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Issue 11, November 2020

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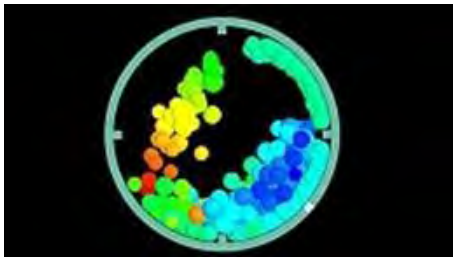

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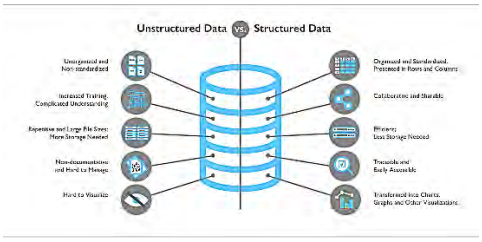

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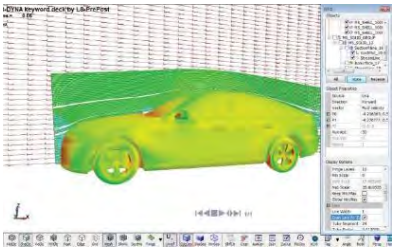

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- Recent Developments in Time Domain Fatigue Analysis with LS-DYNA®

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LS-TaSC (Topology), Dummy & Barrier models and
Tire models for use in various industries.

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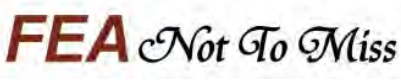

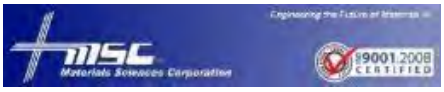

Table of contents

Announcements

We will cease the publication of FEA Information solution and the newsletter by January 2021. December 2020 will be the final issue of the FEA Information newsletter.

We sincerely thank all of our participants and readers over the 20 years of this publication. Our success is in part due to the support from all of you. We cannot thank you enough.

Going forward you can continue to access FEA related information and updates from ANSYS and our participants.

About ANSYS, Inc.

If you've ever seen a rocket launch, flown on an airplane, driven a car, used a computer, touched a mobile device, crossed a bridge or put on wearable technology, chances are you've used a product where ANSYS software played a critical role in its creation. ANSYS is the global leader in engineering simulation. Through our strategy of Pervasive Engineering Simulation, we help the world's most innovative companies deliver radically better products to their customers. By offering the best and broadest portfolio of engineering simulation software, we help them solve the most complex design challenges and create products limited only by imagination. Founded in 1970, ANSYS is headquartered south of Pittsburgh, Pennsylvania, U.S.A., Visit www.ansys.com for more information.

Ansys Website **Ansys Blog**

We would like to congratulate Marsha Victory, and the new magazine FEA Not To Miss Software & Engineering Solutions (website - www.feantm.com) for receiving their ISSN number. Marsha was editor of FEA Information but now is editor of FEANTM website and News (sign up) for continued coverage of Finite Element Analysis news.

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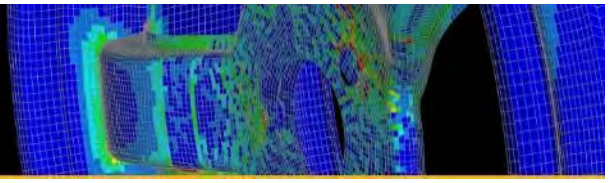
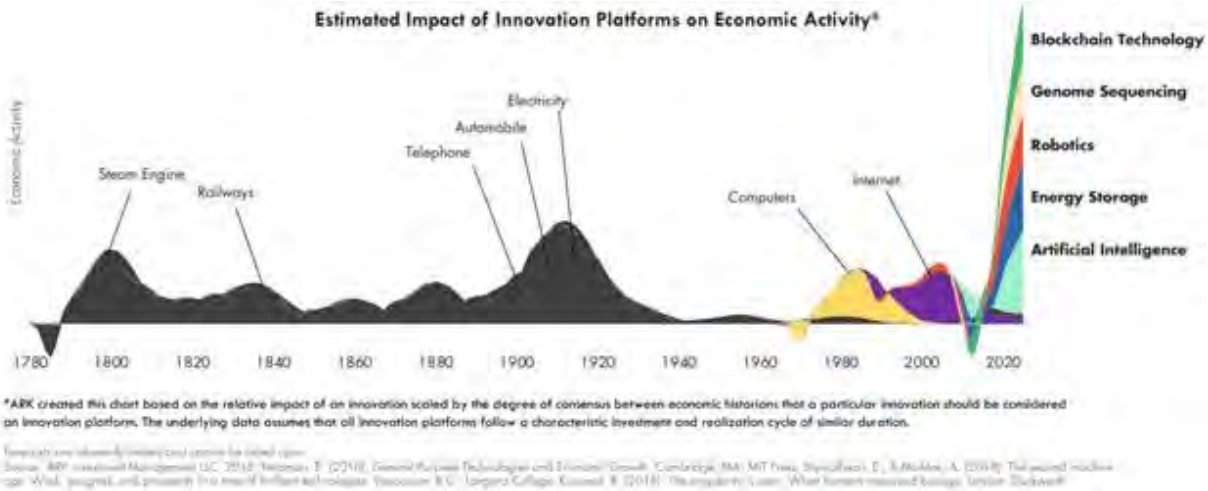
Ansys Blog



Published on November 2, 2020
by Tarun Tejpal
Automotive, Systems Engineering, Autonomous Vehicles, Virtual Prototyping, Digital Twin, Electric Vehicles

Simulating the Future of Transportation and Mobility

Today, after many decades of incredible innovation, technological innovation is expected to rise exponentially higher than ever before. This is no prediction. Today, ARK Investment Management calls out five platforms involving more than a dozen technologies that are causing the global economy to experience the largest technological transformation in history: blockchain, genome sequencing, robotics, energy storage and artificial intelligence.



Blockchain technology, genome sequencing, robotics, energy storage and artificial intelligence are multi-trillion-dollar platforms that are launchpads for more innovation, according to ARK Investment Management.

Technology does not advance in a vacuum. Change is driven by global urbanization trends, population growth, environmental concerns, government regulations, the threat of pandemics, a paradigm shift in working from home, the move to a zero-contact service industry and increased demand for more sustainability.

Megatrends Converge on Electric Vehicles and Autonomous Vehicles

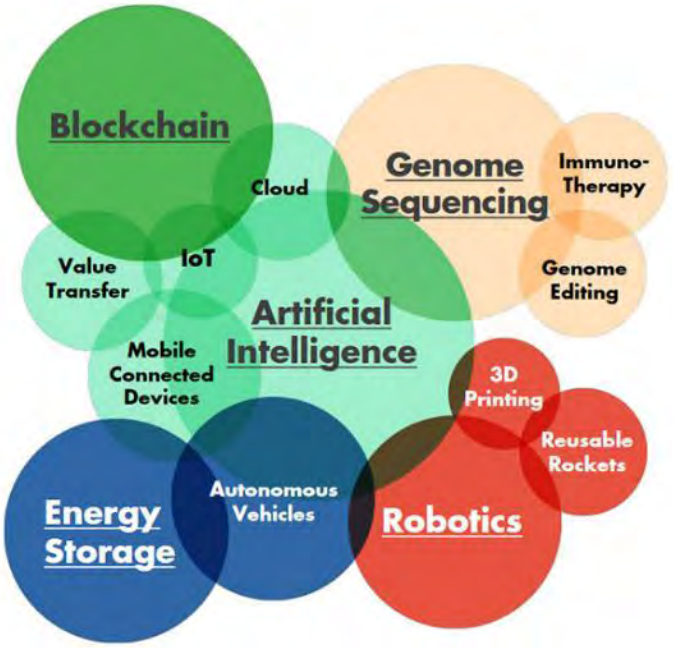
Consumers want a safer, personalized, connected, affordable, convenient, environmentally friendly and socially responsible mobility experience. Service providers need more efficiencies of scale as they comply with environmental and regulatory standards while reinventing their business models to compete with more agile startups. These factors are driving the business cases for electric and autonomous vehicles, autonomous air taxis, micro mobility, shared mobility, high-speed magnetic levitation trains and autonomous delivery with drones. They also drive the demand for many enablement technologies, such as 5G connectivity, cybersecurity, edge computing, cloud computing, hydrogen fuel cells, solar power, energy storage/distribution and advanced manufacturing with 3D printing and robotics.

"Technology has advanced more in the last 30 years than in the previous 2000. The exponential increase in advancement will only continue."

– Physicist Niels Bohr said this more than 50 years ago

These megatrends are putting tremendous pressure on the automotive industry to reinvent quickly and deliver differentiating mobility and transportation experiences, or risk being left behind. The industry is well aware that the differentiation will not come in the form of traditional vehicle hardware, but in the user experience. Much of that user experience is created with software and hardware that is relatively new to the automotive industry. To deliver the optimum user experience, the industry needs to innovate with advanced product design, simulation technologies and manufacturing capabilities.

This technological innovation is leading to an evolution of modern transportation systems that is one of the most critical business and societal challenges we are facing. The time for the mobility and transportation experience of the future driven by exponential innovation is here.



Five platforms for future innovation and the technologies they includeFive multi-trillion dollar platforms, according to ARK Investment Management.

Digital Design and Simulation Drive Exponential Innovation

Digital technologies are critical aspects of exponential innovation. Transitioning from a linear thinking process to an exponential thinking process is key. For example, imagine taking 30 linear steps. You would get about 30 meters. Now, imagine taking 30 exponential steps (1, 2, 4, 8, 16, 32, 64, 128, etc.). Do you know how far you would go? In the last step alone, you would go around the world 26 times!

Inventor and futurist Ray Kurzweil said it very well: "Our intuition about the future is linear. But the reality of information technology is exponential, and that makes a profound difference. If I take 30 steps linearly, I get to 30. If I take 30 steps exponentially, I get to a billion."

The Digital Twin at the Heart of Innovation

Today it is common for engineering teams creating a digital twin of a product or system to design, simulate and verify its behavior and performance in the real world in order to find weaknesses, failure points and limitations before manufacturing. This increases the quality, safety and durability of the physical product. If we follow the analogy of taking 30 linear steps between each design cycle of the digital twin, we will only innovate in a linear manner and take much more time to optimize the product. We also run the danger of not testing and optimizing all the possible scenarios and boundary conditions.

In the case of developing electric and autonomous vehicles, nearly 8 billion miles of road testing and safety engineering are required to ensure delivery of safe, reliable, durable, high-quality products at scale and at lower cost. So, linear innovation technologies and processes cannot deliver the future of transportation and mobility. Compounding improvements between each design and optimization cycle of the digital twin is critical. Leveraging the right digital transformation technologies and implementing the optimal processes on the digital twin of a product or system to achieve exponential innovation is critical to developing electric and autonomous vehicles.

With Ansys simulation technologies, designers have the power to explore multiple design possibilities by simulating all the physics of the digital twin at the same time and performing parametric optimization. Using a unified simulation environment that is CAD-agnostic on an open architecture, designers execute rapid feedback loops on fewer iterations to converge on the optimal design faster and deliver exponential innovation. As a result, with Ansys solutions, the automotive industry can achieve 1,000X faster testing while simultaneously engineering for safety to exponentially innovate and decrease time to market. Ansys simulation technologies give engineers the power to simulate billions of miles of virtual driving on a digital twin, which is critical for automotive original equipment manufacturers to test, verify and certify autonomous car designs.

Delivering the Future of Mobility with Ansys Simulations

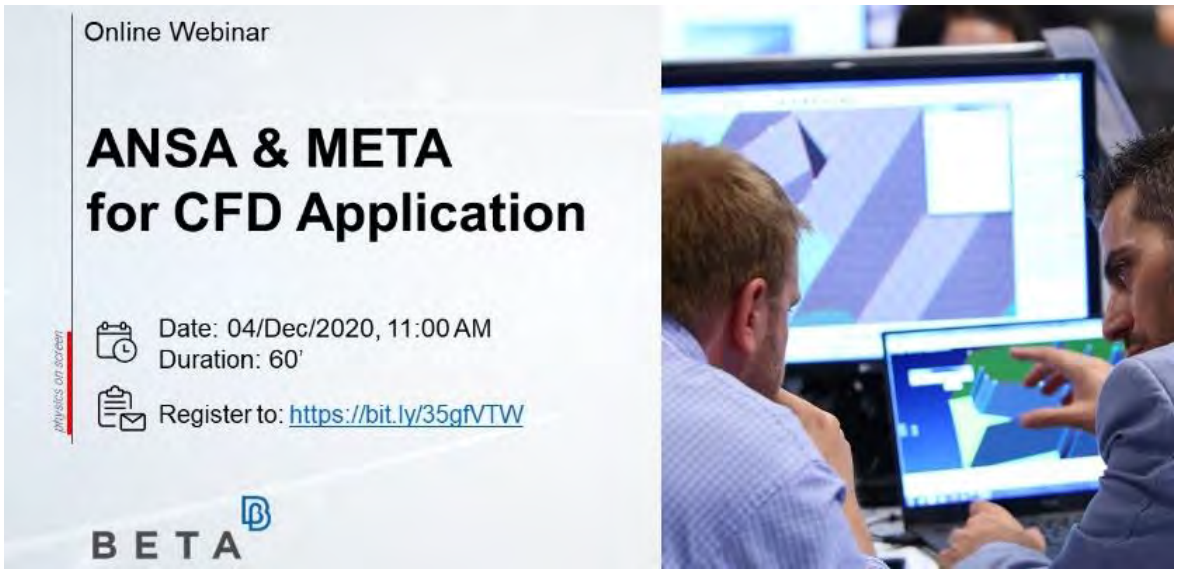
Simply put, the future of transportation and mobility cannot be delivered without simulation because engineers must be able to exponentially innovate. Companies such as Porsche, Cummins, Velodyne, GM, Red Bull Technology, CSO, Eaton, Meta System, Kodiak Robotics and Metawave are leveraging Ansys simulation solutions to innovate. Learn from them and from Ansys experts how to deliver the future of transportation and mobility at these two events:

- Ansys Mobility Tech Conference, November 12. Review the Mobility Tech Conference agenda and register here.
- Simulating the Mobility Experience of the Future, November 19. Review Simulating the Mobility Experience of the Future event and register here.

Read from website

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…

Online Webinar: ANSA and META for CFD Application



(Registration link: https://bit.ly/35gfVTW)

BETA CAE Systems India would like to invite you for a free CFD Webinar (WebEx) on 4th December 2020 at 11:00 am. The webinar will be for an hour duration, covering an insight into state-of-the-art method of pre and post processing CFD simulations.

All Managers, Engineers, and any interested Technical Staff can attend this Webinar on ANSA and META for CFD application.

ANSA pre-processor, with its powerful functionality provides high efficiency solutions for CFD applications. It is the choice of the leaders in CFD simulations in various sectors such as automotive, motorsports, and aerospace among others. Its capabilities meet the industries demanding needs for external and internal flow simulations, increase productivity and contribute to the high quality of CFD results.

META, the leading post-processor extends its support to CFD codes. META indisputable high-performance capabilities enable engineers to easily handle and explore extremely large and complex models.

About "B-webinars"

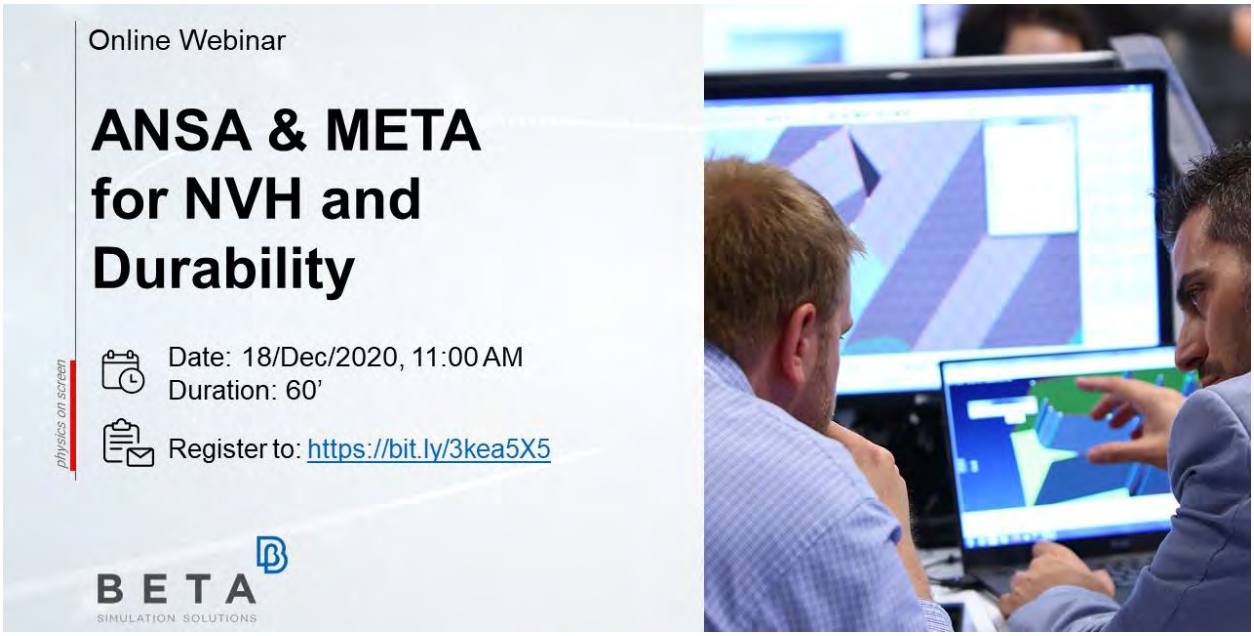
Beyond the numerous videos that we release every week, which allow you to enhance your knowledge upon demand, this is a new series of live webinar events.

The events comprise talks, presentations and demos, on topics related to the use and deployment of BETA software for solving demanding problems in computational engineering.

You are all welcomed to enjoy the webinars and take the most out of it by deepening your knowledge and broaden your horizons.

Learn more: https://www.beta-cae.com/training.htm#live_webinars

Online Webinar: ANSA and META for NVH and Durability



(Registration link: https://bit.ly/3kea5X5)

BETA CAE Systems India would like to invite you to a free NVH & Durability webinar on 18th December 2020 at 11:00 am. The webinar will be for an hour duration, covering an insight into state-of-the-art method of pre and post processing NVH simulations.

All managers, engineers, and any interested technical staff can attend this Webinar on ANSA and META for NVH & Durability application.

ANSA is a standard and robust solution for NVH & Durability pre-processing tasks that addresses the industry needs for process efficiency and simulation results reliability. It constitutes a complete platform covering equally and at the highest level of all pre-processing activities from CAD input to the output of a ready-to-run model. It efficiently supports all popular codes used at your facility.

META brings a new dimension to the NVH & Durability post-processing by successfully addressing the bottlenecks and constraints involved. It's optimized performance for graphics & memory usage along with a broad range of features and calculation options, makes it an efficient environment for handling results from all popular solvers, as well as real-life test data and can even be integrated in optimization processes for NVH & Durability post-processing requirements.

About "B-webinars"

Beyond the numerous videos that we release every week, which allow you to enhance your knowledge upon demand, this is a new series of live webinar events.

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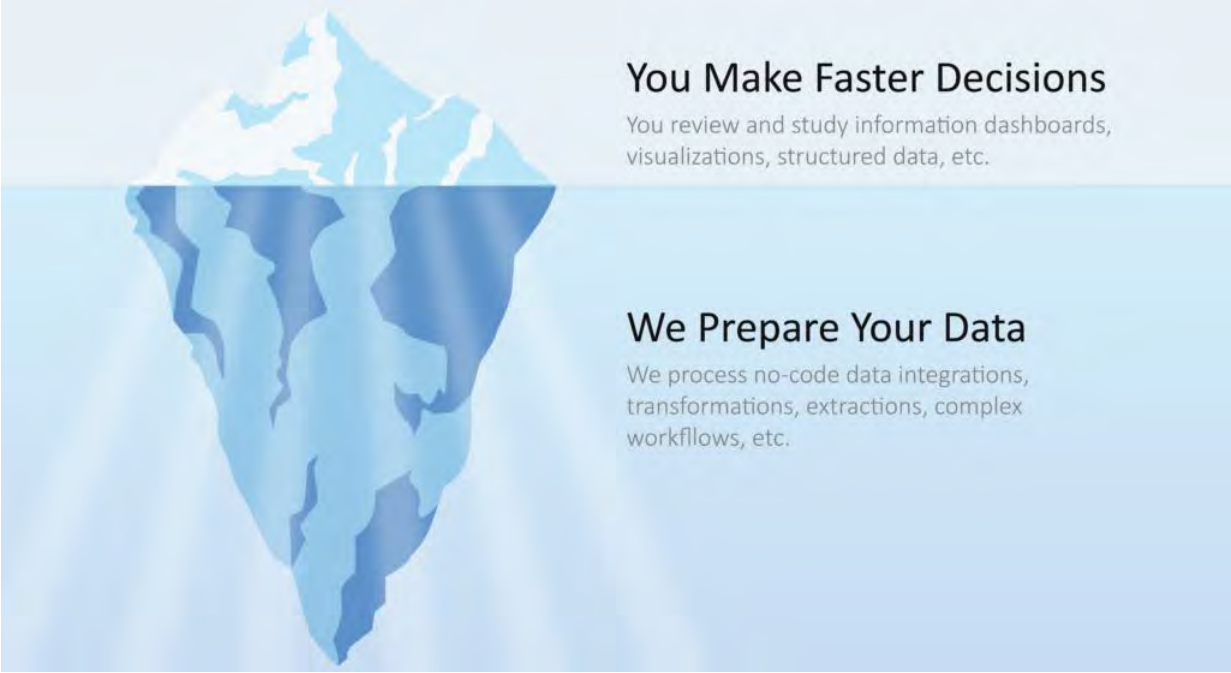
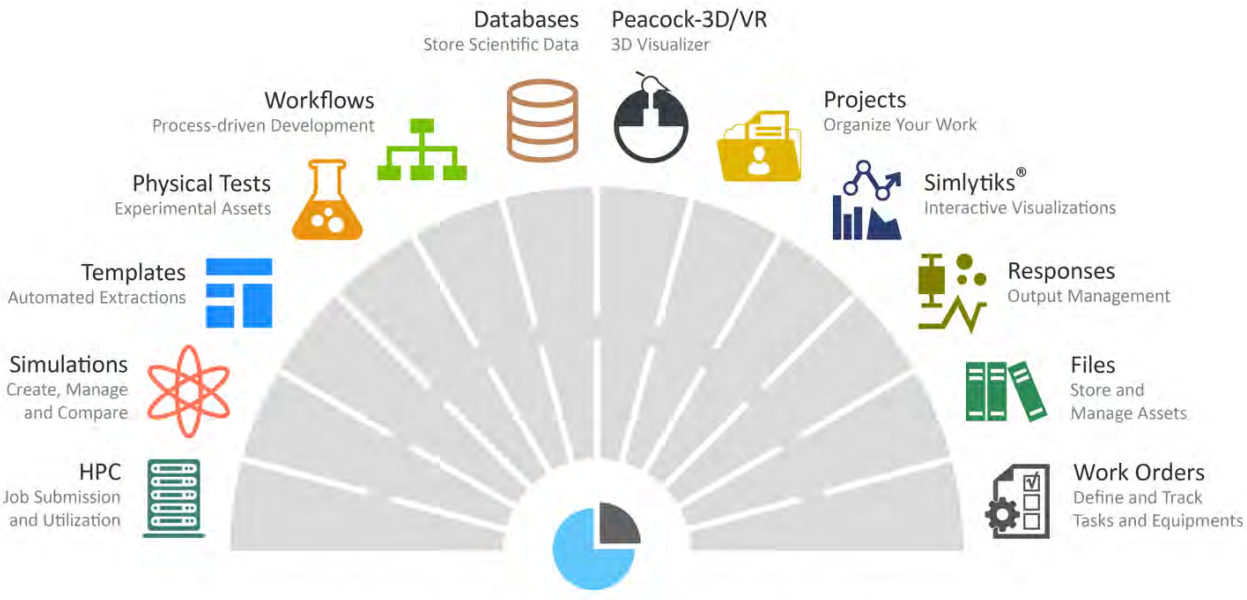
d3VIEW is a data to decision platform that provides out-of-the box data extraction, transformation and interactive visualizations. Using d3VIEW, you can visualize, mine and analyze the data quickly to enable faster and better decisions.





Multiple Applications, One Platform.

www.d3view.com | support@d3view.com

Author: Christian Frech christian.frech@dynamore.de

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DYNAmore Video Seminars
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The convenient video seminars allow you to take part at our courses on your own computer and according to your own time preferences. The trainings are video recordings of the on-site seminars or the webinars and correspond exactly to these in terms of content and scope. Please register via our website at www.dynamore.de/en/seminars.

Modeling Metallic Materials (New)
Scope: Part 1 - Isotropic Modeling: *MAT_024, *MAT_081, *MAT_251
Part 2 - Anisotropic Modeling: *MAT_036, *MAT_037, *MAT_133
Lecturer: Dr. Filipe Andrade (DYNAmore)
Date: anytime
Fee:400 Euro plus VAT
Registration: www.dynamore.de/en/vs20-03

LS-OPT Optimization (New)
Scope: corresponds to webinar
Lecturer: Katharina Liebold (DYNAmore)
Date: anytime
Fee: 200 Euro plus VAT
Registration: www.dynamore.de/en/vs20-04

LS-OPT Robustness (New)
Scope: corresponds to webinar
Lecturer: Katharina Liebold (DYNAmore)
Date: anytime
Fee: 200 Euro plus VAT
Registration: www.dynamore.de/en/vs20-05

Introduction to LS-DYNA
Scope: corresponds to 3 seminar days (11 chapters and 11 exercises)
Lecturers: Dr. Maik Schenke, Dr. Steffen Mattern (DYNAmore)
Date: anytime
Fee: 1,575 Euro plus VAT
Registration: www.dynamore.de/en/vs20-02

Crashworthiness Simulation with LS-DYNA
Scope: corresponds to 4 seminar days (15 chapters)
Lecturer: Paul Du Bois (Consultant)
Date: anytime
Fee: 2,400 Euro plus VAT
Registration: www.dynamore.de/en/vs20-01

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

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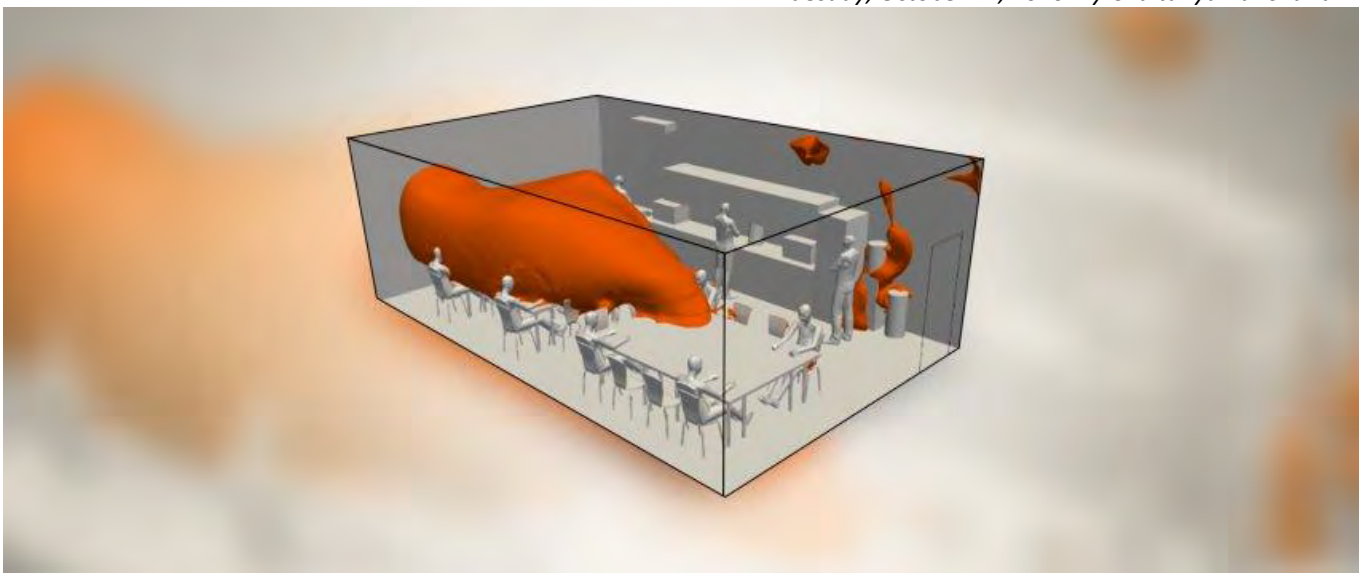
Return to Your Office with Confidence: Validation of the Safety of Workspaces

When our colleagues in India became concerned about going back to the office after COVID lockdowns were easing up, we decided what better use of our expertise than to reassure the worried minds of our fellow team members? Keep reading to find out how safe each space in your office place is.

Tuesday, October 27, 2020 By Chaitanya Kancharla



The world has been dealing with the COVID-19 pandemic for several months now. While some countries have managed to flatten the curve, others are still struggling to control transmission. Regardless of the state of the curve, many nations are faced with tough decisions related to safely reopening the economy to save their countries from financial depression. While normalcy seems like a distant possibility, many essential workers have come to terms with going back to work and risk getting infected.

Like other companies, ESI has mandated precautions and strives to implement safety procedures intended to control and prevent the virus from spreading. While these measures are a good starting point, our team in India felt the need to evaluate how effective they really would be at ensuring the safety of their workplace and their colleagues.

The Coronavirus crisis, which we have all been experiencing for several months, is distressing a lot of habits and has resulted in new issues to be addressed by companies. Employee safety has always been key, but when the danger is invisible and circulating in the air, the topic appears to be more complicated. Just like other industrial and technological players, we seek to provide as many people as possible with solutions to help rebuild, secure, and reassure. Simulation is an ideal tool that enables testing a large range of scenarios without endangering anyone – which is exactly what we did to reassure our very own employees. Our expertise allowed us to create realistic scenarios of droplet behavior in enclosed and ventilated spaces. We are pleased to provide our input and to continue being faithful to our values: being as close as possible to our customers to help them achieve their goals, including the most challenging ones, and to always work in the best interest of our own people as 'One ESI'.

Modern offices are designed to ensure that they protect people from external elements like pollution and dust to maintain an atmosphere that is comfortable for its occupants. Unfortunately, this also means less direct ventilation. If fresh air is introduced, it can be done only through the central air conditioning system, which is always mixed with return air for energy efficiency. A configuration like this is good for both the occupants and the climate as it reduces the energy consumed by the air conditioning systems. However, these modern workspace designs fail to consider and address risks such as the spread of a virus, as such scenarios were not the primary concern.

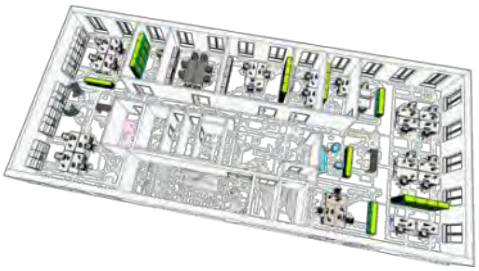


Fig. 1 Rendering of a typical office space

According to the World Health Organization (WHO), COVID-19 is an airborne disease. Naturally, this raises concerns over the safety of workspaces and triggers the following questions:

- How safe is my workspace?
- Do air conditioning systems spread the virus?
- How effective is ventilation (windows, doors, etc.)?
- What happens in a factory environment?

The list goes on.

Our engineers got to work on this right away, digging into how simulation can address these concerns for others and for their own colleagues. They replicated various real-life scenarios and conducted virtual tests to locate the areas in the given workspaces that are relatively safe to occupy; this means learning about the air movement pattern and how it can be controlled.

They considered the following scenarios:

- No ventilation (without air-conditioning)
- With air-conditioning
- With ventilation

To represent a typical office or factory scenario, we considered individual office spaces, a common work area, a kitchen/dining area, and an assembly line.

Individual Office Cabin Simulation

Naturally, personal offices are high on the list of problematic workspaces. Some might think of their office as a haven, closing the door and hoping visitors stay at bay. On the other hand, a small, closed-off area could raise fears of lingering germs lying dormant in the stagnant airspace. So, how safe are we really and how safe are the people visiting our space?

To make the simulation setup realistic, we used one of our own office layouts, replicating the HVAC ducts exactly. We considered flow rates in line with actual flow rates.

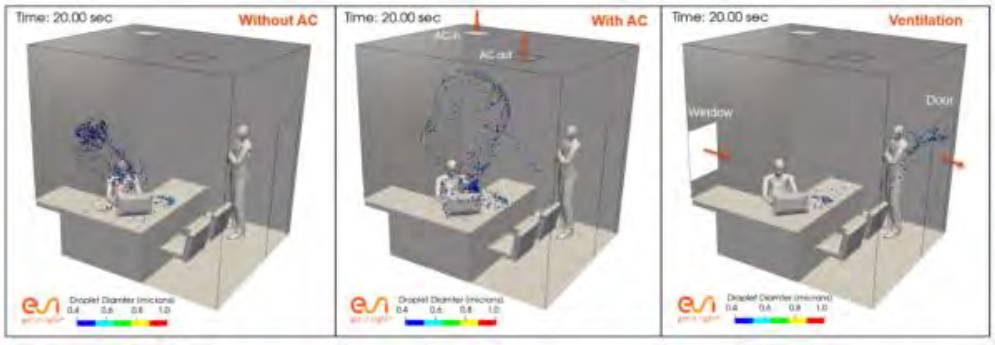


Fig. 2 Cabin cough simulations scenarios | Without AC | With AC | With Ventilation

We based this simulation on the cough of a person walking into the office (the person standing). The cough was modeled considering the density of water vapor, the theoretical distribution of cough particles, the number of cough particles, as well as their velocity based on actual test data [1]. The natural air movement from the open window in the ventilation model (far right, Fig. 2) was modeled with a wind velocity of 0.5 m/s, consistent with a light breeze.

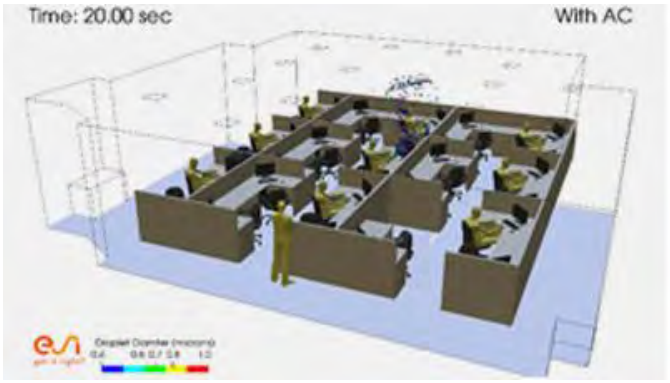
In the ventilation model, most of the particles drifted away from the cabin 20 seconds after the cough because of the natural ventilation (open window & door).

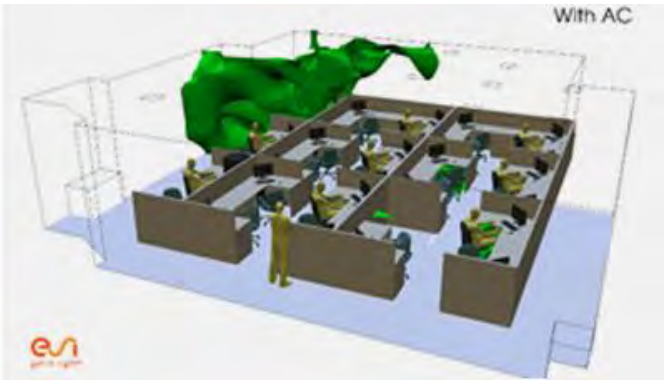
The simulation with air-conditioning (center image, Fig. 2) also yielded encouraging results: the return duct succeeded in attracting particles towards it, as particles are very light averaging around 1 microgram. An even closer look reveals that most of the light particles are sucked into the return duct, which suggests that adding a filter to catch them after they enter the duct would be a probable solution (since most central air-conditioning units run on partial recirculation mode). Filters can be changed often, however, there will be additional pressure drops across these filters, so the power consumption may increase slightly.

Finally, the simulation with no air conditioning, meaning little movement or stagnant air, proves to be the worst-case scenario. The particles float around the room even after several minutes.

Open Work Area Simulation

Open workspaces or cubicles are typically the most populated areas in the office. They also tend to be large with little to no ventilation opportunities. Due to the current social distancing norms, we modeled this scenario with only one person in each cubicle.





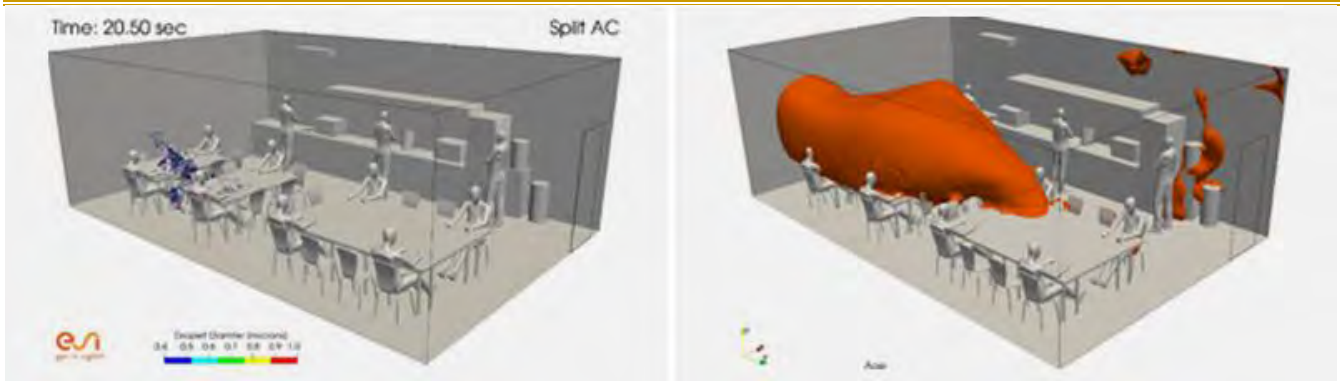
Left: Fig 3. Cough particles in a cubicle setting; Right: Fig 4. Stagnant air (green ISO surface)

Fig. 3 shows us that it is very difficult to draw inferences from this scenario. As the particles are small (only a few microns) and light, they are easily carried by air currents and make their way any and everywhere. Except for the pockets where air stagnates, most of the floating particles will eventually make it to a return duct. Therefore, the consensus would be to avoid these areas of stagnating air and consider new seating arrangements.

The ISO surface shown in Fig. 4 (the envelope of air the same age as initial air in the environment) indicates the area where there is the least amount of fresh air; in other words, the areas where the age of the air is relatively higher. These areas should also be avoided.

The Shared Kitchen

The kitchen/dining area might be the most feared space in today's current climate as people can't depend on masks to protect them while enjoying a meal.



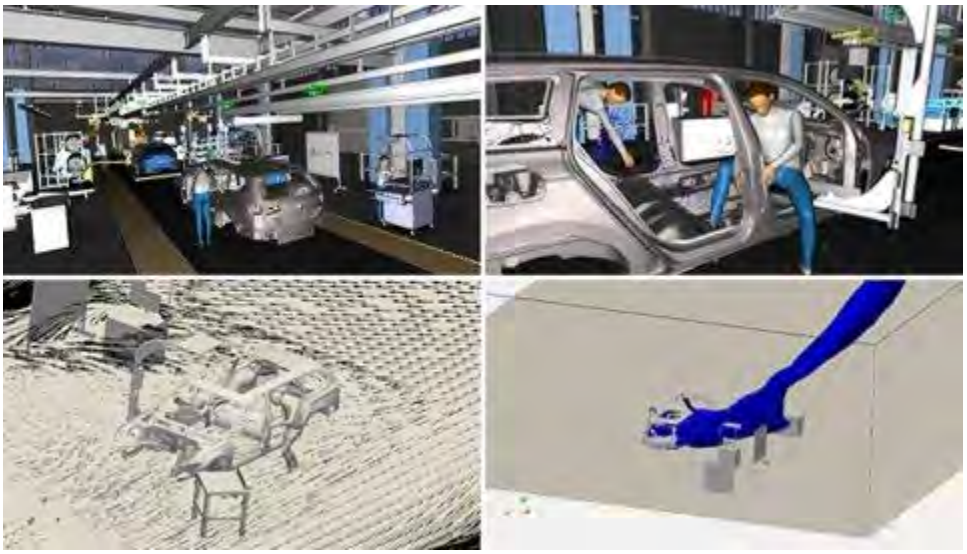
Left: Fig 5. Cough particles in a cafeteria; Right: Fig 6. Stagnant air (orange ISO surface)

As explained in the open work area, the iso-surface in Fig. 6 clearly shows the stagnant pockets of air that should be avoided while seated.

The Assembly Line

After running several simulations to reassure our employees in India about how to safely return to the office, we come to, perhaps, the most essential area for all manufacturing companies or OEMs – the assembly line. How could the industry safely send their teams back to work?

The assembly line is where most goods are produced, some of which are essential to our survival. Assembly lines are usually an enclosed, large space where air movement is bound to be non-uniform due to obstructions and partitions, etc. Also, these spaces are typically dynamic environments, with people moving around, machines running, and parts & components being passed around, which makes social distancing extremely challenging.



Top left: Fig. 7 Assembly line, Image courtesy of Volkswagen; Top right: Fig 8: Assembly line cough Simulation, Image courtesy of Volkswagen; Bottom left: Fig 9: Image showing air velocity vectors; Bottom right: Fig 10: Image showing air velocity vectors

For this simulation, we mimicked a standard automotive assembly line where there is a lot of heavy lifting and movement throughout the day. This also typically means heavy breathing, which can make a person more susceptible to either

transmit or receive the virus than the average person, and while performing especially physically demanding jobs, wearing a mask may not be advisable.

The simulation considered a scenario where two people are working on a car's chassis. The ambient conditions contained powerful drafts of air coming from the blowers. Under these conditions, we simulated one person coughing to assess the spread of particles.

Even in this simulation, the ISO surface in Fig. 11 shows the amount of stagnant air, which should be avoided at all costs. Air velocity vectors around the chassis are also weak as can be seen in Fig. 10, meaning that the cough particles are going to take a long time to drift away with the air current. However, these conditions can be improved by either changing the operating conditions of the blowers or by using additional blowers or localized fans closer to the workers to ensure that there are no stagnant air pockets around them and that fresh air is being circulated.

Making the right decision for your staff

From the various scenarios that we simulated, we observed that Virtual Prototyping gives great insight into the problem and helps us find a customized solution. With the help of these tests, you can ensure proper ventilation of your office space, and most importantly, validate the safety of your employees.

For our team in India, we are happy to report that this simulation experiment validates the local guidelines that were mandated and have armed local management with the right information needed to ensure the safety of the employees, which is always our top priority. As the COVID-19 situation in India hasn't improved yet, working from home remains the default for our India team. However, management is now more confident than ever about the measures or the steps that should be taken to ensure the safety of our employees as a result of the detailed simulation results.

We are proud to share that our team was awarded the COVID-19 prize of the 2020 Simulation and Artificial Intelligence Award by "L'Usine Digitale"(link is external) for the work they did on this project.

Special mention to our local team of experts:

Local Experts team: Venkat Ramana Eaga (CFD), Ravi Kumar Ajjampudi (CFD), Bharath Isandra Govindappa (Virtual Reality), Mr. Sandeep Patil (CFD, Pre-Processing)

References:

Quantity and Size Distribution of Cough-Generated Aerosol Particles Produced by Influenza Patients During and After Illness. Journal of occupational and environmental hygiene. 9. 443-9. 10.1080/15459624.2012.684582. Lindsley, William & Pearce, Terri & Hudnall, Judith & Davis, Kristina & Davis, Stephen & Fisher, Melanie & Khakoo, Rashida & Palmer, Jan & Clark, Karen & Celik, Ismail & Coffey, Christopher & Blachere, Francoise & Beezhold, Don. (2012).

Read from website

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.

ETA Inc., Engineering Technology Associates Announces DYNAmore as Master Distributor in Europe

TROY, Michigan (USA) /STUTTGART, Germany – September 8, 2020 –
ETA Inc. (Engineering Technology Associates), an engineering and software innovator with over 37 years in the automotive engineering community, has signed a master distribution agreement with DYNAmore GmbH. DYNAmore is one of the largest distributors of LS-DYNA simulation software worldwide.

"I highly appreciate to further strengthen our long-standing and very good cooperation with ETA and to coordinate the distribution of Dynaform throughout Europe. Together we are well positioned to meet the increasing demands on deep drawing, hydroforming and tube bending simulations."
Ulrich Franz, Managing Director, DYNAmore GmbH

'It is my pleasure to welcome DYNAmore, our long time Dynaform partner and German distributor as our new Master Distributor for Dynaform in the European Union. I am pleased by DYNAmore's business expansion, as they increase their presence in new growth markets across Europe.'
– Dr. Akbar Farahani, CEO & President, ETA Inc.

ETA and DYNAmore have been the most prominent LS-DYNA distributors for over 25 years. This new partnership will bring both companies closer, strengthen the software sales and support to the end-customer and showcase a unified market expansion to European OEMs' and suppliers.

ETA and DYNAmore are committed to creating a powerful virtual presence with webinars, online support and training for customers during the current pandemic and beyond.

DYNAmore will lead the following efforts:

- Supporting customers with the 6th generation of Dynaform
- Providing assistance to European sub-distributors
- Delivering consistent, streamlined communication for software sales and support throughout Europe

For further information on ETA, please visit eta.com
For further information on DYNAmore, please visit www.dynamore.de/en.

FEA Not to Miss (feantm) comprises a group of interested parties that bring information to you. This is done via this website and a monthly pdf publication FEA Not To Miss Engineering Solutions.

The publication is no fee, and there is no fee to have an article or notice on the FEANTM website or in the publication.

Our main goal is to make sure you have information on companies with expertise and innovative products. Strengths that rely on smart work ethics in today's changing world.

Please sign up for monthly email short news on engineering: **Subscribe**

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

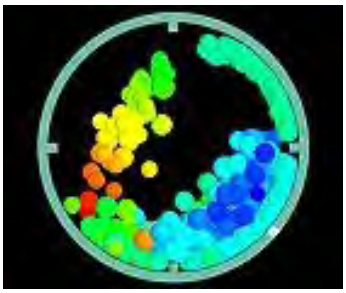
www.feantm.com

11/16/2020 - Marc Font Coffee Day! SO, I thought I would share (NO, not sharing my coffee) the video he brought to my attention.

Euro NCAP Crash & Safety Tests of Volkswagen

A series of... tests are conducted with different impactors...

10/05/2020 - I enjoy watching the below video. Why, you ask? Well, I'm not an engineer (whoever yelled, "WE KNOW!" you don't get coffee today!) Anyway, as I was saying, I enjoy watching it, while I drink coffee. Okay, I used to enjoy watching clothes go around and around in the clothes dryer window!



LancemoreJP

No.503 Tumbling Ball Mill Simulation using DES Elements

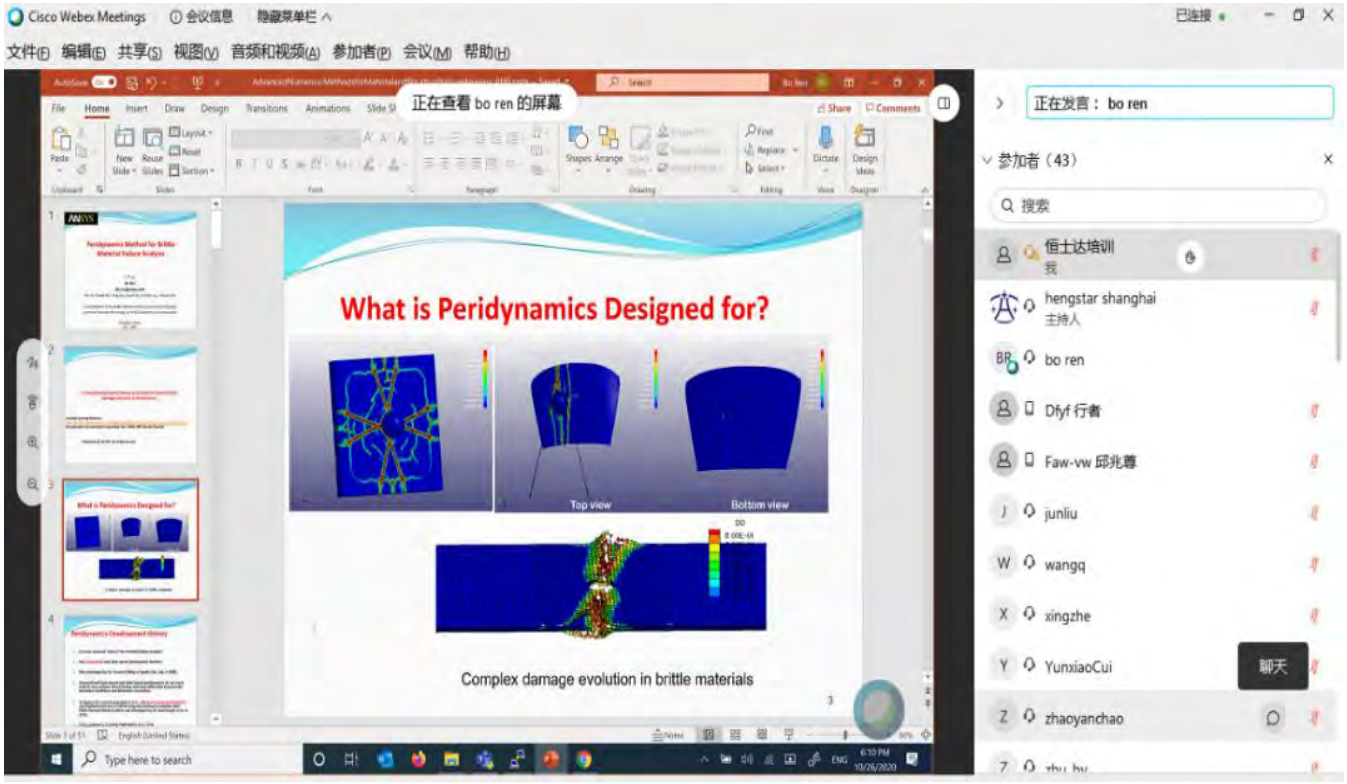
Shanghai Hengstar & Enhu Technology sells and supports LST's suite of products and other software solutions. These provide the Chinese automotive industry a simulation environment designed and ready multidisciplinary engineering needs, and provide a CAD/CAE/CAM service platform to enhance and optimize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

Online workshop of The PeriDynamics theory and application in LS-DYNA

On October 27, 2020, “The PeriDynamics theory and application in LS-DYNA” jointly held by Shanghai Hengstar and ANSYS/LST was successfully accomplished.

The seminar was presented by Dr. Bo Ren from ANSYS/LST. The course mainly includes the development history of traditional finite element method to PeriDynamics, the basic theory of PeriDynamics, as well as the implementation details of PeriDynamics in LS-DYNA®. The keywords and analysis process of PeriDynamics were introduced in detail. Finally, the pre-treatment method of PeriDynamics was illustrated by several examples, and the crack propagation mode was viewed from the results.

More than 40 CAE engineers from FAW, BYD, PATAC, Faway, Volvo, Geely, Vrilliance- auto etc. attended the online seminar. Through this training, the trainees have better understood the application scope and advantages of PeriDynamics.



Online workshop of GISSMO failure theory and application in LS-DYNA

Shanghai Hengstar Technology & Ansys/Lst will jointly organize a Web Training of the GISSMO failure theory and application in LS-DYNA on Dec 17 2020.

Contents:

（1） Basic theory of GISSMO

（2） Failure curve and instability curve

（3） Stress triaxiality

（4） Mesh dependence

(5） Parameter identification of the GISSMO model

Instructor：

Xiaobin Feng (senior engineer)

Xiaobin Feng has a master's degree in mechanics and more than 5 years' working experience. At present, he is mainly responsible for the performance test and simulation calibration of metal/non-metallic materials, including the tensile test calibration and material failure (GISSMO) simulation calibration under different strain rates. At the same time, he also participated in the drop analysis of electronic products, simulation analysis and optimization of the whole vehicle of the railway train industry, etc.

Duration and Style: (3 hours web training) **Time**: Dec 17 2020 (9:00AM-12:00AM) **Language:** Mandarin

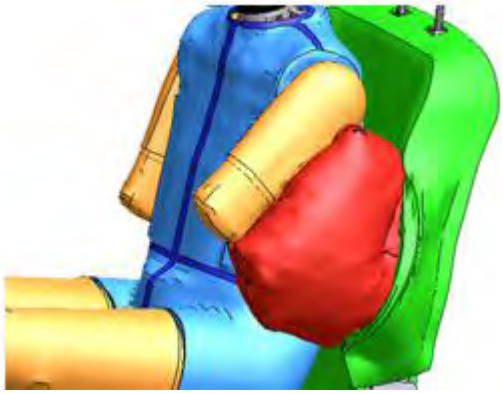
Contact: Xixi Fei Tell: 021-61630122
mobile:13524954631
Email:Training@hengstar.com

Shanghai Hengstar Technology Co., Ltd
hongsheng@hengstar.com
http://www.hengstar.com
Shanghai Enhu Technology Co., Ltd
http://www.enhu.com

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.

JFOLD Features

Towards more accurate airbag deployment simulation



JFOLD was developed to fold airbags for automotive crash simulation. JFOLD can be used to generate a folded airbag model using LS-DYNA simulation, regardless of the complexity of the geometry.

Airbags are one of the important safety devices for protecting the occupant during an accident: airbags are folded compactly and stored in the interior. The deployment behavior of an airbag depends on the pattern through which it is folded. The risk of occupant injury during airbag deployment, the out-of-position problem, considerably affects the occupant's safety performance.

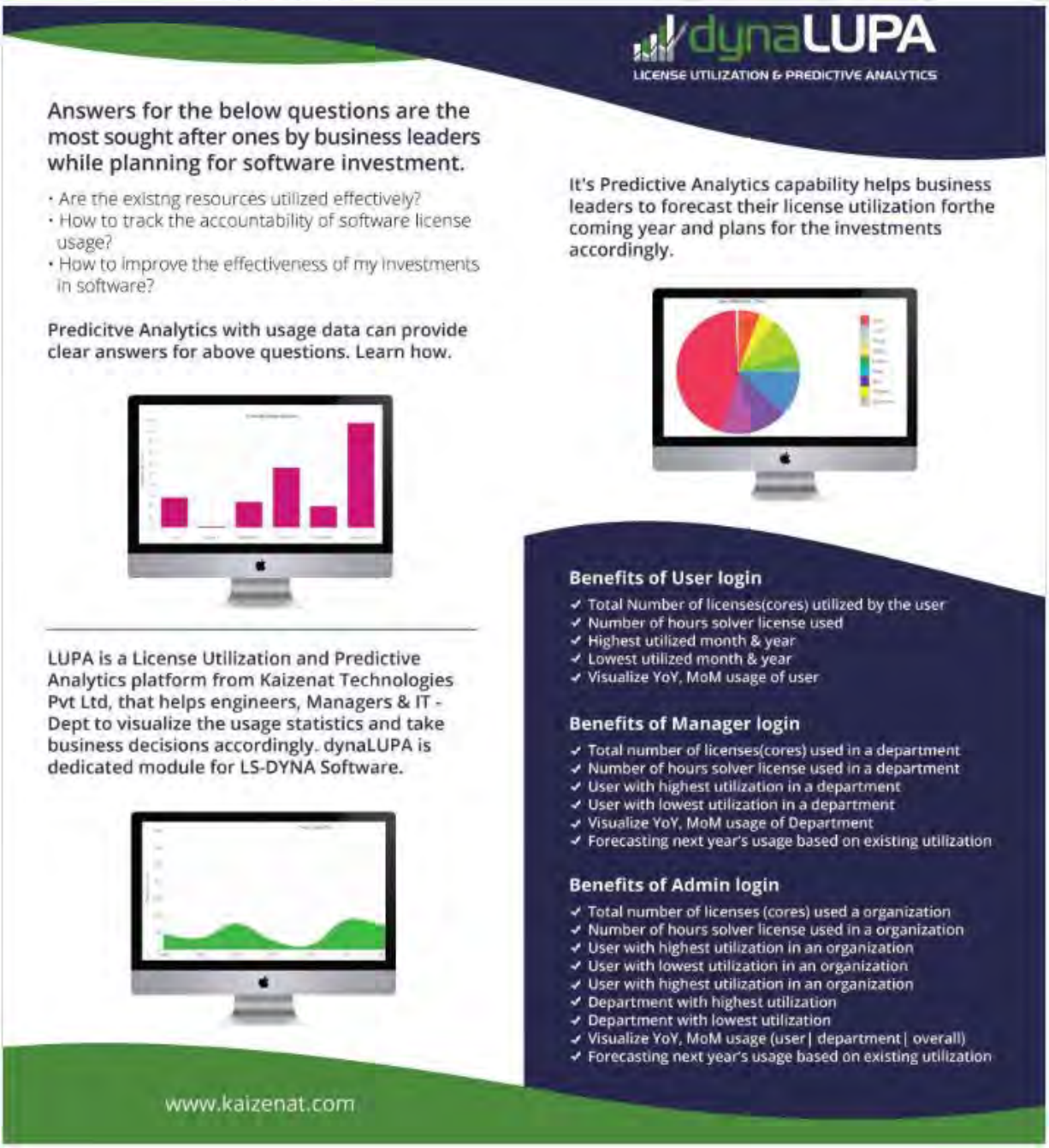
Recently, the demand for more accurate airbag deployment simulation to improve the occupant's safety has been increasing. Building a folded airbag model with complicated geometry was an issue for CAE engineers to address.

JFOLD can manage the complicated folding process of an airbag using a flowchart in an easy-to-understand tree view. Users can build, manage, and view the airbag models in various folding patterns. The intuitive and interactive GUI facilitates the operation of defining the position and behavior of the folding tools.

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.

KAIZENAT Keep Improving

LUPA



Contact
Email : support@kaizenat.com Phone: +91 80 41500008

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

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

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

Geometry and Meshing Includes

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

Pre- and Post-Processing Capabilities

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

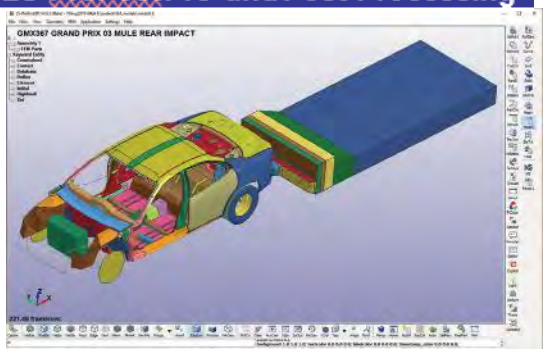
Other General Functions

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

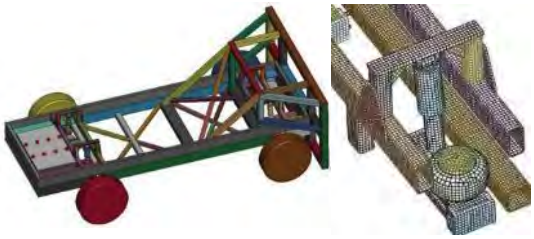
Applications

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

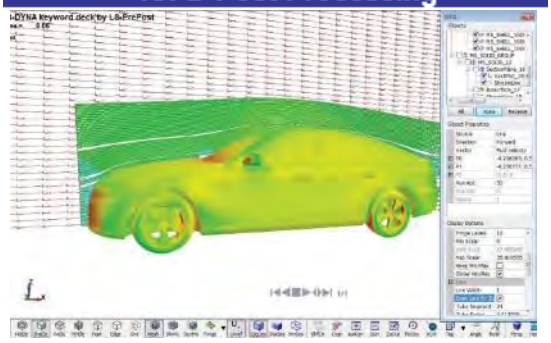
LS-PrePost Pre-and Post-Processing



LS-DYNA Geometry and Meshing



ICFD Post-Processing



LS-PrePost new release version 4.8

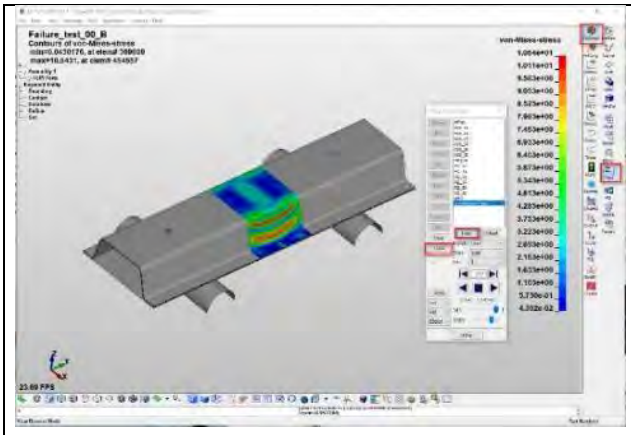
LS-PrePost® is an advanced pre- and post-processor developed for LS-DYNA®. It is fully multi-platform with support for Windows, Linux and Mac OSX. LS-PrePost is based on the OpenGL rendering engine with a design that is both efficient and intuitive. It is delivered with LS-DYNA without additional cost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

A few highlighted items in LS-PrePost 4.8:

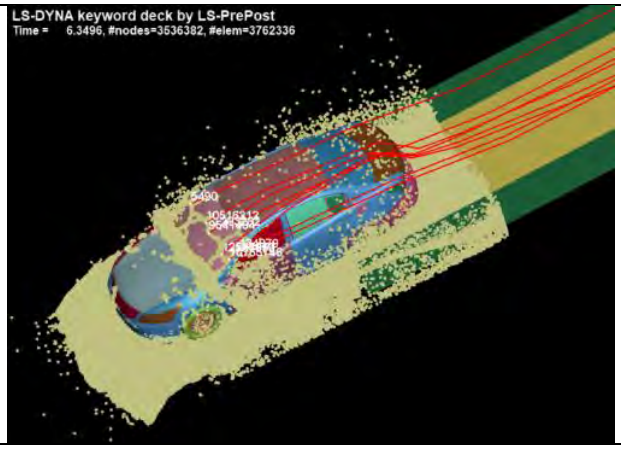
1. Fringe Binout data – data in Binout branches like ELOUT, NODOUT, TPRINT now can be fringed on an input keyword file (without deformation) or d3plot files. (see C1.png)
2. Greatly improved graphic rendering for SPH particle tracing. (C2.png)
3. Better split windows configurations, XY graphs can also be posted in split windows panels along with models (C3.png)
4. Support NVH Panel Contribution Analysis. (C4.png)
5. SCL (Scripting Command Language) now support Python in addition to the C-like language.

LS-PrePost 4.8 can be download from:

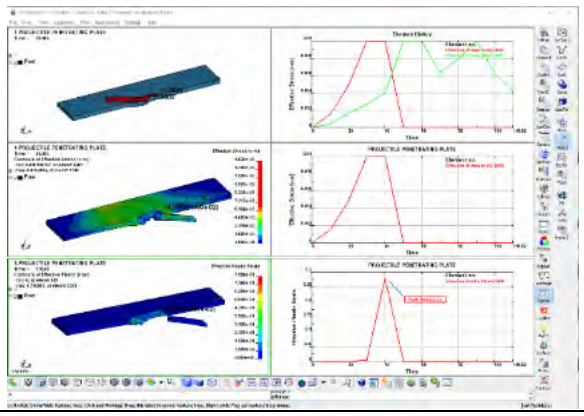
https://ftp.lstc.com/anonymous/outgoing/lsprepost/4.8/



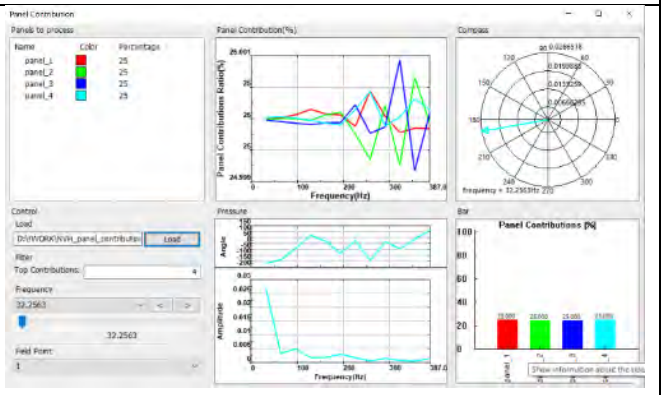
C1



C2



C3



C4

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

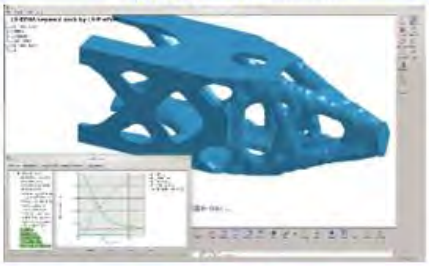
Methodologies

- 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

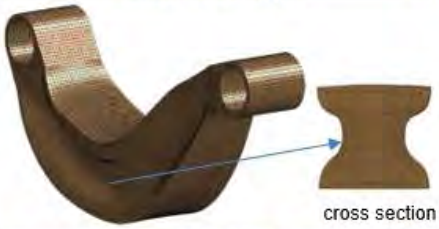
Integration

- 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

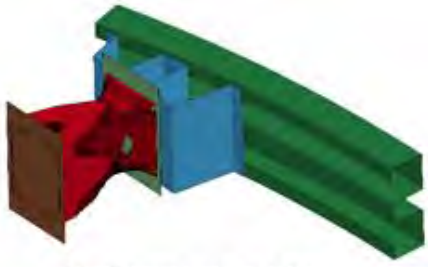


cross section

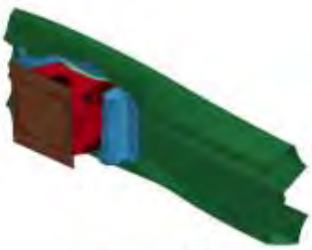
Hood Design

Model courtesy of Jaguar Land Rover

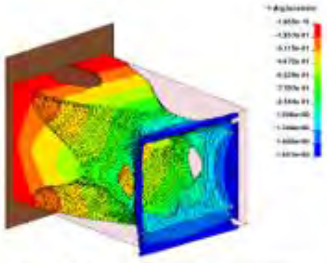
Crash Box Design



Final design of crash box



Deformation at t=30 ms



First bending mode in y-direction

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

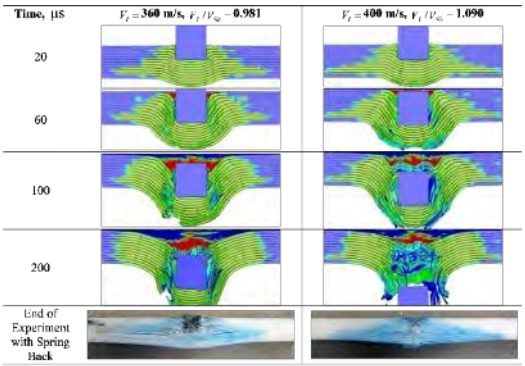
Final 2020 Webinar Course Date
November 17, 2020

Cost: $695 per person
Includes: USB 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, please click here.

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.

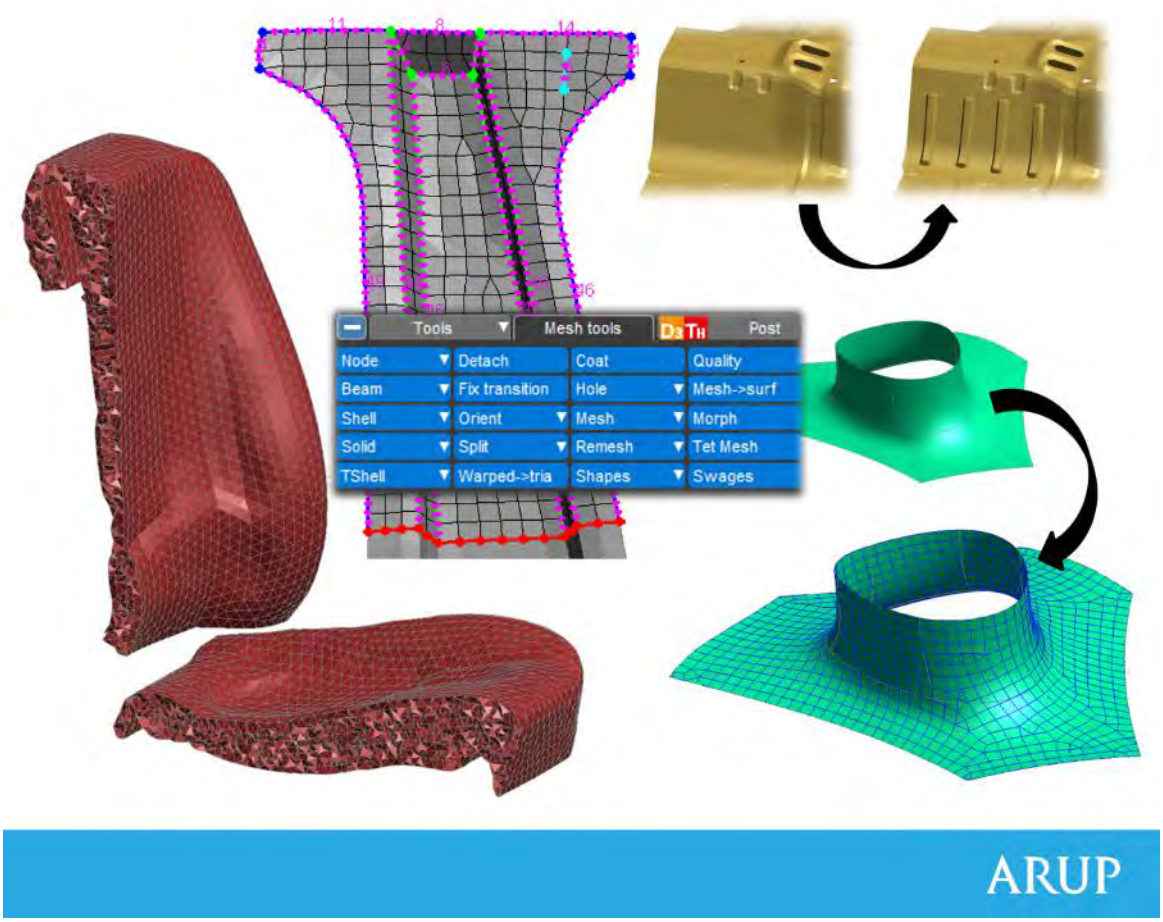
Webinar

Oasys PRIMER - Mesh modifications tools

25th November 2020

In this webinar, we will be looking at the powerful meshing tools that are built into the latest release of Oasys PRIMER. We will cover some fundamentals such as creating, splitting and reviewing meshes as well as some more advanced features such as holes, swages and the tet mesher.

Register



Webinar
Oasys REPORTER - Integration
3rd December 200
12:30 - 01:30 GMT

Learn how to use Oasys REPORTER to accelerate your LS-DYNA post-processing. REPORTER is now seamlessly integrated with the Oasys Suite, so you can quickly add images and key results data directly into reports, for sharing with your team

Register

Oasys LS-DYNA
Social Media Channels

We would like to invite you to join our Oasys LS-DYNA Environment Software LinkedIn Group. It's a channel to share content with other Oasys LS-DYNA software users, from interesting simulations to information about our webinars and training courses.

Please join us.

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

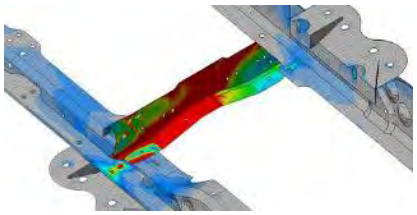
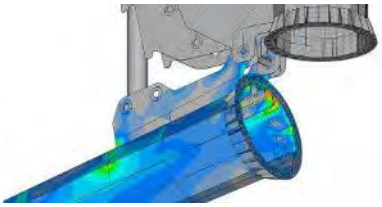
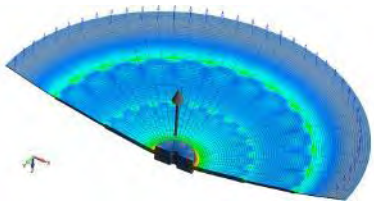
Predictive Engineering – Western States ANSYS LS-DYNA Distributor – Your Free Coffee Cup is On Its Way!

For now, let's talk about those free coffee cups. Predictive is now the western states distributor of ANSYS LS-DYNA and provides complete sales, training and services for ANSYS LS-DYNA clients in this region. It is a continuation of our prior setup with LSTC (now ANSYS LST) with the addition of Predictive's ability to offer ANSYS Workbench with LS-DYNA and other ANSYS software tools. So where's my free coffee cup? If you are a current Predictive ANSYS LS-DYNA client, we'll be shipping'em out to you at the end of February and for our new client's – just send us an email or give us a call.

LS-DYNA has been one of Predictive's core analysis tools pretty much since we got started in 1995. It is an amazing numerical workhorse from the basic linear mechanics (think ANSYS or Nastran) to simulating well nigh the impossible. At least that is the way I feel at times when the model is not solving and spitting out arcane error messages and I'm basically questioning my sanity for accepting this project from hell that has a deadline at the end of the week. Which brings me to my favorite project management image – "trough of despair followed by wiggles of false hope then crash of ineptitude and finally the promised land" but I'll leave that for another blog.

View our portfolio

FEA, CFD and LS-DYNA consulting projects

Contact:

Address:
2512 SE 25th Ave
Suite 205
Portland, Oregon 97202
USA

Phone:
503-206-5571
Fax: 866-215-1220
E-mail:
sales@predictiveengineering.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.

Platform Updates and Software Release Notes – November 2020

November 15, 2020, Jolie Hales
Automotive, English, Product Info & Tutorials

Rescale now works with more than 600 applications.

Here are a few **recent highlights**:

CalculiX 2.17 – CalculiX is free software used to solve field problems via a three-dimensional structural finite element program. Learn more here.

Altair EDEM 2020.3 – EDEM is high-performance software for bulk and granular material simulation. Powered by the Discrete Element Method (DEM), EDEM simulates and analyzes the behavior of coal, mined ores, soils, fibers, grains, tablets, powders, and more. Learn more here.

nTopology – nTopology's computational engineering environment combines synthesized geometry and simulation results into finely tuned manufacturing models. Learn more here.

Rocky DEM 4.2.2 – Rocky DEM simulates the flow behavior of bulk materials with complex particle shapes and size distributions. Learn more here.

ESI ProCAST 2020 – ProCAST software is a casting processes simulation tool, allowing comprehensive modeling of any sand casting process, including high-pressure molding lines. Learn more here.

Our full software catalog is available here.

Interested in learning more or about application availability? CONTACT AN EXPERT

LS-DYNA China, as the master distributor in China authorized by LST, an Ansys company, 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

The 4th LS-DYNA China Forum, 2020

LS-DYNA has been widely used and recognized in the field of engineering simulation in China. In recent years, it has made rapid progress and development in many fields.

Ansys China and Shanghai Fangkun planned to hold the 4th China LS-DYNA Forum on December 8, 2020 vitually. Welcome to join us to share and communicate with experts from all industries.

Since the 1st LS-DYNA China forum in 2014 and biennially, it has been successfully held for three times as a platform for LS-DYNA software developers, experts from various industries and domestic users. Each forum had attracted hundreds of researchers and engineers who came from various application fields such as vehicle OEMs, components factories, die &tooling, aerospace and electronics industries, etc.to attend.

Due to COVID-19, the 4th Forum would be held virtually but it is expected that there will be more attendees than the previous because it's more convenient to attend. For this forum, several speakers including LS-DYNA developers from LST, Ansys, domestic LS-DYNA experts will be invited. We sincerely hope you could join us. For more information, please follow our website www.lsdyna-china.com or Wechat "LSDYNA". Contact: marketing@lsdyna-china.com.

For more LS-DYNA related information please follow our official Wechat Account "LSDYNA".

Contacts: training@lsdyna-china.com.
Website www.lsdyna-china.com.

2020 Annual Training & Workshop

Dear LS-DYNA users，

To help users to better understand LS-DYNA software and use LS-DYNA more efficiently, Shanghai Fangkun releases 2020 annual training and workshop plan as following tables. We welcome those who are interested to attend.

Date	Topic	City	Duration
20-21,Feb.	Introduction to LS-DYNA (basic training)	Shanghai	2 days
Mar.	Product design with LS-OPT	Shanghai	1 day
Apr.	Crashworthiness in LS-DYNA	Shanghai	2 days
May	Material models in LS-DYNA (composite, non-metal)	Shanghai	2 days
Jun.	Introduction to LS-DYNA (basic training)	Chongqing	2 days
Jun.	Restraint system in LS-DYNA	Shanghai	2 days
Jul.	Battery multi-physics simulation with LS-DYNA	Shanghai	1 day
Sep.	Implicit analysis in LS-DYNA	Shanghai	1 day
Oct.	Fluid structure interaction with LS-DYNA (ALE, ICFD)	Shanghai	2 days
Nov.	Introduction to LS-DYNA (basic training)	Beijing	2 days
Dec.	User-Defined Materials in LS-DYNA	Shanghai	1 day

2020 LS-DYNA online workshop plan			
Date	**Topic**	**Duration**	**Fee**
13rd Jan.	Introduction to MPDB	3 hours	Free
Apr.	Contact Modeling in LS-DYNA	2 hours	Free
May	SALE method in LS-DYNA	2 hours	Free
Jun.	Introduction to Q series dummies	2 hours	Free
Jul.	NVH, Fatigue, & Frequency Domain Analysis in LS-DYNA	2 hours	Free
Aug.	SPG method in LS-DYNA	2 hours	Free
Sep.	Introduction to LS-PrePost	2 hours	Free
Sep.	Introduction to LS-OPT	2 hours	Free
Oct.	Introduction to LS-Form & Stamp forming	2 hours	Free
Oct.	Performance analysis of bus with LS-DYNA	2 hours	Free
Nov.	LST Dummy & Barrier	2 hours	Free
Nov.	EM method in LS-DYNA	2 hours	Free
Dec.	Summary of fluid structure interaction method in LS-DYNA	2 hours	Free
Dec.	Virtual Proving Ground training	2 hours	Free

Contact: Elva Yu Tel.: 18221209107, 021-61261195 for more detail information
Email: Training@lsdyna-china.com

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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.




FORD TAPS KANSAS CITY TO ASSEMBLE ALL-ELECTRIC FORD E-TRANSIT; BUILDS OUT $3.2B NORTH AMERICAN EV MANUFACTURING FOOTPRINT

NOV 10, 2020 | CLAYCOMO, MO

- Ford is investing an additional $100 million in its Kansas City Assembly Plant and adding approximately 150 full-time jobs to begin producing the all-new E-Transit on the heels of the all-electric F-150 announced in September; E-Transit arrives late 2021, F-150 electric 2022
- E-Transit, to be revealed Thursday, is part of Ford's $11.5 billion-plus investment in electrification through 2022. The Mustang Mach-E starts reaching customers next month
- Ford is investing approximately $150 million in Van Dyke Transmission Plant in Sterling Heights, Mich., to make e-motors and e-transaxles for new electric vehicles, including the all-electric F-150. This will retain 225 jobs
- Ford is increasing production plans for the fully electric F-150 at the historic Rouge Plant in Dearborn, adding 200 permanent jobs in addition to a previously announced 300 jobs and part of a $700 million investment in building the all-new F-150 and all-electric F-150
- Kansas City and Dearborn plants, together with Oakville, Ontario and Cuautitlan, Mexico, assembly plants, will support the first phase of Ford's growing North American electric vehicle plans

CLAYCOMO, Mo., Nov. 10, 2020 – Ford Motor Company announced today that its Kansas City Assembly Plant will build the all-new E-Transit van, part of a more than $3.2 billion investment in Ford's North American manufacturing facilities to produce a series of new electric vehicles for commercial and retail customers.

The new E-Transit will join the all-electric F-150 announced in September and the all-electric Mustang Mach-E, which begins arriving in dealers' showrooms next month. The new entries support Ford's plan to electrify its iconic and most popular vehicles, including its commercial vehicles. The all-electric F-150, which will be assembled at the new Rouge Electric Vehicle Center in Dearborn, Mich., arrives in mid-2022. The E-Transit arrives in late 2021.

Ford's is building out its manufacturing footprint across North America – working with local and national governments – to lead the transition to electric vehicles and meet consumer demand in the coming years. Electric vehicles are a key part of Ford's commitment meet the requirements of the Paris Accord and achieve carbon neutrality globally by 2050.

"We're taking our most iconic vehicles and using fully electric technology to deliver even more performance, productivity and capability for customers," said Kumar Galhotra, president, Americas and International Markets Group. "We are building out the North American manufacturing footprint to support this growth. This is just the first chapter with more new electric vehicles and more investment to come."

Ford is investing an additional $100 million in its Kansas City plant and adding approximately 150 full-time permanent jobs to build the E-Transit, a zero-emissions version of Transit, America's best-selling commercial van.

The all-electric E-Transit will be unveiled Thursday and arrives in late 2021. The electric van investment in Kansas City is in addition to the $300 million Ford invested for the launch this year of the all-new F-150 at that plant. The plant employs approximately 7,500 workers.

E-Transit is part of Ford's more than $11.5 billion global investment in electrification through 2022.

"Ford's strategy is different – we are delivering affordable, capable electric vehicles in the heart of the retail and commercial market rather than six-figure status vehicles," Galhotra said. "With the stunning Mustang Mach-E SUV, an all-electric F-150 and the new E-Transit, our first wave of EVs in North America will introduce a whole new generation to EVs."

Ford is also investing approximately $150 million in Van Dyke Transmission Plant in Southeast Michigan to build e-motors and e-transaxles beginning in 2021.This will retain 225 jobs at the plant.

Given the strong early interest in Ford's all-electric F-150 since the September announcement, Ford is now increasing production plans by 50 percent versus original plans. To deliver more fully electric trucks, Ford will add 200 new jobs in addition to the 300 jobs previously announced for the new electric F-150.

Ford spends more than $5 billion annually on engineering in America, which includes the development of the all-new, fully electric Transit, the F-150, and the all-new Mustang Mach-E.

"We are investing heavily in our vehicle programs as well as building out our manufacturing capabilities," said Hau Thai-Tang, chief product platform and operations officer. "This will allow us to scale quickly as customer interest in these new products grows."

In addition to electric vehicle manufacturing sites for trucks and vans in the U.S., the company also is investing C$1.8 billion (U.S. $1.35 billion) to transform its Oakville Assembly Complex in Ontario starting in 2024 to include next-generation battery-electric vehicles. It will mark the first time ever that an automaker has produced full BEVs in Canada for the North American market.

Ford also is planning to produce an additional electrified vehicle at its plant in Cuautitlan, Mexico, where the Mustang Mach-E is produced. The new vehicle will share a similar electrified platform as the Mustang Mach-E, delivering manufacturing and engineering efficiencies.

"Our electric vehicle business is a dynamic source of growth," says John Savona, vice president, North American manufacturing. "We're setting ourselves up for profitable business now and in the future."

About Ford Motor Company

Ford Motor Company (NYSE: F) is a global company based in Dearborn, Michigan. The company designs, manufactures, markets and services a full line of Ford cars, trucks, SUVs, electrified vehicles and Lincoln luxury vehicles, provides financial services through Ford Motor Credit Company and is pursuing leadership positions in electrification; mobility solutions, including self-driving services; and connected services. Ford employs approximately 187,000 people worldwide. For more information regarding Ford, its products and Ford Motor Credit Company, please visit corporate.ford.com.

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

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www.lsoptsupport.com

LS-DYNA EXAMPLES

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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

Contact : 513-331-9139
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LS-DYNA LIVE ONLINE TRAINING & CONSULTING SERVICES

Lsdyna online was created by the LSTC instructor after 25 years of teaching various LS-DYNA courses for LSTC nationally and internationally (more than 20 countries). The online company was established in 2012 and we have been providing many live interactive courses to many companies and organizations. We do consulting work in addition to instructions. Here are some courses, for full list see our webpage.

1. Introduction to LS-DYNA (2 days @ $800)
December 11-12

2. Composites in LS-DYNA (2 days @ $1000)
October 1-2

4. Fracture, Damage, & Failure (2 days @ $1000)
October 5-6

5. Fluid Structure Interaction (2 days @ $1000)
September 29-30

6. Material Models Tests to Simulation (2 days @ $1000)
October 8-9

3. Contact in LS-DYNA (2 days @ $1000)
October 12-13

13. Plasticity, Plastics, & Visco-Plasticity (2 day @ $1000)
November 2-3

14. Penetration Using LS-DYNA (2 days @ $1000)
June 15-16

15. Composite Materials (1 day @ $500)
October 30

16. Blast using LS-DYNA (2 days @ $1000)
November 5-6

17. Introduction to LS-PREPOST (1 day @ $500)
November 4

18. Advance LS-PREPOST (1 day @ 500)
email us for dates

About Tabiei

Dr. Al Tabiei has been a consultant on the use of large scale finite element simulation for more than 25 years to more than 80 large and small companies and government labs in the US and abroad. He was the director of the Center of Excellence in DYNA3D Analysis at the University of Cincinnati (1997-2001). He has more than 150 journal, refereed reports, and conferences papers
He lectured at nearly 20 countries. He also did code development for LSTC. The instructor has developed and implemented many material models in LS-DYNA. Composite Shell element for composite materials and various other development in the code. He was consultant to the US government for several years on the use of simulation for home land security problems. He has served as a Subject Matter Expert (SME) for the government for more than 20 years. He was also on a NASA team for the return to the moon program to investigate different landing scenarios (2006-2010).

Response spectrum analysis and DDAM analysis in LS-DYNA®

Yun Huang，Zhe Cui
Livermore Software Technology, an ANSYS company

Abstract

Response spectrum analysis (keyword `*FREQUENCY_DOMAIN_RESPONSE_SPECTRUM`) evaluates the peak response of structures subjected to various loads like ground motions in an earthquake. It combines contribution from each vibration mode of the structures. This feature has important application in Civil and hydraulic engineering, where seismic analysis is critical to the design and safety evaluation of the large scale buildings.

DDAM (Dynamic Design Analysis Method) is a U.S. Navy-developed analytical procedure for shock design. It helps validate the design of onboard equipment and structures subject to dynamic loading caused by underwater explosions (UNDEX). It is a widely accepted procedure for safety evaluation for civil and military ship building. The keyword for response spectrum analysis (`*FREQUENCY_DOMAIN_RESPONSE_SPECTRUM`) in LS-DYNA® has been extended to run DDAM analysis for shipboard components, with the option _DDAM.

This paper first gives a brief review of the theory for response spectrum analysis and DDAM analysis. Then, with several examples, this paper shows how to run response spectrum analysis and DDAM analysis with LS-DYNA and how to perform post-processing of the results. For purpose of cross-validation, the results of DDAM analysis with LS-DYNA are compared with that given by other commercial code.

Introduction

Response spectrum analysis (`*FREQUENCY_DOMAIN_RESPONSE_SPECTRUM`) has been implemented to LS-DYNA since R7 of LS971. It was extended to Dynamic Design Analysis Method since R10. DDAM Dynamic Design Analysis Method (DDAM) is a U.S. Navy standard procedure that has been used for over 30 years for shock design. One can use DDAM to analyze the response of the shipboard equipment, such as antenna, radar, engines, and other critical structures, due to underwater explosions. All mission-essential equipment on board surface ships and submarines must be designed to operate under severe conditions of shock loading, such as from depth charges, explosion of mines, missiles, and torpedoes.

With the fixed structure moving in water, the shock spectrum experienced by the shipboard equipment is higher than that the same equipment fixed on ground would experience. This change in spectrum is called as the spectrum-dip effect, which is similar to soil-structure interaction under earthquake excitation. The interaction between the equipment under shock loading and its fixed structure can be modeled by DDAM. The coefficients included in the load spectrum equation for DDAM analysis allow also for the influence of equipment mounting location and shock direction.

To run DDAM analysis, the first step is to extract natural frequencies and normal modes of the equipment. Then the modal effective mass in each direction (x, y and z) are calculated. After that, DDAM analysis is performed using an

input acceleration spectrum of shock design values. The input spectrum values are provided based on equations provided in unclassified U.S. Navy standard documents (NRL Report 1396), for pre-determined mounting location / load direction / material type, etc., together with the modal weight of the equipment. Alternatively, engineers can use customized equations to define the input shock spectrum, based on user-defined coefficients. Those coefficients can be defined for an alternate unit system or obtained from field testing. NRL (Naval Research Laboratories) sum method is then used to combine the peak responses from all modes into overall response which includes displacements, velocities, accelerations, stresses and strains. After that, evaluation of the DDAM results, in correlation to design standards, or material failure criterion etc., is performed.

There are some limitations on DDAM analysis. First, it is a linear analysis. In other words, some nonlinear behavior or deformation cannot be captured explicitly. Secondly, the available DDAM-NRL coefficients are old and not convenient for new type of the ships and warfare. In addition, those coefficients don‘t consider the size variation of ships. For example, response of the same device on an aircraft carrier and on a small frigate under same shock load should be different. Understanding the limitations of DDAM analysis is necessary for engineers who need to run shock analysis. However, up to today, DDAM is still the most convenient and efficient method for shock analysis of onboard equipment.

Since the implementation of response spectrum analysis into LS-DYNA, LS-DYNA has been used to run the DDAM analysis, based on users' in house script [1] or pre-defined load spectrum. To make the DDAM analysis more convenient, a _DDAM option is added to the keyword `*FREQUENCY_DOMAIN_RESPONSE_SPECTRUM`. With this new option, users can run DDAM analysis with LS-DYNA directly.

Shock spectrum definition

The DDAM SDV (Shock Design Values) is an acceleration spectrum defined in terms of g (gravity acceleration). According to NRL-1396 standard, the following factors are considered to define the SDV

-Type of Ship
  - -Surface
  - -Submarine

-Mounting location
  - -Hull mounted system
  - -Deck mounted system
  - -shell plating mounted system

-Direction of shock load or attack
  - -Vertical
  - -Athwartship
  - -Fore and aft

-Material type
  - -Elastic
  - -Elastic-plastic

For example, for a hull mounted device on a surface ship, NRL-1396 [2] provides the following reference equations:

$$A_0 = 20\left[\frac{\left(37.5+\overline{W}_a\right)\left(12+\overline{W}_a\right)}{\left(6+\overline{W}_a\right)^2}\right] \qquad (g) \quad (1)$$

$$V_0 = 60\left[\frac{12+\overline{W}_a}{6+\overline{W}_a}\right] \qquad (\text{in}/\text{sec}) \quad (2)$$

And design values

	Elastic		Elastic-Plastic	
	A_a	V_a	A_a	V_a
Vertical	1.0 A_0	1.0 V_0	1.0 A_0	0.5 V_0
Athwartship	0.4 A_0	0.4 V_0	0.4 A_0	0.2 V_0
Fore and aft	0.2 A_0	0.2 V_0	0.2 A_0	0.1 V_0

Table 1: Shock spectrum design values for surface ship, hull mounted system

Where,

$$\overline{W}_a = \frac{M_{eff}\, g}{1000} \qquad (\text{kips}) \quad (3)$$

is the modal weight. M_{eff} is the effective modal mass, provided by implicit modal analysis (using keyword `*CONTROL_IMPLICIT_EIGENVALUE` in LS-DYNA).

So, one can use the modal weight (kips) computed for the mode under consideration, calculate the proper A0 and V0 from the reference equations (1) and (2); and then find the appropriate design values Aa and Va using Table 1; and then multiply Aa by g (386 in/sec2) and Va by ωa (round frequency, =2πf); the SDV is the lesser of these two values. If a value of SDV < 2316 in/sec2 (6 g) is determined by this method, the SDV of 2316 in/sec2 should be used.

More reference equations and design values, for different ship types and mounting types, can be found in NRL Memorandum Report 1396 [2].

This procedure is repeated for all modes included in DDAM analysis.

LS-DYNA provides also the option to define the SDV by user directly.

For acceleration input spectrum, it is defined by

$$A = \begin{cases} A_f \times A_a \dfrac{\left(A_b + \overline{W}_a\right) \times \left(A_c + \overline{W}_a\right)}{\left(A_d + \overline{W}_a\right)^2} & if \quad A_d \neq 0 \\ A_f \times A_a \dfrac{\left(A_b + \overline{W}_a\right)}{\left(A_c + \overline{W}_a\right)} & if \quad A_d = 0 \end{cases} \qquad (4)$$

The user defined velocity input spectrum is defined as

$$V = V_f \times V_a \frac{\left(V_b + \overline{W}_a\right)}{\left(V_c + \overline{W}_a\right)} \qquad (5)$$

The parameters Af, Aa, Ab, Ac, Ad and Vf, Va, Vb, Vc are defined in Cards 4b.1 and 4b.2 in LS-DYNA keyword *FREQUENCY_DOMAIN_RESPONSE_SPECTRUM_DDAM.

NRL Sum method

A series of modal combination methods are available in LS-DYNA, for running response spectrum analysis with `*FREQUENCY_DOMAIN_RESPONSE_SPECTRUM`. They include SRSS, CQC, NRC grouping, etc. For DDAM, the standard modal combination method is NRL-sum, given as

$$R = |R_1| + \left[\sum_{i=2}^{N} (R_i)^2\right]^{1/2} \quad (6)$$

The NRL-sum is a statistical estimate of the maximum response created by taking the response for the mode that exhibits the largest response and adding the SRSS response of other modes. The calculated response could be nodal displacement, velocity or acceleration or element stress / strain components, or forces. With this equation, the contribution on overall response from the mode that exhibits the largest response is emphasized.

Though R_1 is used in equation (6) for the response for the mode that exhibits the largest response, it does not suggest that that mode has to be the first mode.

Mode selection

Modal analysis is the first step for running DDAM. A careful selection of modes is critical to the application of DDAM. A well accepted criterion is that the cumulative modal weight (cumulative modal effective mass) of all modes involved in the shock spectrum must be greater than 80%, in each direction. If not, more normal modes should be included.

Closely spaced modes

Modes are close if their frequencies are within 10% of the mean frequency. Once each CSM pair combination is determined, it is used in the NRL-sum as a single effective mode.

LS-DYNA can identify the closely spaced modes automatically. Alternatively, user can pre-define the closely spaced modes pairs using the keyword `*SET_MODE`. If the closely spaced modes are defined by a set ID, additional card (Card 5) is required to input the set ID (sid) for the series of closely spaced mode pairs. For more details about the keyword, please refer to LS-DYNA Keyword Users' Manual [3].

LS-DYNA keywords

To run DDAM analysis, the keyword `*FREQUENCY_DOMAIN_RESPONSE_SPECTRUM_DDAM` is used. Besides, to get the binary plot database d3spcm from DDAM, user needs to define the keyword `*DATABASE_FREQUENCY_BINARY_D3SPCM` and set binary=1 in this keyword. A sample for these keywords is given in Figure 1.

```
*CONTROL_IMPLICIT_GENERAL
$#   imflag        dt0     imform       nsbs        igs      cnstn       form     zero_v
         1     1.0000          0
*CONTROL_IMPLICIT_EIGENVALUE
$#     neig     center      lflag     lftend      rflag     rhtend     eigmth     shfscl
        30         .0
$#   isolid      ibeam     ishell    itshell     mstres     evdump
                                                     1
*FREQUENCY_DOMAIN_RESPONSE_SPECTRUM_DDAM
$#    mdmin      mdmax      fnmin      fnmax     restrt      mcomb     relatv
         1         30         0.     5000.                     4
$#    dampf     lcdamp      ldtyp     dmpmas     dmpstf

$#      std       unit       amin        vid         xc         yc         zc
         1          4          6          1
$#   shptyp      mount     movemt     mattyp
         2          1          3          1
*DATABASE_FREQUENCY_BINARY_D3SPCM
$#   binary
         1
```

Figure 1: Sample keyword setting for running DDAM

Additional keyword *CONTROL_IMPLICIT_EIGENVALUE is also needed, to provide natural frequencies and modal shape vectors for the structure under study. The natural frequencies and modal shape vectors are saved in d3eigv binary database, which can be accessed by LS-PrePost. Another keyword *CONTROL_IMPLICIT_GENERAL is also needed to activate implicit analysis in LS-DYNA.

As shown in Figure 1, the parameters mdmin and mdmax pair (or fnmin and fnmax pair) in card 1 in *FREQUENCY_DOMAIN_RESPONSE_SPECTRUM_DDAM define the range of modes to be used in DDAM analysis. The parameter restrt defines restart option. When modal analysis was already done before, and eigout and d3eigv files are available, one can set restrt = 1 to skip modal analysis in current DDAM computation. LS-DYNA can read eigout and d3eigv to extract the cumulative effective mass data, and eigen frequencies and eigenvectors. The card for damping (card 2) is not needed for DDAM analysis and should be blank. In card 3, unit = 4 means that the unit system [lb, inch, second, lbf and psi] is used. When other units are used, user needs to tell LS-DYNA which set of unit system is used by setting unit appropriately (please refer to LS-DYNA Keyword Users' Manual [3] for more details). The equations (1) and (2) for defining the SDV are based on using [g] as unit for acceleration and [inch/s] as unit for velocity. So some unit conversion is needed and carried out in LS-DYNA to convert the SDV to values using acceleration or velocity units consistent with other variables.

With this keyword, we are running DDAM analysis using NRL-1396 design spectrum standard for shock load (std = 1). The DDAM analysis is performed on an elastic (mattyp = 1) part which is constrained in a surface ship (shptyp = 2) using Hull mounted system (mount = 1). The shock load is in Fore and Aft direction (movemt = 3).

This setting is equivalent to the following setting using user defined spectrum option (std = -1).

```
*CONTROL_IMPLICIT_GENERAL
$#  imflag        dt0    imform      nsbs       igs     cnstn      form    zero_v
         1    1.0000         0
*CONTROL_IMPLICIT_EIGENVALUE
$#    neig    center     lflag    lftend     rflag    rhtend    eigmth    shfscl
        30        .0
$#  isolid     ibeam    ishell   itshell    mstres    evdump
                                                1
*FREQUENCY_DOMAIN_RESPONSE_SPECTRUM_DDAM
$#   mdmin     mdmax     fnmin     fnmax    restrt     mcomb    relatv
         1        30        0.     5000.                 4
$#   dampf    lcdamp     ldtyp    dmpmas    dmpstf

$#     std      unit      amin       vid        xc        yc        zc
        -1         4         6         1
$#      af        aa        ab        ac        ad
       0.2       20.      37.5       12.       6.
$#      vf        va        vb        vc
       0.2       60.       12.       6.
*DATABASE_FREQUENCY_BINARY_D3SPCM
$#  binary
         1
```

Figure 2: Sample keyword setting for running DDAM with user defined constants for SDV

The parameters af, aa, ab, ac, ad, vf, va, vb, and vc come from equations (1) and (2) and table 1. More details about the parameters of the keywords can be found in LS-DYNA Users' Keyword Manual [2].

Postprocessing of DDAM results

The results of DDAM analysis are saved in binary plot database d3spcm, as other response spectrum analysis (`*FREQUENCY_DOMAIN_RESPONSE_SPECTRUM`). To get d3spcm, one needs to set binary = 1 in `*DATABASE_FREQUENCY_BINARY_D3SPCM`.

This database is accessible to LS-PrePost (version 4.0 and above). There is only one state in this database, which shows the peak values of response due to the shock loading. The response includes nodal displacement, velocity, acceleration, and elements' stresses and strains, as shown in Figure 3.

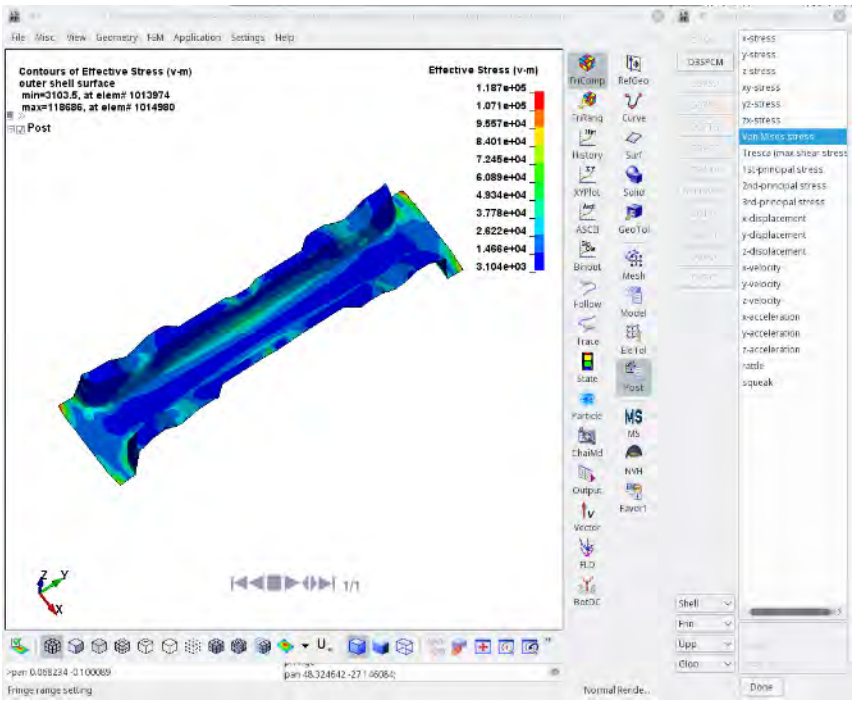


Figure 3: Fringe components of d3spcm, as shown in LS-PrePost

Examples

A benchmark example for a bracket model

A bracket model shown in Figure 4 is adopted for cross-validation of DDAM analysis by LS-DYNA and by third party commercial software - ANSYS. The ANSYS DDAM results were provided by a customer.

The LS-DYNA keyword setting for this model is shown in Figure 1. For this example, the SDV comes from NRL-1396 design spectrum standard (std = 1). The bracket model is elastic (mattyp = 1), and it is fixed on a surface ship (shptyp = 2) using Hull mounted system (mount = 1). The shock load is in Fore and Aft direction (movemt = 3). 30 normal modes are used in DDAM analysis, both in ANSYS and LS-DYNA.

The x-displacement results are shown in Figures 4 and 5. The Von Mises stress results are shown in Figures 6 and 7. One can see that the results given by ANSYS and by LS-DYNA not only match well in numbers, but also match in the fringe plot of the response.

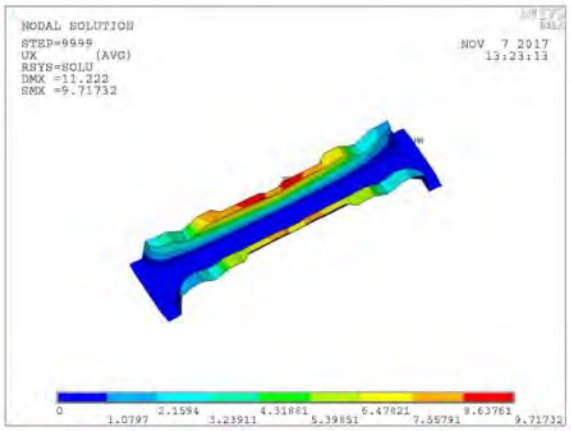


Figure 4: X-displacement by ANSYS

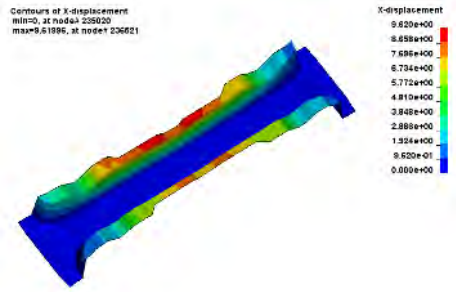


Figure 5: X-displacement by LS-DYNA

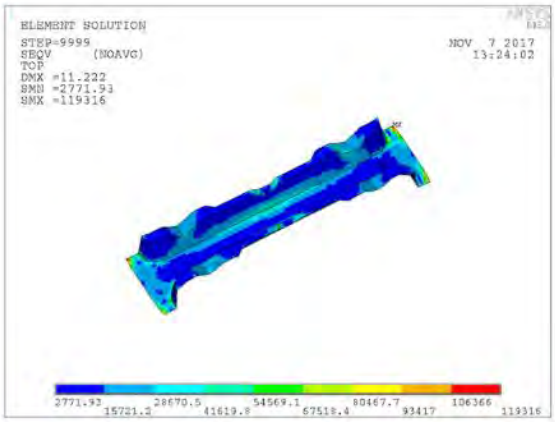


Figure 6: Von Mises stress by ANSYS

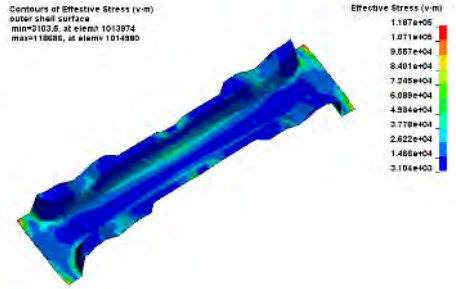


Figure 7: Von Mises stress by LS-DYNA

Table 2 below compares the maximum values of response, by ANSYS and LS-DYNA. For most items in Table 2 there is a good match between ANSYS results and LS-DYNA results.

		ANSYS	LS-DYNA	Diff (%)
Displacement (inch)	x	9.717	9.620	1.00%
	y	1.835	1.856	1.14%
	z	6.304	6.375	1.13%
Velocity (inch/s)	x	206.393	204.265	1.03%
	y	45.884	46.440	1.21%
	z	154.401	156.737	1.51%
Acceleration (inch/s^2)	x	5592.22	5571.59	0.37%
	y	2303.57	2438.19	5.84%
	z	6056.48	6306.27	4.12%
Von Mises stress (psi)		119316	118686	0.53%

Table 2: Maximum response values by ANSYS and LS-DYNA

An example of a simplified engine model

For the second example, a simplified engine model as shown in Figure 8 is considered. The engine model is deck-mounted on a surface ship (shptyp = 2, mount = 2). The shock load is in vertical direction (movemt = 1). Elastic material is used (mattyp = 1). 35 nomal modes are used in DDAM analysis.

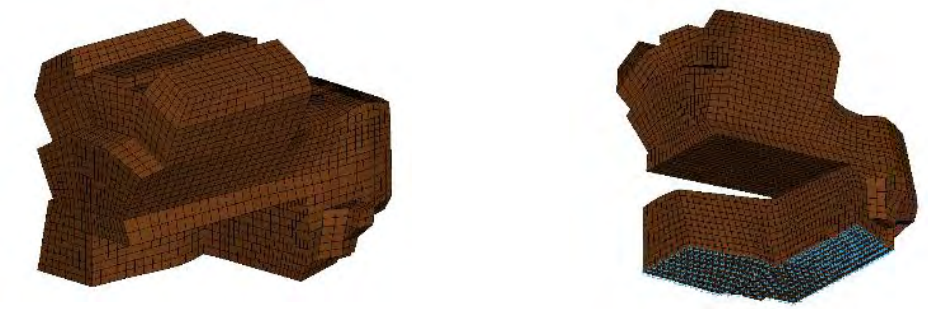


Figure 8: An engine model deck mounted on a surface ship

The DDAM analysis results on this model are given in Figures 9-12 for velocity and Von Mises stress.

To study the effect of CSM (closed spaced modes), two sets of results are given. The first set of results are obtained without considering closed spaced modes and the second set of results are obtained with consideration of closed spaced modes. The pairs of closed spaced modes are identified by LS-DYNA automatically, based on the rule that two modes are close if their frequencies are within 10% of the mean frequency.

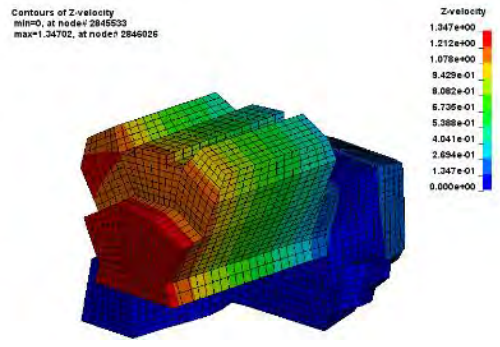


Figure 9: Z-velocity response without considering CSM

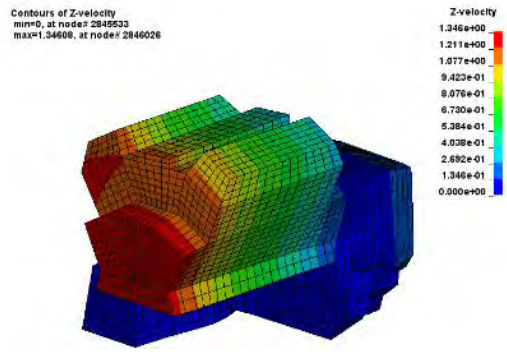


Figure 10: Z-velocity response with considering CSM

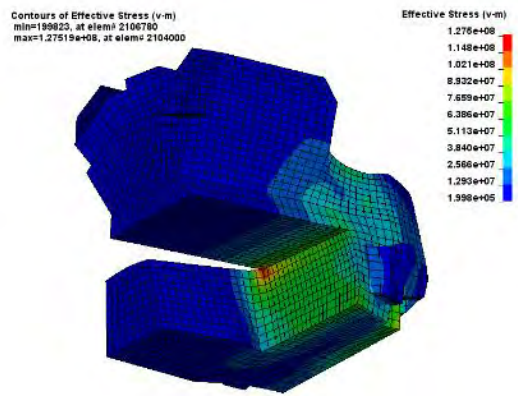


Figure 11: Von Mises stress response without considering CSM

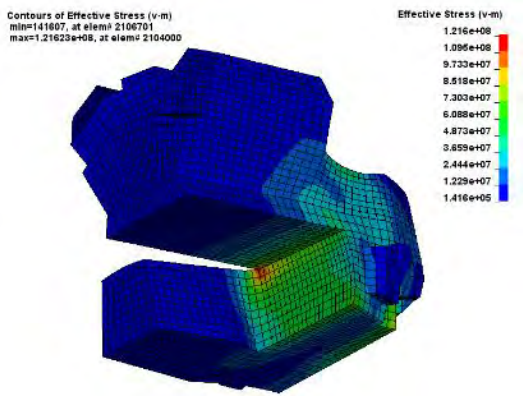


Figure 12: Von Mises stress response with considering CSM

Mode 1	Mode 2	Frequency 1 (Hz)	Frequency 2 (Hz)	closeness
1	2	161.916	183.585	6.27%
8	9	2154.123	2388.604	5.16%
10	11	2514.085	2568.140	1.06%
13	14	2900.369	2978.841	1.33%
15	16	3109.892	3235.419	1.98%
17	18	3440.616	3518.140	1.11%
20	21	3755.087	3769.748	0.19%
23	24	3998.838	4030.054	0.39%
25	26	4119.330	4185.419	0.80%
27	28	4337.447	4368.439	0.36%
29	30	4440.072	4477.796	0.42%
34	35	4885.955	4925.765	0.41%

Table 3: Closed spaced modes pairs identified by LS-DYNA

In Table 3, the values in closeness column (to show how close the two modes are in relation to their mean frequency) are computed as

$$\frac{f_2 - f_1}{f_2 + f_1} \times 100\% \quad (7)$$

For this example, it seems that there is no big difference in the response with or without considering closed spaced modes (of course, this does not have to be true for other cases). Generally speaking, without considering closed spaced modes effect, the total response could be larger.

Summary

DDAM is a standard procedure to validate the design of onboard equipment and structures subject to dynamic loading caused by underwater explosions (UNDEX). Up to today, it is still a convenient and efficient method for shock analysis.

This paper introduces the DDAM analysis feature of LS-DYNA, as an extended option for response spectrum analysis (`*FREQUENCY_DOMAIN_RESPONSE_SPECTRUM`). LS-DYNA provides flexible ways to run DDAM analysis. User can run DDAM analysis with NRL-1396 standard shock spectrum, or with customized shock spectrum with self-defined constants. Closed spaced modes can be considered in DDAM analysis.

Benchmark examples were given in the paper, to show the accuracy and reliability of the DDAM solver. Post-processing of the results by using LSTC's LS-PrePost software, is also reviewed.

References

[1] Koehler M, McCoy W, Patel M: "Dynamic Design Analysis Method to Evaluate Shipboard Shock in LS-DYNA®", Proceedings of the 15th International LS-DYNA® Users' Conference, June 10-12, 2018, Dearborn, MI, USA.
[2] O'Hara, G, Belsheim, R: "Interim design values for shock design of shipboard equipment", National Technical Information Service, 1963.
[3] Hallquist, J. "LS-DYNA Keyword User's Manual, Volume I". LSTC, Livermore, CA, USA, 2017.

Recent Developments in Time Domain Fatigue Analysis with LS-DYNA®

Zhe Cui, Yun Huang
Livermore Software Technology, an ANSYS Company

Abstract

A series of new options were implemented to the time domain fatigue analysis features since the last international LS-DYNA User's Conference 2018. They include:

- *Fatigue mean stress correction methods*
- *Load steps definition*
- *Fatigue damage evolution*
- *Fatigue failure simulation*
- *Multiaxial fatigue analysis*
- *Fatigue summation*

This paper gives a brief review of these new options for time domain fatigue analysis with LS-DYNA. Some examples are provided to demonstrate the new feature of LS-DYNA and show how to use this feature towards different loading cases.

***Keywords**: LS-DYNA, time domain, fatigue analysis*

Fatigue mean stress correction methods

Mean stress has important effect on fatigue behavior of metal structures. Mean stress correction is necessary for accurate prediction of fatigue life of those metal structures. Under different mean stress, the SN curve of the same material can change quite a lot.

In LS-DYNA, two categories of mean stress correction methods are available.

Use equations to perform mean stress correction, based on the SN curves obtained by fully reversed testing (R = -1, or mean stress = 0). Following mean stress correction equations are available

- Goodman equation
- Soderberg equation
- Gerber equation
- Goodman tension only equation
- Gerber tension only equation
- Morrow equation (for fatigue analysis based on EN curve)
- Smith-Watson-Topper equation (for fatigue analysis based on EN curve)

Use *DEFINE_TABLE to define a family of SN curves. Each curve corresponds to a unique mean stress. In *MAT_ADD_FATIGUE keyword, use the table ID for the SN curve. When a mean stress is not represented by the existing SN curves, interpolation is performed to find the corresponding number of cycles for failure N, for the given stress range or stress amplitude S, under current mean stress.

Figure1 and 2 show a pipe model cumulative damage ratio comparison with and without mean stress correction. One can see that the original damage ratio is 0.002853 and the damage ratio is 0.002917 with mean stress correction.

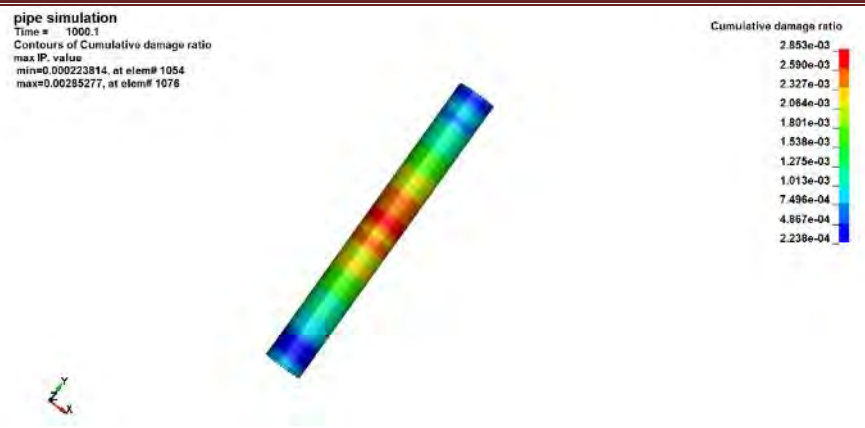


Figure1. Damage ratio without mean stress correction

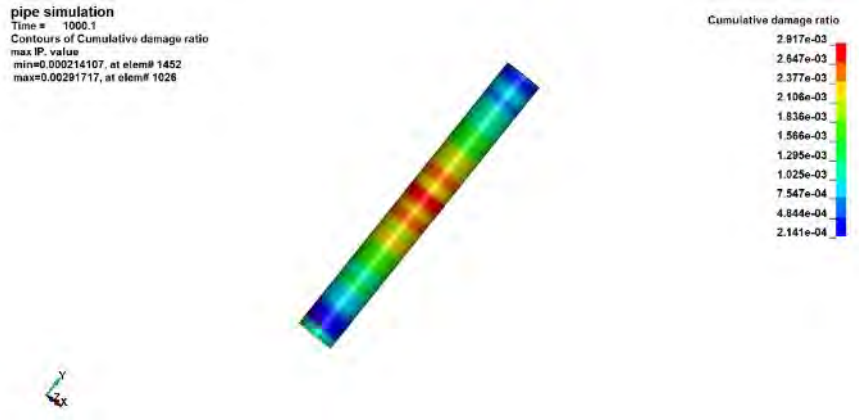


Figure2. Damage ratio with mean stress correction

Load steps definition

A new keyword ***FATIGUE_LOADSTEP** was implemented to define load steps in fatigue analysis.

One can choose which segments of loading history are needed in fatigue analysis. Sometimes user may want to skip the starting transient response in fatigue analysis and use only the steady state cyclic response.

One can compute fatigue cumulative damage ratio for a long-term load, based on representation on a shorter load step. The cumulative damage ratio, computed on the shorter load step, is multiplied by a scale factor (which is the ratio between the duration of real load and the duration of the representative load step), to provide estimation of the cumulative damage ratio for the real load, which could be much longer and be prohibitive to compute otherwise. Of course, it is assumed that stress / strain response in the shorter load step is a good representation of the behavior in the real load step. And the material properties don't change with the number of load cycles, or with the load sequence. In other words, the fatigue behavior of the structure is linear.

The example pipe is modelled by ***MAT_ELASTIC_PLASTIC_THERMAL**. The thermal loading is defined by ***LOAD_THERMAL_LOAD_CURVE**. The keyword cards for ***FATIGUE_LOADSTEP** and other keywords for the load can be found in Figure 3. The thermal loading time history is in Figure4.

```
*FATIGUE_ELOUT
$#     ssid     sstype
$
$#       dt
$
$#   stres      index     restrt     texpos
         0          0
*DATABASE_D3FTG
$#  binary
         1
*FATIGUE_LOADSTEP
$#  tstart       tend     texpos
       0.0        50.    10000.
      50.0       100.    20000.
*DEFINE_CURVE
$#     lcid       sidr        sfa        sfo
      888          0        1.0        1.0
$#                 a1                     o1
                  0.0                    0.0
                  5.0                  200.0
                 10.0                    0.0
                 15.0                  200.0
                 20.0                    0.0
                 25.0                  200.0
                 30.0                    0.0
                 35.0                  200.0
                 40.0                    0.0
                 45.0                  200.0
                 50.0                    0.0
                 55.0                  400.0
                 60.0                    0.0
                 65.0                  400.0
                 70.0                    0.0
                 75.0                  400.0
                 80.0                    0.0
                 85.0                  400.0
                 90.0                    0.0
                 95.0                  400.0
                100.0                    0.0
```

Figure3. Keyword setting for running fatigue time step

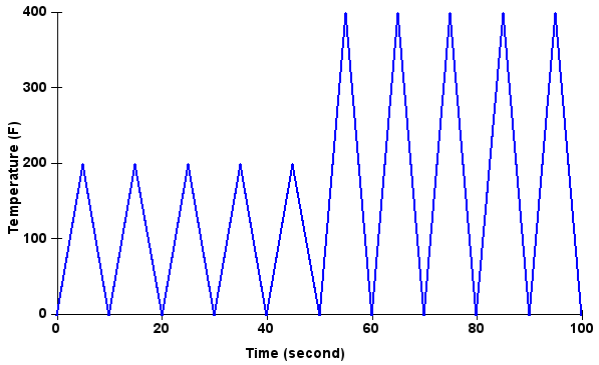


Figure4. Thermal loading time history

The pipe is subjected to two steps of cyclic thermal loading. For the first load step, the temperature varies between 0°F and 200°F and this last for 10000 seconds. For the second load step, the temperature varies between 0°F and 400°F and this last for 20000 seconds. It is very time consuming to run finite element simulation for the whole thermal loading history of 30000 seconds. To get a quick estimation of the cumulative damage ratio, we can reduce the duration for each load step to only 50 seconds, and multiply the cumulative damage ratio generated in each step by a scale factor which is the ratio between the real loading period and the reduced loading period.

Figure 5 shows the distribution of effective stress near the end of simulation. Figure 6 shows the cumulative damage ratio of the pipe, after the 30000 seconds thermal loading. One can see that the maximum values of the effective stress and the cumulative damage ratio appear near the bottom of the pipe, probably due to the stress concentration at the constraints.

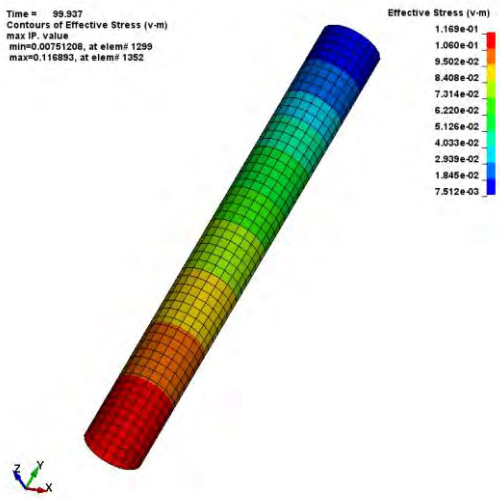


Figure5. Effective stress at the end of simulation

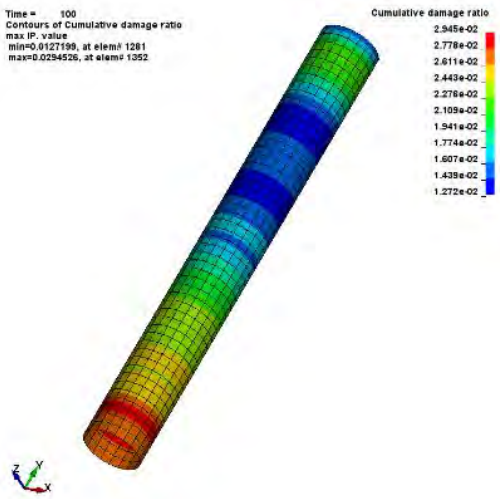


Figure6. Cumulative damage ratio

Fatigue damage evolution

With a nonzero **DT** in ***DATABASE_D3FTG**, LS-DYNA can perform fatigue analysis and dump out d3ftg database every **DT** time. Multiple states are saved in d3ftg and can be plotted using LS-PrePost 4.7 or newer versions. Each state saves cumulative damage ratios for the whole structure at one time point. With this database, user can track the fatigue damage ratio evolution for the structure.

Figure7 shows an L-beam fixed to a bottom plate by four bolts. The plate is constrained to ground. Prescribed harmonic motion (displacement) is applied on the edge of the hole on the L-beam, in the vertical direction. The prescribed displacement time history is shown in Figure8.

The cumulative damage ratio fringe plots at time 0.01s, 0.02s and 0.03s are shown in Figure9. Constant color scale from 0 to 1.0 is used for all the plots so that one can easily compare the magnitude of the cumulative damage ratio and trace the development of the damage. It is clear that the area at the lower edge of the hole experiences higher fatigue damage. The damage ratio increases with time and the damage area expands with time.

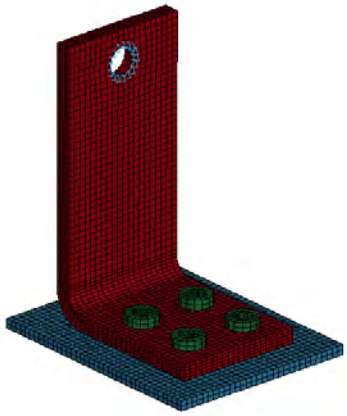


Figure7. A L-BEAM constrained to a bottom plate

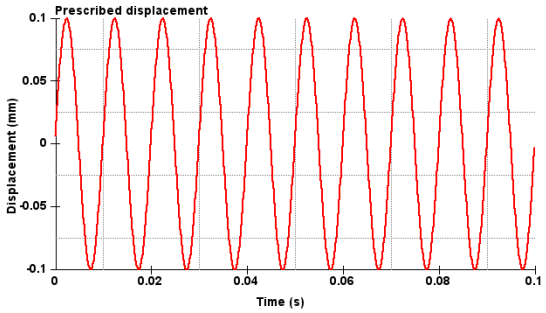
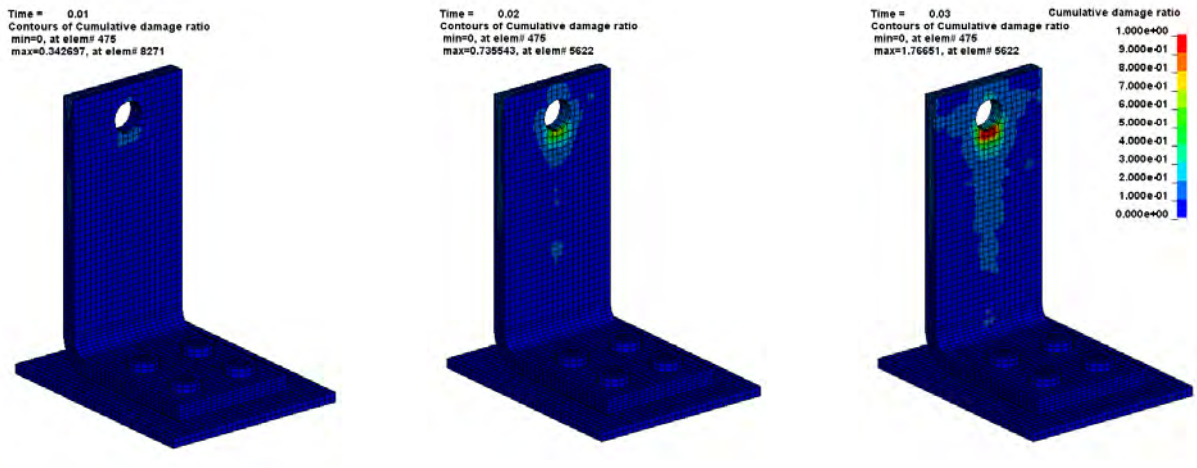


Figure8. Prescribed harmonic displacement on the hole



Time = 0.01s Time = 0.02s Time = 0.03s

Figure9. Cumulative damage ratio at different time points

Fatigue failure simulation

A new keyword ***FATIGUE_FAILURE** was implemented to introduce a mechanism to model the failure of elements due to fatigue. With this keyword, user can define a threshold cumulative damage ratio (the default value is 1.0) and all the elements with cumulative damage ratio larger or equal to this value can be removed from the structure for subsequent simulation. For increased safety factor, the threshold cumulative damage ratio can be defined as a number smaller than 1.0.

This is a simple way to show the local failure of structures due to fatigue, and it provides an opportunity to study the effect of local fatigue failure on the overall behavior of structures in a long term. An approximate fatigue crack propagation trajectory can be obtained by this approach.

A more accurate simulation of the fatigue crack propagation can be achieved by using the approach by fracture mechanics or using the cohesive zone modelling.

The max cumulative damage ratio at time 0.03 second is 1.76651 (see Figure9). It is obvious that several elements have failed (including element 5622, which exhibits the max cumulative damage ratio 1.76651). With ***FATIGUE_FAILURE** and **IFAILURE**= 1 and **DRATIO**=1.0, LS-DYNA automatically removes those elements whose cumulative damage ratio ≥ 1.0 from the structure. The remaining elements and their cumulative damage ratio fringe plot are shown in Figure10. Then the cumulative damage ratio of the remaining elements continues to grow with the loading. Figure11 shows the cumulative damage ratio at 0.04 second. One can see that the cumulative damage ratio of several other elements goes beyond 1.0 at 0.04 second (e.g. element 5587), and this results in failure of those elements too. Those failed elements are removed too, as shown in Figure 12. It is expected that with the loading cycles going on, more and more elements will have cumulative damage ratio ≥ 1.0 and will fail and be removed from the structure. Figure13 shows the keyword setting for modelling fatigue damage evolution and fatigue failure.

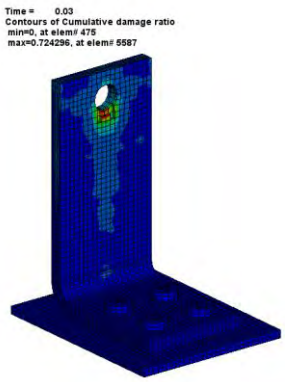


Figure10. Cumulative damage ratio at 0.03s (failed elements are removed)

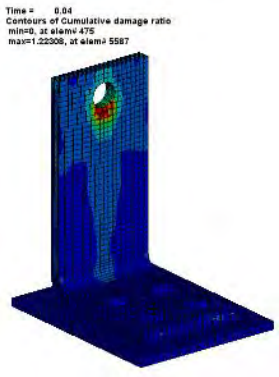


Figure11. Cumulative damage ratio at 0.04s

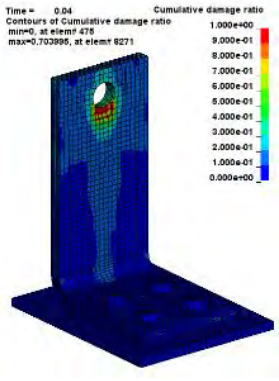


Figure12. Cumulative damage ratio at 0.04s (failed element are removed)

```
*FATIGUE_ELOUT
$#      pid      ptype
$
$#       dt
$
$#    strsn      index     restrt     texpos
          0          0
$
*DATABASE_D3FTG
$#  binary          dt
          1     1.E-02
*FATIGUE_FAILURE
$#ifailure     dratio
          1          1.
*DATABASE_ELOUT
    1.E-05          2
```

Figure13. Keyword setting for modelling fatigue damage evolution and fatigue failure.

Multiaxial fatigue analysis

Many mechanical components experience multiaxial cyclic loadings during their service life. Compared with the uniaxial fatigue problem, the multiaxial fatigue problem is more complex due to the complex stress / strain states and loading histories. Stress / strain state is always three dimensional.

Three multiaxial fatigue methods are provided in LS-DYNA time domain fatigue analysis. Figure14 shows keyword setting for modelling multiaxial fatigue.

- A scalar index (e.g. Von-Mises stress, 1st principal stress) can be used
- Fatigue damage is computed on multiple planes and the max value is picked
- A critical plane is located, and fatigue analysis is performed on the critical plane

```
*FATIGUE_ELOUT
$#     ssid     sstype
$
$#       dt
$
$#    stres      index
                      1
*FATIGUE_MULTIAXIAL
$#  maxial     nplane
         1        180
```

Figure14. Keyword setting for modelling multiaxial fatigue

Figure15 and 16 show the cumulative damage ratio of a simple plate with different multiaxial approaches. One can see that the damage ratio is 1.2655 with MAXIAL=0 and the damage ratio is 1.3045 with MAXIAL=2.

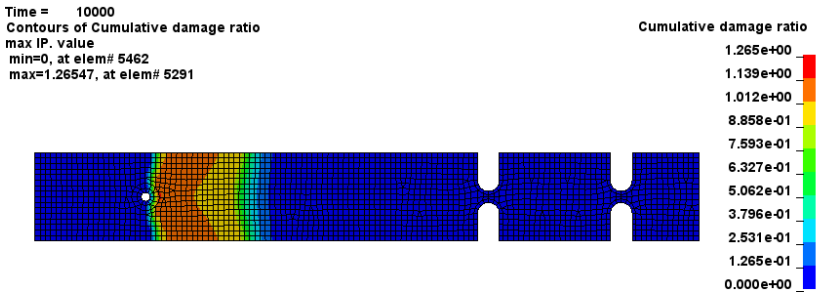


Figure15. Cumulative damage ratio for MAXIAL=0

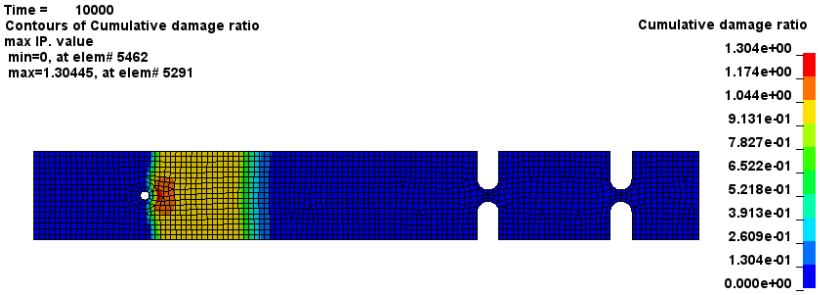


Figure16. Cumulative damage ratio for MAXIAL=2

Fatigue summation

This keyword reads in existing fatigue databases defined by ***INITIAL_FATIGUE_DAMAGE_RATIO** and sum up the damage ratio results from them to obtain the final cumulative damage ratio. The final cumulative damage ratio results are dumped to a new d3ftg database. The Figure17 and 18 show a comparison of a simple plate cumulative damage ratio with and without damage from transient preload. One can see that the damage ratio is 0.3440 from fatigue load and the damage ratio is 0.3443 from fatigue load plus transient preload.

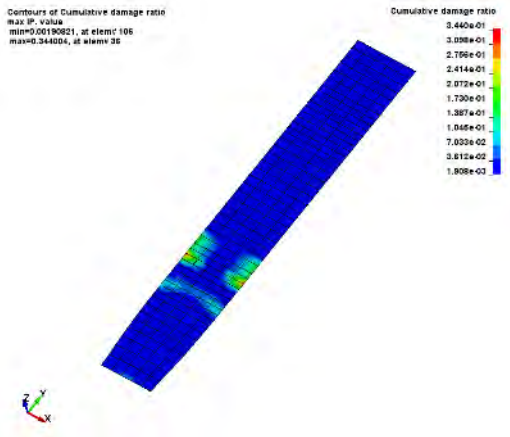


Figure17. Damage ratio from fatigue load

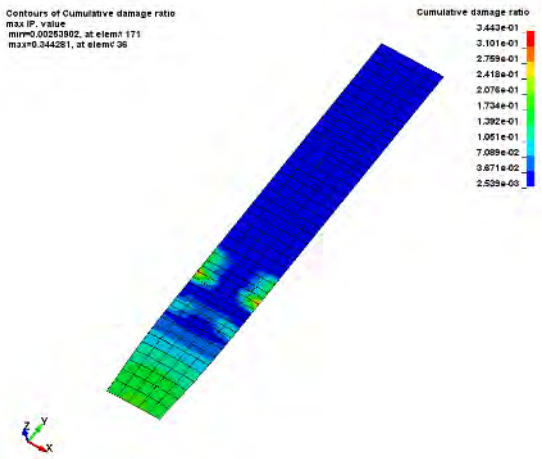


Figure18. Cumulative damage ratio from transient preload + fatigue load

Summary

This paper reviews recent updates in time domain fatigue analysis in LS-DYNA, and introduces several new keywords and options for running these features. These new options and enhancements enable users to solve more comprehensive problems in NVH and durability analysis.

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BETA CAE Systems μETA

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Process Automation - Data Management – Meshing – Durability - Crash & Safety NVH - CFD - Thermal analysis - Optimization - Powertrain
Products made of composite materials - Analysis Tools -
Maritime and Offshore Design - Aerospace engineering - Biomechanics

ETA – Engineering Technology Associates www.eta.com
etainfo@eta.com

Inventium Suite™

Inventium Suite™ is an enterprise-level CAE software solution, enabling concept to product. Inventium's first set of tools will be released soon, in the form of an advanced Pre & Post processor, called PreSys.

Inventium's unified and streamlined product architecture will provide users access to all of the suite's software tools. By design, its products will offer a high performance modeling and post-processing system, while providing a robust path for the integration of new tools and third party applications.

PreSys

Inventium's core FE modeling toolset. It is the successor to ETA's VPG/PrePost and FEMB products. PreSys offers an easy to use interface, with drop-down menus and toolbars, increased graphics speed and detailed graphics capabilities. These types of capabilities are combined with powerful, robust and accurate modeling functions.

VPG

Advanced systems analysis package. VPG delivers a unique set of tools which allow engineers to create and visualize, through its modules--structure, safety, drop test, and blast analyses.

DYNAFORM

Complete Die System Simulation Solution. The most accurate die analysis solution available today. Its formability simulation creates a "virtual tryout", predicting forming problems such as cracking, wrinkling, thinning and spring-back before any physical tooling is produced.

ESI Group www.esi-group.com

Visual-Environment is an integrative simulation platform for simulation tools operating either concurrently or standalone for various solver. Comprehensive and integrated solutions for meshing, pre/post processing, process automation and simulation data management are available within same environment enabling seamless execution and automation of tedious workflows. This very open and versatile environment simplifies the work of CAE engineers across the enterprise by facilitating collaboration and data sharing leading to increase of productivity.

Visual-Crash DYNA provides advanced preprocessing functionality for LS-DYNA users, e.g. fast iteration and rapid model revision processes, from data input to visualization for crashworthiness simulation and design. It ensures quick model browsing, advanced mesh editing capabilities and rapid graphical assembly of system models. Visual-Crash DYNA allows graphical creation, modification and deletion of LS-DYNA entities. It comprises tools for checking model quality and simulation parameters prior to launching calculations with the solver. These tools help in correcting errors and fine-tuning the model and simulation before submitting it to the solver, thus saving time and resources.
Several high productivity tools such as advanced dummy positioning, seat morphing, belt fitting and airbag folder are provided in **Visual-Safe,** a dedicated application to safety utilities.

Visual-Mesh is a complete meshing tool supporting CAD import, 1D/2D/3D meshing and editing for linear and quadratic meshes. It supports all meshing capabilities, like shell and solid automesh, batch meshing, topo mesh, layer mesh, etc. A convenient Meshing Process guides you to mesh the given CAD component or full vehicle automatically.

Visual-Viewer built on a multi-page/multi-plot environment, enables data grouping into pages and plots. The application allows creation of any number of pages with up to 16 windows on a single page. These windows can be plot, animation, video, model or drawing block windows. Visual-Viewer performs automated tasks and generates customized reports and thereby increasing engineers' productivity.

Visual-Process provides a whole suite of generic templates based on LS-DYNA solver (et altera). It enables seamless and interactive process automation through customizable LS-DYNA based templates for automated CAE workflows.

All generic process templates are easily accessible within the unique framework of Visual-Environment and can be customized upon request and based on customer's needs.

Visual*DSS* is a framework for Simulation Data and Process Management which connects with Visual-Environment and supports product engineering teams, irrespective of their geographic location, to make correct and realistic decisions throughout the virtual prototyping phase. Visual*DSS* supports seamless connection with various CAD/PLM systems to extract the data required for building virtual tests as well as building and chaining several virtual tests upstream and downstream to achieve an integrated process. It enables the capture, storage and reuse of enterprise knowledge and best practices, as well as the automation of repetitive and cumbersome tasks in a virtual prototyping process, the propagation of engineering changes or design changes from one domain to another.

JSOL Corporation www.jsol.co.jp/english/cae/

HYCRASH

Easy-to-use one step solver, for Stamping-Crash Coupled Analysis. HYCRASH only requires the panels' geometry to calculate manufacturing process effect, geometry of die are not necessary. Additionally, as this is target to usage of crash/strength analysis, even forming analysis data is not needed. If only crash/strength analysis data exists and panel ids is defined. HYCRASH extract panels to calculate it's strain, thickness, and map them to the original data.

JSTAMP/NV

As an integrated press forming simulation system for virtual tool shop the JSTAMP/NV meets the various industrial needs from the areas of automobile, electronics, iron and steel, etc. The JSTAMP/NV gives satisfaction to engineers, reliability to products, and robustness to tool shop via the advanced technology of the JSOL Corporation.

JMAG

JMAG uses the latest techniques to accurately model complex geometries, material properties, and thermal and structural phenomena associated with electromagnetic fields. With its excellent analysis capabilities, JMAG assists your manufacturing process.

LST

Livermore Software Technology, an ANSYS Company
www.lstc.com

LS-DYNA

A general-purpose finite element program capable of simulating complex real world problems. It is used by the automobile, aerospace, construction, military, manufacturing, and bioengineering industries. LS-DYNA is optimized for shared and distributed memory Unix, Linux, and Windows based, platforms, and it is fully QA'd by LST, an ANSYS company. The code's origins lie in highly nonlinear, transient dynamic finite element analysis using explicit time integration.

LS-PrePost

An advanced pre and post-processor that is delivered free with LS-DYNA. The user interface is designed to be both efficient and intuitive. LS-PrePost runs on Windows, Linux, and Macs utilizing OpenGL graphics to achieve fast rendering and XY plotting.

LS-OPT

LS-OPT is a standalone Design Optimization and Probabilistic Analysis package with an interface to LS-DYNA. The graphical preprocessor LS-OPTui facilitates definition of the design input and the creation of a command file while the postprocessor provides output such as approximation accuracy, optimization convergence, tradeoff curves, anthill plots and the relative importance of design variables.

LS-TaSC

A Topology and Shape Computation tool. Developed for engineering analysts who need to optimize structures, LS-TaSC works with both the implicit and explicit solvers of LS-DYNA. LS-TaSC handles topology optimization of large non-linear problems, involving dynamic loads and contact conditions.

LST, AN ANSYS COMPANY Dummy Models

Anthropomorphic Test Devices (ATDs), as known as "crash test dummies", are life-size mannequins equipped with sensors that measure forces, moments, displacements, and accelerations.

LST, AN ANSYS COMPANY Barrier Models

LSTC offers several Offset Deformable Barrier (ODB) and Movable Deformable Barrier (MDB) model.

Material Sciences Corporation www.materials-sciences.com

Materials Sciences Corporation has provided 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. MSC's corporate mission has expanded beyond basic research and development now to include transitioning its proprietary technologies from the research lab into innovative new products. This commitment is demonstrated through increased staffing and a more than 3-fold expansion of facilities to allow in-house manufacturing and testing of advanced composite materials and structures.

Materials Sciences Corporation (MSC) MAT161/162 - enhanced features have been added to the Dynamic Composite Simulator module of LS-DYNA.

This enhancement to LS-DYNA, known as MAT161/162, enables the most effective and accurate dynamic progressive failure modeling of composite structures to enable the most effective and accurate dynamic progressive failure modeling of composite structures currently available.

MSC/LS-DYNA Composite Software and Database -

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

- MSC and LSTC have joined forces in developing this powerful composite dynamic analysis code.
- For the first time, users will have the enhanced ability to simulate explicit dynamic engineering problems for composite structures.
- 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.

MSC's LS-DYNA module can be used to characterize a variety of composite structures in numerous applications—such as this composite hull under blast.

Oasys Ltd. LS-DYNA Environment www.oasys-software.com/dyna

The Oasys Suite of software is exclusively written for LS-DYNA® and is used worldwide by many of the largest LS-DYNA® customers. The suite comprises of:

Oasys PRIMER

Key benefits:

- Pre-Processor created specifically for LS-DYNA®
- Compatible with the latest version of LS-DYNA®
- Maintains the integrity of data
- Over 6000 checks and warnings – many auto-fixable
- Specialist tools for occupant positioning, seatbelt fitting and seat squashing (including setting up pre-simulations)
- Many features for model modification, such as part replace
- Ability to position and depenetrate impactors at multiple locations and produce many input decks automatically (e.g. pedestrian impact, interior head impact)
- Contact penetration checking and fixing
- Connection feature for creation and management of connection entities.
- Support for Volume III keywords and large format/long labels
- Powerful scripting capabilities allowing the user to create custom features and processes

www.oasys-software.com/dyna

Oasys D3PLOT

Key benefits:

- Powerful 3D visualization post-processor created specifically for LS-DYNA®
- Fast, high quality graphics
- Easy, in-depth access to LS-DYNA® results
- Scripting capabilities allowing the user to speed up post-processing, as well as creating user defined data components

www.predictiveengineering.com

Predictive Engineering provides finite element analysis consulting services, software, training and support to a broad range of engineering companies across North America. We strive to exceed client expectations for accuracy, timeliness and knowledge transfer. Our process is both cost-effective and collaborative, ensuring all clients are reference clients.

Our mission is to be honest brokers of information in our consulting services and the software we represent.

Our History

Since 1995, Predictive Engineering has continually expanded its client base. Our clients include many large organizations and industry leaders such as SpaceX, Nike, General Electric, Navistar, FLIR Systems, Sierra Nevada Corp, Georgia-Pacific, Intel, Messier-Dowty and more. Over the years, Predictive Engineering has successfully completed more than 800 projects, and has set itself apart on its strong FEA, CFD and LS-DYNA consulting services.

Shanghai Hengstar www.hengstar.com

Center of Excellence: Hengstar Technology is the first LS-DYNA training center of excellence in China. As part of its expanding commitment to helping CAE engineers in China, Hengstar Technology will continue to organize high level training courses, seminars, workshops, forums etc., and will also continue to support CAE events such as: China CAE Annual Conference; China Conference of Automotive Safety Technology; International Forum of Automotive Traffic Safety in China; LS-DYNA China users conference etc.

On Site Training: Hengstar Technology also provides customer customized training programs on-site at the company facility. Training is tailored for customer needs using LS-DYNA such as material test and input keyword preparing; CAE process automation with customized script program; Simulation result correlation with the test result; Special topics with new LS-DYNA features etc..

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.

Hengstar also distributes and supports d3View; Genesis, Visual DOC, ELSDYNA; Visual-Crash Dyna, Visual-Process, Visual-Environment; EnkiBonnet; and DynaX & MadyX etc.

Consulting

As a consulting company, Hengstar focuses on LS-DYNA applications such as crash and safety, durability, bird strike, stamping, forging, concrete structures, drop analysis, blast response, penetration etc with using LS-DYNA's advanced methods: FEA, ALE, SPH, EFG, DEM, ICFD, EM, CSEC..

Cloud - HPC Services - Subscription JSOL

Contact: JSOL Corporation Engineering Technology Division cae-info@sci.jsol.co.jp

Cloud computing services
for
JSOL Corporation LS-DYNA users in Japan

JSOL Corporation is cooperating with chosen cloud computing services

JSOL Corporation, a Japanese LS-DYNA distributor for Japanese LS-DYNA customers.

LS-DYNA customers in industries / academia / consultancies are facing increased needs for additional LS-DYNA cores

In calculations of optimization, robustness, statistical analysis, we find that an increase in cores of LS-DYNA are needed, for short term extra projects or cores.

JSOL Corporation is cooperating with some cloud computing services for JSOL's LS-DYNA users and willing to provide short term license.

This service is offered to customers using Cloud License fee schedule, the additional fee is less expensive than purchasing yearly license.

The following services are available (only in Japanese). HPC OnLine:

NEC Solution Innovators, Ltd. - http://jpn.nec.com/manufacture/machinery/hpc_online/

Focus - Foundation for Computational Science
http://www.j-focus.or.jp

Platform Computation Cloud - CreDist.Inc.

PLEXUS CAE
Information Services International-Dentsu, Ltd. (ISID) https://portal.plexusplm.com/plexus-cae/

SCSK Corporation - http://www.scsk.jp/product/keyword/keyword07.html

Cloud - HPC Services - Subscription RESCALE

www.rescale.com

Rescale: Cloud Simulation Platform

The Power of Simulation Innovation

We believe in the power of innovation. Engineering and science designs and ideas are limitless. So why should your hardware and software be limited? You shouldn't have to choose between expanding your simulations or saving time and budget.

Using the power of cloud technology combined with LS-DYNA allows you to:

- Accelerate complex simulations and fully explore the design space
- Optimize the analysis process with hourly software and hardware resources
- Leverage agile IT resources to provide flexibility and scalability

True On-Demand, Global Infrastructure

Teams are no longer in one location, country, or even continent. However, company data centers are often in one place, and everyone must connect in, regardless of office. For engineers across different regions, this can cause connection issues, wasted time, and product delays.

Rescale has strategic/technology partnerships with infrastructure and software providers to offer the following:

- Largest global hardware footprint – GPUs, Xeon Phi, InfiniBand
- Customizable configurations to meet every simulation demand
- Worldwide resource access provides industry-leading tools to every team
- Pay-per-use business model means you only pay for the resources you use
- True on-demand resources – no more queues

ScaleX Enterprise: Transform IT, Empower Engineers, Unleash Innovation

The ScaleX Enterprise simulation platform provides scalability and flexibility to companies while offering enterprise IT and management teams the opportunity to expand and empower their organizations.

Rescale Cloud Simulation Platform www.rescale.com

ScaleX Enterprise allows enterprise companies to stay at the leading edge of computing technology while maximizing product design and accelerating the time to market by providing:

- Collaboration tools
- Administrative control
- API/Scheduler integration
- On-premise HPC integration

Industry-Leading Security

Rescale has built proprietary, industry-leading security solutions into the platform, meeting the needs of customers in the most demanding and competitive industries and markets.

- Manage engineering teams with user authentication and administrative controls
- Data is secure every step of the way with end-to-end data encryption
- Jobs run on isolated, kernel-encrypted, private clusters
- Data centers include biometric entry authentication
- Platforms routinely submit to independent external security audits

Rescale maintains key relationships to provide LS-DYNA on demand on a global scale. If you have a need to accelerate the simulation process and be an innovative leader, contact Rescale or the following partners to begin running LS-DYNA on Rescale's industry-leading cloud simulation platform.

LSTC - DYNAmore GmbH JSOL Corporation

Rescale, Inc. - 1-855-737-2253 (1-855-RESCALE) - info@rescale.com

944 Market St. #300, San Francisco, CA 94102 USA

ESI Cloud Based Virtual Engineering Solutions

www.esi-group.com

ESI Cloud offers designers and engineers cloud-based computer aided engineering (CAE) solutions across physics and engineering disciplines.

ESI Cloud combines ESI's industry tested virtual engineering solutions integrated onto ESI's Cloud Platform with browser based modeling,

With ESI Cloud users can choose from two basic usage models:

- An end-to-end SaaS model: Where modeling, multi-physics solving, results visualization and collaboration are conducted in the cloud through a web browser.
- 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.

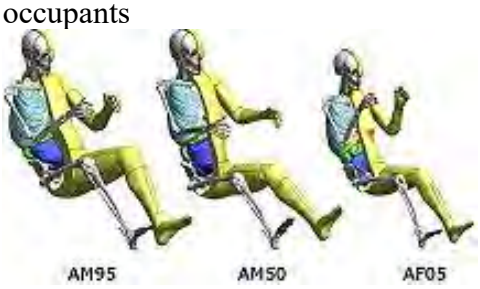
Key collaboration capabilities:

- 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

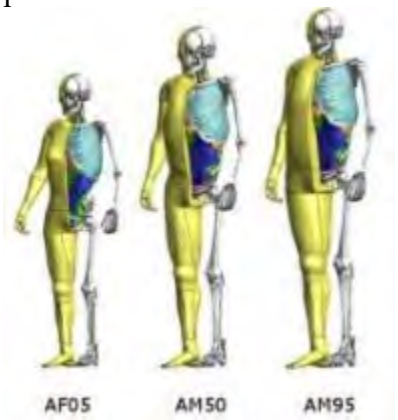
TOYOTA - Total Human Model for Safety – THUMS

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.

LST, An ANSYS Company – Dummy Models

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

LST, An ANSYS Company – 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.

Social Media

FACEBOOK

BETA CAE Systems
CADFEM
ESI Group

TWITTER

BETA CAE Systems
ESI Group
ETA
CADFEM

LINKEDIN

BETA CAE Systems
CADFEM
DYNAmore Nordic
ETA
ESI Group

YOUTUBE

YOUTUBE Channel	WebSite URL
BETA CAE Systems	www.beta-cae.com
CADFEM	www.cadfem.de
ESI Group	www.esi-group.com
ETA	www.eta.com
Lancemore	www.lancemore.jp/index_en.html
LS-DYNA OnLine - (Al Tabiei)	https://www.youtube.com/user/LSDYNATV

GOOGLE+

BETA CAE Systems