

RESOLVING THE FUEL SAVING INTERVENTIONS TESTING PROBLEM

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THE PROBLEM



- Fuel Saving Interventions:
 - Some work; some only work under specific conditions and some don't work
- Operators have a healthy cynicism to interventions
- Selection of test and control vehicles is of critical importance.
- How to effectively evaluate.
- Operators aversion to risk, especially in the case of warranty implications.

OUR APPROACH

- Understand the problem.
- Examine the potential solutions.
- Produce a viable solution.
- Deliver a commercially viable solution.



SIMPLIFY THE INTERVENTIONS



- SFC of the engine
- Drivetrain efficiency
- Rolling resistance
- Aerodynamic drag
- Acceleration resistance
- Climbing resistance
- Braking resistance
- Transport efficiency
- Driver skills
- Vehicle specification
- Effective maintenance
- Monitoring

Source: Coyle 2002

M2 SOLUTION

- Testing processes:
 - Engine Dynamometer
 - Test Track
 - Live
- Identify the best testing process in terms of accuracy.
- Trade off – Accuracy V Representativeness.
- Use dynamometer and test track processes as filters.

INTERVENTION CATEGORIES AND TEST PROCESSES

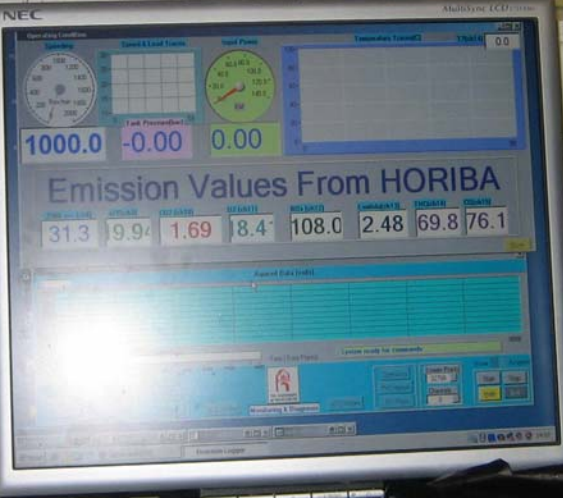
No	CATEGORY	ENGINE DYNAMOMETER	TEST TRACK	LIVE
1	Specific fuel consumption of the engine	Yes	Yes	Yes
2	Transmission efficiency of the drivetrain	N/A	Yes	Yes
3	Rolling resistance	N/A	Yes	Yes
4	Aerodynamic drag	N/A	Yes	Yes
5	Acceleration resistance	Yes	Yes	Yes
6	Climbing resistance	N/A	N/A	Yes
7	Braking resistance	N/A	N/A	Yes
8	Transport efficiency management	N/A	N/A	Yes
9	Driver's fuel efficiency skills	N/A	N/A	Yes
10	Correct vehicle specification	N/A	Yes	Yes
11	Effective Maintenance	N/A	N/A	Yes
12	Monitoring	N/A	N/A	Yes

ENGINE DYNAMOMETER

- Minimum number of variables.
- SFC, Torque and Power all measured.
- PPM measurement of
 - CO, NOx and THC
- % measurement of
 - CO₂ and O₂



IF IT DOESN'T WORK IN THE LAB THEN IT HAS
NO CHANCE AT THE TEST TRACK OR 'LIVE'



Mass Flow

2.59 Min 1.48 Max 3.56 g/Sec

Specific Fuel Consumption

316.43 Min 181.88 Max 433.88 g/KWhr

Volume Flow

3.04 Min 1.74 Max 4.19 mL/Sec

Fuel / Stroke

65.18 Min 37.35 Max 89.57 mL3/Stk

Consumption

0.00 Km/L

Power

29.4 KW

Cycle Information

Sample Period 20 Secs

Completed Cycles 4

Instant Values

Cycle Values

Progress

FMS in Measure

Reading In Progress

Standby

ReFill

Fill Before Measure

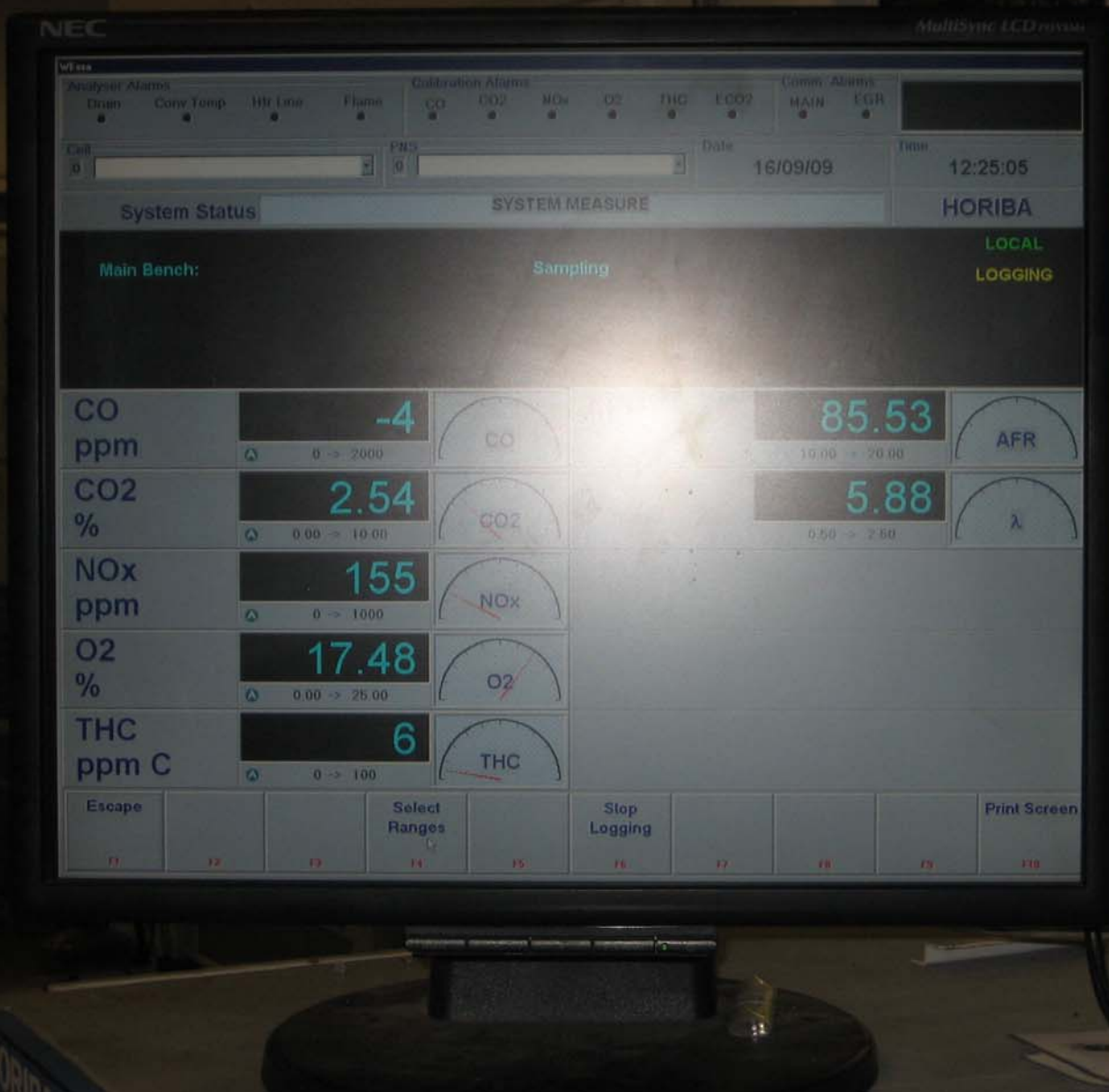
Calibration

Sample by Time

Rolling Average

Main Diagnostics

Dyno Speed 1,399 Rpm		Torque 199.6 Nm		Obs Power 29.0 KW		PTX 1 Oil Press. 4.80 Bar		PRT15 Eng Cool Out 44.9 oC		Throttle Position 53.9 %	
Dyno A	Throttle A	Auto		Setpoints 03 to 10		Water Temp A	Oil Temp A	I'Cooler Temp A	Cell Temp A		
Rpm	%	0.0		Setpoints 11 to 18		90.0	90.0	0.0	25.0		
1000	0.0	0.0		Setpoints 19 to 26		Water F	Oil F	I'Cooler F	Recirc Fan A		
Dyno M	Throttle M	Manual		Setpoints 27 to 34		%	%	%	0.0		
Rpm	Nm	Lock Crank		Setpoints 35 to 42		0.0	0.0	0.0	0.0		
1400	202.0			Setpoints 43 to 50						I/O Onk User Onk	
				System						HWP	
3568:17/Sep/09 14:20:21 - Engine Started											
001: Manual Run		Cycle 0001		Duration 998:59:59.0		Remaining 998:54:20.8		TS		Clock 0000:00:00.0	
										Logs 0	
										17/Sep/09 14:25:14	



TEST TRACK



- Fewer variables than live.
- Can incorporate gravimetric fuel measurement.



IF IT DOESN'T WORK AT THE TEST TRACK
THEN IT HAS NO CHANCE 'LIVE'

LIVE TESTING

- Maximum number of variables.
- Inherent volatility in fuel consumption data.
- Seasonal influence if testing long term, therefore not recommended.
- Year on year seasonal influence is not identical, so comparison with last year's figures has no validity.

M2 SOLUTION - OVERVIEW

- Joint venture with University of Huddersfield to bring all the knowledge, skills, experience and physical resources together in one team.
- Minimise cost to operators and intervention suppliers.
- Apply powerful statistical techniques to ensure validity of outcome.
 - $\sum_{\pm\infty} \mu\alpha (\sum \epsilon \geq \Gamma)$
- Full economic and environmental analysis.

UNDERSTAND THE INTERVENTION



➤ Understand:

- Physics – does it conform to what we know?
- To which variables is it sensitive and to what degree?
- What is its potential to do harm?
- Positive effects?
- Negative effects?
- Cost – is it likely to be financially viable?

DYNAMOMETER

- Snapshot test to determine if it is worth moving to full blown testing.
- Implement powerful and appropriate test processes incorporating different engine speeds and loads.
- Apply statistical techniques to all metrics to ensure validity of outcome.



TEST TRACK

- Electronic displays to show to at least one decimal point in one point increments
- Fuel measurement
 - Use of fuel flow meters *or*
 - Gravimetric tanks to calibrate CANbus data
- Use of control and alternate vehicles
- Apply proven and powerful statistical techniques to determine effect.

ACCURACY?



LIVE

- In-depth understanding of the intervention, key variables and sensitivities.
- Selection of test and control vehicles via operational logic and statistical analysis.
- Minimum of three test and three control vehicles, preferably with fuel flow meters, but can work with 'tank to tank' and CANbus data although the analysis will not be as robust as when done with a fuel flow meter.

LIVE

- Minimise operators resource requirement.
- Implement M2 test protocols and procedures to ensure accuracy and repeatability, which can also reduce test period to two to three months.
- Daily data collection and continual statistical analysis.

DELIVERING THE SOLUTION

- The following interventions are in various stages of testing:
 - Aerodynamics – 4 projects
 - Transmission efficiency – 2 projects
 - SFC of the engine - 3 projects
 - Monitoring – 1 project
 - Advanced driver skills – 1 project
- Most of the above are new interventions and most involve patents.

DEVELOPING IN-COMPANY

FUEL CHAMPIONS

➤ Neil Callaghan at Castle Cement:

- Enrolled on our unique 'Fuel Champion by Distance Learning' course run in conjunction with the Division of Transport & Logistics at the University of Huddersfield.
- Underwent applied training and skills development - all company based.
- Delivered significant savings for Castle Cement as reported in DfT publications.
- M2 case study to be published soon. Saving £1,867 per vehicle per year. Costs £0 to £800 depending upon equipment modified.

ONE OF NEIL'S PROJECTS

SAVING 6.37%



SO DOC HOW DO YOU PERFORM?



Jaguar 'X' Type 2.0 Diesel – 30,795 miles in 27 months

FUEL STATS		
True average MPG		46.57
Statistical average MPG		46.68
Target MPG		45.00
Tonnes of CO ₂		7.94
Tonnes of Carbon		2.16
Fuel cost (£)		3,166
Pence per mile		10.28
CO ₂ - g/km		157.94

THANK YOU



MICHAEL COYLE M2 Training Limited

- Unique 'Fuel Champion by Distance Learning'.
- Independent Intervention testing using proven powerful techniques.
- 'No Saving – No Fee' fuel efficiency service.