Recent Developments and Roadmap
Part 0: Introduction

12th International LS-DYNA User's Conference
June 5, 2012

LSTC
Livermore Software
Technology Corp.

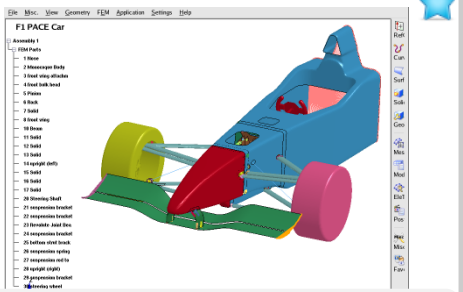
Outline

- Introduction
- Recent developments. See the separate PDFs for:

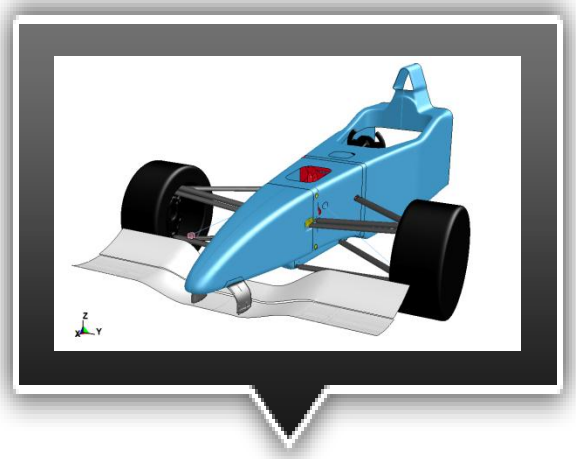
LS-PrePost	Mr. Philip Ho
Dummies	Dr. Christoph Maurath
Incompressible CFD	Dr. Facundo Del Pin
Electromagnetics	Dr. Pierre L'Eplattenier
ALE, DEM, SPH, Particle	Dr. Jason Wang

- Conclusions

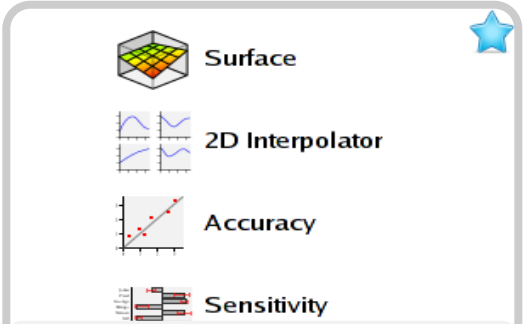
LSTC Products



LS-PrePost

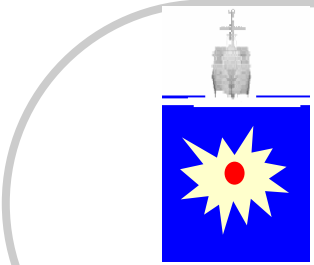


LS-DYNA



LS-OPT/LS-TaSC

Dummies & Barriers



USA

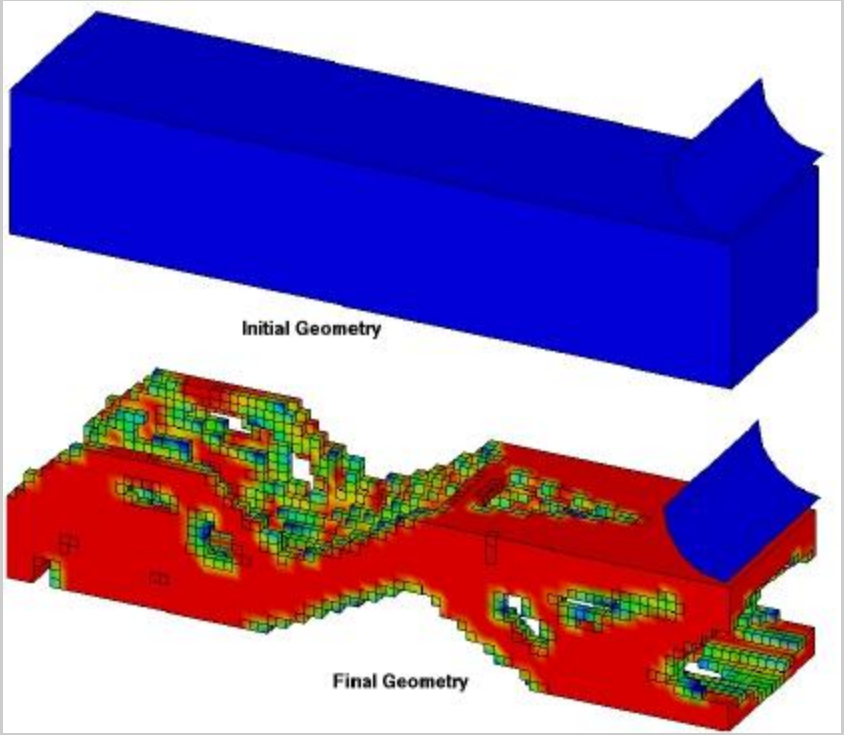
No additional license cost

LS-TaSC v2

Was LS-OPT/Topology for V1; renamed as LS-TaSC, Topology and Shape Computation, since V2.

For the topology optimization of non-linear problems involving dynamic loads and contact conditions.

Can be used to find a concept design for most structures analyzed using LS-DYNA.



LS-DYNA Application Areas

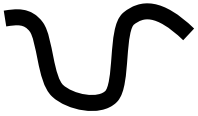
Development costs are spread across many industries

Automotive

- Crash and safety
- NVH
- Durability

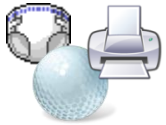
Aerospace

- Bird strike
- Containment
- Crash

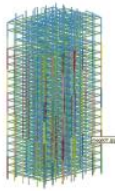


Manufacturing

- Stamping
- Forging



Consumer Products

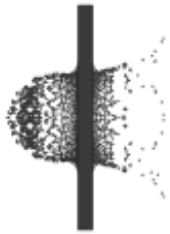


Structural

- Earthquake safety
- Concrete structures
- Homeland security

Electronics

- Drop analysis
- Package analysis
- Thermal



Defense

- Weapons design
- Blast response
- Penetration
- Underwater Shock Analysis

LS-DYNA

One Code Strategy

"Combine the multi-physics capabilities into one scalable code for solving highly nonlinear transient problems to enable the solution of coupled multi-physics and multi-stage problems"

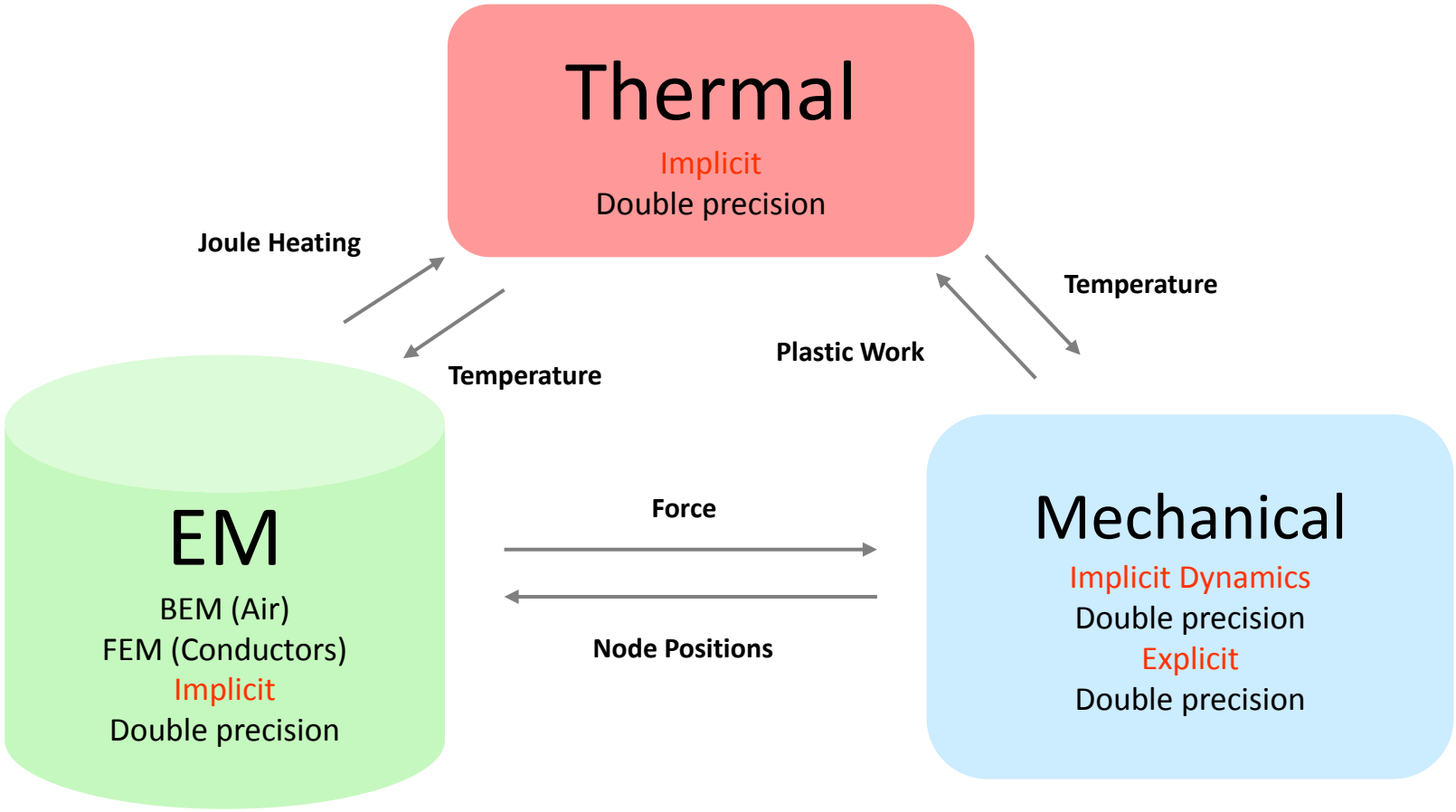
- Explicit/Implicit
- Heat Transfer
- ALE & Mesh Free
  i.e., EFG, SPH, Airbag Particle
- User Interface
  Elements, Materials, Loads
- Acoustics, Frequency Response, Modal Methods
- Discrete Element Method

After more than a decade the next major release includes:

- Incompressible Fluids
- CESE Compressible Fluid Solver
- Electromagnetics

Accommodates Coupled Simulations

Multiple field equations are strongly coupled

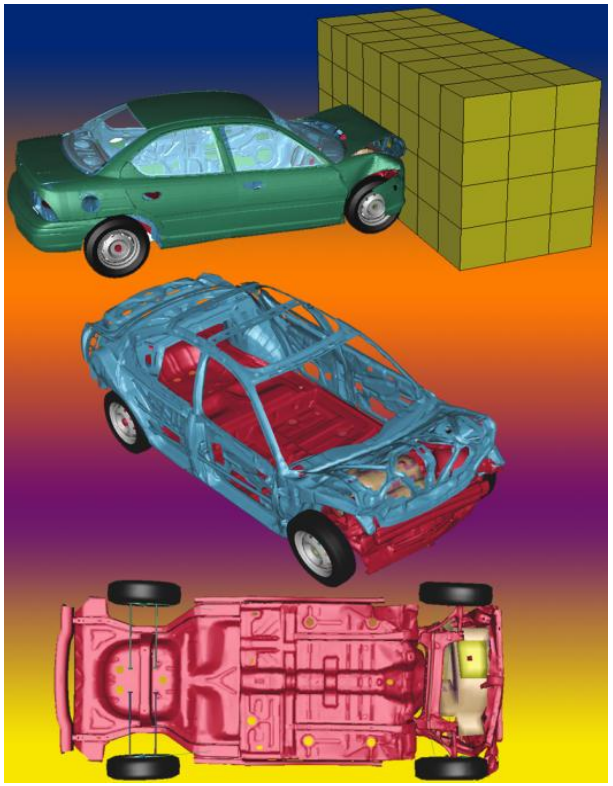


One Code Strategy

One Model

LS-DYNA

Multi-physics
Multi-stage
Multi-formulations
Massively parallel
Adaptive



Many Results

Manufacturing, Durability, NVH, Crash

One Code Strategy

Specialized codes for each problem

Multi-physics problems are difficult to solve.

Analysts must be trained in each specialized code

Limits career paths to specific applications.

Licensing costs are too high.

With one code.

Multi-physics problems are easily solved

Analysts can work on many types of related problems that are currently solved on multiple codes.

Flexibility in assignments

Flexibility in career paths

One Model for All Applications

Analysts work in parallel to reduce the time to produce the initial model. In crash, one model for frontal, side, offset, and rear impacts. Durability, NVH, and crash models are identical with possible adjustments related to mesh density

Only one model to revise for design changes.

Only one model to check for errors.

All models use the same connectors in assembly

Multi-physics problems can be addressed as needed

Easier database management

Initial stress, strain, and thickness distributions from manufacturing simulations are available in all performance simulations

Multi-Physics

- Multi-physics problems require solution methods from more than one discipline.
- Examples

Fluid-Structure Interaction
Tire Hydroplaning, Airbags

Bird Strike on Engine
Initial stresses, Impact + linear Response

Design Optimization
Optimization + Mechanics

Thermo-Mechanical
Hot Forging and stamping

Multi-Stage

- Multi-stage problems require sequential simulations
- Examples

Stamping
Binderwrap *Implicit Dynamics*
Stamping *Explicit*
Springback *Implicit Static*

Static Initialization Dynamic Simulations
Gravity loading prior to crash, durability and NVH
Spinning jet engine fan blades prior to impact or blade-off

Manufacturing Results into Performance Simulation
Stamping introduces texturing and thinning
Crash simulation accounts the effects of manufacturing

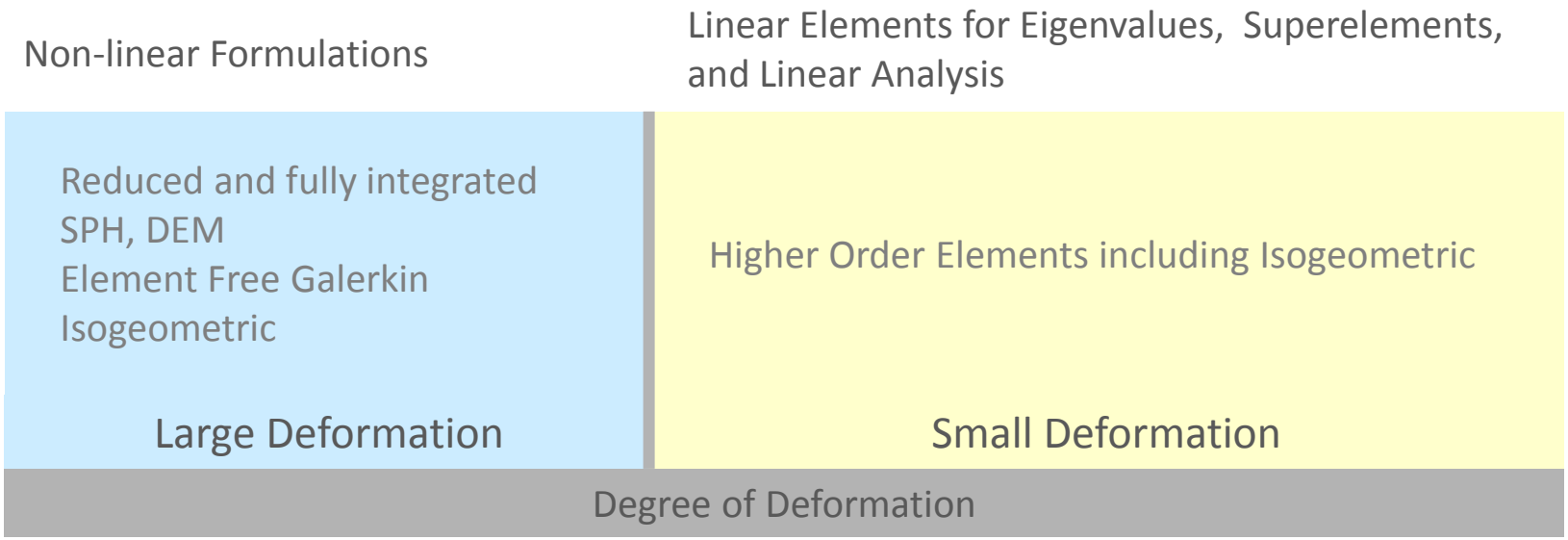
Crash simulation followed by Implicit Springback

- Requires one code with Implicit and Explicit solution

One Code Strategy: multi-formulations

- No single solution method is suitable for all applications.

- Solid mechanics



One Code Strategy: multi-formulations

- Solid mechanics

  Dynamics

  Explicit methods for short duration transient problems.

  Implicit methods for static and long duration problems.

  Instantaneously switch between methods implicit to explicit and vice versa.

  Fluid mechanics formulations

  Incompressible flow.

  Compressible flow.

  Acoustics

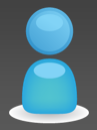
  Airbag particle methods for bag deployment

One Code Strategy: multi-processing

- Massively Parallel Processing (MPP) is here to stay.
  - MPP is moving downscale: Desktop MPP under Windows or Linux environments
  - Heterogeneous processing.
    - Processing across high speed networks.
  - Large MPP machines have many parallel jobs running simultaneously on subsets of processors.
    - 32-256 are preferred for LS-DYNA
  - Stamping analysis with adaptivity is ideally suited to MPP machines due to the simplicity of contact.
- Hybrid LS-DYNA combines SMP and MPI to improve scalability to more than 10K cores

Adaptive

- To handle manufacturing simulations adaptive remeshing is necessary
  - Used in sheet metal stamping and forging today
- Advantages:
  - Reduces run time
  - While increasing accuracy
  - Initial meshing is simplified
- Types of adaptivity:
  - r-method, relocate nodes
    - Number of nodes are not constant , EFG forging
  - h-method, adapt element size h
    - LS-DYNA shell and solids in future releases



New single user license

- Node locked SMP Window license for single user O/S to allow usage of **16 processor cores from AMD and INTEL**
- **40% price reduction** compared to 16 cores with network license
  - 16 one core simultaneous jobs,
  - 8 two core simultaneous jobs,
  - 4 four core simultaneous jobs,
  - etc.
- Extension of security software to single user Window's O/S to license **MPP version is underway** to take advantage of better scaling
  - The SMP version does not scale well after 6 to 8 cores.
- For additional information contact sales@lstc.com

Development Speakers

See separate PDFs for the following content:

LS-PrePost	Mr. Philip Ho
Dummies	Dr. Christoph Maurath
Incompressible CFD	Dr. Facundo Del Pin
Electromagnetics	Dr. Pierre L'Eplattenier
ALE, DEM, SPH, Particle	Dr. Jason Wang

Summary

- LSTC is working to be the leader in scalable, low cost, large scale, multi-physics simulations, leading to solutions to a variety of problems with a single universal numerical model. To make this possible:
  - LS-PrePost, LS-Opt, and LS-TaSC are continuously improving and gaining more usage within the LS-DYNA user community
  - LSTC is providing dummy, barrier, and head form models to reduce customer costs.
  - The incompressible flow solver is fully coupled to heat transfer and structures for FSI simulations
  - Also, the electromagnetics solver is coupled to heat transfer and structural elements for fully coupled simulations
  - Coupling between ALE methodology, SPH, discrete elements, and the airbag particle method will lead to new application areas in the future and improve current methodologies

Future

- LSTC is not content with what has been achieved
- New features and algorithms will be continuously implemented to handle new challenges and applications
  - Electromagnetics,
  - Acoustics,
  - Compressible and incompressible fluids
  - Isogeometric elements, contact, and related developments
  - Discrete element methodology for modeling granular materials
  - Simulation based airbag folding and THUMS dummy positioning underway
- Multi-scale capabilities are under development
  - Implementation underway (New approach which is more user friendly)
- Hybrid MPI/OPENMP developments are showing significant advantages at high number of processors for both explicit and implicit solutions

Thank You !