



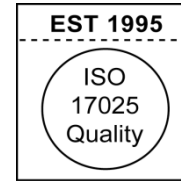
A Standardized Methodology for the Digimat MX Reverse Engineering Process

*Hubert Lobo,
DatapointLabs, USA*



DatapointLabs

expert material testing



Material Model Calibration Services

- Since 1995 -

DatapointLabs

expert material testing

∞ Scope

- ✓ Over 200 physical properties
 - Mechanical properties
 - Thermal properties
 - Flow properties

∞ Technical Heritage

- ✓ Cornell University & C-Mold
 - Cornell Injection Molding Program

∞ Expertise

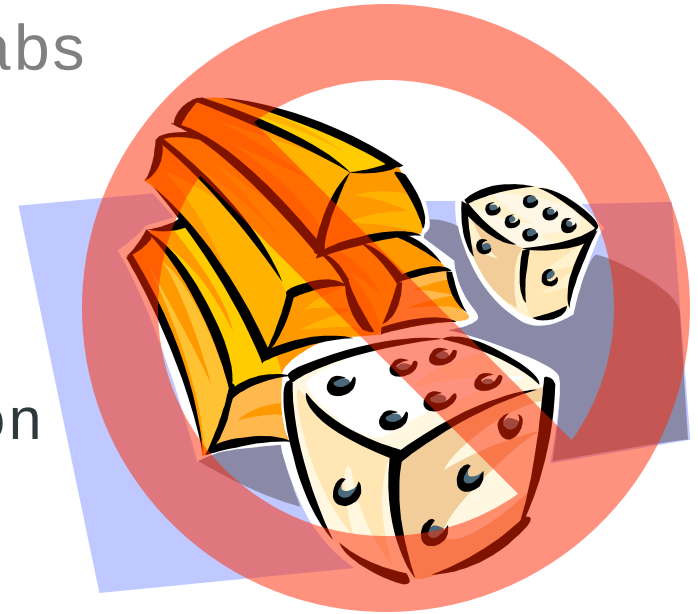
- ✓ *TestPaks* for CAE/ product development
 - 25 CAE codes supported
- ✓ >1,000 materials tested per year
 - Wide variety of materials

tensile
compressive
flexural
stress-strain
Poisson's ratio
high strain rate
bulk modulus
fatigue
visco-elasticity
stress relaxation
creep
friction
hyperelasticity
thermal expansion
thermal conductivity
specific heat
PVT
rheology

TestPaks® from DatapointLabs

∞ Material Testing
+
Material Parameter Conversion

- ✓ precise
- ✓ confidential
- ✓ fast & economic
- ✓ expert technical support



no gamble

available worldwide

Outline

- ☞ 1. Standardized test methodology for DIGIMAT MX
 - ✓ Test plaque
 - ✓ Molding
 - ✓ Specimen profile
 - ✓ Machining procedure
 - ✓ Testing procedures
 - Quasi-static
 - Crash
 - Creep
 - Fatigue (under development)
- ☞ 2. Obtaining DIGIMAT data from Matereality databases
- ☞ 3. **NEW**- DIGIMAT MX reverse engineering service
 - e-Xstream + DatapointLabs joint cooperation

The DIGIMAT MX *TestPak* ...how it works

- ∞ Order your Digimat MX *TestPak* at datapointlabs.com
- ∞ Ship one 25kg bag of material
 - ✓ DHL pick-up service available
- ∞ One week for molding
- ∞ One week for testing
- ∞ DIGIMAT MX-ready data delivered via Internet
 - ✓ Pdf test report
 - ✓ Digital data to client material database at www.matereality.com

Basic DIGIMAT MX *TestPak* Protocol

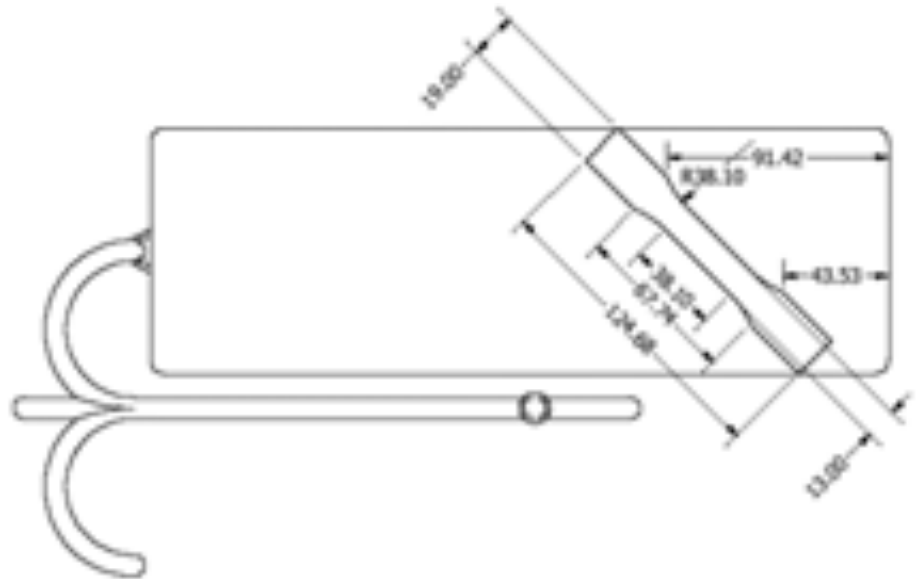
∞ Critical points to obey for experimental measurements
(e-Xstream engineering)

✓ Experimental measurements

- Obey the correct relative humidity!!!
 - One of the classical issues
- Choose a good plate geometry
 - Datapoint Labs
- Clean up experimental curve
 - 0 MPa stress at 0% strain
 - » Initial step of RE evaluation of the Young's modulus

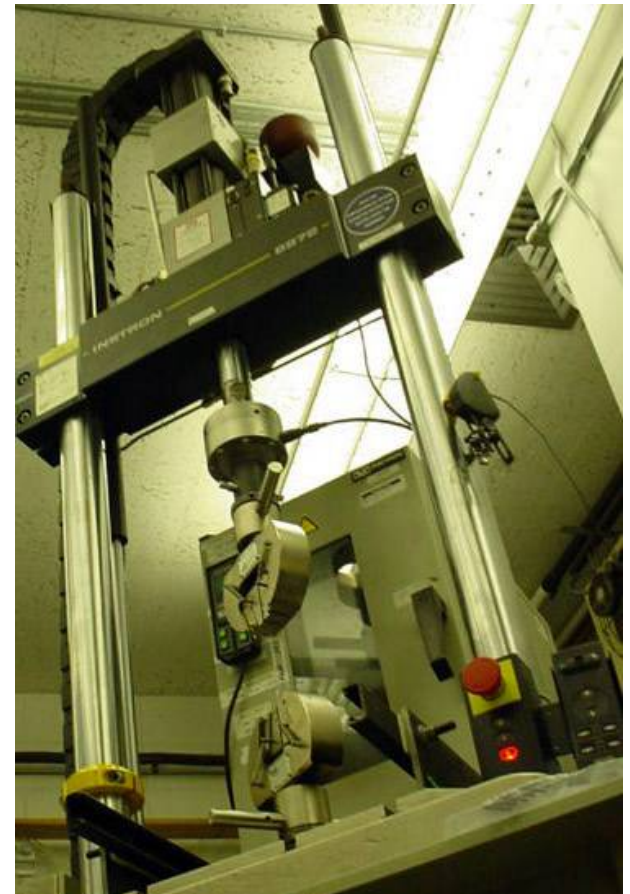
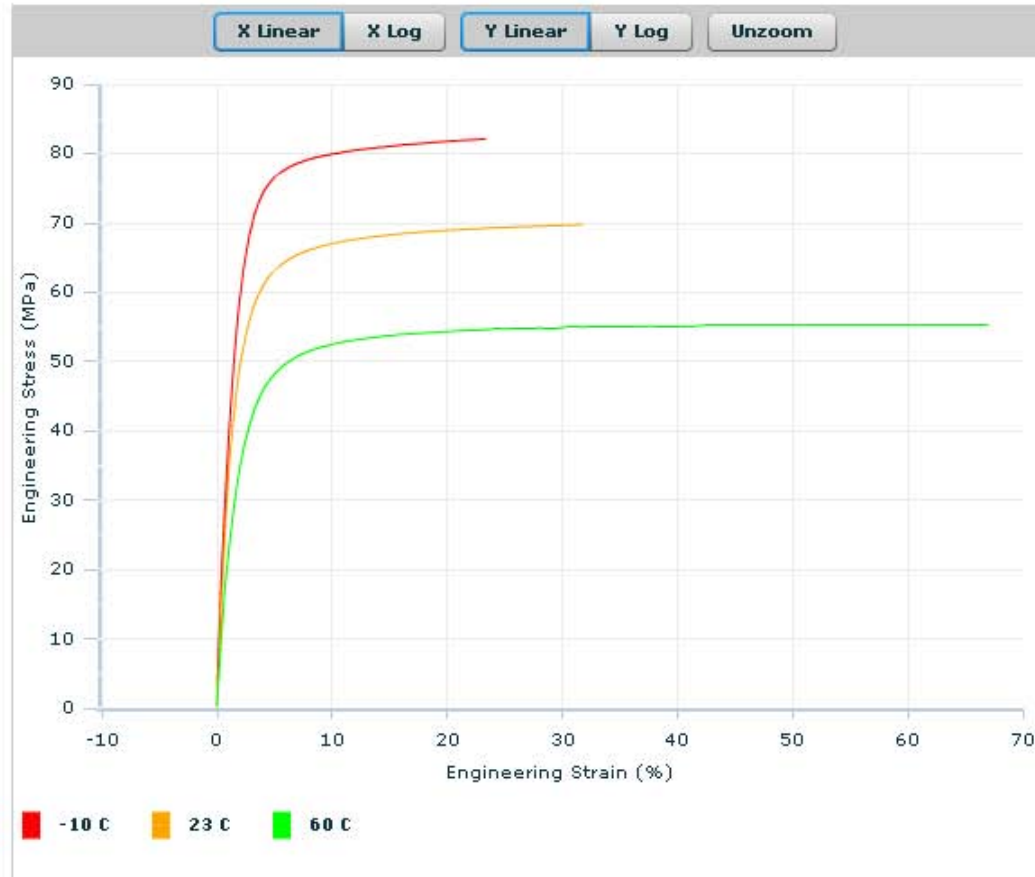
Basic DIGIMAT MX *TestPak* Protocol

- ∞ Mold 100X200X3.16mm plaques
 - ✓ Edge gated on 100 mm end
 - ✓ Long flow length
 - ✓ Fully developed flow
 - ✓ Highly fiber orientation
- ∞ Cut test specimens by CNC
- ∞ 5 specimens each (0° , 90° , other orientations...)
- ∞ Obtain true stress-strain data



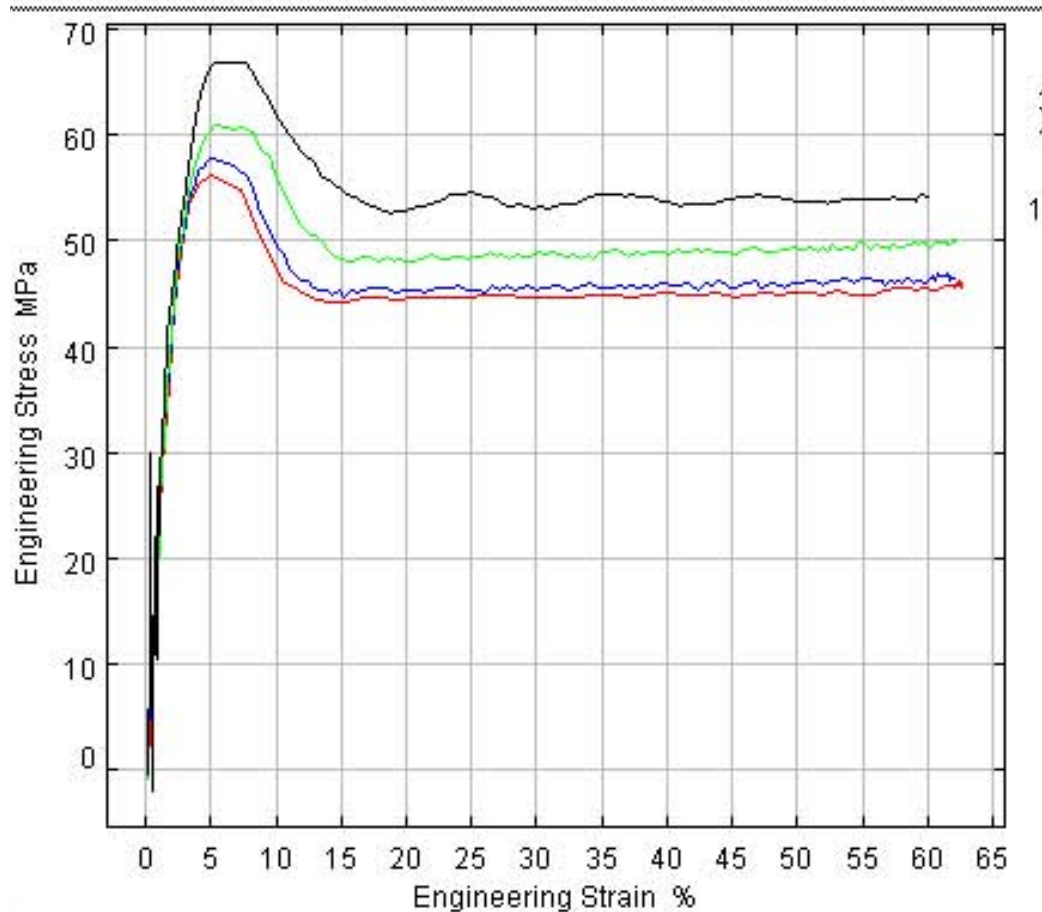
Stress-strain data

Engineering Tensile Stress-Strain Curves



Example: Crash properties for DIGIMAT

Engineering Tensile Stress-Strain Curves



DIGIMAT *TestPak* options

- ∞ Additional directions (10° , 20° , 45°)
- ∞ Thermomechanical (from -40° to 150°C)
- ∞ Strain-rate dependent (0.01 to 100/s)
- ∞ 3 point bend data (quasi isotropy)
- ∞ Tensile bar data (coarse fit)
- ∞ Visco-elasticity
- ∞ Low cycle fatigue (Lemaitre-Chaboche)
- ∞ High cycle fatigue (under development)

DIGIMAT MX *TestPak* outputs

Reverse Engineering of DIGIMAT material model

✓ Injection molding simulation of the dumbbells

- Obey the experimental injection conditions!
- Extract layered microstructure
 - O.k.:
 - » Extract OT of representative element per layer
 - Best:
 - » Compute average OT per layer by extracting the dumbbell

DIGIMAT MX *TestPak* outputs

Datapoint Labs:

- ✓ CAD drawings of plaque and specimens
- ✓ Plaque molding conditions

DIGIMAT MX *TestPak* outputs

Reverse Engineering of DIGIMAT material model

✓ Digimat-MF

- Build first a high quality material model
- Material model should contain
 - Microstructure
 - » Volume fraction (final quality)
 - » Orientation (layered!) (final quality)
 - » Aspect ratio (rough assumption)
 - Failure indicator if needed (see later)

DIGIMAT MX *TestPak* outputs

Reverse Engineering of DIGIMAT material model

✓ Digimat-MX

- Import experimental curves
- Reverse engineer step-by-step
 1. Elastic part + aspect ratio
 2. Plastic part
 3. Failure
 - » If non-FPGF

✓ Digimat-MF

- Reverse engineer
 - Failure
 - » If complex & FPGF

DIGIMAT MX *TestPak* outputs

∞ Datapoint Labs:

- ✓ True stress strain data (M-204) at 23°C
- ✓ 0°, 90° orientation from plaque

∞ Customer

- ✓ Performs DIGIMAT MX Reverse Engineering
- ✓ Data is ready for FEA



Part 2: DIGIMAT CAE Modeler

Workflow to locate and extract material data
from your Matereality database to DIGIMAT
and to import data into Digimat-MX materials
exchange platform

You can extract data from the Global Data Center, company workgroup or your own material database

matereality

Home Help Settings Logout
Confidential Demo Purposes's Matereality

Global Data Center My Workgroup My Database

Quick View Properties Design Data

Locate Properties in My Database

Class	Sub Class	Supplier
Any	Any	Any

All Properties Search for properties by type Go

Create Material Models for your CAE

ALGOR esi LSTC Moldex3D DS SIMULIA ANSYS Autodesk Moldflow

Find Materials for Automotive Applications [change industrv](#)

Next, Select the CAE software of interest: DIGIMAT

Start DIGIMAT CAE Modeler

Hands-on with Windo x W/ Skeuomorph - Wikip... Windows 8 for softwa x Paxfire: our search qu x NameValueCollection x XML Transforms - xsl: x Select Material x

servertwo/dev/Digimat/CAESearch.aspx?CAE=Digimat

Home Help Settings Logout
Confidential Demo Purposes's Matereality

 matereality

Locate Data for Digimat in the Global Data Center

Tutorial

Apply Material Constraints

Class	Sub Class	Supplier
Any v	Any v	Any v

Get [Plugins](#) for your software.

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View available DIGIMAT data



CAE Wizard : Digimat

[Revise Search](#)

Note: Some MIRO wizard searches are highly restrictive to permit the necessary downstream data-processing. A failed search does not necessarily mean that the data you need is not within Matereality. More data may be found by doing a Property Search. Additional manual data processing may be needed to make it ready for your end-use application.

	Match 0	Match 1	Match 2
8539K13 NYLON 66			
8586K162 ABS			
8619K441 HDPE			
8742K133			
8742K133 PP			
8752K111 UHMWPE			
9266K14-PTFE			



Add additional required information

Bayblend FR 2010 - Digimat Calibration - Google Chrome

servertwo/dev/Digimat/Export/SelectExportFormat.aspx?rid=35_634516107354015777&orid=15_634516107144795688&STemplate

CAEmodeler

Bayblend FR 2010 - Digimat Calibration

Material Raw Data CAE Model

Update

View Model

Download

Fillers

-----	%
Calcium Carbonate	%
Carbon Fiber	%
Glass Bead	%
Glass Fiber	%
Mica	
Talc	
Other	

	angle
flow	°

Typically orientations such as flow, long are 0°, while orientations such as x-flow, crossflow, etc. are 90°

Enter the filler type and the % content

Add orientation information

Bayblend FR 2010 - Digimat Calibration - Google Chrome

servertwo/dev/Digimat/Export/SelectExportFormat.aspx?rid=35_634516107354015777&orid=15_634516107144795688&STemplate

CAEmodeler

Bayblend FR 2010 - Digimat Calibration

Material Raw Data CAE Model

Update

View Model

Download

Fillers

Glass Bead 5 %

----- %

----- %

Orientations

Orientation Label	angle
flow	0

Typically orientations such as flow, long are 0°, while orientations such as x-flow, crossflow, etc. are 90°

Download

Enter the orientation angle of the data. eg. 0, 15, 30, 45 or 90

Click Download to send the material model file directly into your CAE

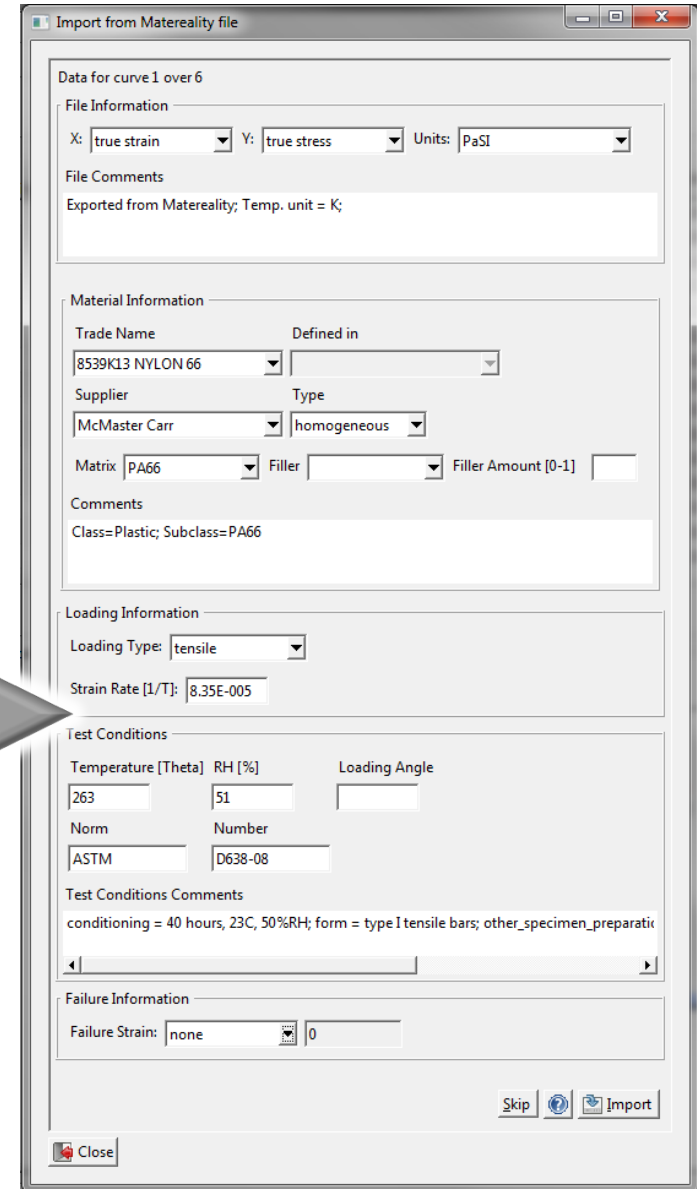
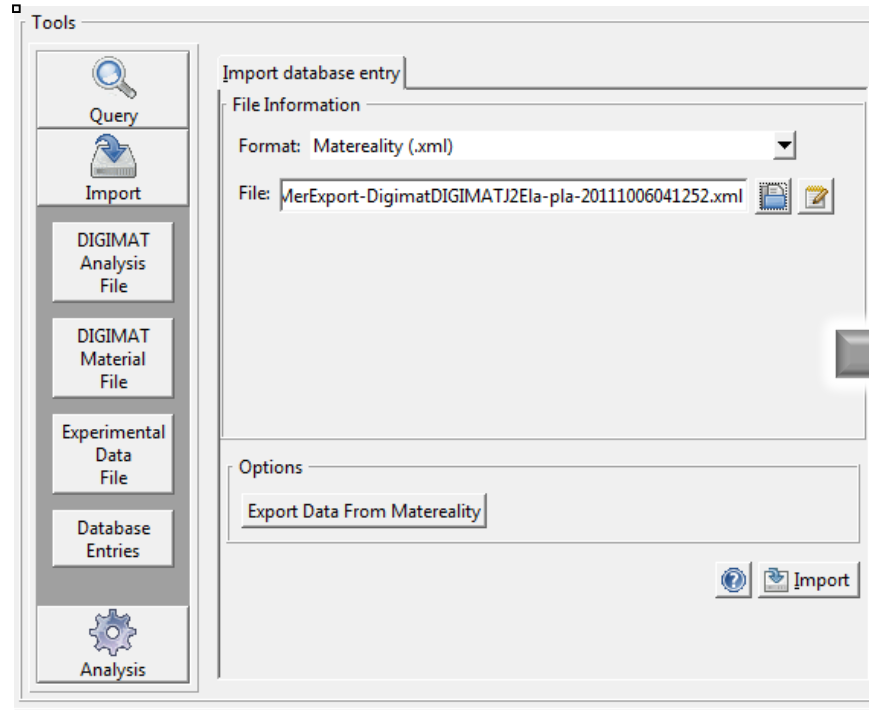
DIGIMAT-ready XML output

```
<MatML_Doc xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:noNamespaceSchemaLocation="http://www.matml.org/downloads/matml.xsd">
  <!-- MatML version 3.0 -->
  <Material>
    <BulkDetails>
      <Name>Bayblend FR 2010</Name>
      <Class>Plastic</Class>
      <Subclass>PC/ABS</Subclass>
      <Source>Bayer</Source>
    </BulkDetails>
    <PropertyData property="Tensile_Properties.Tensile_Modulus" technique="ISO_527-1.1993"
source="Confidential_Demo_Purposes" specimen="I18655">
      <Data format="float">2700000000</Data>
      <ParameterValue format="float" parameter="Tensile_Properties.test_temperature">296</ParameterValue>
      <ParameterValue format="string" parameter="Tensile_Properties.form">"ISO Type
1A"</ParameterValue>
      <ParameterValue format="string"
parameter="Tensile_Properties.specimen_orientation">"0"</ParameterValue>
      <ParameterValue format="float" parameter="Tensile_Properties.thickness">0.004</ParameterValue>
      <ParameterValue format="float" parameter="Tensile_Properties.width">0.01</ParameterValue>
    </PropertyData>
    <PropertyData property="Tensile_Properties.Tensile_Strength_at_Break" technique="ISO_527-1.1993"
source="Confidential_Demo_Purposes" specimen="I18655">
      <Data format="float">600000000</Data>
      <ParameterValue format="float" parameter="Tensile_Properties.test_temperature">296</ParameterValue>
      <ParameterValue format="string" parameter="Tensile_Properties.form">"ISO Type
1A"</ParameterValue>
      <ParameterValue format="string"
parameter="Tensile_Properties.specimen_orientation">"0"</ParameterValue>
      <ParameterValue format="float" parameter="Tensile_Properties.thickness">0.004</ParameterValue>
      <ParameterValue format="float" parameter="Tensile_Properties.width">0.01</ParameterValue>
    </PropertyData>
    <PropertyData property="Tensile_Properties.Engineering_Tensile_Stress-
Strain_Curves.Engineering_Stress" technique="ISO_527-1.1993" source="Confidential_Demo_Purposes">
```

Digimat-MX Interface

Import of data

- ✓ Selection of curve to import
- ✓ Data check
- ✓ Experimental curves ready to use



Part 3

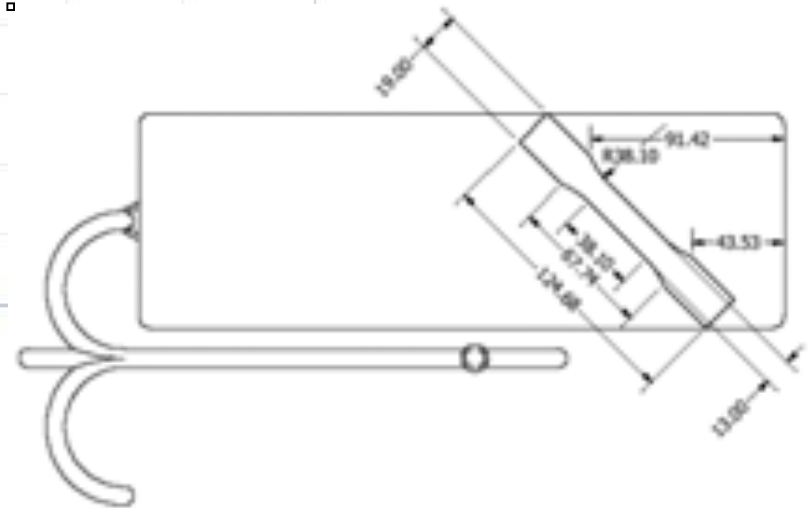
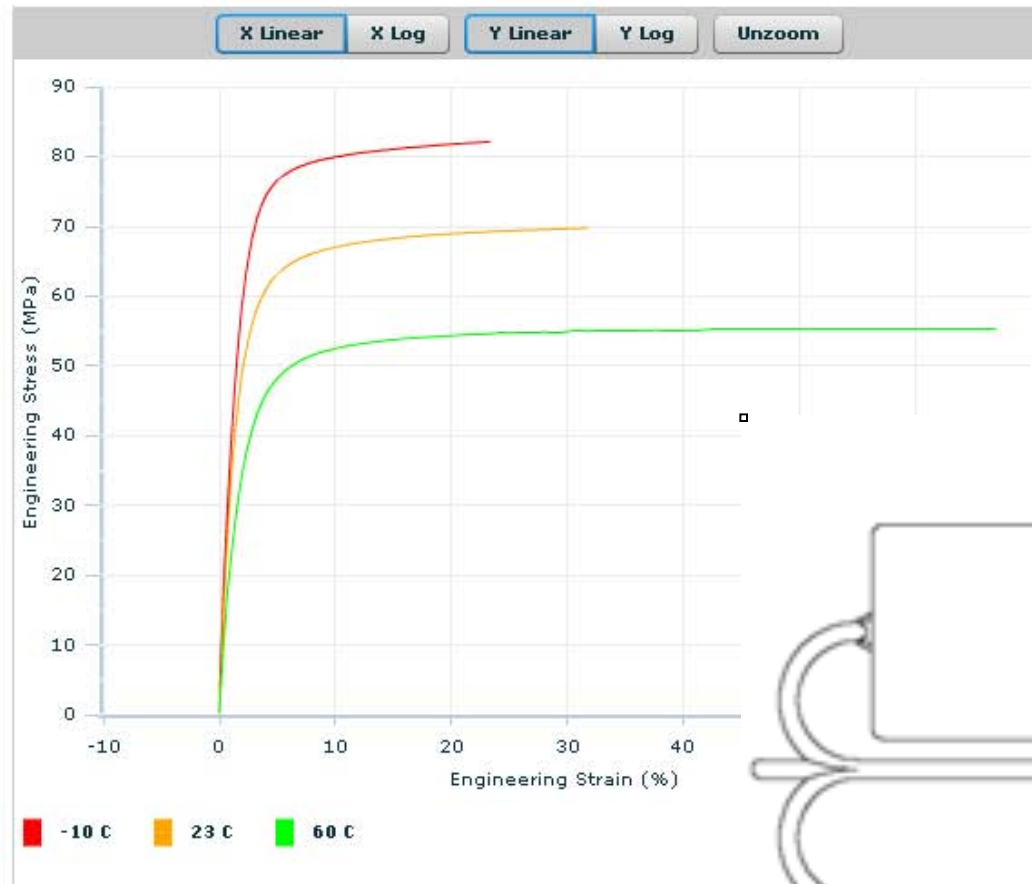
NEW DIGIMAT MX Reverse Engineering Service

→ e-Xstream + DatapointLabs joint
cooperation

NEW DIGIMAT MX Reverse Engineering Service

∞ Testing performed at DatapointLabs

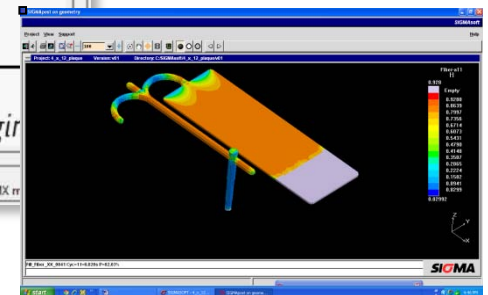
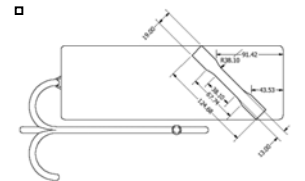
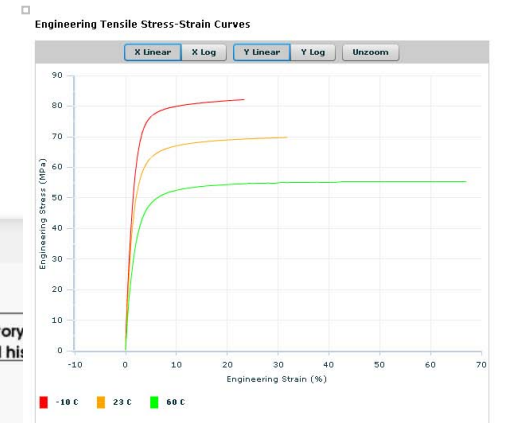
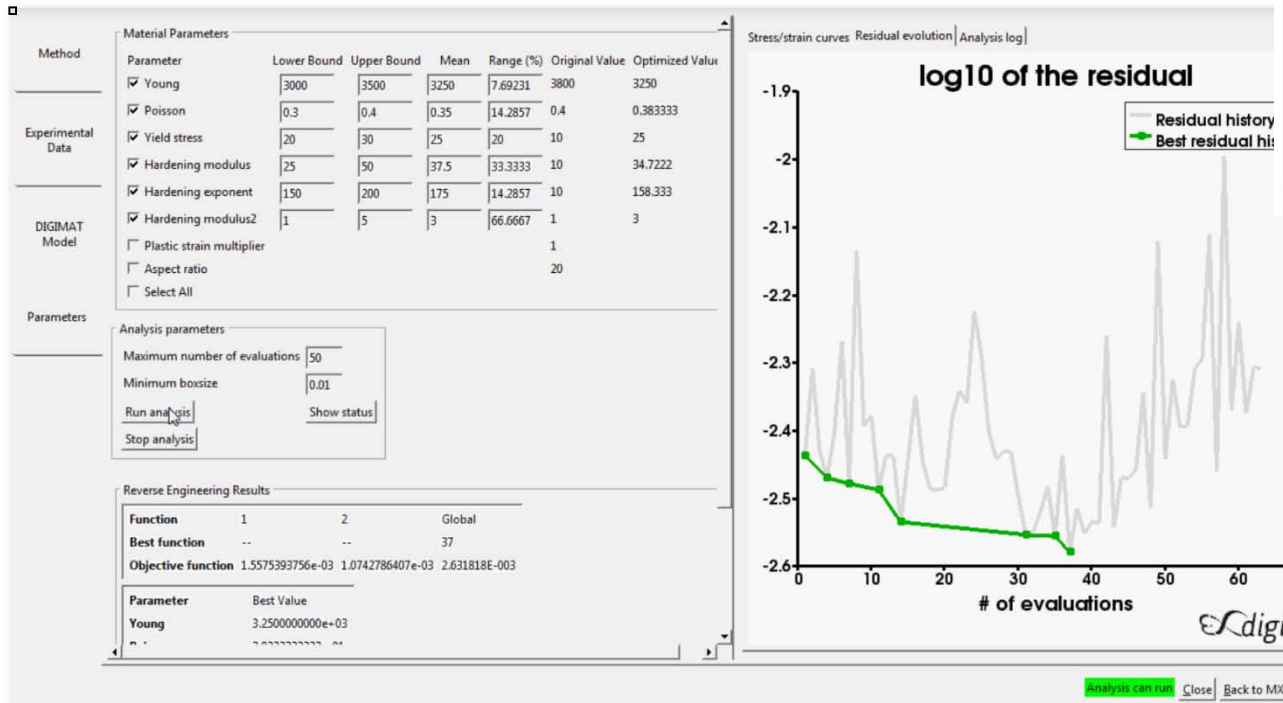
Engineering Tensile Stress-Strain Curves



NEW DIGIMAT MX Reverse Engineering Service

∞ DIGIMAT MX-ready data sent to e-Xstream for reverse engineering

✓ Using full expertise / experience



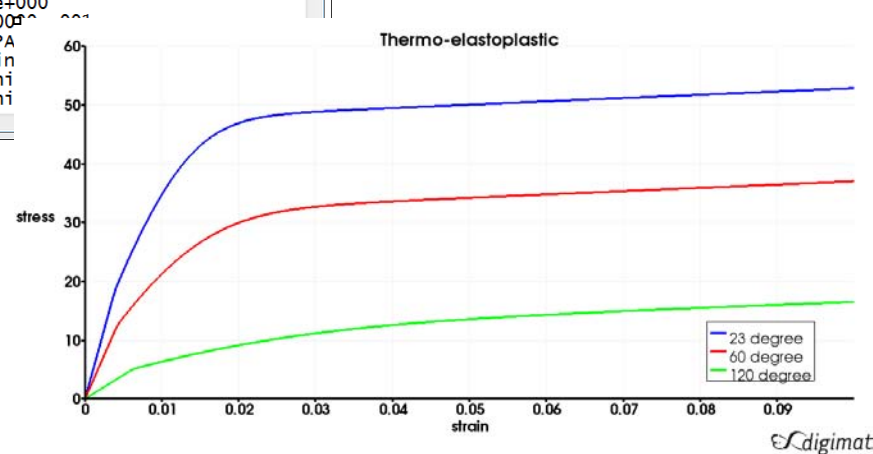
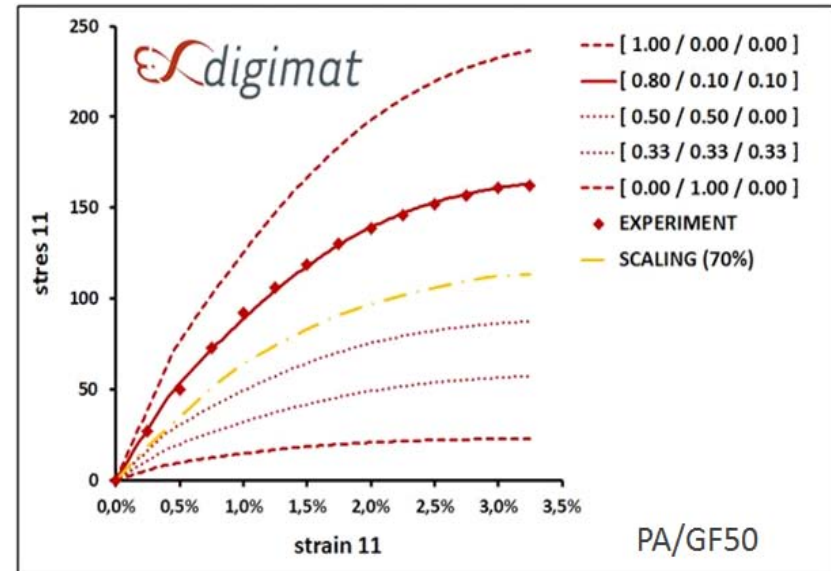
NEW DIGIMAT MX Reverse Engineering Service

Simulation-ready data delivered to client

```
ThermoElastoPlastic.daf - Notepad
File Edit Format View Help

#####
MATERIAL
name = Glass
type = elastic
density = 2.540000000000000e-009
Young = 7.200000000000000e+004
Poisson = 2.200000000000000e-001
thermal_expansion = 0.000000000000000e+000
reference_temperature = 2.300000000000000e+001

#####
MATERIAL
name = PA6
type = J2_thermoplasticity
density = 1.130000000000000e-009
consistent_tangent = on
Young = 1.000000000000000e+003
Poisson = 4.000000000000000e-001
Young_dependence = youngPA6,temperature
yield_stress = 1.000000000000000e+000
hardening_model = exponential_linear
hardening_modulus = 1.000000000000000e+000
hardening_exponent = 1.000000000000000e+000
hardening_modulus2 = 1.000000000000000e+000
isotropic_method = spectral
thermal_expansion = 0.000000000000000e+000
reference_temperature = 2.300000000000000e+001
yield_stress_dependence = yieldStressPA
hardening_modulus_dependence = hardenin
hardening_exponent_dependence = hardeni
hardening_modulus2_dependence = hardeni
```



NEW Process with Reverse Engineering

Performed by e-Xstream engineering

- ∞ Order your Digimat *TestPak* at datapointlabs.com
- ∞ Ship one 25kg bag of material
 - ✓ DHL pick-up service
- ∞ One week for molding
- ∞ One week for testing
- ∞ One week for reverse engineering
- ∞ DIGIMAT ready data delivered via Internet
 - ✓ Pdf test report
 - ✓ Raw digital data to client material database at www.matereality.com
 - ✓ DIGIMAT-ready data file

THANK YOU FOR YOUR ATTENTION

ANY QUESTION?

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