Cranfield Impact Centre Moment of Inertia Test Software

Utilising National Instruments LabVIEW and modular DAQ hardware

Simplicity AI developed a sophisticated measurement and analysis application

The Challenge

Cranfield Impact Centre is a UK based organisation which is internationally respected in the field of vehicle crashworthiness and analysis. One of their key test laboratory facilities is a 3-axis moment of inertia/centre of gravity measurement platform, which can be used to test components such as transmissions, or complete vehicles including Formula One cars.

Simplicity AI were tasked with providing a new application for carrying out moment of inertia measurements, completely replacing a legacy solution . The software is required to perform data acquisition from sensors within the test rig, then process the data, performing over 150 calculations to produce the required results. There are only two main types of test performed but each one is performed under different rig orientations and they are all repeated multiple times to ensure best measurement accuracy. The software must log and display all the data from the repeated tests and allow the user to remove any spurious results to ensure the best quality analysis.

ABOVE: The moment of inertia facility at Cranfield with a formula-One car in position

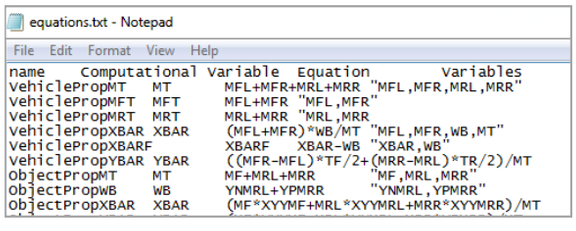
> ″The LabVIEW application developed by Simplicity AI has greatly accelerated the process of evaluating moments of inertia and centre of gravity of a vehicle”
>
> Dr James Watson
>
> Senior Safety Engineer, Cranfield Impact Centre

The Solution

Products & Services Delivered

- ✓ LabVIEW Development
- ✓ DAQ Programming
- ✓ Custom Acquisition Enclosure
- ✓ Telephone, email and remote support
- ✓ On-site Installation

The software was required to perform extensive mathematical calculations on the data it acquired. Additionally there was a need to verify that these equations were correct, both for the commissioning phase and the commercial operation of the software. To satisfy this the system was designed to load the equations from a text file and execute them using LabVIEW native formula processing functions. This allowed the engineers to easily verify that the equations were correct without having to understand the LabVIEW code.

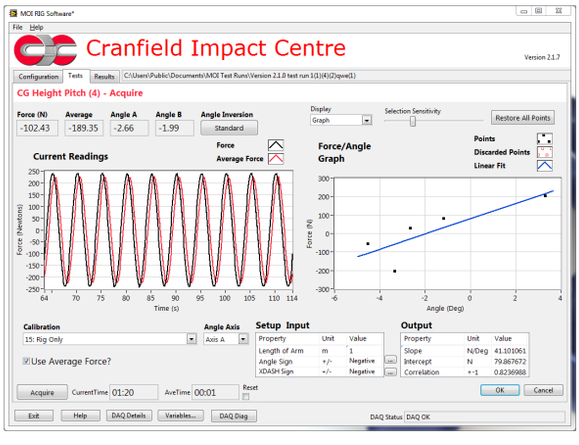

equations.txt - Notepad

File Edit Format View Help

```
name    Computational Variable  Equation        Variables
VehiclePropMT   MT      MFL+MFR+MRL+MRR "MFL,MFR,MRL,MRR"
VehiclePropMFT  MFT     MFL+MFR "MFL,MFR"
VehiclePropMRT  MRT     MRL+MRR "MRL,MRR
VehiclePropXBAR XBAR    (MFL+MFR)*WB/MT "MFL,MFR,WB,MT"
VehiclePropXBARF        XBARF   XBAR-WB "XBAR,WB"
VehiclePropYBAR YBAR    ((MFR-MFL)*TF/2+(MRR-MRL)*TR/2)/MT
ObjectPropMT    MT      MF+MRL+MRR      "MF,MRL,MRR"
ObjectPropWB    WB      YNMRL+YPMRR     "YNMRL,YPMRR"
ObjectPropXBAR  XBAR    (MF*XYYMF+MRL*XYYMRL+MRR*XYYMRR)/MT
```

User Interface

The application user interface was designed to be a flexible as possible. Live data and previous measurements are displayed alongside each other. Current test results can easily be compared to previous runs to ensure data collection is accurate. Individual tests and individual measurements can be disabled from the calculations to remove any spurious results without the requirement to repeat all the tests. Tests can also be repeated, reviewed and parameters changed without loosing data.



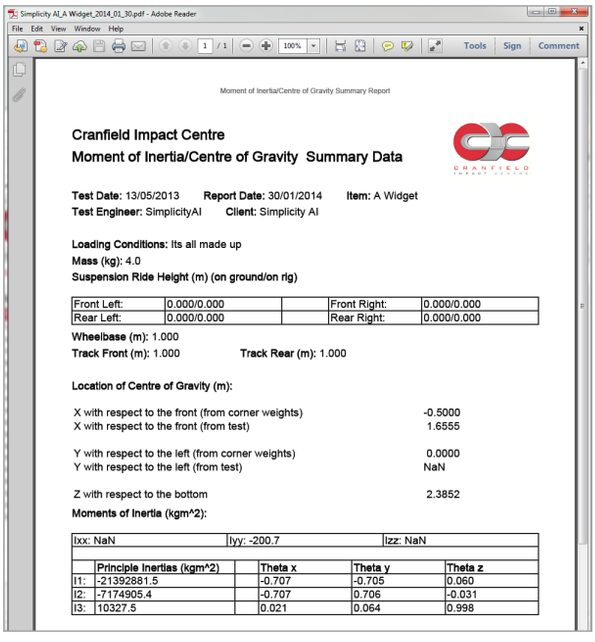
TOP LEFT:
Equations text file

LOWER LEFT:
User interface for Centre of Gravity tests.

RIGHT:
Final report format

Reporting

Simplicity AI used their 'Custom PDF Generator' to format the result of the test into a document that can be presented directly to the customer. Automatic generation of this report have greatly decreased the amount of time required to provide test results to customers.


Simplicity AI_A Widget_2014_01_30.pdf - Adobe Reader

Moment of Inertia/Centre of Gravity Summary Report

Cranfield Impact Centre
Moment of Inertia/Centre of Gravity Summary Data

Test Date: 13/05/2013 **Report Date:** 30/01/2014 **Item:** A Widget
Test Engineer: SimplicityAI **Client:** Simplicity AI

Loading Conditions: Its all made up
Mass (kg): 4.0
Suspension Ride Height (m) (on ground/on rig)

Front Left:	0.000/0.000	Front Right:	0.000/0.000
Rear Left:	0.000/0.000	Rear Right:	0.000/0.000

Wheelbase (m): 1.000
Track Front (m): 1.000 **Track Rear (m):** 1.000

Location of Centre of Gravity (m):

X with respect to the front (from corner weights)	-0.5000
X with respect to the front (from test)	1.6555
Y with respect to the left (from corner weights)	0.0000
Y with respect to the left (from test)	NaN
Z with respect to the bottom	2.3852

Moments of Inertia (kgm^2):

Ixx: NaN	Iyy: -200.7	Izz: NaN

	Principle Inertias (kgm^2)	Theta x	Theta y	Theta z
I1:	-21392881.5	-0.707	-0.705	0.060
I2:	-7174905.4	-0.707	0.706	-0.031
I3:	10327.5	0.021	0.064	0.998

Upgrades and Long Term Support

The application continues to be extended beyond its original capabilities. Software updates have been provided by Simplicity AI in a mix of electronic delivery and onsite installation. Support for different axis of measurement were added along with advanced Eigen value calculations that previously had to be computed in an external application. One of the additional requirements was a 'second screen' that could display levelling information when setting up the rig. Simplicity AI leveraged the National Instruments Data Dashboard for iOS to provide a simple remote screen for displaying levelling information. This was implemented successfully within a few minutes and allowed the technicians to set up the test rig without having someone in front of the PC calling out instructions.

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