LSTC | Products

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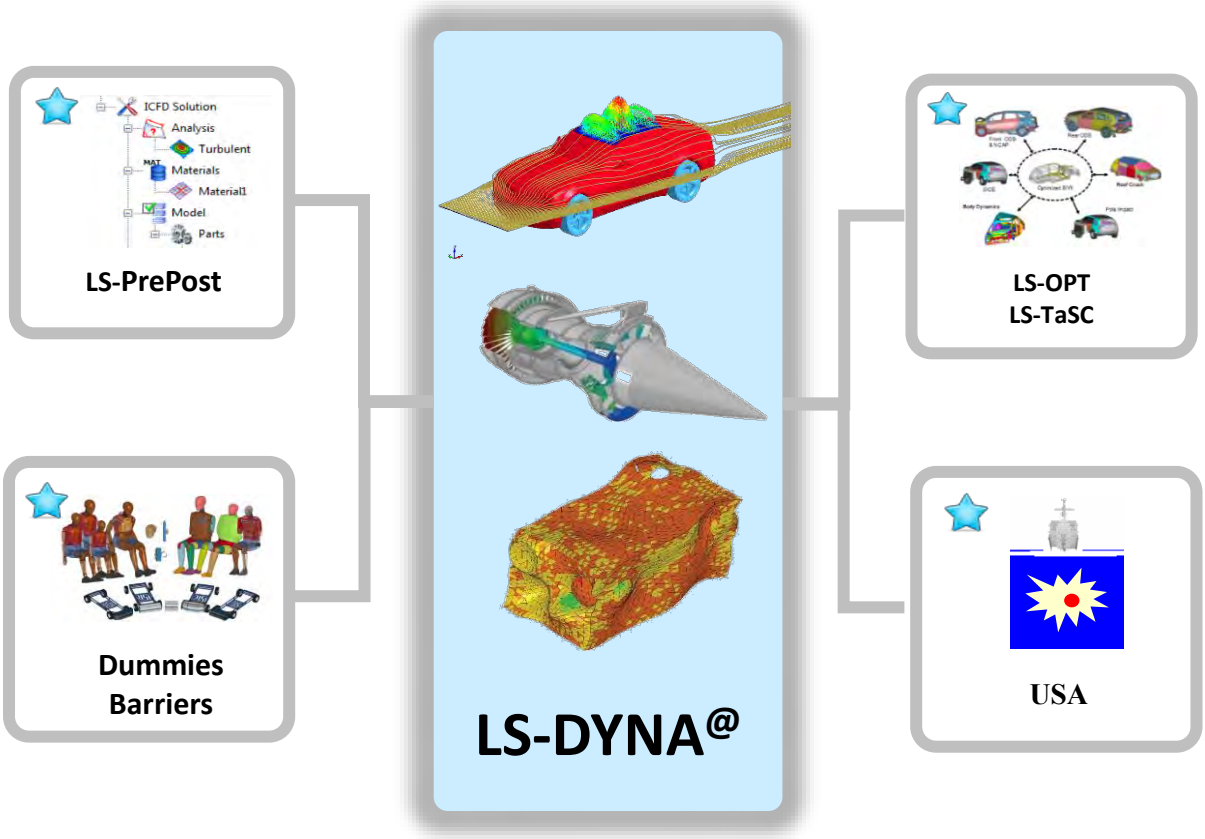
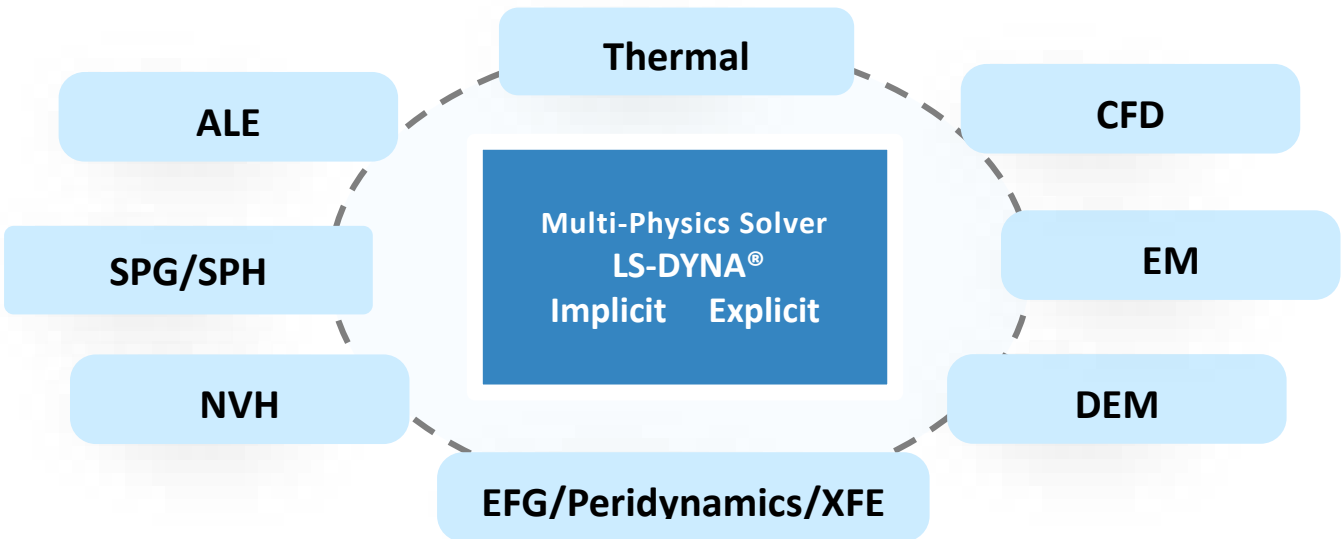
LS-DYNA@ Multi-Physics Solver, Pre-and-Post Processor, Optimization, and Library of Validated Dummies and Barriers





LS-DYNA@ is a highly advanced general purpose nonlinear finite element program that is capable of simulating complex real world problems. With LS-DYNA, LSTC aims to provide methods to seamlessly solve problems requiring "Multi-Physics", "Multi-Processing", "Multiple Stages",

LS-DYNA® | Applications and Capabilities

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Development costs are spread across many industries

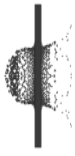
Automotive
Crash and safety
NVH & Durability
FSI

Structural
Earthquake safety
Concrete and composite structures
Homeland security

Aerospace
Bird strike
Containment
Crash

Electronics
Drop analysis
Package analysis
Thermal

Manufacturing
Stamping
Forging
Welding



Defense
Weapons design
Blast and penetration
Underwater Shock Analysis

Consumer Products

Biosciences

Includes coupled Multi-Physics, Multi-Scale, and Multi-Stage in one Scalable Code

- **Explicit/Implicit**
- **Heat Transfer**
- **ALE & Mesh Free**
  EFG, SPH, Airbag Particle
- **User Interface**
  Elements, Materials, Loads
- **Acoustics, Frequency Response,**
  Modal Methods
- **Discrete Element Methods**
- **Incompressible Fluids**
- **CESE Compressible Fluids**
- **Electromagnetics**
- **Control Systems**

Single Model for Multiple Disciplines - Manufacturing, Durability, NVH, Crash, and FSI

LS-DYNA® Arbitrary Lagrangian Euleri

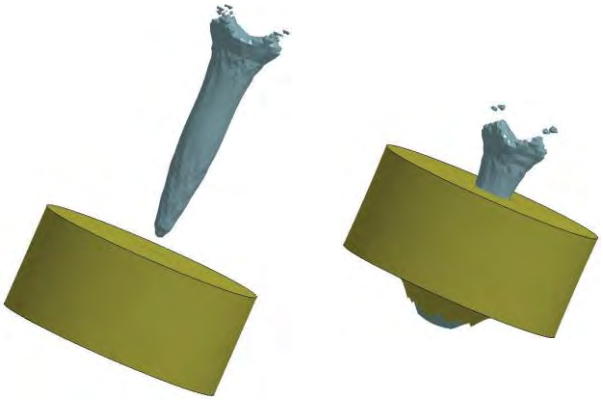
The ALE solver is tightly coupled to the LS-DYNA® multi-physics solver. It fully interacts with Lagrangian structures, smoothed particle hydrodynamics, and the discrete element method; thus, providing a computational tool for solving a wide range of practical but difficult problems.

Solver Features:

- Available on laptops, work stations, and massively parallel computers.
- 1-Dimensional, 2-Dimensional & 3-Dimensional analyses.
- Unstructured and structured mesh options.
- Mesh refinement and automatic mesh smoothing algorithms.
- Donor cell and Van Leer advection.
- Accurate interface reconstruction to support multiple materials.

Applications Include:

- Shock loading from shaped charges perforating oil well casings.
- Design of blast resistant structures.
- Ship responses due to under water explosions.
- Hyper-velocity impact (e.g. a meteor striking a satellite).
- Bird strike.
- Fuel tank sloshing, forging, hydroplaning, and airbag deployment.
- Low velocity flows such as sailing boat wave and wind interactions, water landing.

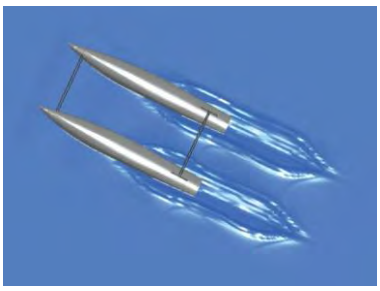


Shaped Charge Modeling

Fuel Tank Sloshing

Bird Strike

Ferryboat Sewol Rapid Turning
Sang-Gab Lee, Korea Maritime & Ocean Univ.



Amphibious Plane Water Landing

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LS-DYNA® Advanced CFD Analysis

LS-DYNA® Incompressible CFD (ICFD) tool combines state-of-the-art numerical techniques that allow robust, scalable, and accurate simulations of fluid flows. Its ability to couple with the structural, thermal, and Discrete Element Method solvers make it an excellent option for multi-physics problems.

Applications:

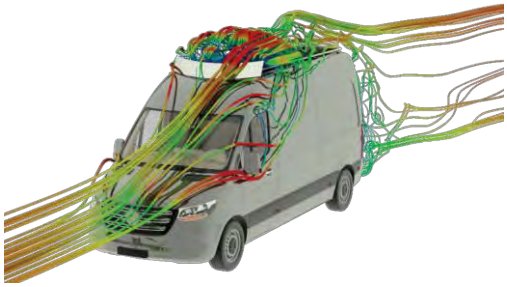
- Ground vehicle aerodynamics
- Cooling analysis
- Resin Transfer Molding for manufacturing of composites
- Turbomachinery
- Fluid-Structure Interaction in the biomedical field

Features:

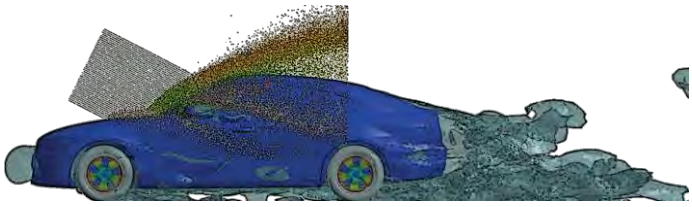
- FEM based
- Large library of RANS and LES turbulence models
- Automatic meshing and re-meshing
- Free surface flow
- Non-Newtonian flows
- Non-inertial reference frames
- Porous media models

Learn more at:
www.lstc.com/applications/icfd

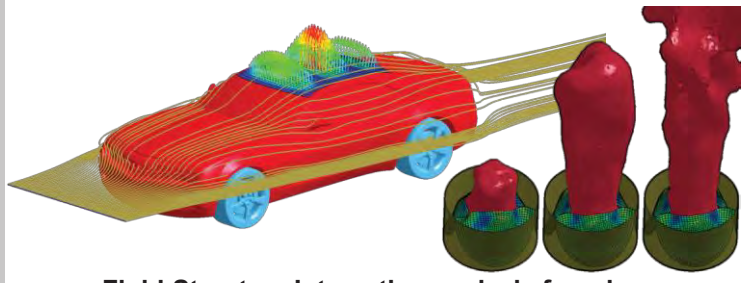
YouTube:
www.youtube.com/user/980LsDyna



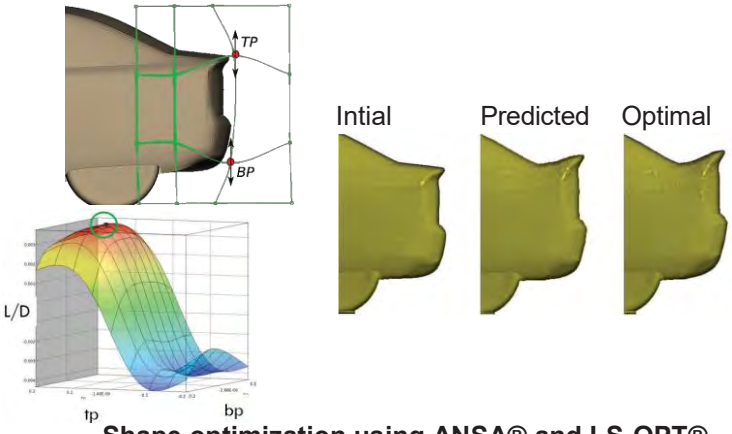
Accurate prediction of aerodynamic forces for turbulent flows



Coupling with Discrete Element Method (DEM) for water management simulations



Fluid-Structure Interaction analysis for a large number of applications including automotive and bio-medical industries



Shape optimization using ANSA® and LS-OPT®

For demo version, pricing and learning version contact:
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www.lstc.com

LS-DYNA® Electromagnetics (EM)
Coupled EM, Mechanical, Thermal, CFD Simulations

The LS-DYNA® Electromagnetic solver (EM) combines the Finite Element Method (FEM) and the Boundary Element Method (BEM) in a way that allows robust, scalable, and accurate simulations of electromagnetic processes. Strong coupling between the EM solver with the structural, thermal and Computational Fluid Dynamics (CFD) solvers makes LS-DYNA an excellent option for multi-physics problems.

Applications:

- Magnetic metal forming/welding
- Induced heating
- Rail gun
- Resistance spot welding
- Battery abuse
- Cardiac electro-physiology

Features:

- FEM and BEM based
- 3 dimensional, 2 dimensional and 2 dimensional axisymmetric
- Available for solids, shells beams and composite thick shells
- EM contact
- Computation of inductances
- EM equations-of-state
- Misc battery models from cell to pack
- Cell ionic models for Electro-Physiology (EP)
- EP mono and bi-domain models
- EP with Purkinje networks
- EP/mechanics/FSI coupled cardiac simulations

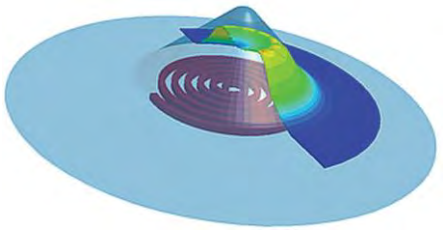
Website:

www.lstc.com/applications/EM

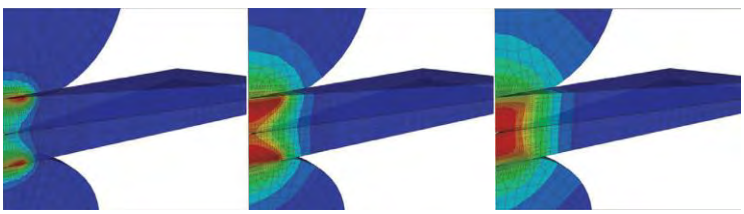
www.dynaexamples.com/em

YouTube:

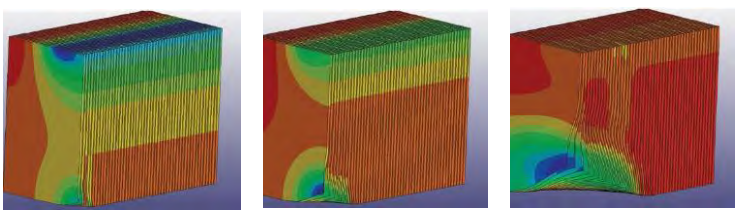
www.youtube.com/user/980LsDyna



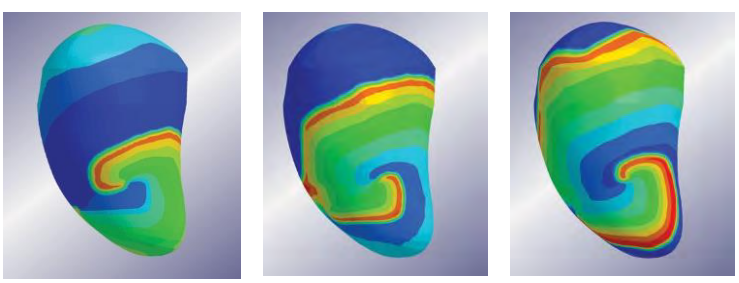
Magnetic forming of a metallic plate against a conical die.



Hot nugget development in a resistance spot welding simulation.



Evolution of the potential during the crush of a pack of 50 Li-ion cells.



Formation of a spiral wave in a ventricle during fibrillation.

For demo version, pricing and learning version contact: sales@lstc.com

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LS-DYNA® Frequency Domain Analysis

Vibration, acoustic and fatigue solution package

LS-DYNA Frequency Domain Analysis (FDA) module allows performing engineering simulation and analysis in frequency domain. It provides solutions for customers from industries where vibration, noise and structural durability are big concerns, for example, NVH (Noise, Vibration and Harshness) of vehicles and durability of metal structures and components. This type of analysis is crucial to the comfort, safety and integrality of vehicles and other structures.

Solvers:

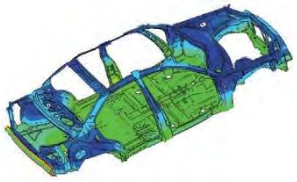
- FRF (Frequency Response Function)
- SSD (Steady State Dynamics)
- Random vibration
- Response spectrum analysis
- Acoustics (by boundary and finite element methods, BEM and FEM)
- Fatigue analysis

Application:

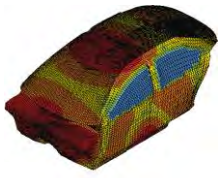
- Assessment of dynamic properties of structures
- Energy transfer path analysis
- Shaker table testing simulation
- NVH of vehicles and aircrafts
- Noise control of machines and engines
- Fatigue analysis of structures
- Safety evaluation of buildings under earthquake induced ground motion

Features:

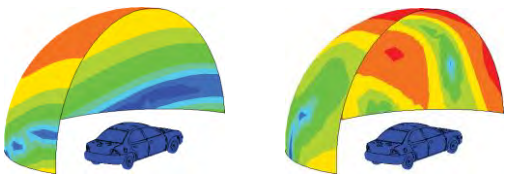
- Seamless vibro-acoustic analysis
- Seamless vibration-fatigue analysis
- Options to run:
  - Equivalent Radiated Power(ERP),
  - Acoustic Transfer Vectors (ATV),
  - Incident waves,
  - Acoustic eigenvalue analysis.
- Element and panel acoustic contribution for sensitivity studies
- Multiple fatigue analysis methods



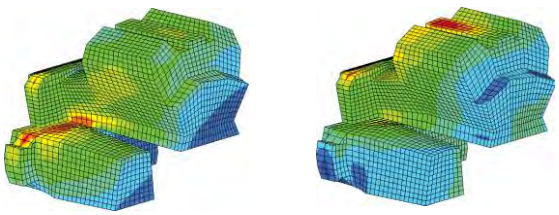
Displacement RMS of Body In White



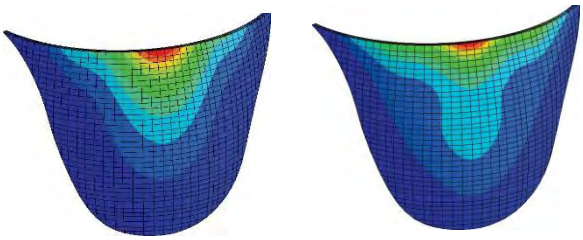
Cabin noise computation by FEM acoustic solver



Radiated noise from vehicle at 10 Hz and 140 Hz, by BEM acoustic solver



ATV plot (real and imaginary parts) for engine model, by BEM acoustic solver



Response spectrum analysis of dam under earthquake excitation

For information about 30-day LS-DYNA demo license email: sales@lstc.com

www.lstc.com

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LS-DYNA® Advanced FEM, Meshfree & Particle Methods

Intelligent Manufacturing, Advanced Material Design & Integrated Structural Analysis

LS-DYNA® integrates the finite element, meshfree, and particle methods for solving some of the most challenging problems in manufacturing processes, material design, and structural analysis. Such problems typically involve large deformations, material failure, crack propagation, and composite materials. Some of these methods are coupled with the thermal, fluids, and electro-magnetic solvers in LS-DYNA to perform multi-physics analysis as needed.

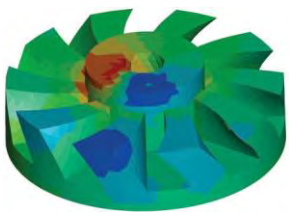
Applications:

- Nondestructive manufacturing: forging, extrusion, 3D printing, compression molding
- Destructive manufacturing: cutting, drilling, grinding, machining, self-piercing riveting, flow drill screwing
- Material design: Representative Volume Element (RVE), reduced–order modeling
- Structural analysis: lap-shear, tearing, crack propagation, bird strike, impact penetration, fluid-structure interaction

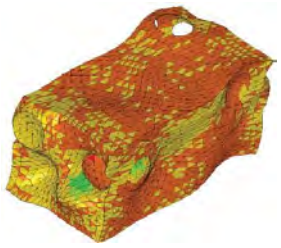
Features:

- Meshfree-enriched FEM, eXtended FEM (XFEM), adaptive FEM
- Element Free Galerkin (EFG), Peridynamics, adaptive EFG
- Smoothed Particle Hydrodynamics (SPH), Smoothed Particle Galerkin (SPG)
- Immersed particle algorithm for composites
- Particle contact for impact problems
- Brittle, semi-brittle, ductile, rubber type materials, composites
- Shell and solid applications
- Explicit and implicit solvers
- Multi-physics analysis
- Multi-scale composite modeling
- Material data processing for material design
- Physics-based failure mechanism
- Material failure and separation

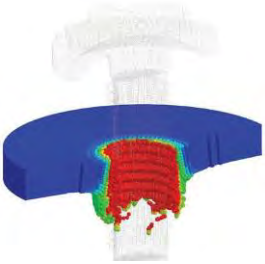
Group Website: www.lstc-cmmg.org



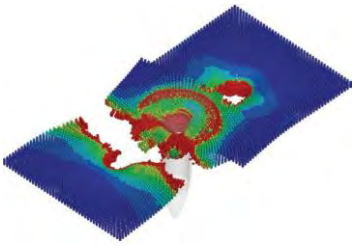
3D printing



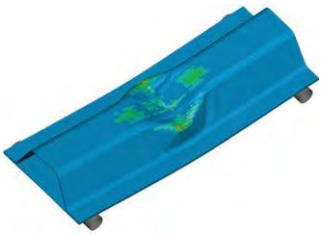
RVE for nano-particle reinforced rubber



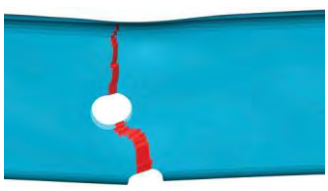
Flow drill screwing (FDS)



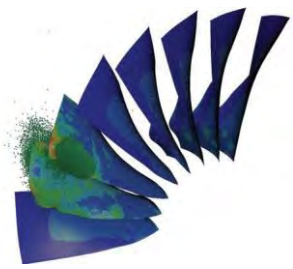
Lap-shear after FDS



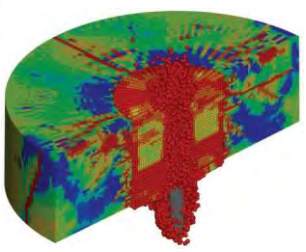
Carbon fiber reinforced polymer



Ductile cracking in shell



Bird strike



Perforation of concrete

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LS-DYNA® Implicit Mechanical Analysis

LS-DYNA® Implicit Mechanics provides a comprehensive set of analysis tools for engineering applications. It is fully integrated with the Explicit counterpart, using the same element and material libraries, and thus enables users to have one model for a broad range of analyses. This also allows for seamlessly switching between Implicit and Explicit during the same simulation, thereby increasing the level of applicability. The Implicit solver provides both Linear and Nonlinear analysis options, including the additional choice of Static or various kinds of Dynamic solution schemes.

APPLICATIONS:

Implicit Mechanical Analysis can be used on a wide variety of application areas, including but not limited to;

Automotive

- Gravity Loading
- Dummy Seating
- Door Sag
- Roof Crush
- Seat Pull

Aerospace

- Fuselage Drop Test
- Jet Engine Start Up
- Analysis of Seats
- Satellite Stress and Vibration Tests

Consumer Goods

- Drop Test
- Vibration computations for Acoustical Analysis

FEATURES:

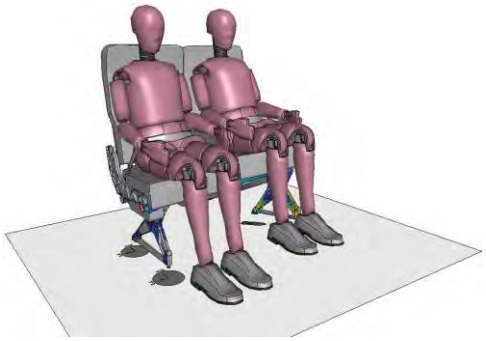
- Linear and Nonlinear Analysis
- Buckling, Vibration and Modal Analysis
- Shared Memory Parallel (SMP)
- Massive Parallel Processing (MPP)
- Hybrid Parallel-combines SMP and MPP for scalability that can exceed 10K cores.

YouTube Channel:

www.youtube.com/channel/UCPuoss7k_-IouTDXGT2EFiw

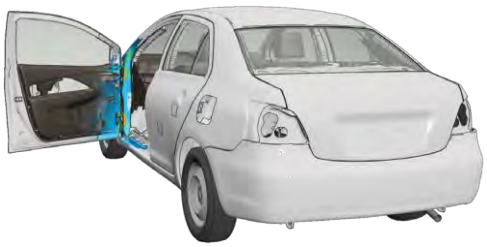
Twitter:

https://twitter.com/LSTCandDYNAmore

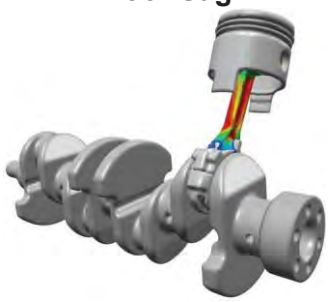


Aerospace Seat Pre-Loading

RollOver Protection Structure



Door Sag



Crank Shaft

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LS-DYNA® in Stamping Applications

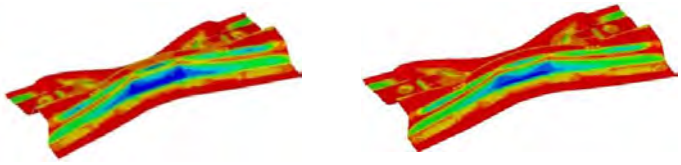
For more than two decades, the usage of LS-DYNA® in the simulation of sheet metal stamping has been steadily increasing with a reputation for prediction accuracy. During this period, state-of-the art constitutive models were added for simulating high strength steel and aluminum alloys now commonly used in the automotive industry. In addition, the much improved robustness, speed, and accuracy of the implicit solver has resulted in gravity loading, binder wrap, and springback calculations becoming routine. Die face compensation calculations in LS-DYNA® save money and time by eliminating the trial and error in die manufacturing. Many original and unique ideas are implemented for insuring reliable stamping simulations, which make LS-DYNA® an excellent choice for this manufacturing process.

Typical Applications:

- Sheet metal gravity loading, binder closing, deep-drawing
- Springback prediction, and springback compensation
- Trimming and lancing
- Flanging and hemming
- Hydro-forming
- Magnetic forming and thermal forming
- Superplastic forming
- Denting
- Scrap fall simulation
- One-Step simulation for woven carbon fiber composite

Features:

- Mesh adaptivity
- Advanced material models for aluminum alloy and high strength steels
- Smooth contact to minimize contact noise
- One-step method in blanksize development
- Un-flanging method in trimming curve development
- Parametric input
- Mesh coarsening
- Formability Index gave more reliable forming limit prediction for non-linear strain path
- Predict fiber orientations in the final part
- Predict initial blank size corresponding certain fiber orientation

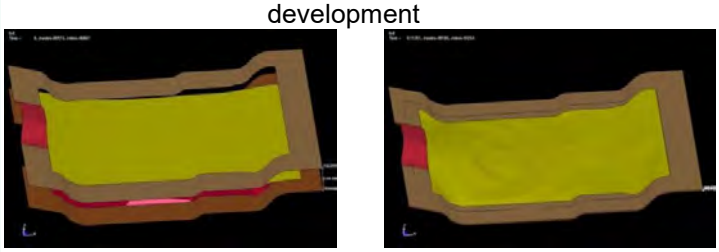


(a) Incremental solution (b) One-step result

One step result vs. incremental result

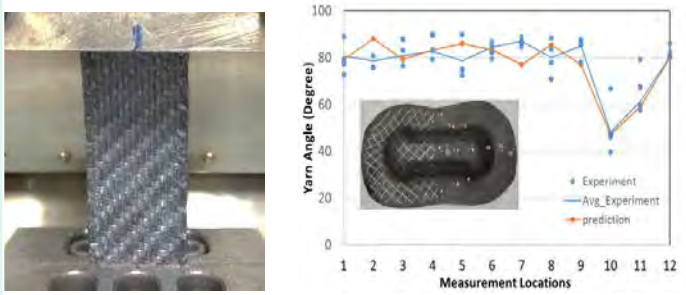
(a) Before un-flanging (b) After un-flanging

Accurate un-flanging simulation for trimming curve development



(a) Before closing (b) After closing

Implicit binder closing for floor-pan



One-Step prediction of fiber orientation matches test data

(Courtesy of Dr. Danielle Zeng of Ford)

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LSTC's LS-DYNA® Dummy and Barrier Models

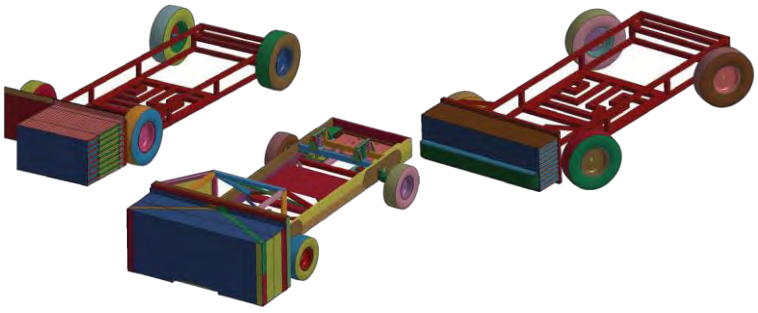
LSTC offers a wide range of dummy and barrier models. They are available free of charge to current licensees and are provided unencrypted and fully accessible.

Barrier Models:

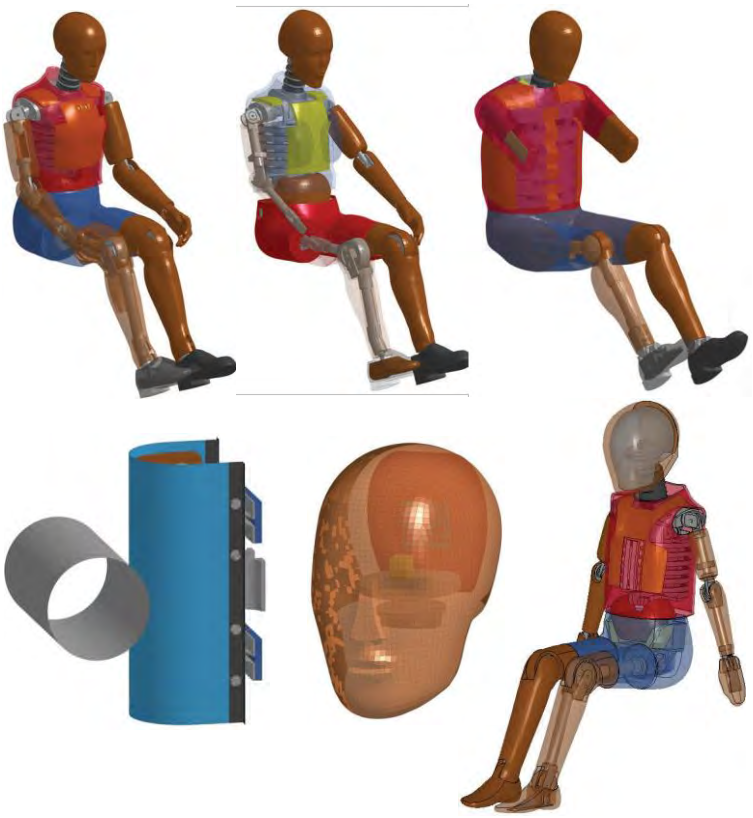
- Barrier models for most Federal Motor Vehicle Safety Standards (FMVSS) test scenarios
- Additional barriers beyond FMVSS requirements
- Models validated with publicly available data and proprietary tests obtained from customers
- Solid and shell mesh models of most barriers

Dummy Models:

- Dummy models covering most automotive regulations
- Models validated with publicly available data and proprietary tests obtained from customers
- Coarse and detailed mesh models available
- Regular updates based on additional data and customer feedback



LSTC Barrier Model Examples



LSTC Dummy Model Examples

For more information and a complete list of available models, visit the website:
www.lstc.com/models

For demo version, pricing and learning version contact:
sales@lstc.com

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LS-OPT® for Design Optimization and Parameter Identification

LS-OPT® is a simulation-based optimization tool which enables the solution of complex, multi-stage design processes or regression/classification tasks. LS-OPT® interfaces with LS-DYNA® (e.g. result extraction) and also supports popular pre- and post-processors, e.g. for shape optimization. For visualization of results, graphical pre- and post-processing tools are included in the package.

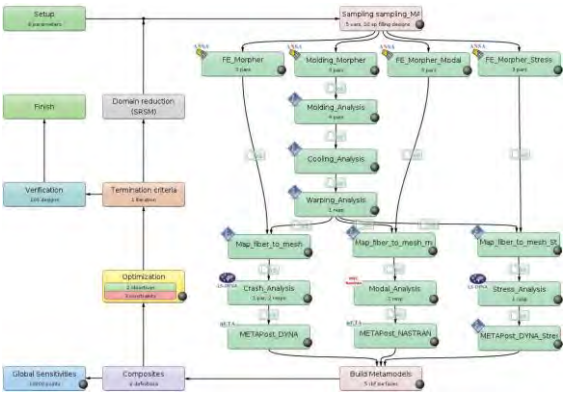
Tasks:

- Multidisciplinary and Multi-Objective Optimization (MDO/MOO)
- Discrete and Mixed Optimization
- Global Optimization
- Robust and/or Reliability-based Optimization
- LS-DYNA® statistics, including outlier analysis and LS-PrePost® support
- Parameter Identification with matching of noisy, steep and hysteretic curves
- Full-field calibration using Digital Image Correlation
- Uncertainty Quantification
- Sensitivity Analysis

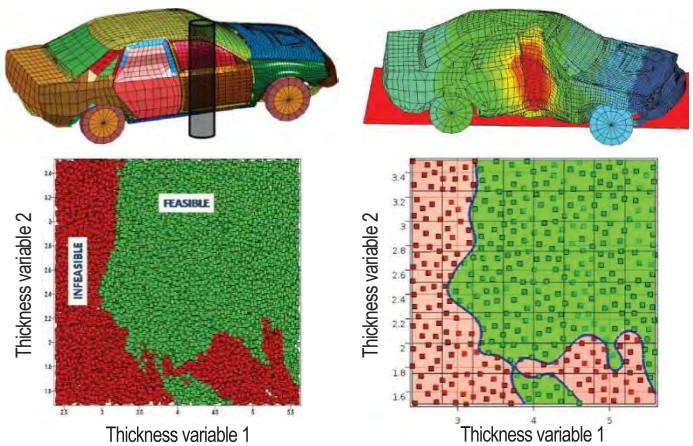
Solvers and Methods:

- Sequential Response Surface Method
- Genetic Algorithm and Efficient Global Optimization (EGO)
- NSGA-II algorithm for MOO
- Monte Carlo methods (direct and metamodel-based)
- Outlier Analysis
- Support Vector Machines (SVMs) for Statistical Classification
- Taguchi Method
- Curve similarity measures: Dynamic Time Warping (DTW), Partial Curve Mapping and Discrete Fréchet
- Experimental Design: Space-filling, Full or Fractional Factorial, Latin Hypercube
- Metamodels: Neural networks, Polynomials, Kriging and Support Vector Regression
- Network-based job scheduling

LS-OPT® GUI Defining Process Flow

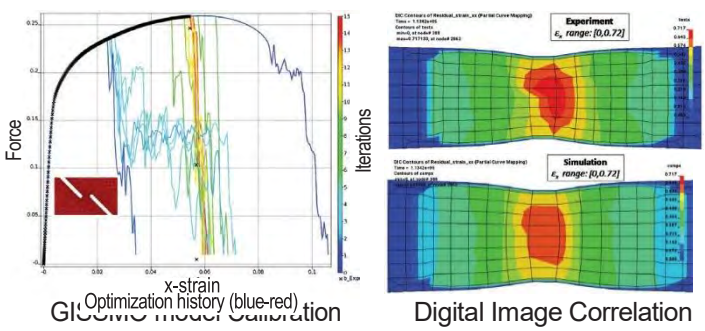


Parametric Vehicle Side Intrusion Using a Classifier



Actual (LS-DYNA) | Classifier (blue outline)

Material Parameter Identification



GISSMO model calibration (DTW) | Digital Image Correlation (Full Field)

www.lsoptsupport.com

LSTC
Livermore Software Technology Corp.

LS-PrePost® an Advanced Pre- and Post-processor

LS-PrePost® is an advanced pre- and post-processor developed for LS-DYNA®. It is fully multi-platform with support for Windows, Linux and Mac OSX. LS-PrePost is based on the OpenGL rendering engine with a design that is both efficient and intuitive. It is delivered with LS-DYNA without additional cost and may be installed on multiple platforms. License keys are not needed.

Geometry and Meshing Includes

- A geometry engine which allows the creation and modification of curves, surfaces, and solid objects. Also included are tools to heal and simplify the geometry model
- An automatic surface meshing tool
- An automatic 3-Dimension(3D) tetrahedron meshing module
- Various methods to create a mesh by dragging, spinning, offsetting, and sweeping
- The construction of middle surface shells from 3D Solids

Pre- and Post-Processing Capabilities

- Complete LS-DYNA Keyword management
- Tools to create and modify LS-DYNA entities
- General model setup for NVH (Noise, Vibration and Harshness), Implicit, and Thermal Analyses
- Tools to measure FEA data like distance, area, angle, volume, etc.
- Section cuts for better visualization in complicated models
- Comprehensive time history plotting for the d3plot, ASCII history, and BINOUT databases
- Time history plotting for user defined data
- Particle and Discrete element visualization
- CFD model and result visualization

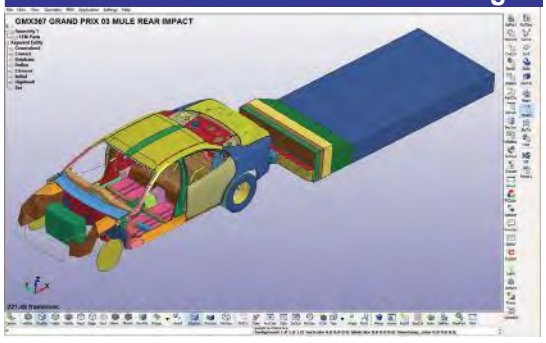
Other General Functions

- Tools to display, reverse, and auto reverse the normal vector directions of Shells, Segments, Thick Shells, and Cohesive Elements
- Printing of High Definition pictures in a choice of formats
- Movie creation for animation sequences
- Commands, Macros and a Scripting Command Language (SCL) for automated Pre- and Post-Processing

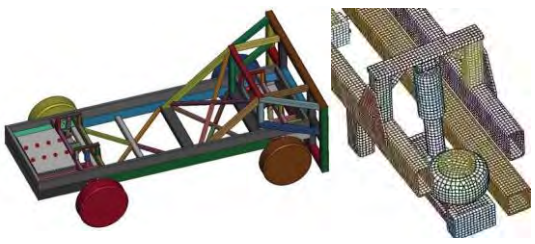
Applications

- Airbag folding
- Comprehensive model checking including contact initial penetration check
- Dummy positioning
- Metal forming process setup
- Seatbelt fitting

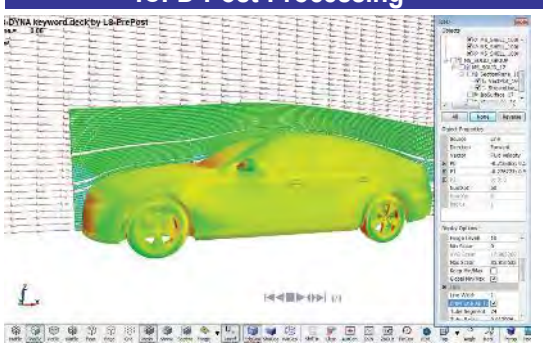
LS-PrePost Pre-and Post-Processing



LS-DYNA Geometry and Meshing



ICFD Post-Processing



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