BLAST MODELING WITH LS-DYNA®

An LS-DYNA Training Class
Presented by

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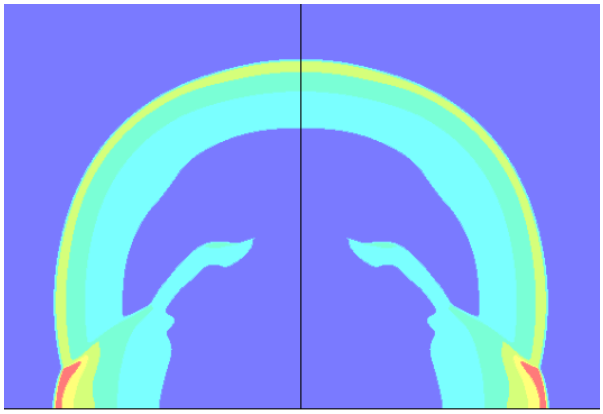

Abstract

Blast events form a class of simulation environments well suited to the solution capabilities of LS-DYNA. LS-DYNA is unique in offering the analyst the choice of Lagrange, Eulerian (MM-ALE) and Simple Engineering solvers, and combinations of these solvers, for simulating high energy events such as blast loading. In addition to air blast, the traditional focus of blast modeling, buried explosive charges have recently become important in the design of troop transportation.

This class focuses on the application of LS-DYNA for the simulation of high energy events. The analysis methods, and modeling, are illustrated through case studies. An emphasis is placed on modeling techniques: guidelines for which technique(s) to select, insights into which techniques work well and when, and possible pitfalls in modeling choice selections. Sufficient mathematical theory is presented for each technique, to provide the typical user with adequate knowledge to confidently apply the appropriate analysis technique. However, this training class is not a substitute for the in-depth treatments presented in the associated LS-DYNA training classes, i.e. *Advanced ALE* and *ALE/Eulerian Fluid Structure Interaction.*

Intended Audience

This training class is intended for the LS-DYNA analyst possessing a comfortable command of the LS-DYNA keywords and options associated with typical Lagrange analyses. The training class will attempt to provide the analyst with the additional tools and knowledge required to model the above described class of high energy events. The typical attendee is likely to have a background in defense applications, to include protective structures and vehicle vulnerability, homeland defense topics, and terrorist threat mitigation techniques. Because the class uses example problems to illustrate concepts and techniques, numerous modeling 'tricks' and options are discussed, and this knowledge would benefit any LS-DYNA user. Non-LS-DYNA users have taken this class and benefited as many explicit codes have similar capabilities.

Instructors

In 2010 the instructors decided to split the previously combined Blast & Penetration class into two separate classes. In the four years the combined class had been presented, a significant amount of material was added, mostly in the area of Blast. To accommodate this additional blast related material, the penetration portion of the class was diminished. Separating the two topics allows LS-DYNA users to select the most appropriate class, and provides for more in depth coverage of both important topics. Those interested in blast modeling may also want to attend the *Explosive Modeling for Engineers* class offer by the instructors.

Over 50 years of LS-DYNA experience in a wide range of commercial and defense applications allows the instructors to provide insights into many aspects of modeling and simulation. In addition, their presentation style has often been complemented for being clear, concise, useful, and interesting, and at times hopefully also entertaining.

Paul Du Bois has worked as an independent consultant in the field of industrial application of large scale numerical simulations since September 1987. He has specialized in the application of explicit integration techniques for crashworthiness and impact problems. Amongst Paul's customers are most of the world's automotive assemblers such as Daimler, GM, Ford, Opel, Fiat, Porsche, Volvo, PSA, Renault, Toyota, Nissan, Honda, Hyundai and many others including automotive suppliers and design and engineering companies. Paul's more recent projects include

a Daimler sponsored development of a generalized plasticity law for the simulation of plastics and the formulation of a tabulated hyper-elastic material law with damage for the simulation of rubber and foam. He was involved with the joint research organization of the German automotive industry, FAT, in the working groups: 'side impact dummies' from 1992 through 1997 and 'Foam materials' from 1996 until 2009. In 2003 Paul was asked by LSTC to perform a training mission at the Russian national laboratory in Snezinskh. Since 2004 he has also been a consultant to NASA and has worked on the space shuttle's 'return-to-flight' program. In the field of defense applications, he is a consultant to Rafael in Haifa, Israel where he was involved with the simulation of mine blast problems and helicopter crash landings.

Paul Du Bois also teaches the LS-DYNA training classes *Advanced Impact Analysis, User Material Implementation in LS-DYNA*, and *Polymeric Material Modeling with LS-DYNA*. He co-teaches, with Len Schwer, the LS-DYNA *Explosives, Penetration, and Modeling & Simulation* classes.

Len Schwer has worked in the area of defense applications where failure prediction is of primary interest, for the past 30 years; he had been a DYNA3D user since 1983 and an LS-DYNA user since 1998. His early work at SRI International included modeling the collapse of deeply buried tunnels under very high pressure loadings. While at Lockheed Missile and Space Company he worked on high speed earth penetrators designed to penetrate reinforced concrete structures buried in soil. He has worked with the US Navy to develop an analysis capability for predicting the penetration & perforation of metallic, concrete, and soil targets associated with improvised explosive devices (IED's). He has a strong interest in verification and validation in computational solid mechanics, and is the past Chair of the ASME Standards Committee on Verification and Validation in Computational Solid Mechanics. Dr. Schwer is a Fellow of the American Society of Mechanical; Engineers (ASME) and the United States Association of Computational Mechanics (USACM).

Len Schwer also teaches the LS-DYNA training class *Geomaterial Modeling with LS-DYNA*, and co-teaches, with Paul Du Bois, the LS-DYNA *Explosives, Penetration, and Modeling & Simulation* classes.

Daily Class Schedule

Day 1

Opening Remarks **(*Len*)**

Equations-of-State (EOS) and Shocks (***Paul***)

*Engineering Model (**LOAD_BLAST_ENHANCED*) for Air Blast* **(*Len*)**

Comparison of Engineering Models and MM-ALE *for Air Blast* **(*Len*)**

Day 2

*LOAD_BLAST_ENHANCED *Coupling with* MM-ALE ***(Len)***

*Engineering Model (**INITIAL_IMPULSE_MINE*) for Buried Charges* **(*Len*)**

*Vehicle Mine Blast Workshop (**Paul**)*

*OPTIONAL - Vehicle Mine Blast Occupant Application (**Paul**)*

Participant Comments:

> "Thank you for hosting the Blast and Penetration Course last week. It was outstanding on all levels. The instruction was excellent and best of all Len and Paul made the subject entertaining with their occasional interjections of humor." Feb 2010