Understanding and Coping with Material Modeling Limitations in FEA

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- Research quality material testing
- ISO 17025 production environment
- Results in 5 days (48 hour RUSH service)
- Web-based quotation & data delivery
- Domain expertise in CAE material calibration

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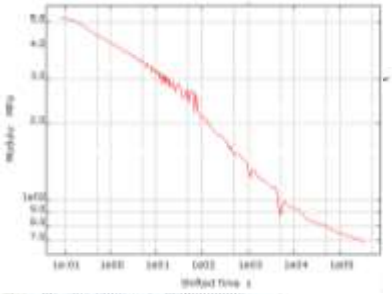
expert material testing

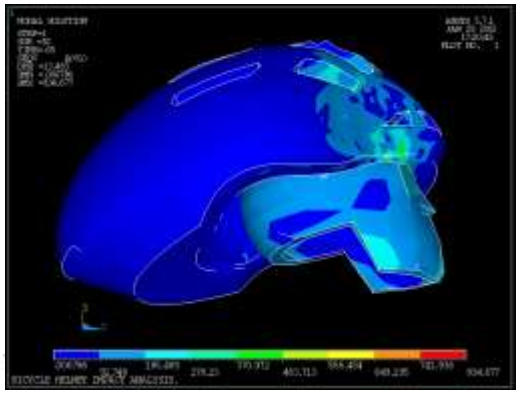
materials

testing

+



data conversion



Your CAE

- *TestPaks*® = Materials testing + CAE material parameter conversion
  - metal, plastic, foam, rubber, composites…
  - over 20 CAE software codes

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Modeling Limitations

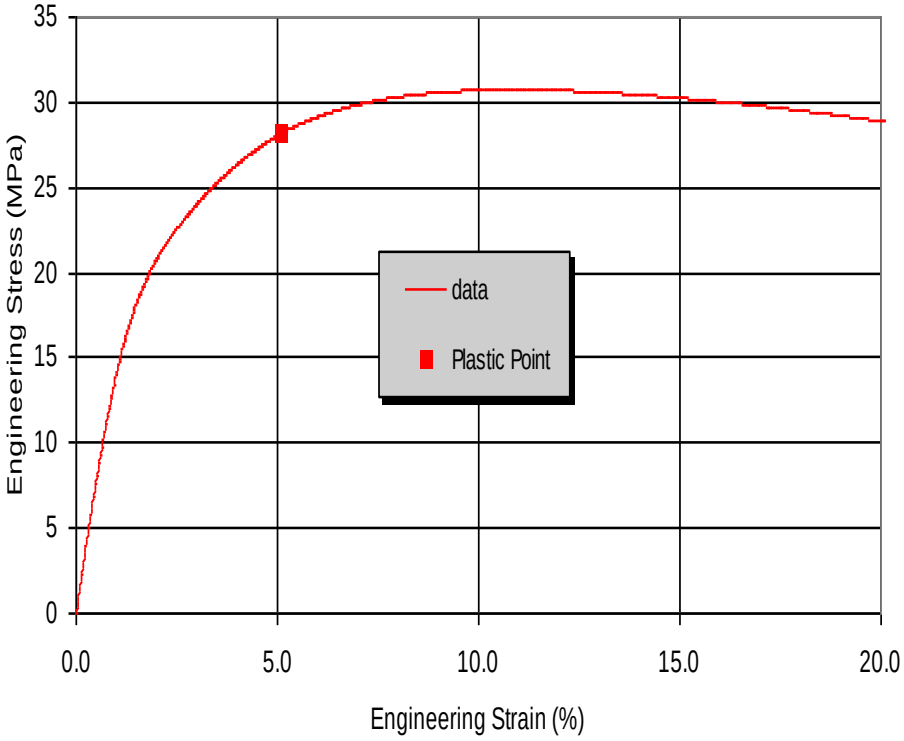
- Understanding material model requirements
- Gaps between material data and model
- Obtaining pertinent properties
- Difficulties in parameter conversion (fitting)
- Preparation of input files

Unclear model requirements

- Modeling terminology not compatible with testing terminology
  - Confusion causes interpretation error
- Common mistakes
  - Engineering/true/plastic stress-strain
  - Engineering instead of true yield stress

Gaps between model and data

- Non-linear elasticity
- Elastic limit well below classical yield point
- Significant plastic strains prior to yield
- Post-yield with necking behavior



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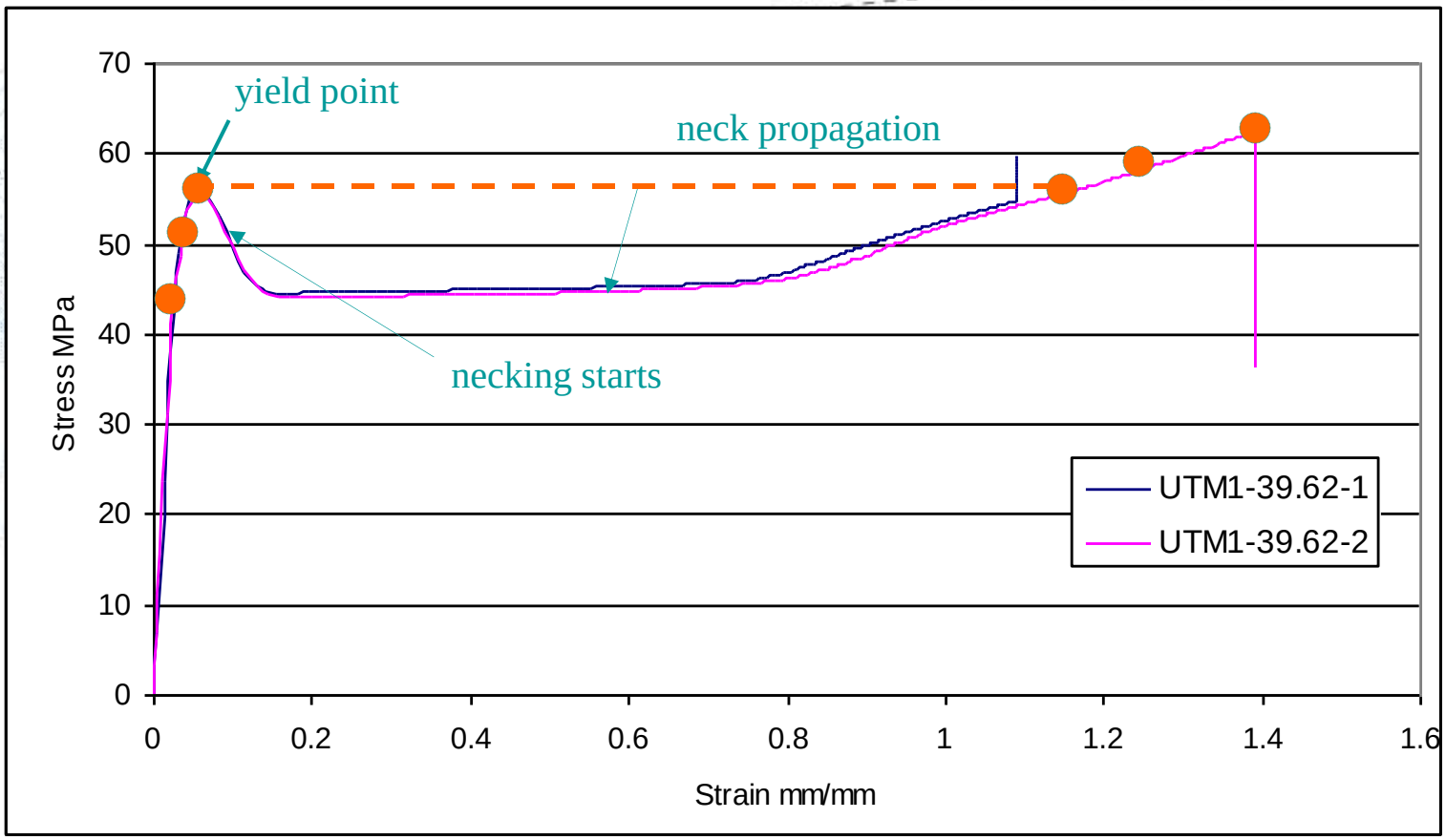
Handling complex phenomena



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Getting pertinent properties

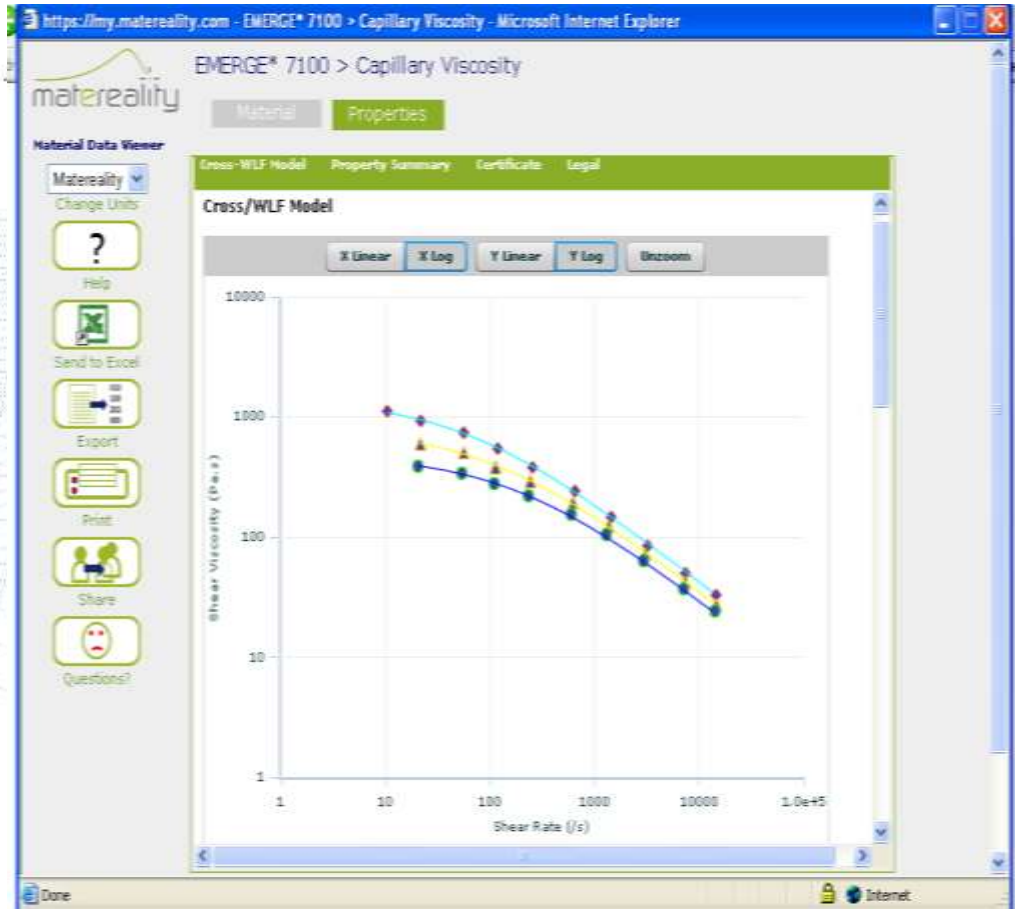
- Importance of measuring the right property
- Artifact free data
  - Properly designed experiments
  - eg. not using crosshead displacement to calculate strain
- Traceable data (ISO 17025)
  - NIST traceable instruments
  - Certified trained technicians

Getting the right samples

- Spatial variation
  - Properties vary with location
  - Forming, stretching, molding…
- Environmental variation
  - Ageing and conditioning
- Process variation
  - Degradation from processing
  - Recycled materials

Model Fitting

- Complex non-linear regression
- Importance of good fits
- Evaluating quality of fitted data
  - Visual measures
  - Quantitative measures



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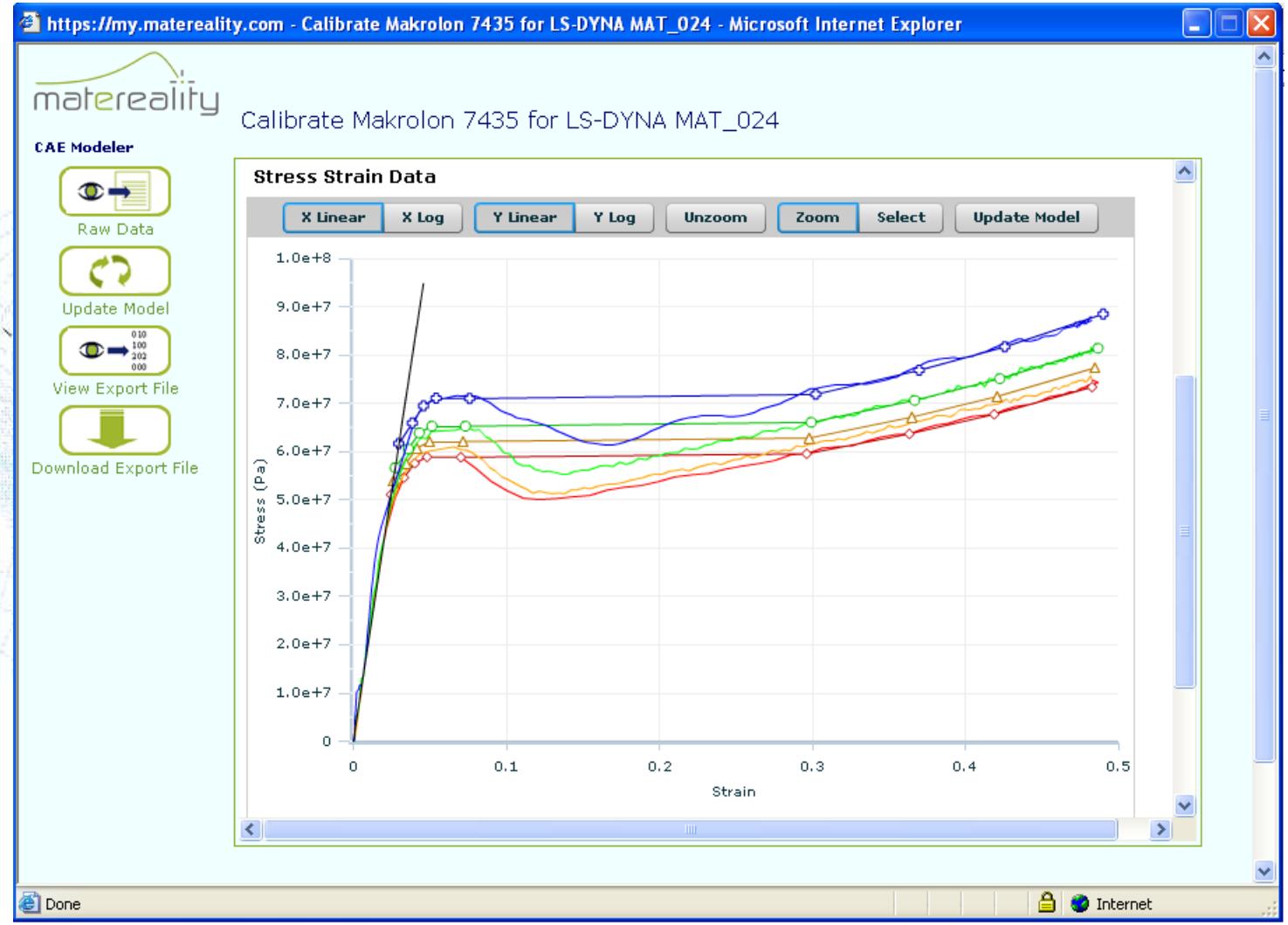
Complex Modeling



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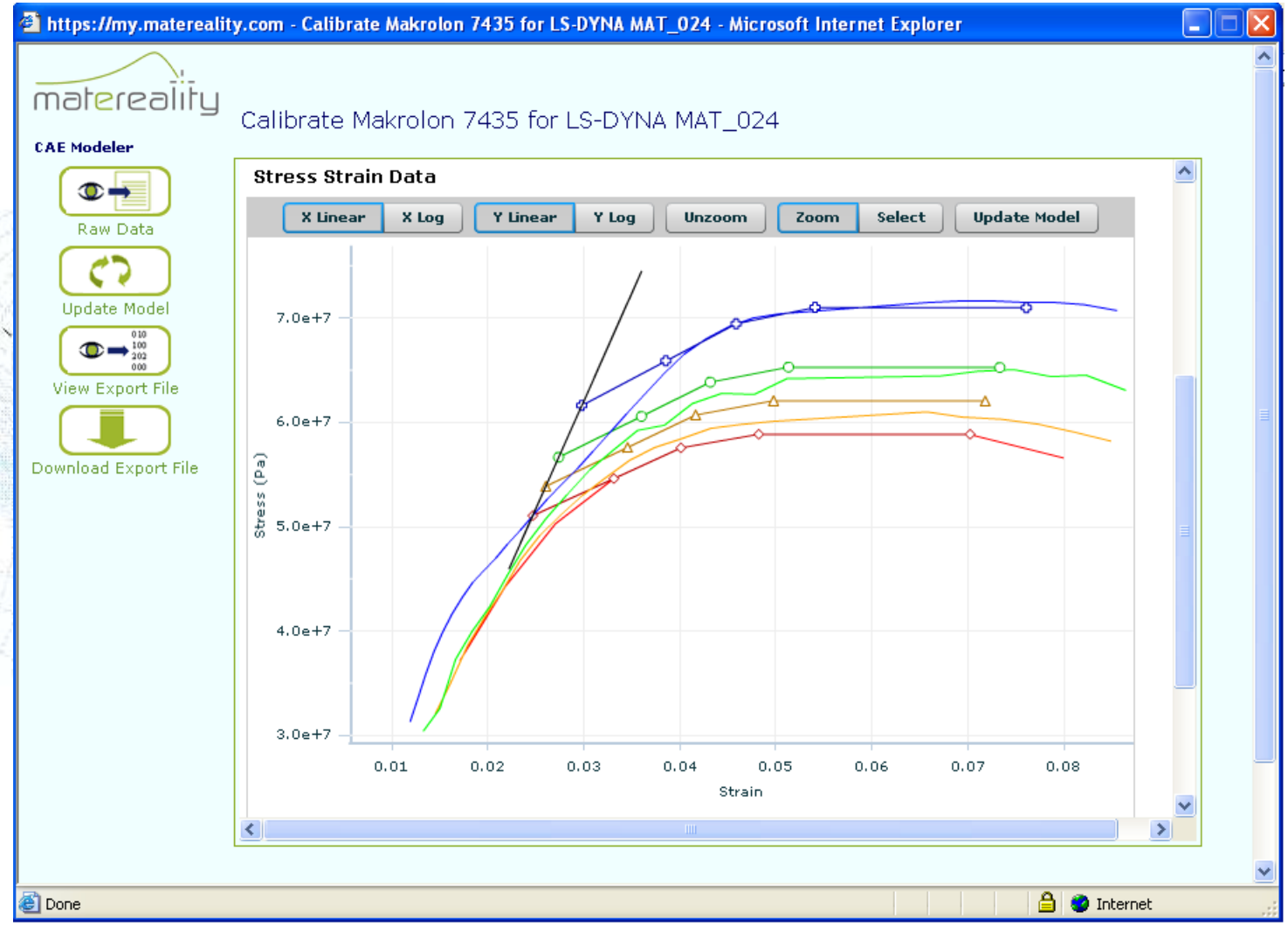
Model limitation



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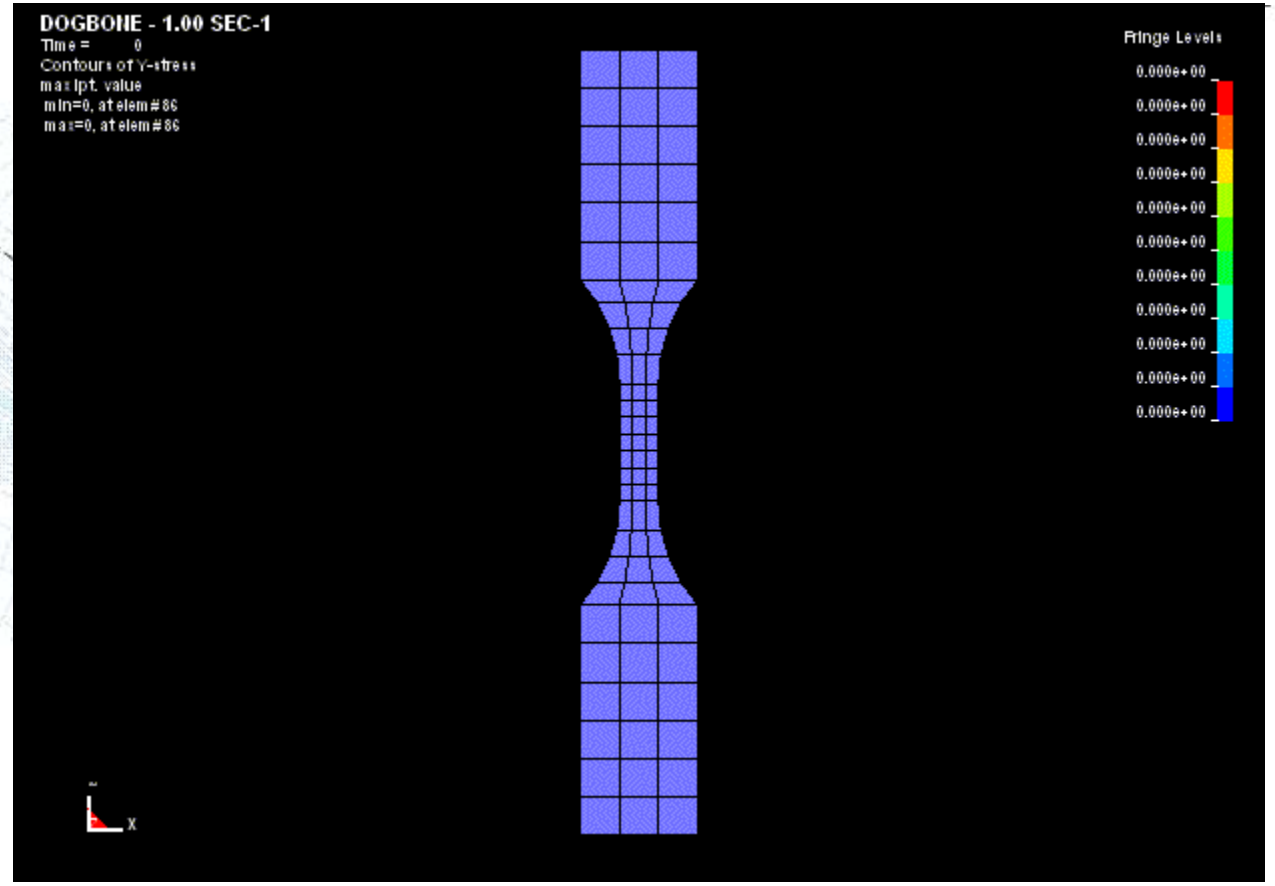
Validation



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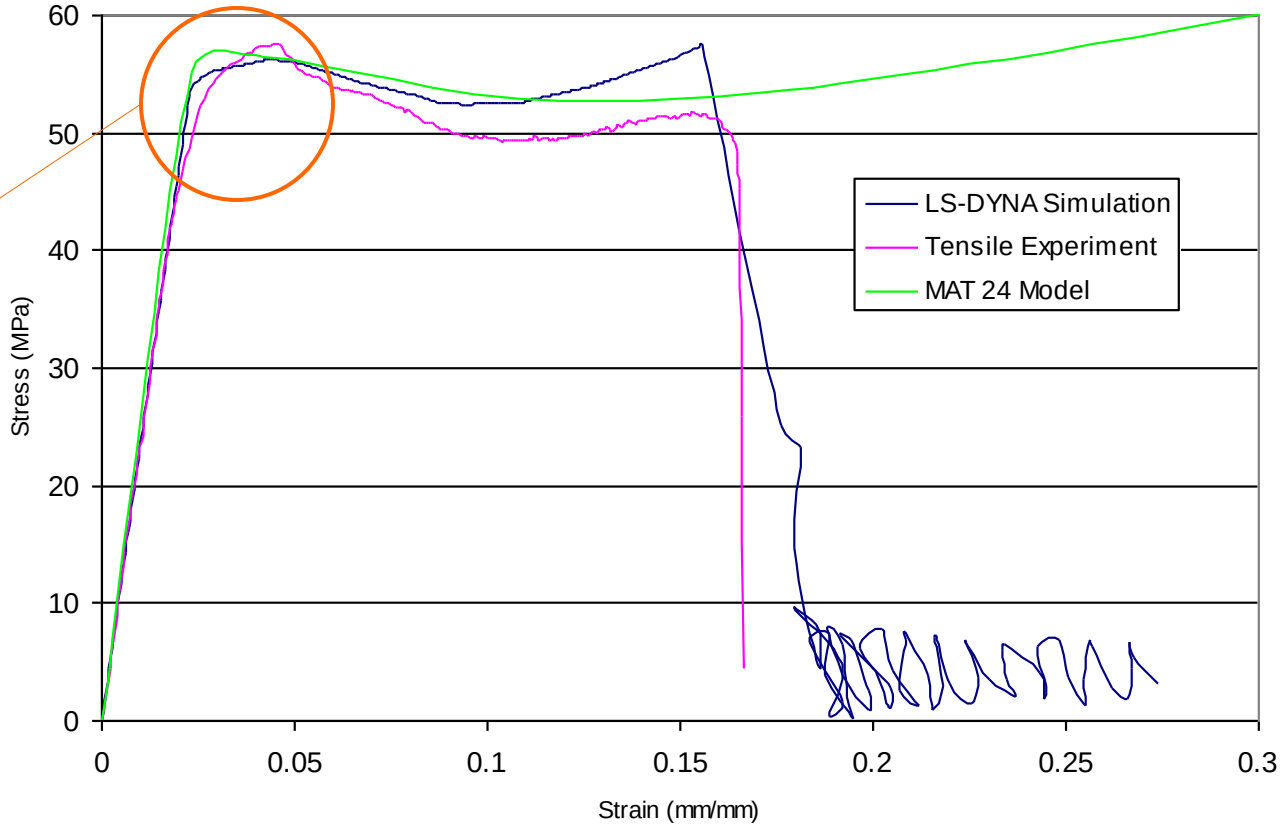
Comparison to experiment

limitation



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Input file creation

- Time-consuming exotic formats
- Error prone data entry
- Need to define the undefinable
  - Some terms not known
  - Some terms assumed
  - Impact on simulation = unknown

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** Output generated by Matereality
** Abaqus Plastic Model
*MATERIAL, name=Delrin8753K13
*ELASTIC
3607.59123689013, 0.2413, -10
3183.7938807461, 0.323571664399527, 23
2174.59568965032, 0.39415, 60
****
*PLASTIC
46.381708640637, 0,-1.000E+01
59.3182190072696, 0.0028490427305577354,-1.000E+01
71.8736400512504, 0.01017006174294555,-1.000E+01
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**
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Solutions

- Try to understand the model completely
- Measure the correct data with precision and minimum noise
- Measure the right material
- Select the best model for the data
- Ensure the best fit of model to data
- Validate against a simple experiment
- Create error-free input file

Improvements

- Simple improvements can add power
- Validated models represent baseline
- Models can be tuned for multi-axial loadings

Measure • Calibrate • Validate • Tune

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