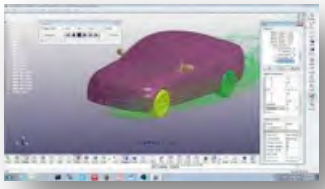
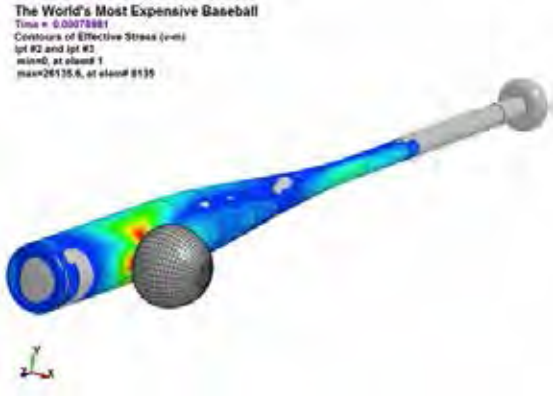
fea INFORMATION
Engineering Solutions

Volume 5, Issue 01, January 2016

ICFD Post treatment with LSPP4.3

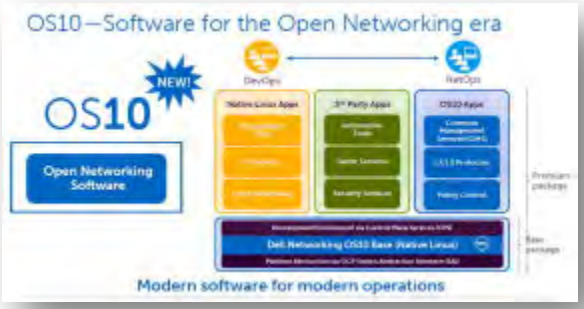


Observations on Material Modeling



NASA's CORAL Campaign

DELL Raises the Bar for Open Networking



FEA Information Inc.

A publishing company founded April 2000 – published monthly since October 2000.

The publication's focus is engineering technical solutions/information.

FEA Information Inc. publishes:

FEA Information Engineering Solutions

FEA Information Engineering Journal

FEA Information China Engineering Solutions

Livermore Software Technology, Corp. (LSTC) Developer of LS-DYNA One Code Methodology.

LS-DYNA provides fully integrated, strongly coupled, solvers for extensive multiphysics capabilities. Integrated, at no additional cost. Optimized for shared and distributed memory for Unix, Linux, & Windows Based platforms.

FEA Information Engineering Solutions – Dedicated To:

Finite Element Analysis * Hardware * Software * Cloud * Consulting * CAD * CAE Distribution* * Implicit * Explicit *Applications * Press Releases * Events * Training

logo courtesy - Lancemore


BETA
CAE Systems SA


CRAY


eta


esi


JSOL


恒士达科技
Hengstar Tech.


Oasys
The Software House of Arup


rescale


DELL

FEA Information News Sections

Articles – Blogs - News

AEROSPACE NEWS & EVENTS

Automotive & Aerospace Will Return January 2016

LS-DYNA Resources

Publication Showcase - Qiangsheng Zhao

Welcome Dell as a Platinum Participant – www.dell.com

Welcome to 2016 and we hope to continue with technical articles and articles of interest.

With the February issue LSTC will be publishing the Sponsors and Exhibitors to their upcoming June Conference.

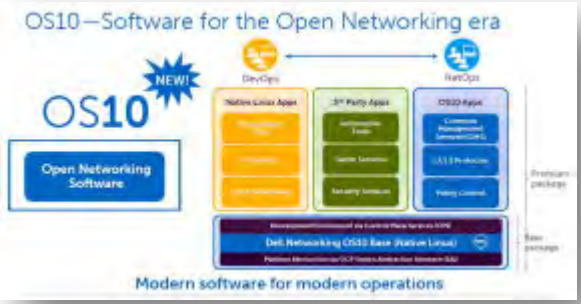
If you are interested in participation for the 2016 FEA Information Engineering Solutions please contact Marsha Victory mv@feainformation.com

Sincerely,

Marsha Victory Trent Eggleston Marnie Azadian
Suri Bala Dilip Bhalsod Yanhua Zhao
FEA Information Engineering Solutions US Edition

DELL Raises the Bar for Open Networking

For High resolution graphic www.dell.com Date : 1/20/2016 - Round Rock, Texas



Dell Raises the Bar for Open Networking with New Disaggregated Software to Maximize Customer Choice and Capability

- Operating System 10 (OS10) from Dell Networking establishes a new benchmark for open software modularity and design for large-scale data centers, cloud operators
- Base module leverages unmodified, open-source Linux with platform portability and rich application development environment
- Dell plus third-party applications and programmability available to tailor software for different use cases and operational models

Dell today extended its reach in Open Networking with the announcement of Operating System 10 (OS10) from Dell Networking. This next-generation networking software is designed to introduce new levels of software flexibility and programmability in large-scale data center environments. The OS10 software environment advances the functionality of modern data centers by disaggregating network software, so customers have more choice in how software is used throughout IT operations.

"Modern, software-defined, data centers require a fresh approach to operations – not just for the network, but across compute and storage elements as well," said Tom Burns, vice president and general manager, Dell Networking and Enterprise Infrastructure. "OS10 gives customers a future-ready springboard to innovate their networks and data center infrastructure more quickly and consistently, affording customers greater efficiency and capability at scale."

"OS10 represents an interesting new direction for Dell as it continues to extend and enhance its networking portfolio with innovations in software and hardware," said Brad Casemore, Research Director, Datacenter Networks, IDC. "It's worth noting that Dell also is looking beyond networking as

an operational silo or a discrete domain, anticipating fast-evolving requirements for consumption models, IT operations, and the breaking down of traditional IT silos."

Disaggregating the Network OS Stack

The OS10 platform is designed around new benchmarks for open software modularity so users can create the most efficient and flexible paths across networked systems. OS10 is comprised of a base module and various optional application modules. Now, what had formerly been bundled into tightly-integrated, vendor-specific stacks, has been separated to enhance customer choice, control and programmability.

- **OS10 Base Module** – The OS10 Base Module is available for free and runs a fully-open, unmodified Linux distribution. Linux is one of the most widely-used operating systems and can provide a common language across multiple IT layers including networking, storage and compute. The OS10 Base Module can leverage the Linux community-based benefits which can help enhance its programmability, portability, and flexibility for the application layer above it.

Below it, the OS 10 Base Module employs the Open Compute Project Switch Abstraction Interface (SAI) that enables a common, programmer-friendly language between vendor network operating systems and the particular silicon residing on the physical switch. Today, SAI helps web-scale companies and cloud providers take advantage of the latest silicon innovation by enabling them to program the switches more granularly.

- **OS10 Application Modules** – On top of the base module, OS10 can support traditional networking functions (L2/L3 protocols) from Dell as well as numerous third-party, native Linux, and open source applications such as IP, fabric and security services combined with management and automation tools. This allows customers to tailor IT operations for different use case and operational processes.

From Network Operations to Development Operations

OS10's unmodified Linux base provides distinct advantages as customers increasingly look to design applications and data centers across server, storage and networking – not just one silo. While OS10 will have appeal for traditional network operators seeking conventional programming means, the software will also appeal to DevOps communities seeking a consistent, common development environment across server, storage and networking elements.

DELL Raises the Bar for Open Networking

"The ability for organizations to define their infrastructure-as-code is a foundational and necessary part of any DevOps initiative, enabling practices like collaboration and continuous delivery," said Nigel Kersten, CIO at Puppet Labs. "It provides one common language that can be shared across traditionally siloed organizations - like development, compute, networking and storage - reducing unnecessary complexity, while increasing both speed and availability. We look forward to continuing to work with Dell and the new OS10 offering as more organizations apply DevOps practices to network management."

Unlocking Customer Innovation - OS10 highlights the potential for helping customers rapidly develop, customize and ultimately take advantage of a true software-defined data center. Some examples include:

- "OS10 from Dell Networking provides the unique flexibility and programmability necessary for a modern cloud provider to innovate and succeed in a fast-changing environment. We're already seeing significant operational benefits from having server-like manageability combined with our server-centric automation tools." - Jason Long, Director, Network Architecture & Operations, Joyent
- "I believe Dell is onto something special with OS10. It provides a unique development platform to rapidly prototype customized solutions and help slash time to production. With OS10's openness and programming adaptability, I've been able to install standard mono runtime and the F# language packages and quickly develop a secure IoX application gateway. I can even compile and debug on OS10, and because I have the same software stack, I can do it on my PC to be more productive. I love it!" - Prof. Antonio Cisternino, Vice-Director IT Center, University of Pisa

Availability - In March, Dell expects OS10 base module will begin shipping and Dell-developed application modules will enter beta testing for release later in the year.

Links for the article visit www.dell.com – this insures DELL updated link changes

- Video: Tom Burns, VP and GM, Dell Networking and Enterprise Infrastructure, discusses OS10
- Blog: Dell Networking Rocks the Data Center Again
- OS10 product page - Dell Networking home page \
- pen Networking wiki, Dell TechCenter
- Follow us at @DellNetworking on Twitter and Dell Enterprise Group on LinkedIn

About Dell - Dell Inc. listens to customers and delivers innovative technology and services that give them the power to do more. For more information, visit www.dell.com.

LS-DYNA: Observations on Material Modeling

A series of informal articles about one engineer's usage of LS-DYNA to solve a variety of non-crash simulation problems.

By: George Laird, PhD, PE
Principal Mechanical Engineer, Predictive Engineering

www.predictiveengineering.com

As a former metallurgist whose specialty was structure-property relationships, I have a keen appreciation for how materials deform under load. At the federal lab where I worked, we had a lot of mechanical test equipment where I could break, crush and impact all sorts of things. This experience grounded me in my appreciation of how difficult it is to simulate the mechanical response of materials using some sort of X-Y plot of stress versus strain.

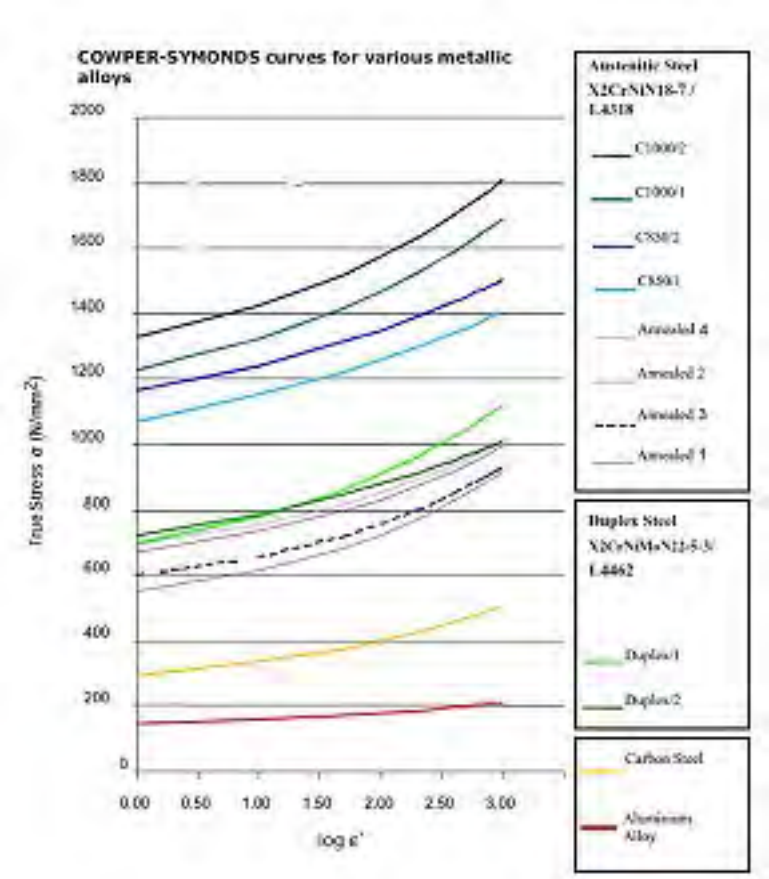
If one has been reading my prior articles, one knows that I obsess on error management. One client remarked, "Could you put error bars on your stress numbers?" I wish I could, but we do engineering projects that have tight schedules and finite budgets. To really quantify your model's error, or perhaps better said, its deviation from experimental truth, requires one to start first with the material model and then move along through all the other modeling assumptions and slights of hand. One day I'll find my Unicorn client that wants to do this but I'm not holding my breath. In the meantime, for us working engineers, let's talk about simple material modeling that will keep you out of the weeds (since for the difficult stuff I punt and hire a real 'DYNA material expert).

General Entry-Level Discussion on Material Modeling Everybody's Favorite: HSLA Steel

If you are looking for a primer on how to convert engineering stress v strain into true stress v strain, you have come to the wrong place. That's too simple and enough academicians have already covered it in detail. So let's talk about some of the tricks of the trade that I have learned from reading and my colleagues. A quote that I just love to repeat is "A piece of paper with a stress v strain curve on it is NOT material test data." That is, one starts with real experimental test data in spreadsheet form and not picking points off of a curve with a straight-edge and pencil. Once you have real data, it can be imported into one of the world's handiest material test data processing free software – LS-PrePost (LSPP). With your data in LSPP, you can average it to remove little spikes and then with the reduced data (one saves the averaged data and then reads it back into LSPP), one can take the derivative to find slope changes. Since steel deforms in a smooth continuous manner through dislocation movement, one should find no sharp slope changes in the curve.

If you do – go back and do some more averaging. Once you have a smooth curve, you can then convert it to true stress versus strain. Also keep in mind that LS-DYNA discretizes your curve down to a default 100 points (see Remark 1 in *DEFINE_CURVE writeup). For basic steels this is fine but for most rubbers/foams/bone/etc. it is useful to bump this value up to say 500 (see LCINT in *CONTROL_SOLUTION) since the curve goes from compression to tension and is highly nonlinear. What this means is that when you are smoothing your material data, there is rarely a need to have a 'DYNA material curve with more than 500 XY pairs.

For metallic materials, a better way is to use an equation and avoid this whole messy point-to-point interpolation. A good choice is the *MAT_SIMPLIFIED_JOHNSON_COOK (*MAT_098) for numerical efficiency and, an even better reason, that Varmint Al has compiled a list of 1,044 metallic materials such as aluminum, copper, magnesium, steel, stainless steel, etc. all ready to drop into your 'DYNA model.



What about Strain Rate for Steels?

Most 'DYNA simulations are dynamic, meaning that the yield stress will scale (i.e., increase) with the strain rate (see Figure 1). This, of course, is a generality and unless you have published or experimental data, it is a bit of guess work. It is not something to run from; just realize that if you have a high-strain rate event, you might want to play around with strain rate effects.

Figure 1: Strain rate effect in steel and aluminum

Material Failure Modeling: GISSMO et al.

I would be remiss not to say a few words about Generalized Incremental Stress-State dependent damage Model or GISSMO (I know – it doesn't exactly match up) that is setup under the *MAT_ADD_EROSION card. Let me say that if you think you need to use GISSMO it might be a good time to hire a 'DYNA material modeling expert and that is not me.

My observation on GISSMO is that it allows one to account for triaxial stress effects and facilitates a more accurate prediction of material failure. My more basic approach is to differentiate between tensile and compressive failure modes. This can be done by using EFFEPS to define compressive failure strain and MXEPS to define tensile failure. I like to use a ratio of 3-to-1 between EFFEPS and MXEPS. Why? Lots of reasons due to compressive failure in metals, but as a mechanician I like to explain the use of this 3-1 ratio based on the stress concentration factors for a hole in an infinite plate.

Under compressive load, a tensile stress of +1 exists at the 0 degrees (aligned with the load) and a
compressive stress of -3 at 90 degrees and of course, vice-a-versa for a tensile load. Thus, under compressive load, all defects and voids in the material will have tensile stresses equivalent to yield at 3x compressive loads – to a general back-of-the-envelope degree.

One can also desensitize the failure behavior by requiring all integration points in the element to fail prior to element deletion (NUMFIP) and so on and so forth. The number of options is truly amazing and scary. Before getting lost in the bark and not seeing the forest, accurately predicting material failure can be crazy complex and it requires companion studies on mesh sensitivity, element choice (plate v solid), element formulation, hourglass, contact formulation, mass scaling (come on – everybody uses a bit of mass scaling) and I'm sure more stuff.

My approach is to keep it simple going out of the gate and just use EFFEPS and MXEPS. For our simulations over the last decade, it has served us well with accurate predictions but since all models are wrong, your experience may be different from ours.

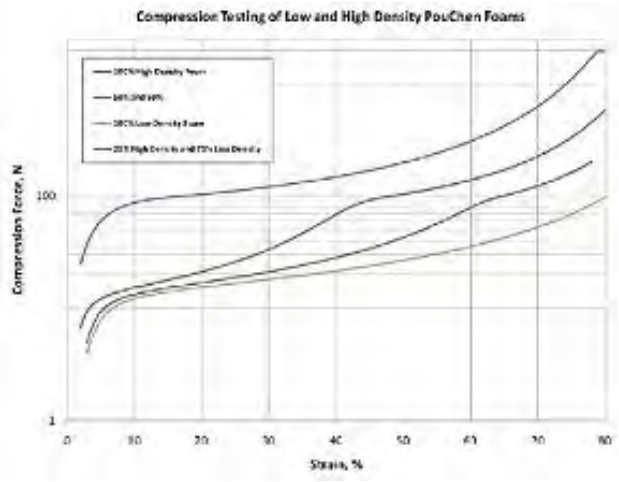
The Softer Side of Material Modeling: Plastics / Elastomers / Foams

Let's get it out on the table, *MAT_PIECEWISE_LINEAR_PLASTICITY (*MAT_24) does a really nice job in capturing the deformation response of engineering plastics. One just has to be careful with how you define the stress v strain curve (understatement). As for elastomers (rubbers) and foams, I have relied upon *MAT_SIMPLIFIED_RUBBER/FOAM (*MAT_181) and *MAT_FU_CHANG_FOAM (*MAT_83), respectively. What I like about *MAT_181 and likewise with *MAT_83) is that one can enter experimental force versus elongation data directly into the material card and be done with it.

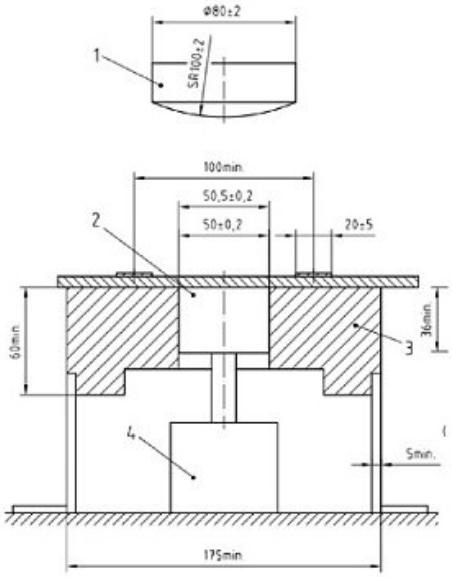
In Figure 2, on the next page, I show some test data and its comparison to experimental results. There is a funny story behind this project. For several long days I labored to get correlation between the model and the test. The test's peak impact force was far higher than my model. After suffering enough, I called my material expert and expressed my plight.

He asked how the experimental data was being processed and I said that they were averaging the data over several impacts. There was a long pause and then the obvious was spoken. If the impact is sufficiently severe, the foam walls will break down and the foam crushes into a dense brick of plastic. Hence, the peak force would, of course, steadily increase after each impact. I went back and used only the data from the first impact event and the model correlated to engineering perfection (i.e., 5%).

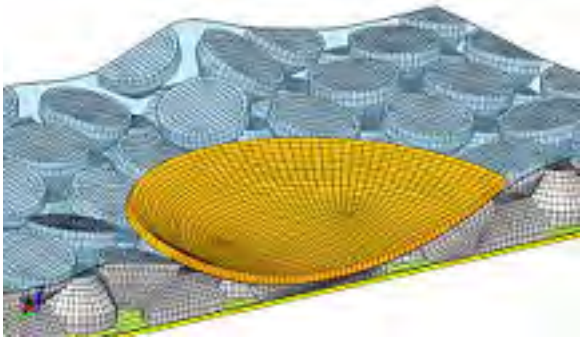
Experimental Foam Data



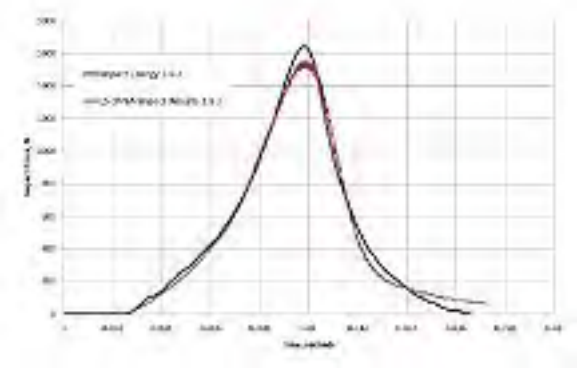
EN-1621-2 Impact Test



LS-DYNA Impact Analysis of Foam Model



Comparison of Impact Test Data with FEA



Before leaving material modeling of soft stuff, I want to show (on the following page) a really sweet *MAT_181 curve for an elastomer. Such a curve was used for modeling a baseball. It was a nice little project where the cost to model the bat was a few thousand but the cost to calibrate the material model to match a "baseball" was in the tens of thousands. Why so much? The bat was simple aluminum but the complex response of a baseball under large deformation was a whole other ball game. Figure 3, on the next page, shows the material curve and a few freeze-frames of the ball's response.

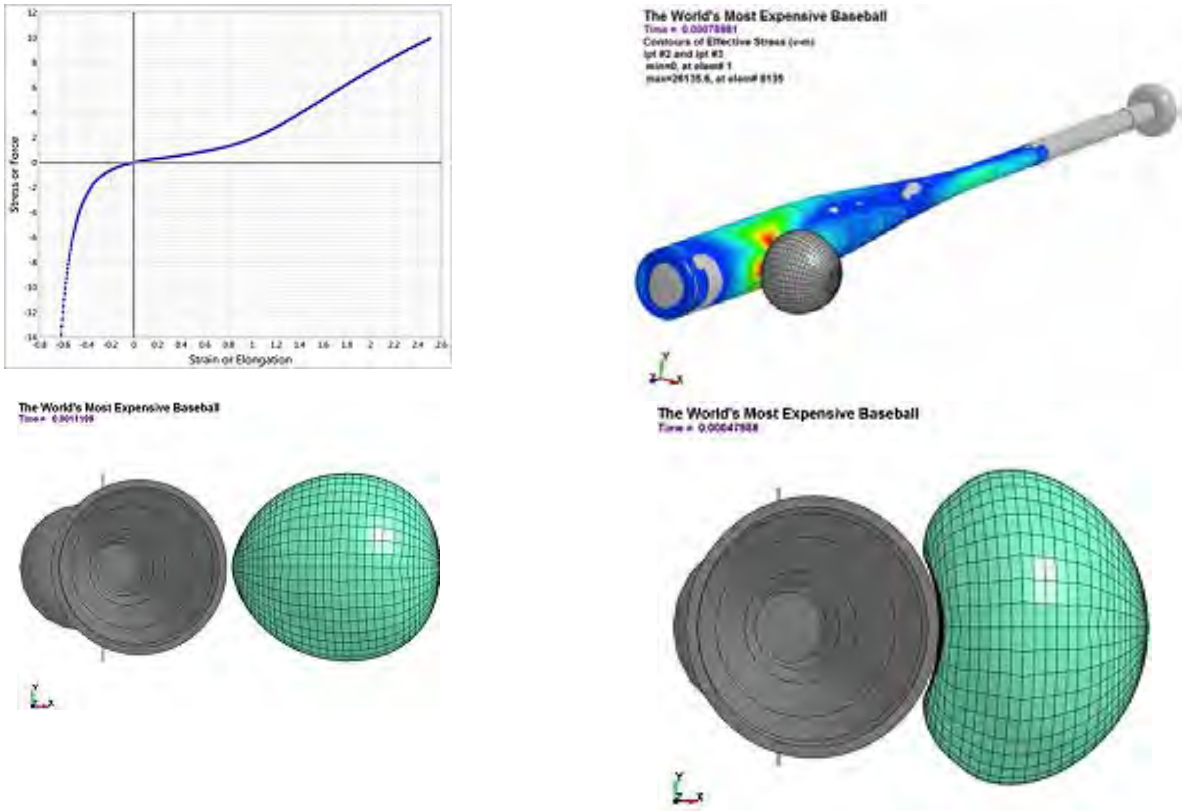


Figure 1: *MAT_181 is handy for all sorts of complex soft materials

The Cutting Edge: Composite Material Modeling

We tend to advocate getting good with one material model and then sticking with it unless some dire emergency requires something different. Under this banner, *MAT_ENHANCED_COMPOSITE_DAMAGE (*MAT_54) is hard to beat. As for damage prediction in composites, it is a very complex subject and a prior blog covers some of the challenges around composite modeling. On our work, we just stick to using fiber failure strains and avoid touching the concept of interlaminar failure and fiber debonding. There are a couple of reasons for this basic approach: (i) Our work uses plate elements and (ii) in failure, once the outer fibers start to pop, the only thing that holds the composite structure together is a bit of weak epoxy or for sandwich materials, the foam core. If one is interested in damage tolerance over multiple cycles, it is a bit of a quasi-research project.

My Cookbook Recipe for Material Modeling

Enough with generalities. Here's the cookbook recipe for when I have to create my own material curve from experimental data. I start with a LS-DYNA model of the test setup and input my true stress v strain or force v elongation curve. Often times I'll run the analysis in both implicit and explicit, just be sure everything is working as advertised. To verify your material model, take the force versus elongation output and overlay it on your original spreadsheet data. Of course, this may seem a bit odd at first but remember that experimental stress v strain data is engineering stress v strain data and that the cross-sectional area is constant and that one starts with a known sample length. Thus, your 'DYNA results of force versus elongation should overlay perfectly your experimental data.

If You Would Like to Get Better at Material Modeling

I would suggest three things: (i) Read with a critical eye and check out the authors background whether they are engineers solving problems or academicians generating CV bullets; (ii) Get experimental test data and do your own material model generation and (iii) Attend FEA material modeling classes given by industry experts.

Running for the Door

For now, I have exhausted my current list of bloggable items of interest from implicit analysis, composite modeling, explicit meshing and now general material modeling. I know that other topics surely await but for now, this is what I've got. I hope you have enjoyed my blog and maybe in six months or so something else will come up.

Kaizenat - New Employee Joins Kaizenat

Mr. Pankaj Kumar is taking on the Regional Manager for West and North India position. He will be overseeing the business development in these regions.

Kaizenat is pleased to welcome one of its newest team members. Mr. Pankaj Kumar is taking on the Regional Manager for West and North India position. He will be overseeing the business development in these regions.

He is a seasoned professional with having 14 years of rich experience in business development and sales for the CAD/CAE industry serving from technical support to regional sales manager.

Helping the engineering industry further reduce time-to-market, increase productivity and profitability.

Mr. Kumar's strengths include the ability to understand customers key business issues, provide business initiatives and solutions to meet and exceed customers' expectations.

Additionally he is strong in business management, managing customers relationships, and experienced dealing with customers special solution needs.

Among the industries he will be covering are: automotive, manufacturing, military & defense, machinery & equipment, consumer products etc...

CAEI – February to July 2016 Training Schedule

https://caeai.com/ansys-training/classes

February to May

- **Finite Element Analysis Fundamentals**
  Feb 11, 2016 1 Day $600
- **ANSYS SpaceClaim Direct Modeler for FEA**
  Feb 18, 2016 1 Day $600
- **Introduction to ANSYS Mechanical (Workbench)**
  Feb 22, 2016 3 Days $1800
- **ANSYS Mechanical (Workbench) - Structural Nonlinearities**
  Feb 25, 2016 1 Day $600
- **ANSYS Mechanical (Workbench) - Dynamics**
  Mar 17, 2016 2 Days $1200
- **Explicit Dynamics with ANSYS/LS-DYNA (Traditional GUI)**
  Mar 28. 2016 2 Days $1200
- **ANSYS Mechanical (Workbench) - Heat Transfer**
  Mar 30, 2016 2 Days $1200
- **ANSYS SpaceClaim Direct Modeler for CFD**
  Apr 1, 2016 1 Day $600
- **Advanced Meshing in ANSYS Mechanical (Workbench)**
  Apr 4, 2016 2 Days $1200
- **Introduction to ANSYS Workbench/ LS- DYNA**
  Apr 6, 2016 3 Days $1800
- **FEA Best Practices**
  Apr 21, 2016 2 Days $1200
- **Introduction to ANSYS nCode DesignLife**
  May 2, 2016 1 Day $600
- **Introduction to ANSYS Mechanical APDL**
  Part I (Traditional GUI)
  May 9, 2016 3 Days $1800
- **Introduction to ANSYS Mechanical APDL**
  Part II (Traditional GUI)
  May 12, 2016 2 Days $1200
- **ANSYS DesignModeler for CFD**
  May 16, 2016 1 Day $600
- **ANSYS Workbench Meshing for CFD**
  May 17, 2016 1 Day $600
- **Introduction to CFX**
  May 18, 2016 2 Days $1200
- **Introduction to ANSYS FLUENT**
  May 23, 2016 2 Days $1200

BETA CAE Open Meetings 2016

www.beta-cae.com/ourevents.htm

BETA CAE Open Meeting
France
February 4, 2016
SAFRAN Etablissement de Paris-Saclay
Chateaufort, France
hosted by SAFRAN Engineering Services

BETA CAE Open Meeting
& Seminars
Bangalore, India
February 17 & 18, 2016
SheratonGrand Hotel at Brigade Gateway
Bangalore, India
hosted by Xitadel CAE Technologies India

BETA CAE Open Meeting
in Brazil
March 17, 2016
hosted by Grupo SMARTtech

BETA CAE Nordic Open Meeting
Gothenburg, Sweden
April 5, 2016
Lindholmen Conference Center &
Science Park
Gothenburg, Sweden
hosted by BETA CAE Nordic

BETA CAE Open Meeting
Korea
May 10, 2016
InterContinental Seoul COEX
Seoul, S. Korea
hosted by Hankook AAC

BETA CAE Open Meeting
Turkey
June 3, 2016
Byotell - Istanbul, Turkey
hosted by A-Z Tech

BETA CAE Open Meeting
Italy
June 28, 2016
NH Torino Lingotto Tech
Torino, Italy
hosted by BETA CAE Italy

BETA CAE Open Meeting
North America
October 11, 2016
The Inn at St. John's
Plymouth, MI, USA
hosted by BETA CAE Systems USA

BETA CAE Open Meeting
Japan
November 8, 2016
Nagoya, Japan
hosted by TOP CAE Corp.

BETA CAE Open Meeting
Beijing, China
November 22, 2016
Beijing, China
hosted by Beijing E&G Software

BETA CAE Open Meeting
Shanghai, China
November 25, 2016
Shanghai, China
hosted by Shanghai Turing Info. Tech.

FEA Information Inc. 2016 LS-DYNA Conference Reception

14TH International LS-DYNA Users Conference - Welcome Reception Sunday, June 12, 2016

FEA Information Inc., D3View and the following FEA Information Participating LS-DYNA distributors will be hosting the Welcome Reception at the 14th International LS-DYNA Conference .

During the reception each participant will be announced giving you the opportunity to meet and know the FEA Information LS-DYNA's global representatives. We will be adding additional co-sponsors to our list each month. **Please join us in 2016**

From China:

- Shanghai Hengstar Technology Co., Ltd.
- Dalian Fukun
- ARUP China

From Korea:

- THEME
- KOrea Simulation TECHnology Co.,Ltd

From Sweden:

- DYNAmore Nordic AB

From Germany:

- DynaMORE GmbH
- CADFEM GmbH

From India:

- Kaizenat Technologies Pvt. Ltd.
- Arup India Pvt Ltd

From the US

- Dynamax
- LSTC

From the UK

- ARUP UK

From France

- DynaS+

FEA Information Editors –Marnie Azadian

Keynote speaker Paul DuBois who will be presenting a joint presentation at the conference:

A new versatile tool for simulation of failure in LS-DYNA and the application to aluminum extrusions

- **Paul Du Bois, Consulting engineer**
- **Dr. Tobias Erhart, Dr. Filipe Andrade, Dr. Andre Haufe, Dynamore GmbH**
- **Drs. Frieder Neukamm, Dr.Markus Feucht, Daimler AG**

Presentation Contents

- **Aluminium extrusions**
- **Material modeling of Aluminium extrusions**
- **Concept of a generalized failure model**
- **Example of anisotropic damage**
- **Example of volumetric/deviatoric damage**
- **Plane stress anisotropic failure : directional dependency upon the state of stress**
- **Failure model for aluminum extrusion**
- **Example of a bumper component**
- **Conclusions**

14th International LS-DYNA Users Conference

Welcome The conference will host a forum for engineers, professors, students, consultants, industry leaders, and interested parties to exchange their ideas, and listen to the latest in industry and academic presentations..

The presenter (1) of the accepted paper will receive a complimentary (no fee) registration, when they register using the "LSTC Conference Registration," at the Royal Dearborn Hotel.

Corporate Participation: Platinum, Gold, Silver, Bronze

Conference Dates

Sunday, June 12, 2016:
Registration Exhibition Area, Reception

Monday, June 13, 2016:
Registration Exhibition Area Banquet

Tuesday, June 14, 2016:
Registration Exhibition Area Closing

Wednesday & Thursday, June 15 & 16, 2016:
Training Classes

Contact Information

Abstracts & papers:
papers@lstc.com

Participation, Registration:
Marsha Victory vic@lstc.com

Paper Submission

- Deadline: March 05, 2016
- Length: 3,000 word maximum
- Format: 8½" x 11" paper, single-spaced
  MS Word template provided

Conference Schedule & Training

Sunday, June 12, 2016:

- Registration for early arrivals,
- Training opportunities during day
- Exhibitors open in evening,
- Reception

Monday, June 13:

- Registration,
- Conference,
- Banquet

Tuesday, June 14, 2016.

- Registration,
- Conference
- Closing session - about 3pm

Wednesday, June 15

Thursday, June 16

- 1& 2-day Training at U-M Dearborn

Conference Sponsorship and Booth Information

For information on Sponsorships and Booths please contact Marsha vic@lstc.com

Previous Sponsors and Exhibitors: If you would like the same booth that you hosted, at the last conference, please let me know so I can quickly reserve your booth placement.

AUTOMOTIVE NEWS & EVENTS

Dilip Bhalsod

The purpose of this section is to provide a place, for our automotive readers, to share news and events relative to their company and/or products.

The criteria for submitting information is as follows:

- It has to be public information
- Published on the Internet
- Be automotive informational, or human interest.
- We do not accept financial quarterly information

We would welcome the opportunity to share information about your company with our readership.

You may send Title to your information and the accompanying URL to agiac99@aol.com - Subject Line please use " Automotive News"

Submissions should be received by the 15th of each month, of the month you want your article placed

Submission publications is at the sole discretion of FEA Information Inc.

Mercedes-Benz launches a further revolution in mobility in Detroit

1886 to 2016: from the Benz Patent Motor Car to the semi-autonomous new E-Class: 130 years of the automobile: Mercedes-Benz launches a further revolution in mobility in Detroit

World Premiere of the new Mercedes-Benz E-Class: Mercedes-Benz New Year's Reception 2016 in Detroit.

The inventor of the automobile is presenting the most advanced production vehicle in the world, the new E-Class, at the Detroit motor show. It sets new standards for safety, efficiency and automobile intelligence.

On 29 January 1886 Carl Benz applied to the Imperial Patent Office in Berlin for the most significant patent of the industrial age: a "motorised vehicle powered by a gas engine" - the initial idea behind all further automobile designs in the century that followed. 130 years later, on 11 January 2016, Mercedes-Benz is in "Motown" Detroit to show the new E-Class, the car with the technological capability to revolutionise mobility all over again.

As the inventor of the automobile, Mercedes-Benz continues to press forward with the development of mobility in all areas. The company's expertise at both a technical and a conceptual level is underscored by more than 90,000 registered patents, together with a long list of innovations that were first introduced to the market in models from Mercedes – these range from engines to safety, comfort and design features. The absolute state of the art of automotive development in all these areas is reflected by the new E-Class.

Just two examples: the innovative plug-in hybrid drive system, coupled with lightweight construction techniques and superb aerodynamic performance, sets new standards for efficiency. The similarly new multi-chamber air suspension is an option that ensures outstanding ride comfort. The tremendous scope of the E‑Class's innovative features, which include among them the Active Lane-change Assistant that steers the saloon as if by magic into the lane selected by the driver, makes it the most intelligent saloon in the business class.

It is this intelligence that also makes the new E-Class a milestone on the way to the self-driving automobile - for Mercedes-Benz and for the automotive industry as a whole. The latest evidence of this special status was provided just a few days ago, when the authorities in the US state of Nevada gave their approval to allow the testing of autonomous driving with the new E-Class – not with a prototype but with a

production vehicle. Mercedes-Benz was the first motor manufacturer in the world to receive the relevant licence during this year's International Consumer Electronics Show (CES).

The processing power of the car's high-tech electrical/electronic systems and its IT infrastructure, together with its sensors, allow a level of mobile autonomy hitherto unmatched in series production: the driver only needs to steer – assuming they wish to do so - on a temporary basis. The traffic lane and speed are regulated, while the vehicle reacts to speed limits and to the traffic around it.

The E-Class as the next stage of automotive evolution

The new Mercedes-Benz E-Class thus marks the beginning of a new phase in automotive development: "For Mercedes, as the inventor of the automobile, it was always clear that the next great revolution in mobility would be the self-driving car", notes Dr Dieter Zetsche, Chairman of the Board of Management of Daimler AG and Head of Mercedes-Benz Cars. At the Consumer Electronics Show 2015 in Las Vegas, which saw the world premiere of the fully autonomous Mercedes-Benz F 015 Luxury in Motion research vehicle, Dr Zetsche was already talking about this role for the automobile of the future: "People have been dreaming of self-driving cars since the 1950s. We at Mercedes were the ones who once turned the vision of mobility without a horse into reality. Now it's time for us to offer the possibility of managing without a driver as well."

Building the technological bridge to freedom

As the Head of Group Research at Daimler, Anke Kleinschmit sees this technological avant-garde as part of a cultural tradition: "At the time of its invention, the groundbreaking innovation of the automobile brought about what could perhaps be described as a space warp. Suddenly distances contracted and people came closer together. Fast, individual transport provided a technological bridge between two worlds that until then had lain so very far apart."

This bridge was to prove extremely successful: since its invention, the automobile has developed into one of the world's most important economic factors, with more than 50 million people working in countless companies carrying forward the legacy of Carl Benz and Gottlieb Daimler. The desire for individual transport is still a strong selling point today, when so many people rely on the car for personal freedom.

Self-driving vehicles in the 21st century

But while in the 20th century this freedom was above all the freedom to travel and get around, today's cars allow a different sort of freedom. As Dr Zetsche describes it: "Cars have become mobile homes, in the truest sense of the words. Protected spaces, as it were, where people can pursue their dreams and fulfil their individual needs." Daimler's Board Chairman sees the autonomous vehicle as holding a key role in this respect: "This technology will give every occupant of a vehicle completely new opportunities to make use of valuable time."

With the new E-Class now going into production, Mercedes-Benz is able to look back on a thirty-year tradition of technology for self-driving cars. Although the first experimental vehicles with autonomous mobility functionality formed part of the Prometheus project as far back as the late 1980s, the pace of development has been stepped up in recent years: in August 2013, the so-called "Bertha Benz Drive" saw an autonomous S-Class follow the historic route of the first journey ever in an automobile.

Two years later Mercedes-Benz presented the F 015 Luxury in Motion, a design study for the car of the future, in Las Vegas. And just a few months after that, the Governor of Nevada issued the first official licence plate for an autonomously driving truck: the Inspiration Truck of Daimler subsidiary Freightliner has been operating its freight routes ever since as the first goods vehicle with autonomous technology on board.

The automobile of the future

The new E-Class now transfers this technology to a standard-production passenger car, so securing mobile autonomy as an established part of everyday life. This model series enjoys particular popularity as a business saloon and, over the decades since it was first introduced, has built up its standing as the mainstay of the company. For Professor Dr Thomas Weber, Member of the Board of Management of Daimler AG, responsible for Group Research and Mercedes-Benz Cars Development, this makes the new E-Class the right model to take up this trend: "We are taking a further major step on the way to autonomous and networked driving. The innovations found in the new E-Class define a new benchmark in terms of safety, stress relief, comfort and networked living, so allowing Mercedes-Benz once again to underline its leadership position."

In this, the 130th year since Carl Benz invented the motor car, there is one thing about which Dr Dieter Zetsche is certain: "The best is still to come for the car sporting the three-pointed star. The Mercedes of the future will drive not only with zero emissions, but autonomously, too. It will be even safer, even more luxurious and fully networked as well. A comfortable retreat for the journey between office and home – a place to work, communicate, relax and enjoy."

Toyota to Commercialize New Telematics System Using SmartDeviceLink Agreement with Ford and Livio

Toyota to Commercialize New Telematics System Using SmartDeviceLink Agreement with Ford and Livio To Establish Industry Development and Operation Framework to Deploy SDL

January 04, 2016 Las Vegas, Jan. 4, 2016
Toyota Motor Corporation has entered into an agreement with Ford and Livio to establish an industry development and operation framework to deploy Livio's SmartDeviceLink (SDL). Other automakers and app developers are welcome to join this collaboration. Toyota will also commercialize a telematics system using SDL.

SDL is an open source platform for smartphone apps and car connectivity where customers can use apps in their vehicle through voice recognition function and operation panel.

Shigeki Terashi, Executive Vice President of Toyota Motor Corporation, said: "Developing a safer and more secure in-car smartphone connectivity service which better matches individual vehicle features is exactly the value and advantage an automaker can offer customers. We expect that many companies share our view and will participate in the industry SDL collaboration."

In August 2011, Toyota and Ford entered a collaboration agreement for next generation in-car telematics system standardization. In June 2015, Toyota entered into an agreement with Ford and Livio to explore SDL introduction to its vehicles*1. Toyota's investigation and consideration of SDL has been completed successfully, and the company found SDL suitable for its in-car app connectivity.

With SDL, automakers can offer smartphone apps which match each company's in-car system characteristics and interface. This enables customers to use apps they want more safely and comfortably.

At the same time, if more automakers apply SDL, app developers can develop apps which are compatible with multiple automakers' telematics systems at one time, meaning more apps available to customers in a shorter development time.

At 2016 CES, Toyota demonstarted an SDL integration in the Livio exhibit, LVCC – North from January 6th through the 9th. On Wednesday, January 6, 11:30 a.m. – 1 p.m., Ken-ichi Murata, General Manager of Toyota BR Connected Strategy and Planning, appaeared at the SDL Summit. Murata and officials from Ford, Livio and others will deliver remarks followed by a Q+A session.

http://newsroom.toyota.co.jp/en/detail/8099666

Media Contacts
Elizabeth Winter ewinter@golin.com
Rebecca Lee rlee@golin.com

John Hanson john_hanson@toyota.com
Cindy Knight cindy_knight@toyota.com

AEROSPACE NEWS & EVENTS

Marnie Azadian

The purpose of this section is to provide a place, for our automotive readers, to share news and events relative to their company and/or products.

The criteria for submitting information is as follows:

- It has to be public information
- An internet URL
- Be technical, informational, or human interest.
- We do not accept financial quarterly information

We would welcome the opportunity to share information about your company with our readership.

You may send Title to your information and the accompanying URL to Marnie Azadian at agiac99@aol.com - Subject Line please use "Aerospace News"

Submissions should be received by the 15th of each month, of the month you want your article placed. For example: We would need the title of the news or event by December 15th, 2015 to be featured in the December 2015 FEA newsletter.

Submission publications is at the sole discretion of FEA Information Inc.

NASA's CORAL Campaign Will Raise Reef Studies to a New Level

Jan. 6, 2016 16-003

A new three-year NASA field expedition gets underway this year that will use advanced instruments on airplanes and in the water to survey more of the world's coral reefs in far greater detail than has ever been assessed before. The COral Reef Airborne Laboratory (CORAL) will measure the condition of these threatened ecosystems and create a unique database of uniform scale and quality.

Coral reefs, sometimes called the rainforests of the sea, are home to a quarter of all ocean fish species. They protect shorelines from storms and provide food for millions of people, yet very little of the world's reef area has been studied scientifically. Virtually all measurements have been made by expensive, labor-intensive diving expeditions. Many reefs never have been surveyed, and those reefs that have been studied were measured only at a few dive sites.

"Right now, the state of the art for collecting coral reef data is scuba diving with a tape measure," said Eric Hochberg, CORAL principal investigator and scientist at the Bermuda Institute of Ocean Sciences, St. George's. "It's analogous to looking at a few trees and then trying to say what the forest is doing."

Hochberg's team will survey the condition of entire reef systems in Florida, Hawaii, Palau, the Mariana Islands and Australia. CORAL will use an airborne instrument called the Portable Remote Imaging Spectrometer (PRISM), developed and managed at NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California. Concurrent in-water measurements will validate the airborne measurements of reef condition. In turn, reef condition will be analyzed in the context of the prevailing environment, including physical, chemical, and human factors. The results will reveal how the environment shapes reef ecosystems.

Reefs worldwide are threatened by human impacts and climate change. The limited observations made to date suggest that 33 to 50 percent of our planet's coral reefs have been significantly degraded or lost, and the concern among reef scientists is that most functioning reef ecosystems will disappear by mid-century.

"We know reefs are in trouble," Hochberg said. "We've seen the reefs of Jamaica and Florida deteriorate and we think we know what is happening there. However, reefs respond in complex ways to environmental stresses such as sea level change, rising ocean temperatures and pollution. The available data were not collected at the appropriate spatial scale and density to allow us to develop an overarching, quantitative model that describes why and how reefs change in response to environmental changes. We need accurate data across many whole reef ecosystems to do that."

According to Michelle Gierach, a CORAL project scientist at JPL, PRISM was specifically created for remote sensing of coastal and inland waters. PRISM records the spectra of light reflected upward toward the instrument from the ocean below, allowing researchers to pick out the unique spectral signatures of living corals and algae. As corals die, algae increase on a reef, so the ratio of coral to algae is an indicator of the ecosystem's health.

"Now, estimates of global reef status are synthesized from local surveys with disparate aims, methods and quality," Gierach said. "With CORAL, we will provide not only the most extensive picture to date of the condition of a large portion of the world's coral reefs, but a uniform dataset, as well."

JPL is providing engineering support and management for CORAL's airborne campaigns under project manager Ian McCubbin. CORAL science team members come from institutions across the United States, each bringing different subject expertise.

After the 2016-2017 field campaign, the CORAL science team will analyze the new data to catalog the relative abundance of coral, algae and sand on each reef. "Then we'll be able to start making predictions about what might happen to the world's reefs that are based on numbers, rather than just ideas," said Hochberg.

Although CORAL will vastly increase the amount of data available on the health of coral reefs, it will cover just three to four percent of the world's reefs.

"Ideally, in a decade or so we'll have a satellite that can frequently and accurately observe all of the world's reefs, and we can push the science and most importantly our understanding even further," said Hochberg.

NASA's CORAL Campaign Will Raise Reef Studies to a New Level

NASA funded CORAL through its Earth Venture-Suborbital program, which competitively selects airborne and field investigations that target specific scientific questions, complementing the agency's satellite missions. Earth Venture-Suborbital, as well as spaceborne Earth Venture mission and instrument investigations are part of NASA's Earth System Science Pathfinder program managed at the agency's Langley Research Center in Hampton, Virginia. NASA's Earth Venture program supports innovative approaches to address Earth science research with regular and frequent windows of opportunity to accommodate new scientific priorities.

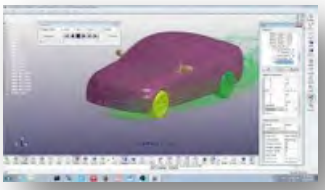
NASA uses the vantage point of space to increase our understanding of our home planet, improve lives, and safeguard our future. NASA develops new ways to observe and study Earth's interconnected natural systems with long-term data records. The agency freely shares this unique knowledge and works with institutions around the world to gain new insights into how our planet is changing.

To find out more about NASA's Earth science research, visit:

http://www.nasa.gov/earth

Steve Cole
Headquarters, Washington
202-358-0918
stephen.e.cole@nasa.gov

Alan Buis
Jet Propulsion Laboratory, Pasadena, Calif.
818-354-0474
alan.buis@jpl.nasa.gov



ICFD Post treatment with LSPP4.3

Tutorial video Available for viewing

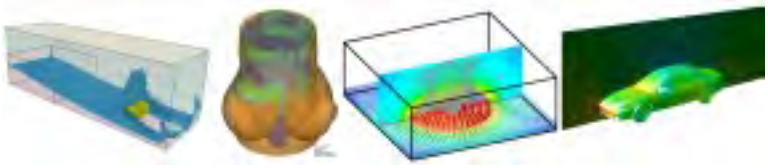
Published on January 15, 2016 a new Tutorial Video on introducing the new post treatment tools available in LSPP4.3 for the LS-DYNA ICFD solver.

FAQs

LSTC provide a huge number of FAQs at the ftp site ftp.lstc.com/outgoing/support/FAQ . Many thanks to Jim Day of LSTC for making this information available.

Some specific popular FAQs include:

consistent units
ftp://ftp.lstc.com/outgoing/support/FAQ/consistent_units
An overview of Contact
ftp://ftp.lstc.com/outgoing/support/FAQ/contact.overview
Soft Contact
ftp://ftp.lstc.com/outgoing/support/FAQ/contact.soft1
General guidelines for Crash Analysis
ftp://ftp.lstc.com/outgoing/support/FAQ/guidelines.pdf
Hourglass Control
ftp://ftp.lstc.com/outgoing/support/FAQ/hourglass_condensed
Dealing with Instabilities
ftp://ftp.lstc.com/outgoing/support/FAQ/instability.tips
Dealing with long run times
ftp://ftp.lstc.com/outgoing/support/FAQ/long_run_times
Mass Scaling
ftp://ftp.lstc.com/outgoing/support/FAQ/mass_scaling
Negative Volume in Brick Elements
ftp://ftp.lstc.com/outgoing/support/FAQ/negative_volume_in_brick_element.tips
Quasi-static simulations
ftp://ftp.lstc.com/outgoing/support/FAQ/quasistatic
Restarting Analyses
ftp://ftp.lstc.com/outgoing/support/FAQ/restart
Modeling spinning bodies
ftp://ftp.lstc.com/outgoing/support/FAQ/spin
Spring Back
ftp://ftp.lstc.com/outgoing/support/FAQ/springback
Stress vs Strain for plasticity models
ftp://ftp.lstc.com/outgoing/support/FAQ/stress_vs_strain_for_plasticity_models
User-defined materials
ftp://ftp.lstc.com/outgoing/support/FAQ/user_defined_materials.faqFAQs



LS-DYNA Support

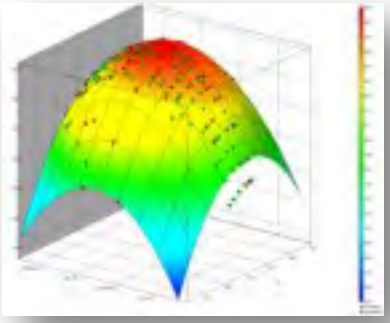
At this site you will find answers to basic and advanced questions that might occur while using LS-DYNA, information about new releases and ongoing developments**.**

Jan 22, 2016 - Rich document History Variables for Certain Material Models

2015 Recent Changes

The Support Website has the direct pdfs for the following October Updates

- History Variables for Certain Material Models
- LS-DYNA Manual R 8.0 - Vol III
- LS-DYNA Manual R 8.0 - Vol II
- LS-DYNA Manual R 8.0 - Vol I



LS-OPT

LS-OPT, the graphical optimization tool that interfaces perfectly with LS-DYNA,

Allows the user to structure the design process, explore the design space and compute optimal designs according to specified constraints and objectives. The program is also highly suited to the solution of system identification problems and stochastic analysis.

The graphical tool LS-OPTui interfaces with LS-DYNA and provides an environment to specify optimization input, monitor and control parallel simulations and post-process optimization data, as well as viewing multiple designs using LS-PREPOST.

Optimization

- Size-/Shape optimization
- Constraints, mixed continuous/discrete variables, multiple load cases, etc.
- Multi-Objective optimization (Pareto Frontier)
- Reliability based design optimization

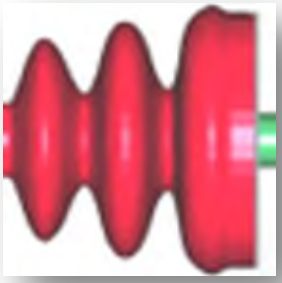
LS-TaSC - LS-TaSC 3.1 released

Topology Optimization

A tool for the topology optimization of non-linear problems involving dynamic loads and contact conditions. It can be used to find a concept design for most structures analyzed using LS-DYNA.

LS-DYNA EXAMPLES

www.dynaexamples.com



LS-DYNA Examples

The site presents approximately 200 LS-DYNA examples from various training classes. The input files and several class notes are available for download.

The download is free of charge, a login is not required. The majority of content has been contributed by LSTC/DYNAmore. The content is prepared for educational purposes. Hence, material properties and other parameters might be non-physic for simplification.

Among the files and Sections:

LS-DYNA Keyword Search If you are looking for an example containing some specific LS-DYNA keyword you may use the site search in the header section of this page.

Show Cases This folder contains several LS-DYNA examples focusing on specific load cases or keywords.

Metal Forming The examples in this section are from the introductory class on metal forming from LSTC. You may access the examples separately by the menu on the left. The examples are prepared for LS-DYNA 970 and upwards.

ALE The examples in this section are from the ALE (Arbitrary Lagrangian Eulerian Method) class of M'hamed Souli. M'hamed Souli is Professor at the University in Lille France. Both authors are key developers for the powerful capabilities of the Eulerian Methods in LS-DYNA. You may access the examples separately by using the menu on the left. The examples run with LS-DYNA 970 and upwards.

Thermal The examples in this section present examples about the thermal capabilities of LS-DYNA. The examples are provided by Dr. Art Shapiro. Art is working since decades on topics reated to DYNA3D, LS-DYNA and TOPAZ. He is the key developer for the thermal capabilites of LS-DYNA. Art is one of the co-founders of LSTC. You may access the examples separately by using the menu on the left.

LS-DYNA CONFERENCE PUBLICATIONS

www.dynalook.com

DYNAlook

DYNAlook

The site presents papers from European and International LS-DYNA User Conferences and papers provided by other users. 1604 papers are available.

The papers are from LS-DYNA Conferences and are accessible via the search functionality.

2015 will be published soon.

13th International
LS-DYNA Conference
Detroit, 2014

9th European
LS-DYNA Conference
Manchester, 2013

12th International
LS-DYNA Conference
Detroit, 2012

8th European LS-DYNA
Conference
Straßburg, 2011 …

ATD –DUMMY MODELS

www.dummymodels.com

DUMMY Model Support - Currently, the manuals of models developed by DYNAmore are available.

This site provides detailed information on dummy models for LS-DYNA. In the near future the models developed by LSTC will be added. The LSTC dummy and barrier are models are no fee and included with the LS-DYNA license.

To license the models we kindly ask to contact your local LS-DYNA distributor. Any kind of proposal or enhancements for the models and this site is very welcome.

Among the Dummy Models on this site you can find:

Side Impact Dummies

ES2/ES2re -
DYNAmore

World SID 50%
DYNAmore

US-SID
DYNAmore

Rear Impact Dummies

BioRID-II V3.
DYNAmore

Child Dummies

P-1.5
DYNAmore
P-3.0
DYNAmore

LSTC ATD MODELS

www.lstc.com/models

LSTC Models Overview

Free or low cost FE models are important to LS-DYNA users in various fields. Therefore, LSTC is developing models with the help and support of our customers. Some of the models are joint developments with our partners.

LSTC's Models are available at no cost to licensees of LS-DYNA who are current with their annual license fees (Annual License) or maintenance fees (Paid-up License). Models are fully unencrypted and accessible. LSTC endeavors to make the models as complete, accurate, reliable, and easy to use as possible.

This section of our site was created to keep users informed about our models. It will be updated periodically to reflect changes to existing models and announce newly released models.

Feedback about the models is welcome and will be used to improve future releases. To submit questions, suggestions, or feedback about LSTC's models, please send an e-mail to: atds@lstc.com.

For news and updates about our dummy models, please join our models news mailing list.
www.lstc.com/products/models/mailinglist

Barrier Models

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

AEROSPACE WORKING GROUP

http://awg.lstc.com/tiki/tiki-index.php

The LS-DYNA® Aerospace Working Group (AWG) is a partnership of federal agencies, corporations, and universities working together to develop and publish aerospace test cases and modeling guidelines for finite element analyses with LS-DYNA®.

The actions of the AWG serve to support the use, development, and reliability of LS-DYNA® for aerospace numerical analyses.

Some participants are partially or fully funded by the Federal Aviation Administration (FAA) in the National Aviation Research Plan 'Aircraft Catastrophic Failure Prevention Research' program, or by the National Aeronautics and Space Administration (NASA), or associated with the participants as LS-DYNA® users.

Engine Related Impact Failure (ERIF) - Arizona State University (ASU)

- Boeing
- Central Connecticut State University (CCSU)
- Federal Aviation Administration (FAA)
- General Electric Aviation
- George Mason University (GMU)
- Honda Aircraft Engine
- Honeywell
- Livermore Software Technology Corporation (LSTC)
- National Aeronautics and Space Administration (NASA)
- Ohio State University (OSU)
- Pratt & Whitney
- Pratt & Whitney Canada
- Rolls-Royce
- University of Akron
- Williams International

Cabin Interior (CI)

- B/E Aerospace
- Boeing
- Bombardier
- Central Connecticut State University
- Cessna
- Federal Aviation Administration (FAA)
- Humanetics
- National Aeronautics and Space Administration (NASA)
- Wichita State University
- Zodiac Aerospace

Participant's Training Classes

Webinars

Info Days

Class Directory

Participant Class Directory

Arup **(corporate)**	www.oasys-software.com/dyna/en/training
BETA CAE Systems S.A. **(corporate)**	www.beta-cae.com/training.htm
DYNAmore **(corporate)**	www.dynamore.de/en/training/seminars
ESI-Group **(corporate)**	https://myesi.esi-group.com/trainings/schedules
ETA **(corporate)**	www.eta.com/support2/training-calendar
LSTC **(corporate)**	www.lstc.com/training
LS-DYNA OnLine **(Al Tabiei)**	www.LSDYNA-ONLINE.COM

ARUP Visit the website for complete listings/changes/locations

www.oasys-software.com/dyna/en/training

To enrol on any of these courses please email Dyna Support at dyna.support@arup.com.

Date	Training Class
Scheduled on request	Oasys PRIMER - An Introduction
Scheduled on request	Oasys PRIMER - Automatic Assembly of Multiple Crash Cases
Scheduled on request	Oasys PRIMER - Spotwelds and Connections
Scheduled on request	Oasys PRIMER - Seat and Dummy Positioning
Scheduled on request	Oasys PRIMER & D3PLOT - An Introduction to JavaScripting

BETA CAE Visit the website for complete listings/changes/locations

www.beta-cae.com/training.htm

Basic and advanced training courses can be scheduled upon request. A variety of standard or tailored training schedules, per product or per discipline, are being offered to meet customers needs.

A number of recommended training courses offered are described below. The list is not exhaustive and more courses can be designed according to your needs.
Please, contact ansa@beta-cae.gr for further details.

Recommended Training Courses (Complete information on website)

- SPDRM
- ANSA / μETA Basics
- ANSA / μETA for CFD
- ANSA / μETA for Crash & Safety simulation
- ANSA / μETA for Durability simulation
- ANSA / μETA for NVH analyses
- Multi-Body Dynamics
- Laminated Composites
- Morphing and Optimization
- Automation
- Additional special sessions

DYNAmore Visit the website for complete listings / changes / locations

www.dynamore.de/seminars

New seminar brochure for 2016 published by DYNAmore

Download (pdf): www.dynamore.de/seminars-2016

We are pleased to offer you our new seminar brochure for 2016. Once again, we have adapted our extensive range of seminars and free-of-charge information events to current developments as well as the needs of our customers.

With the newly founded DYNAmore subsidiary DYNAmore France SAS, selected seminars are now also offered in the new office in Versailles.

Selection of trainings and free-of-charge information & support days in the first quarter of 2016

Joining Techniques for Crash Analysis	10-11 Feb. (L) / 1-2 March
Introduction to LS-PrePost	15 Feb. / 14 March
Introduction to LS-DYNA	16-18 Feb. / 15-17 March
Parameter Identification with LS-OPT	19 Feb. / 8 March (L)
User Interfaces in LS-DYNA	29 Feb.
Implicit Analysis with LS-DYNA	3-4 March
Introduction to Passive Safety Simulation	10-11 March
Damage and Failure Modeling	15-16 March (T) / 15-16 March (G)
CPM for Airbag Modeling	18 March
ALE and Fluid-Structure Interaction	21-22 March (V)

Information day: Possibilities with LS-DYNA/Implicit	23 Feb.
Information day: ANSA, LS-OPT and META	29 Feb.
Information day: Welding and Heat Treatment	7 March
Information day: PRIMER (Preprocessor for LS-DYNA)	8 March

Support day: LS-DYNA	15 Jan. / 19 Feb.
Support day: Occupant Safety	18 March

If not otherwise stated, the event location is Stuttgart, Germany. Other event locations are:
L = Linköping, Sweden; G = Göteborg, Sweden; T = Turin, Italy; V = Versailles, France

Overview and registration: www.dynamore.de/seminars

If the offered seminars do not fully suit your needs, we are pleased to meet your individual requirements by arranging tailored on-site training courses on your company premises.

https://myesi.esi-group.com/trainings/schedules

Basic OpenFOAM training for application engineers
3 Feb 2016 to 4 Feb 2016
CFD & Multiphysics
Bangalore, India

VA One: FE/BEM Training
9 Feb 2016 to 10 Feb 2016
Vibro-Acoustics
San Diego, CA

VA One: Coupled FEA/SEA Training
11 Feb 2016 to 12 Feb 2016
Vibro-Acoustics
San Diego, CA

Basic OpenFOAM and Visual-CFD Training
17 Feb 2016 to 19 Feb 2016
CFD & Multiphysics
Singapore

PAM-STAMP for the automotive industry (Group Learning)
17 Feb 2016 to 19 Feb 2016
Sheet Metal Forming
Farmington Hills, Detroit, MI

Introduction to QuikCAST
23 Feb 2016 to 25 Feb 2016
Casting
Farmington Hills, Detroit, MI

VA One: FE/BEM Training
1 Mar 2016 to 2 Mar 2016
Vibro-Acoustics
Farmington Hills, Detroit, MI

Basic OpenFOAM training for application engineers
2 Mar 2016 to 3 Mar 2016
CFD & Multiphysics
Pune, India

VA One: Coupled FEA/SEA Training
3 Mar 2016 to 4 Mar 2016
Vibro-Acoustics
Farmington Hills, Detroit, MI

VPS - Getting started with CRASH simulation
7 Mar 2016
Crash, Impact & Safety
Seoul, Korea

LSTC Visit the website for complete listings/changes/locations

www.lstc.com/training

February Training

- **CA ALE/Eulerian/FSI**
- **CA SPH**

March

- **MI Intro LS-PrePost**
- **MI Intro LS-DYNA**

May

- **CA Intro LS-PrePost**
- **CA Intro LS-DYNA**
- **MI Contact**
- **MI Composite**

LS-DYNA On Line Visit the website for complete listings/changes/locations

www.LSDYNA-ONLINE.COM

For Information contact: courses@lsdyna-online.com or 513-3319139

Composite Materials In LS-DYNA

This course will allow first time LS-DYNA users to use composite materials. The most important elements to start using all the composite material models in LS-DYNA will be presented in the 8 hours.

Foam & Viscoelastic Materials in LS-DYNA

Objective of the course: Learn about several foam material models in LS-DYNA to solve engineering problems. Detailed descriptions are given of the data required to use such material in analysis. Examples are used to illustrate the points made in the lectures

Plasticity, Plastics, and Viscoplastics Materials in LS-DYNA

Objective of the course: Learn about several plasticity based material models in LS-DYNA to solve engineering problems. Detailed descriptions are given of the data required to use such material in analysis. Examples are used to illustrate the points made in the lectures.

Rubber Materials in LS-DYNA

Objective of the course: Learn about several rubber material models in LS-DYNA to solve engineering problems. Detailed descriptions are given of the data required to use such material in analysis. Examples are used to illustrate the points made in the lectures.

BETA CAE Systems S.A. **www.beta-cae.gr**

BETA CAE Systems S.A.– ANSA

An advanced multidisciplinary CAE pre-processing tool that provides all the necessary functionality for full-model build up, from CAD data to ready-to-run solver input file, in a single integrated environment. ANSA is a full product modeler for LS-DYNA, with integrated Data Management and Process Automation. ANSA can also be directly coupled with LS-OPT of LSTC to provide an integrated solution in the field of optimization.

BETA CAE Systems S.A.– μETA

Is a multi-purpose post-processor meeting diverging needs from various CAE disciplines. It owes its success to its impressive performance, innovative features and capabilities of interaction between animations, plots, videos, reports and other objects. It offers extensive support and handling of LS-DYNA 2D and 3D results, including those compressed with SCAI's FEMZIP software

Solutions for:

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

CRAY **www.cray.com**

THE CRAY® XC™ SERIES: ADAPTIVE SUPERCOMPUTING ARCHITECTURE

The Cray® XC™ series delivers on Cray's commitment to an adaptive supercomputing architecture that provides both extreme scalability and sustained performance. The flexibility of the Cray XC platform ensures that users can precisely configure the machines that will meet their specific requirements today, and remain confident they can upgrade and enhance their systems to address the demands of the future.

Cray® XC40™ and XC40-AC™ supercomputers are enabled by a robust Intel® Xeon® processor road map, Aries high performance interconnect and flexible Dragonfly network topology, providing low latency and scalable global bandwidth to satisfy the most challenging multi-petaflops applications.

While the extreme-scaling Cray XC40 supercomputer is a transverse air-flow liquid-cooled architecture, the Cray XC40-AC air-cooled model provides slightly smaller and less dense supercomputing cabinets with no requirement for liquid coolants or extra blower cabinets. A reduced network topology lowers costs, and the system is compatible with the compute technology, OS, ISV and software stack support of high-end XC40 systems.

MAXIMIZE PRODUCTIVITY WITH CRAY CS SERIES SUPERCOMPUTERS

Understanding the need for nimble, reliable and cost-effective high performance computing (HPC), we developed the Cray® CS™ cluster supercomputer series. These systems are industry-standards-based, highly customizable, and expressly designed to handle the broadest range of medium- to large-scale simulation and data analytics workloads.

All CS components have been carefully selected, optimized and integrated to create a powerful HPC environment. Flexible node configurations featuring the latest processor and interconnect technologies mean you can tailor a system to your specific need — from an all-purpose cluster to one suited for shared memory, large memory or accelerator-based tasks.

Innovations in packaging, power, cooling and density translate to superior energy efficiency and compelling price/performance. Expertly engineered system management software instantly boosts your productivity by simplifying system administration and maintenance.

Maximize your productivity with flexible, high-performing Cray CS series cluster supercomputers.

CRAY www.cray.com

CRAY® SONEXION® SCALE-OUT LUSTRE®STORAGE SYSTEM

Brought to you by Cray, the world's leading experts in parallel storage solutions for HPC and technical enterprise, the Cray® Sonexion® 2000 system provides a Lustre®-ready solution for popular x86 Linux® clusters and supercomputers through Cray Cluster Connect™. As a leader in open systems and parallel file systems, Cray builds on open source Lustre to unlock any industry-standard x86 Linux compute cluster using InfiniBand™ or 10/40 GbE utilizing proven Cray storage architectures.

The Cray Sonexion 2000 system provides 50 percent more performance and capacity than the Sonexion 1600 system in the same footprint.

Simplify

- Through its fully-integrated and pre-configured design, Cray Sonexion storage gets customers deployed faster and reduces the total number of components to manage.
- The Sonexion system's compact design reduces the total hardware footprint of petascale systems by 50 percent over component-based solutions.

Scale

- Performance scales from 7.5 GB/s to 1.7 TB/s in a single file system.
- Capacity scales in modular increments; the Sonexion 2000 system stores over two usable petabytes in a single rack. Fewer drives and components reduce capital costs as capacity grows.

Protect

- New software-based GridRAID offers higher levels of data protection and up to 3.5 times faster rebuild times than traditional RAID6 and MD-RAID storage.
- Cray ensures quality, reliability and stability at scale through exhaustive thermal and real-world stress testing, system hardening and availability, and tight hardware and software integration.

OPEN ARCHIVE AND TIERED STORAGE SYSTEM FOR BIG DATA AND SUPERCOMPUTING

Cray Tiered Adaptive Storage (TAS), powered by Versity, is designed to meet the expansive data preservation and access needs driven by big data, where data needs to migrate fluidly from high performance storage to deep tape archives, while always being accessible to users.

CRAY www.cray.com

With Cray TAS you can:

- Deploy tiered storage and archives faster
- Feel confident preserving and protecting data into the future, using Linux®
- Simplify managing data using familiar tools for years to come

CRAY® URIKA-XA™ EXTREME ANALYTICS PLATFORM

Pre-integrated, open platform for high performance analytics delivers valuable business insights now and into the future

The flexible, multi-use Cray® Urika-XA™ extreme analytics platform addresses perhaps the most critical obstacle in data analytics today — limitation. Analytics problems are getting more varied and complex but the available solution technologies have significant constraints. Traditional analytics appliances lock you into a single approach and building a custom solution in-house is so difficult and time consuming that the business value derived from analytics fails to materialize.

In contrast, the Urika-XA platform is open, high performing and cost effective, serving a wide range of analytics tools with varying computing demands in a single environment. Pre-integrated with the Apache Hadoop® and Apache Spark™ frameworks, the Urika-XA system combines the benefits of a turnkey analytics appliance with a flexible, open platform that you can modify for future analytics workloads. This single-platform consolidation of workloads reduces your analytics footprint and total cost of ownership.

Based on pioneering work combining high-performance analytics and supercomputing technologies, the Urika-XA platform features next-generation capabilities. Optimized for compute-heavy, memory-centric analytics, it incorporates innovative use of memory-storage hierarchies and fast interconnects, which translates to excellent performance at scale on current as well as emerging analytics applications.

Additionally, the enterprise-ready Urika-XA platform eases the system management burden with a single point of support, standards-based software stack and compliance with enterprise standards so you can focus on extracting valuable business insights, not on managing your environment.

CRAY **www.cray.com**

THE URIKA-GD™ GRAPH DISCOVERY APPLIANCE IS A PURPOSE-BUILT SOLUTION FOR BIG DATA RELATIONSHIP ANALYTICS.

The Urika-GD™ appliance enables enterprises to:

- Discover unknown and hidden relationships and patterns in big data
- Build a relationship warehouse, supporting inferencing/deduction, pattern-based queries and intuitive visualization
- Perform real-time analytics on the largest and most complex graph problems

The Urika-GD system is a high performance graph appliance with a large shared memory and massively multithreaded custom processor designed for graph processing and scalable I/O.

With its industry-standard, open-source software stack enabling reuse of existing skill sets and no lock in, the Urika-GD appliance is easy to adopt.

The Urika-GD appliance complements an existing data warehouse or Hadoop® cluster by offloading graph workloads and interoperating within the existing enterprise analytics workflow.

Realize rapid time to powerful new insights.

DatapointLabs **www.datapointlabs.com**

Testing over 1000 materials per year for a wide range of physical properties, DatapointLabs is a center of excellence providing global support to industries engaged in new product development and R&D.

The compary meets the material property needs of CAE/FEA analysts, with a specialized product line, TestPaks®, which allow CAE analysts to easily order material testing for the calibration of over 100 different material models.

DatapointLabs maintains a world-class testing facility with expertise in physical properties of plastics, rubber, food, ceramics, and metals.

Core competencies include mechanical, thermal and flow properties of materials with a focus on precision properties for use in product development and R&D.

Engineering Design Data including material model calibrations for CAE Research Support Services, your personal expert testing laboratory Lab Facilities gives you a glimpse of our extensive test facilities Test Catalog gets you instant quotes for over 200 physical properties.

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.

ESI Group **www.esi-group.com**

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.

Latest Release is Visual-Environment v11.0

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

Livermore Software Technology Corp. **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 LSTC. 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.

LSTC 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.

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

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

Oasys T/HIS

Key benefits:

- Graphical post-processor created specifically for LS-DYNA®
- Automatically reads all LS-DYNA® results
- Wide range of functions and injury criteria
- Easy handling of data from multiple models
- Scripting capabilities for fast post-processing

Oasys REPORTER

Key benefits:

- Automatic report generation tool created specifically for LS-DYNA®
- Automatically post-process and summarize multiple analyses
- Built-in report templates for easy automatic post-processing of many standard impact tests

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 focus 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..

Lenovo www.lenovo.com

Lenovo is a USD39 billion personal and enterprise technology company, serving customers in more than 160 countries.

Dedicated to building exceptionally engineered PCs, mobile Internet devices and servers spanning entry through supercomputers, Lenovo has built its business on product innovation, a highly efficient global supply chain and strong strategic execution. The company develops, manufactures and markets reliable, high-quality, secure and easy-to-use technology products and services.

Lenovo acquired IBM's x86 server business in 2014. With this acquisition, Lenovo added award-winning System x enterprise server portfolio along with HPC and CAE expertise.

www.penguincomputing.com

Penguin Computing provides customized build-to-order server solutions for enterprises and institutions with special hardware requirements. We complement our hardware and software solutions with Penguin Computing on Demand (POD)—a public HPC cloud that provides supercomputing capabilities on-demand on a pay-as-you-go basis.

Penguin is a one-stop shop for HPC and enterprise customers, providing solutions for a wide array of computing needs and user profiles:

HPC and cloud solutions optimized for industry-specific uses

High-powered workstations for individual power users

Highly power-efficient server platforms for enterprise computing

Private and public cloud solutions, including hybrid options.

Focus

Penguin Computing is strictly focused on delivering Linux-optimized enterprise solutions. We use a thorough, proven hardware qualification and testing process to ensure that our solutions deliver optimal performance and robustness.

Penguin's in-house development team is dedicated to providing a complete highly interoperable software stack that is tuned for Penguin hardware. As a result our solutions are easy-to-use and "just work." Our integrated approach even extends to our hybrid compute solutions, which combine local and cloud computing resources, taking ease-of-use and cost-effectiveness to the next level. Penguin customers can reduce capital expenditures by right-sizing clusters for average resource utilization and easily and quickly offload excess workload into the cloud.

Penguin also offers a full range of services and support that is backed by a seasoned team of Linux, HPC and application experts.

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

United States	**DYNAMAX**		sales@dynamax-inc.com	
	www.dynamax-inc.com			
	LS-DYNA	LS-OPT	LS-PrePost	LS-TaSC
	LSTC Dummy Models		LSTC Barrier Models	

United States	**ESI-Group N.A** www.esi-group.com			
	QuikCAST	SYSWELD	PAM-RTM	PAM-CEM
	VA One	CFD-ACE+	ProCAST	Visual-Process
	VisualDSS	Weld Planner	Visual-Environment	IC.IDO
United States	**Engineering Technology Associates – ETA** www.eta.com		etainfo@eta.com	
	INVENTIUM/PreSy	NISA	VPG	LS-DYNA
	LS-OPT	DYNAform		
United States	**Gompute** www.gompute.com		info@gompute.com	
	LS-DYNA Cloud Service		Additional software	
	Additional Services			
United States	**Comet Solutions**		steve.brown@cometsolutions.com	
	Comet Software			

United States	**Livermore Software Technology Corp**		sales@lstc.com	
	LSTC www.lstc.com			
	LS-DYNA	LS-OPT	LS-PrePost	LS-TaSC
	LSTC Dummy Models	LSTC Barrier Models	TOYOTA THUMS	

United States	**Predictive Engineering** www.predictiveengineering.com		george.laird@predictiveengineering.com	
	FEMAP	NX Nastran	LS-DYNA	LS-OPT
	LS-PrePost	LS-TaSC	LSTC Dummy Models	
			LSTC Barrier Models	

France	**DynaS+**		v.lapoujade@dynasplus.com	
	www.dynasplus.com		Oasys Suite	
	LS-DYNA	LS-OPT	LS-PrePost	LS-TaSC
	DYNAFORM	VPG	MEDINA	
	LSTC Dummy Models		LSTC Barrier Models	

Germany	**CADFEM GmbH**		lsdyna@cadfem.de
	www.cadfem.de		
	ANSYS	LS-DYNA	optiSLang
	ESAComp	AnyBody	
	ANSYS/LS-DYNA		

Germany	**DYNAmore GmbH**		uli.franz@dynamore.de	
	www.dynamore.de			
	PRIMER	LS-DYNA	FTSS	VisualDoc
	LS-OPT	LS-PrePost	LS-TaSC	DYNAFORM
	Primer	FEMZIP	GENESIS	Oasys Suite
	TOYOTA THUMS		LSTC Dummy & Barrier Models	

The Netherlands	**Infinite Simulation Systems B.V**		j.mathijssen@infinite.nl	
	www.infinite.nl			
	ANSYS Products	CivilFem	CFX	Fluent
	LS-DYNA	LS-PrePost	LS-OPT	LS-TaSC

Italy	**EnginSoft SpA**		info@enginsoft.it	
	www.enginsoft.it			
	ANSYS	MAGMA	Flowmaster	FORGE
	CADfix	LS-DYNA	Dynaform	Sculptor
	ESAComp	AnyBody	FTI Software	
	AdvantEdge	Straus7	LMS Virtual.Lab	ModeFRONTIER
Russia	**STRELA**		info@dynarussia.com	
	LS-DYNA	LS-TaSC	LS-OPT	LS-PrePost
	LSTC Dummy Models		LSTC Barrier Models	
Sweden	**DYNAmore Nordic**		marcus.redhe@dynamore.se	
	www.dynamore.se		Oasys Suite	
	ANSA	µETA	LS-DYNA	LS-OPT
	LS-PrePost	LS-TaSC	FastFORM	DYNAform
	FormingSuite		LSTC Dummy Models	
			LSTC Barrier Models	
Sweden	**GOMPUTE**		info@gridcore.com	
	www.gridcore.se		www.gompute.com	
	LS-DYNA Cloud Service		Additional software	

Switzerland	**DYNAmoreSwiss GmbH**		info@dynamore.ch	
	www.dynamore.ch			
	LS-DYNA		LS-OPT	LS-PrePost
	LS-TaSC		LSTC Dummy Models	
			LSTC Barrier Models	

UK	**Ove Arup & Partners**		dyna.sales@arup.com	
	www.oasys-software.com/dyna		TOYOTA THUMS	
	LS-DYNA		LS-OPT	LS-PrePost
	LS-TaSC	PRIMER	D3PLOT	T/HIS
	REPORTER	SHELL	FEMZIP	HYCRASH
	DIGIMAT	Simpleware	LSTC Dummy Models	
			LSTC Barrier Models	

China	**ETA – China**		lma@eta.com.cn	
	www.eta.com/cn			
	Inventium	VPG	DYNAFORM	NISA
	LS-DYNA	LS-OPT	LSTC Dummy Models	LS-PrePost
			LSTC Barrier Models	LS-TaSC
China	**Oasys Ltd. China**		Stephen.zhao@arup.com	
	www.oasys-software.com/dyna			
	PRIMER D3PLOT	HYCRASH	T/HIS REPORTER	SHELL
	LS-DYNA	LS-OPT	LSTC Dummy Models	LS-PrePost
	DIGIMAT	FEMZIP	LSTC Barrier Models	LS-TaSC
China	**Shanghai Hengstar Technology**		info@hengstar.com	
	www.hengstar.com			
	LS-DYNA	LS-TaSC	LSTC Barrier Models	D3VIEW
	LS-PrePOST	LS-OPT	LSTC Dummy Models	
	Genesis	VisualDoc		ELSDYNA
	Visual-Crahs DYNA	Visual-Proeces		DynaX & MadyX
	Enki Bonnet	Visual Environement		

India	**Oasys Ltd. India**		lavendra.singh@arup.com	
	www.oasys-software.com/dyna			
	PRIMER	D3PLOT	T/HIS	
			LS-OPT	LSTC Dummy Models	LS-PrePost
			LS-DYNA	LSTC Barrier Models	LS-TaSC

India	**CADFEM Eng. Svce**		info@cadfem.in	
	www.cadfem.in			
	ANSYS	VPS	ESAComp	optiSLang
	LS-DYNA	LS-OPT	LS-PrePost	

India	**Kaizenat Technologies Pvt. Ltd**		support@kaizenat.com	
	http://kaizenat.com /			
	LS-DYNA	LS-OPT	LSTC Dummy Models	LS-PrePost
	Complete LS-DYNA suite of products		LSTC Barrier Models	LS-TaSC

Distribution/Consulting	Asia Pacific	Distribution/Consulting

Japan	**CTC**	LS-dyna@ctc-g.co.jp		
	www.engineering-eye.com			
	LS-DYNA	LS-OPT	LS-PrePost	LS-TaSC
	LSTC Dummy Models	LSTC Barrier Models	CmWAVE	
Japan	**JSOL**			
	www.jsol.co.jp/english/cae		Oasys Suite	
	JSTAMP	HYCRASH	JMAG	
	LS-DYNA	LS-OPT	LS-PrePost	LS-TaSC
	LSTC Dummy Models	LSTC Barrier Models	TOYOTA THUMS	
Japan	**FUJITSU**			
	http://jp.fujitsu.com/solutions/hpc/app/lsdyna			
	LS-DYNA	LS-OPT	LS-PrePost	LS-TaSC
	LSTC Dummy Models	LSTC Barrier Models	CLOUD Services	
Japan	**LANCEMORE**	info@lancemore.jp		
	www.lancemore.jp/index_en.html			
	Consulting			
	LS-DYNA	LS-OPT	LS-PrePost	LS-TaSC
	LSTC Dummy Models	LSTC Barrier Models		
Japan	**Terrabyte**	**English:**		
	www.terrabyte.co.jp	www.terrabyte.co.jp/english/index.htm		
	Consulting			
	LS-DYNA	LS-OPT	LS-PrePost	LS-TaSC
	LSTC Dummy Models	LSTC Barrier Models	AnyBody	

Korea	**THEME**	wschung@kornet.com		
	www.lsdyna.co.kr		Oasys Suite	
	LS-DYNA	LS-OPT	LS-PrePost	LS-TaSC
	LSTC Dummy Models	LSTC Barrier Models	eta/VPG	Planets
	eta/DYNAFORM	FormingSuite	Simblow	TrueGRID
	JSTAMP/NV	Scan IP	Scan FE	Scan CAD
	FEMZIP			

Korea	**KOSTECH**	young@kostech.co.kr		
	www.kostech.co.kr			
	LS-DYNA	LS-OPT	LS-PrePost	LS-TaSC
	LSTC Dummy Models	LSTC Barrier Models	eta/VPG	FCM
	eta/DYNAFORM	DIGIMAT	Simuform	Simpack
	AxStream	TrueGrid	FEMZIP	

Taiwan **Flotrend** gary@flotrend.tw

www.flotrend.com.tw

LS-DYNA	LS-OPT	LS-PrePost	LS-TaSC
LSTC Dummy Models	LSTC Barrier Models	eta/VPG	FCM

Taiwan **APIC**

www.apic.com.tw

LS-DYNA	LS-OPT	LS-PrePost	LS-TaSC
LSTC Dummy Models	LSTC Barrier Models	eta/VPG	FCM

POD (Penguin Computing on Demand) offers software including LSTC's LS-DYNA

www.penguincomputing.com/services/hpc-cloud

Penguin HPC clusters are optimized for engineering workloads and offer:

- Instant access to an HPC Cloud Cluster
- High performance InfiniBand bare-metal compute
- Free support from HPC experts
- No charges for network transfers
- Cost-effective, pay-per-use billing model
- Secure environment for private data
- Detailed billing reports for user groups and projects

Self Registration Portal – featuring rich--documentation, wiki, FAQ, pricing and more.

https://pod.penguincomputing.com/

POD Software Applications and Libraries (visit site for complete listing)

FEA, CFD and FDTD Modeling

- **LS-DYNA** / LS-PrePost LS-DYNA is an advanced general-purpose multiphysics simulation software package. Its core-competency lie in highly nonlinear transient dynamic finite element analysis (FEA) using explicit time integration. LS-PrePost is an advanced pre and post-processor that is delivered free with LS-DYNA.
- **OpenFoam:** OpenFOAM (Open source Field Operation And Manipulation) is a C++ toolbox for the development of customized numerical solvers, and pre-/post-processing utilities for the solution of continuum mechanics problems, including computational fluid dynamics (CFD).

- **ANSYS HFSS:** ANSYS HFSS software is the industry standard for simulating 3-D full-wave electromagnetic fields. Its gold-standard accuracy, advanced solver and compute technology have made it an essential tool for engineers designing high-frequency and high-speed electronic components.
- **ANSYS Fluent** ANSYS Fluent software contains the broad physical modeling capabilities needed to model flow, turbulence, heat transfer, and reactions for industrial applications.
- **Star-CD** and **Star-CCM+:** STAR-CCM+ is CD-adapco´s newest CFD software product. It uses the well established CFD solver technologies available in STAR-CD, and it employs a new client-server architecture and object oriented user interface to provide a highly integrated and powerful CFD analysis environment to users.
- **Convergent:** CONVERGE is a Computational Fluid Dynamics (CFD) code that completely eliminates the user time needed to generate a mesh through an innovative run-time mesh generation technique.
- **Lumerical:** Simulation tools that implement FDTD algorithms.

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 to the increase use of LS-DYNA more and more in recent years.

In calculations of optimization, robustness, statistical analysis, larger amount of LS-DYNA license in short term are required.

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

This service is offered to the customers by the additional price to existence on-premises license, which is relatively inexpensive 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.
http://www.credist.co.jp /

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

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

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

Rescale Cloud Simulation Platform

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.

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.

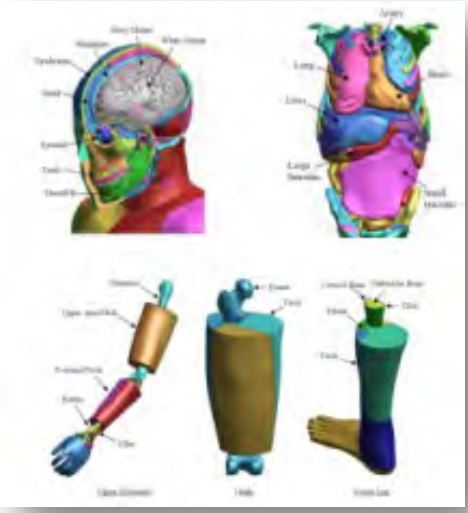
- Manage engineering teams with user authentication and administrative controls
- Data is secure every step of the way with end-to-end data encryption
- Jobs run on isolated, kernel-encrypted, private clusters
- Data centers include biometric entry authentication
- Platforms routinely submit to independent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

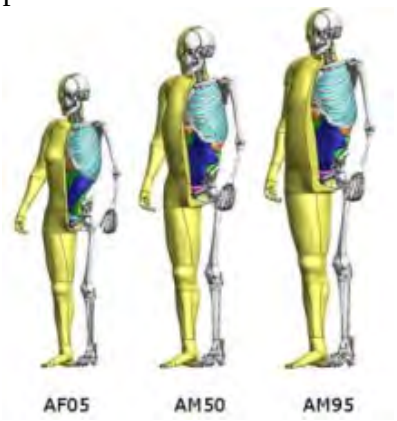
TOYOTA - Total Human Model for Safety – THUMS



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

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

and as standing model to represent pedestrians.



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

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

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

For information please contact:
THUMS@lstc.com

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

LSTC – Dummy Models

LSTC Crash Test Dummies (ATD)

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

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

e-mail to: atds@lstc.com

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

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

Models In Development

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

Planned Models

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

LSTC – Barrier Models

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

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

- ODB modeled with shell elements
- ODB modeled with solid elements
- ODB modeled with a combination of shell and solid elements

- MDB according to FMVSS 214 modeled with shell elements
- MDB according to FMVSS 214 modeled with solid elements
- MDB according to ECE R-95 modeled with shell elements
- AE-MDB modeled with shell elements

- IIHS MDB modeled with shell elements
- IIHS MDB modeled with solid elements
- RCAR bumper barrier

- RMDB modeled with shell and solid elements

e-mail to: atds@lstc.com.

 **FACEBOOK**

BETA CAE SYSTEMS SA | CADFEM | Cray Inc.

ESI Group | Lenovo

 **TWITTER**

BETA CAE SYSTEMS SA | Cray Inc. | ESI Group

ETA | CADFEM | Lenovo

 **LINKEDIN**

BETA CAE SYSTEMS SA | CADFEM | Cray Inc.

DYNAmore Nordic | ETA | Oasys

 **NEWS FEEDS** ETA:

YOUTUBE

YOUTUBE Channel	WebSite URL
BETA CAE SYSTEMS SA	www.beta-cae.gr
CADFEM	www.cadfem.de
Cray Inc.	www.cray.com
ESI Group	www.esi-group.com
ETA	www.eta.com
Lancemore	www.lancemore.jp/index_en.html
Lenovo	

Publications Showcase

The following paper has been submitted so share with the engineering community.

New Material Models for Carbon Fiber Compression Molding Simulation in LS-DYNA

Qiangsheng Zhao

Livermore Software Technology Corporate, Livermore, California, USA

New Material Models for Carbon Fiber Compression Molding Simulation in LS-DYNA

Qiangsheng Zhao

Livermore Software Technology Corporate, Livermore, California, USA

Abstract:

With automotive industry adopting carbon fiber reinforced plastic as a new weight saving measure, LS-DYNA developed several new material models to simulate the compression molding manufacturing process of carbon fiber composite. MAT 277 is based on viscoelastic material model MAT 076, with Prony series of viscoelasticity being functions of the curing degree, which is in turn modeled with Kamal model. MAT 277 is capable of modeling curing process of epoxy resin. MAT 278 employs a micro mechanics model to include both carbon fiber, with reorientation, and viscoelastic epoxy resin, with curing kinetics, in one material card.

Keyword: Carbon fiber, woven carbon fiber, curing, reorientation

1 Introduction

With Corporate Average Fuel Economy (CAFE) law requiring 42 miles per gallon by 2020 and 54.5 mpg by 2025, car manufacturers are now searching for new lightweight materials. Aluminum and magnesium have been successfully utilized to save weight in body panels and engine blocks for decades. To further save weight, carbon fiber emerged as a great choice. While sports cars like formula 1 have been using carbon fiber for many years, it is only until 2014 when BMW introduced the first mass production car i3 with carbon fiber bodywork. Other car manufacturers, like Ford and Toyota, also start considering carbon fiber for mass production. Thus, there is an urgent need to model carbon fiber manufacturing process and its crashworthiness.

One of the widely used techniques for making carbon fiber composites in automotive industry is by using prepreg, which is carbon fiber pre-impregnated with epoxy resin and resin hardener. Process of prepreg being cured under heat and pressure is called compression molding, which produce complex parts with a high quality surface finish, low resin content and great structural performance.

Several new material models have been implemented to simulation the aforementioned compression molding process of carbon fiber composite. MAT 277 ADHESIVE CURING VISCOELASTIC is useful to model adhesive viscoelastic material during chemical curing. MAT 234 VISCOELASTIC LOOSE FABRIC is mechanism model which incorporates the crimping of fibers as well as the trellising with reorientation of yarns and locking phenomenon observed loose fabric. These two material models together with PART_COMPOSITE can be used to model compression molding process. MAT 278 CARBON FIBER MICROMECHANICS is another new material model which takes a micro-mechanics approach to include both fiber reorientation and resin curing in one material card.

In the rest of this paper, Section 2 will first introduce MAT 277 and a simulation of complete curing process under displacement boundary condition and heating/cooling cycle. Section 3 will give a preliminary look into the new material model MAT 278.

2 MAT_277_ADHESIVE_CURING_VISCOELASTIC

MAT 277's viscoelastic constitutive model is based on MAT 076 GENERAL VISCOELASTIC, and calculates the stress with rate effects by convolution integral as following,

$$\sigma_{ij} = \int_0^t G_{ijkl}(t-\tau)\frac{\partial \varepsilon_{kl}}{\partial \tau}d\tau,$$

where $G_{ijkl}(t-\tau)$ is the relaxation functions, and Prony series is used,

$$G(t,\alpha) = G_\infty(\alpha) + \sum_{i=1}^{N} G_i(\alpha)e^{-\beta_i t}.$$

Each term in Prnoy series is curing degree α dependent. Curing kinetics is modeled here with Kamal model, and follows an ordinary differential equation as below

$$\frac{d\alpha}{dt} = (K_1 + K_2\alpha^m)(1-\alpha)^n,$$

$$K_1 = k_1 e^{\frac{-c_1}{RT}}, K_2 = k_2 e^{\frac{-c_2}{RT}},$$

where $k_1\ k_2\ c_1\ c_2\ m\ n$ are material constants.

A simple test case with one cubic epoxy resin element size of 1mm x 1mm x 1mm under a displacement boundary condition and heating and cooling process is conducted with material properties provided by a large carbon fiber manufacturer. At time 0, one side of the cube is stretched by 0.10 mm and fixed at that position for the rest of test. Temperature starts at 25°C at time 0, and ramps up linearly to 180°C in 20 minutes, and kept at 180°C for next 35 minutes, after which temperature ramps down linearly back to 25°C in 10 minutes. The initial curing degree is 0, and during the 60 minutes test, it cures up to 1. History plot of curing process is shown below, which matches well with experiment data.

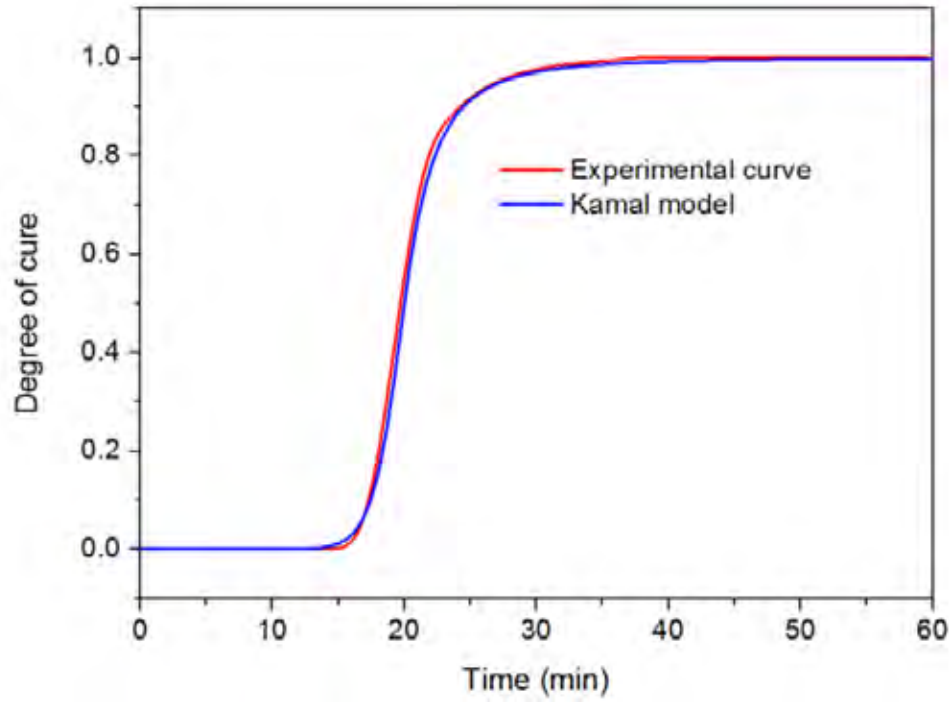


Figure 1 Curing degree of MAT277 single element test

Thermal strain and chemical strain of the cubic epoxy resin are also plotted in Figure 2 and 3.

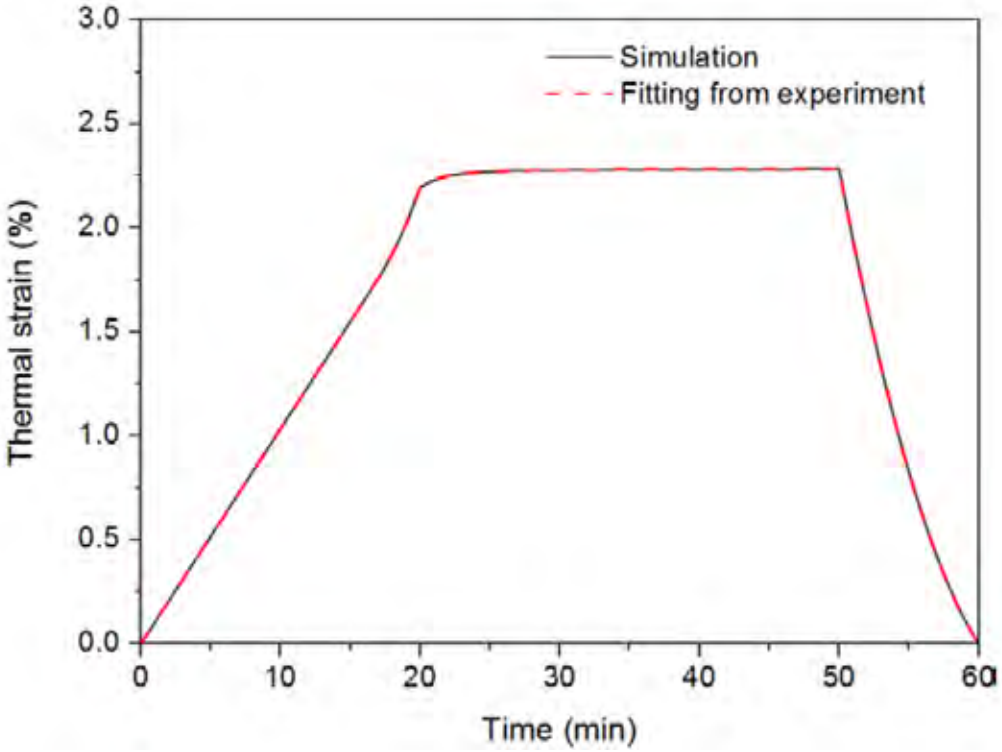


Figure 2 Thermal strain of the MAT277 single element test

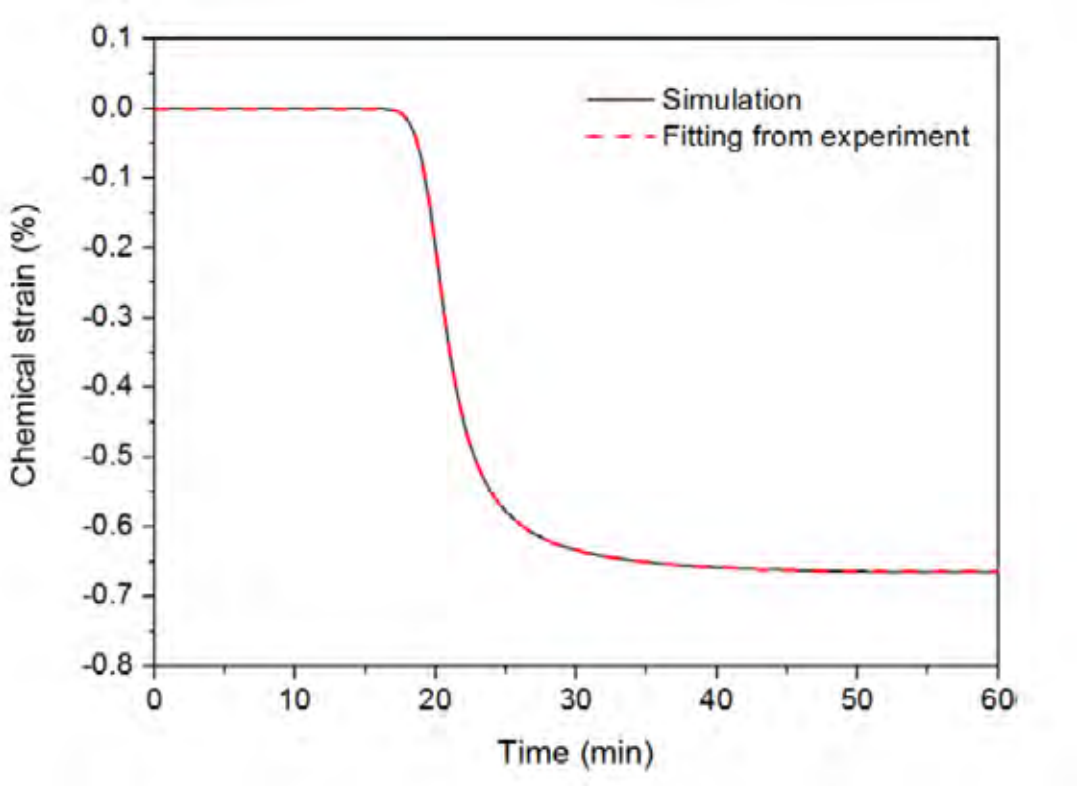


Figure 3 Chemical strain of MAT277 single element test

Stress σ_{xx} is compared to similar material model from another finite element commercial software, which shows great qualitative match.

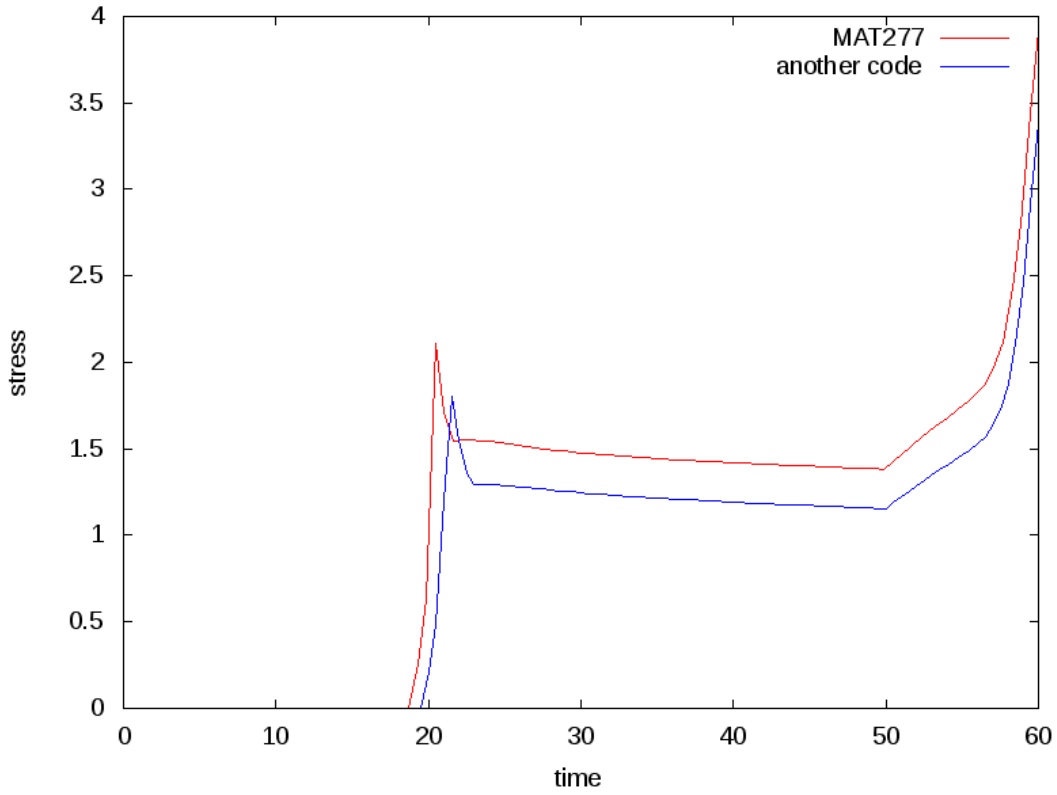


Figure 4 stress in xx direction of MAT277 single element test

With this test, we conclude that MAT 277 is a great candidate to simulate the whole process of carbon fiber compression molding. By the time of writing this paper, shell version of MAT 277 is under final development stage, which will be used in conjunction with loose fabric material model such as MAT 234 for PART_COMPOSITE to simulate layers of carbon fiber fabric and epoxy resin in prepreg.

3 MAT_278_CARBON_FIBER_MICROMECHANICS

MAT 278 include both loose fabric model and curing viscoelastic resin model in one material card. A representative volume of woven carbon fiber is shown below in Figure 5, and orientation of the fiber is described with the undulation angle β and the braid angle θ.Orientation vector can be written as $[\cos\beta\cos\theta \quad \cos\beta\sin\theta \quad \sin\theta]$, and each time step new orientation vector can be calculated by multiplying with deformation gradient tensor.

Total strain can be transferred to principal material coordinate system of the fiber by

$$\varepsilon_{ij}^{\mathrm{f}} = Q_{ki}Q_{lj}\varepsilon_{kl},$$

and here the rotation tensor **Q** is defined as following,

$$\mathbf{Q} = \begin{bmatrix} \cos\beta\cos\theta & -\sin\theta & -\sin\beta\cos\theta \\ \cos\beta\sin\theta & \cos\theta & -\sin\beta\sin\theta \\ \sin\beta & 0 & \cos\beta \end{bmatrix}.$$

Stress calculation is then carried out for fiber in its own principal material coordinate system. And for resin, its stress and curing process is calculated in global coordinate system in the same manner as in MAT 277.

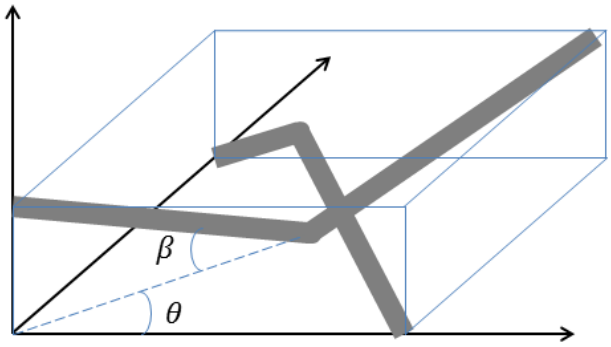


Figure 5 Fiber orientation description

Final stress will include contribution from both the epoxy resin material and the carbon fiber material, with the carbon fiber stress being transformed from its principal material coordinate system to global coordinate system by

$$\sigma_{ij}^{g} = Q_{ik}Q_{jl}\sigma_{kl}.$$

A single element test was conducted with same loading condition as the single element test for MAT 277, with a very soft material property for the fiber. During the test, curing degree, thermal strain and chemical strain of the resin material all match will MAT 277 test result. The braid angle starts at 45°, which is half of 90° given that fibers are perpendicular to each other at the beginning of the test, decreases to just above 41°, and then increases, flats out, and decreases again as the epoxy resin material cures. History plot of the braid angle is given in Figure 6.

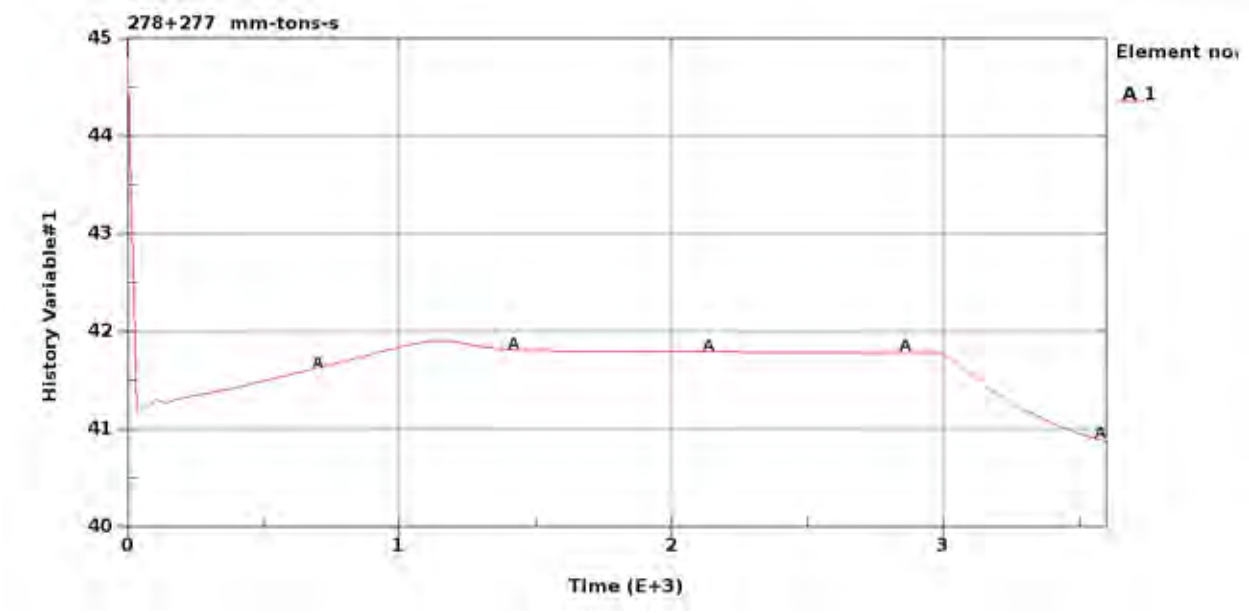


Figure 6 The braid angle of fiber during tension and curing test

The undulation angle starts at 6°, and follows a similar pattern during tension and curing process, which is shown in Figure 7.

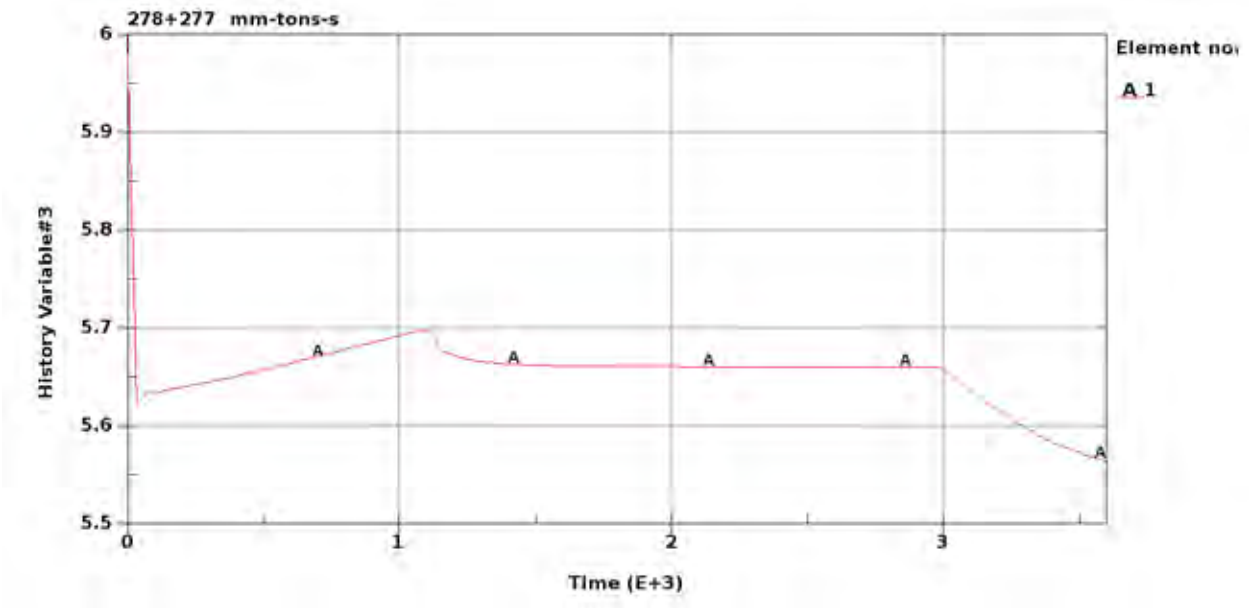


Figure 7 The undulation angle during tension and curing test

Stress in XX direction is shown in Figure 8, which is very similar to the test result in MAT 277 due to the fact that very soft material property is used for the fiber material.

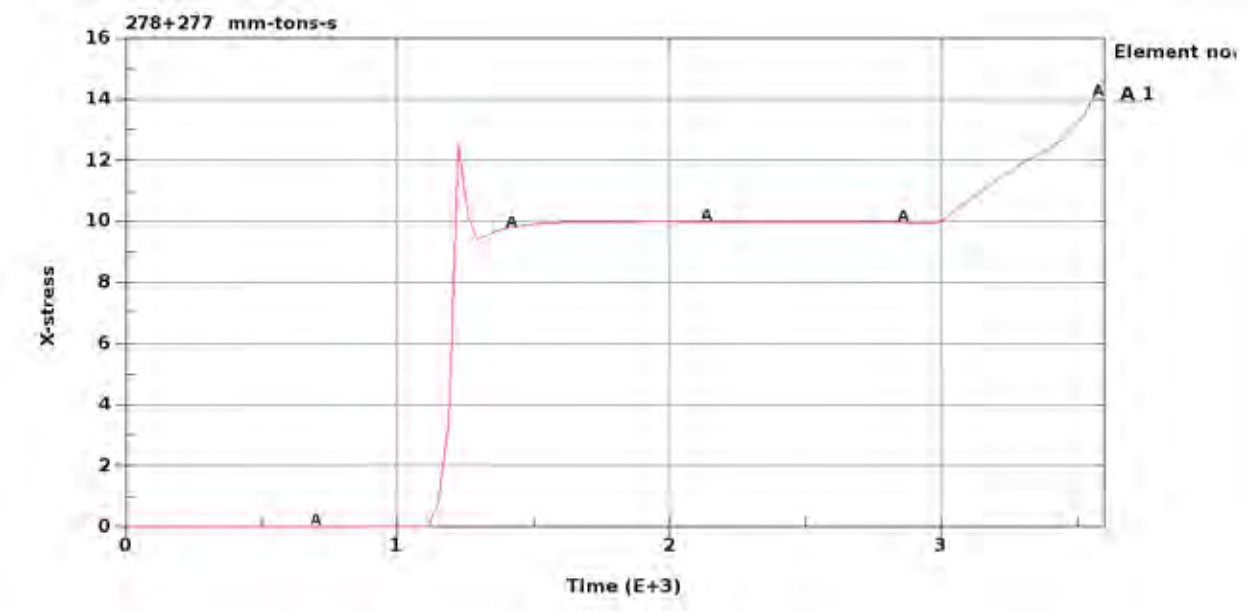


Figure 8 Stress in XX direction during tension and curing test

4 Conclusions

It is demonstrated that new material models in LS-DYNA are capable of predicting the curing kinetics, stress response of epoxy resin during tension and heating/cooling loading condition very well, and can also capture even very small reorientation of the fiber during the test process. The two material models show great potential for a full simulation of a complete compression molding process of carbon fiber composite.

References

[1] LS-DYNA KEYWORD USER MANUAL

[2] LS-DYNA THEORY MANUAL

[3] LS-DYNA MATERIAL MANUAL