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.
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
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

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

- Minimum number of variables.
- SFC, Torque and Power all measured.
- PPM measurement of CO, NOx and THC
- % measurement of CO$_2$ and O$_2$

IF IT DOESN’T WORK IN THE LAB THEN IT HAS NO CHANCE AT THE TEST TRACK OR ‘LIVE’
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.
- 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.
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.
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%
Jaguar ‘X’ Type 2.0 Diesel – 30,795 miles in 27 months

<table>
<thead>
<tr>
<th>FUEL STATS</th>
<th></th>
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<tbody>
<tr>
<td>True average MPG</td>
<td>46.57</td>
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<tr>
<td>Statistical average MPG</td>
<td>46.68</td>
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<tr>
<td>Target MPG</td>
<td>45.00</td>
</tr>
<tr>
<td>Tonnes of CO₂</td>
<td>7.94</td>
</tr>
<tr>
<td>Tonnes of Carbon</td>
<td>2.16</td>
</tr>
<tr>
<td>Fuel cost (£)</td>
<td>3,166</td>
</tr>
<tr>
<td>Pence per mile</td>
<td>10.28</td>
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<tr>
<td>CO₂ - g/km</td>
<td>157.94</td>
</tr>
</tbody>
</table>
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.