

## Product information

### **QanTiM - The solution to your control and simulation problems**

QanTiM – Service Load Simulation and Control Enhancement – Unique Time Domain Formulation



QanTiM simulation testing enables you to bring greater realism, accuracy and repeatability to mechanical testing. Laboratory testing helps shorten your product development cycle for structures or components. QanTiM simulation enables you to reproduce the actual real-time loading conditions for a vehicle or structure in a test laboratory. Real-Time Simulation Testing offers the only method of reliably conducting interactive multi-axis tests.

A QanTiM Test and Simulation System provides a complete laboratory solution with a suite of control and analysis software modules for a wide range of testing.

- Motion Simulation
- Durability Testing
- Squeak & Rattle Investigation
- Shock & Impact Loading
- Cancellation of Test Rig Interaction

#### **QanTiM Multi-axis simulation**

QanTiM offers simulation and control in the re-creation of service loads using ride or motion simulators.

The QanTiM suite of software is available in modular form to enable an expansion from low functionality through to full simulation with durability programs and data analysis.



## Features

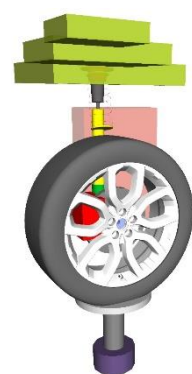
- An affordable method of entry into simulation testing
- Low training costs

## Overview of Real-Time Simulation

State-of-the-art in Servo-hydraulic Test Rig Control Software

The time domain-based testing system QanTiM provides state-of-the-art testing technology. QanTiM allows actual operationally measured response conditions to be reproduced on the test structure in the laboratory. QanTiM provides control of randomly loaded single or multiple axis fatigue test rigs, particularly for service-load simulation testing.

The object is to measure the dynamic response of the test structure during operational conditions and to recreate these conditions in a laboratory on the full-scale structure loaded by servo-hydraulic actuators. Generally, it is not possible to measure the actual loads acting on the structure, and instead the dynamic responses to these loads are measured at positions remote from the load inputs. These remotely measured responses are subsequently utilized to derive the system input forcing-functions (actuator drive signals).



The use of time domain technology has proved to exhibit performance characteristics that have to date been impossible using traditional methods. These include much greater capabilities at the extremes of simulation testing, such as very low frequency events and efficient operation from short duration input data. This new approach to simulation testing also results in a test system that is exceptionally easy to use, compared with traditional simulation products operating in the frequency domain. In spite of its sophistication, QanTiM does not burden the user with its clever technology. Instead the empowering technology is hidden to enable the rapid execution of tests. In this way, the efficient gathering of test results remains the prime objective.

## Features

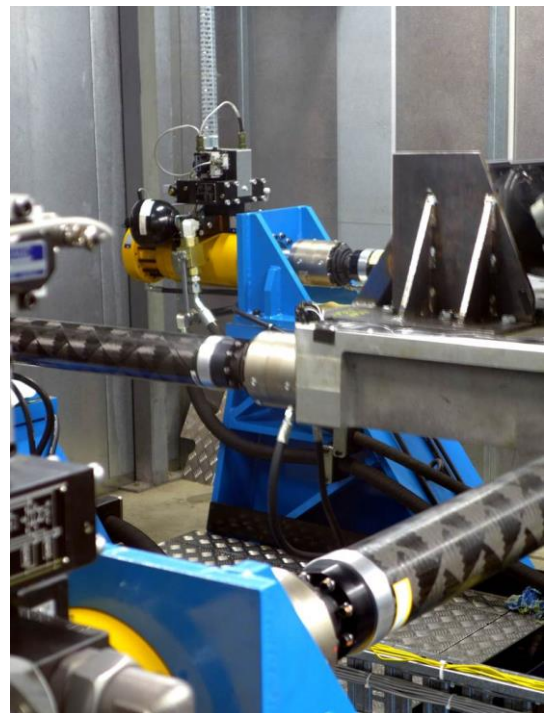
- Time Domain Analysis:
- Easy to use
- Requires only short duration excitation
- Good for DC and transient events
- Eliminates FFT analysis

## QanTiM General Description

QanTiM can be applied to tests ranging from straightforward single-axis tests to multi-axis, cross-coupled tests replicating real-time service load data. QanTiM will interface with most existing servo-hydraulic equipment and may be configured for any specific test.

## Software Features

- Signal Generation, Test and Analysis Module
  - Data import / export
  - Signal Generation
  - Data Analysis
  - Data Edit
- Simulation Module
- Durability Test Module



## QanTiM Signal Generation, Test and Analysis Module (SIGTA)

The Signal Generation, Test and Analysis Module provides a selection of software tools designed for application in mechanical testing. The wide selection of command waveforms, feedback signal analysis and editing features are presented in a highly graphic format to ensure ease of use.



## Signal Generation

- Constant Amplitude
- Sine
- Square
- Triangle
- Sawtooth
- Block Cycle Generation
- Programmable frequency, amplitude bias and cycle count
- Import from CSV/ASCII/RPC
- Automatic generation of block-to-block transitions

## Swept Frequency Signal Generation

- Constant amplitude
- Swept amplitude
- Constant acceleration
- Constant velocity
- Linear or logarithmic sweeps

## Transition and Constants

- Haversine
- Ramp profile
- Constant DC level
- Point-by-point signal generation
- Random Waveform
- Uniform
- Normal
- Pseudo Random
- Band-limited white noise
- Uses graphically defined shaped spectral contents
- Tabular input for spectra

Note: Generation of signals from any user-defined mathematical function using Matlab.



## Data File Management

### Data File Import and Export

- ASCII
- RPCIII
- Most popular simulation data file formats
- Most popular analysis software file formats

### Configuration

- Sample frequency
- Number of channels
- Channel descriptions
- Channel units and calibration
- Test set-up

### Signal Analysis

- Graphical Data Plotting and Printing
- Time history data files
- Spectral data
- XY plotting
- Time-history step through
- Zoom
- Restore
- Channel selection
- Linear/Logarithmic scales
- Printing



## Statistics

- Max/Min
- Mean
- RMS
- Standard Deviation
- Variance
- Crest Factor

## Second-Order Statistics

- Spectral analysis
- Power spectral density (PSD)
- Cross-spectral density (CSD)
- Coherence (partial and multiple)
- Frequency response function (FRF)

## Dynamic Analysis

- Bode plot
- Transmissibility
- Frequency response function (FRF)
- Automated batch analysis of multiple data files

Note: Analysis of data by any user-defined mathematical functions using Matlab's capabilities.

## Signal Editing and Manipulation

### Multi-Channel Graphical Data Editing

- Cut
- Join
- Zero
- Enforced value
- Spline
- Attenuate
- Clip
- Point-by-point draw
- Undo
- Scale
- Offset Manipulation
- Detrend (DC and/or slope)
- Differentiation and Integration
- Phase Shifting

### Digital Filtering

- Low pass
- High pass
- Band pass
- Band stop
- Phase shift correction

### Data File and Channel Manipulation

- Cut, paste, augment data files
- Split and combine channels over different files
- Automated batch editing and manipulation of multiple data files

Note: Manipulation of data by any user-defined mathematical functions using the wealth of Matlab's capabilities.

## QanTiM Operational Overview

Recording of operational responses to be replicated. The structural dynamic response of the test structure is recorded with suitable transducers under operational field conditions, and transferred via QanTiM's data import tools. These transducers may be accelerometers, strain gauges, LVDTs etc. The test structure is thereafter installed in the test rig and the objective is then to determine the unknown actuator drive signals which will result in an identical response in the laboratory as had previously been recorded. QanTiM also allows importing of field data from other systems.

### Identification of test system

The test rig is then excited by the servo-hydraulic actuators, using synthetically generated drive signals, while simultaneously recording the responses. This data is used to calculate a dynamic, multiple input multiple output, state space, time domain model of the complete system using parametric dynamic system identification techniques.

## **Calculation of initial drive signals**

QanTiM uses the inverse dynamic model and the measured field responses to generate the initial actuator drive signals. These drive signals are applied to the test rig while comparing the resulting rig response to the measured field response.

## **Iteration process**

Since a linear dynamic model is used and most servo-hydraulic systems are inherently non-linear, iterations around the initial estimate are required to achieve an accurate simulation of the measured field responses. Two or three iterations are usually sufficient when using QanTiM.

## **Durability fatigue test**

Having determined the actuator drive signals for each profile to be replicated, the fatigue test may be conducted. The Cubus based durability test module (Dura) allows the profiles to be applied in any order with any number of repeats. The test can be monitored to check for component deterioration or failure. This involves statistical monitoring of dynamic and quasi-static response data.

## **Advantages of QanTiM in Non-Simulation Fatigue Applications**

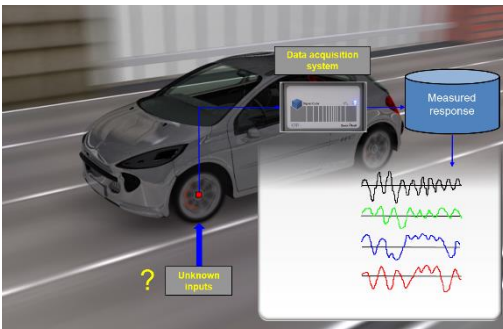
The use of QanTiM is essential in the fatigue environment and also in those applications where service-load simulation testing is not required. In the fatigue environment, it is well established that small deviations from the specified testing amplitude can have a marked effect on test results. By using QanTiM, the accurate achievement of the required testing load amplitudes onto the test specimen can easily be achieved.

In many applications, no other means of determining suitable input signals is possible.

The use of QanTiM allows a force, acceleration, strain or any other parameter on the test specimen to be simulated with the actuator utilizing either a displacement or load drive command signal.



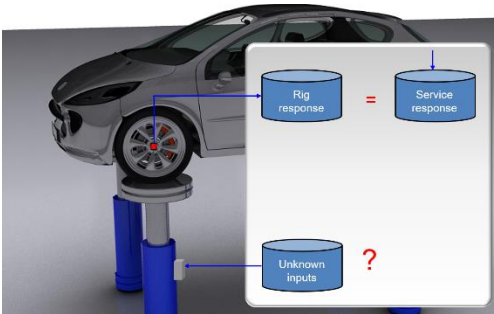
## Step 1: Acquisition of Field Service Data



The first step in simulation testing is to acquire field data under operational conditions. In the case of a vehicle it is impractical to fit transducers between the road and tyre and generally some parameter remote from the point of application of load is measured. Using a Signal Cube (or other data acquisition system), a number of time-history channels are recorded under representative service conditions.

The example shows the front wheel of a motor vehicle where accelerometers are used to measure acceleration at the vehicle suspension.

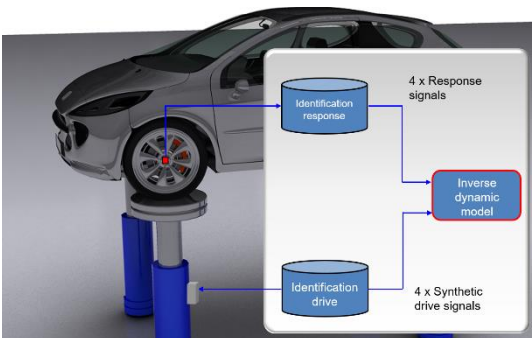
## Step 2: Transfer to the Test Lab



The test vehicle is mounted on a servo-hydraulic test rig in place of the road surface and the recorded field data is transferred to the laboratory simulation using QanTiM's data-import tools. At this point, a measured response at some remote point is stored as a data file and the command signals for the test rig to simulate these responses is unknown.

Note: Only a single channel is shown in this diagram; for a multi-channel system each channel would have its own measured field response data.

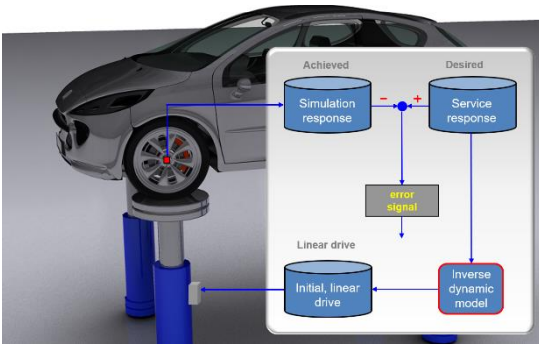
## Step 3: Excitation and System Modelling



The QanTiM system will identify a dynamic model of the complete system including servo-hydraulic actuator, control system and vehicle test component with associated remote transducer. To do this, a short synthetic drive signal (typically 10 to 20 sec.) is generated within the QanTiM system and the test rig's corresponding response is measured. QanTiM uses this input and output data to compute an inverse dynamic model using

parametric dynamic system identification techniques. Special features provide automatic model order selection.

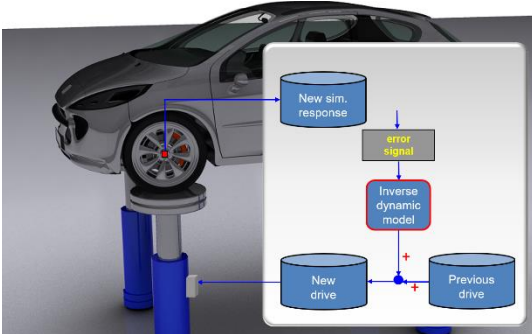
## Step 4: Linear Drive Solution



a small error.

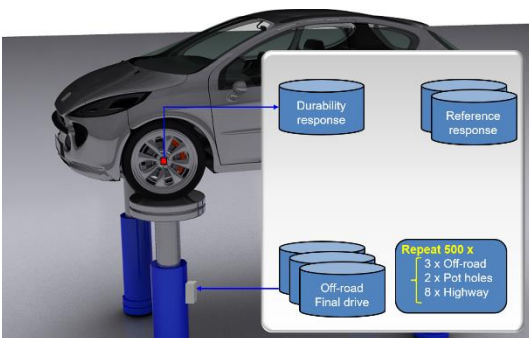
The desired field response signals are passed through the inverse dynamic model to generate a linear drive solution or first attempt drive signal. This is applied to the servo-hydraulic test rig and the responses from the remote transducers become an achieved laboratory simulation response. This laboratory response is compared directly with the desired field response recorded on the vehicle. On the first attempt there is usually

## Step 5: Iteration



To overcome errors between the laboratory simulation and the desired field response, the error between those two signals is passed through the inverse dynamic model to create an updated drive signal. The updated signal is once again applied to the test rig and the iteration process continues until the desired field responses are reproduced accurately. Iteration may be performed automatically.

## Step 6: Durability



Having established a source of drive files for a variety of different road surfaces, a structural endurance test may be carried out in a predefined sequence and number of repeats. During this durability sequence the test rig response is monitored and should the response signals deviate from their expected values by more than a predefined amount, the test can be halted and investigations carried out.