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Engineering Solutions

LSTC Livermore Software Technology Corp.

Volume 8, Issue 10, October 2019

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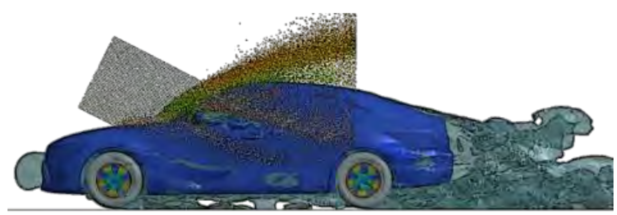
LSTC

DYNAmore

JSOL

Shanghai Fangkun



Livermore Software Technology Corp. 1987 - 2019



FEA Information Engineering Solutions

www.feapublications.com

The focus is engineering technical solutions/information.

FEA Information China Engineering Solutions

www.feainformation.com.cn

Simplified and Traditional Chinese

The focus is engineering technical solutions/information.

LSTC - Livermore Software Technology Corp.

Development of LS-DYNA, LS-PrePost, LS-OPT, LS-TaSC (Topology), and LSTC's Dummy & Barrier models for use in various industries.

www.lstc.com

To sign up for the FEA News send an email - subject "subscribe" to news@feainformation.com
To be removed from the FEA News send an email - subject "Remove" to news@feainformation.com

If you have any questions, suggestions or recommended changes, please contact us.

Editor and Contact: Yanhua Zhao - yanhua@feainformation.com
Noi Sims – noi@feainformation.com

Platinum Particpants

Platinum Particpants

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Announcements

ANSYS and LS-DYNA Creator Livermore Software Technology Corporation Sign Definitive Acquisition Agreement

NEWS PROVIDED BY ANSYS, Inc   Sep 11, 2019, 18:39 ET

PITTSBURGH, Sept. 11, 2019 /PRNewswire/ -- ANSYS (NASDAQ: ANSS), the global leader and innovator of engineering simulation software, announced today that it has entered into a definitive agreement to acquire Livermore Software Technology Corporation (LSTC), the premier provider of explicit dynamics and other advanced finite element analysis technology. Once closed, the acquisition will empower ANSYS customers to solve a new class of engineering challenges, including developing safer automobiles, aircraft and trains while reducing or even eliminating the need for costly physical testing. Read more

"As an ANSYS partner for nearly 25 years, I am excited to formally join ANSYS and contribute to their place as the leader in engineering simulations," said John O. Hallquist, founder and CEO of LSTC. "ANSYS is the perfect home for LSTC's world-class team of scientists, mathematicians and engineers to continue advancing state-of-the-art, scalable and fully coupled, multiphysics computations. The ANSYS Workbench platform provides their customers with access to a uniquely broad portfolio of simulation technologies packaged into a user-friendly interface that is the envy of the industry. I expect that the combination of Workbench and LS-DYNA will expand our user base by at least an order of magnitude. Here at LSTC, nothing makes all of us happier than when our research enables more customers to imagine, design and implement ambitious projects that were previously impossible."

2019 China LS-DYNA Conference   October 21-23, Shanghai, China

The 4th China LS-DYNA Users' Conference will be held on October 21st - 23rd, 2019 in Shanghai by LSTC and Shanghai Fangkun. LSTC will share the latest product function and development strategy during the conference. We wholeheartedly welcome your paper submission and attendance.

Conference Website: conference.lsdyna-china.com/

2019 Journals – Q4   *FEA Information Engineering Journal (FEAIEJ™)*

FEA Information Engineering Journal (FEAIEJ™) is a quarterly on line publication focusing on specific disciplines within Finite Element Analysis.

Developing CAE software systems for all simulation disciplines. Products: ANSA pre-processor/ EPILYSIS solver and META post-processor suite, and SPDRM, the simulation-process-data-and-resources manager, for a range of industries, incl. the automotive, railway vehicles, aerospace, motorsports, chemical processes engineering, energy, electronics…

BETA CAE Systems announces the release of the v19.1.4 of its software suite

September 19, 2019

About this release

BETA CAE Systems announces the fourth evolution release of ANSA/EPILYSIS/META v19.1.x series.

Apart from code fixes in the detected issues, this version also hosts noteworthy enhancements and implementations.

Notably, new options have been added in ANSA for comparing differences between models and for handling Connections, Connectors, GEBs, and Model Setup Entities.

EPILYSIS further expands its performance, while META offers new capabilities for Occupant Injury Criteria and EU-NCAP MPDB

The most important enhancements and fixes implemented appear in the announcement on our web site.

Contents

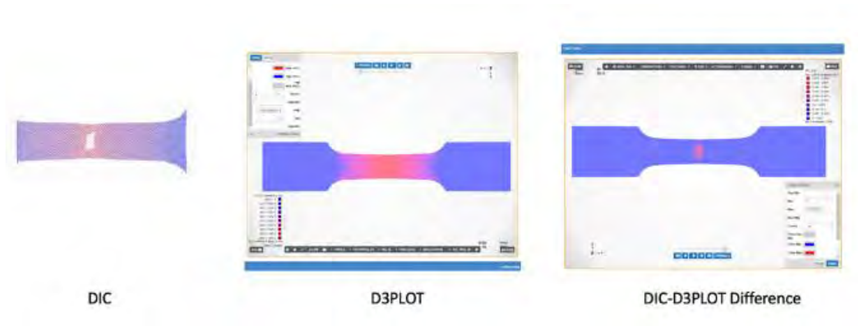
Enhancements and known issues resolved in ANSA
Known issues resolved in EPILYSIS
Enhancements and known issues resolved in META
Compatibility and Supported Platforms
New documentation
Download

Read more from website

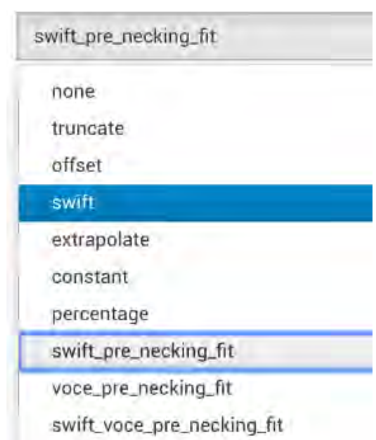
d3VIEW is a data to decision platform that provides out-of-the box data extraction, transformation and interactive visualizations. Using d3VIEW, you can visualize, mine and analyze the data quickly to enable faster and better decisions.

New Developments in Semi-Supervised Material Calibration using Workflows

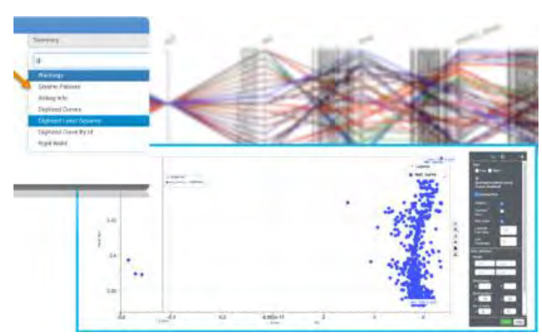
DIC data from coupon tests have proven to provide insights into local deformation. d3VIEW now includes a worker to compute the difference in strain field between DIC (csv format) and D3PLOTs



Post-necking characterization of hardening curves requires an iterative approach. The true to effective stress worker now includes an initial estimate that is based on pre-neck behavior for faster convergence



New worker is now available to extract GISSMO failures and visualize them in a scatter or parallel plots



www.d3view.com. For more information email info@d3view.com

Author: Christian Frech christian.frech@dynamore.de

DYNA MORE Finite Elements Solutions

The company
DYNAmore GmbH – Gesellschaft für FEM-Ingenieursdienstleistungen – is one of the largest distributors of LS-DYNA simulation software worldwide. But we offer far more in the way of services: in addition to our guaranteed, expert support in all areas of application for the LS-DYNA and LS-OPT software packages, we offer FEM calculation services as well as general consulting on any questions concerning structural dynamics.

Engineering services
DYNAmore provides extensive services for numerous tasks in simulating nonlinear structures. Here, we mainly focus on both conventional and pilot projects and a variety of industries.

Portfolio

- Software solutions
- Method development
- Support and consulting
- Calculation services
- IT solutions for CAx and data management processes
- Training and information sessions
- Conferences

Facts

- Approx. 150 employees
- Subsidiaries in Germany, Sweden, Italy, France, Switzerland and the USA
- Offices in Ingolstadt, Dresden, Berlin, Langlingen, Wolfsburg, Linköping, Gothenburg, Turin, Versailles, Zurich and Dublin/Ohio
- 5 service centers at customers' sites
- More than 800 customers from industry and research, both in Germany and abroad (including almost all OEMs)
- Worldwide use of our ATD models
- FEM experience since the early 1980s.
- Ongoing development of LS-DYNA and LS-OPT

Contact
DYNAmore GmbH
Industriestr. 2,
D-70565 Stuttgart, Germany
Tel. +49 (0) 7 11 - 45 96 00 - 0
E-Mail:info@dynamore.de
www.dynamore.de

ESI Group www.esi-group.com

A leading innovator in Virtual Prototyping software and services. Specialist in material physics, ESI has developed a unique proficiency in helping industrial manufacturers replace physical prototypes by virtual prototypes, allowing them to virtually manufacture, assemble, test and pre-certify their future products.

ESI Forum in Germany 2019 Nov 6-7, 2019

The ESI Forum in Germany will unite the areas of Virtual Performance, Virtual Manufacturing, Virtual Reality and System Simulation under the topic "Celebrating 40 years ESI in Germany".

We are looking forward to welcoming users from industry, research and science to present their experiences, best practices, challenges, and successes. The 2-day event is divided into a conference and exhibition.

The ESI Forum will take place in the heart of Berlin.

Use our expert platform to inform yourself and exchange with other users about efficient simulation methods for CAE supported development as well as 3D technologies of real-time visualization of virtual prototypes.

In October 2019, Czech Republic will be once again the place where the VPS community comes together. You will have again the opportunity to get an objective overview of many different applications of new version of Virtual Performance Solution.

Register here

Conference Fee

Regular Fee: 590 € Students: 200 € Confirmed Speaker: Free of Charge

Registration Deadline: 5 November 2019

Event Location:

Maritim proArte Hotel Berlin
Friedrichstraße 151
10117 Berlin
Mail: vgudinoramirez.bpa@maritim.de

Contact:

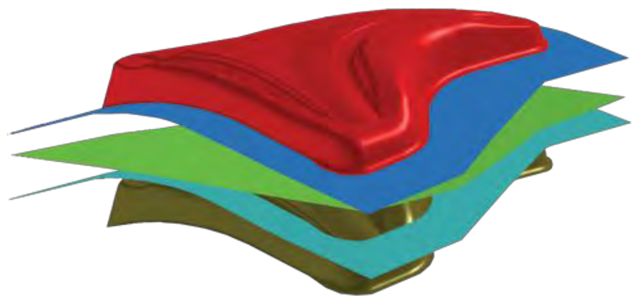
Egon Wiedekind
Marketing and Business Development Manager
Egon.Wiedekind@esi-group.com
+49 6102 2067 183
Neu-Isenburg

Diseree Alcantara
Marketing Assistant
Diseree.Alcantara@esi-group.com
+49 6102 2067 179
Neu-Isenburg

ETA has impacted the design and development of numerous products - autos, trains, aircraft, household appliances, and consumer electronics. By enabling engineers to simulate the behavior of these products during manufacture or during their use, ETA has been involved in making these products safer, more durable, lighter weight, and less expensive to develop.

DYNAFORM

DYNAFORM is a simulation software solution, which allows organizations to bypass soft tooling, reducing overall tryout time, lowering costs, increasing productivity & providing complete confidence in die system design. It also allows for the evaluation of alternative and unconventional designs & materials.



ACP Process

The patented Accelerated Concept to Product (ACP) Process® has revolutionized and streamlined the product development process, through optimization led design. The performance-driven development process relies heavily on simulations to meet timing and budget targets, whereas the traditional processes have been built around a build-test philosophy.

VPG

VPG is a set of plug-ins, which allow the user to quickly & efficiently create finite element models & define the models for mechanical system analyses.

<u>ETA Team Members Head to Asia for Roadshow</u>

A number of our team members have started to head to Asia to take part in ETA's Technology Roadshow. They will begin at the LSTC conference in Shanghai and continue to support LSTC and ETA's distributors in Korea and then head to Japan. The team will conclude in Bangalore – taking part in ETA APME's 'Disrupting Simulation with New Technologies Conference.'

FEA Not To Miss

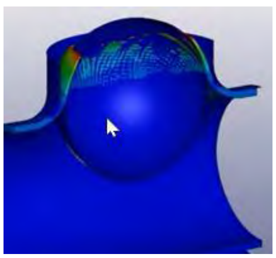
www.feantm.com

FEA Not To Miss, is a weekly internet blog on helpful videos, tutorials and other Not To Miss important internet postings. Plus, a monthly email blog.

Start your Monday with coffee or tea reading our engineering blog, at the FEA Not To Miss coffee shop.
Postings every Monday on what you have missed

www.feantm.com

Monday 10/14/2019 - This week is hot extrusion coffee. This week is also new pdf on Guests page AND on the Past Week page, so it is not so long to scroll. AND the 13th was my birthday! Happy Birthday to meeeeeee! feaanswer@aol.com - yes I expect to hear from all of youuuuuu



LS-DYNA hot extrusion

LS-DYNA Demo License mv@feainformation.com

Monday 10/07/2019 - Okay, NO place would be safe for my to go coffee cups for below simulation. BUT we sooooo love Lego Crash cars by DYNAmore/SCALE. What flavor you ask? Crash Chocolate with a dash of bumper vanilla. Ouch!

Lego Crash 2019

LS-DYNA Demo License mv@feainformation.com

09/23/2019 - CAR time! Who was that person that owned a 1969 Camaro? Who parked the car facing away from the movie at the Drive In Theaters? My brother owned a 442 and I had a baby blue Impala, SO who owned that Camaro? And with a Camaro to go cup - ZOOOOM Camaro time!

LS-DYNA CFD simulation of the GMC Camaro model

LS-DYNA Demo License mv@feainformation.com

Hengstar Technology

www.hengstar.com

Shanghai Hengstar & Enhu Technology sells and supports LSTC's suite of products and other software solutions. These provide the Chinese automotive industry a simulation environment designed and ready multidisciplinary engineering needs, and provide a CAD/CAE/CAM service platform to enhance and optimize the product design and therefore the product quality and manufacture.

Shanghai Hengstar & Enhu Technology

Sub-distributor and CAD/CAE/CAM consulting in China, especially for FEA needs for engineers, professors, students, consultants.

Contact us for our LS-DYNA training courses and CAD/CAE/CAM consulting service, such as

- Crashworthiness Simulation with LS-DYNA
- Restraint System Design with Using LS-DYNA
- LS-DYNA MPP
- Airbag Simulation with CPM
- LS-OPT with LS-DYNA

Our classes are given by experts from LSTC USA, domestic OEMs, Germany, Japan, etc. These courses help CAE engineers to effectively use CAE tools such as LS-DYNA to improve car safety and quality, and therefore to enhance the capability of product design and innovation.

Consulting - Besides solver specific software sales, distribution and support activities, we offer associated CAD/CAE/CAM consulting services to the Chinese automotive market.

Solutions - Our software solutions provide the Chinese automotive industry, educational institutions, and other companies a mature suite of tools - powerful and expandable simulation environment designed and ready for future multidisciplinary CAE engineering needs.

Shanghai Hengstar provides engineering CAD/CAE/CAM services, consulting and training that combine analysis and simulation using Finite Element Methods such as LS-DYNA.

Shanghai Hengstar Technology Co., Ltd

hongsheng@hengstar.com

http://www.hengstar.com

Shanghai Enhu Technology Co., Ltd

http://www.enhu.com

JSOL

http://www.jsol.co.jp/english

JSOL supports industries with the simulation technology of state-of-the-art. Supporting customers with providing a variety of solutions from software development to technical support, consulting, in CAE (Computer Aided Engineering) field. Sales, Support, Training.

JSOL CAE Forum 2019

JSOL Corporation is holding the "JSOL CAE Forum" to provide our users with the latest and most comprehensive simulation technologies and case studies for various JSOL CAE packages including LS-DYNA. Until last year, we had held user's events individually for each package, like LS-DYNA & JSTAMP Forum, J-OCTA Users Conference, and Moldex3D technology exchange. In 2019, we decided to hold a comprehensive and unified event called "JSOL CAE Forum" at Shinagawa, Tokyo, from November 6 through 8. During the three-day event we will showcase a wide range of information to our structural, manufacturing, and material CAE package users all together.

We will start accepting applications in late September. A detailed program will be published on this page around the same time.

We encourage our users to take advantage of this opportunity and look forward to your attendance at the event.

JSOL Corporation

Engineering Technology Division

JSOL CAE Forum Website

J-OCTA Feature enhancement: Finite Element Method (FEM) simulation

Interface for LS-DYNA supports large-deformation simulation

Recently, it is in high demand to estimate and evaluate the behavior during large deformation of micro-structured composites which contain phase separation and filler, by performing simulations.

Existing FEM engine of J-OCTA, "MUFFIN-Elastica" is for elastic simulation and is specialized for the behavior during a small deformation.

To extend its applicability to FEM simulation, the updated J-OCTA 4.1 version will provide the interface for a multi-purpose nonlinear structural analysis engine "LS-DYNA".

The phase-separated structure computed by "COGNAC or "SUSHI" can be output as a mesh data for LS-DYNA simulation. After the user specifies the material properties for each component and deformation (boundary) condition, LS-DYNA simulation can be started from J-OCTA directly. As a material model being appropriate for nonlinear structural simulation, materials including elastoplastic, viscoelastic, and hyperplastic such as rubber are available for use.

From version 4.1, J-OCTA can deal a large-deformation FEM calculation of a multi-phase structure which contains phase separation and filler dispersed structure.

KAIZENAT

https://www.kaizenat.com/

KAIZENAT Technologies Pvt Ltd is the leading solution provider for complex engineering applications and is founded on Feb 2012 by Dr. Ramesh Venkatesan, who carries 19 years of LS-DYNA expertise. KAIZENAT sells, supports, trains LS-DYNA customers in India. We currently have office in Bangalore, Chennai, Pune and Coimbatore.

Review International Machine Tools & Industrial Trade Fair Coimbatore – INTEC 2019

Kaizenat Technologies Pvt. Ltd. participated in the International Machine Tools & Industrial Trade Fair Coimbatore – INTEC 2019 as an Exhibitor with a booth to present the latest capabilities of LSTC's suite of products.

International Machine Tools & Industrial Trade Fair Coimbatore – INTEC 2019 was held at CODISSIA Trade Fair Complex, Coimbatore, India. More than 1 lakh business visitors witnessed the event.

We had the opportunity to meet leading visionaries, developers, and practitioners of CAE-related technologies in the INTEC Event, as well as share experiences, discuss trends and future issues with our customers and other attendees.

Among the discussions at the conference that were of interest and we will pursue in future discussions are:

- The future for engineering analysis and simulation - where it will lead.
- Best practices how designers and engineers can realize full potential.
- The past and current successful developments bringing them to new levels.

We found it to be a forum that we look forward to future participation in and its future successes.

To know more about the simulation, please contact support@kaizenat.com

A team of engineers, mathematicians, & computer scientists develop LS-DYNA, LS-PrePost, LS-OPT, LS-TaSC, and LSTC's Dummy & Barrier models.

Livermore Software Technology Corporation (LSTC)

1987 - 2019

Headquartered in Livermore, California, Livermore Software Technology Corporation (LSTC) develops LS-DYNA and a suite of related and supporting engineering software products.

LSTC was founded in 1987 by John O. Hallquist to commercialize as LS-DYNA the public domain code that originated as DYNA3D. DYNA3D was developed at the Lawrence Livermore National Laboratory, by LSTC's founder, John O. Hallquist.

LSTC's headquarters comprises three buildings that house offices, meeting rooms, and a state-of-the-art training room with audio and video equipment.

A team of engineers, mathematicians, and computer scientists are engaged in the development of LS-DYNA, LS-PrePost, LS-OPT, LS-TaSC (Topology), and LSTC's Dummy, Barrier & Tires models for use in various industries, including Automobile Design, Aerospace, Manufacturing, and Bioengineering. LS-DYNA development is focused on one code methodology that includes Implicit, Explicit, SMP and MPP solvers. It is optimized on all platforms including clusters running Unix, Linux, and Windows operating systems.

LSTC is focused on technical excellence and support. The worldwide growth of the LS-DYNA user base is attributable to both the quality of LSTC's software and the extraordinary efforts regularly made by the technical staff to ensure customer satisfaction.

With regard to LS-DYNA pricing, LSTC consistently offers a more competitive product because 90% of the work force is solely dedicated to technical endeavors. LSTC directs its resources towards producing high quality software and supporting licensee's projects.

LSTC Livermore Software Technology Corp.

LS-TaSC™ for Topology and Shape Design

LS-TaSC is for the topology and shape optimization of large non-linear problems, involving dynamic loads and contact conditions. The focus is on multidisciplinary topology optimization considering a combination of impact, statics, and NVH load cases. The methodology is specifically developed for huge models and requires no special treatment for nonlinearities such as contact.

General abilities

- Solid design using 1st-order hexahedrons, pentahedra, and tetrahedral elements
- Shell design using 1st-order quadrilateral and triangular elements
- Global constraints using the multi-point scheme and surrogate models
- Multiple load cases such as impact, statics, and NVH load cases with/out element deletion
- Occupant safety features such as global variables and responses
- Models with more than 10 million elements
- Geometry definitions such as multiple parts, extrusion, symmetry, edge smoothing, one or two sided casting

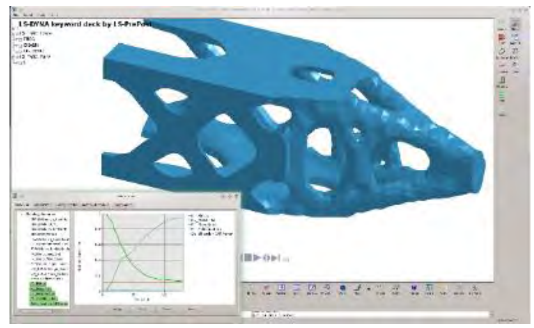
Methodologies

- Solid / Void Schemes: SIMP, True Mechanics
- Analytical and/or Numerical Design Sensitivity Analysis
- Optimality Criteria for Dynamic Problems
- Projected Sub-gradient Design Optimization Method
- Design Contribution Estimation

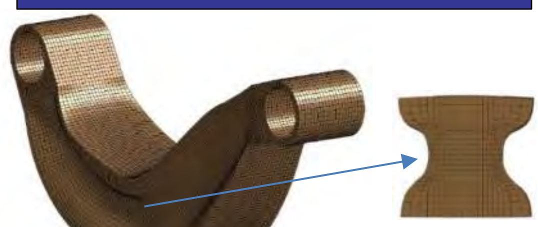
Integration

- With LS-DYNA@ – No special treatment for nonlinearities such as contact
- With LS-PrePost – Results visualization and model editing
- With LS-OPT – LS-OPT can drive LS-TaSC for complex design schemes

LS-TaSC User Interface



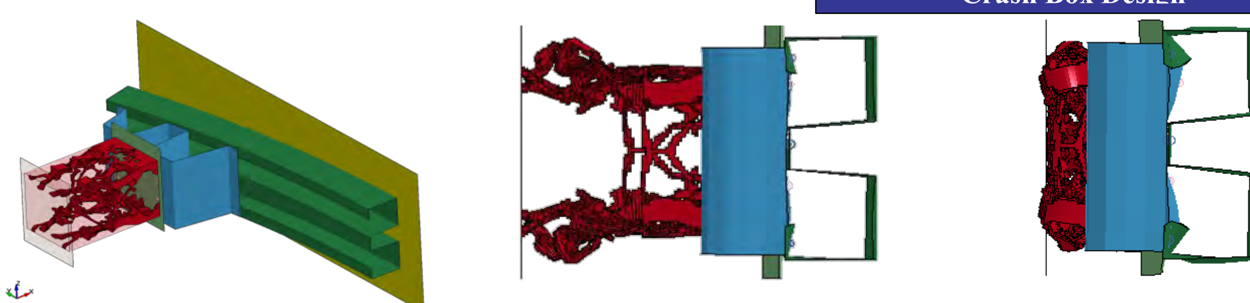
Surface Design



cross section

Hood Design

Crash Box Design



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MSC www.materials-sciences.com

Providing engineering services to the composites industry since 1970. During this time, we have participated in numerous programs that demonstrate our ability to perform advanced composite design, analysis and testing; provide overall program management; work in a team environment; and transition new product development to the military and commercial sectors.

Progressive Composite Damage Modeling in LS-DYNA (MAT162 & Others)

Bazle Z. (Gama) Haque, Ph.D.
Senior Scientist, University of Delaware Center for Composite Materials (UD-CCM)
Assistant Professor of Mechanical Engineering, University of Delaware, Newark, DE 19716
P: (302) 690-4741 | E: bzhaque@udel.edu

2019 Workshops:
Webinar Course Dates
November 19, 2019 | 9am-5pm

In House Course Dates
November 20, 2019 | 9am-5pm

Cost: In-House Class: $695 per person
Includes: Coffee, Lunch, Parking, USB with Course Content
Email Robin Mack for driving direction.

Web Conference: $695 per person
Includes: CD with Course Content

Description:

Progressive damage modeling of composites under low velocity impact, and high velocity impact is of interest to many applications including car crash, impact on pressure vessels, perforation and penetration of thin and thick section composites. This course will provide a comparison between available composite models in LS-DYNA for shell and solid elements, e.g., MAT2, MAT54, MAT59, & MAT162. Among these material models, rate dependent progressive composite damage model MAT162 is considered as the state of the art. This short course will include the theory and practice of MAT162 composite damage model with applications to low and intermediate impact velocities, understanding the LS-DYNA programming parameters related to impact-contact, damage evolution, perforation and penetration of thin- and thick-section composites. Printed copies of all lecture notes will be provided along with a CD containing all example LS-DYNA keyword input decks used in this short course.

Topics Covered in this Short Course:

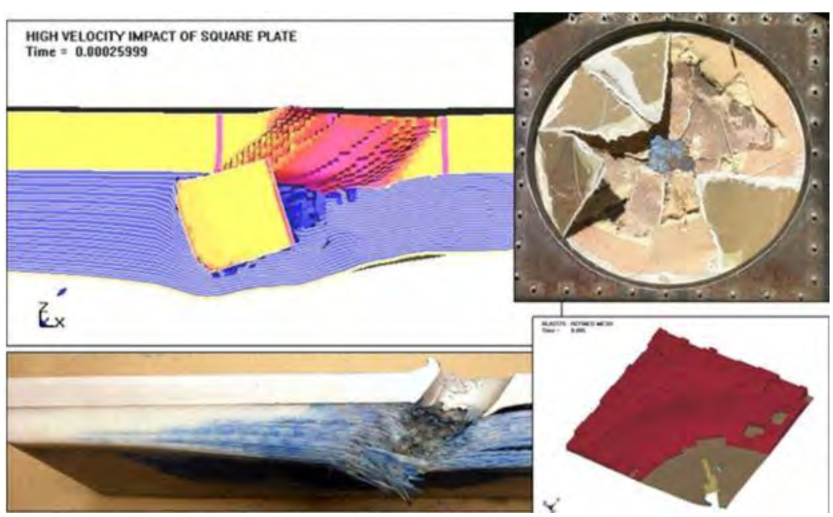
- Impact and Damage Modeling of Composites
  Application of MAT162 in Engineering and Research Problems
- Introduction to Composite Mechanics
  Introduction to Continuum Mechanics and Composite Mechanics

- Composite Material Models in LS-DYNA for Shell and Solid Elements
  Discussion on MAT2, MAT54, MAT59, & MAT162
- Theory and Practice in MAT162 Progressive Composite Damage Model for Unidirectional and Woven Fabric Composites
  MAT162 User Manual – Version 15A 2015
  Progressive Damage Modeling of Plain-Weave Composites using LS-Dyna Composite Damage Model MAT162
  Unit Single Element Analysis
- Comparison between Different LS-DYNA Composite Models
  Sphere Impact on Composite SHELL & SOLID Plates
- Low Velocity Impact and Compression after Impact Applications
  Modeling the Low Velocity Impact and Compression after Impact Experiments on Composites Using MAT162 in LS-DYNA
- Perforation Mechanics of 2-D Membrane and Thin Composites
- Penetration Mechanics of Composites and Soft-Laminates
- Introduction to LS-DYNA (Document Only)

To register, email Robin Mack your full name, and if you're attending in house or web conference.

Engineering Services

MSC brings a long-range perspective to its engineering services clients. We understand the history of our core technologies, and can project likely new developments, and seek to provide innovation. A keen appreciation of the materials and structures state-of-the-art gives us the ability to create a development roadmap that efficiently reaches the clients goal, while taking full advantage of what already exists. We have an unusually broad exposure to materials applications; we have been involved with everything from infrastructure applications to spacecraft. This broad perspective allows us to draw on approaches and trends in one application area, and apply it to another. This helps our clients avoid pitfalls, and make exceptionally rapid technological progress. The same broad reach allows us the opportunity to interact with, and evaluate a wide range of suppliers.



OASYS

www.oasys-software.com/dyna

Oasys Ltd is the software house of Arup and distributor of the LS-DYNA software in the UK, India and China. We develop the Oasys Suite of pre- and post-processing software for use with LS-DYNA.

Oasys Suite v 16.1 now released

The Oasys LS-DYNA team are pleased to announce the release of the Oasys Suite version 16.1

Version 16.1 of the Oasys Suite includes updated versions of PRIMER, D3PLOT, T/HIS, REPORTER and SHELL and has been thoroughly tested through our QA procedures.

This version is available for 64bit architectures, on both Windows and Linux.

Release notes outlining the new bug fixes, can be downloaded from:
https://www.oasys-software.com/dyna/wp-content/uploads/2019/10/Update-and-Release-Notes-16.1.pdf

The software can be downloaded from:
https://www.oasys-software.com/dyna/downloads/oasys-suite/

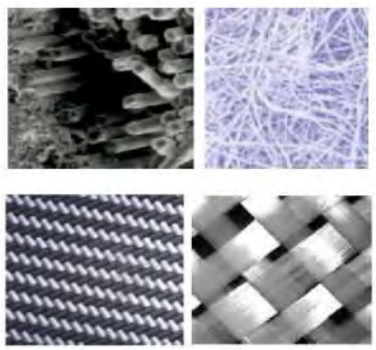
Please get in touch with us at dyna.support@arup.com if you have any queries.

Webinars

Oasys and LS-DYNA team offers free webinars

6th November 2019 - Oasys FAST-TCF: an introduction

- To view past and future webinars click here.



Training

Fibre Reinforced Composites Courses

DYNAmore GmbH

Don't miss out on the opportunity to attend the composites courses run by a specialist from DYNAmore GmbH - Christian Liebold at Arup office in Solihull UK.

3rd - 4th December Continuous Fiber Reinforced Composites £800 + VAT
5th December Short/Long Fiber Reinforced Composites £400 + VAT

Predictive Engineering

www.predictiveengineering.com

Predictive Engineering provides FEA and CFD consulting services, software, training and support to a broad range of companies.

Who We Are

We are experienced simulation engineers that have successfully analyzed and validated hundreds and hundreds of finite element analysis (FEA) projects. With decades of experience in FEA and CFD, we know how to optimize your design to deliver every last bit of performance and to ensure that it will meet your service requirements whether in Aerospace, Marine, Energy, Automotive, Medical or in Consumer Products.

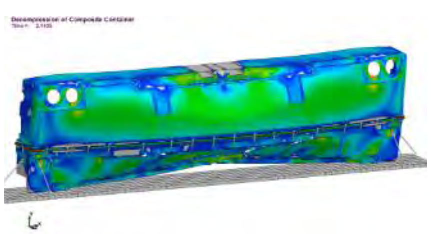
Our History

Since 1995, Predictive Engineering has continually expanded its client base. Our clients include the total spectrum from large Fortune 500 companies to start-ups looking to launch the next generation of satellites. We are also proud of work in the renewable energy fields from wind to solar. Over the years, one of our core strengths is in the vibration analysis of composite structures, aerospace electronic components and large industrial machinery. What has set us apart from the competition is our experience in the successful completion of more than 800 projects.

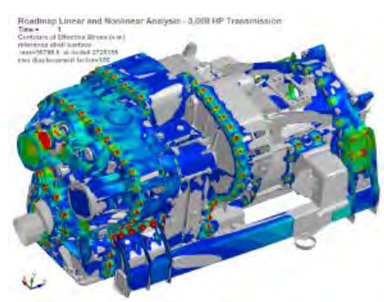
View our portfolio

FEA, CFD and LS-DYNA consulting projects

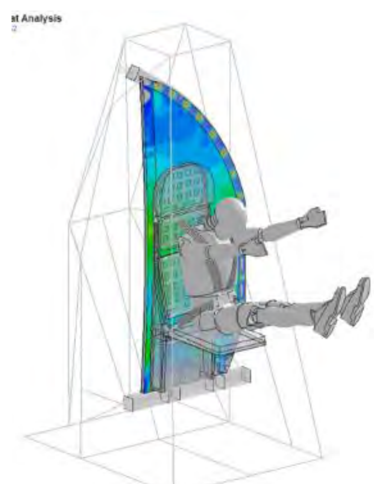
Composite Engineering



Nonlinear Dynamics



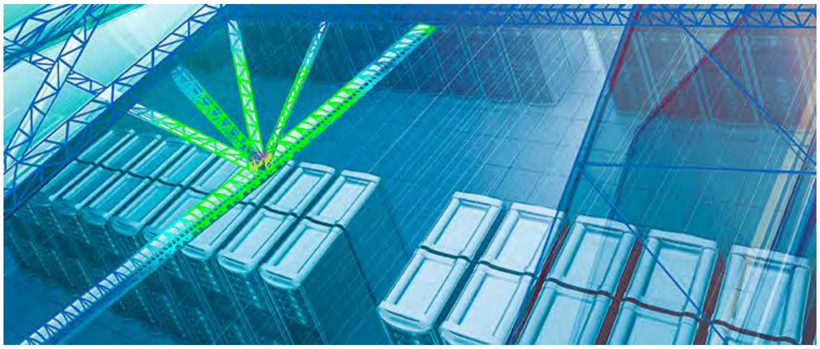
Aerospace



Rescale

www.rescale.com

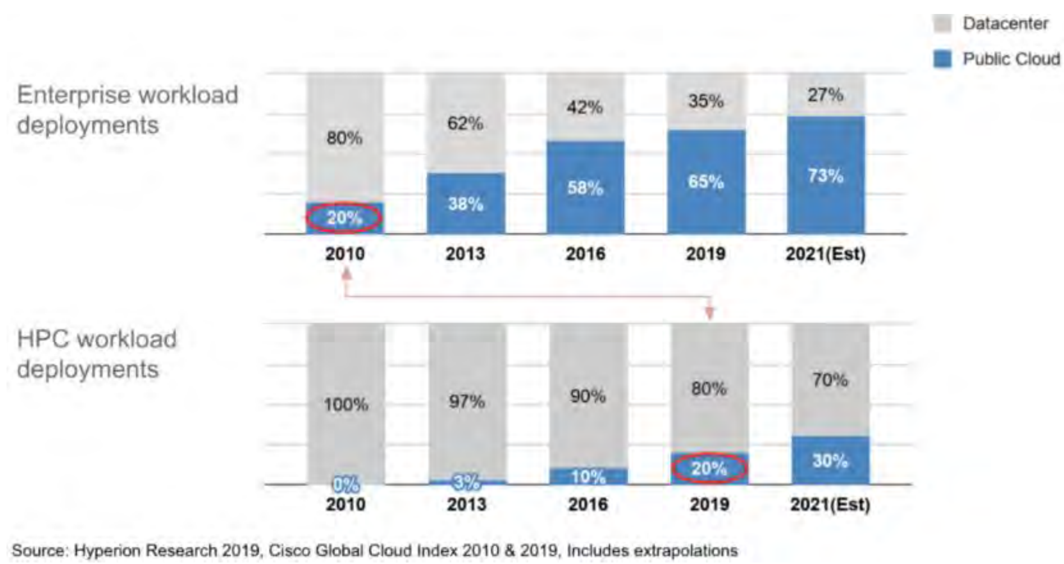
Offering industry-leading software platforms and hardware infrastructure for companies to perform scientific and engineering simulations. Providing simulation platforms that empower engineers, scientists, developers, and CIO and IT professionals to design innovative products, develop robust applications, and transform IT into unified, agile environments.



Advancing Cloud Computing's Final Frontier

October 3 Edward Hsu

Public cloud computing's momentum is undeniable. In less than a decade, businesses went from debating whether to use public cloud, to running the majority of workloads on public cloud (58% as of 2016 according to Cisco). Cisco expects this number to jump to 73% by 2021. Repatriation to data centers (private clouds) occur but are rare exceptions. Initially, many found justification for workload to stay on prem, but as we heard in Star Trek, "now they are all Borg."



Cloud computing adoption is similar to enterprise computing circa 2010. There's been one holdout to this trend, however, and that's high performance computing (HPC). HPC is used by engineers to create the planes, cars, medicine, electronics, and AI-enabled services we use every day. Scientists use HPC to power weather, climate and astrophysics simulations that push the boundaries of our knowledge. Example techniques they use include computational fluid dynamics (CFD), electronics design automation (EDA), molecular dynamics calculations, and artificial intelligence model training.

As of 2019, only 20% of HPC workloads are running in the cloud, according to Hyperion Research. Unlike cloud native web applications that run on commodity compute, HPC infrastructures are specialized with a tremendous amount of cores & memory, as well as high-speed interconnects between machines. This specialized software+hardware architecture has been an inhibitor to HPC's transition to public cloud.

For more information: https://resources.rescale.com/advancing-cloud-computings-final-frontier/

Shanghai Fangkun

http://www.lsdyna-china.com/

LS-DYNA China, as the master distributor in China authorized by LSTC, is fully responsible for the sales, marketing, technical support and engineering consulting services of LS-DYNA in China.

仿坤软件 LS-DYNA China

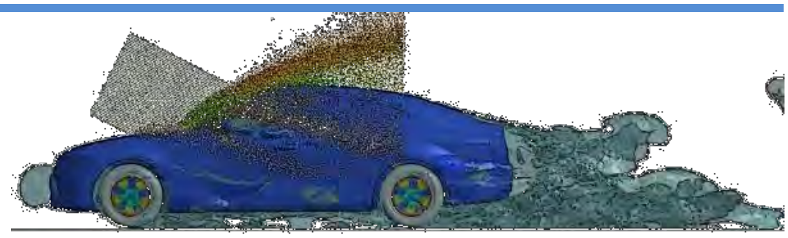
Shanghai Fangkun Software Technology, Ltd.

Shanghai Fangkun Software Technology Co., Ltd. was established in May 2018. It is fully responsible for sales, marketing, technical support and engineering consulting services of LS-DYNA software in China. It will meet this responsibility through the integration and management of various resources of LS-DYNA's Chinese sub-distributors and partners, providing expert technical support services for China's LS-DYNA users, helping customers to use LS-DYNA software more efficiently and effectively for product design and development, thereby improving the efficiency and effectiveness of LS-DYNA software usage by the customers.

The sub-distributors under Shanghai Fangkun are ARUP-China, ETA-China and Shanghai Hengstar. Through cooperation with sub-distributors and partners, Shanghai Fangkun will provide customers with a full range of LSTC products: LS-DYNA, LS-OPT, LS-PREPOST, LS-TASC and LSTC's dummy and barrier models. Shanghai Fangkun Software Technology Co., Ltd. brings together a group of top application engineers of LS-DYNA software, focusing on sales and technical support in various industries such as automotive, aerospace and general machinery.

- **Website**: http://www.lsdyna-china.com
- **Sales Email**: sales@lsdyna-china.com
- **Technical support Email:** support@lsdyna-china.com
- **Customer Service Number**: 400 853 3856 021-61261195
- **Address**: Room 2219, Building No.1, Global Creative Center
  Lane 166, Minhong Road,
  Shanghai, China 201102

2019 4th China LS-DYNA Users' Conference



The 4th China LS-DYNA Users'Conference will be held on October 21st - 23rd, 2019 in Shanghai. During this conference LSTC will share the details of its latest product developments as well as its road map for the future. At this conference engineers and scientists from LSTC and customers from all over the world will meet to share their experiences and successful cases with LS-DYNA, to discuss the latest features and developments in LS-DYNA, and to explore industrial development trends.

This conference aims to promote interaction and communication among developers and end users. Therefore, we call for papers with topics covered but not limited to the automotive industry, aerospace and aeronautics, electronics industry, daily consumer goods, biomechanics, locomotive, shipbuilding, civil engineering, and general machinery.

Shanghai Fangkun

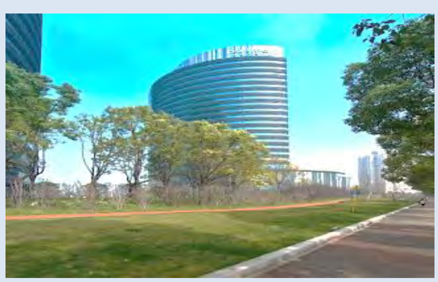
http://www.lsdyna-china.com/

LSTC, Shanghai Fangkun Software Technology, Ltd., and Dalian Fukun Technology Development Corporation wholeheartedly welcome your paper submission and attendance.

Hosts:	**Livermore Software Technology Corp. USA** **Shanghai Fangkun Software Technology, Ltd. China** **Dalian Fukun Technology Development Corp. China**
Date:	**October 21st- 23rd, 2019**
Location:	**Pullman Shanghai South Hotel** No.1 Pubei Road, Xuhui District, Shanghai, China, 200235
Training:	There will have 8 training classes being held on Oct. 21st, 24th and 25th All training courses will be taught by senior engineers from LSTC except C1

Course No.	Course Topic	Date
C1	LS-DYNA blasting analysis and application	21st Oct.
C2	Theory and Applications of LS-DYNA SPH Method	21st Oct.
C3	Introduction to LS-PrePost	21st Oct.
C4	LS-DYNA in stamping simulation and application	21st Oct.
C5	Industrial Applications of LS-DYNA Advanced FEM / Meshfree /Particle Methods	24th-25th Oct.
C6	Contact Modeling in LS-DYNA	24th-25th Oct.
C7	NVH, Fatigue and frequency domain analysis with LS-DYNA	24th-25th Oct.
C8	Crash and Safety	24th-25th Oct.

Conference Website: http://conference.lsdyna-china.com/
Contact us: conf@lsdyna-china.com



Terrabyte

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CAE software sale & customer support, initial launch-up support, periodic on-site support. Engineering Services. Timely solutions, rapid problem set up, expert analysis, material property test Tension test, compression test, high-speed tension test and viscoelasticitiy test for plastic, rubber or foam materials. We verify the material property by LS-DYNA calculations before delivery.

CAE consulting - Software selection, CAE software sale & customer support , initial launch-up support, periodic on-site support.

Engineering Services - Timely solutions, rapid problem set up, expert analysis - all with our Engineering Services. Terrabyte can provide you with a complete solution to your problem; can provide you all the tools for you to obtain the solution, or offer any intermediate level of support and software.

FE analysis

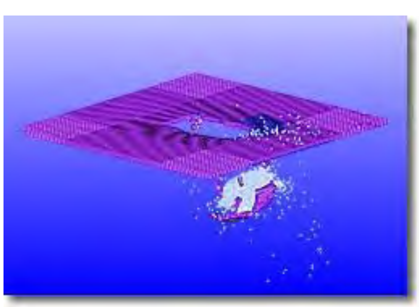
- LS-DYNA is a general-purpose FE program capable of simulating complex real world problems. It is used by the automobile, aerospace, construction, military, manufacturing and bioengineering industries.
- ACS SASSI is a state-of-the-art highly specialized finite element computer code for performing 3D nonlinear soil-structure interaction analyses for shallow, embedded, deeply embedded and buried structures under coherent and incoherent earthquake ground motions.

CFD analysis

- AMI CFD software calculates aerodynamics, hydrodynamics, propulsion and aero elasticity which covers from concept design stage of aerocraft to detailed design, test flight and accident analysis.

EM analysis

- JMAG is a comprehensive software suite for electromechanical equipment design and development. Powerful simulation and analysis technologies provide a new standard in performance and quality for product design.



Metal sheet

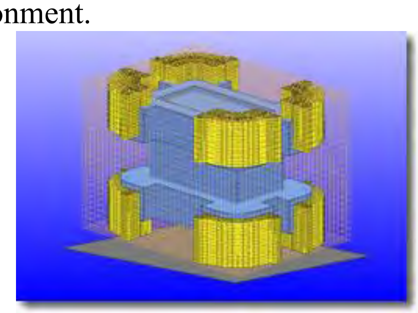
- JSTAMP is an integrated forming simulation system for virtual tool shop based on IT environment. JSTAMP is widely used in many companies, mainly automobile companies and suppliers, electronics, and steel/iron companies in Japan.

Pre/ Post

- **PreSys** is an engineering simulation solution for FE model development. It offers an intuitive user interface with many streamlined functions, allowing fewer operation steps with a minimum amount of data entry.
- **JVISION** - Multipurpose pre/post-processor for FE solver. It has tight interface with LS-DYNA. Users can obtain both load reduction for analysis work and model quality improvements.

Biomechanics

- **The AnyBody Modeling System™** is a software system for simulating the mechanics of the live human body working in concert with its environment.



Successful Ocean-Monitoring Satellite Mission Ends

NEWS| Oct. 4, 2019

The Jason-2/OSTM satellite provided insights into ocean currents and sea level rise with tangible benefits to marine forecasting, meteorology and understanding of climate change. These observations are being continued by its successor, Jason-3. Credit: NASA/JPL-Caltech

The Jason-2/Ocean Surface Topography Mission (OSTM), the third in a U.S.-European series of satellite missions designed to measure sea surface height, successfully ended its science mission on Oct. 1. NASA and its mission partners made the decision to end the mission after detecting deterioration in the spacecraft's power system.

Jason-2/OSTM, a joint NASA mission with the French space agency Centre National d'Etudes Spatiales (CNES), the National Oceanic and Atmospheric Administration (NOAA), and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), launched in June 2008. The mission extended the long-term record of sea surface height measurements started by the NASA-CNES TOPEX/Poseidon and Jason-1 missions. Jason-2/OSTM's 11-year lifetime well exceeded its three-year design life. These measurements are being continued by its successor, Jason-3, launched in 2016.

"Today we celebrate the end of this resoundingly successful international mission," said Thomas Zurbuchen, associate administrator of the Science Mission Directorate at NASA Headquarters in Washington. "Jason-2/OSTM has provided unique insight into ocean currents and sea level rise with tangible benefits to marine forecasting, meteorology and our understanding of climate change."

Since its launch, Jason-2/OSTM charted nearly 2 inches (5 centimeters) of global sea level rise, a critical measure of climate change. The mission has also resulted in the distribution of over a million data products and the publication of more than 2,100 science papers.

"Jason-2/OSTM was a high point of operational satellite oceanography as the first Jason mission to formally include EUMETSAT and NOAA as partners," said Steve Volz, assistant administrator of NOAA's Satellite and Information Service. "During its 11-year run, Jason-2/OSTM helped improve NOAA's hurricane intensity forecasts and provided important observations of marine winds and waves and in doing so has anchored these essential ocean altimetry observations in NOAA's operational observing system requirements."

Aerospace News - Ocean-Monitoring Satellite

With the recent degradation of the spacecraft's power system, mission partners decided to end the mission to decrease risks to other satellites and future altimetry missions, and to comply with French space law. Final decommissioning operations for Jason-2/OSTM are scheduled to be completed by CNES on Oct. 10.

"With the involvement of EUMETSAT and NOAA, Jason-2 brought high precision monitoring of ocean surface topography and mean sea level to operational status," said Alain Ratier, EUMETSAT's director general. "Its 11-year lifetime in orbit was rewarding for the four program partners and the ocean and climate user community."

Jason-2/OSTM's mission might have ended earlier if not for the ingenuity of its mission teams. In July 2017, the degradation of critical onboard components and control systems required that Jason-2/OSTM move from its original science orbit, deplete excess propellant reserves, and be maneuvered into a slightly lower orbit, away from functioning satellites. In close collaboration with the Ocean Surface Topography Science Team, mission partners identified an orbit that would allow for the continuation of the Jason-2/OSTM measurements while still being compatible with orbital-debris mitigation constraints and of scientific benefit.

This new orbit resulted in less frequent observations of the same location on Earth, but overall resolution of the data improved because the ground tracks of the observations were closer together. This improved resolution is extremely useful for marine gravity studies and the mapping of seafloor topography. It also allowed for valuable operational oceanographic and science observations.

"Not only did Jason-2 extend the precise climate record established by TOPEX/Poseidon and continued by Jason-1, it also made invaluable observations for small- to medium-scale ocean studies in its second, interleaved orbit," said CNES President Jean-Yves Le Gall. "Even when moved to the 'graveyard' orbit, Jason-2 continued to make unprecedented new observations of the Earth's gravity field, with precise measurements right until the end."

The technological advancements proven on Jason-1, Jason-2/OSTM and Jason-3 will be put to use well into future decades. Following Jason-3 will be two future Sentinel-6/Jason-CS satellites, planned for launch in 2020 and 2025.

For more information about NASA's Earth science activities, visit:

https://www.nasa.gov/earth

As Expedition Sales Surge, Ford Reintroduces Legendary King Ranch Edition with Authentic, Premium Texas Design

Sep 25, 2019 | Dallas

2020 Ford Expedition King Ranch

- King Ranch® edition of 2020 Ford Expedition and extended-length Expedition MAX reintroduces premium option for buyers of large SUVs inspired by iconic Texas ranch, extending 20-year collaboration
- Expedition King Ranch features three rows of seats trimmed in Del Rio leather; exterior highlights include Stone Gray accent paint, power-deployable running boards and 22-inch wheels with King Ranch center caps
- Expedition Platinum introduces more premium updates for 2020, including leather-wrapped instrument panel topper and door rollovers, plus more aluminum interior touches

2020 Expedition Product Page

DALLAS, Sept. 25, 2019 – Aiming to continue meeting growing demand for Ford Expedition, Ford today reveals two new models for the 2020 model year – Expedition King Ranch® and an upgraded Platinum model with new materials and high-end finishes.

Large SUVs continue to appeal to customers across the U.S. Through August, U.S. sales of Expedition for 2019 were up 56 percent versus the same period last year – the best eight-month start for the nameplate in more than a decade. The addition of a new King Ranch version aims to build on that success.

"The King Ranch name carries with it a legacy of hard work that defines the American ranching lifestyle, with the heritage and family traditions Ford Expedition represents," said Andrew Kernahan, Expedition chief engineer. "It's a great addition to the lineup, growing Expedition's appeal and personality in Texas as well as with customers across the U.S. looking for western-inspired style and timeless design."

Today, approximately one in five Expedition buyers opts for the top-end Platinum model, while about six in 10 choose either a Platinum or a Limited model.

Expedition King Ranch – which first debuted in 2005, following the Ford F-Series King Ranch in 1999 – grows the range of high-end choices.
Expedition King Ranch sports unique style inside and out. Elegant Stone Gray paint on the grille mesh, power-deployable running boards, rear bumper skid plate, trailer hitch cover, roof-rack side rails and side mirror caps immediately distinguish it as a King Ranch. Other exterior highlights include body color-painted upper bumpers and Stone Gray-painted lower bumpers, and 22-inch six-spoke painted machine-finished aluminum wheels with dark tarnish-painted

pockets. King Ranch badging – mirroring the ranch's distinctive "Running W" brand – appears on the body sides, liftgate and wheel center caps. Inside, the use of premium Del Rio leather extends over all three rows of seats, and more.

Ebony Del Rio leather covers the door trim while the leather-wrapped steering wheel features intricate Kingsville stitching adding satisfying texture to the touch. Del Rio trim on the console is accented by the distinctive grain of Ziricote wood veneer. The King Ranch "Running W" logo is emblazoned into the seatbacks of all three rows. The second-row is highlighted by power-folding, tip-and-slide captain's chairs with perforated inserts.

As with Platinum models, King Ranch comes standard with Ford Co-Pilot360™ Assist driver-assist technology, continuously controlled damping, 360-degree camera with split-view and front and rear washers, power-folding, heated sideview mirrors with turn signal indicators, security approach lamps and auto-dimming driver's side mirror.

Expedition Platinum is updated with new 22-inch wheels and new premium finishes. Leather upgrades highlight the interior, including an instrument panel topper wrapped in leather, plus front door trim rollover and console rails.
Platinum also includes premium features such as leather-trimmed front- and second-row seats with perforated seat inserts and quilted bolsters, multi-contour front seats with Active Motion, and Wollsdorf leather-wrapped steering wheel with Pecan stitching.

In addition to its expansive cargo space and exceptional towing capability, Expedition is loaded with technology. More technology now comes standard, including FordPass Connect™, with 4G LTE Wi-Fi hotspot for up to 10 mobile devices. Ford reminds you to not drive distracted or while using handheld devices. SYNC® 3 is also included which features compatibility with Apple CarPlay™ and Android Auto™.

Ford Co-Pilot360 is standard for 2020, providing driver-assist features such as Pre-Collision Assist with Automatic Emergency Braking and Pedestrian Detection, Forward Collision Warning and Dynamic Brake Support; Blind Spot Information System with Cross-Traffic Alert; a Lane-Keeping System; rear backup camera with built-in lens washer; and auto high-beam headlamps.

King Ranch is available on Expedition standard-wheelbase, as well as Expedition MAX extended-wheelbase. King Ranch is a registered trademark of King Ranch, Inc. Click here for important information about FordPass Connect.

Go to Website

LS-DYNA - Resource Links

LS-DYNA Multiphysics YouTube

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

FAQ LSTC

ftp.lstc.com/outgoing/support/FAQ

LS-DYNA Support Site

www.dynasupport.com

LS-OPT & LS-TaSC

www.lsoptsupport.com

LS-DYNA EXAMPLES

www.dynaexamples.com

LS-DYNA CONFERENCE PUBLICATIONS

www.dynalook.com

ATD –DUMMY MODELS

www.dummymodels.com

LSTC ATD MODELS

www.lstc.com/models www.lstc.com/products/models/mailinglist

AEROSPACE WORKING GROUP

http://awg.lstc.com

Training - Webinars

Participant's Training Classes

Webinars

Info Days

Class Directory

Directory

BETA CAE Systems	www.beta-cae.com/training.htm
DYNAmore	www.dynamore.de/en/training/seminars
Dynardo	http://www.dynardo.de/en/wost.html
ESI-Group	https://myesi.esi-group.com/trainings/schedules
ETA	http://www.eta.com/training
KOSTECH	www.kostech.co.kr
LSTC	www.lstc.com/training
LS-DYNA OnLine - (Al Tabiei)	www.LSDYNA-ONLINE.COM
OASYS	www.oasys-software.com/training-courses
Predictive Engineering	www.predictiveengineering.com/support-and-training/ls-dyna-training

Training - Dynamore

Author: Christian Frech christian.frech@dynamore.de

Seminars 2019

Visit the website for complete overview and registration www.dynamore.de/seminars

Selection of trainings for November/December

Introduction	
Introduction to LS-DYNA	12-14 November (I)
	10-12 December (V)
	10-12 December
Introduction to Simulation Technology	2 December
Nonlinear Implicit Analyses	13 December
Crash	
Joining Techniques in LS-DYNA	4-5 November
Crash Analysis	3-6 December
Passive Safety	
CPM Airbag Modeling	20 November
Metal Forming	
Applied Forming Simulation with eta/DYNAFORM	4-5 November
Metal Forming with LS-DYNA	6-8 November
Introduction to Draping Simulation with LS-DYNA	21-22 November
Material	
Modeling Metallic Materials	11-12 November
Parameter Identification with LS-OPT	13 November
Material Failure	14-15 November
Advanced Damage Modeling: Orthotropic Materials	18 November
Simulation of short fiber reinforced composites	25-26 November
Implicit Capabilities	
Implicit Analysis using LS-DYNA	6-7 November (V)
Optimization	
LS-OPT - Optimization & Robustness	26-28 November (T)

Information days and Webinars (free of charge)

Infoday Certification of human models according to EuroNCAP TB024	7 November
Infoday Welding & Heat Treatment	19 November (A)

We hope that our offer will meet your needs and are looking forward to welcoming you at one of the events.

If not otherwise stated, the event location is Stuttgart, Germany. Other event locations are:
A = Aachen, Germany, G = Gothenburg, Sweden; I = Ingolstadt, Germany; L = Linköping, Sweden,
V = Versailles, France; T = Turin, Italy, Tr = Traboch, Austria, Z = Zurich, Switzerland

Training - LSTC

www.lstc.com

October 21-31, 2019

Date				Location	Course Title	Days	Instructor(s)
Oct 21		Mon		CA	EM: Eddy Current Applications	1	I. Caldichoury
Oct 22		Tu		CA	EM: Battery Modeling, Spot Welding, and Resistive Heating Applications	1	I. Caldichoury
Oct 23	Oct 24	Wed	Fri	CA	Introduction to ICFD	2	I. Caldichoury
Oct 29	Nov 1	Tu	Fri	MI	Introduction to LS-DYNA®	4	S. Adya
Oct 30	Oct 31	Wed	Th	CA	Comprehensive ALE and Structure-ALE Modeling Methods and Applications	2	I. Do, H. Chen

November 2019

Date				Location	Course Title	Days	Instructor(s)
Nov 5	Nov 8	Tu	Fri	CA	Introduction to LS-DYNA®	4	B. Aminjikarai
Nov 6		Wed		***MI***	Introduction to LS-PrePost	1	P. Ho, Q. Yan
Nov 11	Nov 15	Mon	Fri	***MI***	Crashworthiness in LS-DYNA (This class is 4 days of instruction; the fifth day is a half day optional workshop.)	4 + 0.5	P. Du Bois, S. Bala

Crashworthiness and Lightweight Optimization of an Automotive Crash Box Using LS-TaSC

Imtiaz Gandikota, Guilian Yi, Willem Roux

Livermore Software Technology Corporation

Abstract

A crash box has the vital functions of absorbing the impact energy and protecting the occupants from serious damage during collisions. This study demonstrates the topology optimization design of automotive crash box using LS-TaSC, which resulted in a lightweight crash box structure with improved crashworthiness performances. Two different optimization problems are formulated to optimize a solid design part of the crash box subject to high-speed collision: (1) mass minimization with a constraint on energy absorption ability of the crash box, and (2) mass minimization with a constraint on peak acceleration at the back end of the crash box. A shell structure of conventional thin-walled crash box in a front bumper assembly is used to provide reference values of crashworthiness performance metrics and be compared with the optimum designs. In the first problem, a 15% lighter design with same energy absorption as the reference shell structure was obtained, whereas the second problem resulted in 9% mass savings with twice the performance, in terms of lower peak acceleration, as compared to the reference shell structure.

Keywords*: automotive crash box, energy absorption, peak acceleration, lightweight, topology optimization, crashworthiness*

1. Introduction

Designs of modern vehicles tend to be more crashworthiness-and-lightweight oriented than the conventional ones, so that the vehicles can simultaneously meet safety requirements and cost saving needs in material usage and fuel efficiency. Topology optimization for automotive crashworthiness is definitely an efficient technological means to provide best conceptual designs of automotive components (e.g. crash box, bumper beam, side rails, etc.) with balanced features of crashworthiness and lightweight. However, topology optimization for crashworthiness has been a challenging topic due to the highly nonlinear vehicle crash simulation and complex design optimization synthesis [1]. The ultimate goal of topology optimization for automotive crashworthiness is to increase passenger safety (see e.g. [2] for criteria) and protect automobiles from serious damage during collisions, which is of great importance to the automotive industry in the early stage of automotive component design process.

Crash box is an important energy absorption component attached between the vehicle bumper structure and the side rail. It undergoes deformation in collision by absorbing kinetic energy through crash event. It plays an essential role in crashworthiness to improve the impact strength of the frontal bumper assembly and shield the occupants. In this paper, a topology optimization design for crashworthiness and lightweight is performed on a solid design part of the automotive crash box subject to high-speed collision using LS-TaSC v4.0 [3], in which the Projected Subgradient algorithm [6] incorporating the solid/void strategy and multipoint approach is used to solve dynamic response constrained optimization problems [4, 5]. With the LS-TaSC interface, two different optimization problems are formulated and solved: (1) mass minimization with a constraint on energy absorption ability of the crash box, and (2) mass minimization with a constraint on peak acceleration at the back end of the crash box. A shell structure of conventional thin-walled crash box in a front bumper assembly is used to provide reference values of crashworthiness performance metrics (i.e. constraint bounds) and its crashworthiness performance is compared with that of the optimum designs.

2. Baseline Design

The LS-DYNA finite element model of the baseline design consists of bumper assembly of four parts: bumper beam, intermediate support bracket, crash box, and support plates. Symmetric boundary conditions are defined on the bumper beam to reduce computational cost. The crash box was selected as the design part for optimization. The initial design of the crash box was modeled as a solid block to start with a minimal design and to allow sufficient design space for the optimizer to obtain a more complicated structure. The bumper assembly is impacted against a rigid wall at a velocity of 30 mph. The baseline finite element model of the bumper assembly is shown in Figure 1 as below.

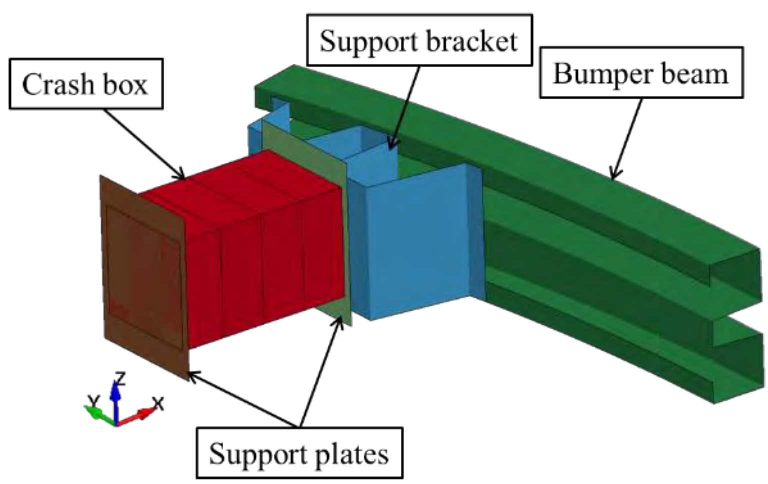


Figure 1: Baseline bumper assembly with solid design part (crash box)

A reference bumper assembly with the crash box modeled with shell elements is used for comparison of the optimum design. The baseline design and reference shell structure at time t=0 ms and t=20 ms are shown in Figure 2.

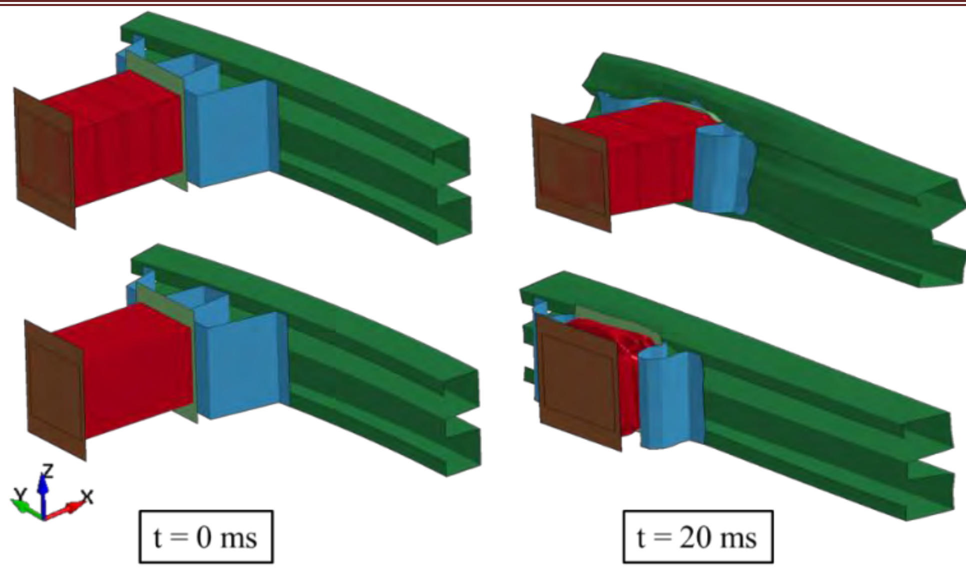


Figure 2: Frontal crash of bumper assembly with solid crash box (top) and reference shell structure (bottom).

The maximum energy absorption and peak acceleration of the shell structure are used as reference constraint bounds for optimization. Therefore, an optimum material layout with minimum mass should be obtained without exceeding the constraints set using the reference shell model. The mass, maximum internal energy, and peak acceleration of the reference shell structure are 1.54 kg, 52 KJ, and 10 mm/ms^2, respectively.

3. Problem Formulation using Multi-point Method

The multi-point method in LS-TaSC is unique to vehicle crash application with dynamic response constraints. The mathematical formulations of the multi-point method are defined as below with a two-fold optimization problem. The global problem is defined as,

$$\min_{\boldsymbol{\xi}} f(\boldsymbol{\xi})\ with\ \boldsymbol{\xi} = (M_1, M_2, \dots M_p, w_1, w_2, \dots w_L)$$

$$\text{s.t.}\quad g_c^{low} \leq g_c(\boldsymbol{\xi}) \leq g_c^{up},\ with\ c = 1, \dots, C \tag{1}$$

$$\xi_i^{low} \leq \xi_i \leq \xi_i^{up}\ \textit{(variable move limits)}$$

with the global variables M and w as mass fractions and load case weights, while f and g_c can be any objective or design constraint. The local problem with topology variables is formulated as,

$$\min_{\mathbf{x}} \quad E(\boldsymbol{\xi}, \mathbf{x})$$

$$\text{s.t.}\quad \sum_{i=1}^{N} \rho(x_i) V_i = M^*, \tag{2}$$

$$x_{min} \leq x_i \leq 1.0$$

with E the energy state of the structure, M^* is target mass fraction, and x_i is element density of element 'i'.

In the above two optimization formulations, the local problem is formulated to solve for the load path, and the global problem aims to satisfy the design constraints. The global problem takes part mass fractions and load case weights as global design variables, and the sensitivity of design constraints with respect to these global variables can be evaluated using meta-model approximations in LS-OPT® or finite difference methods implemented in LS-TaSC. With the sensitivities, the part mass fractions and load case weights for the next iteration are updated. The local problem takes elemental densities as design variables and work done by the structure as the objective to yield a minimum compliance design. The topology optimization problem is solved using the Projected Subgradient method [6].

To handle local constraints such as displacement or acceleration effectively it is recommended to split the design part into multiple parts for a better approximation. Therefore, in this study, the solid crash box was split into four design parts along the longitudinal axis such that sensitivity of the constraints can be evaluated using four global mass fraction variables. It is important to note that higher the number of global variables, higher the computation cost associated with constrained optimization using multi-point method.

4. Topology Optimization of Crash Box

Two studies on topology optimization of crash box are conducted using LS-TaSC 4.0: (1) mass minimization with a constraint on energy absorption ability of the crash box, and (2) mass minimization with a constraint on peak acceleration at the back end of the crash box. Detailed parameter settings and computation procedures defined using LS-TaSC 4.0 user interface are shown in the following sections.

4.1 Design Problem 1: Minimize mass with an energy absorption constraint

The goal of the first optimization study is to obtain the best material layout with reduced mass but with at least same maximum energy absorption as the reference shell structure. The optimization problem is formulated as,

$$\begin{cases} \min_{\mathbf{x},\boldsymbol{\xi}} & mass \\ \text{s.t.} & E \geq E^* \end{cases} \tag{3}$$

where $\mathbf{x}$ is design variable vector of relative element densities, $\boldsymbol{\xi}$ is design part mass fractions, E is total maximum internal energy of the design parts, and E^* is the maximum internal energy of the reference shell structure, which is E^* = 52 KJ.

The baseline bumper assembly model is imported into LS-TaSC user interface and the four design parts of the crash box are selected as design domain for optimization. Definitions and setup for the design parts in LS-TaSC GUI are shown in Figure 3. To assist with progressive axial crush of the crash box, the four design parts are assigned with varying initial part mass fractions of 0.4, 0.3, 0.2, and 0.1 along the longitudinal axis with 0.4 at the front (part in pink shown in Figure 3). Moreover, symmetric geometrical constraints are defined in XZ and YZ planes to yield a symmetrical structure.

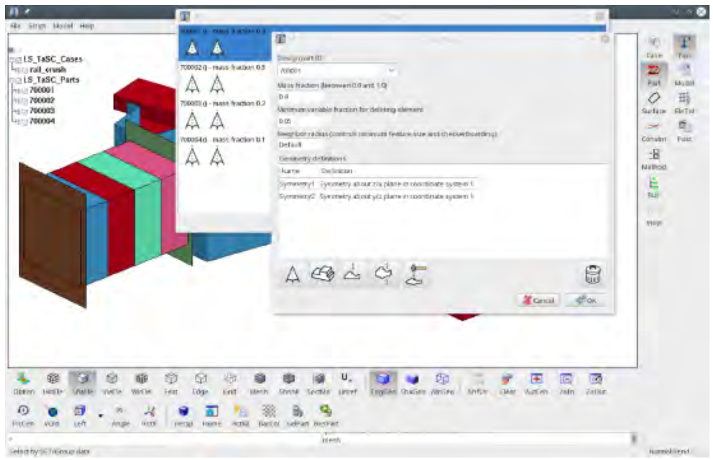


Figure 3: Design part definitions in LS-TaSC GUI

The total maximum internal energy of the four design parts extracted from LS-DYNA is normalized with the maximum internal energy of the reference shell structure. Therefore, the lower bound of the normalized internal energy constraint is set as 1.0. The optimization problem setup and constraint definitions in LS-TaSC GUI are shown in Figure 4.

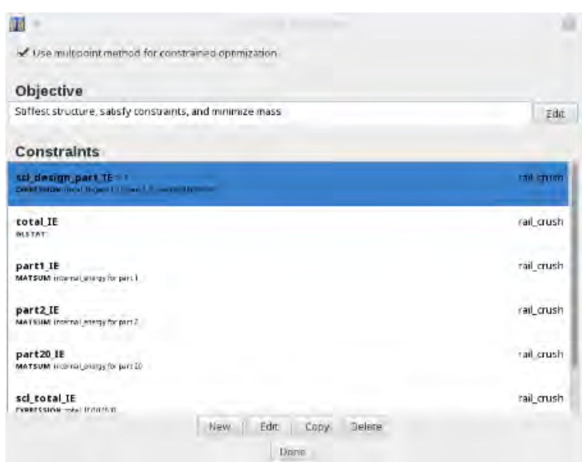


Figure 4: Objective and constraint definitions in LS-TaSC GUI

Projected sub-gradient method is selected as optimization algorithm in LS-TaSC with termination criteria of 40 iterations and solidification factor of 0.98 (i.e. topology optimization is converged when 98% of the structure is either solid or void). The constraint design sensitivities are evaluated using central difference method. Since there are four global variables, each design sensitivity analysis iteration requires 9 LS-DYNA runs to conduct the central difference computation. However, to reduce the overall computation cost, constraints sensitivities are evaluated starting from iteration 5 and at the third subsequent iteration. The optimization algorithm settings and multi-point options in LS-TaSC GUI are shown in Figure 5.

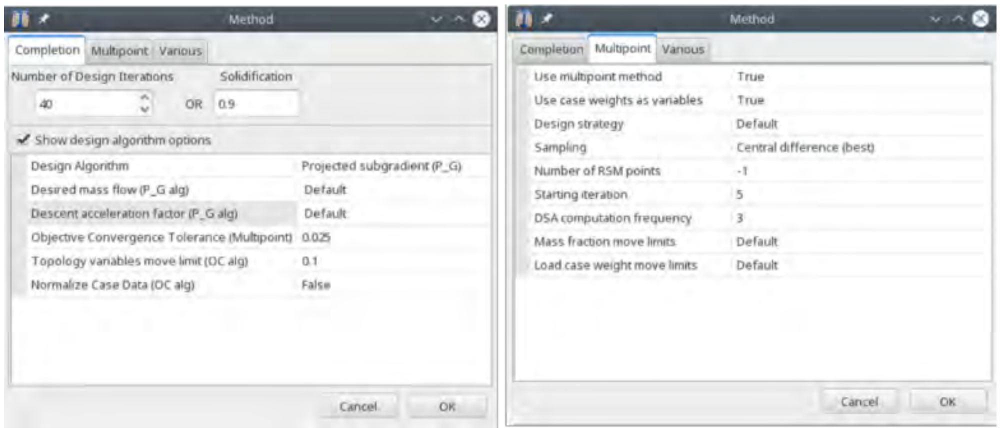


Figure 5: Optimization algorithm and constraint sensitivity settings in LS-TaSC GUI

The optimization converged in 34 iterations, requiring a total of 114 LS-DYNA runs of which 81 runs were required to evaluate constraint sensitivities. The optimum structure of the crash box has the same maximum energy absorption ability as the reference shell structure, and has a total mass of 1.31 kg, which is 15% less than that of reference shell structure. The optimum topology of the crash box is shown in Figure 6.

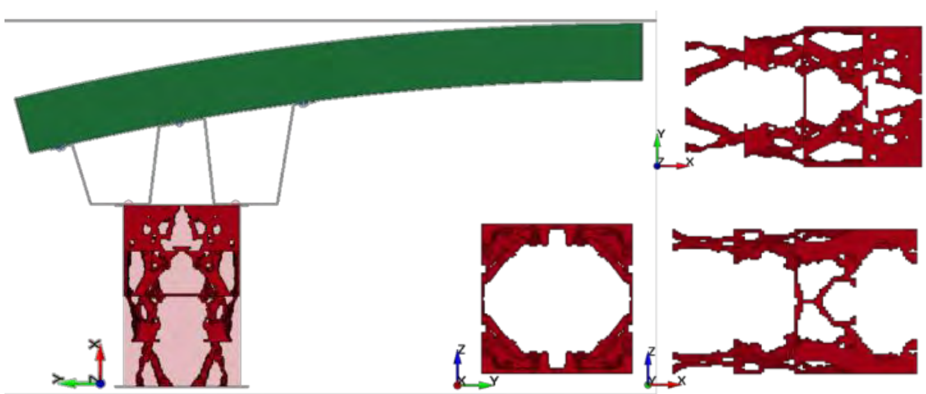


Figure 6: Top view of the bumper assembly and optimum crash box with initial design as transparent overlay (left), optimum design at different views (right).

The comparison of energy absorption of the design parts and peak acceleration extracted at center node of the rear rigid support plate with respect to the reference shell crash box is shown in Figure 7. The deformations of bumper assembly with the optimum crash box at different time step and its comparison with reference shell structure are shown in Figure 8.

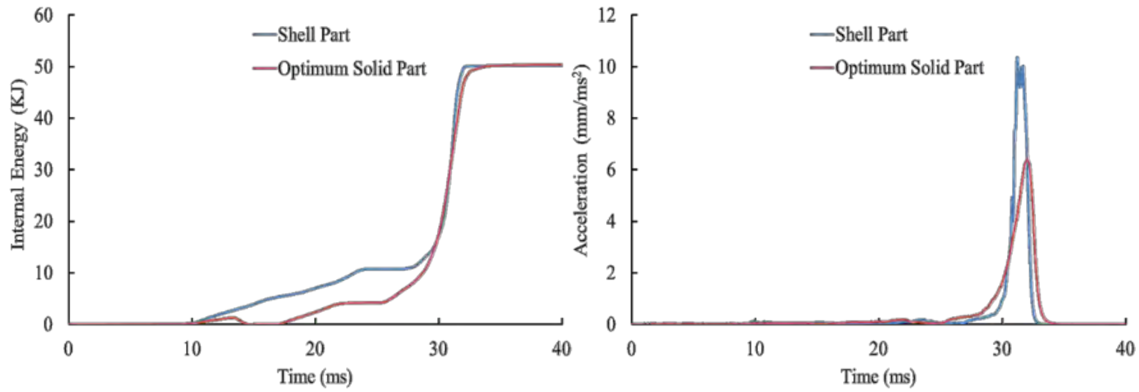


Figure 7: Comparison of Internal energy (left) and peak acceleration (right) of optimum design with reference shell structure.

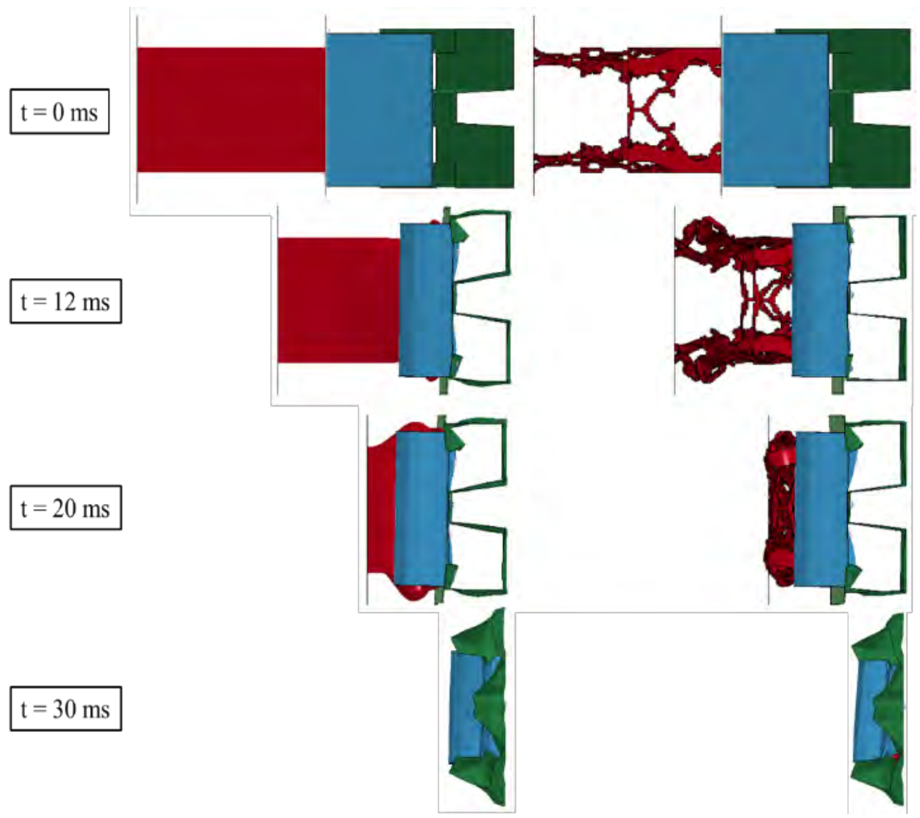


Figure 8: Deformation of bumper and crash box assembly using reference shell design part (left) and optimum solid part (right).

The results show that the optimum structure of crash box is lighter and produced much smaller peak acceleration at the support plate than the shell structure subject to the same high-speed impact. The variation of mass fractions in different design parts of the optimum structure yields varied stiffness in each part, but overall it enables the whole crash box to absorb as much crash energy as possible during the progressive collapse. Note that the energy absorption is maximized for the crash box only – the energy in the system remains constant at $1/2mv^2$.

4.2 Design Problem 2: Minimize mass with peak acceleration constraint

The goal of the second optimization study is to minimize mass of the crash box but with a constraint on the peak acceleration at the center of the rear rigid plate. In order to further improve the occupant safety in terms of the peak acceleration at the rear end of the crash box, the upper bound of the peak acceleration at the center of the rear plate is defined to be 50% of that from the reference structure. The global optimization problem is formulated as,

$$\begin{cases} \min\limits_{\mathbf{x},\boldsymbol{\xi}} \quad mass \\ \text{s.t.} \quad A \leq 0.5A^* \end{cases} \tag{3}$$

where $\mathbf{x}$ is design variable vector of relative element densities, $\boldsymbol{\xi}$ is design part mass fraction, A is the peak acceleration at the center of the rear rigid plate, and $A^* = 10$ mm/ms^2, is the peak acceleration at the center of the rear rigid plate produced from the reference shell structure. The optimization problem setup, algorithm, convergence criteria, and DSA settings are same as the previous problem.

The optimization terminated after 40 iterations with a solidification factor of 0.96. The optimized structure of the crash box has a mass of 1.40 kg, 9% less than that of the reference shell structure. The optimum topology of the crash box is shown in Figure 9. The comparison of energy absorption of the crash box and peak acceleration at the center of the rear plate from the optimum design with those from the shell structure is shown in Figure 10. In this study, the optimum design of crash box yields a maximum internal energy of 56 KJ and a peak acceleration value of 4.17 mm/ms^2 at the center of the rear plate, which indicates improved crashworthiness performances of the current optimum design than that of the previous design.

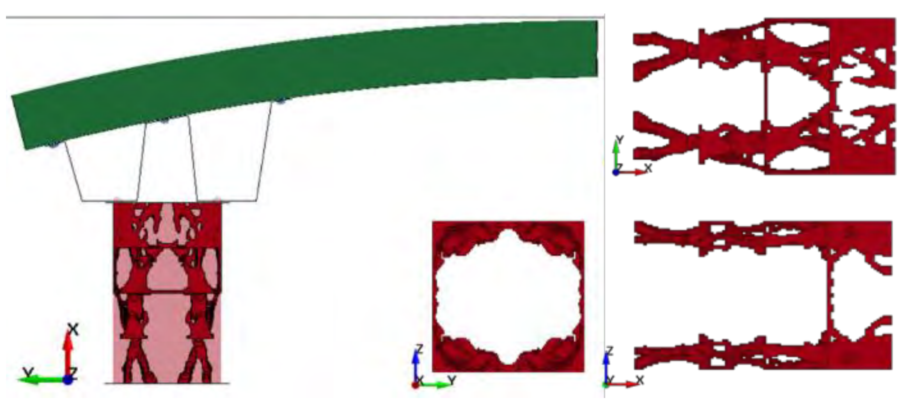


Figure 9: Top view of bumper assembly with optimum design of problem 2 with initial design as transparent overlay (left), optimum design at different views (right).

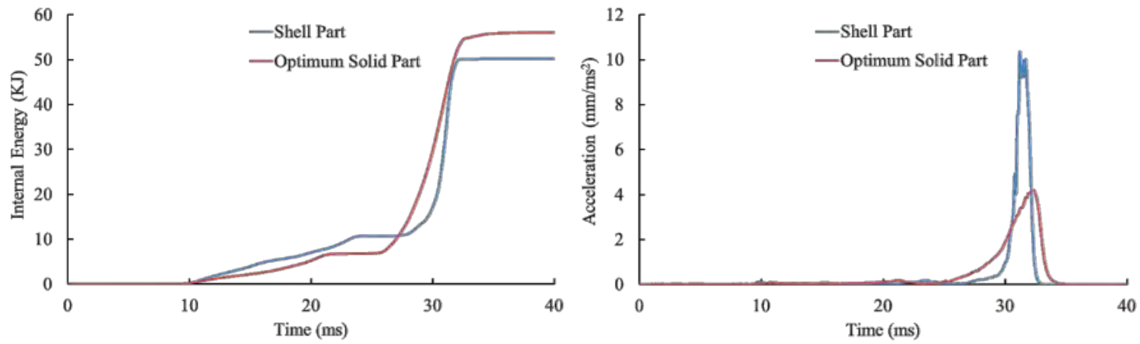


Figure 10: Comparison of energy absorption (left) and peak acceleration (right) of optimum design with reference shell structure.

Figure 11 shows the deformations of bumper assembly with the optimum crash box at different time step and its comparison with reference shell structure.

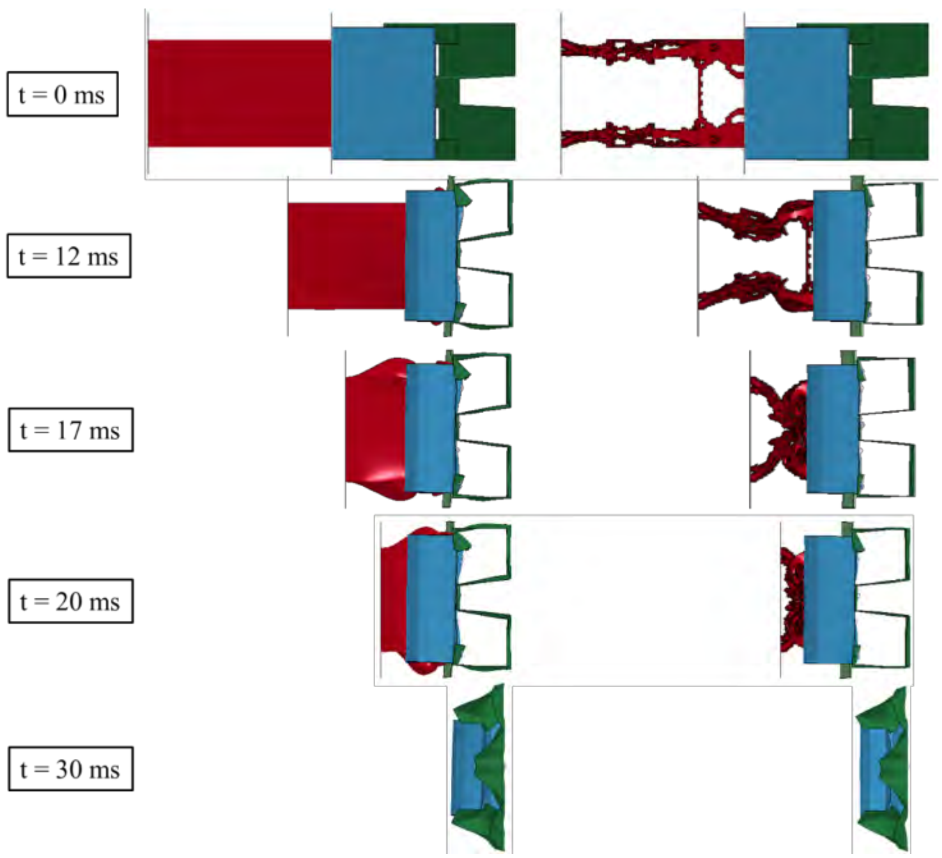


Figure 11: Deformation of bumper and crash box assembly using reference shell design part (left) and optimum solid part (right).

5. Conclusion

In this study, topology optimization of a crash box for crashworthiness and lightweight designs is conducted by solving two different optimization problems regulating the energy absorption and maximum accelerations properties. Both optimum designs obtained from two optimization problems yield lighter mass and better crashworthiness performances than the conventional shell structure of crash box. This study demonstrates the capability of LS-TaSC in addressing constrained automotive crashworthiness optimization problems. As part of further study, topology optimization of automotive components with multi-disciplinary constrains subject to crash and NVH load cases can be also conducted and solved. Moreover, a multi-level optimization strategy of LS-TaSC incorporating LS-OPT can be applied to solve complex topology optimization problems with single or multiple constraints for automotive crashworthiness and lightweight design applications.

6. Acknowledgement

The authors thank Mr. Dilip Bhalsod for providing the original model of the bumper assembly.

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Fact Sheet: http://www.materials-sciences.com/dyna-factsheet.pdf

- MSC and LSTC have joined forces in developing this powerful composite dynamic analysis code.
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- The integration of this module, known as 'MAT 161', into LS-DYNA allows users to account for progressive damage of various fiber, matrix and interply delamination failure modes.
- Implementing this code will result in the ability to optimize the design of composite structures, with significantly improved survivability under various blast and ballistic threats.

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Distribution & Support: Hengstar distributes and supports LS-DYNA, LS-OPT, LS-Prepost, LS-TaSC, LSTC FEA Models; Hongsheng Lu, previously was directly employed by LSTC before opening his distributorship in China for LSTC software. Hongsheng visits LSTC often to keep update on the latest software features.

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- A Hybrid model: Where modeling is done on desktop with solve, visualization and collaboration done in the cloud through a web browser.

Virtual Performance Solution:

ESI Cloud offers ESI's flagship Virtual Performance Solution (VPS) for multi-domain performance simulation as a hybrid offering on its cloud platform. With this offering, users can harness the power of Virtual Performance Solution, leading multi-domain CAE solution for virtual engineering of crash, safety, comfort, NVH (noise, vibration and harshness), acoustics, stiffness and durability.

In this hybrid model, users utilize VPS on their desktop for modeling including geometry, meshing and simulation set up. ESI Cloud is then used for high performance computing with an integrated visualization and real time collaboration offering through a web browser.

The benefits of VPS hybrid on ESI Cloud include:

- Running large concurrent simulations on demand
- On demand access to scalable and secured cloud HPC resources
- Three tiered security strategy for your data
- Visualization of large simulation data sets
- Real-time browser based visualization and collaboration
- Time and cost reduction for data transfer between cloud and desktop environments
- Support, consulting and training services with ESI's engineering teams

VPS On Demand

ESI Cloud features the Virtual Performance Solution (VPS) enabling engineers to analyze and test products, components, parts or material used in different engineering domains including crash and high velocity impact, occupant safety, NVH and interior acoustics, static and dynamic load cases. The solution enables VPS users to overcome hardware limitations and to drastically reduce their simulation time by running on demand very large concurrent simulations that take advantage of the flexible nature of cloud computing.

Key solution capabilities:

- Access to various physics for multi-domain optimization
- Flexible hybrid model from desktop to cloud computing
- On demand provisioning of hardware resources
- Distributed parallel processing using MPI (Message Passing Interface) protocol
- Distributed parallel computing with 10 Gb/s high speed interconnects

Result visualization

ESI Cloud deploys both client-side and server-side rendering technologies. This enables the full interactivity needed during the simulation workflow along with the ability to handle large data generated for 3D result visualization in the browser, removing the need for time consuming data transfers. Additionally ESI Cloud visualization engine enables the comparisons of different results through a multiple window user interface design.

Key result visualization capabilities:

- CPU or GPU based client and server side rendering
- Mobility with desktop like performance through the browser
- 2D/3D VPS contour plots and animations
- Custom multi-window system for 2D plots and 3D contours
- Zooming, panning, rotating, and sectioning of multiple windows

Collaboration

To enable real time multi-user and multi company collaboration, ESI Cloud offers extensive synchronous and asynchronous collaboration capabilities. Several users can view the same project, interact with the same model results, pass control from one to another. Any markups, discussions or annotations can be archived for future reference or be assigned as tasks to other members of the team.

Key collaboration capabilities:

- Data, workflow or project asynchronous collaboration
- Multi-user, browser based collaboration for CAD, geometry, mesh and results models
- Real-time design review with notes, annotations and images archiving and retrieval
- Email invite to non ESI Cloud users for real time collaboration

Distribution, Consulting

Canada	**Metal Forming Analysis Corp MFAC**		galb@mfac.com		
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	LS-DYNA	LS-OPT	LS-PrePost	LS-TaSC	
	LSTC Dummy Models	LSTC Barrier Models	eta/VPG		
	eta/DYNAFORM	INVENTIUM/PreSys			

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	ANSYS/LS-DYNA		

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China	**Shanghai Fangkun Software Technology Ltd.**		
	www.lsdyna-china.com		
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Taiwan	**Flotrend**			
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	www.simware.com.tw			
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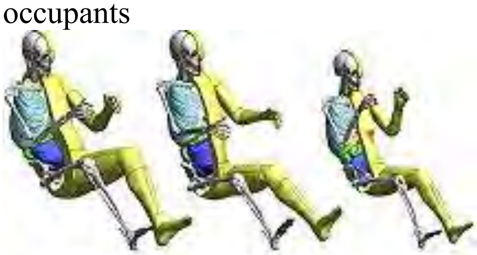
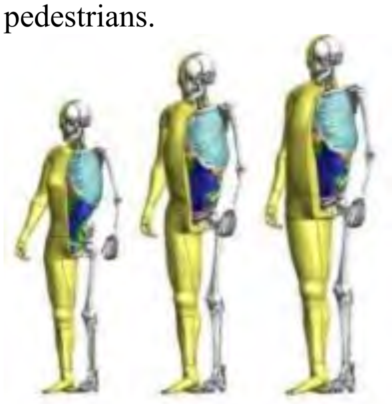
TOYOTA - Total Human Model for Safety – THUMS

The Total Human Model for Safety, or THUMS®, is a joint development of Toyota Motor Corporation and Toyota Central R&D Labs. Unlike dummy models, which are simplified representation of humans, THUMS represents actual humans in detail, including the outer shape, but also bones, muscles, ligaments, tendons, and internal organs. Therefore, THUMS can be used in automotive crash simulations to identify safety problems and find their solutions.

Each of the different sized models is available as sitting model to represent vehicle occupants



and as standing model to represent pedestrians.



The internal organs were modeled based on high resolution CT-scans.

THUMS is limited to civilian use and may under no circumstances be used in military applications.

LSTC is the US distributor for THUMS. Commercial and academic licenses are available.

For information please contact: THUMS@lstc.com

THUMS®, is a registered trademark of Toyota Central R&D Labs.

LSTC – Dummy Models

LSTC Crash Test Dummies (ATD)

Meeting the need of their LS-DYNA users for an affordable crash test dummy (ATD), LSTC offers the LSTC developed dummies at no cost to LS-DYNA users.

LSTC continues development on the LSTC Dummy models with the help and support of their customers. Some of the models are joint developments with their partners.

e-mail to: atds@lstc.com

Models completed and available
(in at least an alpha version)

- Hybrid III Rigid-FE Adults
- Hybrid III 50th percentile FAST
- Hybrid III 5th percentile detailed
- Hybrid III 50th percentile detailed
- Hybrid III 50th percentile standing
- EuroSID 2
- EuroSID 2re
- SID-IIs Revision D
- USSID
- Free Motion Headform
- Pedestrian Legform Impactors

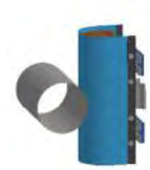
Models In Development

- Hybrid III 95th percentile detailed
- Hybrid III 3-year-old
- Hybrid II
- WorldSID 50th percentile
- THOR NT FAST
- Ejection Mitigation Headform

Planned Models

- FAA Hybrid III
- FAST version of THOR NT
- FAST version of EuroSID 2
- FAST version of EuroSID 2re
- Pedestrian Headforms
- Q-Series Child Dummies
- FLEX-PLI




LSTC – Barrier Models

Meeting the need of their LS-DYNA users for affordable barrier models, LSTC offers the LSTC developed barrier models at no cost to LS-DYNA users.

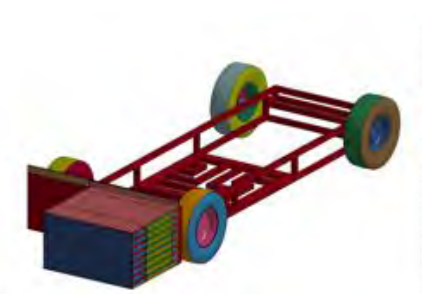
LSTC offers several Offset Deformable Barrier (ODB) and Movable Deformable Barrier (MDB) models:

- ODB modeled with shell elements
- ODB modeled with solid elements
- ODB modeled with a combination of shell and solid elements
- MDB according to FMVSS 214 modeled with shell elements
- MDB according to FMVSS 214 modeled with solid elements
- MDB according to ECE R-95 modeled with shell elements
- AE-MDB modeled with shell elements
- IIHS MDB modeled with shell elements
- IIHS MDB modeled with solid elements
- RCAR bumper barrier
- RMDB modeled with shell and solid elements

LSTC ODB and MDB models are developed to correlate to several tests provided by our customers. These tests are proprietary data and are not currently available to the public.

All current models can be obtained through our webpage in the LSTC Models download section or through your LS-DYNA distributor.

To submit questions, suggestions, or feedback about LSTC's models, please send an e-mail to: atds@lstc.com. Also, please contact us if you would like to help improve these models by sharing test data.



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