

Reducing Greenhouse Gas Emissions From Light-Duty Motor Vehicles

Presented to
California ARB Workshop
April 20, 2004

Stephen Brueckner
AVL Powertrain Engineering, Inc.

Outline

- Who is AVL?
- CRUISE Modeling Process
- Task 1 - Assessment of Individual Technologies
- Task 2 - Assessment of Technology Combinations

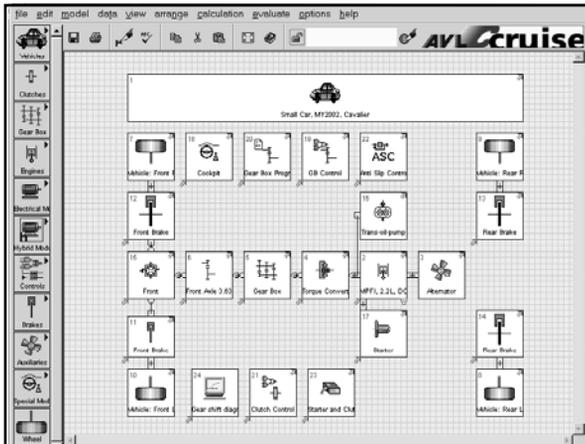
The Company



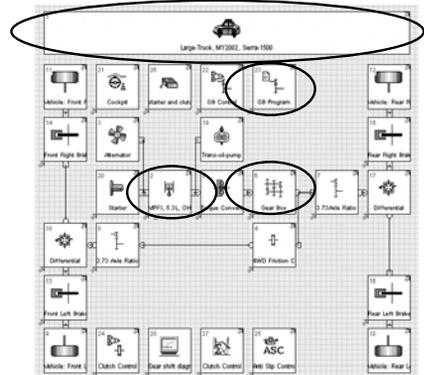
The world's largest independent company providing powertrain systems engineering and the manufacture of powertrain test systems and instrumentation.

CRUISE Modeling Process

- Who is AVL?
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- Task 2 - Assessment of Technology Combinations



CRUISE Vehicle Model - Large Truck



CRUISE Vehicle Model Parameters

Vehicle - Small Car, MY2002, Cavalier

Author: AVL
 Comment: Small Car, MY2002, Cavalier
 Notice 1: Speed At, FWD
 Notice 2: 1.63
 Notice 3: Date of Development: 18 Jul 2003 14:08:37

Gas Tank Volume: 68.1 USGallon
 Pressure Difference Engine-Environment: 0.0 bar
 Temperature Difference Engine-Environment: 0.0 K
 Distance from Hubs to Front Axle: 2942.0 mm
 Wheel Base: 2542.0 mm
 Height of Support Point at Bump Top: 100.0 mm

Load Dependent Characteristics
 Distance of Gravity Center in mm: [] Height of Gravity Center in mm: []
 Wheel Pressure Front Axle in bar: [] Wheel Pressure Rear Axle in bar: []

Nominal Weight
 Curb Weight: 2076.0 lb mass
 Gross Weight: 3176.0 lb mass

Air Coefficient
 Frontal Area: 2.04 m²
 Drag Coefficient: 0.36
 Lift Coefficient Front Axle: 0.01
 Lift Coefficient Rear Axle: 0.01

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CRUISE Vehicle Model Parameters (2)

Vehicle - Small Car, MY2002, Cavalier

Total Driving Resistance
 Author: AVL
 Comment: EPA coefficients for Cavalier
 Notice 1: []
 Notice 2: []
 Notice 3: []
 Date of Development: 18 Jul 2003 14:08:37

Reference Vehicle for Driving Resistance
 Frontal Area: [] m²
 Drag Coefficient: []
 Weight: [] kg

Resistance Function
 Constant Part: 27.9
 Linear Part: 0.3077 B/mph
 Quadratic Part: 0.07143 B/mph²

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CRUISE Vehicle Model Parameters (3)

Vehicle - Small Car, MY2002, Cavalier

Author: AVL
 Comment: Small Car, MY2002, Cavalier
 Notice 1: Speed At, FWD
 Notice 2: 1.63
 Notice 3: Date of Development: 18 Jul 2003 14:08:37

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CRUISE Engine Model

Engine - MPFI, 5.3L, OHV

Author: Russell Trueman
 Comment: MPFI 5.3L, OHV
 Notice 1: gasoline
 Notice 2: MPFI Tech V&A Maps
 Notice 3: []
 Date of Development: 06 Nov 2003 16:42:50

Engine Type: Gasoline
 Charge: Without
 Conversion to different Displacement: []

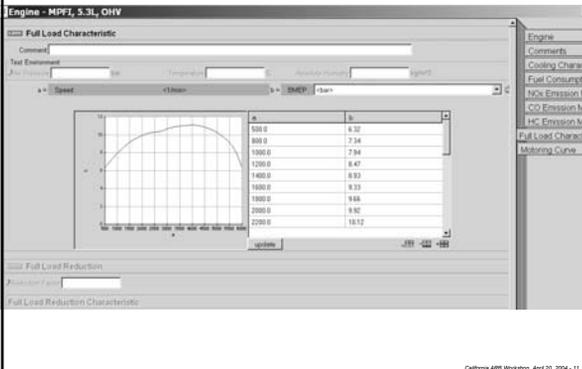
Engine Displacement: 5.3
 Engine Working Temperature: 90.0 C
 Number of Cylinders: 6
 Number of Strokes: 4
 Inertia Moment: 0.18 kg*m²
 Maximum Speed: 3000.0 1/min
 Response Time: 0.1

Fuel Type
 Fuel Type: []
 Speed: 500.0 1/min
 Consumption: [] g/kWh
 Emission HC: [] g/kWh
 Emission CO: [] g/kWh
 Emission NOx: [] g/kWh

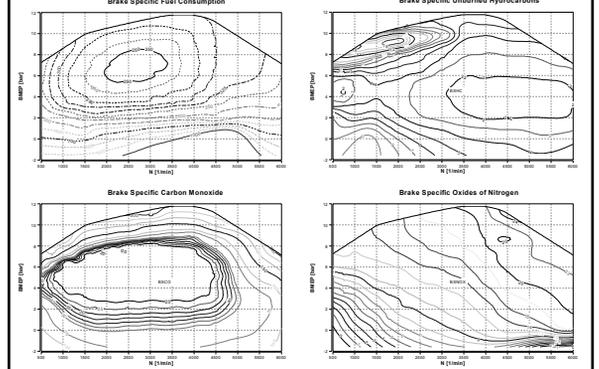
Friction Mean Effective Pressure (FMEP)
 Normal Temperature: 70.0 C
 Equivalent Mass: 16.45 kg

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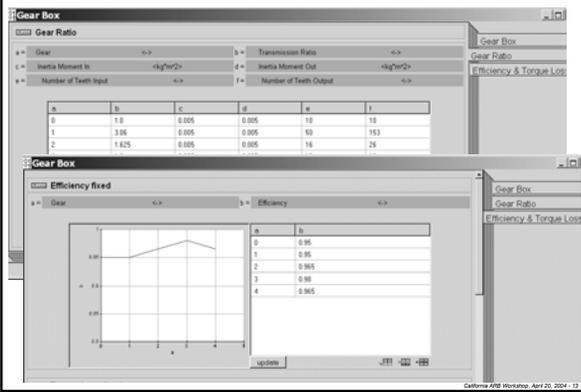
CRUISE Engine Model (2) - Full Load Curve



CRUISE Engine Model (3) - Sample Engine Maps

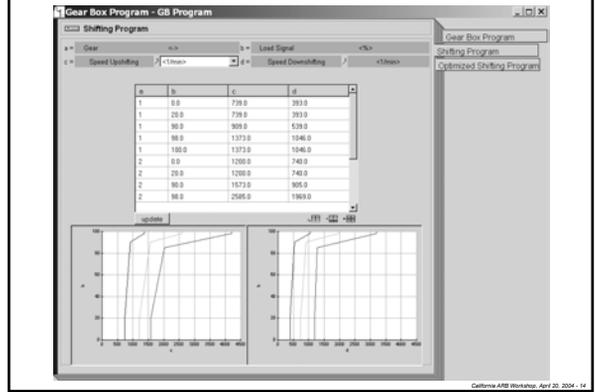


CRUISE Transmission Model - 4 Speed Automatic



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CRUISE Gear Box Control Program - Sample Shift Curves



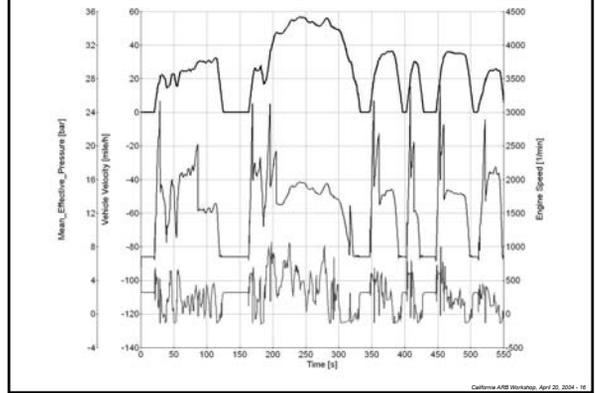
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CRUISE Vehicle Simulation Tasks



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CRUISE Vehicle Simulation Sample Output



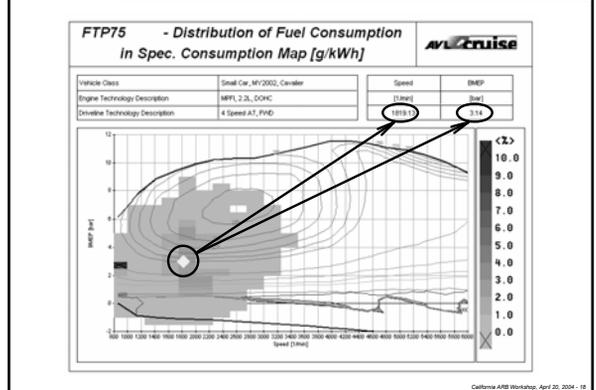
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Task 1 - Assessment of Individual Technologies

- Who is AVL?
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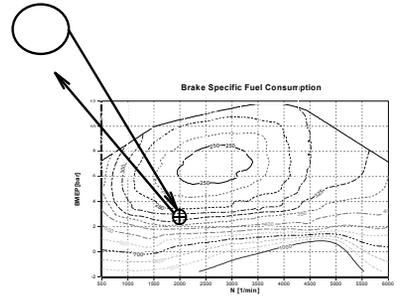
CRUISE Vehicle Simulation Output - "Single Point" Determination



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CRUISE Vehicle "Single Point" Matrix

CRUISE "Single Point" Engine Technology Assessment



Individual Technologies Reduction in Combined CO₂ Emissions

Engine Technology

Camless Valve Actuation - Electromagnetic

Turbocharging
Cylinder Deactivation

Variable Compression Ratio

Diesel - HSDI
Diesel - Advanced Multi-Mode

Individual Technologies Reduction in Combined CO₂ Emissions (2)

Drivetrain Technology

Individual Technologies Reduction in Combined CO₂ Emissions (3)

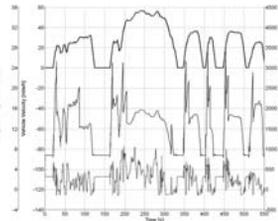
Other Vehicle Technology

Task 2 - Assessment of Technology Combinations

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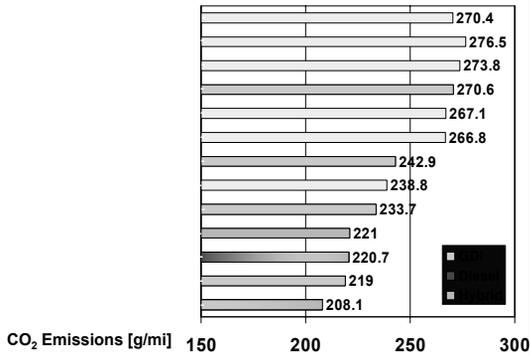
2009 MY Vehicle Data Assumptions

Simulation of Combined Technologies

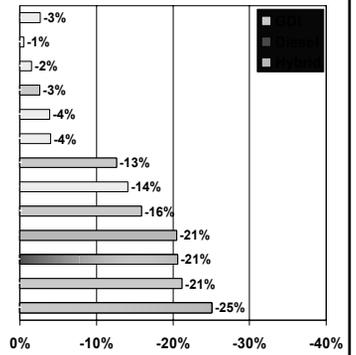


- Selection of Modeled Technologies
- Engine Maps and Full Load Curves Selected
- Engine Displacement and Final Drive Ratio Adjusted to Match 2009 Baseline Performance Levels
- Drivetrain and Engine Selection Determine Engine Operating Point
- CO₂ Emissions a Function of Operating Point and Engine Maps

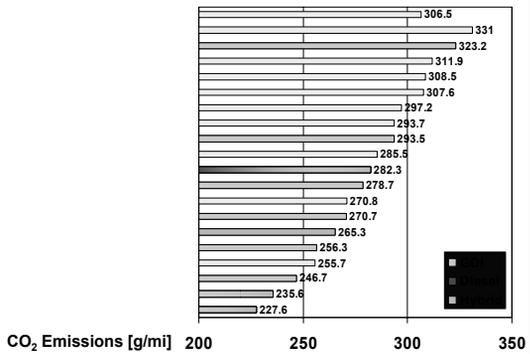
Small Car Combined CO₂ Emissions



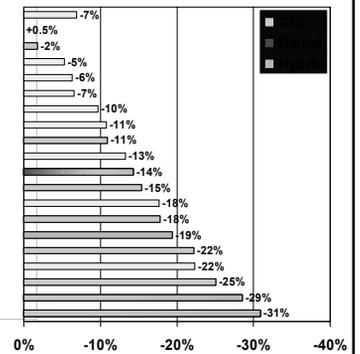
Small Car Reduction in Combined CO₂ Emissions



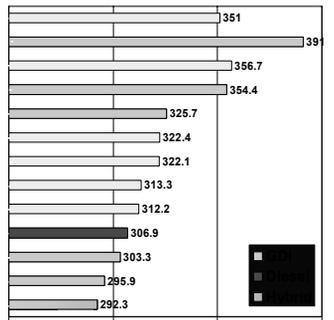
Large Car Combined CO₂ Emissions



Large Car Reduction in Combined CO₂ Emissions

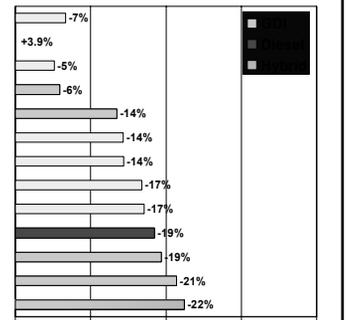


Minivan Combined CO₂ Emissions



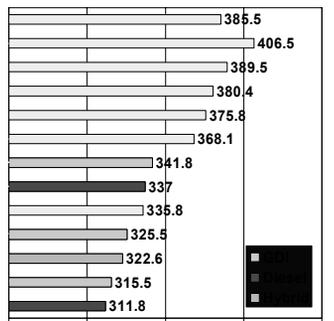
CO₂ Emissions [g/mi] 250 300 350 400

Minivan Reduction in Combined CO₂ Emissions



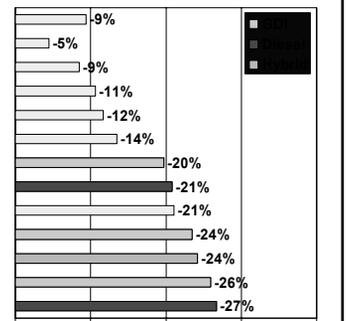
0% -10% -20% -30% -40%

Small Truck Combined CO₂ Emissions



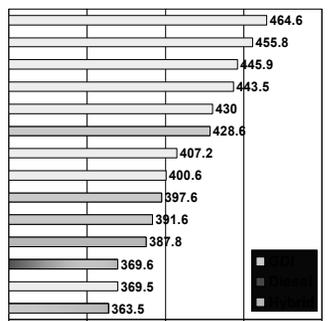
CO₂ Emissions [g/mi] 250 300 350 400 450

Small Truck Reduction in Combined CO₂ Emissions



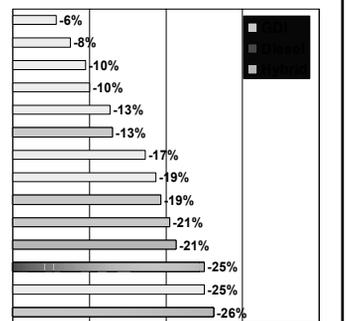
0% -10% -20% -30% -40%

Large Truck Combined CO₂ Emissions



CO₂ Emissions [g/mi] 300 350 400 450 500

Large Truck Reduction in Combined CO₂ Emissions



0% -10% -20% -30% -40%

Contact Information:

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