FTSS Dummy Models Update

April 14th, 2005

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Presentation Outline

- Overview
  - Introduction to FTSS
  - Model Development Methodology
  - Future dummies and new regulations
- Frontal Impact Dummies
  - Hybrid III Adult: 50th %, 5th % and 95th %
  - Hybrid III Child: 3 yr old and 6 yr old
- Side Impact Dummies
  - SIDIIs and SIDIIsFRG
  - WorldSID50th
- Future Model Developments

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Introduction to FTSS

- Largest Crash Test Dummy Manufacturer and Crash Test Dummy Model Supplier
- Headquarters Located in Plymouth, Michigan
  - Manufacturing Plant
  - Engineering
  - Test Laboratories
- Offices in:
  - USA, Korea, Japan, China, UK, Netherlands, Germany, India, Aust'l
- Test Labs in:
  - USA, Netherlands, Germany, Japan, Korea, China
- Computer Aided Engineering
  - Plymouth, USA
  - Shanghai, China
  - Coventry, UK
  - 10 CAE Engs

FTSS Plymouth Michigan USA Technical Headquarters

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FE Model Library

Livermore Software Technology Corp.

- **Frontal Dummies**
  - H3-50 Male
  - H3-5 Small Female
  - H3-95 Large Male
  - H3-3 year old
  - H3-6 year old
  - H3-10 year old (Apr '05)
  - Free Motion Headform

- **Side Dummies**
  - SID-IIs
  - SIDIIs FRG
  - WorldSID 50th
- **Future Dummies**
  - Thor-Lx (July '05)
 - Q3 Child (Jan '06)

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Customer Base

FTSS has over 70 customers worldwide with over 250 users, using the finite element models as a core part of the vehicle design and development process

• GM	• BMW	• Mitsubishi
• DCX	• Audi	• Takata
• Ford	• VW	• TATA
• Toyota	• TRW	• Suzuki
• Mazda	• Autoliv	• Magna Steyr
• Daihatsu	• Delphi	• Opel
• Honda	• Land Rover/Jaguar	• EDAG
• Isuzu	• Lotus	• Idiada
• Nissan	• Gedas	• SAAB
• Hyundai	• Karmann	• Porsche

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Development and Validation Methodology

- Accurate Geometry Data
- Testing and correlation for model development
  - Material level
  - Component level
  - Sub-assembly level
- Fully dummy validation
  - Assembly level
  - Sled test level
- Robustness checks
- QA checks and Documentation

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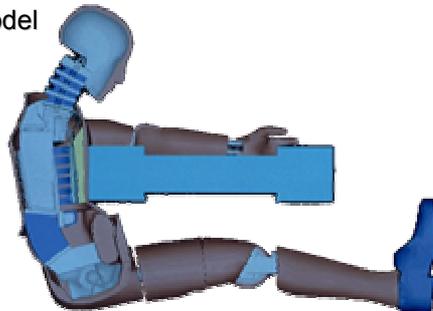
Model development
- Typical Dummy Materials

- Metals
  - Steels, Aluminium, Lead, brass
- Viscoelastic materials
  - Rubbers (several grades/durometer readings), Vinyls (several grades), Hyperlast (several grades)
- Low Density Foam
  - Urethane (varied density), Confor foam (high and low density), Foamed Hyperlast, Brand specific foams
- Elastic behaviour
  - Polyurethane (bib, bones), Ureol (iliac wing)
- Unusual materials
  - Rib damping material (pseudo-plastic & creep), Nitinol (shape memory Nickel-Titanium alloy)

FTSS Manufacture majority of the material on-site

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Model Development – material testing

- Over 1000 materials tests have been conducted for model development by FTSS
- **Low Density Foams** – high speed **Drop Tests** at several rates (up to 90% compression) are used to develop material data for rate-dependent foams
- **Elastomers** or Viscoelastic materials – **Stress relaxation** and **compression tests** are used to develop OGDEN_RUBBER material properties and verified on component tests
- **Vinyl-foam-vinyl sandwich** structure **Drop Tests** at various speeds: pelvis, legs, arms, etc.

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Elastomer Material Testing

Stress Relaxation & Compression Tests
Test example: Hyperlast cube (3" each side)

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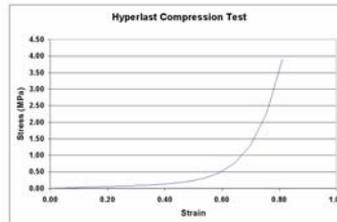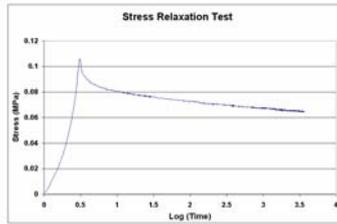
Drop Testing – Foams and Sandwiches

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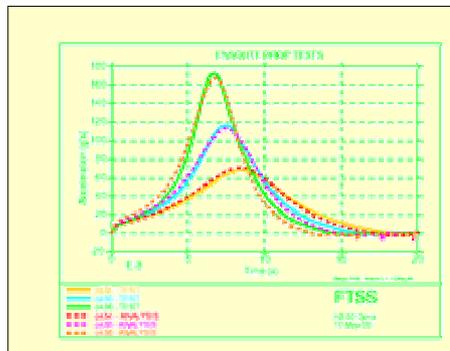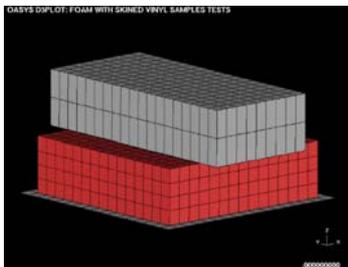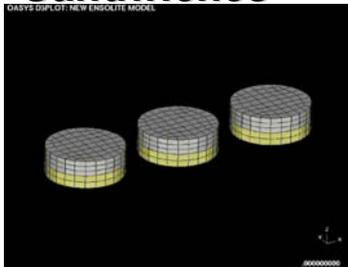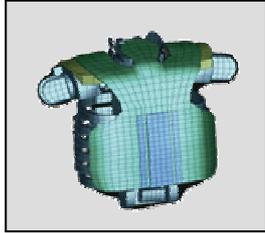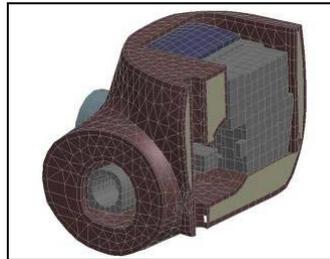
Model Development – geometry data

- **Accurate geometry data** – from design CAD data or drawings, or directly digitized from mould surfaces where necessary.
- The assembled model is verified to dimensions of the production crash dummy.

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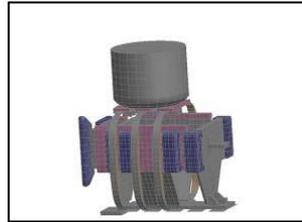# Geometry Data – SID-IIs Pelvis Flesh

- The pelvis flesh is modeled with separated vinyl and foam to match closely the physical construction.

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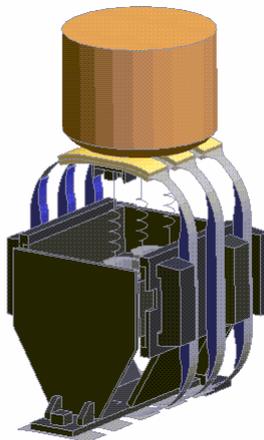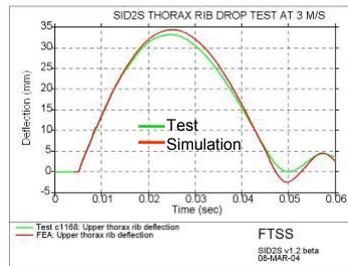
Model Development – component

- **Component level validation**
- Each component is tested and validated using representative drop or pendulum tests at a multiple of speeds and realistic crash load cases
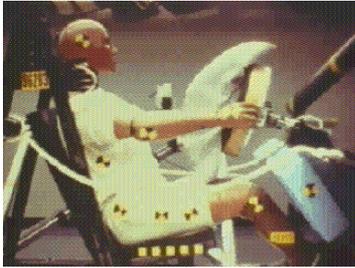
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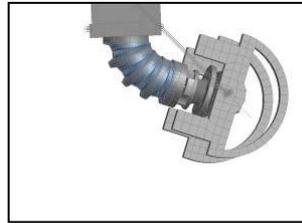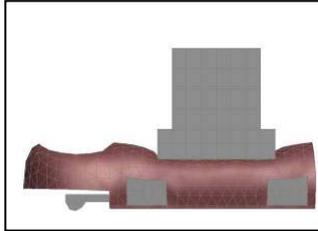
SID-IIs rib cage validation

- Thorax Development
  - Single rib tests
  - 3-rib tests

SID2S THORAX RIB DROP TEST AT 3 M/S

Deflection (mm)

Test
Simulation

Time (sec)

Test c1168: Upper thorax rib deflection
FEA: Upper thorax rib deflection

FTSS
SID2S v1.2 beta
08-MAR-04

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Pendulum and Sled Testing

- Pendulum tests offer a controlled environment for full dummy model evaluation
- Sled tests include the complexity of different loading into the dummy
- Fully instrumented dummies used for model correlation

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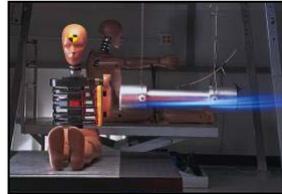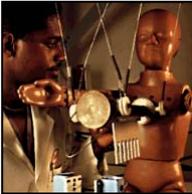
Assembly and sled Validation

- Check for correct assembly and joints
- Test effect on parts of the model that are not directly impacted
- Contact modelling developments
- Robustness checks

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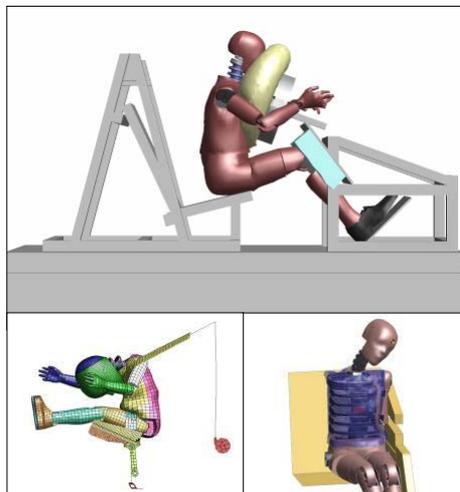
QA procedure and documentation

- ISO 9001 QA procedure for all new modeling projects starting from project planning through material testing, component validation, and whole assembly correlation.
- Dummy model release package contains the following
  - LS-Dyna input deck/s in two common unit systems
  - user manual (injury output, filters, positioning, user tips etc)
  - technical report (describing the correlation and improvements)

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