Federal Reserve Automotive Symposium

June 4, 2009

Agenda

– 2:00 Welcome & Overview	Dave Shemmans, CEO Ricardo plc Dean Harlow, President, North America
– 2:10 Strategic Consulting	Andy Chien, President, Strategic Consulting
– 2:25 Fuel Economy Overview	
– Total Vehicle Fuel Economy	Sandy Stojkovski, Director
– Vehicle Electrification	
– Ethanol Boosted Direct Injection Engine (EBDI)	Rod Beazley, Director
– 2:55 Questions	
– Facility Tour	Three facility tour groups

Welcome

Dave Shemmans
CEO
Ricardo plc

Ricardo Overview

Dean Harlow
President
Ricardo, Inc.

Ricardo is an Eco-innovation Technology Company Offering:

- Product Engineering/R&D
- Software
- Management Consulting

Global Client Base

Partial List

Clean Energy	Financial Firms	Oil Companies and Utilities	Governmental Agencies
NTDA, PLANET GbR, MECHANOLOGY, QinetiQ, INFINIA CORPORATION, AFS TRINITY POWER CORPORATION	GREENBRIAR EQUITY GROUP LLC, CLAYTON DUBILIER & RICE, Berkshire Partners, Baring Private Equity Partners, BARCLAYS Private Equity, 3i, ROTHSCHILD, GE imagination at work, CHARTERHOUSE, NORDIC CAPITAL, UBS	bp, ExxonMobil, npower, Duke Energy, Gaz de France, British Gas, Hawaiian Electric Company, Inc.	Institute for Energy, DTI New & Renewable Energy Programme, CARB California Air Resources Board, UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Automotive	On/Off Highway	Suppliers and Aftermarket	Defense Sector
TOYOTA, HONDA, GM, Ford, JAGUAR, FIAT, NISSAN, MITSUBISHI, DAIMLER, CHRYSLER	JOHN DEERE, CATERPILLAR, PACCAR, DOOSAN, VOLVO, SCANIA, FREIGHTLINER	DETROIT DIESEL, ZF, DELPHI, GKN, EATON, Visteon, Aftermarket Technology Corp., Honeywell	TACOM, UK MoD, de&s, ARMY, L3 communications, BAE SYSTEMS, GENERAL DYNAMICS, Pinzgauer, STEYR MOTORS, OSHKOSH, Cummins, LAND ROVER

The Ricardo Advantage

Ricardo Product Areas

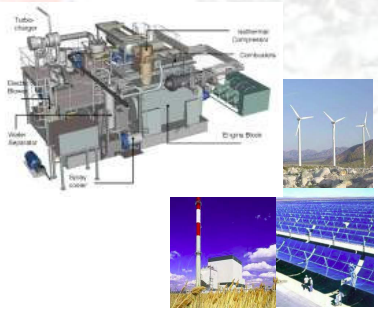
Vehicle Engineering	Hybrid Systems	Diesel and Gasoline Engines	Driveline Systems	Controls and Electronics	Advanced Technology	Clean Energy

Ricardo is on the leading edge of new technologies……

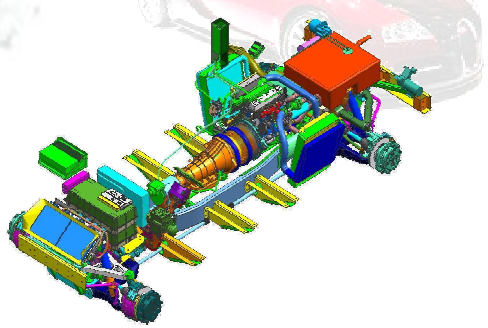
Rapid Prototypes

to here…

Efficient Power



Advanced Hybrid Systems and Battery Technology

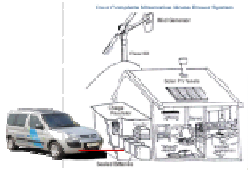


…… adapting to real world needs…….

5.7L HEMI® Engine

Bugatti Veyron Transmission

…… and looking towards the future.



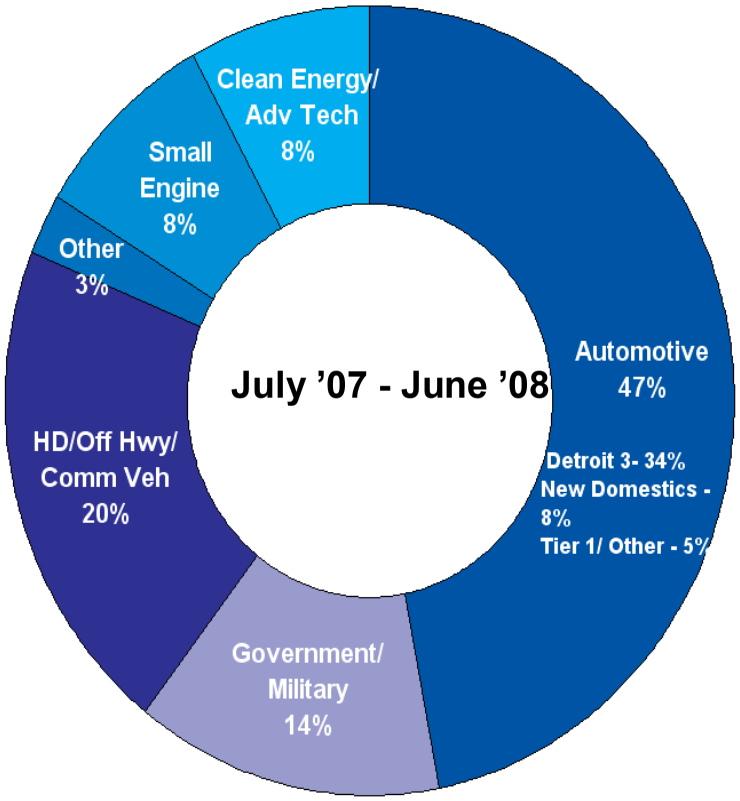
Vehicle To Grid

Unmanned Vehicles

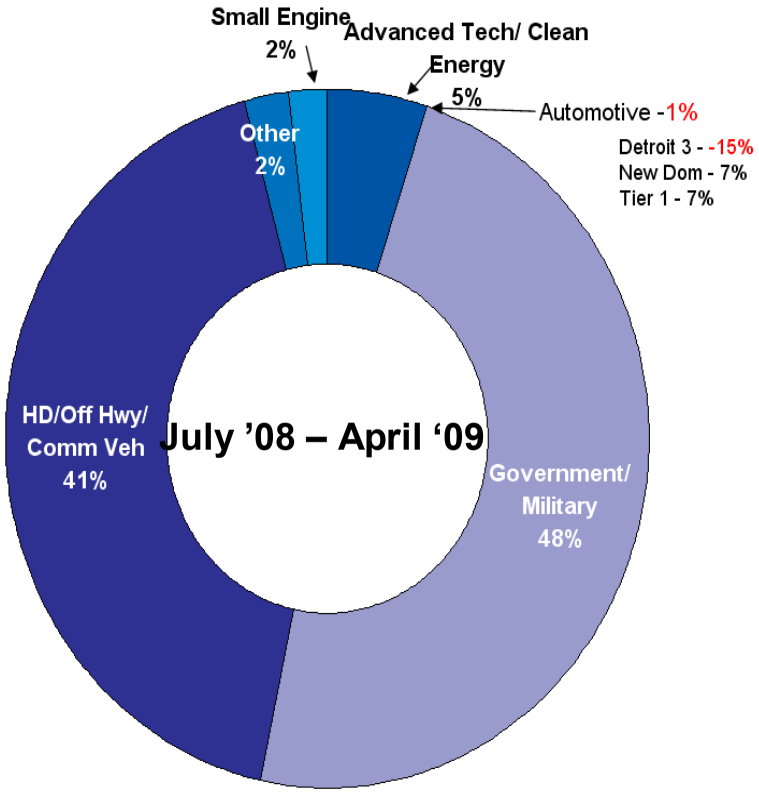
RICARDO

Automotive Has Collapsed Overnight, But Still Profitable

Prior FY Order Intake



Order Intake to Date



- Margins & Mix
- Volume
- Costs

=$ Profitability Maintained

Key Business Drivers are Strong Strategy → Go Where the Money Is

New

Global Climate Change

- Military fuel reduction agenda
  - #2 priority for ground fleet
- State legislation - Renewable Portfolio Standards
- Efficiency issues exploding in adjacent markets
- Autos still 90%+ gas
  - Downsizing, DI, turbo's, VVT, DCT's
- Fuel price spikes

CAFE/CO2 Regulations

- CAFE standards - 35% FE improvement required
- Accelerates growth of alternative propulsion
  - Vehicle Electrification - hybrid version of every model
  - $2B advanced battery pack market by 2011
- Vehicle to Grid
- Off-Hwy regulations

Government Stimulus

- $40B in DOE funding
- Oil Independence
  - 1M PHEV's by 2015
- Fuel diversity
  - Bio-fuels like ethanol – EBDI
- Clean Energy

Ricardo is in the Sweet Spot

Emerging Strategic Issues That Will Help Shape the North American Auto Industry

Andy Chien
President and Managing Director – RSC North America

On top of the macro-economic slowdown, the auto industry faces additional disruptors that will reshape the industry

Economic Volatility

- Nearly unprecedented volatility in exchange rates, factor inputs (steel, copper, precious metals) and energy impacting both costs and revenues

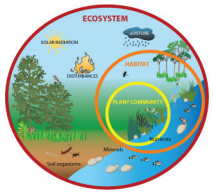
Product Mix Uncertainty

- Rapidly shifting consumer preferences and evolving federal and state level regulations leading to historic levels of product uncertainty

Future State

Sector "Ecosystem" Damage

- Automotive value chain (supply chain, distribution) severely disrupted by downturn and restricted capital flows; may constrain recovery



Disruptive Technologies

- Green (CO_2, tailpipe emissions), and energy security legislation driving accelerated adoption of disruptive technologies

Automakers need to be formulate a response to these future issues

Emerging Issues

Critical Supplier Viability	• Operational improvement support to assist critical suppliers with a particular focus on "chokepoint" suppliers with few viable alternatives due to technology or product capabilities
Portfolio Optimization	• Portfolio and technology diversification strategies to reduce risk associated with uncertain energy prices, consumer preferences, changing regulatory environment
Scalable Energy Optimized Vehicle PD Process/Practices	• Reinventing the Product Development (PD) process to facilitate the development and production of energy optimized vehicles
Product Development Cycle Time Reduction	• Dramatic product cycle time reductions to better match development times with future market volatility

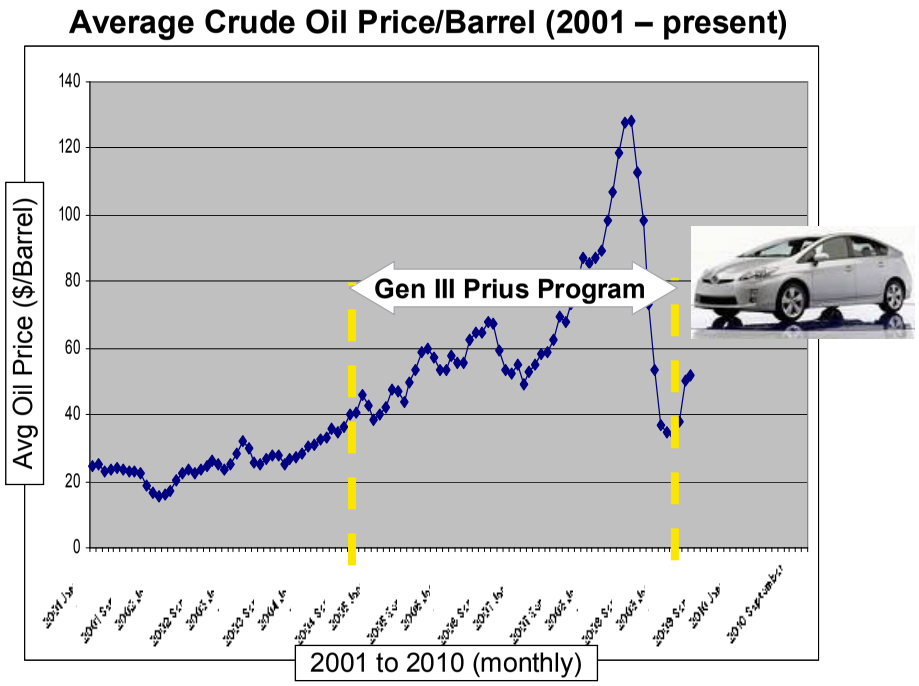
A fundamental disconnect exists between development and market cycle times, adding additional risk to the enormous cost of new vehicle development

Current Automotive Development is a High Investment, Long Lead Activity

- Average program cost
  - MY Update (~5% of content): <$10M
  - Mid-Cycle Enhancement/Minor Upgrade (~20%): $100M to $150M
  - Major Upgrade (~50%): $150M to $250M
  - New Vehicle (~90%): $500M to $1B
- Average Development time
  - Model Year Update: 9 to 12 months
  - Mid-Cycle Enhancement/Minor Upgrade: 12 to 18 months
  - Major Upgrade: 18 to 24 months
  - New Vehicle: 36 to 60 months

Direct cost of poorly developed vehicles are enormous: $24B in industry warranty costs, 10.8 M vehicles recalled in 2008

Shifts in Market Drivers Can Occur in Far Less Time



During the 54 month Gen III Prius development cycle, oil prices/barrel went from $40 to $140, and back to $36!

Source: Warranty Week, Autoloan Daily, Japan Times, EIA, Ricardo Analysis

As automakers regroup and seek competitive advantage, cycle time reduction needs to be aggressively addressed

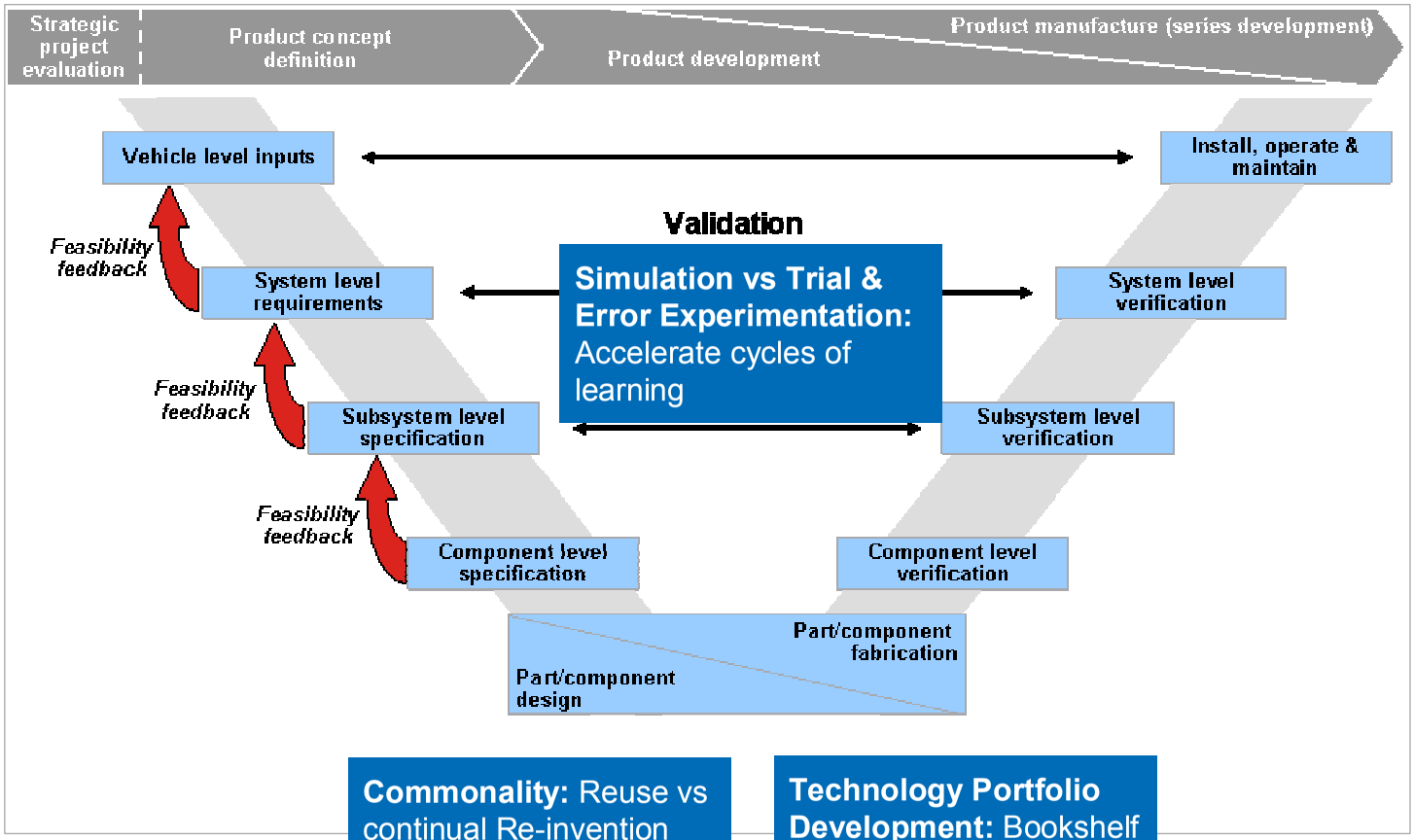
New Product Development ("V-Model") Cycle Time Reduction Levers

Evolutionary Development: Singles/ Doubles vs. Home Runs/Grand Slams

Resource front loading: Build the blueprint and execute to it

Requirements Optimization: Eliminate waste from over/under specification

Earlier Supplier Integration: Pre-selection and early co-development



Commonality: Reuse vs continual Re-invention

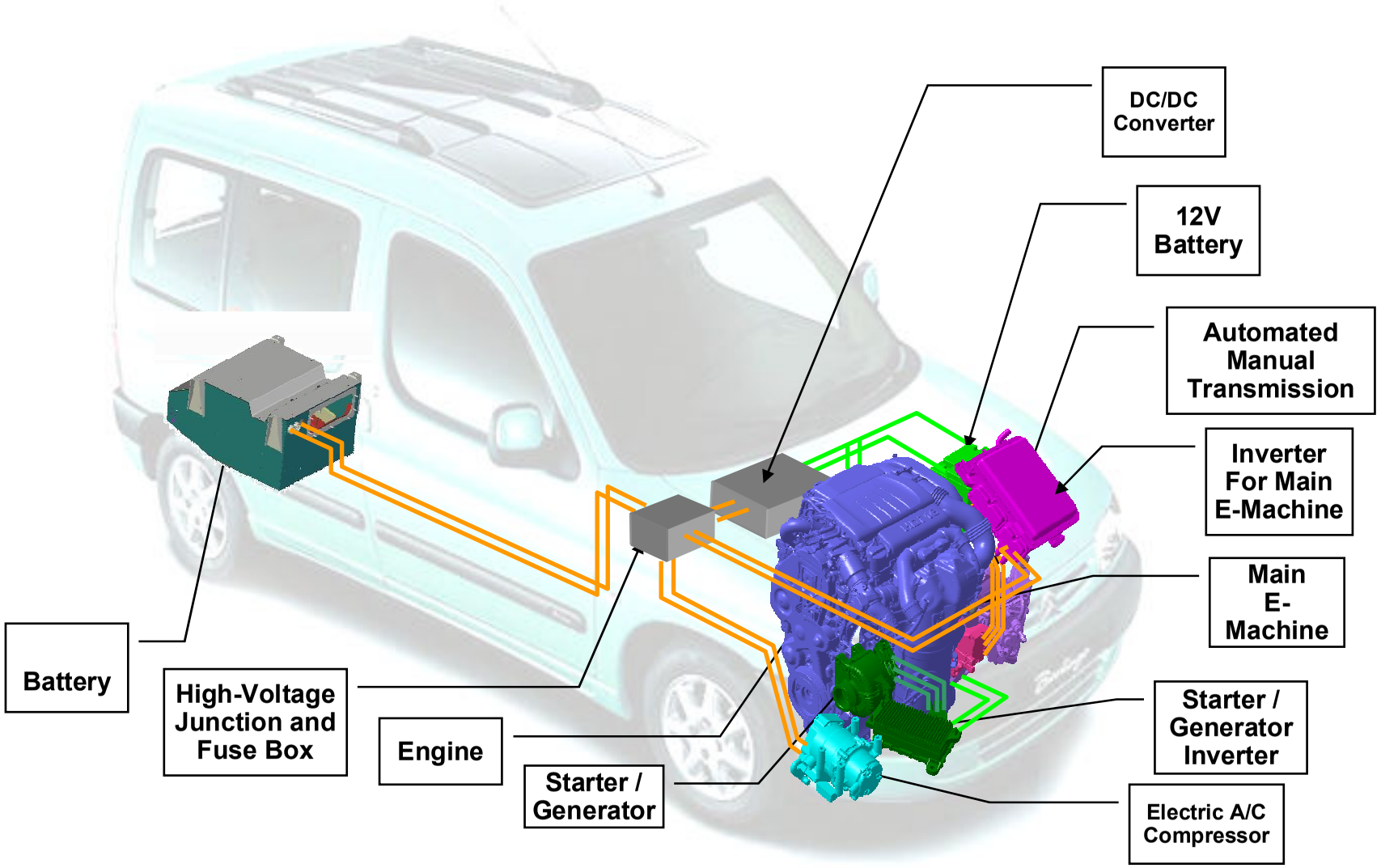
Technology Portfolio Development: Bookshelf production ready technology

Total Vehicle Fuel Economy

Sandy Stojkovski
Director

Vehicle Electrification

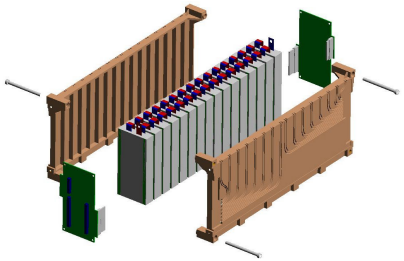
Hybrid and Electric Vehicles are Completely Electrifying the Vehicle



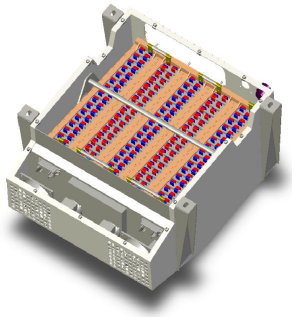
Batteries are Key to the Electric Vehicle Solution

- Complete, outsourced battery pack design and integration
- Seamless extension of customer's battery system development
- Evaluation in our Battery System Development Center

Cells



Modules



Packs

Vehicles

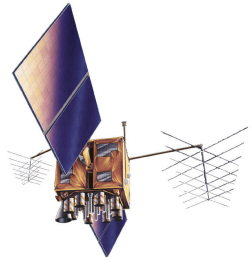
A new generation of electronic technology is required to help meet these challenges

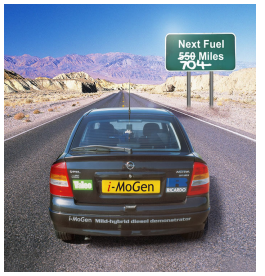
Improving Road Safety

Cutting Emissions/ Pollution

Reducing Congestion

- **Recent advances in Electronics technology provides increased information**
  - GPS / Map systems for navigation, Long and Short range radar, RDS/TMC Traffic info, Telematics information…
- **These systems can be used to improve Environmental Performance:**
  - Reduction of Fuel Consumption, CO_2 emissions and Pollutant emissions via better powertrain control
  - The more flexible the future powertrain, the bigger the potential gain..
- **They can also provide information for improved Safety…**
  - Warnings for Proximity, Lane Departure, Adverse Conditions, Approaching Hazard; Inputs to Stability Control / Active Chassis programs
  - Possible future source of information for Safe Driving Enforcement and Automated Accident Avoidance
- **Congestion can be reduced by better traffic management & reducing accidents.**





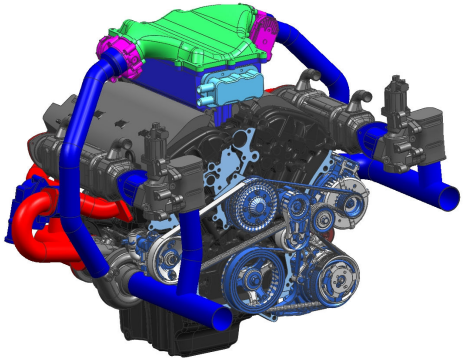
Ethanol Boosted Direct Injection Engine "EBDI"

Rod Beazley
Director

Ricardo Ethanol Boosted Direct Injection (EBDI®)
Research Engine

Environment

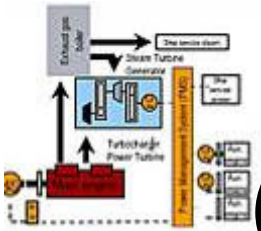
Reduce CO_2 Emissions



Future Engine Challenges - Drivers of Change

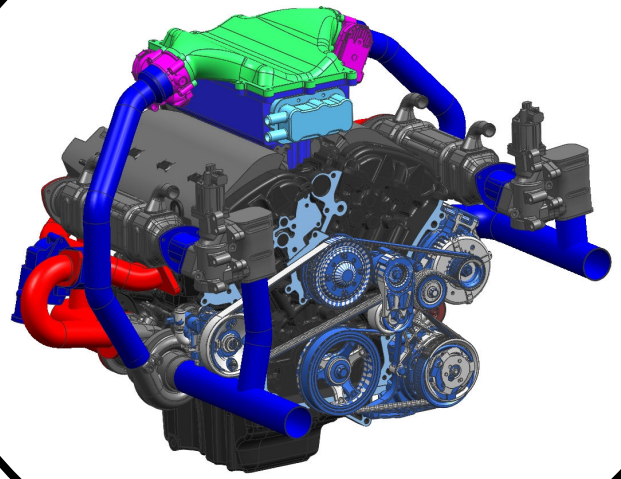
FUEL

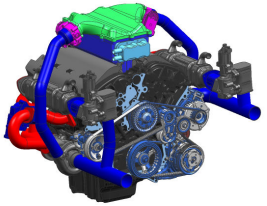
Diesel vs gas cost differential
Variability / Volatility of fuel costs
Availability of alternative fuels

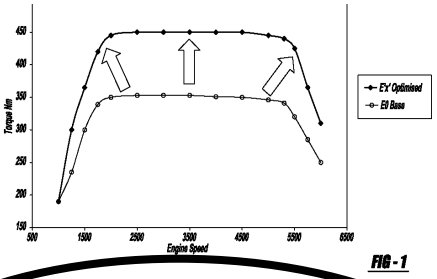


Technology Advancement

Emissions driven aftertreatment complexity
Gasoline / SI efficiency advancement
Waste heat recovery

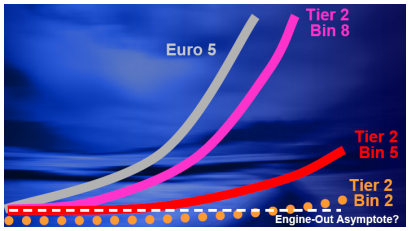






Emissions Legislation

Tier 4
Retrofit emissions
2010
$C0_2$ legislation



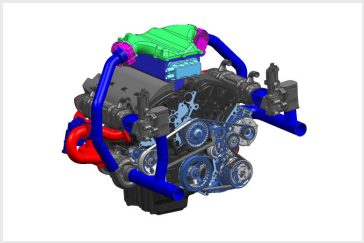
Increasing Customer Demands

Cost reduction
Reduced cost of ownership
Increasing engine output

Downsizing = "Doing More With Less"

Ethanol Boosted Direct Injection (EBDI)®

EBDI= EXTREME Downsizing



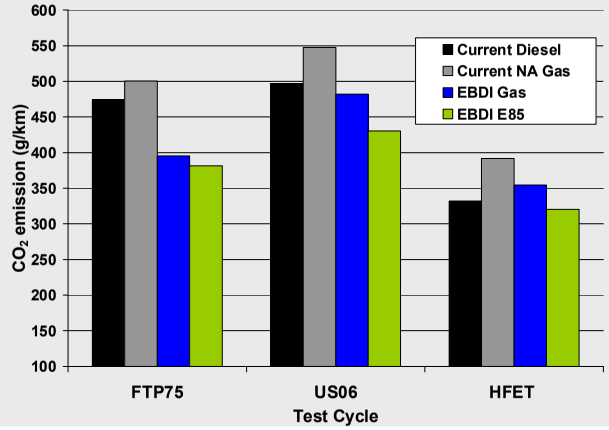
Fuel economy improvement solutions for multiple applications:

- Passenger cars
- Truck and medium duty vehicles
- Off road applications: Agricultural and Construction

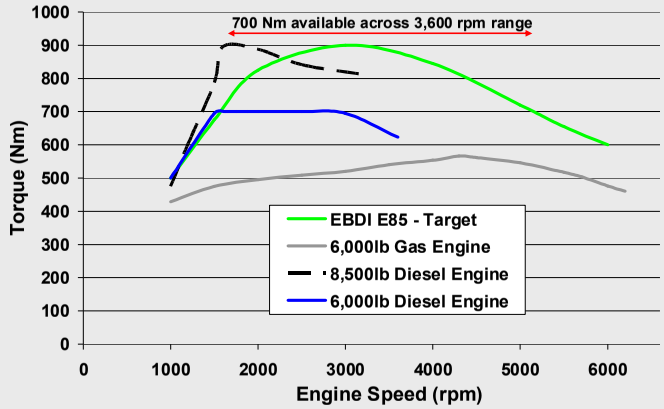
A scaleable SI engine technology package

3.2L Spark Ignited engine running on E85 ethanol with performance of 6-7L Diesel engine
Fully flexible powertrain optimized for operation on standard pump gasoline to E85

Vastly Reduced CO_2 Emission



Unprecedented Spark-Ignited Performance



BEHR BOSCH DELPHI FEDERAL MOGUL Honeywell

DELIVERING VALUE THROUGH INNOVATION & TECHNOLOGY

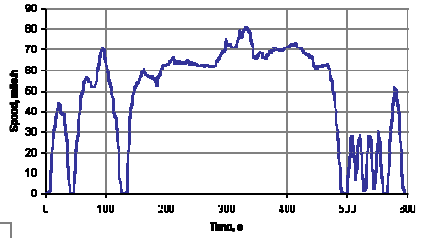
DELIVERING VALUE THROUGH INNOVATION & TECHNOLOGY

www.ricardo.com

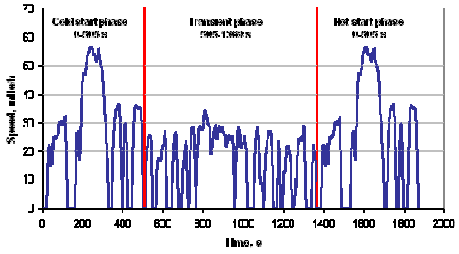
EBDI® – Regulated Cycle CO_2 Reduction

- Initial simulation performed on 8,000 lb truck shows excellent results for the EBDI® concept
- Further improvement potential with final drive ratio adjustment

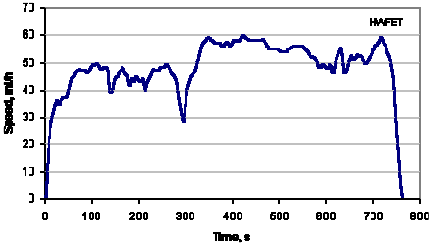
US06

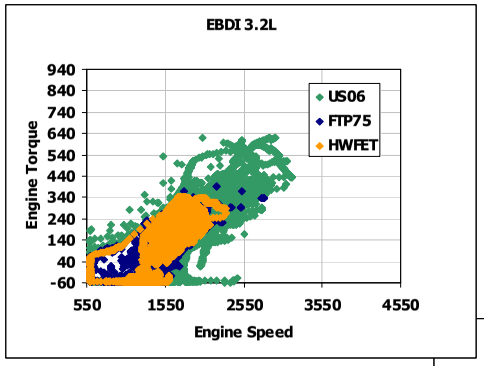


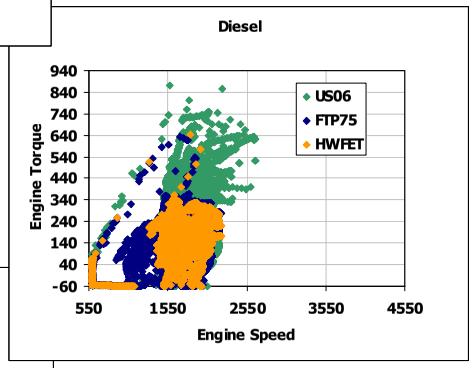
FTP 75

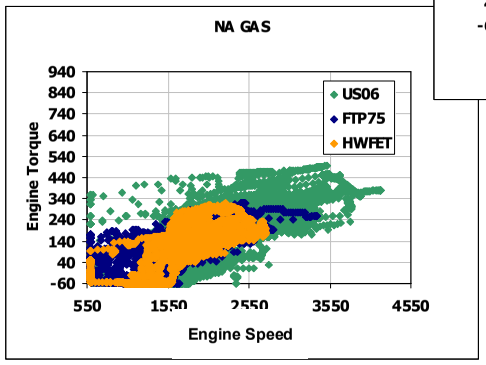


HWFET

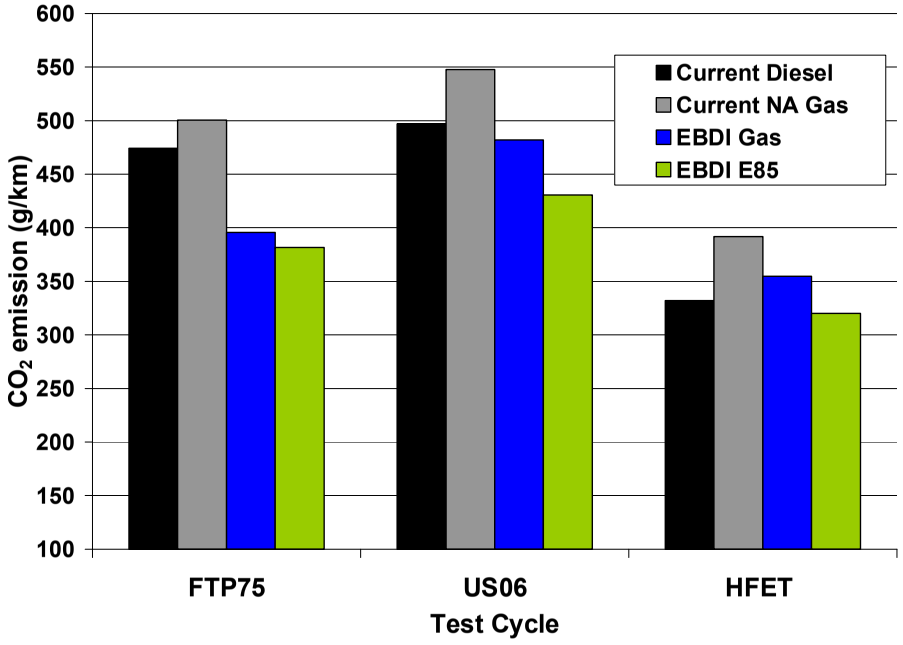








Transmissions		
Gasoline	Diesel	Ratio
4.027	3.1	1.30
2.364	1.81	1.31
1.532	1.41	1.09
1.152	1	1.15
0.852	0.71	1.20
0.667	0.61	1.09



Thank You