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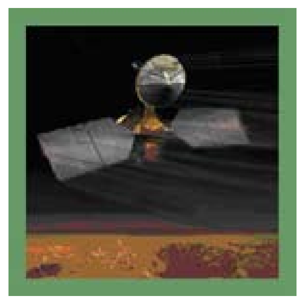
COVER STORY

Jet Propulsion Laboratory

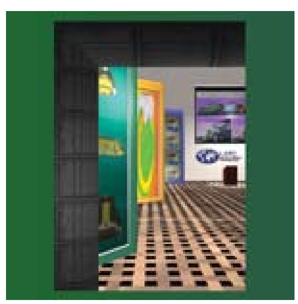
Pace Quickens for NASA Spacecraft

Orbiting Mars



PRODUCT SPOTLIGHT

LS-DYNA® Development



CONFERENCE SPOTLIGHT

MSC.Software

Virtual Product Development Conference

July 17 – 19, 2006

Huntington Beach, CA

FEA INFORMATION RESOURCE MAGAZINE

FEA Information Worldwide Participants

Contents

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FEA Information Announcements

Revsied Resource Page

TABLE 2: MPP Interconnect and MPI **PathScale Infinipath has been updated to Qlogic Infinipath.**

For website information the URL is www.qlogic.com

LSTC Announcement - Released 06/16/2006

LS-DYNA 971/7600
LS-OPT 3.1

LS-DYNA Released Versions Authorized for Benchmark Results TopCrunch SMP/MPP	
06/15/06	Version ls970.6763.169

Sincerely, ***Trent Eggleston & Marsha Victory***

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9th International LS-DYNA® Users Conference -

INTRODUCTION LS-DYNA Development

- We recognize that no single method is superior in all applications
- New developments and methodologies take time before gaining general acceptance and robustness
- Requests for developments from users are given the highest development priority
- Accuracy, speed, and scalability are the critical considerations for large scale simulations
- New releases must accept and run all input files from all previous releases without translation

DEVELOPMENT GOALS

- Combine multi-physics capabilities in a scalable code for solving highly nonlinear transient problems to enable the solution of coupled multi-physics and multi-stage problems in one run
    - Full 2D & 3D capabilities
    - Explicit Solver
    - Implicit Solver
    - Heat Transfer
    - ALE, EFG, SPH, particle methods
    - Navier-Stokes Fluids (version 980)
    - Radiation transport (version 980)
    - Electromagnetics (version 980)
    - Interfaces for users, i.e., elements, materials, loads, etc.
    - Interfaces with other software, Madymo, USA, etc.

DEVELOPMENT GOALS - Implicit

- Springback for sheet metal stamping
- Static initialization of crash models
- Dynamic springback simulation after crash simulation
    - o Reliable measurements between numerical and physical results can be more easily obtained
- An embedded linear capability to automatically solve for normal modes, attachment modes, and constraint modes
    - o Include infinitesimal motions superimposed on rigid bodies for NVH and durability modeling
- Eigenvalue analysis to check the rigid body modes in the crash models
    - o Identify inadvertent constraints

DEVELOPMENT OF ONE CODE HAS ADVANTAGES

- Huge cost savings relative to developing an array of software applications.
    - Explicit elements only need added stiffness matrix
    - Features needed for implicit applications are available for explicit
        - Double precision
        - 2nd order stress updates
- Implicit MPP utilizes all prior efforts for explicit solver
- Pre and post-processing software development supports one interface and common databases
- QA is performed on one code.

LSTC's Vision

- In automotive, one model for crash, durability, NVH shared and maintained across analysis groups
- One scalable multi-physics code, LS-DYNA, to enable the complete modeling of crash including airbags, occupants, and fuel tank.
- Manufacturing simulation results from LS-DYNA used in crash, durability, and NVH modeling
- Explicit durability and NVH modeling go mainstream in MD Nastran
- No optional added cost LSTC developed features in LS-DYNA
- LS-DYNA specific pre-processing, post-processing, LS-PrePost, and optimization, LS-OPT, with no added charges.
- Unrestricted open databases
- Focus on large distributed memory low-cost clusters running large simulations
- As processor costs decrease and cluster sizes increase, LS-DYNA software prices per processor will proportionally decrease to keep simulation costs affordable
- Optimization technology will automate engineering design calculations. LS-OPT is considered a critical enabling technology

Current State of Explicit

- Currently, typical large simulation models typically contain 1,000000 to 4,000,000 elements.
- FEA dummies are preferred over rigid body dummies in crash simulations
- 12-32 processors are used in runs that complete within 12-24 hours
- Calculations give digit-to-digit repeatability for a fixed domain decomposition.
- MPP version is recommended if more than 4 processors are used per run
- Model sizes continue to grow faster than Processor speed

Near Future For Explicit

- Model sizes of 10,000,000 elements
- 128-512 processors in overnight runs
- Human dummy models, such as THUMS, will increase model sizes even further
- Honeycomb barriers will be modeled by shell elements
- Number of processors will increase 5-10 times
- Optimization software use in crash analysis will become widespread

Final Goal For Explicit Simulations

- Simulation results accepted in place of prototype testing
    - What is required?
        - Strict modeling guidelines for analysts, and a single comprehensive model for crash, NVH, Durability, etc.
        - Continued software improvements
            - Constitutive models
            - Contact
            - FSI with SPH, ALE, Particle methods
            - Sensors and control systems
            - Complete compatibility with NASTRAN
        - Manufacturing simulations (in LS-DYNA, Moldflow, etc.) providing the initial conditions for crash simulations

Parallel Computing

- In less than one decade from 1998-2006 the use of explicit codes has undergone a radical transformation
    - From 100% serial and SMP licensed CPU's for crash to 90% MPP with the remaining 10% of CPU's typically running smaller models on 1-8 processors
    - Today serial and SMP explicit codes are becoming obsolete and will eventually be phased out

- What about implicit?
    - More difficult to create an MPP version
    - Requires more expensive hardware so there is less customer pressure to create MPP versions
    - However, it is safe to predict that serial and SMP implicit solvers *used in large scale nonlinear simulations* will also become obsolete within the next 5 years

Scalability On Large Clusters

- IBM BlueGene/L computer is based on low cost PowerPC processors with modest clock speed, low power consumption, high speed network
- 2**16 (65000+) parallel processors
- Scalability of LS-DYNA on 1,048,576 element customer model run to completion:
    - 128 -Elapsed time 5 hours 27min. 437564 cycles
    - 256 -Elapsed time 2 hours 44min. 437564 cycles
    - 512 -Elapsed time 1 hour 27min. 437564 cycles
    - 1024 -Elapsed time 50min. 437564 cycles
    - 2048 -Elapsed time 32min. 437564 cycles

- Cray XD1 with RapidArray interconnects AMD Dual Core Opteron 2.2 GHz
- 3 Car crash simulation run to completion (750K nodes)

Dual Core (Nodes x CPUs/node x Cores/cpu)	CPU Time (sec)	Single Core (Nodes x CPUs/node x Cores/cpu)	CPU Time (sec)
64 x 2 x 2 = 256	1696		
32 x 2 x 2 = 128	2416	32 x 2 x 1 = 64	4619
24 x 2 x 2 = 96	2981		
16 x 2 x 2 = 64	3846		
12 x 2 x 2=48	5226		
8 x 2 x 2 = 32	7591		
4 x 2 x 2 = 16	14078		
2 x 2 x 2 = 8	26230	4 x 2 x 1 = 8	24681
1 x 2 x 2 = 4	49460	2 x 2 x 1 = 4	47611

Release Of Version 971_R2

- Version 971 was intended to be an update to version 970 to include parallel implicit
- Implementation of implicit parallel has taken years longer than planned
- Version 971_R1 was released during the 4th quarter of 2005
    - Multiple customers requested additional capabilities before switching from version 970
- Version 971_R2 now includes nearly all additional requested capabilities
- Manual will be published by August 2006 and will include new features in the R3 release.

Version 971_R2 Developments

*Database_extent_binary

- New flag to output nodal mass scaling information into the D3PLOT database
    - EQ.1: Output incremental nodal mass
    - EQ.2: Output percentage increase in nodal mass

- In the past only the change in mass at the element level was available
- New output options for metal forming applications
- For each contact interface a new flag is available to output:
  - peak pressure
  - surface energy density
- Allows segregating the energies generated on the upper and lower shell surfaces
- Data is remapped after each H-adaptive remesh.
- For metalforming applications with thermal effects, there is a new option to output of thermal data to d3plot:
  - EQ.0: (default) output temperature
  - EQ.1: output temperature and flux
  - EQ.2: output temperature, flux, and shell lower and upper surface temperatures for the 12-node thermal shells

*Database_nodout

- The size for the nodal history file NODOUT can be huge due to the need for have a small set of nodal output at a very high frequency
- Two NODOUT files can now be created:
  - NODOUT at a large output time interval
  - NODOUTHF at a small output time interval
    - For accelerometer nodes
- Nodes for high frequency output are flagged in *DATABASE_HISTORY_NODE input

*Database_matsum

- *CONTROL_OUTPUT flag to:
  - Output eroded internal and kinetic energy into the MATSUM file by part ID.
  - Output the kinetic energy from the added mass under part ID 0, which includes mass defined under:
    - *ELEMENT_MASS
    - Nonstructural mass distributions defined in *SECTION_SHELL
    - *ELEMENT_MASS_PART.

Labels and Numeric ID's

- 8-character alphanumeric labels can now be used for: SECID, MID, EOSID, HGID, and TMID throughout the keyword input

Card	1	2	3	4	5	6	7	8
Variable	PID	SECID	MID	EOSID	HGID	GRAV	ADPOPT	TMID
Type	I	I/A	I/A	I/A	I/A	I	I	I/A
Default	none	none	none	0	0	0	0	0

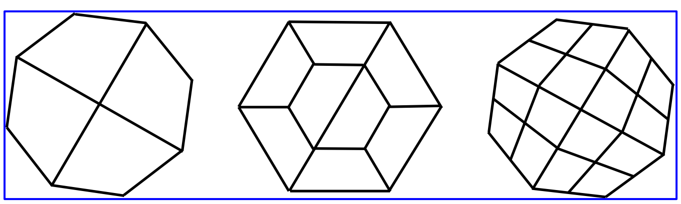
*Element_mass_part

- Defines the total additional non-structural mass to be distributed by an area weighted distribution to all nodes of a given part ID.
- Applies to all part ID's defined by shell elements.
- Provides an alternative method to giving the non-structural mass per unit area in the section definition.

*Define_hex_spotweld_assembly

- Development motivated by spotweld studies at Honda USA which showed the superiority of using multiple solid elements for each weld.
- Define a list of hexahedral solid elements clusters that make up a single spot weld for computing the force and moment resultants that are written into the SWFORC output file and also used for failure predictions.
- A maximum of a 16 element cluster may be used to define single spot weld.
- This table is generated automatically when beam elements are converted to solid elements.

- Sample four, eight, and sixteen element spot weld clusters comprised of solid hexahedron elements. {Courtesy Honda, USA}



*CONTROL_SPOTWELD_BEAM

- New option to replace each spot weld beam element with a cluster of solid elements of 1, 4, or 8 solid elements.
- For 4 or 8 solid elements, a table is automatically generated to output the force and moment resultants into the SWFORC using the ID of the beam element which is replaced by the solid elements and for failure predictions
- The beam elements are automatically deleted from the calculation, and the section and material data is automatically changed to be used with solid element or solid element cluster

Spot weld Failure

- The recent use of high strength steels has motivated new developments for predicting spot weld failure
  - With mild steels the spot weld failure mode is tear out
  - With high strength steels the failure mode is either tear out or spot weld fracture
    - Depends on the ratio of shear versus axial loading
- Two failure models are now available: the first for beam elements, developed by Toyota; and the second for single solid elements, developed by Daimler-Chrysler

Spot weld New Development

- New constitutive model: *MAT_SPOTWELD_ DAIMLERCHRYSLER
  - The DAIMLERCHRYSLER failure model assumes that failure of the spot weld depends on properties of the welded materials so this keyword allows shell material failure data to be input for the connection
  - References connection ID which is defined via:
    - *DEFINE_CONNECTION_PROPERTIES
  - Implemented for single solid elements
  - Includes damage and rate effects
  - Much easier to use and more general than the previous option: *DEFINE_SPOTWELD_FAILURE_RESULTANTS

- *DEFINE_CONNECTION_PROPERTIES
  - References material ID's used in part definitions and defines a failure criteria for the material ID's.
  - One or more connection ID's can be defined
  - A 3-parameter failure criteria is used

$$f = \left(\frac{\sigma_n}{\sigma_n^F(\dot{\varepsilon})}\right)^{m_n} + \left(\frac{\sigma_b}{\sigma_b^F(\dot{\varepsilon})}\right)^{m_b} + \left(\frac{\tau}{\tau^F(\dot{\varepsilon})}\right)^{m_\tau} - 1$$

$$\sigma_n = \frac{N_{rr}}{A} \qquad \sigma_b = \frac{\sqrt{M_{rs}^2 + M_{rt}^2}}{Z} \qquad \tau = \frac{M_{rr}}{2Z} + \frac{\sqrt{N_{rs}^2 + N_{rt}^2}}{A}$$

Sensors For Automotive Safety

- There are over 110 sensors in the average vehicle today, e.g.,
  - pressure sensor for brake, tire
  - Force and torque sensor for suspension
  - Acceleration, velocity and displacement sensor for suspension, vehicle and occupant
  - Occupant classification sensor for restraint system
  - Strain gauge for steel and seat

*SENSOR

- *SENSOR_DEFINE defines a physical sensor.
  The output signal is the numerical value of a physical sensor.
- *SENSOR_SWITCH compares the sensor signal with a given criterion. The output signal is the logical result, true or false.
- *SENSOR_CONTROL controls a function, airbag, contact,..., based on the logical result of a set of SENSOR_SWITCH. Multiple status switch is possible.

*Contact_force_tranducer

- Scalability of LS-DYNA to hundred's of processors is limited by contact
  - Scalability for 1-2 contact definitions covering the entire vehicle is excellent
  - Scalability for 300+ contact definitions diminishes significantly as the number of processors increase
    - 300 contact definitions are used to obtain detailed reaction force information.
- Force transducers measure contact forces within a vehicle by accumulating all forces acting on a segment set during contact.
  - Problem is that these transducers cannot separate the forces in two-sided contact
- In version 971_R2 a master surface is also accepted such that the reaction force is accumulated by the interactions of the slave and master surfaces
  - It is now possible to move to fewer contact interfaces and improve scalability.

Jet Propulsion Laboratory – California Inst. of Technology

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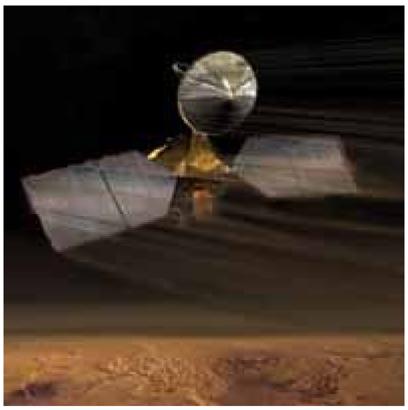
Pace Quickens for NASA Spacecraft Orbiting Mars - June 19, 2006



NASA's newest spacecraft at Mars has already cut the size and duration of each orbit by more than half, just 11 weeks into a 23-week process of shrinking its orbit. By other indicators, the lion's share of the job lies ahead.

Artist concept of Mars Reconnaissance Orbitor during aerobraking – Image credit: NASA/JPL

"The orbits are getting shorter and shorter. We've finished about 80 of them so far, but we have about 400 more to go, and the pace really quickens toward the end," said Dan Johnston, Mars Reconnaissance Orbiter deputy mission manager at NASA's Jet Propulsion Laboratory, Pasadena, Calif.

Supplementing the daily attentions of navigators, engineers and scientists, the orbiter has begun using unprecedented onboard smarts to schedule some of its own attitude maneuvers during each orbit.

The current phase of the Mars Reconnaissance Orbiter mission, called "aerobraking," began in late March with the spacecraft in a pattern of very elongated, 35-hour orbits. It will end in early September, according to current plans, once hundreds of careful dips into Mars' atmosphere have adjusted the orbit to nearly circular, two-hour loops. Then, after some touch-up engine burns, deployment of a radar antenna and other transitional tasks, the spacecraft will be in the right orbit and configuration to start its main science phase in November.

During the two-year science phase, Mars Reconnaissance Orbiter will examine Mars from subsurface layers to the top of the atmosphere. It will use its 3-meter (10-foot) diameter dish antenna to pump data Earthward at up to 10 times the pace of any previous Mars mission. Besides providing information about the history and extent of Mars' water, the orbiter will assess prospective landing sites for NASA robots launching in 2007 and 2009.

When the spacecraft first entered orbit around Mars, its farthest point from the planet was about 45,000 kilometers (28,000 miles). After 11 weeks of aerobraking operations, this distance has been reduced to about 20,000 kilometers (12,000 miles). On each orbit since early April, the nearest-to-Mars portion of the orbit has passed through the upper atmosphere, usually at about 105 kilometers (65 miles) above the surface of the planet. The drag created by interaction of the atmosphere with spacecraft surfaces slows the craft.

"Our biggest challenge is the variability of the atmosphere," Johnston said. "It's not uncommon to get a 35 percent change in how much drag the spacecraft experiences from one pass to the next. We need to monitor each pass carefully and be prepared to change the altitude to a safe one for the next pass, if necessary."

While the orbiter is above the atmosphere, it can orient its antenna toward Earth and its solar panels toward the sun. Before it enters the atmosphere for each pass, it pivots so that the back surfaces of the solar panels and antenna face the direction of travel. An innovative capability of Mars Reconnaissance Orbiter's onboard software enables it to calculate the time when it needs to reorient itself for the next pass. This feature, called "periapsis timing estimator," was activated in May.

JPL's Jim Graf, project manager for Mars Reconnaissance Orbiter, said, "In the past, the times for turning to aerobraking attitude had to be calculated on the ground and sent to the spacecraft for each pass. Now, the spacecraft can do that itself. This will be especially helpful when the spacecraft gets to the point when it is doing several drag passes per day."

Mars Reconnaissance Orbiter is the third NASA Mars mission -- after Mars Global Surveyor in 1997 and Mars Odyssey in 2001 -- to use aerobraking to get into a desired, near-circular orbit. The strategy allows launching the spacecraft with much less fuel than would be required if using just rocket engines to decelerate into the desired orbit. Each drag pass this month is slowing Mars Reconnaissance Orbiter by an average of about 2 meters per second (4.5 miles per hour), which would otherwise require consuming about a kilogram (2.2 pounds) of fuel.

Transition activities during the two months between the end of aerobraking and the beginning of the main science phase will include unfolding two 5-meter (16-foot) lengths of antenna for a ground-penetrating radar instrument, removing the lens cap from a mineral-identifying spectrometer instrument and characterizing all instruments' performance in different modes of use. From early October to early November, Mars will be nearly behind the sun as viewed from Earth. Communication with all spacecraft at Mars will be unreliable during portions of that period, so commanding will be minimized.

Additional information about Mars Reconnaissance Orbiter is available online at http://www.nasa.gov/mro . The mission is managed by JPL, a division of the California Institute of Technology, Pasadena, for the NASA Science Mission Directorate, Washington. Lockheed Martin Space Systems, Denver, is the prime contractor for the project and built the spacecraft.

Yahoo Group Yammerings

Jim Kennedy
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Len Schwer
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Len Schwer will be conducting an LS-DYNA 'Discussion Group Forum' at the 77th Shock & Vibration Symposium, October 29 - November 3, 2006 at the Hyatt Regency Monterey in Monterey, CA. Visit www.saviac.org for more details.

This installment of "Yahoo Yammerings" features four questions, with responses, and two posting of general interest, from the past month of postings to the LS-DYNA Yahoo Group:

1. Geometric Nonlinearity?
2. *Using MAT_RIGID versus RIGIDWALL_GEOMETRIC?*
3. *How to Model Local Material Softening Response Artificially*
4. *Bolt Failure Criteria?*
5. *Contact Algorithm - Calculation of Minimum Time Step.*
6. *Intel Core Duo CPU Comparison.*

Question: Geometric Nonlinearity?

Does LS DYNA takes geometric nonlinearities into account by default? If not, how to include it in the analysis? Which element types can handle geometrical nonlinearity? Does it have something to do with material models?

I am trying to model low velocity impact behavior on sandwich panels. The dimensions of sandwich plate is 300mm x 300mm x 25.7 mm, and I am getting maximum z-displacement of 5.1 mm. which means I have large displacements for my model and should consider geometrical nonlinearity.

Response by Jim Kennedy

It is my understanding that most of the widely used elements incorporated in the LS-DYNA use a large deformation formulation. Please see the LS-DYNA Theory Manual.

LS-DYNA outputs the Cauchy (true) stress and true strain.

The nonlinear material behavior will depend on your constitutive model choice from the large material law library. In addition, some linear material laws are available.

Question : Using MAT_RIGID versus RIGIDWALL_GEOMETRIC?

I am doing a impact analysis of rigid sphere impacting a plate. For the rigid sphere I have taken MAT_RIGID (MAT_020) material model and I have specified the mass density according to its weight and volume; I do not know the material of the sphere. Is it necessary to specify Young's modulus and Poisson's ratio for the rigid sphere?

What is the difference between MAT_RIGID and RIGIDWALL_GEOMETRIC_SPHERE? Will both provide the same results?

Response by Jim Kennedy

Reasonable values of Young's modulus and Poisson's should be used for the rigid material to minimize problems with the contact (please see pages 20.82 and 20.84 of the LS-DYNA Version 970 User's Manual).

MAT_RIGID is used to provide the material model used for a meshed arbitrary body.

RIGIDWALL_GEOMETRIC_SPHERE defines a rigid wall via an analytical description.

If good modeling practices are used, they should give similar results.

Question: How to Model Local Material Softening Response Artificially

I am working with an SPH model, i.e. cylindrical rotating rigid part plunging into SPH plate. In reality there is localized thermal softening of the material. However, from prior knowledge, I know SPH does not support a thermal solution. (I do not know/think if the situation has since changed). Anyway, an alternative would be to obtain a softening response by inducing it artificially.

My original model uses a Johnson Cook constitutive model. Currently, I am using MAT_PLASTIC_KINEMATIC (MAT 3) for simplicity reasons.

Some of the ideas, I have are:

1. Decreasing the ETAN value in Mat_3 to a smaller value (3 or +more orders less than E) or a negative value. (I have tried this, and see a decrease to the order of .about 10^8.

Any comments on my approach?

Can someone answer which direction should my approach go, and how to visually (or by observing stress/strain values) can a softening response be observed in LS-PrePostt?

Response by Jim Kennedy

I would suggest using the Johnson-Cook model (MAT_015) as a structural only problem.

I also suggest reading the following paper to understand how the thermal softening is addressed in the Johnson-Cook model:

Johnson, G.R. and W.H. Cook, "A Constitutive Model and Data for Metals Subjected to Large Strains, High Strain Rates, and High Temperatures," 7th International Symposium on Ballistics, pp. 541-547, The Hague, Netherlands, April 1983.

In the structural only approach, the adiabatic heating is calculated if you enter a value for specific heat CP on the *MAT_JOHNSON_COOK keyword. Temperature change is calculated by dividing the plastic work by (rho)*(cp). This temperature change is used in calculating T* (please see page 20.64 of the LS-DYNA Version 970 User's Manual). The temperature is written to d3plot as HV#1 (NEIPH=0) or HV#5 (under the Fcomp/MISC menu of LS-PrePost, after setting NEIPH=6 on the LS-DYNA input *DATABASE_EXTENT_BINARY).

Question Bolt Failure Criteria?

How do I use the force failure criteria with beam elements. I have modeled a bolt with a beam element and I want to have it break during a quasi-static simulation if the beam experiences an axial force greater than a set axial force target value and resultant shear force greater than a set shear force target value.

The ultimate would be to have a bolt force failure criteria set using the combination of tensile -shear force experimental curve. I am not sure if LS-DYNA has this feature?

Response by Jim Kennedy

Two things you might consider:

1. Write your own User Supplied material Model (UMAT).

2. This type of failure is specified in *CONSTRAINED_SPOTWELD and *CONTACT_TIEBREAK_Options, you might consider modifying your model to make use of these features, e.g., join beam nodes by welds.

Follow-up by Conrad Izatt

In addition to the two suggestions from James, you could try using a 'discrete' beam (beam type 6) instead and combine it with using *MAT_NONLINEAR_PLASTIC_DISCRETE_BEAM. This will allow you to define the yield, plastic and failure behavior for all 6 degrees of freedom with basic interactions.

Contact Algorithm - Calculation of Minimum Time Step

Posting by Len Schwer

Lee Bindeman of LSTC recently provided some insight on the calculation of the minimum time step size for the contact algorithms in LS-DYNA. I thought this me be of interest to the Group:

"For each contact interface in the model, we loop over the slave and master nodes and calculate the contact frequency of each by considering its contact stiffness (by soft=0 method) and its mass. From the Courant condition, we calculate a stable time step as dt=2/w where w is the frequency. We store the smallest dt of all the nodes and report this as the surface time step. The current minimum is the smallest of all the contact interfaces that have been checked."

Lee adds that for the SOFT=2 contact option, no minimum time step is computed.

LS-DYNA Yahoo Groups

There are over 1790 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 250 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 .

Virtual Product Development Conference
July 17 – 19, 2006 – Huntington Beach, CA

The following are excerpts – full information can be found at:
http://vpd.mscsoftware.com/americas/

Among The 2006 keynote speakers are:

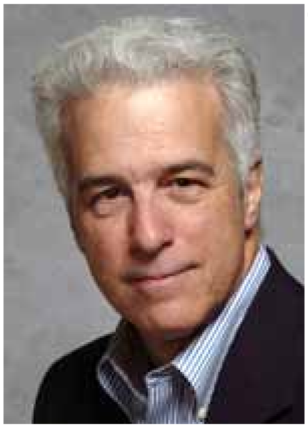
William Weyand - Chairman of the Board and Chief Executive Officer MSC.Software

Mr. Weyand assumed the role of chairman and CEO of MSC Software in February 2005

Mr. Weyand was Chairman and CEO of Structural Dynamics Research Corporation (SDRC) from 1997 to 2001. During that time, he redefined SDRC's strategic direction to capitalize on new growth opportunities, establishing the company as a market leader in Product Lifecycle Management (PLM) solutions. Under his direction, SDRC acquired seven companies. In 2001, he successfully facilitated the sale of SDRC to Electronic Data Systems (NYSE: EDS) for $1 billion

Dave Fennell - Vice President of Information Technology - Boeing Commercial Airplanes

Dave Fennell is vice president of Information Technology for The Boeing Company. He is responsible for the design and support of company-wide engineering, manufacturing and quality assurance systems, collectively known as Product Life Cycle Management (PLM) Systems. In addition, Mr. Fennell is responsible to the Boeing Commercial Airplane (BCA) Business Unit...

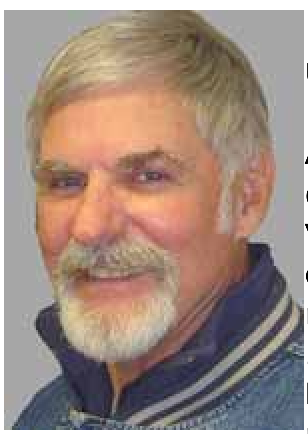


Thomas C. Tecco - Global Director, Computer-Aided Engineering, Electrical and Test Systems -General Motors Corporation

Mr. Tecco is the Director of Global CAE/Test Systems and Electrical for the Information Systems and Services (IS&S) organization at General Motors. He also has responsibility for Systems Engineering and the Designing Engineer initiative.

Reza Sadeghi, Ph.D. - VP, Product Development - MSC.Software

Dr. Reza Sadeghi is currently Vice President of Product Development (Enterprise Computing) at MSC.Software with responsibility for strategy and development of MSC's MultiDscipline Products, (Nastran, Marc, Adams, Dytran and Patran). Prior to MSC he was responsible for the simulation methods group at Goodrich aerospace, where he led the development of a number of math based tools for design and manufacturing of commercial and military jet engine nacelle structures. Over the past 10 years, he has been asked to serve on a number of science and technology review boards, among them DOE and DOD.



Dick Rutan, Commander of the World's First Non-Stop, Unrefueled Flight

As a Tactical Air Command fighter pilot during most of his two decades in the Air Force, Dick Rutan few 325 combat missions in Vietnam, 105 of them as a member of a high-risk classified operation commonly known as the MISTY's." While on his last strike reconnaissance mission over North Vietnam in September of 1968, he was hit by enemy ground fire, and forced to eject from his burning F-100. Dick evaded enemy capture and was later rescued by the Air Force's "Jolly Green Giant" helicopter team. Before retiring from the Air Force in 1978, Lt. Col. Rutan had been awarded the Silver Star, five Distinguished Flying Crosses, 16 Air Medals and the Purple Heart. '

Imitation of Life – SGI www.sgi.com

http://www.sgi.com/features/2006/june/ncsa/

For the first time, researchers simulated a complete, functioning organism at the atomic level. How NCSA's SGI Altix system helped them make history.

Picture an object with a million moving parts. Now imagine building a model to simulate that object - one that reveals how each part interacts with the other, every one-millionth-of-a-billionth of a second.

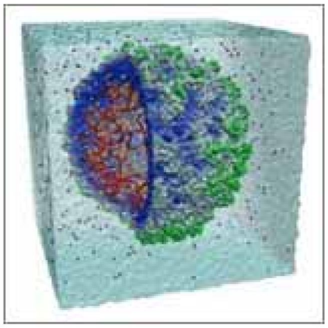
No, it's not rocket science. But it just might be harder.

For nearly as long as biophysicists have relied on computers to study the dynamics of molecules, they've hoped to replicate a functioning life form at the atomic level. Yet even the simplest of these organisms proved too complex to simulate in total. But now, thanks to the efforts of three Illinois researchers, a highly scalable molecular dynamics application, and one very powerful computer, all that is history.

At the University of Illinois at Urbana-Champaign, two graduate students and their professor have achieved what until now had been patently unachievable. They generated the world's first atomic-level simulation of a simple, but complete, functioning organism. And they did it on an SGI® Altix® system.

A research team led by Professor Klaus Schulten, head of the Theoretical and Computational Biophysics Group at Illinois, simulated a plant virus with as many as 1 million moving atoms. Dr. Schulten worked with grad students Peter Freddolino and Anton Arkhipov on the year-long project, which was reported in the March 2006 issue of the scientific journal *Structure*.

Intricate mechanisms



Satellite Tobacco Mosaic Virus
The world's first atomic-level simulation of a functioning organism.

The smallest natural organisms known, viruses contain intricate mechanisms for infecting host cells. The Illinois team simulated one of the tiniest and most primitive viruses in an attempt to recreate the process of infection and propagation. The satellite tobacco mosaic virus - it's called a *satellite virus* because it relies on a host cell and a primary virus to reproduce - attacks tomato and tobacco plants throughout the US, leading to mosaic-like discolorations.

While the virus attacks plants, the researchers predict that someday, drugs for animals or even humans may be designed and refined with the help of computer-based simulations like the one developed in Illinois.

The satellite tobacco mosaic virus is so small that biologists refer to it as a particle. Nevertheless, simulating the organism and how it functions holds tremendous promise for medical research. "It allows us to see how the virus assembles and disassembles," notes team member Peter Freddolino. "Because assembly and disassembly are two of the key steps in the viral life cycle, understanding these events could lead to the development of drugs designed to attack them at these vulnerable points."

After several months of careful planning and preliminary research, the team secured time on Cobalt, an SGI® Altix® 3700 Bx2 system located at the National Center for Supercomputing Applications (NCSA). It proved a powerful, efficient resource. Despite the complexity of the project, the researchers needed just a fraction of the NCSA's 1,024-processor Altix system: Most simulations used 256 Intel® Itanium® 2 processors and 128GB of total memory, leaving the rest of the NCSA system available for other projects. The team's scalable molecular dynamics code, a Gordon Bell Award-winning application called NAMD, segments tasks across processors and memory, enabling simulations to draw the most of as many of processors and as much memory as they require.

The entire simulation was completed in 50 days. Had the researchers relied on today's desktop computer systems, they wouldn't have finished until 2041.

Biological reverse-engineering

The project is also the first successful case of biological reverse-engineering of a complete virus. "This is on the highest end of what is feasible today," says Schulten. "The approach is something that we learned from engineers: Reverse engineer the subjects you're interested in and test fly them in the computer to see if they work *in silico* (or simulated on a computer) the way they do *in vivo* (in the body). Naturally, deeper understanding of the mechanistic properties of other, more complicated viruses will eventually contribute to public health and medicine."

The entire simulation covers just over 50 nanoseconds of time, or 50 billionths of a second. Still, it was enough time for Schulten's team to make several conclusions about the virus. Among them: although the organism appears symmetrical, it actually pulses in and out in an asymmetrical pattern.

As it turns out, the Illinois team's simulated findings support observations made by other researchers in traditional "wet lab" work. Those earlier observations, however, left scientists wondering what caused the viral behavior - something that remained a mystery until today.

They accomplished this by studying the virus not just as a whole, but as the sum of its separate components - its protein shell and nucleic acid core. "The going theory was that the protein shell pulled the entire thing together and was responsible for its assembly," explains Freddolino. "But the simulation showed that the nucleic acid was even more important for keeping the virus together."

When simulated as a whole, the virus appeared stable and symmetrical. But after removing a component, the researchers saw how vital the nucleic acid was to the structure of the virus. "The protein shell just fell out without the nucleic acid," recalls Freddolino. "That told us a lot."

"The analysis of the results required originality," says Arkhipov, who leveraged his physics training to analyze the diffusion of ions and other phenomena. "It's interesting to see how each part of the structure moves a little bit on its own, and how that affects its symmetry."

An invaluable resource

NCSA's large Altix system allowed the team to focus more on science than computing. "The ideal situation is to work with a powerful computing platform that provides output quickly and with minimal disturbance. In this way, the underlying science is the focus of the effort. NCSA provided exactly that," added Schulten, a long-time NCSA user.

"The Altix platform has excellent single node performance and a very efficient MPI implementation," said Freddolino, "and both of these factors made the system very useful in performing our work efficiently."

"It's incumbent upon centers like NCSA to make the most of the federal government's technology investments by working closely with scientists like Professor Schulten as well as entire communities of scientists," said Thom Dunning, director, NCSA. "We have developed new ways to allocate supercomputing resources, such as our large-scale SGI Altix deployment, to give scientists what they need in order to make incredible breakthroughs like the simulation of an entire living thing."
Image courtesy of NCSA and University of Illinois at Urbana-Champaign

TOP CRUNCH NEWS – Benchmarks Online
Dr. David Benson – www.topcrunch.org
FEA Information Participant INTEL

Intel/Intel	S5000XAL/*Information Not Provided*	Intel® Xeon™ Dual Core 5160 EM64T	1 x 2 x 2 = **4**	40350	3 Vehicle Collision	05/22/2006
Intel/Intel	S5000PAL/Infiniband	Intel® Xeon® Dual Core 5160 EM64T	32 x 2 x 1 = **64**	244	neon_refined	05/31/2006
Intel/Intel	S5000PAL/Infiniband	Intel® Xeon® Dual Core 5160 EM64T	16 x 2 x 2 = **64**	289	neon_refined	05/31/2006
Intel/Intel	S5000PAL/Infiniband	Intel® Xeon® Dual Core 5160 EM64T	16 x 2 x 1 = **32**	364	neon_refined	05/31/2006
Intel/Intel	S5000PAL/Infiniband	Intel® Xeon® Dual Core 5160 EM64T	8 x 2 x 2 = **32**	451	neon_refined	05/31/2006
Intel/Intel	S5000PAL/Infiniband	Intel® Xeon® Dual Core 5160 EM64T	8 x 2 x 1 = **16**	630	neon_refined	05/31/2006
Intel/Intel	S5000PAL/Infiniband	Intel® Xeon® Dual Core 5160 EM64T	4 x 2 x 2 = **16**	803	neon_refined	05/31/2006
Intel/Intel	S5000PAL/Infiniband	Intel® Xeon® Dual Core 5160 EM64T	4 x 2 x 1 = **8**	1138	neon_refined	05/31/2006
Intel/Intel	S5000PAL/Infiniband	Intel® Xeon® Dual Core 5160 EM64T	2 x 2 x 2 = **8**	1548	neon_refined	05/31/2006
Intel/Intel	S5000PAL/Infiniband	Intel® Xeon® Dual Core 5160 EM64T	2 x 2 x 1 = **4**	2174	neon_refined	05/31/2006
Intel/Intel	S5000PAL/Infiniband	Intel® Xeon® Dual Core 5160 EM64T	32 x 2 x 1 = **64**	2539	3 Vehicle Collision	05/31/2006
Intel/Intel	S5000PAL/Infiniband	Intel® Xeon® Dual Core 5160 EM64T	16 x 2 x 2 = **64**	3402	3 Vehicle Collision	05/31/2006
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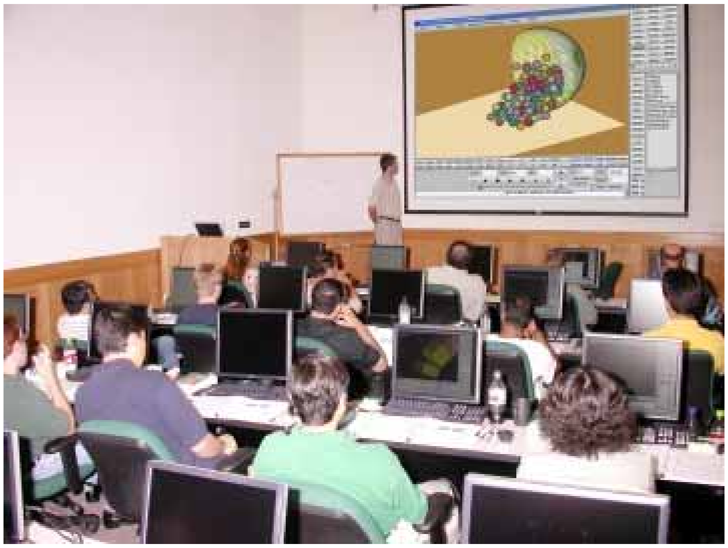
Intel/Intel	S5000PAL/Infiniband	Intel® Xeon® Dual Core 5160 EM64T	8 x 2 x 2 = **32**	5955	3 Vehicle Collision	05/31/2006
Intel/Intel	S5000PAL/Infiniband	Intel® Xeon® Dual Core 5160 EM64T	8 x 2 x 1 = **16**	8481	3 Vehicle Collision	05/31/2006
Intel/Intel	S5000PAL/Infiniband	Intel® Xeon® Dual Core 5160 EM64T	4 x 2 x 2 = **16**	11408	3 Vehicle Collision	05/31/2006
Intel/Intel	S5000PAL/Infiniband	Intel® Xeon® Dual Core 5160 EM64T	4 x 2 x 1 = **8**	17414	3 Vehicle Collision	05/31/2006
Intel/Intel	S5000PAL/Infiniband	Intel® Xeon® Dual Core 5160 EM64T	2 x 2 x 2 = **8**	23418	3 Vehicle Collision	05/31/2006
Intel/Intel	S5000PAL/Infiniband	Intel® Xeon® Dual Core 5160 EM64T	32 x 2 x 1 = **64**	28218	car2car	05/31/2006
Intel/Intel	S5000PAL/Infiniband	Intel® Xeon® Dual Core 5160 EM64T	16 x 2 x 2 = **64**	31213	car2car	05/31/2006
Intel/Intel	S5000PAL/Infiniband	Intel® Xeon® Dual Core 5160 EM64T	2 x 2 x 1 = **4**	33668	3 Vehicle Collision	05/31/2006

LSTC Training Classes – 2006



For Training Information:

www.lstc.com

jane@lstc.com

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

LSTC Training Classes – 2006 - continued

Training Class	US $	Livermore, CA	Detroit, MI
Advanced LS-DYNA for Impact Analysis	$950	June 27-30 Sept 5-6	
Advanced Options in LS-DYNA	$750	August 15-16	
ALE/Eulerian & Fluid/Structure Interaction in LS-DYNA	$750	July 12-14	
Concrete and Geomaterial Modeling with LS-DYNA	$750	Oct 24-25	
Contact in LS-DYNA	$750	Sept. 12-13	Aug 15-16

Introduction to LS-DYNA	$750	May 02-05 Aug. 01-04 Nov. 14-17	April 25-28 July 25-28 Oct 16-19 Dec. 11-14
Introduction to LS-OPT	$750	May 16-19 Nov. 07-10	
LS-DYNA Composite Materials	$750	Sept. 14-15	
LS-DYNA Implicit	$750	June 15-16	Sept. 07-08
LS-DYNA for Heat Transfer & Thermal-Stress Problems	$500		
Material Modeling Using LS-DYNA User Defined Options	$750	June 13-14	
MESH Free Methods in LS-DYNA (SPH and EFG)	$750		

EVENTS – 2006

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

2006	
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
August	**Altair Engineering's: South Asia CAE Users' Conference 2006**
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, QLogic InfiniPath	LAM/MPI, MPICH, HP MPI, SCALI
FUJITSU Prime Power	SUN OS 5.8		
FUJITSU VPP	Unix_System_V		
HP PA8000	HPUX		
HPIA64	HPUX		
HP Alpha	True 64		
IBM Power 4/5	AIX 5.1, 5.2, 5.3		
IBM Power 5	SUSE 9.0		LAM/MPI
INTEL IA32	Linux, Windows	InfiniBand (Voltaire), MyriCom	LAM/MPI, MPICH, HP MPI, SCALI
INTEL IA64	Linux		LAM/MPI, MPICH, HP MPI
INTEL Xeon EMT64	Linux	InfiniBand (Topspin, Voltaire), MyriCom, QLogic InfiniPath	LAM/MPI, MPICH, HP MPI, INTEL MPI, SCALI
NEC SX6	Super-UX		
SGI Mips	IRIX 6.5	NUMAlink	MPT
SGI IA64	SUSE 9 w/ProPack 4 RedHat 3 w/ProPack 3	NUMAlink, InfiniBand, (Voltaire)	MPT, Intel MPI, MPICH

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

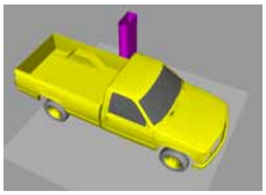
Includes a complete CAD interface capable of importing, modeling and analyzing, any die design. Available for PC, LINUX and UNIX, DYNAFORM couples affordable software with today's high-end, low-cost hardware for a complete and affordable metal forming solution.

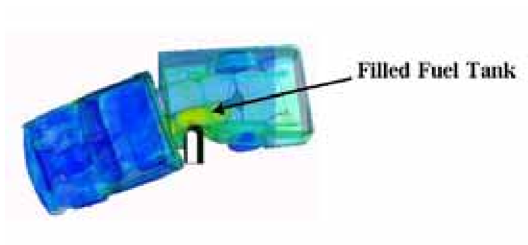
ETA – VPG
www.eta.com

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

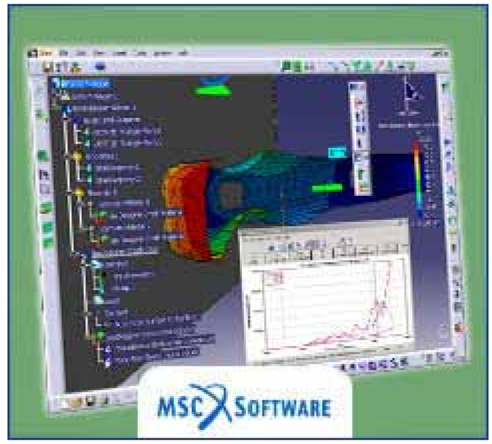
MSC.Software - MSC.Nastran/SOL 700

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.

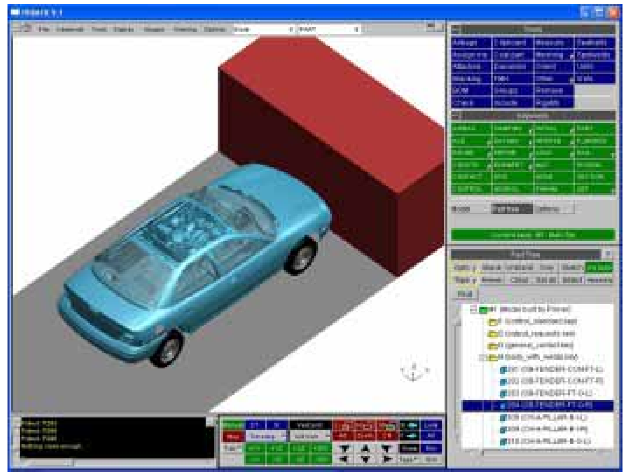
MSC.Software – Gateway for LS-DYNA

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.

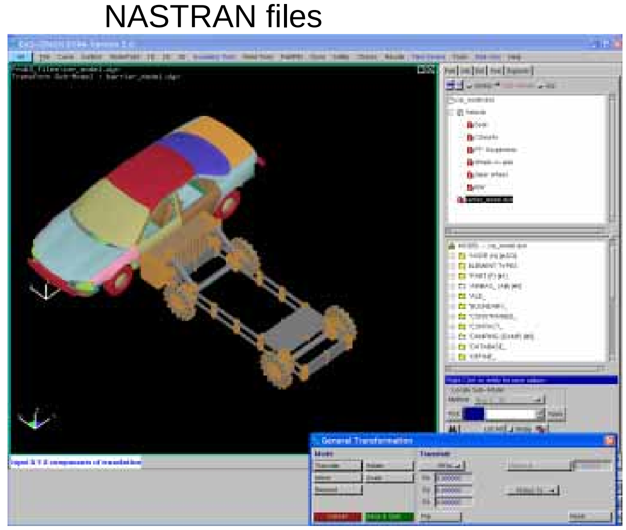
EASi-CRASH DYNA
http://www.esi-group.com/SimulationSoftware/EASi_CRASH-DYNA/

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 - Communication Products

www.amd.com

www.fujitsu.com

www.hp.com

www.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	**Arup** www.arup.com/eastasia/
China	**MSC. Software – China** www.mscsoftware.com.cn
Germany	**CAD-FEM** www.cadfem.de
Germany	**Dyna*More*** www.dynamore.de
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
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

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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

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

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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.

The following publication in it's entirety is on line at: www.crashoptimization.com

New Features in LS-OPT® Version 3

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Abstract
An overview of LS-OPT features is given with special emphasis on new features available in LS-OPT Version 3.1. The main features added to Version 3 include discrete optimization, 3-D metamodel plotting, additional statistics features, and a simplification of parameter identification. LS-OPT is now available for MS Windows®.

Introduction and Overview

In today's CAE environment it is unusual to make engineering decisions based on a single physics simulation. A typical user conducts multiple analyses by varying the design and uses the combined results for design improvement. LS-OPT [1] provides an environment for design and is tightly interfaced to LS-DYNA and LS-PREPOST with the goal of allowing the user to organize input for multiple simulations and gather and display the results and statistics. More specifically, LS-OPT has capabilities for improving design performance in an uncertain environment and conducting system and material identification. These objectives can be achieved through the use of statistical tools and optimization. The individual tasks that can thus be accomplished are:

- Identify important design variables
- Optimize the design
- Explore the design space using surrogate design models
- Identify sources of uncertainty in FE models
- Visualize statistics of multiple runs

The typical applications are: Multidisciplinary Design Optimization (crashworthiness, modal analysis, durability analysis, etc.), system and material identification (biomaterials, metal alloys, concrete, airbag properties, etc.) and process design (metal forming).

The main technologies available in LS-OPT are:

- *Experimental Design (DOE). D*-Optimal design, Latin Hypercube sampling, Space Filling and others. DOE allows the user to automatically select a set of different designs to be analyzed. The main types mentioned here are each suited to a different type of analysis: *D*-Optimal for polynomials and sequential optimization, Latin Hypercube for stochastic analysis and Space Filling for Neural Networks.
- *Metamodels (approximations).* Response Surface Methodology and Neural Networks are the most important. With these tools, the user can explore the design space and quantify the predictability of a response, i.e. identify sources of noisy response.

- *Variable screening* [4] provides information on the relative importance of design variables.
- *Probabilistic analysis* includes Reliability and Outlier Analysis [3]. The former allows the user to evaluate the probability of failure while the latter allows the identification of parts of a model that contribute to noisy response and therefore affect the predictability of the results. The outlier analysis uses integrated LS-PREPOST features.
- *Optimization*. Used for automated design improvement. The Successive Response Surface Method (SRSM) [5] is the principal iterative tool for finding a converged optimum. A similar methodology is used for finding a converged result using neural net updating.

Features are available to distribute simulation jobs across a network, using a queuing system.