Role of Materials in Simulation

reducing materials risk through testing, modeling, validation, management and knowledge capture



expert material testing | CAE material parameters | CAE Validation | software & infrastructure for materials | materials knowledge | electronic lab notebooks

Mission

We strengthen the materials core of manufacturing enterprises to facilitate their use of new materials, novel manufacturing processes, and simulation-based product development.







Brands







20+ years of **Datapoint**Labs

- Focused on "materials in simulation" since 1995
- Deep domain expertise
 - physics of materials, CAE parameter conversion, software for materials
- Market dominant and world renowned





Yesterday's product development

- Conventional, well understood materials
 - Handbook material data was adequate
 - Material testing in a few cases, in an R&D mode
- Large factors of safety
- Simulation used on the sideline, as "trendy"





Today's landscape

- New materials
 - Behavior not completely understood
- New production processes
 - Can affect product performance
- Light-weighting
 - Shape optimization
 - Critical designs with optimal factor of safety
- Trend to simulation driven product development
 - Design decisions being based on simulation results
 - Reduced or eliminate late-stage prototyping

Failure can be expensive







Contribution of materials

- Need for accuracy & traceability
 - Data from internet presents unmanaged risk
- Modern material data can be complex
 - Not easily understood by design/CAE engineers
- Conversion to material parameters for CAE
 - Need for correct data processing





What is needed – a process approach

- The right material data
 - Actual material, correct manufacturing process
 - Accurately measured properties
- Fitted to correct model
 - Right material model
 - Correct parameter conversion
 - Correct material file
- Mid-stage validation of simulation
 - Check if simulation produces correct result
- Error-free export to simulation
 - Master material files
 - Correct material name (same as on the BOM / print)
- Consistency: All users must use the same master material files





Materials Workflow for Simulation





Obtaining physical properties of your materials

- Mechanical Properties
 - Tensile
 - Compressive
 - Shear
 - Hyperelastic
 - High strain-rate
 - Fatigue
 - Creep
- Thermal Properties
 - Expansion
 - Conductivity
 - Specific Heat
- Flow Properties
 - Rheology
 - Viscoelasticity

crash and drop simulation data



Advanced measurements

- DIC
- High speed data
- Composite shear
- Validation







Simulation properties

hyperelastic modeling of rubber







testing of foams



creep, fatigue, long term behavior





1e04

1e05





Material parameter conversion process

- Need accurate consistent data on your material
- All required properties must be measured
- Material parameter generation must be correct

RTHO Option

1187

Validation can be beneficial





testing

MID PRCA PRBC 0.361 GAB GBC 4458 3371 500 NISO MID C11 C12 1.23E-04 6.8E-07 C14 C24 C44 2.24E-04 C55 AOPT

conversion



your design





Obtaining material parameters for CAE TestPaks



testing | material parameters | CAE material file | validation

Your data, material cards and test reports are deposited directly into your Matereality database







Matereality's framework assemble: convert: deploy







Software for material parameter conversion







DIY: fitting material parameters with Matereality







Integration with the enterprise materials landscape the big picture

- Material Data Server for Enterprises
 - Libraries
 - Material information
 - Properties
 - Material specifications
 - CAE material files
 - Test reports
 - Software modules
 - Load, view, compare materials
 - Create CAE material cards
 - Create master material files
 - Create/manage specifications







3D printing validation by CAETestBench



Validation of ANSYS® simulation for a 3D printed aluminum component, using a standardized bike crank (from-Cornell's Swanson Laboratory for Advanced Engineering Simulation) and DIC.

DIC validation





Failure validation







SDPD process applied to 3D printing







Crash validation by CAETestBench



TestPaks









Plastics validation by CAETestBench











strengthening the materials core of manufacturing enterprises

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Rubber hyperelasticity validation CAETestBench











Use Knowmats[™] to learn more about *materials in simulation*

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Material Types Model Types Industries	September 15, 2013 (by DatepointLans) (views 4 The development of material parameters for FEA is heavily reliant on precision material data that captures the stress-strain relationship with fidelity. While conventional methods involving UTMs and extensioneters are quite adequate for obtaining such data on a number of materials, there are important cases where they have been known to be inadequate. The testing of composites to obtain directional properties remains a complex task because of the difficulty related to measuring these properties in different orientabions. Digital Image Correlation (DIC) methods are			Related Posts Validating Simulation Using Digital Image Correlation
Technical Interests CAE Types Other	able to capture the stress-strain relationship all the way to failure. In this paper, we combine DIC and conventional methods to measure directional properties of composites. We exploit the unique capability of DIC to retroactively place virtual strain gauges in areas of critical interest in the test specimen. Utilising an lospiescu future, we measure shear properties of structured composites in a variety of orientations to compute the parameters of an orthotropic linear elastic material model. Model consistency is checked by validation using Abaqus.			A Novel Technique to Measure Tensile Properties of Plastics at High Strain Rates
	Brian Croop and Hubert Lobo. NAFEMS World Congress. 2013.			A Robust Methodology to Calibrate Crash Material Models for Polymers
	Links Use of Digital Image Correlation to Obtain Material Model Parameters for Composites		High Speed Stress Strain Material Properties as Inputs for the Simulation of Impact Situations	
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Knowledge accumulated by DatapointLabs, partners, industry experts



Share your findings and get peer review related to materials in simulation





Topics for today's presentations

- Plastics: testing, modeling and model validation
- Hyperelastic: testing, modeling and model validation
- Creep/Stress Relaxation/Viscoelastic/Fiber-filled: testing, modeling
- Rate Dependent: testing, modeling and model validation





Some interesting 10-year testing trends

- Metals 5%
- Plastics 76%
- Rubber
- Foam
- Composite
- Adhesives
- Paper

76% 5% **}** 7%

1.5%

-Aerospace -Automotive -Appliance -Biomedical -Consumer products -Electronics -Industrial Goods -Materials -Petroleum -Packaging





