Online-Seminar

Effizientes Testen der Betriebsfestigkeit mechanischer Komponenten, Systeme und Fahrzeuge

Andreas Langmann


Strength & Durability

Target setting & procedures

Physical product optimization & validation.

Understanding operational loads.

Design optimization. Virtual product validation.

Final product test.

Durability Load Data Analysis Tasks

SIEMENS
Ingenuity for life

Input source-1: Test

Roads

Measure

Test engineer

Roads/Office

Validate

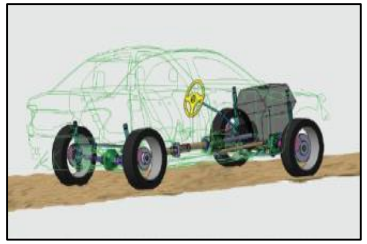
Test engineer

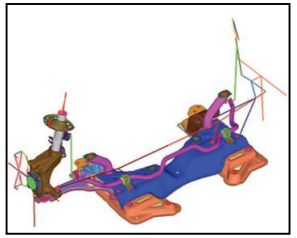
Input source-2: Simulation

Office

Simulation

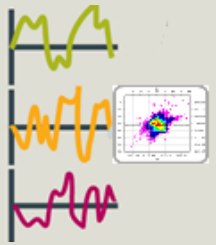
Simulation engineer





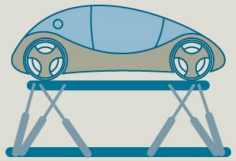
Office

Analysis



Report & share

Test schedule creation



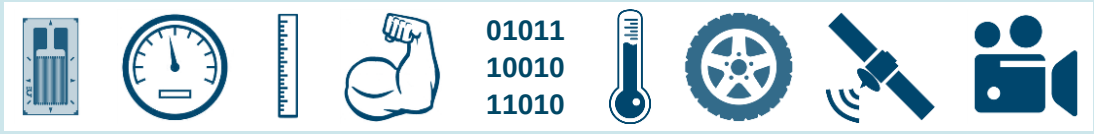
Test engineer

Data Acquisition with Siemens SCADAS

SIEMENS
Ingenuity for life

Challenges

- Acquire & synchronize wide range of different sensor types

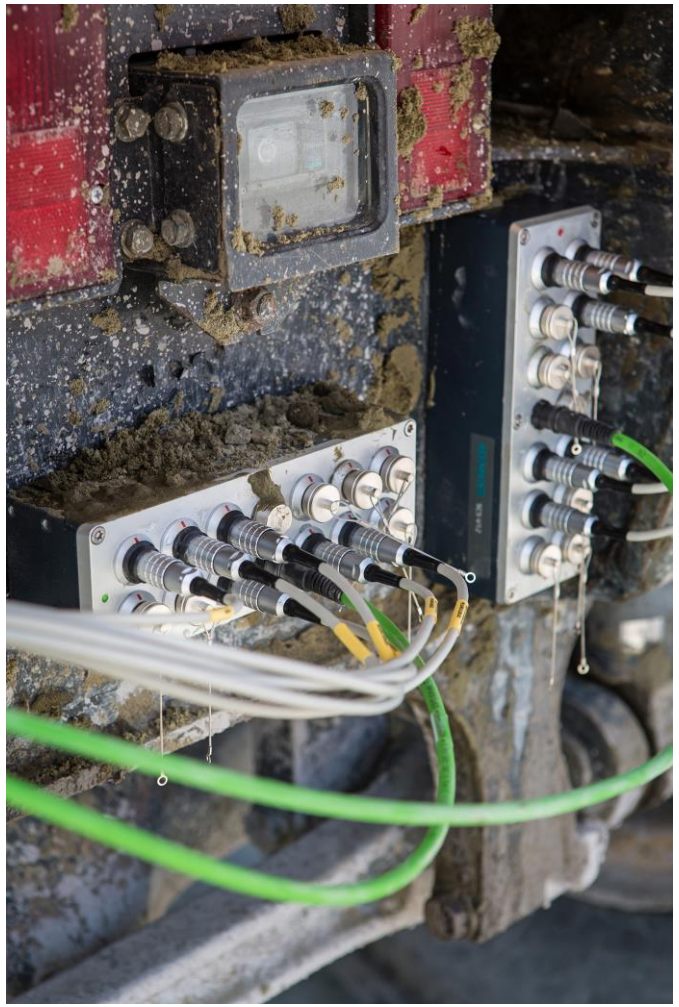


- Limited space in vehicle

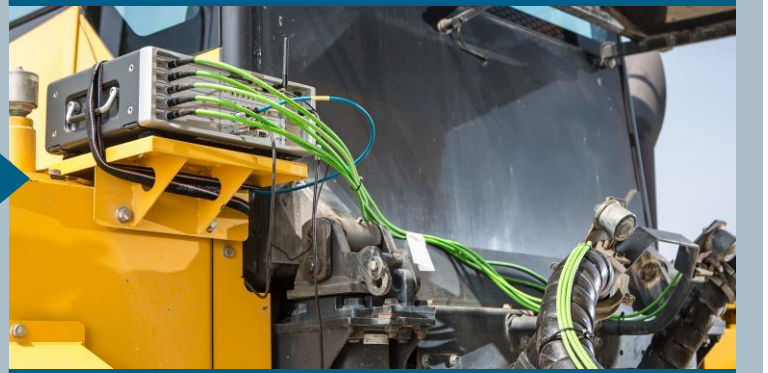
Universal signal conditioning

- Complete range of embedded universal signal conditioning
- Fit for high channel count
- Channel flexibility

Distributed setup with SCADAS Satellites



- Distributed setup mounts acquisition units near sensors

Centralized setup	Distributed setup
	
60 (long) cables	5 (green) cables

- One single (green) cable carrying data and power for 12 channels simplifies instrumentation and repair

SCADAS Satellites - Certified and rugged equipment

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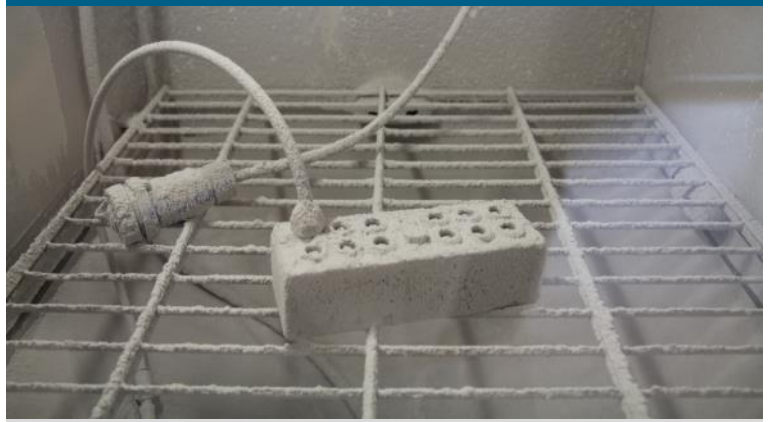
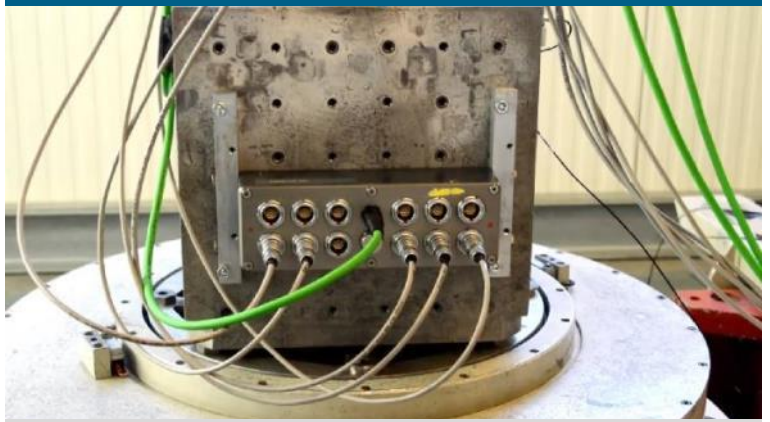
Water and dust



IEC 60529: IP66 and IP67

- Dust-tight (IP6x)
- Power water jet (IPx6)
- Immersion up to 1m (IPx7)

Shock and vibration



MIL-STD-810F

- Vibration: 7.7grms
- Shock: 100g shock

Temperature

Wide range

- -40 ºC up to 85 ºC
  -40 ºF up to 185 ºF

SIEMENS

Simcenter Testlab Time Data Acquisition

Select the task you want to perform

INSTRUMENTATION

Channels | Tacho Scope | CAN Setup

Virtual Channels | Database Setup | Database Lookup

CALIBRATION

Offset Calibration | Shunt Calibration

DC Calibration | AC Calibration

MEASURE

Setup | Offset Check | Shunt Check

Measure | Validate

DESKTOP

View Data | Interact

PROCESSING

Universal | Data Selection | Process

HELP

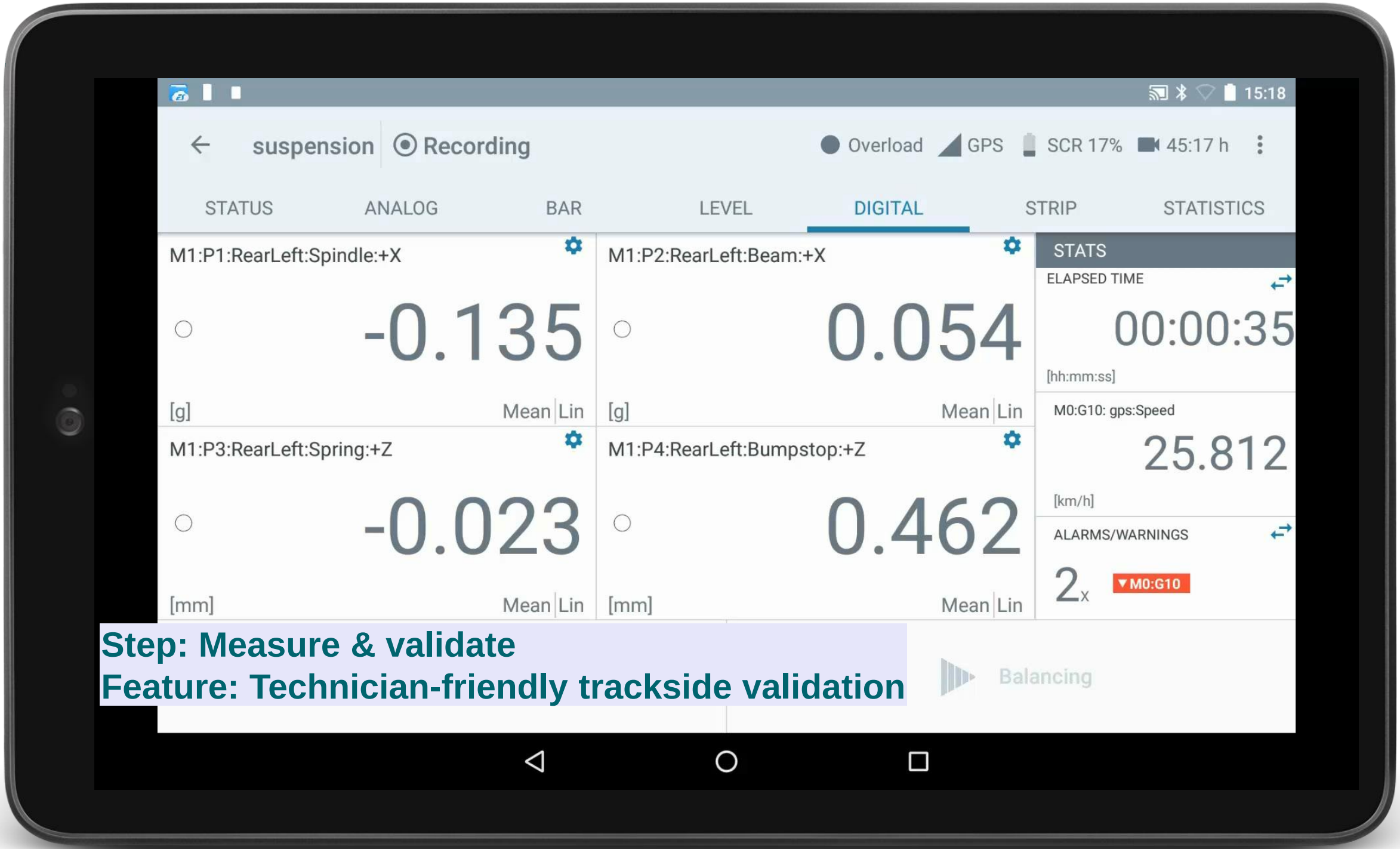
Getting started

Step: Test setup

Feature: Powerful channel setup with embedded sensor checks

Validate | Tecware

Show at startup



Step: Measure & validate
Feature: Technician-friendly trackside validation

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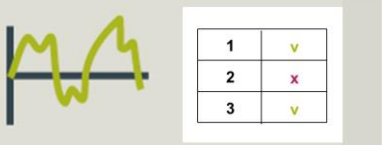
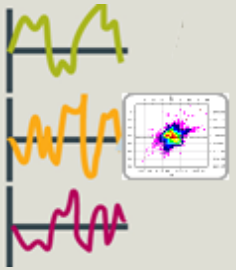
Validate



Analysis



Test schedule creation

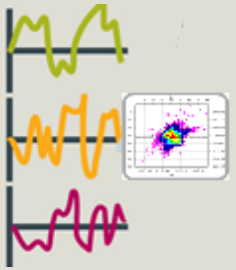
Report & Share

Generate and run processes up to 50% faster than traditional solutions

Validate

1	v
2	x
3	v

Analysis



Test schedule creation

Report & Share

Validate your acquired data

Validate your acquired data
Challenges

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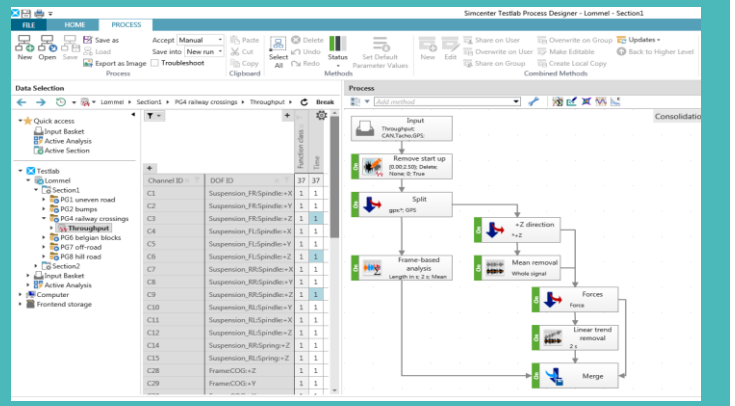
Channel & run comparison

Compare large amount of channels in quick and efficient way

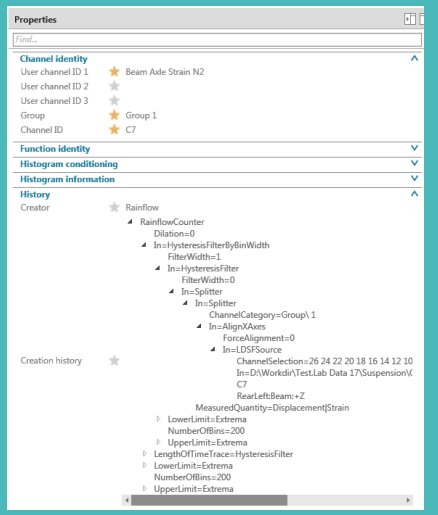
Automate processes

Standardize on procedures to eliminate human errors



Traceability of data processing

Store relevant information about the process



Maximize productivity with instant data visualization and test procedure check

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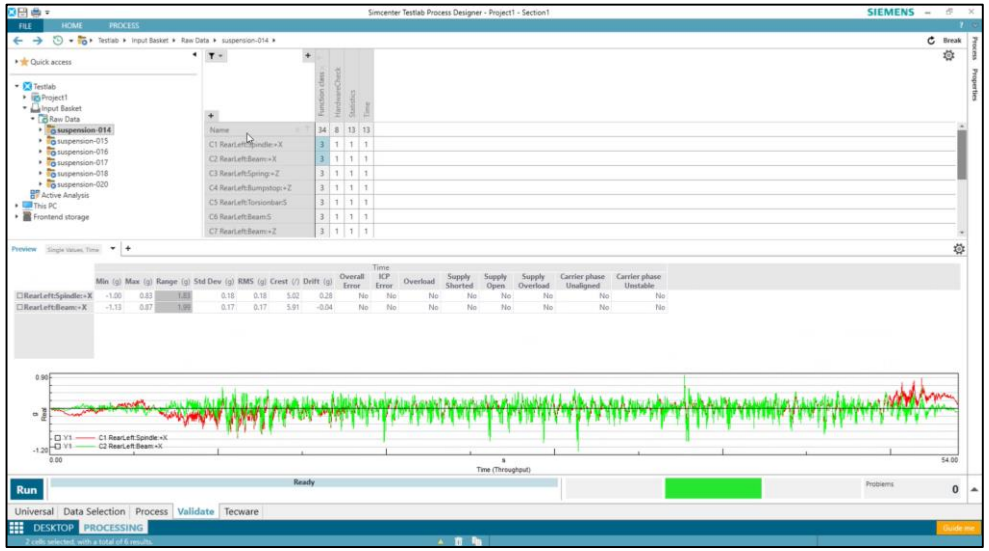
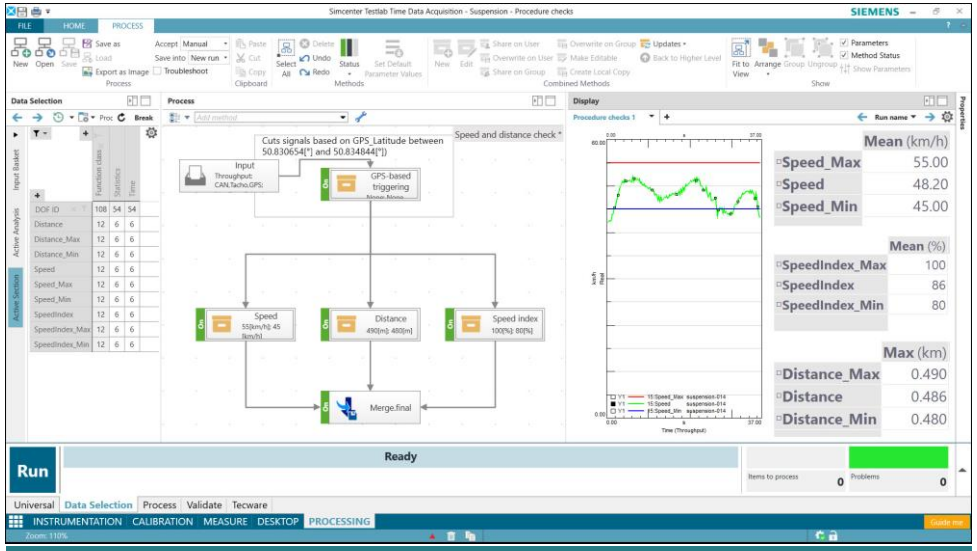
Fast, easy and intuitive validation of raw time signals including a broad set of analysis



Quick channel and run comparison thanks to Pivot table and instant data visualization

Productivity



Advanced validation of test procedure after measurement

Gaining confidence and productivity with the Anomaly Library

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RAW load data

Signal Failures

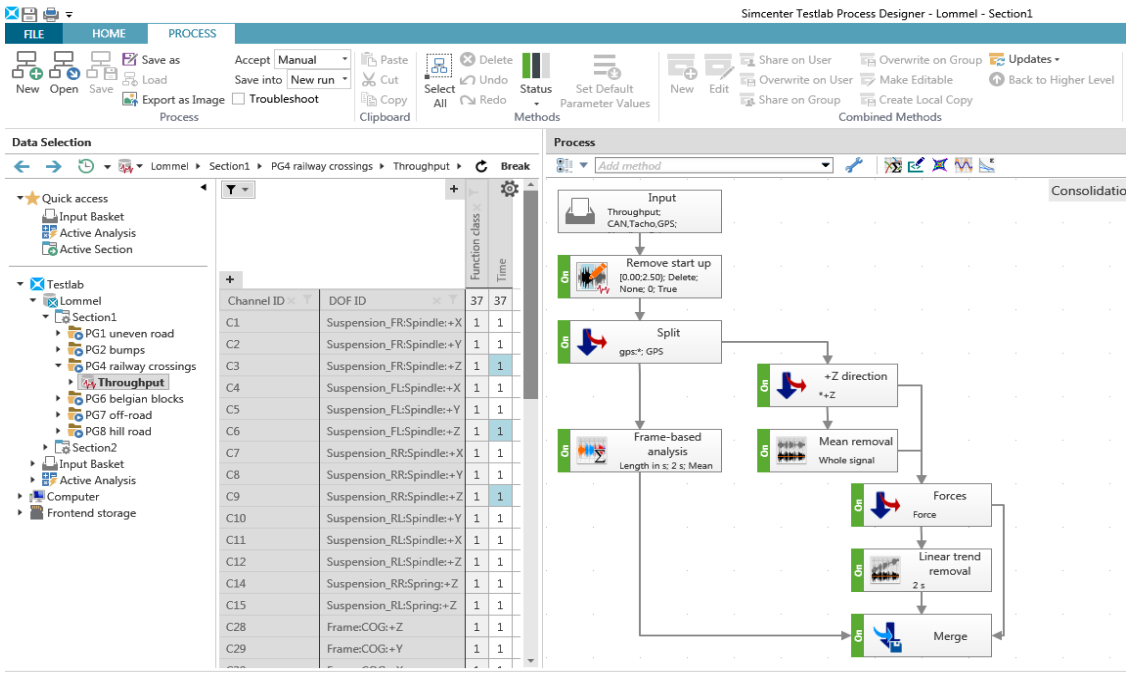
Artefact Identification

Spike Identification

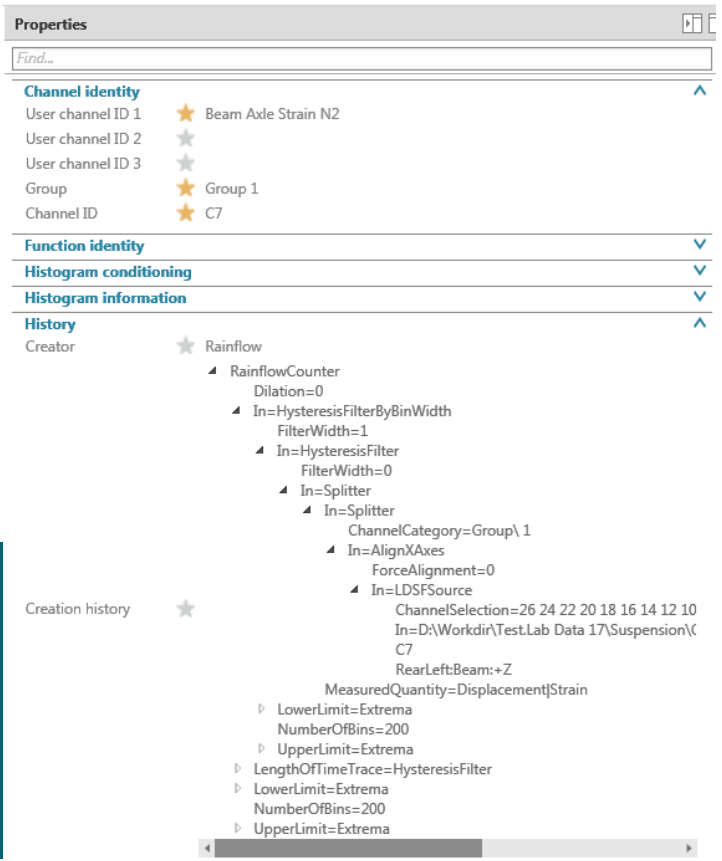
Drift & Offset Correction

Rename or Calculate Channels

CONSOLIDATED load data



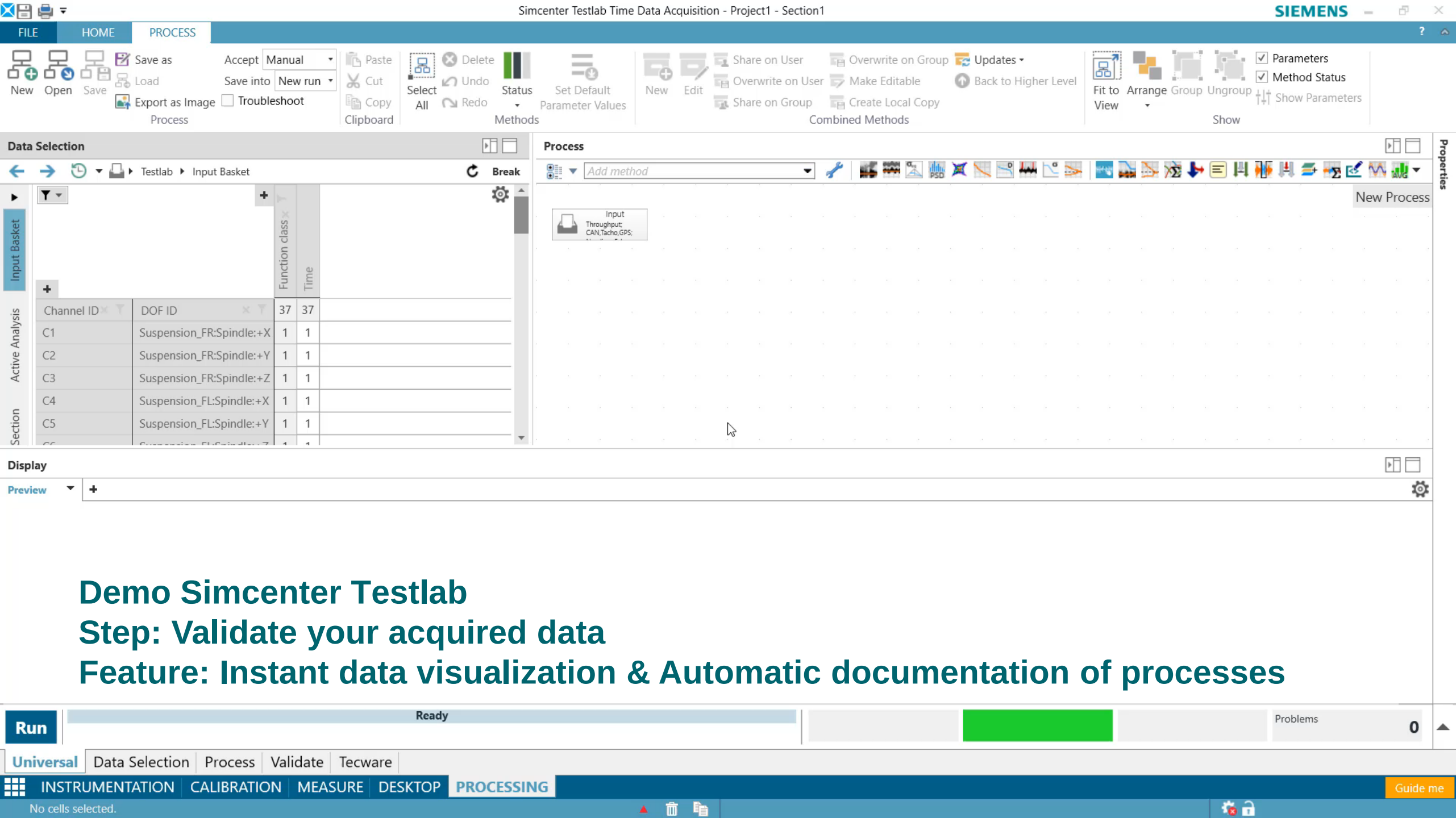
Automatic documentation of consolidation result & steps



Productivity

Securing best, high-grade consolidated and accurate load data

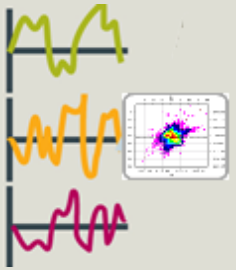
Confidence


Simcenter Testlab Time Data Acquisition - Project1 - Section1
SIEMENS
FILE
HOME
PROCESS
New
Open
Save
Save as
Load
Export as Image
Process
Accept
Manual
Save into
New run
Troubleshoot
Paste
Cut
Copy
Clipboard
Select All
Delete
Undo
Redo
Status
Methods
Set Default Parameter Values
New
Edit
Share on User
Overwrite on User
Share on Group
Overwrite on Group
Make Editable
Create Local Copy
Updates
Back to Higher Level
Combined Methods
Fit to View
Arrange
Group
Ungroup
Parameters
Method Status
Show Parameters
Show
Data Selection
Testlab
Input Basket
Break
Input Basket
Active Analysis
Section
Function class
Time
Channel ID
DOF ID
37
37
C1
Suspension_FR:Spindle:+X
C2
Suspension_FR:Spindle:+Y
C3
Suspension_FR:Spindle:+Z
C4
Suspension_FL:Spindle:+X
C5
Suspension_FL:Spindle:+Y
Process
Add method
New Process
Input
Throughput:
CAN,Tacho,GPS;
Properties
Display
Preview
Demo Simcenter Testlab
Step: Validate your acquired data
Feature: Instant data visualization & Automatic documentation of processes
Run
Ready
Problems
0
Universal
Data Selection
Process
Validate
Tecware
INSTRUMENTATION
CALIBRATION
MEASURE
DESKTOP
PROCESSING
Guide me
No cells selected.

Validate

1	v
2	x
3	v

Analysis



Test schedule creation

Report & Share

Analyze durability potential

Analyze durability potential
Challenges

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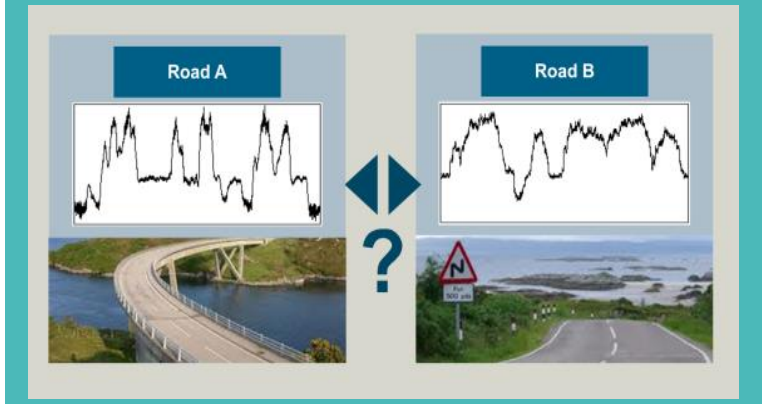
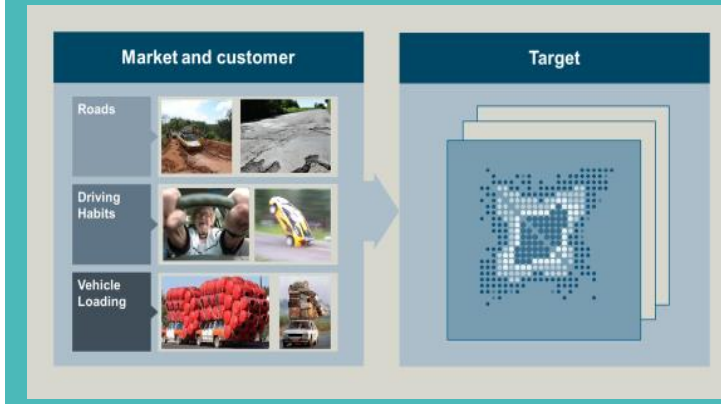
Valuable insights

Qualify and quantify the durability potential of vehicle loads



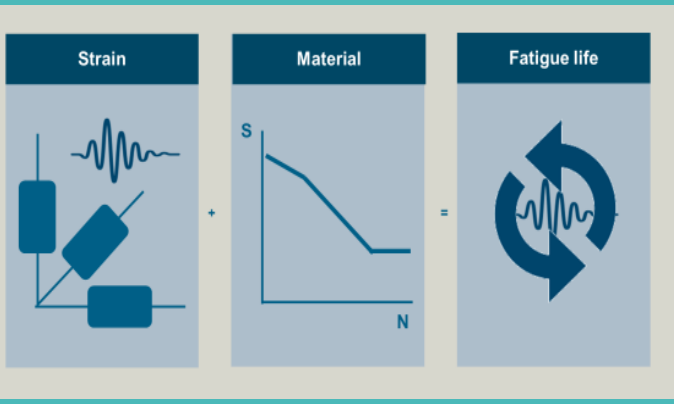
Create realistic targets

Increase realism by creating correct targets



Fatigue life prediction

Compare design options by estimating fatigue life from measured stress or strain



How to understand fatigue content of loads ?
Pseudo-damage

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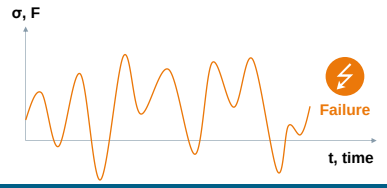
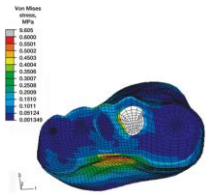
Loads (force, disp., …)



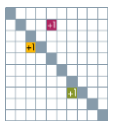
Geometry



Material

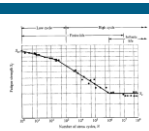
Stress-concentration $K_t = 1$

Rainflow counting
→ Cycles, range & mean



$$\sum_{i=1}^{I} \frac{n_i}{N_i}$$

Generic S-N curve
Define slope-k



n_i

N_i

Damage accumulation

Pseudo-damage

Getting insights with innovative load analysis

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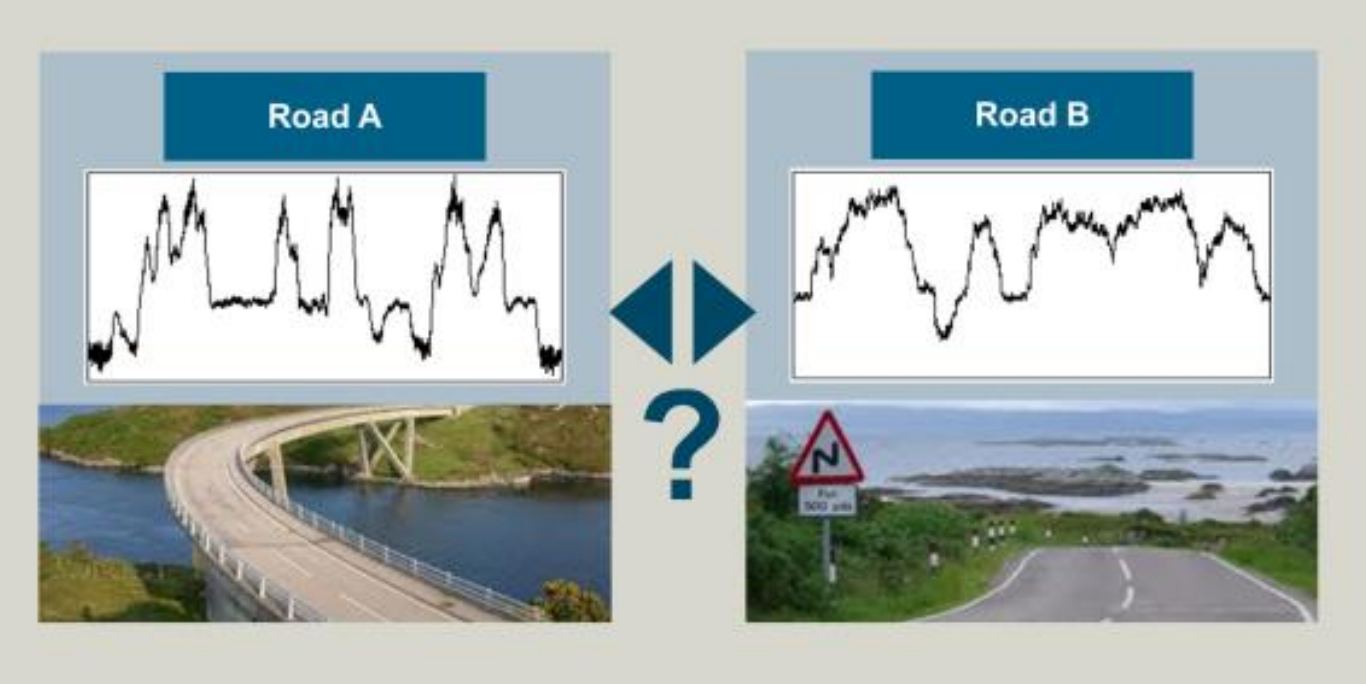

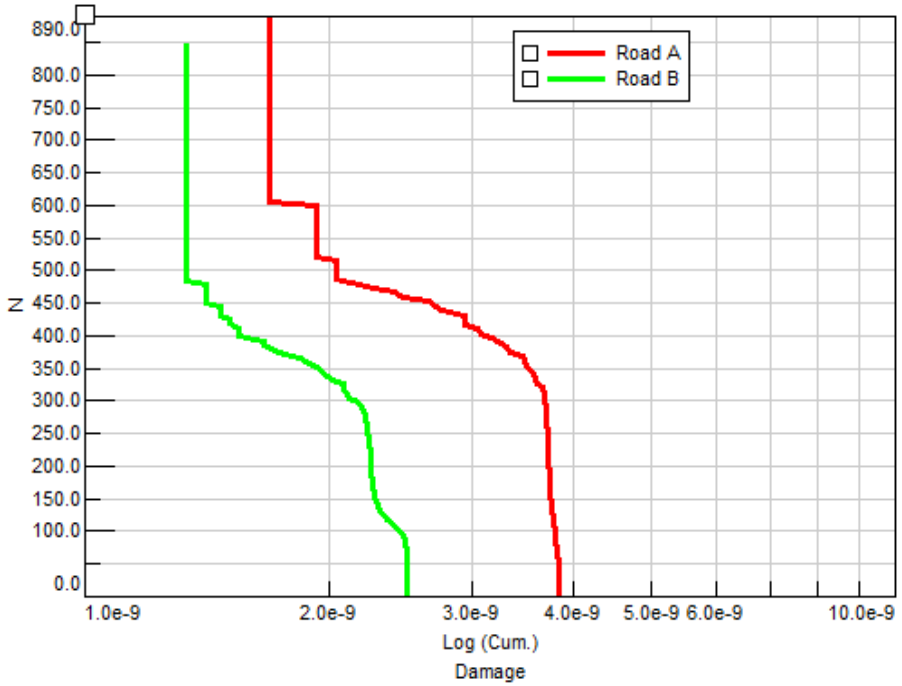

Qualify and quantify the durability potential of vehicle loads with innovative load analysis technology shown as either Range Pair vs. Damage or as Pseudo Damage values

Insights

Increase realism by creating correct targets

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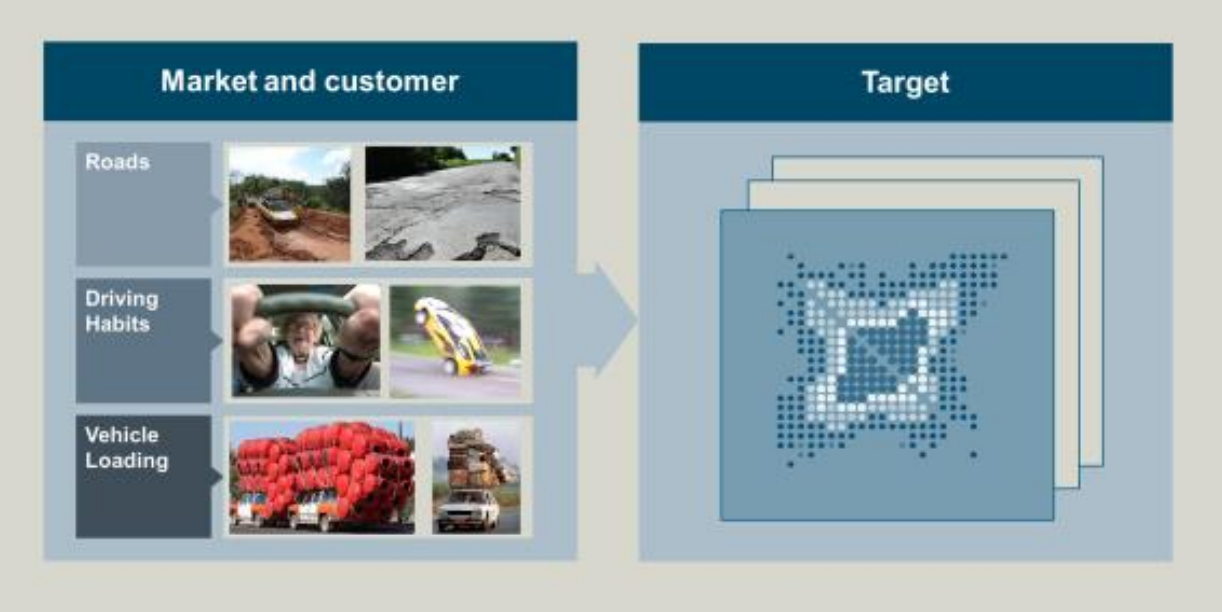

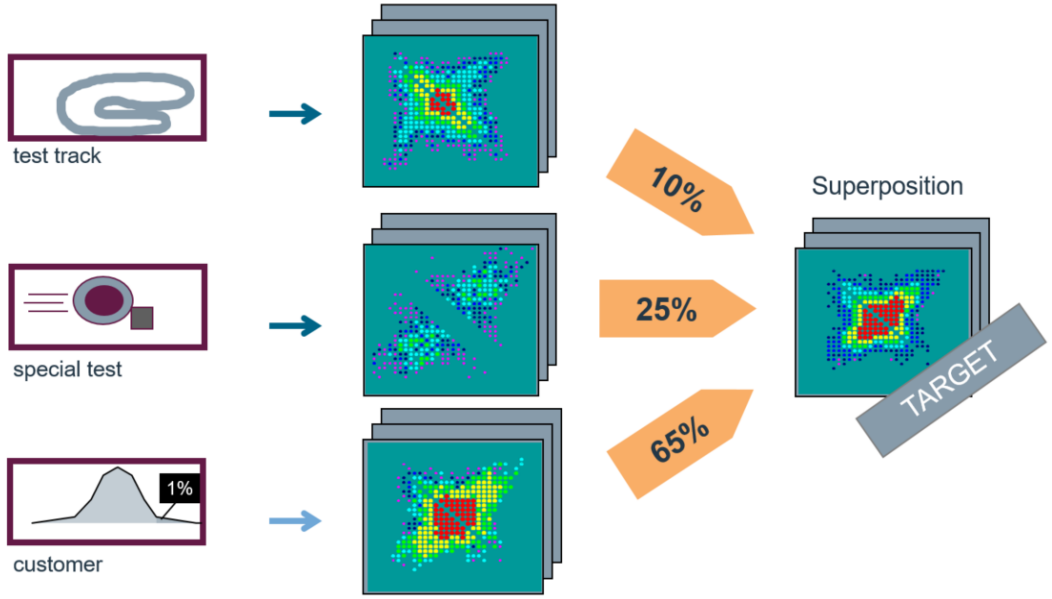

Take market and customer into account
by using rainflow superposition to create realistic targets

Confidence

Compare different design options by using in-depth fatigue analysis

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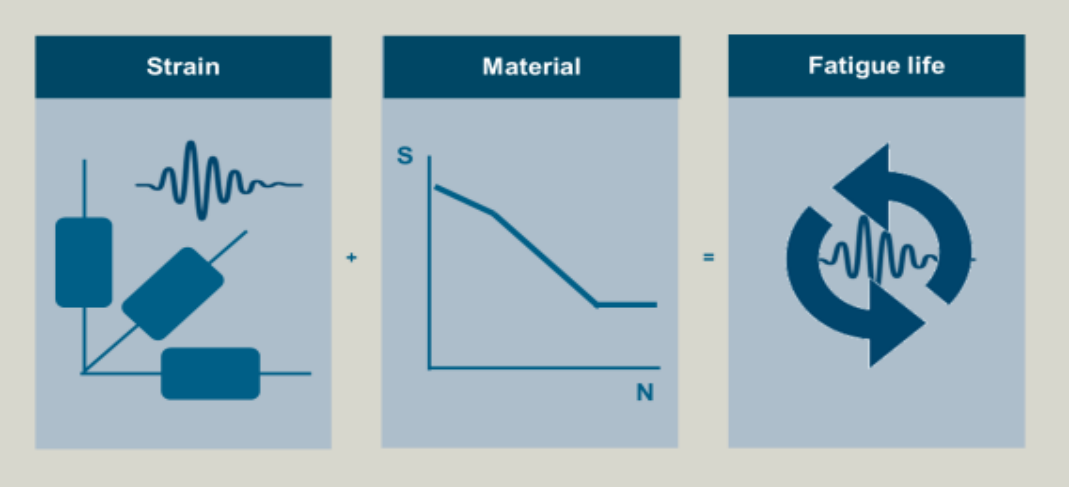
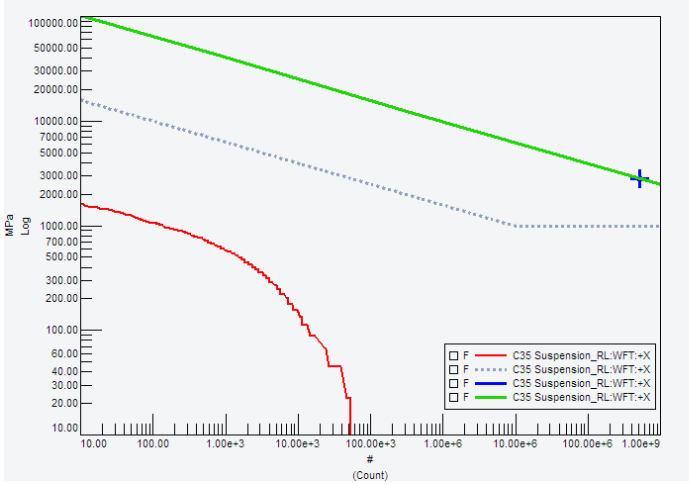
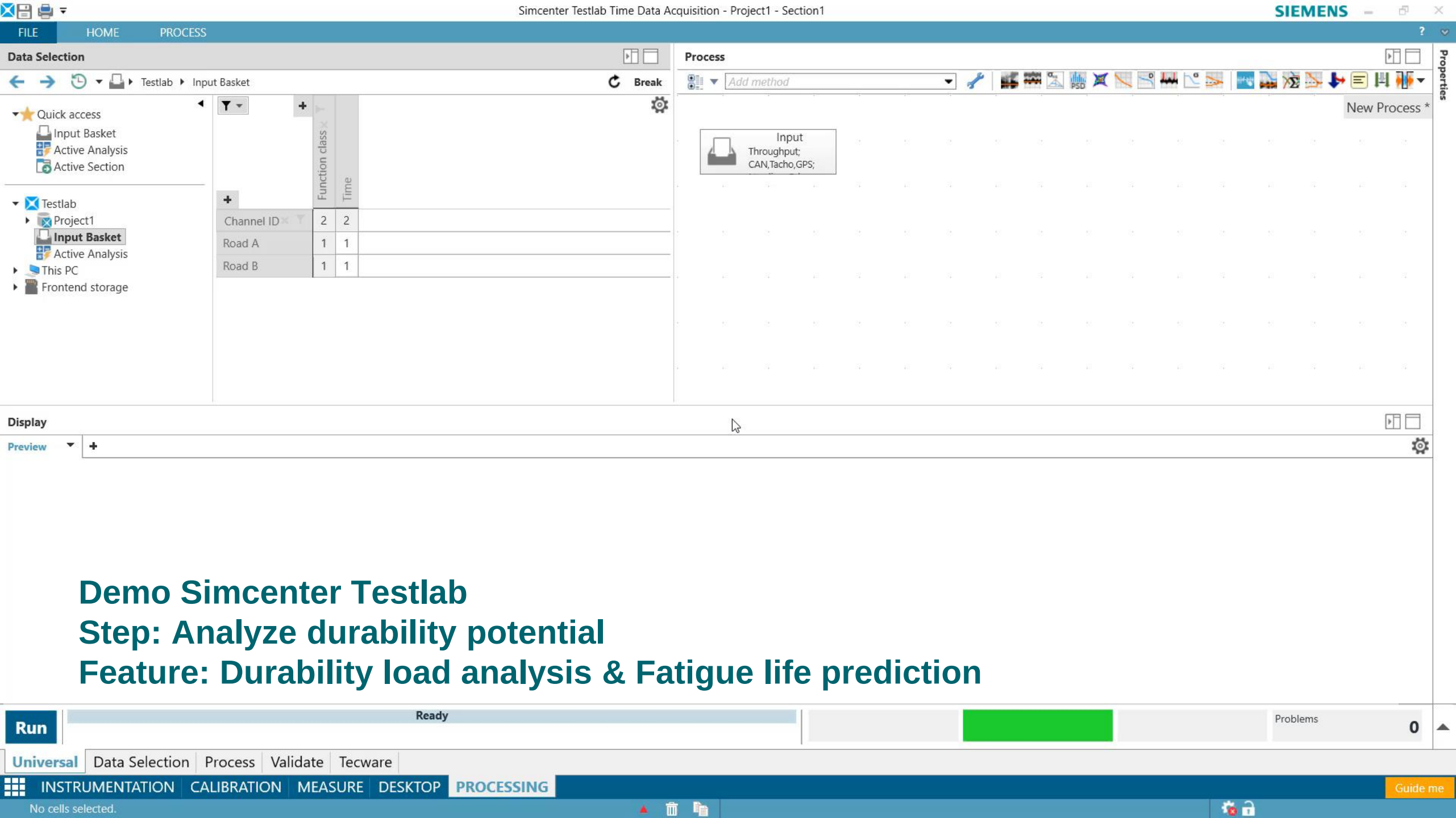




Compare design options for long-term quality by estimating fatigue life from measured stress or strain histories combined with material data

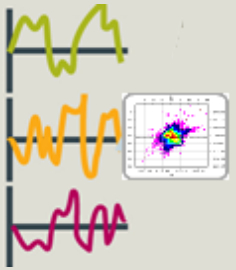
Preview | Single Values | +

	Time				
	Design Point (MPa)	Design Point (Weighted) (MPa)	Design Point Cycles (#)	Design Point Blocks (blocks)	Damage (Damage)
Suspension_RL:WFT:+X	2822.84	3077.17	298.86e+6	5591.78	0.18e-3
Suspension_RL:WFT:+Y	2955.81	3266.82	3.82e+9	18671.57	0.05e-3
Suspension_RL:WFT:+Z	4039.02	3136.30	93201117.07	4392.14	0.23e-3
Suspension_RR:WFT:+X	2257.04	2035.12	3.23e+9	32877.06	0.03e-3
Suspension_RR:WFT:+Y	2161.56	2057.04	2.78e+9	36313.01	0.03e-3
Suspension_RR:WFT:+Z	3270.62	2576.86	71328838.32	3614.70	0.28e-3


Simcenter Testlab Time Data Acquisition - Project1 - Section1
SIEMENS
FILE
HOME
PROCESS
Data Selection
Testlab
Input Basket
Break
Quick access
Input Basket
Active Analysis
Active Section
Testlab
Project1
Input Basket
Active Analysis
This PC
Frontend storage
Function class
Time
Channel ID
Road A
Road B
Process
Add method
New Process *
Input
Throughput;
CAN,Tacho,GPS;
Properties
Display
Preview
Demo Simcenter Testlab
Step: Analyze durability potential
Feature: Durability load analysis & Fatigue life prediction
Run
Ready
Problems
0
Universal
Data Selection
Process
Validate
Tecware
INSTRUMENTATION
CALIBRATION
MEASURE
DESKTOP
PROCESSING
Guide me
No cells selected.

Validate

Analysis



Test schedule creation

Report & Share

Accelerated test schedule creation

Accelerated test scenarios creation
Challenges

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Test more at the same time

Less testing during early design phases, more problems in final validation

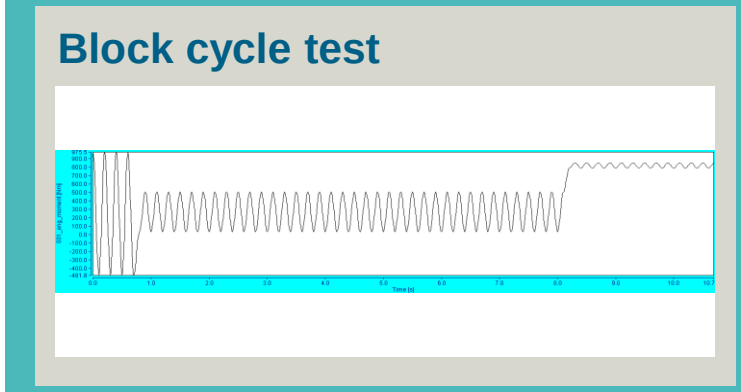
Compress time signals

Design accelerated damage equivalent test schedules

https://www.youtube.com/watch?v=sDIM83jTuwk

Create constant amplitude tests

Create simplified block cycle tests for relevant test benches



How can you accelerate a test?

Omit non-damaging events - Multi-axial – RP-filtering

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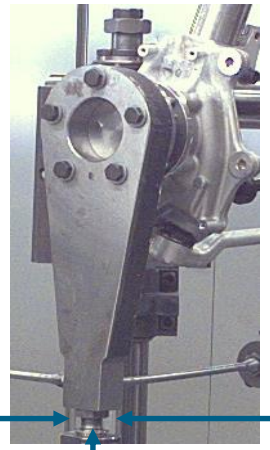
Ingenuity for life

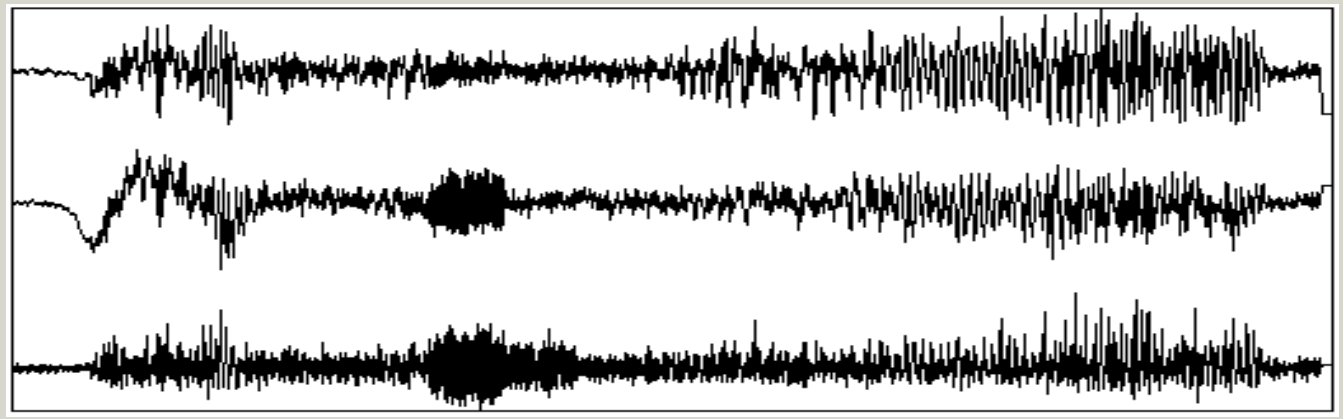


Longitudinal

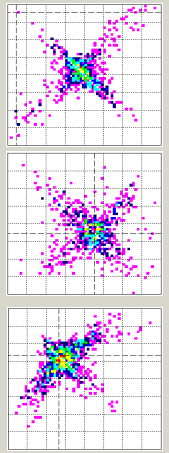
Lateral

Vertical

Uni-axial rainflow channel-per-channel is not OK
→ Phase relation lost !



Different loads !



How can you accelerate a test ?
Omit non-damaging events – Uni-axial

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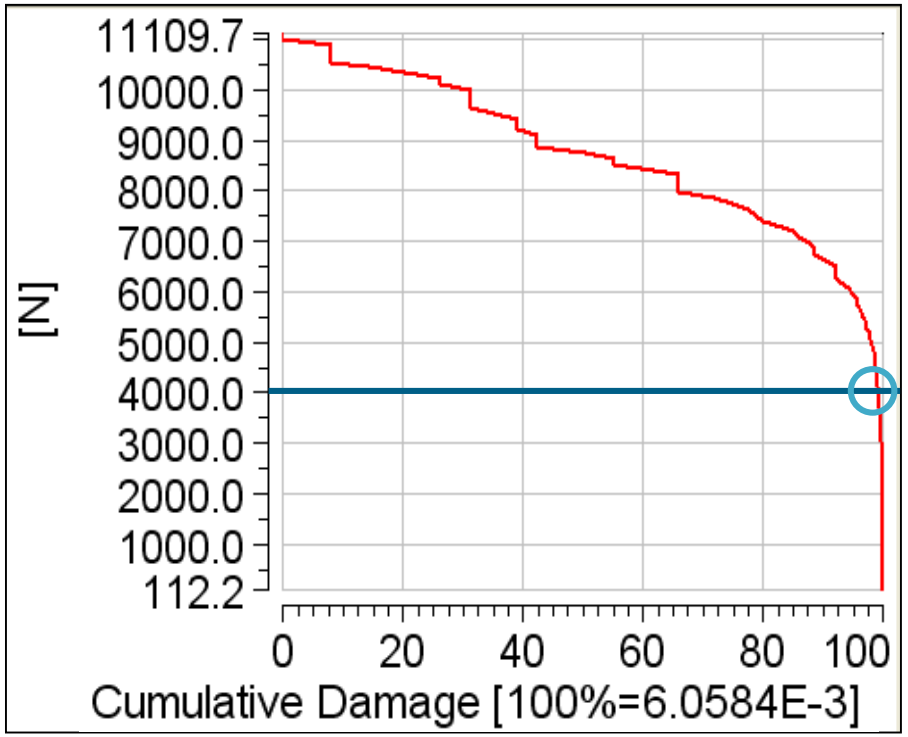
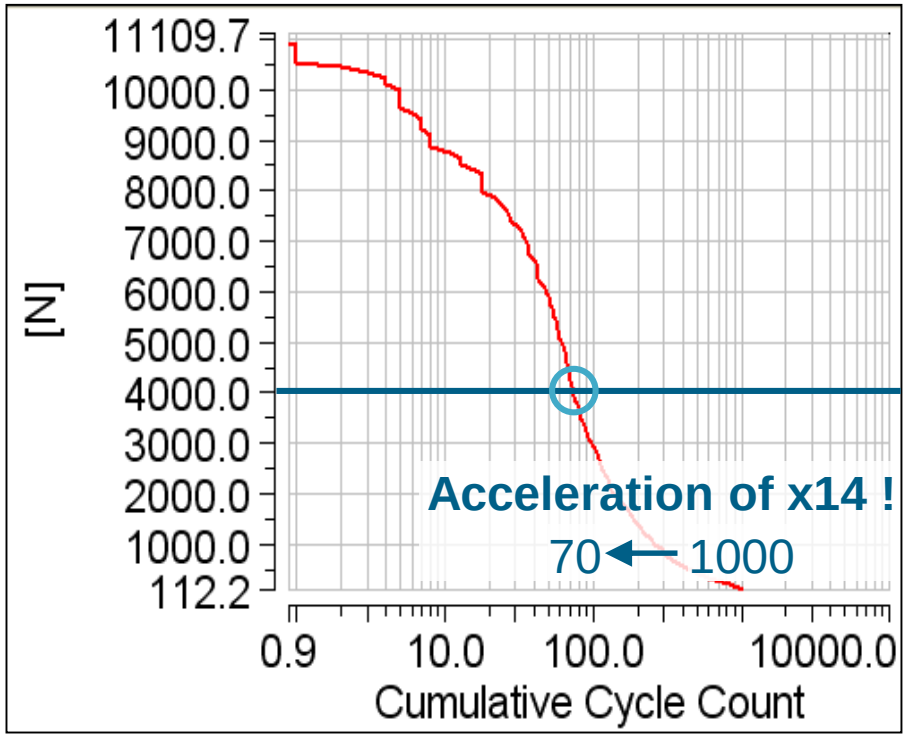
Ingenuity for life

All cycles below 4000N only contribute less than 0.5% of the total damage



If you remove these from the loading, you end up with 70 cycles instead of 1000



How can you accelerate a test?

Omit non-damaging events - Multi-axial – RP-filtering

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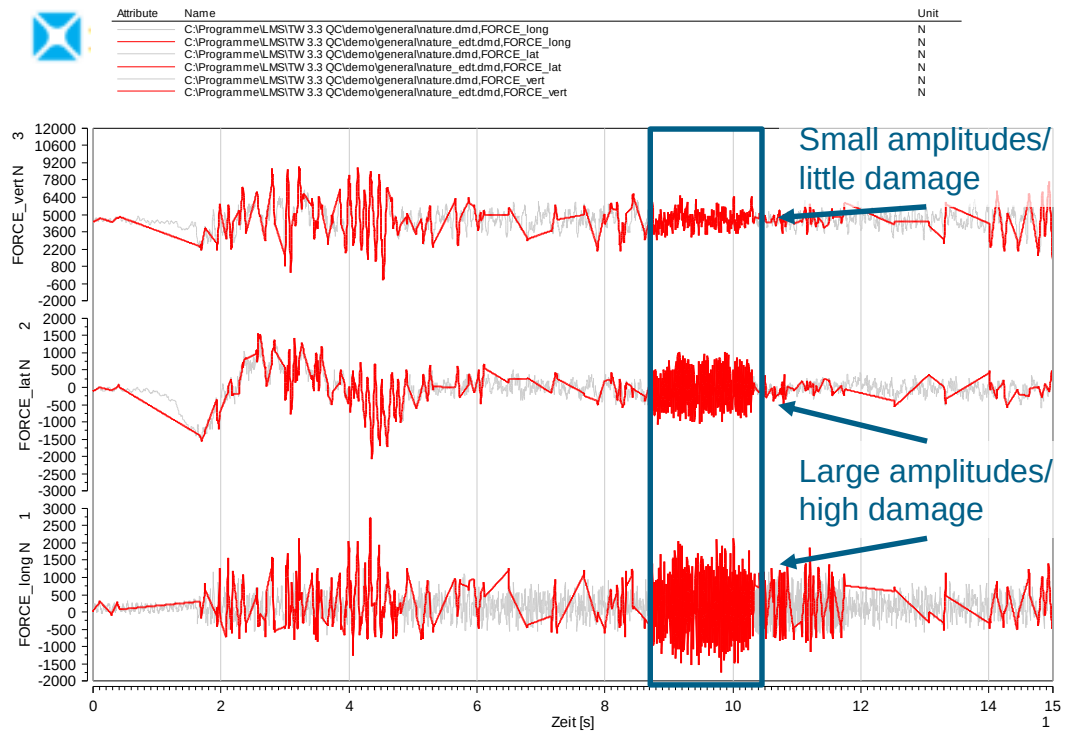
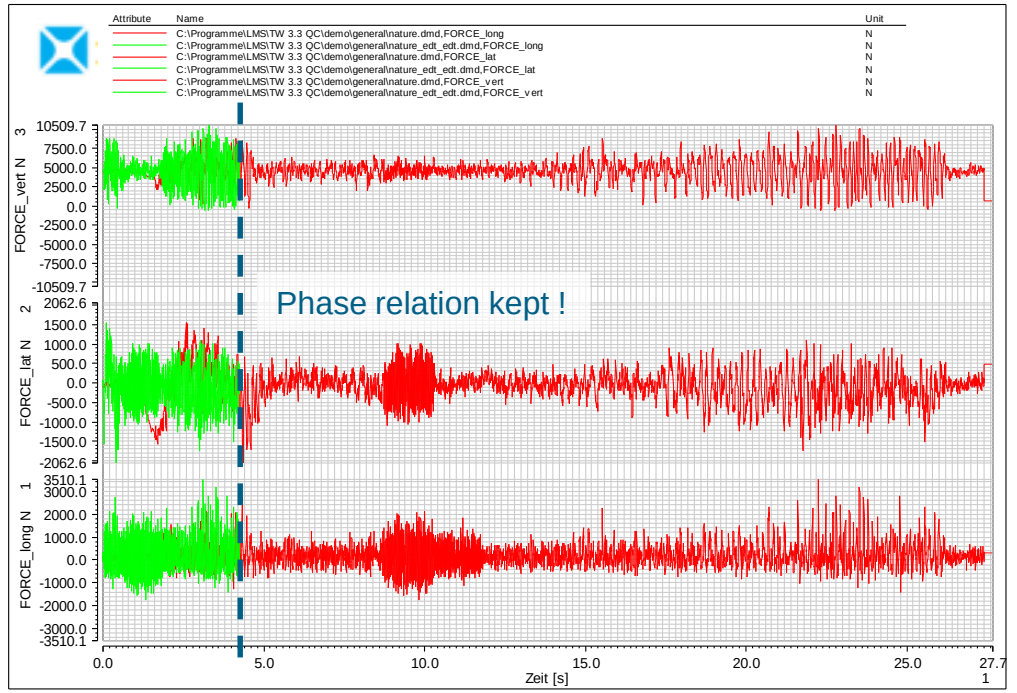
Ingenuity for life





Create damage equivalent and accelerated test profiles

Insights

How can you accelerate a test?
Simplify the test – Block cycle test

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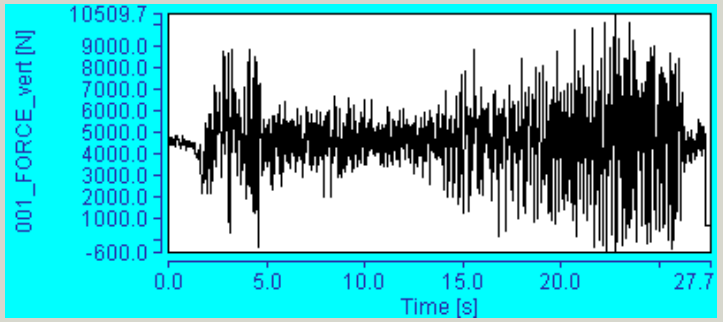
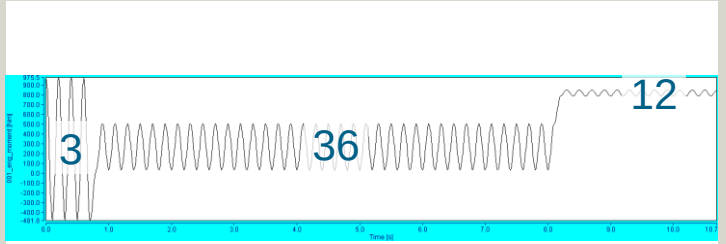
Mix of different ‘Constant-amplitude’ tests for more representative results

Original time series

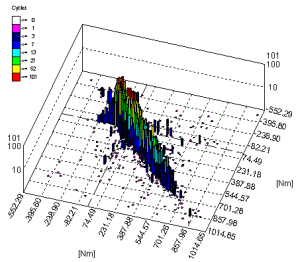


Damage equivalent

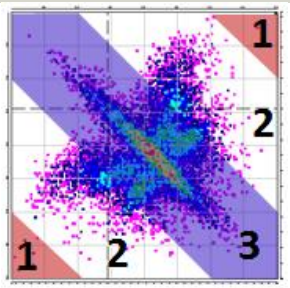
Block cycle test



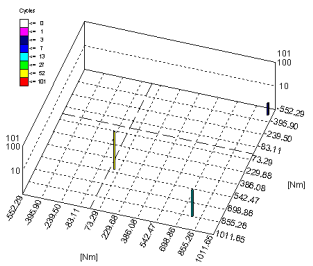
Rainflow matrix

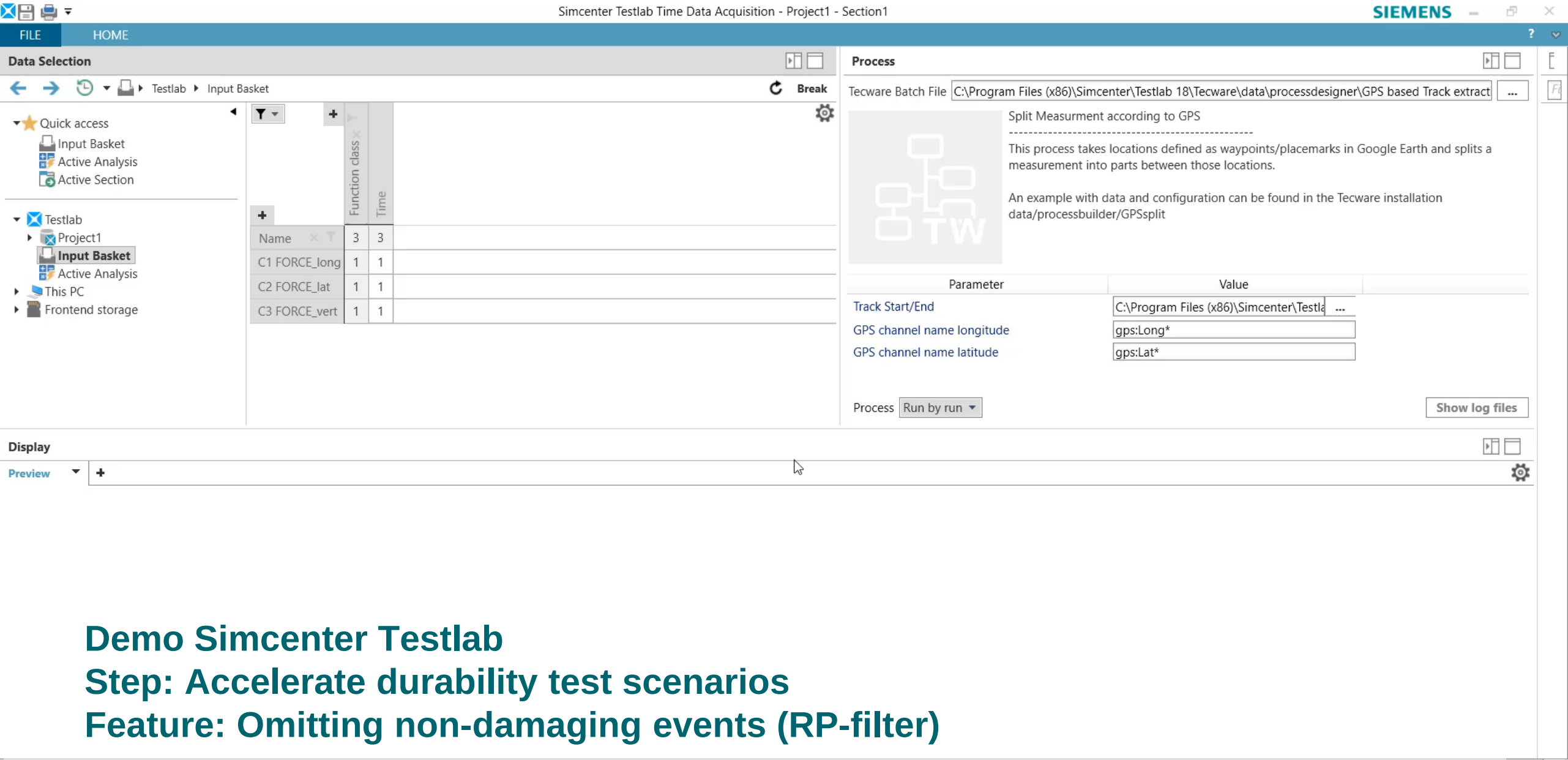


Normal/incidental/accidental
(automatic or user-defined)



Damage calculation
(Standard S-N curve or user-defined)




Simcenter Testlab Time Data Acquisition - Project1 - Section1
SIEMENS
FILE
HOME
Data Selection
Testlab ▸ Input Basket
Break
Quick access
Input Basket
Active Analysis
Active Section
Testlab
Project1
Input Basket
Active Analysis
This PC
Frontend storage
Function class
Time
Name
C1 FORCE_long
C2 FORCE_lat
C3 FORCE_vert
Process
Tecware Batch File
C:\Program Files (x86)\Simcenter\Testlab 18\Tecware\data\processdesigner\GPS based Track extract
Split Measurment according to GPS
This process takes locations defined as waypoints/placemarks in Google Earth and splits a measurement into parts between those locations.
An example with data and configuration can be found in the Tecware installation data/processbuilder/GPSsplit
Parameter
Value
Track Start/End
C:\Program Files (x86)\Simcenter\Testla
GPS channel name longitude
gps:Long*
GPS channel name latitude
gps:Lat*
Process
Run by run
Show log files
Display
Preview
Demo Simcenter Testlab
Step: Accelerate durability test scenarios
Feature: Omitting non-damaging events (RP-filter)
Run
Ready
Problems
0
Universal
Data Selection
Process
Validate
Tecware
INSTRUMENTATION
CALIBRATION
MEASURE
DESKTOP
PROCESSING
Guide me
Ready

Test.lab Report1 [Compatibility Mode] - Word

File Edit View Window Help

Active Picture name: fLC+fRP+fT+fTL

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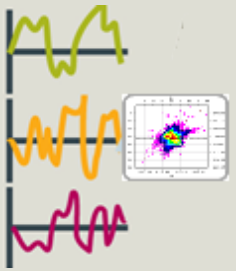
Validate

1	v
2	x
3	v

Analysis



Test schedule creation

Report & Share

Report and share

Created by Simcenter Testlab

1

PAGE 1 OF 1 0 WORDS ENGLISH (UNITED KINGDOM) 100%

Report and share
Challenges

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Correlate test & simulation

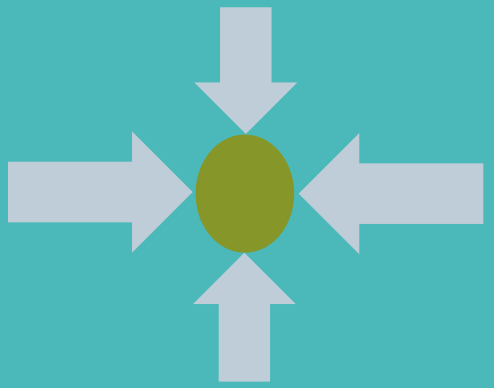
Correlate test & simulation load data using proven data analysis

Time-consuming reports

Accelerate decisions during team meetings

Direct access to various data types

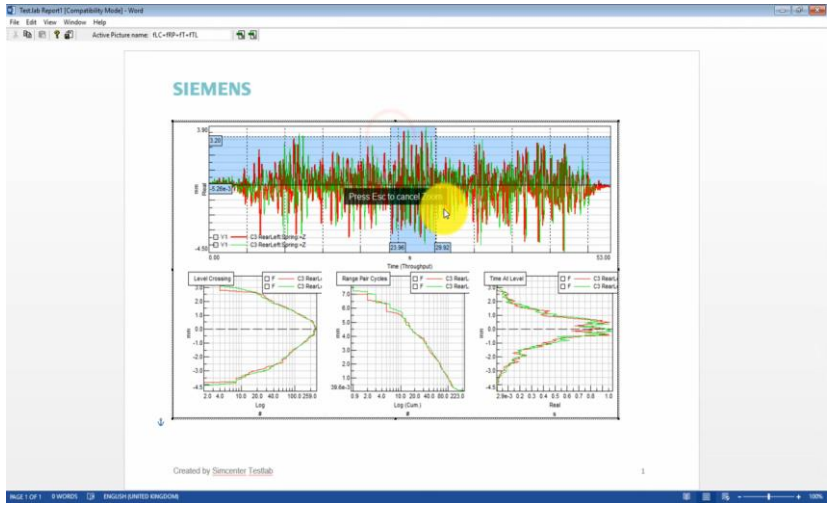
Avoid data conversion when using 3rd party input data for processing



Enable Collaboration within Simulation and Test

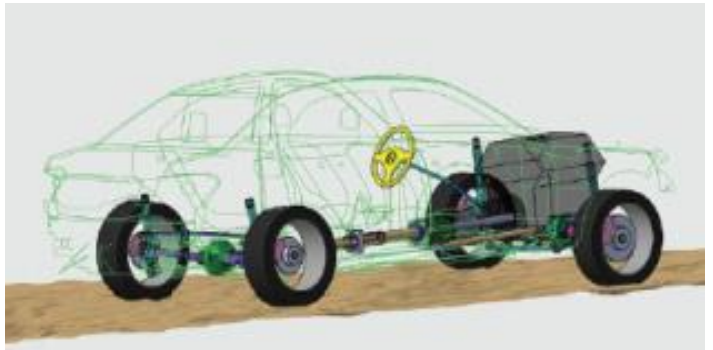
SIEMENS
Ingenuity for life

Create actionable reports to accelerate decisions



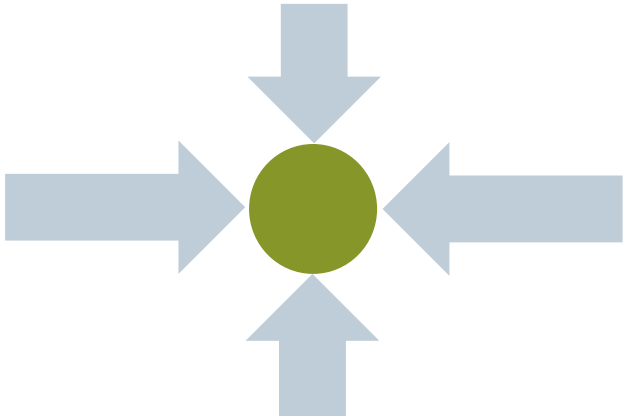
Collaboration

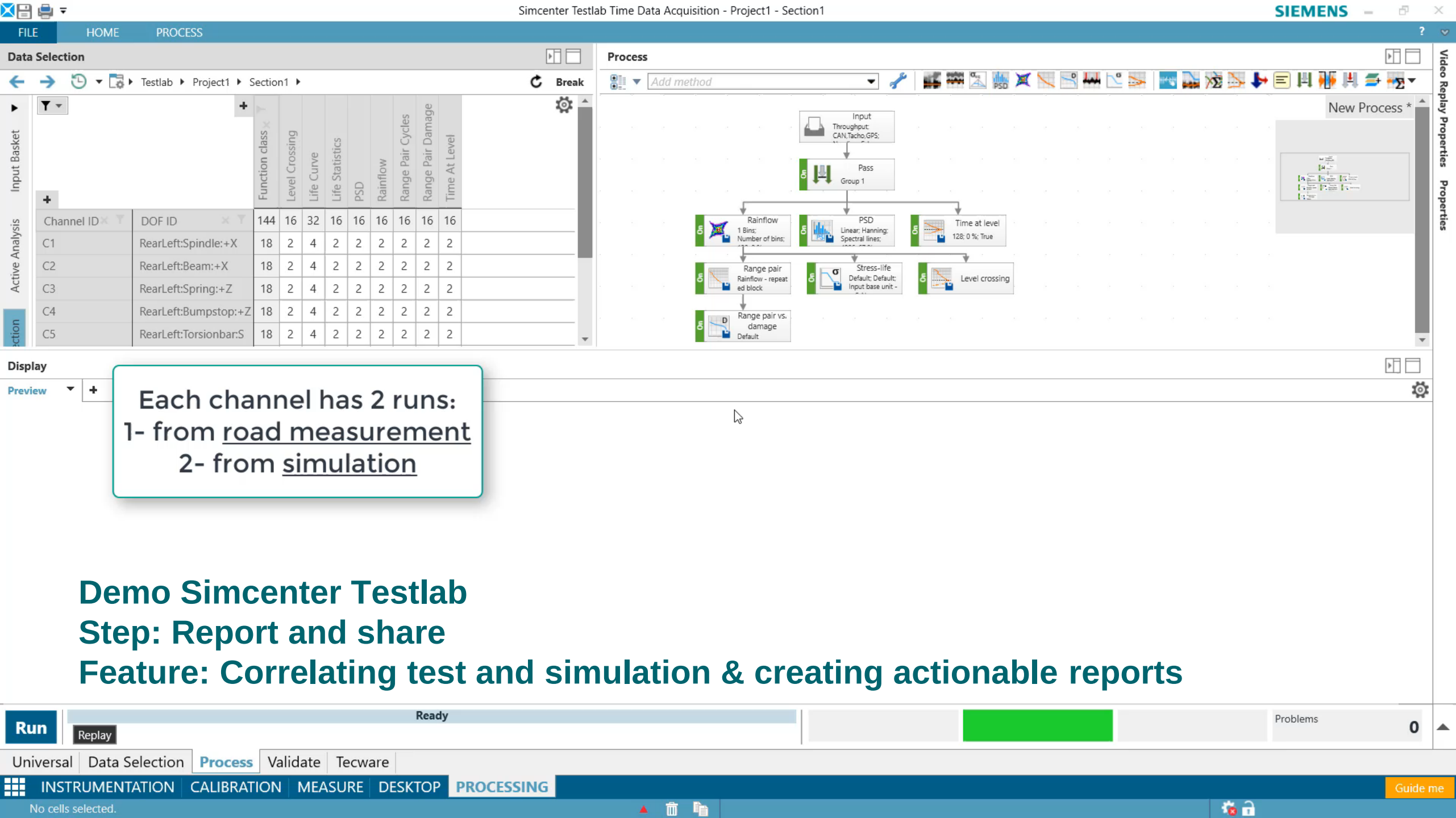
Delivering Continuity



Correlate test and simulation load data using proven data analysis

Open Software by avoiding conversion when using 3rd party input data for processing.




Simcenter Testlab Time Data Acquisition - Project1 - Section1
SIEMENS
FILE
HOME
PROCESS
Data Selection
Testlab ▸ Project1 ▸ Section1 ▸
Break
Input Basket
Active Analysis
Function class
Level Crossing
Life Curve
Life Statistics
PSD
Rainflow
Range Pair Cycles
Range Pair Damage
Time At Level
Channel ID
DOF ID
144 16 32 16 16 16 16 16 16
C1 RearLeft:Spindle:+X 18 2 4 2 2 2 2 2 2
C2 RearLeft:Beam:+X 18 2 4 2 2 2 2 2 2
C3 RearLeft:Spring:+Z 18 2 4 2 2 2 2 2 2
C4 RearLeft:Bumpstop:+Z 18 2 4 2 2 2 2 2 2
C5 RearLeft:Torsionbar:S 18 2 4 2 2 2 2 2 2
Process
Add method
New Process *
Input
Throughput;
CAN,Tacho,GPS;
Pass
Group 1
Rainflow
1 Bins;
Number of bins;
PSD
Linear; Hanning;
Spectral lines;
Time at level
128; 0 %; True
Range pair
Rainflow - repeat
ed block
Stress-life
Default; Default;
Input base unit -
Level crossing
Range pair vs.
damage
Default
Video Replay Properties
Properties
Display
Preview
Each channel has 2 runs:
1- from road measurement
2- from simulation
Demo Simcenter Testlab
Step: Report and share
Feature: Correlating test and simulation & creating actionable reports
Run
Replay
Ready
Problems
0
Universal
Data Selection
Process
Validate
Tecware
INSTRUMENTATION
CALIBRATION
MEASURE
DESKTOP
PROCESSING
Guide me
No cells selected.

Become a frontrunner in the global innovation race with Simcenter Testlab Load Data Analysis

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Productivity

- Generate and run processes up to 50% faster
- End-to-end durability platform for acquisition and analysis

Confidence

- Consistency and quality with standardized procedures and reports
- Increase realism by creating correct targets

Insights

- Valuable & precise insights to optimize the durability performance of your next designs
- Create damage equivalent and accelerated test profiles

Collaboration

- Team effectiveness by reducing learning effort for novice and expert users
- Correlate test and simulation load data

Fiat Group Automobiles S.P.A.

Using Simcenter Simulation & Test to verify and validate durability virtually

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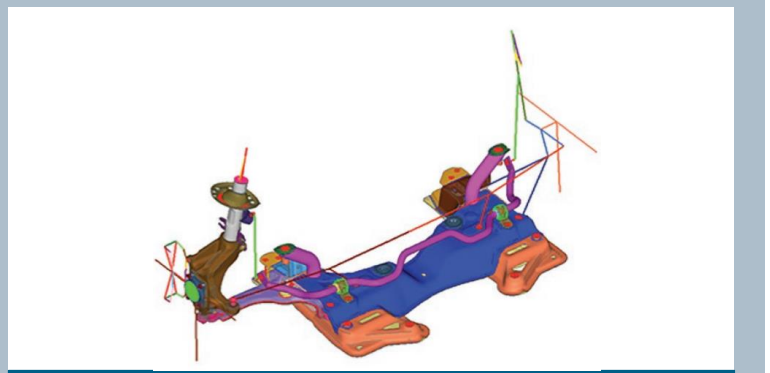
- **Reduced margin of error in real loads between 8 and 15 percent**
- **Reduced overdesign by performing simulation prior to building a prototype**
- **Diminished costs by developing equivalency between two proving grounds**

Conducting complete fatigue analysis

Proving grounds in Turin, Italy



Virtual prediction and use experimental data for model validation

- Long-term partnership between Fiat and Siemens PLM Software
- The ability of Siemens PLM Software to deliver customized solutions

"Although we can't measure the improvement because we previously didn't use virtual data, the results that we have received by using both Simcenter products are absolutely excellent."

Marco Spinelli, Head of the Chassis CAE Department

Ford Otosan

Cut time to reproduce 1.2 million kilometers of customer usage

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- **Reproduced 1.2 million kilometers of customer usage in a condensed proving ground test period**
- **Developed 4-week accelerated rig test to represent 1.2 million kilometers of customer usage**
- **Provided opportunity to optimize cost and weight**

Conducting customer correlated procedures

Customer correlated proving ground test

Cabin rig test to represent 1.2 million kilometers

- Qualify and quantify the durability potential of vehicle loads with innovative analysis
- Replace time-consuming and costly tests by deriving compressed load time histories with an equivalent damage potential for uniaxial and multi-axial loading conditions

"We selected Siemens PLM Software for its capabilities and experience in durability field testing, load data analysis and test schedule development for virtual simulation and durability track and rig testing."

Vehicle Durability Supervisor

Simcenter for Vehicle Performance Engineering

Vehicle Strength & Durability

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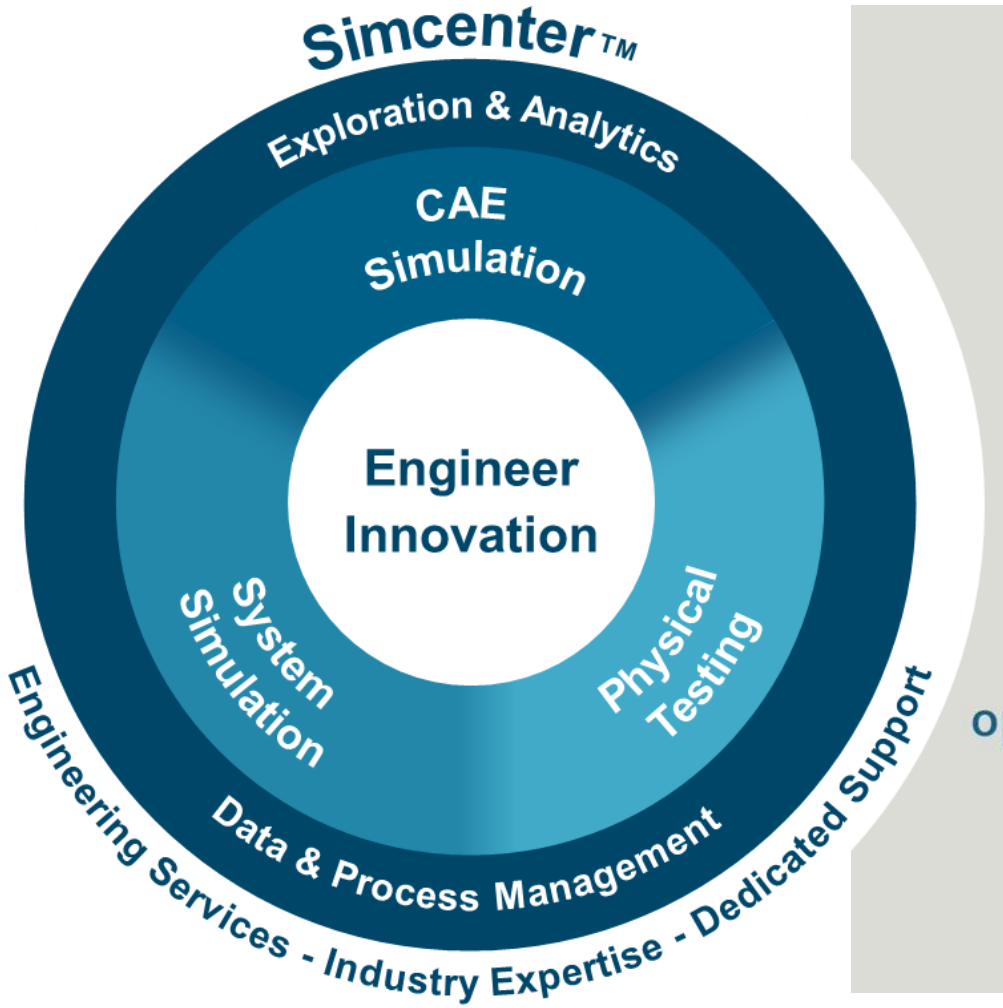

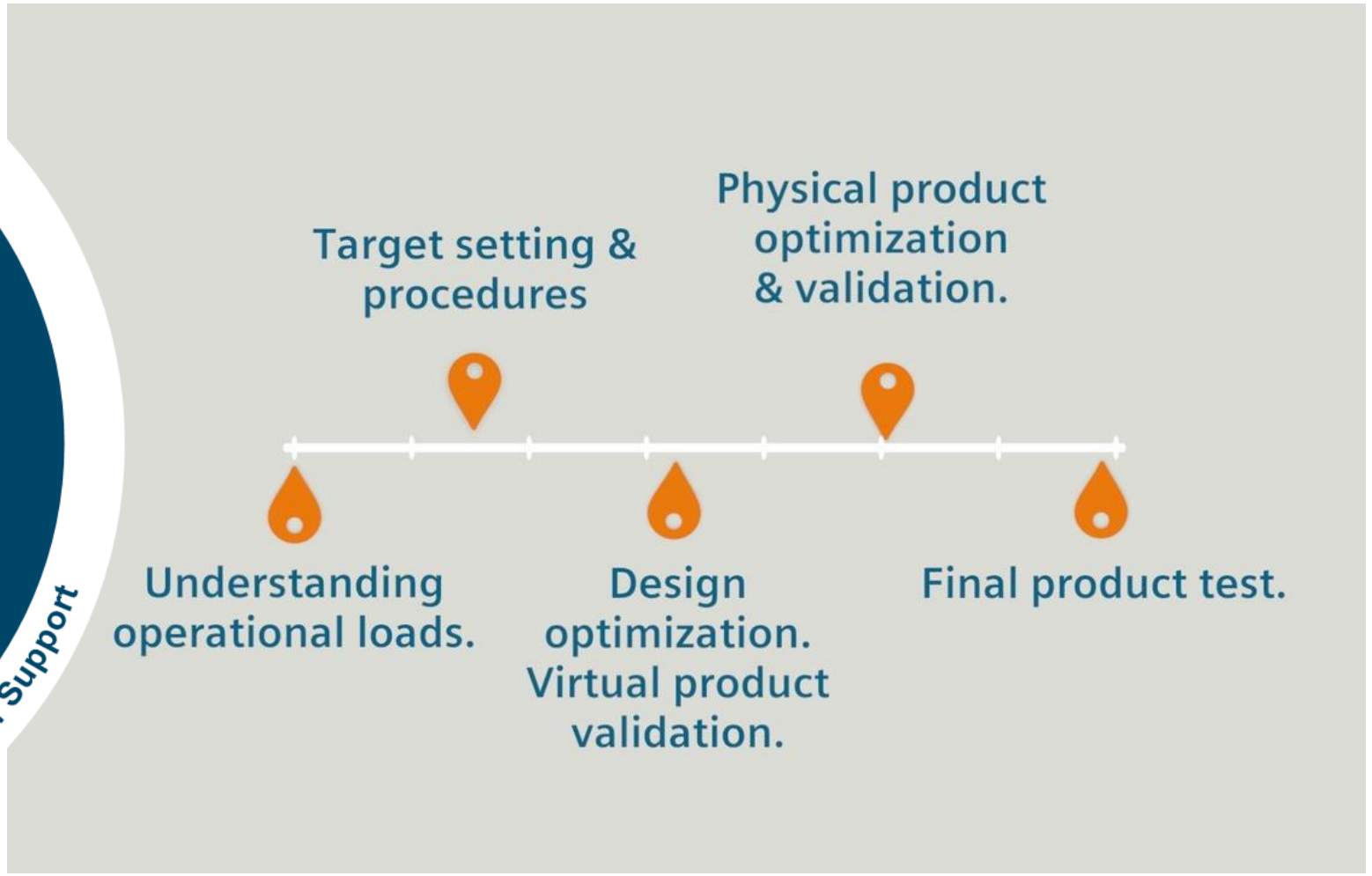

Thank you! Want to know more?

SIEMENS
Ingenuity for life

Read more

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Watch videos

Contact the expert