmk@kbs2.com

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

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

1. *Quasi-Static Simulation with LS DYNA*
2. *Hourglass Control*
3. *Plasticity Algorithm Warning Messages*

Question: Quasi-Static Simulations with LS DYNA

Static tests run 200 to 300 seconds with constant loading rates of around 15mm/min. To simulate these using transient codes like LS-DYNA we need a Quasi-Static approach. Do we need to run the simulations for 200 to 300 seconds? My question is how to replicate theses tests, with a shorter duration but without inducing dynamic or rate effects?

Response by Calvin Rans

How to replicate a static test in LS-DYNA? This is a common question that unfortunately does not have a simple answer. As you alluded to in your question, simulating a static test over the same duration as the physically test leads to impractically long computational times. So this is really a question of how to shorten computational times. To achieve this, there are two basic methods: mass-scaling and time-scaling.

MASS-SCALING:

The computation time required for a simulation is proportional to the number of time steps required to reach the simulation termination time. So to reduce computation time, we can reduce the number of time steps required by increasing the time step size. Since the time step size is related to the speed of sound through the smallest element, we can increase the time step (by reducing the speed of sound through the material) by increasing the density of the elements. This is known as mass-scaling. Mass scaling can be selectively applied (it only affects the smallest elements controlling the time step) or globally applied (affects all elements); however the effect on the time step is the same (not on dynamic effects; more on this later).

TIME-SCALING:

With mass-scaling, we decrease the number of time steps required to complete a simulation (thus computational time) by reducing the time step size. Time-scaling achieves the same effect by reducing the period of time simulated. Thus, rather than simulating 300 seconds, you may simulate 30 or even 3 seconds. Effectively, this increases the velocities of parts in your simulation.

Whether using mass-scaling or time-scaling, you need to be aware of how you are affecting the dynamics of your simulation. Since the simulation replicates a static test, dynamic effects should be negligible. Applying either mass-scaling or time-scaling, however, alters the dynamics of the simulation by adding mass or increasing velocities, respectively (both of which alter momentum and kinetic energy). Thus there is a limit to how much mass-scaling and or time-scaling can be applied before the assumption that dynamic effects are negligible falls apart. Unfortunately, there is no rule or simple measure to determine this threshold. Usually, I monitor the amount of kinetic energy relative to the total energy in the simulation to help assess whether I have applied too much time- or mass-scaling, but this only gives an indication of passing the threshold. For example, if mass-scaling is applied, and it only affects a few elements, the overall amount of added mass to the simulation may not affect the global kinetic energy significantly, but it could introduce some sever dynamic effects, local to the mass-scaled elements. Ultimately, to assess if I have introduced any significant dynamic effects, I end up running the simulation twice for two different amounts of time- or mass-scaling to see if the results of interest to me are sensitive to the change.

Additional Notes:

Since the time step is related to the speed of sound through your smallest element, you can often greatly reduce computational times by eliminating any unnecessary small elements in your model.

Follow-up Response by James Kennedy

Karl Schweizerhof, et al, offered some very interesting comments at the European User's Conference in 1999. Their focus was more on practical solutions; however, the principles are the same.

> Schweizerhof, K., Walz, M., Rust, W., Franz, U. and Krichner, M., "Quasi-static Structural Analysis with LS-DYNA - Merits and Limits," 2nd European LS-DYNA User's Conference, Gothenburg, Sweden, June, 1999.

For your convenience, I am including here the Abstract from that paper:

Abstract

In principle all events in structural mechanics can be considered as transient, however a static approach allows often much simpler analysis, in particular, if inertia or friction effects do not play a major role and if the structural behavior remains linear. However, in the nonlinear regime the situation is rather different. Though much success has been achieved in static analysis of mildly nonlinear structures, computing buckling loads, ultimate loads with nonlinear material and even contact problems with fairly constant contact partners, often convergence is very poor, even if the algorithms are consistently developed e.g. concerning linearization.

Convergence is often difficult to achieve, if post-buckling loads of complex structures and contact problems with changing contact regimes involving friction have to be considered. Then treating the problems as transient - so-called “quasi- static” - resolves many algorithmic and numerical obstacles, though other problems appear, in particular concerning the interpretation of the results for practical use. The highly sophisticated contact algorithms in addition to the large numbers of model features available in LS-DYNA make it a very valuable tool for quasi-static analyses such as roof-crushing, buckling and post-buckling behavior of shell structures. Even with the rather small time steps needed for explicit time integration LS-DYNA proves to deliver reliable results, if some standard measures are taken into account and if the analyst checks the results carefully for kinetic effects.

Within the analysis particular focus is on the sensitivity of the results concerning element type and hourglass control versus fully integrated elements, loading velocity and mesh refinements. Also the computer time-saving effects of mass- scaling are discussed. A final discourse shows the possibilities as well as the limits of the present procedure.

Question: Hourglass Control?

I am having difficulties eliminating hourglass in my model. I am using the standard *Hourglass keyword with Option 1 for the control type and 0.15 for the hourglass coefficient. I have tried refining the mesh and applying a smaller velocity to my model. Is there anything else I can do?

Response by Conrad Izatt

The default Type 1 hourglass suppression, as well as Types 2 and 3, are a viscosity based methods. Therefore, if you do not eliminate the cause of the hourglassing, using a lower velocity will tend to increase the hourglassing problem (because the velocities are less, the hourglass suppression will be less).

For low velocity and quasi-static analyses, the stiffness based hourglass rules (Types 4 and 5) can be used, but they tend to increase the overall stiffness of the model.

In addition to the methods already suggested (i.e. using fully integrated elements), it is advisable to investigate and eliminate the reason for the hourglassing. Hourglassing is often caused by point or line-loads, constraints, restraints or deformation modes that are incompatible with the element formulation or mesh.

Question: Plasticity Algorithm Warning Messages

My run does not terminate, but I keep getting several warnings and then a plot state is written and then again more warnings, i.e.

*** WARNING plasticity algorithm did not converge for MAT15

Does anybody have any ideas?

Response by Dilip Bhalsod

These warning messages are most likely coming from MAT_JOHNSON_COOK viscoplastic option VP=1. Try setting VP=0 or try a more recent version of LS-DYNA. I thought this problem was resolved some time ago.

Follow-up by Jim Kennedy

Partial thoughts/information shared by several colleagues on a similar question we had been discussing. Be advised that these thoughts may not be up to date.

When VP=1, it's possible for the "plasticity algorithm" to not converge. This is true of any material supporting the VP=1 option. It probably relates to the fact that the plastic strain rate is solved for in an iterative manner. Considerable time was spent in modifying the VP=1 option for MAT_024 to reduce or eliminate these failures to converge.

Follow-up by Len Schwer

To add a bit more to Jim Kennedy's nice response:

The viscoplastic option VP=1 is recommended for accuracy and additional stability, but it is more CPU expensive due to the iterations required to solve for the increment in effective plastic strain. The number of iterations is fixed at a maximum of 20, so the failure to converge indicates the maximum was reached before the rather tight tolerance for convergence was met.

In some recent experimentation with this model, I found the failure to converge can also be affected by "incorrect" input parameters, e.g. errors in the Johnson-Cook parameters. The use of this model for shell elements also requires more iterations to converge than for a corresponding solid element; this due to the additional requirement of plane stress for the shell element formulation. Finally, decreasing the time step may help with the iteration convergence, as the strain increments will be smaller, and thus the effective plastic strain increment will also be smaller.

Postscript – The iteration scheme for the viscoplastic option in the Johnson-Cook model (Material Model 15) is currently under review at LSTC.

LS-DYNA Yahoo Groups

There are over 1740 subscribers from all over the world, and this list seems to grow by a hundred new subscribers ever few months; no small testament to the rapidly growing popularity of LS-DYNA. The group currently averages about 300 message per month, i.e. about 10 message per day. 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

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 .

TOP CRUNCH NEWS – Benchmarks Online

Dr. David Benson – www.topcrunch.org

FEA Information Participants: IBM - AMD

IBM / IBM	IBM Blade Center 8843-25V/*Information Not Provided*	**Xeon 3.2G**	1 x 1 x 1 = **1**	25106	neon_refined	03/21/2006
Sun Microsystems/Sun Microsystems	Sun Fire X2100/Infiniband (Topspin)	**AMD Opteron 156 3.0 GHz**	32 x 1 x 1 = **32**	433	neon_refined	04/21/2006
Sun Microsystems/Sun Microsystems	Sun Fire X2100/Infiniband (Topspin)	**AMD Opteron 156 3.0 GHz**	16 x 1 x 1 = **16**	703	neon_refined	04/21/2006
Sun Microsystems/Sun Microsystems	Sun Fire X2100/Infiniband (Topspin)	**AMD Opteron 156 3.0 GHz**	8 x 1 x 1 = **8**	1283	neon_refined	04/21/2006
Sun Microsystems/Sun Microsystems	Sun Fire X2100/Infiniband (Topspin)	**AMD Opteron 156 3.0 GHz**	4 x 1 x 1 = **4**	2446	neon_refined	04/21/2006
Sun Microsystems/Sun Microsystems	Sun Fire X2100/Infiniband (Topspin)	**AMD Opteron 156 3.0 GHz**	2 x 1 x 1 = **2**	4629	neon_refined	04/21/2006
Sun Microsystems/Sun Microsystems	Sun Fire X2100/Infiniband (Topspin)	**AMD Opteron 156 3.0 GHz**	31 x 1 x 1 = **31**	5680	3 Vehicle Collision	04/21/2006
Sun Microsystems/Sun Microsystems	Sun Fire X2100/Infiniband (Topspin)	**AMD Opteron 156 3.0 GHz**	1 x 1 x 1 = **1**	9222	neon_refined	04/21/2006
Sun Microsystems/Sun Microsystems	Sun Fire X2100/Infiniband (Topspin)	**AMD Opteron 156 3.0 GHz**	16 x 1 x 1 = **16**	10987	3 Vehicle Collision	04/21/2006
Sun Microsystems/Sun Microsystems	Sun Fire X2100/Infiniband (Topspin)	**AMD Opteron 156 3.0 GHz**	8 x 1 x 1 = **8**	18044	3 Vehicle Collision	04/21/2006
Sun Microsystems/Sun Microsystems	Sun Fire X2100/Infiniband (Topspin)	**AMD Opteron 156 3.0 GHz**	4 x 1 x 1 = **4**	34928	3 Vehicle Collision	04/21/2006
Sun Microsystems/Sun Microsystems	Sun Fire X2100/Infiniband (Topspin)	**AMD Opteron 156 3.0 GHz**	2 x 1 x 1 = **2**	69984	3 Vehicle Collision	04/21/2006

ETA Expands Its Worldwide Information

© Copyright ETA, April 2006

Focusing on the needs of the worldwide engineering community Engineering Technology Associates, Inc., established in 1983 and headquartered in Michigan, USA expands its horizons with new web based information and a newsletter. With international offices in Canada, India and China and a global network of distributors in North & South America, Europe, Asia and Australia ETA launched its first newsletter April 21, 2006.

In an effort to better serve customers and communicate with prospective customers, ETA has launched a new web site. Visit www.eta.com providing current news and product information.

Additional informational sites:

Eta / DYNAFORM

www.dynaform.com: THE DIGITAL PRESS : TRYOUT BEFORE TOOLING **-** DYNAFORM drastically reduces the risk and costs associated with the die design and development cycle by predicting formability problems before tooling takes place.

Eta / VPG

www.etavpg.com: The eta/VPG software product is revolutionary**.** Delivering the only true multi-code modeling software for structural analysis applications VPG support users of LS-DYNA, NASTRAN and RADIOSS to a degree not found in any other software package. Model construction is made efficient and simple with VPG's "zero-text editing environment", allowing users complete access to all of the features within these FEA software packages.

ETA China

www.eta.com.cn / index.asp

NewsLetter:

To sign up for News from Engineering Technology Associates, Inc. contact Tim Palmer – tpalmer@eta.com

9th International LS-DYNA Users Conference

ETA will again be an integral part of the LS-DYNA conference. ETA will be sponsoring the backpack and you can visit their booth for information on their software products.

LS-DYNA® THEORY Manual Now Available

ISBN 0-9788540-0-0 2006 Edition: Theory Manual

Pricing and your shipping address will be confirmed by e-mail prior to Credit Card Charge. Shipping within 24 hours of confirmation.

Pricing Includes Shipping – Visa, MC, AMEX accepted
For any questions contact Marsha vic@lstc.com

US, Canada, Mexico	$100 USD
Europe	$150 USD
Asia Pacific	$175 USD

FAX TO: LSTC – 925 961 0806

Visa _________ MC_______ AMEX________

Name of Cardholder: ___________________________________

CC Numbers:____

Expiration Date _________________

E-mail for Confirmation______________________________

Shipping:

Technology Day 2006 - June 7, 2006

UNIVERSITY OF MICHIGAN-DEARBORN

http://www.engin.umd.umich.edu/ceep.

The Center for Engineering Education and Practice (CEEP) supports relevant collaborative projects of faculty and industrial partners. Technology Day is an annual event sponsored by CEEP to provide an update of the University's collaborations with industry.

The Purpose of Technology Day

- Showcase faculty research
- Encourage dialog between faculty and industry guests
- Exhibit student senior design and student competition projects
- Feature prominent external speakers on topics relevant to education & industry
- Exhibit industry advanced technology design concepts and products
- Look for collaborative applied research opportunities for faculty with industry

For Information Visit http://www.engin.umd.umich.edu/ceep.

Or contact:

Donna Goddard, Administrative Assistant
Center for Engineering Education and Practice
E-Mail: dgoddard@engin.umd.umich.edu
Telephone: (313) 593-3403

Seminars from the 9th Int'l LS-DYNA Users Conference will be held at the University of Michigan-Dearborn June 7-8.

9th Int'l LS-DYNA Users Conference
at the Hyatt Regency Dearborn on June 4-6, 2006
REGISTER AT: www.ls-dynaconferences.com

Interest has been so great that we've moved the Exhibit and Hospitality/Meal areas to the larger Great Lakes Center at the Hyatt. Participants will find the vendor area more open and easier to navigate.

Presenting keynote addresses we are pleased to have:

James W. Welton
Director of Global CAE Development and Integration at General Motors Corporation

And

Kwan-Hum Park
Director of Hyundai Motor Company

They will be joined by well-know LS-DYNA experts

Dr. Ted Belytschko and **Paul Du Bois**
as well as **Dr. John O. Hallquist**

Registration Includes:

- Conference Proceeding book
- Backpack
- Technical Sessions
- Keynote Presentations
- Reception on Sunday evening
- Banquet on Monday complete with entertainment
- Breakfasts, Lunches, Door Prizes

Our Conference Sponsors

- **AMD**
- **ETA**
- **Fujitsu**
- **HP**
- **Intel**
- **Microsoft**
- **Pathscale**
- **Penguin Computing**
- **SGI**
- **Sun Microsystems**

Our Sunday afternoon event this time is the Ford Rouge Factory Tour. This event is free to registered conference participants. www.thehenryford.org

June edition will have the exhibitors and exhibit floor guide.

A short course taught by Ted Belytschko and Thomas J. R. Hughes

NONLINEAR FINITE ELEMENT ANALYSIS May 22-26, 2006 Austin TX

PURPOSE

To provide engineers, scientists, and researchers with a background in the fundamentals of nonlinear finite element methods and a critical survey of the state-of-the-art. It covers solids, structures, and fluids, with an emphasis on methodologies and applications for non-linear problems. The theoretical background, implementations of various techniques, and modeling strategies will be treated. Advantages and shortcomings of alternative methods and the practical implications of recent research developments will be stressed. The course has been offered for the past 20 years and has been taken by about 2,000 engineers, scientists, faculty members, and graduate students. A synopsis of the topics covered can be found at http://www.zace.com

Registration Fee For This Short Course:

Prior to, or on April 21, 2006	$2,175
After April 21, 2006,	$2,375

Daily Schedule

Registration begins at 8:00 a.m. on Monday. The lectures will start at 9 a.m. and end at 5:30 p.m., Monday-Thursday, and 9 a.m.-12:00 p.m. on Friday.

For additional information:

Contact: Ted Belytschko Inc. TBINC18@aol.com or visit http://www.zace.com

LSTC Training Classes – 2006

Jane Hallquist
Training Coordinator
LSTC California & Michigan
Email: ***jane@lstc.com***
Tel: ***925-449-2500***

California Location

LSTC California
7374 Las Positas Road
Livermore, CA 94551

Michigan Location

LSTC Michigan
1740 W. Big Beaver Rd
Suite 100
Troy , MI 48084

Training Class	US $	Livermore, CA	Detroit, MI
Introduction to LS-DYNA **1. J. Reid** **2. A. Tabiei**	$750	May 02-05 Aug. 01-04 Nov. 14-17	April 25-28 July 25-28 Oct 16-19 Dec. 11-14
Advanced LS-DYNA for Impact Analysis	$950	June 27-30 Sept 26-29	Not Scheduled
Advanced Options in LS-DYNA	$750	Not Scheduled	Not Scheduled
Material Modeling Using LS-DYNA User Defined Options	$750	June 13-14	Not Scheduled
LS-DYNA Implicit	$750	June 15-16	Sept. 07-08
Introduction to LS-OPT	$750	May 16-19 Nov. 07-10	Not Scheduled
ALE/Eulerian & Fluid/Structure Interaction in LS-DYNA	$750	July 12-14	Not Scheduled
Concrete and Geomaterial Modeling with LS-DYNA	$750	Oct 24-25	Not Scheduled

LSTC Training Classes – 2006 - continued

Training Class	US $	Livermore, CA	Detroit, MI
MESH Free Methods in LS-DYNA (SPH and EFG)	$750	Not Scheduled	Not Scheduled
LS-DYNA Composite Materials	$750	Sept. 14-15	Not Scheduled
LS-DYNA for Heat Transfer & Thermal-Stress Problems	$500	Not Scheduled	Not Scheduled
Contact in LS-DYNA	$750	Sept. 12-13	June 22-23

Participant Distribution & Consulting Channels

Sales – Support –Training – Benchmark – Consulting.

Australia	**Leading Engineering Analysis Providers** (LEAP) info@leapaust.com.au
Germany	**CAD-FEM GmbH** lsdyna@cadfem.de
Japan	**CRC Solutions Corp.** ls-dyna@crc.co.jp
Korea	**Korean Simulation Technologies** young@kostech.co.kr
Canada	**Metal Forming Analysis Corp.** galb@mfac.com
USA	**Dynamax** sales@dynamax-inc.com
UK	**Oasys, Ltd.** dyna.sales@arup.com

EVENTS – 2006

If you want your event listed please send the information to: mv@feainformation.com

 **May 4-5, 2006**	**Organized by GissETA India and ETA** **National Conference on Computer Applications in Engineering – May 4-5, 2006, Bangalore. LE MERIDIEN, 28 Sankey Road, BANGALORE**
2006	
May 02-04	**2006 International ANSYS Conference** Pittsburgh, PA - US
June 04-06	**9th International LS-DYNA Users Conference** Dearborn, MI - US -Registration and Hotel available on line
June 07	**Technology Day** - University of Michigan, Deaborn
July 02-06	**ICSV13 Vienna** Vienna, Austria
July 5-7	**HEAT TRANSFER 2006** Ninth International Conference on Advanced Computational Methods and Experimental Measurements in Heat and Mass Transfer - The New Forest, UK
Sept 19-20	**JAPAN LS-DYNA Users Conference 2006** Tokyo, Japan Hosted by JRI
Sept 25	11th Korea LS-DYNA Users Conference 2006, Seoul, Korea Hosted by Theme Engineering Inc.
Oct 12-13	**LS-DYNA Users Meeting in Ulm.** Hosted by DYNAmore
Oct 25-27	**2006 CADFEM Users Meeting** International Congress on FEM Technology Stuttgart area - Germany
Nov 14- 16	**Aerospace Design Expo 06** Anaheim, CA - US

LS-DYNA Resource Page

Interface - Hardware - OS And General Information

Participant Hardware / OS that run LS-DYNA (alphabetical order).

LS-DYNA has been fully QA'd by Livermore Software Technology Corporation for All Hardware and OS listed below.

TABLE 1: SMP
TABLE 2: MPP Interconnect and MPI

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

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

TABLE 2: MPP Interconnect and MPI

Vendor	O/S	HPC Intereconnect	MPI Software
AMD Opteron	Linux	InfiniBand (SilverStorm), MyriCom, Pathscale 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, Pathscale 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, (Vol-taire)	MPT, Intel MPI, MPICH

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
www.ansys.com/products/environment.asp

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
www.eta.com

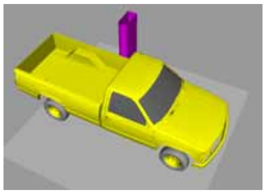
Includes a complete CAD interface capable of importing, modeling and analyzing, any die design. Available for PC, LINUX and UNIX, DYNAFORM couples affordable software with today's high-end, low-cost hardware for a complete and affordable metal forming solution.

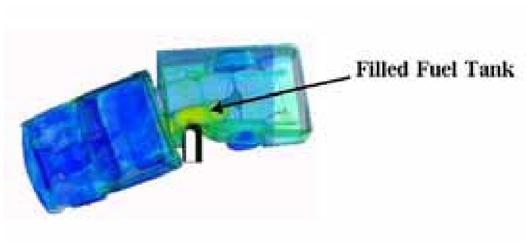
ETA – VPG
www.eta.com

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"
www.msc.software.com

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.





Side Impact With Fuel Oil Inside

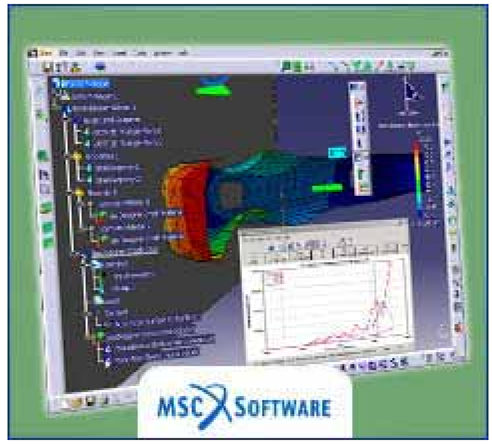
MSC.Software - MSC.Nastran/SOL 700

The MSC.Nastran™ 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.

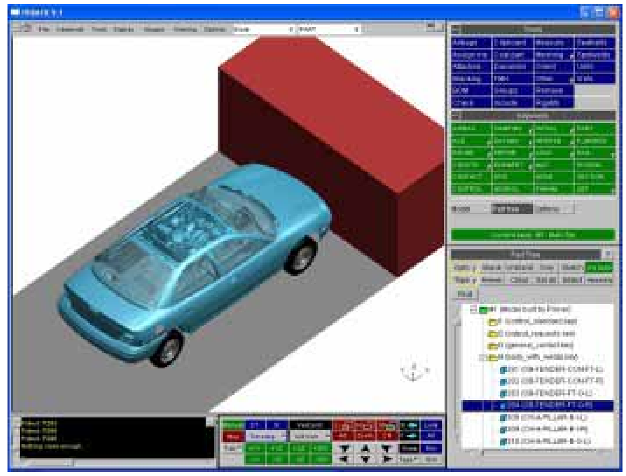
MSC.Software – Gateway for LS-DYNA

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
www.arup.com / 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 offer post-processing software for in-depth analysis of results and automatic report generation.

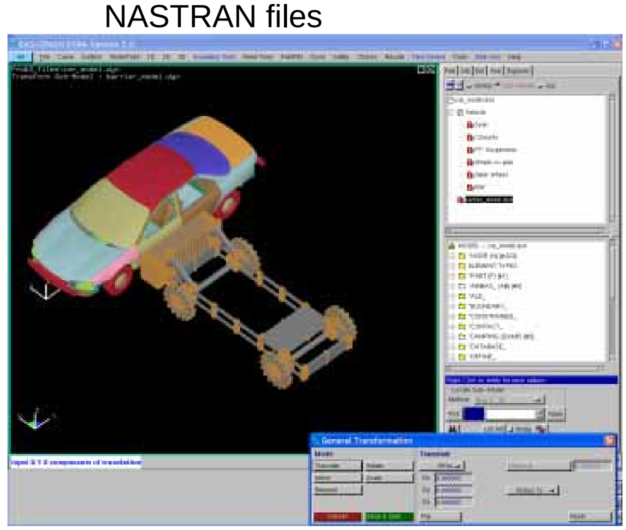
EASi-CRASH DYNA
http://www.esi-group.com/SimulationSoftware/EASi_CRASH-DYNA/

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.

EASi-CRASH DYNA's main features include:

- Support of all keywords of LS-DYNA 970/971
- Powerful mesh editing features, such as automesh and remesh
- LS-DYNA/MADYMO coupling capabilities for pre- and post processing (support of MADYMO format till version 6.2.2)
- Model Assembler for organizing the model through sub assembly/sub models and included files
- Enhanced Weld tools for manipulation of connections and Weld comparison
- Simple dummy positing and seat belt routing
- Pre and Post processing in same environment
- Superpose and merge multiple models
- Animation and plotting
- Process compatible
- Full capability to handle IGES, CATIA V4, CATIA V5, UG and NASTRAN files



Hardware & Computing and Communication Products

www.amd.com

www.fujitsu.com

www.hp.com

www-1.ibm.com/servers/deepcomputing

www.intel.com

www.nec.com

www.sgi.com

www.pathscale.com

www.microsoft.com

Software Distributors
Alphabetical order by Country

Australia	**Leading Engineering Analysis Providers** www.leapaust.com.au
Canada	**Metal Forming Analysis Corporation** www.mfac.com
China	**ANSYS China** www.ansys.cn
China	**MSC. Software – China** www.mscsoftware.com.cn
Germany	**CAD-FEM** www.cadfem.de
Germany	**Dyna*More*** www.dynamore.de
India	**GissETA** www.gisseta.com
India	**Altair Engineering India** www.altair-india.com
Italy	**Altair Engineering Italy** www.altairtorino.it
Italy	**Numerica SRL** www.numerica-srl.it
Japan	**Fujitsu Limited** www.fujitsu.com
Japan	**The Japan Research Institute** www.jri.co.jp
Japan	**CRC Solutions Corp.** www.engineering-eye.com
Korea	**Korean Simulation Technologies** www.kostech.co.kr
Korea	**Theme Engineering** www.lsdyna.co.kr

Software Distributors (cont.)
Alphabetical order by Country

Netherlands	**Infinite Simulation Systems B.V** www.infinite.nl
Russia	**Strela, LLC** www.ls-dynarussia.com
Sweden	**Engineering Research AB** www.erab.se
Taiwan	**Flotrend** www.flotrend.com.tw
USA	**Engineering Technology Associates** www.eta.com
USA	**Dynamax** www.dynamax-inc.com
USA	**Livermore Software Technology Corp.** www.lstc.com
USA	**ANSYS Inc.** www.ansys.com
UK	**Oasys, LTD** www.arup.com/dyna/

Consulting and Engineering Services
Alphabetical Order By Country

Australia Manly, NSW www.leapaust.com.au	**Leading Engineering Analysis Providers** Greg Horner info@leapaust.com.au 02 8966 7888
Canada Kingston, Ontario www.mfac.com	**Metal Forming Analysis Corporation** Chris Galbraith galb@mfac.com (613) 547-5395
India Bangalore www.altair-india.com	**Altair Engineering India** Nelson Dias info-in@altair.com 91 (0)80 2658-8540
Italy Torino www.altairtorino.it	**Altair Engineering Italy** sales@altairtorino.it
Italy Firenze www.numerica-srl.it	**Numerica SRL** info@numerica-srl.it 39 055 432010
UK Solihull, West Midlands www.arup.com	**ARUP** Brian Walker brian.walker@arup.com 44 (0) 121 213 3317
USA Austin, TX	**KBEC L.C** Khanh Bui kdbui@sbcglobal.net (512) 363-2739
USA Windsor, CA www.schwer.net/SECS	**SE&CS** Len Schwer len@schwer.net (707) 837-0559
USA Corvallis, OR www.predictiveengineering.com	**Predictive Engineering** George Laird (1-800) 345-4671 george.laird@predictiveengineering.com
USA Neenah, WI www.structuretechnology.com	**Structure Incorporated** Todd L. Peters (920) 722 7060 info@structuretechnology.com

Educational & Contributing Participants
Alphabetical Order By Country

China	Dr. Quing 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
USA	Tony Taylor	Irvin Aerospace Inc.

FEA Information China Participants

Software, Hardware, Training, Consulting, Services

Altair Engineering Software (Shanghai) Co., Ltd.	Herbert Qi Tel: +86 (0)21 5393 0011 Website: www.altair.com.cn Contact: support@altair.com.cn Contact: sales@altair.com.cn)
Ansys-China, Inc.	Tel: 86-10-84085558 Website: www.ansys.com.cn Contact: China@ansys.com.cn
Oasys Software for LS-DYNA	Kimbal Virdi Tel: +86 21 5396 6633 Contact: Kimbal.virdi@arup.com Website: www.arup.com/dyna
Beijing Yuntong Forever CPC. Co. Ltd.	Tel: +86-10-82561200/01/03 Website: http://cpc.ytforever.com Sole Distributor of LINUX NETWORX, INC. (USA) in China Contact: service@ytforever.com
Engineering Technology Associates (China) Inc.	Martin Ma Tel: + 86-21-64385725 Contact: support@eta.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

FEA Information China Participants

Software, Hardware, Training, Consulting, Services

SGI China	Carl Zhang Tel: +86 -10 - 65228868 Ext. 3362 Contact: carl@sgi.com
Tsinghua University	Qing Zhou, PhD. - Professor Department of Automotive Engineering Beijing, 100084, China
Zhongfang Information Technology Ltd	Larry Liang Tel: +86-21-54973162 Website: http://www.cntech.com.cn Contact: info@cntech.com.cn
Zhong Guo ESI Co., Ltd	Yang Xiaojum Phone: +86 (020) 8235 6272 Contact : Yang Xiaojun

Informational Websites

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

LSTC LS-DYNA Support Site	**www.dynasupport.com**
FEA Informationwebsites	**www.feainformation.com**
TopCrunch – Benchmarks	**www.topcrunch.org**
LS-DYNA Examples (more than 100 Examples)	**www.dynaexamples.com**
LS-DYNA Conference Site	**www.ls-dynaconferences.com**
LS-DYNA Publications to Download On Line	**www.dynalook.com**
LS-DYNA Publications	**www.feapublications.com**
LS-DYNA CADFEM Portal	**www.lsdyna-portal.com.**

March Highlights from FEA Information Inc.

Website: www.feainformation.com

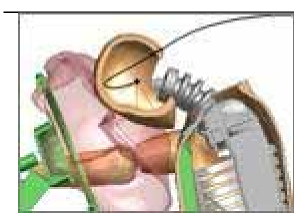
The Japan Research Institute - September 19 - 20th

JAPAN LS-DYNA Users Conference 2006 - Tokyo, Japan Hosted by JR

AMD Athlon™ 64 X2 Dual-Core Processor Product Brief

Take multi-tasking to a whole new level with the AMD Athlon™ 64 X2 Dual-Core Processor.

Engineering Technology Associates, Inc: THE DIGITAL PRESS : TRYOUT BEFORE TOOLING



ARUP In our website you will find details of the Oasys pre and post processing software for LS-DYNA as well as FE models available for purchase and the training courses we offer.

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