Possibilities of finite element analysis with LS-DYNA in industrial applications



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FEA with LS-DYNA in industrial applications



Outline

DYNA*more* at a glance

- short company presentation

LS-DYNA applications

- crash analysis
- occupant safety (airbags, dummy models)
- sheet metal forming
- ... and others

Summary



DYNAmore at a glance



DYNAmore GmbH

Gesellschaft für FEM-Ingenieurdienstleistungen

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Cooperation between

Dr. Hallquist and Prof. Schweizerhof since 1986



- founded in 1987 by Dr. John Hallquist
- located in Livermore, California
- more than 600 customers
- worldwide distribution
- annual growth rate: about 30%





- Distributor of LS-DYNA and related software products
- further development and customization in collaboration with LSTC
- Support, Seminars and Projects





DYNAmore - facts

- 50 employees in 2011
- more than 250 customers in D, A, CH, E, NL, B, PL, P,TK, ...
- LS-DYNA distribution rights for Italy since 3/2007
- additional customers from US, Asia, Australia
- several thousand LS-DYNA licenses are maintained by DYNA*more*
- employees with vast experience in nonlinear FE applications
- headquarters located in Stuttgart/Vaihingen
- office in Langlingen (Wolfsburg)
- office in Ingolstadt (Audi)
- office in Dresden
- on-site office in Sindelfingen (Mercedes passenger cars)
- on-site office in Untertürkheim (Mercedes trucks)
- on-site office in Weissach (Porsche)



DYNAmore – Portfolio





DYNA*more* – e-Services

www.dynamore.de

- All software products
- Actual release notes
- Download area for software & documentation

D

Software

Modelle

Dienstlei IT-Lösun Konferen

Dokumer Unterneh

Suche Web-Sup

Telefon (

- FEM models
- Training schedule

www.dynalook.com

- Database for published papers on LS-DYNA
- Collection of simple examples
- Problem & solution collection build by LS-DYNA users

www.dynaexamples.com

- Seminar notes
- More than 120 examples presented
- Download area

www.dynasupport.com

- any support information regarding LS-DYNA
- FAQ

			ARC 1	Website durchsuchen
ngen	Finite Element home Willkommen bei DYNAr Die Firma DYNArmore steht für Produksportioiu umfass tile Firm optimierungssoftware LS-OPT Ingenieurdiensteilsung und Sp LS-DYNA FF 1213. Oktob	Solutions more excellente Unterstützung bei der numerischen Lösung die Elemente-Software L.S-OYNA, den Pre- und Postp sowie zahrichter F-EModelle. Unsere Schwerpunkter Mvare-Erhwicklung. prum per in Bamberg - In ca. 80 Vorträgen berichten Anwenn	nichtlinearer mechanischer Probleme. Unser ozessor LS-PrePost und die ind. Support, Verfrieb, Schulung, der über ihre Erfahrungen mit LS-DYNA aus den	Website durch suchen nar in attuelen Byrech Seminare Kontatte in LS-DYNA Sutgart, 06.10. Neue Partisenthole zur Arbegsmutation für Out-Of- Postion Lastifile Sutgart, 11.10. Modellerung von Explosionen
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		7th International LS-DYNA Conference Detroit, 2002more	3rd European L Paris, 2001mo	S-DYNA Conference





DYNA*more* – Services

Training and Seminars

- Introductory seminars
- Advanced seminars in LS-DYNA
- Over 50 different topics
- Seminars with focus on automotive applications
- Classes on other specific topics and applications
- Instructors from DYNAmore, LSTC and external experts



Overview of all seminar topics can be found under:

www.dynamore.de/seminars.htm



DYNAmore – SDM-solutions



CAD-Metadata

CAE-Metadata

CAE-Metadata





8th European LS-DYNA[®] Users Conference

23. & 24. May 2011 in Strasbourg (France)

Topics:

- crash
- occupant safety
- optimization
- airbags, dummy modelling
- sheet metal forming
- impact and drop tests
- manufacturing processes
- fluid-structure-interaction
- automotive
- ship building
- aerospace

. . .

- transportation
- biomechanics



more information: www.lsdynaeuc.alyotech.fr



LS-DYNA applications – overview





LS-DYNA applications – crash

Crash simulation:

- Front, side, rear end crash scenarios
- Roof crush simulations
- Non-automotive crash scenarios

(planes, trains, etc.)







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LS-DYNA applications – crash

NCAC Neon 1 million elements

Neon 1 million Element quad model Time = 0



- 130 beams
- ■2852 solids
- I contact for the entire model
- Termination time 0.080 secs
- Timestep 3.618e-6 secs
- Ascii and binary outputs disabled.
- Pre-decomposed with 1cpu



LS-DYNA applications – crash





LS-DYNA applications – occupant safety





LS-DYNA applications – occupant safety



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LS-DYNA applications – occupant safety

- Out of Position Airbag analysis
 - Arbitrary Lagrange Euler
 - Fluid-Structure coupling
 - Calibration of inlet boundary conditions
 - Airbag folding









LS-DYNA applications – compression folding of airbag





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LS-DYNA applications – compression folding of airbag





LS-DYNA applications – compression folding of airbag



LS-DYNA applications – airbag in impactor test (particle method)







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LS-DYNA applications – mixing of two gases (particle method)

Time = 0





LS-DYNA Software Models



- Dummy models
- Barrier models
- Pedestrian safety impactor models



LS-DYNA Software Models

- developed by Toyota
- DYNAmore distributor of THUMS model
- commercial projects with 3 OEMs with THUMS
- licensed to research departments
- work on material modeling for tissues,





LS-DYNA applications – sheet metal forming

Metal forming with eta/DYNAform

Deep drawing, rolling,...

- Sheet Metal forming
 - Gravity loading
 - Trimming
 - Springback analysis
 - Binder wrap
 - Deep drawing
- Hydroforming
- Bending
- Bulk forming
- Thermal coupling











LS-DYNA applications – sheet metal forming

- deep drawing
- tube forming
- flanging, hemming
- thermal forming
- hydro forming
- forging
- extrusion



BULK FORMING USING THE 3D REMESH FUCTIO Time = 0





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LS-DYNA applications – drop test



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LS-DYNA applications – impact

- Bird Impact
 - Comparison of Lagrange, ALE and SPH approach
 - Determine blade load from Fluid-structure interaction
 - Investigation of fiber metal laminate material









LS-DYNA applications – production processes



Extrusion







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LS-DYNA applications – production processes



Cutting



Welding



Fringe Levels

5.100e-01

5.067e-01

5.033e-01

5.000e-01

4.967e-01 _ 4.933e-01 _

4.900e -01 _

LS-DYNA applications – spot weld modeling

- Comparison of spotweld models
 - Beam nodal connection
 - Contact shell set
 - Continuum element connection
 - Mesh dependency







LS-DYNA applications – implicit analysis

- Frequency response
- Static analysis

max displacement factor=5

Transient dynamic analysis



LS-DYNA eigenvalue problem - FORD TAURUS BIW Time = 38.736





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LS-DYNA applications

- Multi-physics (coupling structural, thermal, fluid, Acoustic analysis)
- Arbitrary Lagrangian-Eulerian (ALE)
- Smooth Particle Hydrodynamics (SPH)
- Fluid-Structure-Interaction (FSI)









LS-DYNA applications – recent developments

Meshless methods

- Smooth Particle Hydrodynamics (SPH) schemes
- Element Free Galerkin (EFG) schemes
- Coupled FEM/Mesh-free Galerkin Method





LS-DYNA applications – recent developments

CFD-Method

- Incompressible and compressible Navier-Stokes
- Coupling to heat-transfer
- Turbulence models available
- MPP-version available







LS-DYNA applications – aerodynamics

Flow Around Wheel House and Rotating Tyre

- .* Study of the detached flow
- behind the wheelhouse
- * Incompressible Implicit CFD
- * Reynolds Number 9e5
- * Boundary Layer mesh around vehicle and tyre
- * 1.2M Tet elements with 250K in the Boundary

Layer







LS-DYNA applications – biomechanics

time|sec|: 0.000000

- Strong Fluid-Structure interaction
- coupling is mandatory for bio-medical applications
- Miss-match fluid and structural mesh allows proper resolution for each domain









A special surface reconstruction algorithm is developed for metal cutting analysis.

Interactive adaptivity is able to detect distortion that occurs frequently and irregularly in metal cutting analysis.

Metal cutting Time = 0.#nodes=37397.#elem=158522	Fringe Levels
Contours of Effective Plastic Strain	2.000e+00 _
max ipt, value min=0, af elem# 131398	1.800e+00 _
max=0, at elem# 131398	1.600e+00 _
	1.400e+00 _
	1.200e+00 _
	1.000e+00
	8.000e-01 _
	6.000e-01 _
	4.000e-01 _
	2.000e-01 _
	0.000e+00
Y	
K ⊂	



Summary

many applications

- crash analysis
- occupant safety (dummy modeling, barriers, impactors, thums, ...)
- sheet metal forming
- drop tests
- process simulation
-
- various techniques
 - implicit and explicit time integration
 - eigenvalue analysis
 - fluid-structure-interaction (will come soon)
 - meshless methods (EFG, SPH)
 - particle & discrete methods

-

- one CODE-strategy
- all different disciplines can be performed with one executable



Thank you!





Stefan Hartmann, April 14th, 2011, Pavia, Italy