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Pg

## Featured Articles

- 02 *Multimaterial Eulerian Hydraulics Part II: Eulerian Step* - Dr. David Benson, FEA Information
- 04 *History and Future of Computing Part 2 of 3* - Paul Bemis, ANSYS, Inc.
- 06 *Contact Modeling in LS-DYNA Part 2 of 4* - Suri Bala, LSTC
- 12 **Itanium – The New Technology** – Trent Eggleston, FEA Information; Kathy Fisher, Hewlett-Packard
- 14 Web Site Summary
- 15 Courses & Events
- Monthly Product Showcase  
**Livermore Software Technology Corp.**  
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**Multimaterial Eulerian Hydrodynamics**  
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**Part 3: The Eulerian Step (Multimaterial Elements)**  
**David J. Benson**

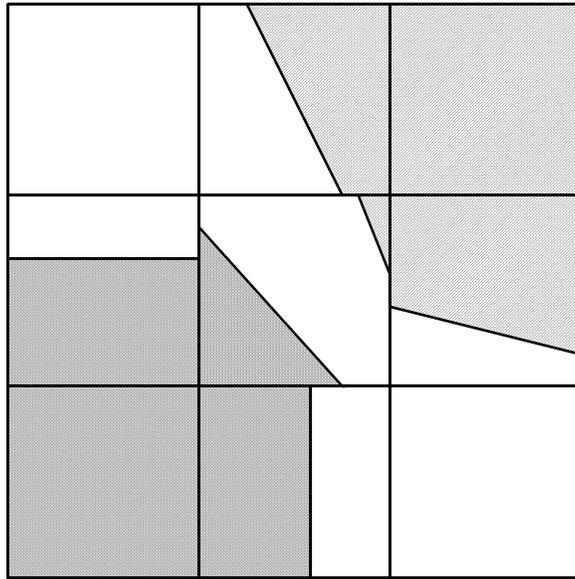
The motion of the nodes during the Lagrangian step defines the transport volumes at the boundaries of the elements. These volumes coincide with the material transport volumes when an element contains only one material, and equal the sum of the material transport volumes for multimaterial elements. An algorithm is therefore required to partition the element transport volumes into the material transport volumes. These algorithms are referred to as “interface reconstruction” methods, although not all of them actually define explicitly define material interfaces.

During the postprocessing, material outlines are commonly generated by plotting the isosurface (surface with a constant level of a variable) of the volume fraction equal to 0.5. While the isosurface has a visually reasonable appearance, it doesn't accurately represent the exact volume of each material within the element. In addition, there is no guarantee that the isosurfaces of two materials don't intersect. Since the amount of each material must be conserved during transport, the isosurfaces can't be used to define the material transport volumes.

One simple approach to handling multimaterial transport is to simply transport the volume fraction of each material using the same algorithm used to transport the other variables (see Part 2). This is a simple strategy to implement, however it diffuses the material interface over two to four elements. Aside from being physically unrealistic, the diffuse nature of the material interface creates a large number of multimaterial elements, with the consequent increase in storage and computational cost.

The interface reconstruction methods evolved from modifications to standard transport methods to prevent interface diffusion to the current methods that explicitly construct the material interface. The most popular class of interface reconstruction methods in common use are the piecewise linear interface reconstruction (PLIC) methods, originally developed by David Youngs. As shown in Figure 1, the material interfaces are straight lines (or planes in three dimensions), and they are generally discontinuous between elements. Most of the variations on Youngs' method are associated with the calculation of the interface normal direction.

The interfaces are created in two steps for each interface. First, the direction of the interface normal is calculated from the volume fractions in the element and its neighbors using a finite difference stencil. Second, the location of the interface is adjusted within the element until the correct volume of material is behind the interface. The equations for calculating the volume are quadratic in two dimensions, and cubic in three dimensions (including axisymmetric problems). The coefficients of the equations change as the material interface crosses a node. To solve the equations, the volumes behind the interface as it intersects each node are calculated. The coefficients are calculated for the interval between two nodes bracketing the material volume and the polynomial is solved analytically.



**Figure 1. The material interfaces of a PLIC method.**

For elements that contain more than two materials, a sequence of interface is constructed using the “onion skin” model. The materials are ordered with the element by using a list specified in the input file or by a specialized algorithm. The first material interface is constructed as described above using the volume fractions for the first material. The second material interface is constructed by summing the volume fractions of the first two materials, so the second material lies between the first and second interfaces. Each subsequent material interface is constructed by summing the volume fractions of all the materials behind it.

The elements are deformed at the end of the Lagrangian step, unlike those drawn in Figure 1. A common strategy to simplify the calculations of the interfaces is to perform them with volume coordinates instead of the physical coordinate system. In this approach, the element is mapped to a unit cube, and the interfaces calculated in this coordinate system give the same results as using the physical coordinate system as long as there is a linear transformation between the two coordinate systems. For elements using linear shape functions, the error introduced by using volume coordinates is second order. If the mesh is initially rectangular, the magnitude of the error introduced by volume coordinates is generally very small.

### **Computing in the Nineties**

During the late 1980's and early 1990's the "personal model" of computing continued to gain acceptance in the marketplace. The continued improvements in performance first outlined by Gordon Moore of Intel drove the microprocessor performance up at a rate of twice every 12-18 months. Furthermore, the once clean distinctions between the Engineering Workstation and the Personal Computer began to blur as Microsoft and Intel drove for an increasingly large and diverse set of customers. However, the central "time-shared" model of computing continued to survive, and in fact thrive, albeit under a new name: client-server computing.

### **Client Server Computing**

In the strict sense, client-server computing can be any kind of client device (including a dumb terminal) attached to a shared server resource. In this sense, the time-sharing model of DEC VT220 terminals attached via RS232 lines to a VAX minicomputer qualifies as a "client server" architecture. However, what is typically meant when using this terminology is the use of a local Engineering Workstation attached via a high speed LAN to a compute/file storage facility. The fact is, both the time-shared servers, and the dedicated clients, have their role in the engineering environment. For example, in the use of ANSYS both the local client and the central resource have merit. A user typically simulates small design models on their desktop system. However when the design becomes too complex to complete in a moderate amount (2-3 hours) of time, then the user will often "off load" the simulation to the larger computational server. This method is quite popular in engineering environments today, and mechanisms for "load balancing" the computational load of the simulation environment is done with third party "middleware" such as the Load Share Facility from Platform Computing Incorporated ([www.platform.com](http://www.platform.com)).

### **Distributed Web Based Computing**

In many ways the web is an extension of client-server computing. The web is nothing more than a computational and storage server that one accesses from their desktop "client". Not only does it provide for large amounts of data storage, but also provides the opportunity to harness multiple processors together for reducing overall simulation times. Furthermore, with the advent of high-speed wide area networks (WAN) the issue of data transmission is becoming less of a constraint. The opportunity exists to take the lessons learned during the client-server period, and apply them to the web. For example, nearly all of the benefits of client-server relate directly to the use of remote "web-based" simulation. The ability to "off-load" the desktop, the centralized amortization of disk and memory investments, and the ability to use multiple processors for improving "time to completion" of large simulation jobs, are all clearly evident in the web base model. In fact, many believe the web will prove to be a key vehicle for providing a collaborative infrastructure that can traverse organizational and geographical boundaries allowing for global design and analysis.

### **Engineering Simulation in the next Decade**

It's clear that the next decade will see the performance of computing and density of storage continue as they have in the past. Performance will double every 12-18 months as competitive pressure continues to drive prices down. This trend is best exemplified by the introduction of the Intel Itanium processor scheduled for deployment this year. Itanium promises to provide extremely high performance capability at 'personal computer' price points. As this trend continues, the ratio of CPU's to users will continue to rise opening the door to massive parallel processing and optimization. For design engineers these trends mean that not only one or two

simulations can be considered for a design, but hundreds. In fact, there will be the opportunity in the next decade to use the excess web capacity to ‘search’ all possible design alternatives for the one that best meets the overall design criteria taking into account product life, warranty costs, and maintenance schedules.

### **Collaborative Engineering Analysis**

The use of engineering science in design became well accepted during the industrial revolution. Prior to this point trial and error was used as a means to develop and acceptable output. Thomas Edison used the “trial and error” method of design to develop many of his significant inventions. As math and physics replaced the more “brute force” methods, engineers were educated in all disciplines equally. A look at the old steam locomotive suggests engineers were equally well-versed in the areas of thermodynamics, fluid dynamics, kinematics and heat transfer. In today’s world it’s common to find engineers specializing in areas with little or no interaction with other disciplines. These individuals are often separated by geography, departmental boundaries, and engineering simulation tools. Corporations, such as ANSYS Inc. e-CAE.com ASP Programs, using the internet have an opportunity to change this “isolation” and improve overall design efficiency.

**For pricing and further information contact: Paul Bemis, [paul.bemis@ansys.com] the author of this series article and the manager of The ANSYS, Inc. e-CAE.com ASP Program that provides:**

- A mechanism for running **ANSYS** simulations and/or **LS-DYNA** simulations on large parallel compute servers, at a remote data center site using the internet.
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### **Part III: FAQ on Web Based Distributed Simulation**

**Contact Modeling in LS-DYNA, © Copyright LSTC – Suri Bala, 2001**  
**Part 2 - Contact Parameters – Default and Recommended Values**

**Articles on Contact Modeling in LS-DYNA in upcoming issues:**  
**Part 3 - Modeling Guidelines For Full Vehicle Contact**  
**Part 4 – Airbag Contact, Edge-to-Edge Contact, and Rigid Body Contact**

## **6.0 Contact Parameters**

There are several contact-related parameters in LS-DYNA that can be used to modify or, in many cases, improve contact behavior. The default settings for these parameters should be used as a starting point, but often non-default values are appropriate depending on the behavior of the contact. The following sections describe the most common contact parameters and make general recommendations regarding their use.

Contact parameters may be set using the commands `*CONTROL_CONTACT`, `*CONTACT`, and `*PART_CONTACT`. Certain parameters may be set using more than one command and so a command hierarchy must exist. Parameters set with `*CONTROL_CONTACT` redefine *default* settings for all contacts in the model. Contact parameters set in `*CONTACT_...` will override default settings for individual contacts. Contact parameters set in `*PART_CONTACT` supercede settings in `*CONTACT` for contact involving a specific part.

### **6.1 Thickness offsets, SLTHK (card 1, \*CONTROL\_CONTACT and Optional Card ‘A’ in \*CONTACT\_option) AUTOMATIC (\*CONTACT\_option)**

In crashworthiness analysis, sheet metal components are represented using shell elements with the nodal points at the mid-plane surface. Each shell has a thickness,  $t_s$ , that by default is equal to the thickness of the sheet metal. When these components are included in the contact treatment, shell thickness offsets are used to project the mid-surface of the shell to create the surface for contact. The choice of the contact type determines whether shell thickness offsets are considered.

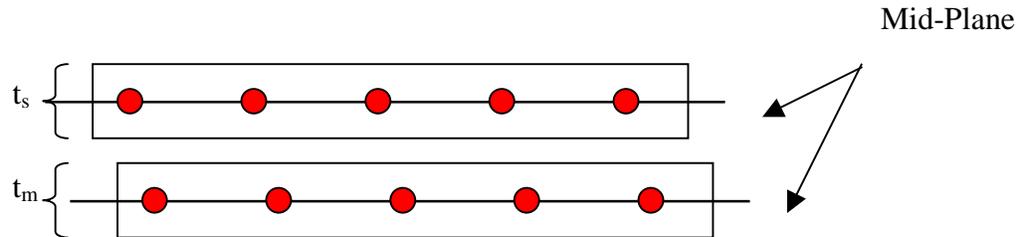
In LS-DYNA the non-automatic contact types:

`*CONTACT_SURFACE_TO_SURFACE`  
`*CONTACT_NODES_TO_SURFACE`  
`*CONTACT_ONE_WAY_SURFACE_TO_SURFACE`

use two different treatments depending on the parameter SHLTHK. This parameter can be specified globally on the `*CONTROL_CONTACT` card and locally for a given contact definition on optional card B of the `*CONTACT` input. If `SHLTHK=0`, an incremental search technique is used to determine the closest master segment and shell thickness offsets are not included. If `SHLTHK=1`, LS-DYNA considers the shell thickness offsets for deformable nodes but ignores the offsets for the nodes of rigid bodies. If `SHLTHK=2`, then LS-DYNA considers the thickness for both deformable and rigid nodes. For `SHLTHK` set to 1 or 2 a global bucket search is used to identify contact pairs. After contact is established, incremental searching is used to track the position of the slave nodes on the master surface. An advantage of global bucket searching is that the master and slave surfaces can be disjoint. This is impossible if incremental searching is used since incremental searching assumes that the contact surfaces are fully connected. In these contact types, it is important to orient the contact segment normals, based on the right-hand-rule, towards the contacting surface before the calculation begins. This is called *oriented contact*. An optional automatic orientation feature may be invoked using the

parameter ORIEN on the \*CONTROL\_CONTACT card; however, for this option to work a gap must exist between opposing shell mid-plane surfaces.

AUTOMATIC and single surface contact types always consider shell thickness offsets as shown in Figure 6.1. These contact types use both global bucket sorting and local incremental searching in determining the contact pairs. AUTOMATIC contacts are generally more robust than their non-automatic counterparts since this contact type has no orientation requirement, i.e., contiguous segments do not obey the right-hand-rule. This is important in crash analysis since metal part can fold over and change the orientation. The contact search algorithm checks for penetration from either side of the shell mid-plane.



**Figure 6.1 Automatic Contact Segment Based Projection**

### **6.1.1 Shell Thickness Offset Recommendations**

The AUTOMATIC contact types, which consider shell thickness offsets, are recommended for impact and crash analysis. If it is desired that shell thickness offsets of rigid components be disregarded, a non-automatic contact type may be used with the parameter SHLTHK set to 1 in either \*CONTROL\_CONTACT or on Optional Card 'B' of \*CONTACT. Additionally, it is important to ensure that the finite element mesh is constructed so that the shell mid-plane surfaces of the opposing parts are set apart by at least  $(t_s+t_m)/2$  with meshes of similar density around sharp changes in curvature. If this condition is not satisfied, LS-DYNA will issue warning messages to indicate that penetrations were detected and that the penetrating nodes were moved to eliminate the penetrations. Sometimes the modification of the geometry can change the results. In version 960 of LS-DYNA, an option exists whereby penetrating nodes are *not* moved but rather the initial penetrations become the baseline from which additional penetration is measured. This option of tracking initial penetrations is invoked by setting the parameter IGNORE equal to 1 on Card 4 of \*CONTROL\_CONTACT or on optional card C of \*CONTACT. We recommend that this option be used in most calculations.

See Sections 6.4 and 6.5 for more on shell thickness offsets. In those sections, the term “contact thickness” refers to the magnitude of the shell thickness offsets.

## **6.2 Contact Sliding Friction, FS and FD (card 2, \*CONTACT option)**

Contact sliding friction in LSDYNA is based on a Coulomb formulation and uses the equivalent of an elastic-plastic spring. Friction is invoked by giving non-zero values for the static and dynamic friction coefficients, FS and FD, respectively, in the \*CONTACT or \*PART\_CONTACT input. For a detailed description of the frictional contact algorithm, please refer to Section 23.8.6 in the LS-DYNA Theory Manual.

### **6.2.1 Contact Sliding Friction Recommendations**

When setting the frictional coefficients, physical values taken from a handbook such as Marks, provide a starting point. Note that to differentiate static and dynamic friction, FD should be less than FS and the decay coefficient DC must be nonzero. For numerically noisy problems such as crash, the static and dynamic coefficients are frequently set equal to avoid the creation of additional noise. The decay coefficient determines the manner in which the instantaneous net friction coefficient is transitioned from FS to FD. The parameter, VC, provides a means to limit the frictional contact stress based on the strength of the material. The suggested value for VC is  $SIGY/\sqrt{3}$  where SIGY is the minimum yield stress of the materials in contact. In LS-DYNA, version 960, the optional parameter FRCENG on card 4 of \*CONTROL\_CONTACT may be set to write the frictional contact energy to the binary interface database (\*DATABASE\_BINARY\_INTFOR).

Routinely, one automatic, single-surface contact with numerous dissimilar materials, are used in full vehicle simulations. In these cases, using a uniform value for FS and FD may be inappropriate. In such instances, it is recommended that the frictional parameters be specified part by part using the contact option in the part definition, \*PART\_CONTACT.

It is helpful in understanding the sensitivity contact friction in a calculation by making two runs utilizing lower-bound and upper-bound friction coefficients.

### **6.3 Penalty Scale Factors, SFS and SFM (card 3, \*CONTACT option)**

So-called penalty scale factors provide a means of increasing or decreasing the contact stiffness. SLSFAC in \*CONTROL\_CONTACT scales the stiffness of all penalty-based contacts, which have the parameter SOFT set equal to 0 or 2. SLSFAC is applied cumulatively with SFS, i.e., the actual scale factor is the product of SFS and SLSFAC, the slave penalty scale factor, or SFM, the master penalty scale factor, defined on card 3 of the \*CONTACT input. SSF, when defined in \*PART\_CONTACT, is cumulative with the aforementioned penalty scale factors. For contacts with SOFT=1, the aforementioned penalty scale factors have no affect; rather SOFSCL on optional card A is used to scale the contact stiffness when SOFT=1. (SOFT is the first parameter specified on optional card A of \*CONTACT.)

#### **6.3.1 Penalty Scale Factors Recommendations**

The default values (SFS=SFM=1.0; SLSFAC=0.1) generally work well for contact between similarly refined meshes of comparably stiff materials. For contacts involving dissimilar mesh sizes and dissimilar material constants, non-default values penalty scale factors may be necessary to avoid the breakdown of contact if SOFT=0. Generally, a better alternative than setting scale factors is to set SOFT=1 and leave all penalty scale factors at their default values.

### **6.4 Contact Thickness SST and MST (card 3, \*CONTACT\_option)**

SST and MST on card 3 of \*CONTACT allow users to directly specify the desired contact thickness. When the default value of SST=MST=0, is used, the contact thickness is equal to the element thickness specified in the \*SECTION\_SHELL card.

#### **6.4.1 Contact Thickness Recommendations**

Nonzero values of SST and MST are sometimes used to decrease the contact thickness and thus eliminate initial penetrations. This is a poor substitute for accurate mesh generation. When using nonzero values of SST and MST, it is highly recommended to use reasonable values. Specifying a very small thickness value, such as 0.1 mm, will result in contact breakdown owing to the fact that contact thickness goes into determining the maximum penetration allowed before the contact releases a

penetrating node. Often, by increasing the contact thickness, breakdown of contact involving very thin materials can be averted. Based on experience, SST and MST should not be less than 0.6-0.7 millimeters.

Since nonzero values of SST and MST are applied to all the parts defined in the contact, it may be more prudent to use the OPTT or SFT parameter in \*PART\_CONTACT to control the contact thickness for individual parts in cases where many parts of widely ranging thickness are included in a single contact.

## **6.5 Contact Thickness Scaling , SFST and SFMT, card 3, \*CONTACT option)**

As an alternative to directly specifying the contact thickness as described above, SFST and/or SFMT may be defined to serve as contact thickness scale factors. These factors are applied to the shell thickness specified in \*SECTION\_SHELL in order to obtain a contact thickness. The default values of SFST and SFMT are 1.0.

### **6.5.1 Contact Thickness Scaling Recommendations**

The same concepts discussed in Contact Thickness Recommendations apply here. Care must be taken though not to assign contact thickness scale factors so small as to result in a contact thickness that is less than 0.6-0.7 mm.

## **6.6 Viscous Damping, VDC (Card 2,\*CONTACT option)**

The viscous contact damping parameter, VDC, on card 2 of \*CONTACT is zero by default. Originally, contact damping was implemented to damp out the oscillations that existed normal to the contact surfaces in sheet metal forming simulations. It has been found that contact damping is often beneficial in reducing high-frequency oscillation of contact forces in crash or impact simulations.

### **6.6.1 Viscous Damping Recommendations**

In contacts involving soft materials such as foams and honeycombs, frequent instabilities exist due to contact oscillations. Using a value of VDC between 40-60 (corresponding to 40 to 60% of critical damping), it is found that the model stability improves; however, it may be necessary to reduce the scale factor for the time step size. Generally, a smaller value of 20 is recommended when metals, which have similar material constants, interact.

## **6.7 Contact Segment Extension, MAXPAR (Optional Card 'A', \*CONTACT\_option)**

MAXPAR on Optional Card A of \*CONTACT controls the enlargement of each contact segment that is needed to combat an inherent flaw in segment-based projection. *This parameter is no longer used in the AUTOMATIC contact options, except for AUTOMATIC\_GENERAL, starting with version 950d of LS-DYNA.* Figure 6.2 shows the contact surface that is projected from the shell mid-plane when using the segment-based projection scheme. It can be seen that at corners of convex surfaces, an open space or gap is present in the contact surface through which a slave node could freely enter without any contact detection. This can result in contact instability, negative contact energy, etc. due to a sudden, large penetration of a node that has entered through a gap. To combat this problem, the contact surface is automatically extended a slight distance parallel to the plane of the contact segment (as well as projected normally from the segment). This slight extension serves to “close” the gap in the contact surface. In versions starting with 950d, a cylindrical surface is created in the valley which is used as the contact surface with the forces acting normal to the surface.

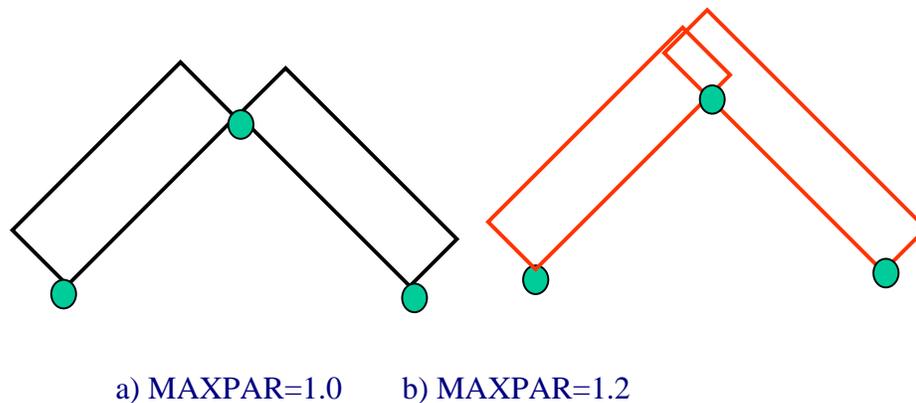


Figure 6.2 Segment extension using MAXPAR. This option is now obsolete in the AUTOMATIC contact types.

### 6.7r Segment Extension Recommendations

The default value of MAXPAR (1.025) works well for most analyses, as most sheet metal components are not much greater than 3-4 mm. However, contact instabilities may develop when a part with a very large thickness (> 5-10mm) or having an angular surface is present in the contact definition. Such an instability may be corrected by reducing the contact thickness (discussed in earlier sections) or by increasing the segment enlargement parameter MAXPAR (to as high as, but no greater than, a value of 1.2). Refining the mesh to reduce sharp angles in the contact surface will also help. A certain cost penalty is paid for MAXPAR values greater than default.

### 6.8 Bucket-Sort Frequency, BSORT (Optional Card 'A', \*CONTACT\_), NSBCS, (Card 2, \*CONTROL\_CONTACT)

Bucket sorting refers to a very effective method of contact searching to identify potential master contact segments for any given slave node. This sorting is an expensive part of the contact algorithm so the number of bucket sorts should be kept to a minimum to reduce runtime. If thickness offsets are considered, then *all* contact types use the bucket sort approach to track the most probable contacting segments. BSORT specifies the number of time steps between bucket sorts. Depending on the contact type, the default bucket sort interval is between 10 and 100 cycles. Except for high speed impact, this interval is almost always adequate. The contact bucket searching frequency should increase, i.e., BSORT should be reduced, if nodes move from one disconnected surface to another in short time intervals or if the surface is folding onto itself. If two relatively smooth simply-connected surfaces are moving across each other without folds, the bucket sorting can be done at larger intervals. Note that if the surfaces are more than several segment widths away from each other, no information is stored related to future contact, and later bucket searching is required to pick up future contacts. Once a slave node is in contact, local searching tracks the motion, and bucket sorting for the nodes, which are in contact, is not necessary.

#### 6.8.1 Bucket-Sort Frequency Recommendations

In certain contact scenarios where contacting parts are moving relative to each other in a rapid fashion, such as airbag deployment, more frequent (than default) bucket sorting intervals may improve the contact behavior. A tell-tale sign inadequate bucket sorting is the appearance of certain penetrating nodes inexplicably being bypassed in the contact treatment. In such cases, using the BSORT parameter

in \*CONTACT or NSBCS in \*CONTROL\_CONTACT, the user can decrease the cycle interval between bucket sorts. Rarely will a value of less than 10 be required.

## **6.9 Maximum Penetration, PENMAX (Optional card 'B', \*CONTROL\_CONTACT), XPENE (Card 2, \*CONTROL\_CONTACT)**

To avoid instability in models, slave nodes that penetrate “too far” are eliminated from the contact algorithm; however, they remain in other calculations. This is done so that very high forces, which are proportional to large penetration values, are not applied to the penetrating nodes that might lead to instabilities. It's also necessary for contacts that consider shell thickness offsets to prevent a sudden reversal in direction of contact force as a penetrating node passes through the shell midplane.

In non-automatic types and SHLTHK=0, the default maximum penetration is set to 1e+20. In other words, no nodes are released at all. When SHLTHK=1 or 2, the XPENE parameter determines the nodal release criteria and is given as follows:

- Max Distance (Solids) = XPENE (default=4.0) \* (thickness of the solid element), SHLTHK=1
- Max Distance (Solids) = 0.05 \* (thickness of the solid element), SHLTHK=2
- Max Distance (Shells) = XPENE (default=4.0) \* (thickness of shell element), SHLTHK=1
- Max Distance (Shells) = 0.05 \* (minimum diagonal length), SHLTHK=2

In AUTOMATIC types and single surface, excluding AUTOMATIC\_GENERAL, the maximum allowable penetration is a function of PENMAX that is set to a default value of 0.4 (40%). The maximum allowable penetration in these cases are shown below:

- Max Distance = PENMAX \* (thickness of the solid)
- Max Distance = PENMAX \* (slave thickness + master thickness)

For AUTOMATIC\_GENERAL only, the default value of PENMAX is set to 200 and provides an almost no nodal release criteria.

### **6.9.1 Maximum Penetration Recommendations**

It is generally recommended that parameters affecting maximum penetration not be changed from the default values. If nodes penetrate too far and are released, the preferred solution is to increase the contact stiffness, change the penalty formulation (SOFT), or increase the contact thickness.

**Itanium™ – A Brief Introduction**  
**Trent Eggleston, Editor FEA Information News**

**Adapted from information provided by**  
**Kathy Fisher, Strategic Alliance Team CSA, Hewlett-Packard**

**Definitions:**

**Architecture:** This term describes the internal structures of a processor and how they work, individually and together. Architecture is a term for the total design and design concepts behind the processor and it also describes the way the processor processes data.

**(EPIC):** Explicit Parallel Instruction Computing is the old term for what is now known as the Itanium™ processor family architecture, co-developed by HP and Intel®.

**(IPF):** Itanium™ processor family

**Itanium™:** On Oct. 4, 1999, Intel Corporation announced Itanium™ as a new brand name for the first product in its Itanium processor family of processors, formerly code-named Merced.

The Intel® Itanium™ processor (formerly code-named Merced) is designed to provide features that enable scalability, high availability, performance, investment protection, and choice for high-end servers and workstations. Itanium processor-based systems will be available at 733 and 800Mhz in 2MB and 4MB L3 cache configurations. The Itanium™ processor family architecture is more scalable, providing:

- Better performance for most applications including high-end visualization applications by taking advantage of the IPF parallel-processing optimization technology
- Software performance upgrades for the IPF system you own. The unique architecture of IPF allows more software tuning than other architectures.
- Platform-level features such as larger memory addresses enhance reliability to boost performance on high-end systems
- Full binary compatibility with existing IA-32 in hardware means that existing software will run seamlessly on IPF.

The Itanium™ processor family is built on the Explicit Parallel Instruction set Computing (EPIC) specifications that were jointly defined by HP and Intel®. This totally new design philosophy incorporates both hardware and software advances focused on enabling, enhancing, expressing, and exploiting parallelism by both the hardware and the software compiler. Some performance-enhancing aspects of the IPF philosophy include:

- Predication
- Speculation
- Rotating registers and other processing efficiencies
- Hardware enhancements such as larger integer and floating point units

The Itanium™ processor family's advanced floating point performance offers major performance advantages in computer-aided engineering and design, fluid dynamics and simulations and other computer-intensive applications. Additionally, Itanium™ will enhance Software development - You

can run object-oriented applications efficiently, the massive register stack gives you the ability to handle context switching and transitions between multiple objects more efficiently.

**For additional testimonials on HP hardware and for complete information on what exclusive Itanium™ processor family advantages are offered by HP, visit the HP website [[www.hp.com](http://www.hp.com)]**

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**LSTC:** "The new Itanium™ processor technology from Intel now available from HP is a significant step forward for LS-DYNA customers who use HP hardware. The advanced performance potential of the Itanium processor will assist LS-DYNA users to solve complex analyses more efficiently, improving turn-around time on critical design and QA cycles."

**Dr. John O. Hallquist**  
**President**  
**Livermore Software Technology Corporation**

**Linux For PC:** [[www.linuxforpc.com](http://www.linuxforpc.com)] **HP – LS-DYNA – MSC.Linux**

## FEA Information Web Sites Summary

Each Monday the news page changes to showcase:  
Software – Product - Participant's Headquarters or a software distributor

### The previous month is archived on the News Page on FEA Information

#### August 6<sup>th</sup>

- **FEA News:** At this time LSTC's LS-OPT and LS-DYNA Version 960 Keyword User Manual are being offered at discount on the site FEA Information.
- **Software Showcase:** eta/FEMB from Engineering Technology Associates. As a high performance, general purpose FEA pre & post processor, FEMB is specifically designed to enhance productivity.
- **Product Showcase:** The Silicon Graphics® F180 - Flat Panel Display offers the optimum combination of screen size, resolution, and flat panel value.

#### August 13<sup>th</sup>

- **ASP Showcase:** The ANSYS, Inc. e-CAE ASP Program is a mechanism for running large ANSYS or LS-DYNA simulations on parallel compute servers at a remote data center site using the Internet or dedicated lines.
- **Product Showcase:** 128-Way PRIMEPOWER 2000 server for the UNIX Environment. Fujitsu Technology Solutions, Inc. recently announced general availability of the 128- processor PRIMEPOWER 2000 SPARC compliant, Solaris compatible servers.
- **Software Showcase:** MSC.Patran - engineers can create finite element models from their computer-aided design (CAD) parts, submit these models for simulation, and visualize the simulated model behavior.

#### August 20<sup>th</sup>

- **Site Update:** Added to our site [www.ls-dyna.com] Material Models, Element Information and Strategic Alliances. Updated the distributor page.
- **Product Showcase:** HP Workstation i2000 1 or 2 Intel® Itanium™ processors at 733MHz or 800MHz; Operating systems: HP-UX, Windows® XP, Linux®; Up to 16GB memory with 4.2GB/s memory bandwidth; Up to 180GB internal storage.
- **Participant Announcement:** The new software release of LS-DYNA Version 960 is available for HP's line of Intel Itanium-based technical computing platforms running HP-UX 11i. These new binaries are a full recompile of LS-DYNA on HP-UX11i under Itanium that takes full performance advantage of the native Itanium instruction set.

#### August 27<sup>th</sup>

- **Site Updates:** We have started building the technical information site Fluid-Structure Interaction and the site Geomaterial Modeling [www.geomaterialmodeling.com]
- **Software:** The Japan Research Institute Limited – **JVISION** – a general purpose pre & post processor for FEM software
- **Hardware:** SGI's high-performance IRIX systems. SGI is committed to a multiplatform strategy with innovative high-performance IRIX® systems, high-value Windows® systems, and industry-leading Linux® systems.
- **Participant MSC Software Announcement:** LSTC Recommends MSC.Software's Linux Operation System - LS-DYNA Running on MSC.Linux Based Clusters Offers Tremendous Price-Performance Benefits
- **Distributor Showcase:** DYNAMAX located in Troy, Michigan. Consulting, Sales and Training to local industries.

**Courses and Events will be limited to 1 page**  
**For further information visit the events page on FEA Information**

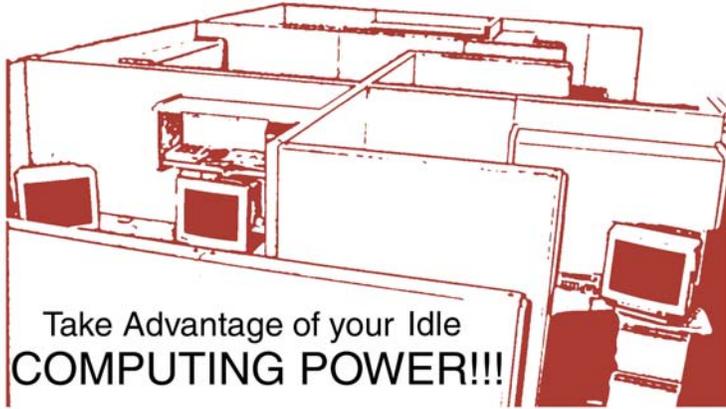
**Events**

France	Sept 24-26	<b>Worldwide Aerospace Conference &amp; Technology Showcase</b> , Toulouse Congress Center, Toulouse, France
USA	Sept 25-26	<b>LMS 2001 Conference for Physical and Virtual Prototyping</b> , Michigan State Management Education Center, Troy, MI.
Germany	Oct 17-19	<b>19th CAD-FEM Users' Meeting</b> - International Congress on FEM Technology will be held October 17-19, 2001 at the DORINT SANS SOUCI Hotel in Potsdam, near Berlin.
Japan	Oct. 30-31	<b>LS-DYNA Users Conference</b> , sponsored by Japanese Research Institute (JRI) - to be held at the Sheraton Grande Tokyo Bay Hotel.
France	Nov 13-14	<b>LMS 2001 Conference for Physical and Virtual Prototyping</b> , Hotel New York, Disneyland Paris, Paris France
USA	April 22-24, 2002	<b>ANSYS Users Conference &amp; Exhibition 2002 - Pittsburgh Hilton, Pittsburgh, PA.</b>
USA	May 19-21 2002	<b>7<sup>th</sup> International LS-DYNA User's Conference</b> , Hyatt Regency Hotel & Conference Center, Dearborn, MI

**October Classes – Seminars**

<b>Start</b>		<b>Company</b>	<b>Training Offered</b>
01	US	ANSYS	Intro to ANSYS Part I
02	US	LMS	Fourier Monitor and Modal Analysis Product Training
02	UK	OASYS	PC-DYNA (intro & pre & post-processing)
04	US	ANSYS	Intro to ANSYS Part II
10	US	LMS	LMS Falanx Product Training
09	UK	OASYS	Automotive Crash Modeling
16	UK	OASYS	Occupant Protection
16	US	ANSYS	Design Optimization
17	KR	THEME	LS-DYNA Introductory Training
17	US	LSTC	LS-OPT training
18	US	LMS	LMS Gateway/Link Product
22	US	MSC	Computer-based modeling for design and analysis with MSC. Patran
26	KR	THEME	eta/FEMB Introductory Training

## FEA Information Showcase



Take Advantage of your Idle  
**COMPUTING POWER!!!**

# LS-DYNA MPP



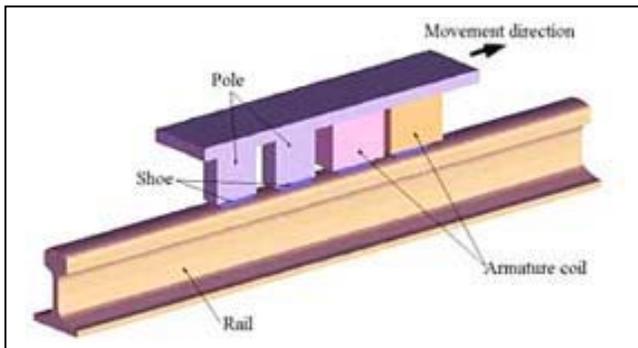
**Livermore Software Technology  
Corporation**  
[[www.ls-dyna.com](http://www.ls-dyna.com)]  
[[www.lstc.com](http://www.lstc.com)]

**For More Information on Availability**

**Contact: Wayne L. Mindle**  
[wlm@lstc.com](mailto:wlm@lstc.com)

**The Japan Research Institute Limited**  
[[www.jri.co.jp/pro-eng/jmag/e/jmg/index.html](http://www.jri.co.jp/pro-eng/jmag/e/jmg/index.html)]  
**JMAG-Studio**  
A magnetic field analysis program

**This example shows how JMAG can be used for  
the analysis of an eddy current brake for railcars**



**FEA Information Inc.**  
[[www.feainformation.com](http://www.feainformation.com)]  
**Online Store**  
**Version 960 LS-DYNA Keyword  
Manual is Available at Special  
Online Pricing**



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