Ricardo Plc - A Framework For Success

TORQUE VECTORING™

Presentation For:
omotive World Conference, London, October 2007

Since it inception Ricardo has continuously developed innovative solutions and technologies to global appraise across the automotive, off-highway and commercial vehicle industries

1900 to 1900

- In 1905 Harry Ricardo launches the "Two Stroke Engine Company"
- Harry Ricardo designs the worlds first successful 150hp Tank engine
- Ricardo develops the Octane Rating scale for Shell
- Ricardo develops & patents the Comet IDI Diesel combustion system
- Works with Frank Whittle during development of the Jet engine
- FFD Designs and Patents the Viscous Coupling for 4WD systems
- Voyager uses a Ricardo designed engine to fly non-stop around the world

2000 onwards

- Ricardo Design & Manufactures the Bugatti DCT Transmission & Drivetrain
- In conjunction with PSA Ricardo develops the world first Diesel Hybrid
- Ricardo supports the JCB DieselMax land speed record car

At the heart of our innovation is the Technology Roadmap Process (TRP). TRP is a key business tool that clarifies debate over the shape of the future whilst encouraging better Corporate Technology Processes

TRP provides a vision of

- WHY new technology is needed: Market drivers, legislation, business trends, consumer preferences etc which impact the need for new technology
- WHEN each new technology step is needed: and by implication when product development, advanced engineering and fundamental research etc have to start in order to be ready
- WHAT new technology best meets these needs: supported by comparison of cost/benefit, development of technology evolution visions, portfolio gap-analysis etc

Separates innovation from product development

- Best practice is to pre-develop next evolutionary or revolutionary technology steps separate from new product engineering
- Technology must pass an "implementation ready" gateway before entering product program
- Product program risk significantly reduced – engineering effort can focus on delivering a good value, quality product on time not making technology work!

Technology Roadmap → Technology Acquisition → New Product Development → Manufacture and Supply → Customer

5-10 years!

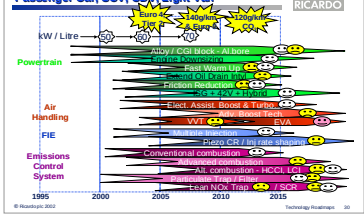
Ricardo delivers world class strategy, engineering and technology programmes (engine, transmission and vehicle) to the leaders in the global automotive industry always focusing on customer profitability

- 2007 Revenue of £171.5m
- Global outreach with engineering centres & customers across US, Europe & Asia
- Corporate, business unit and product strategy
- Powertrain, Vehicle and systems integration engineering
- Research
- Advanced MY programmes and post SOP support
- Volume passenger car
- Niche performance vehicles
- Motorcycle
- Motorsport
- Off highway, Commercial and Heavy duty
- Leading edge technology, support and programme delivery
- Focus on delivering great products while reducing time and cost

Insert slide to describe what we do, how we use technology etc and why it core to our business – bridge previous and next slide.

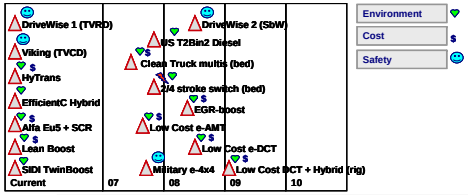
A high level Roadmap identifies key strategic issues for a given sector from market drivers down to sub-system level components

2002 TRP for European LDD



- Basic time-line format (like a Gantt chart)
- Key market drivers & megatrends identified
- "Faces" indicate state of knowledge or capability
- Horizontal bars identify
  - First application of the technology
  - Technology universal or saturated
  - Technology obsolete or mature

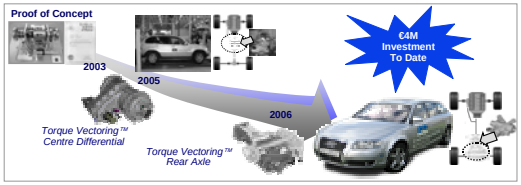
Future technologies to meet legislation and tackle climate change are at the centre of our research activity. Automotive safety technologies are also being developed from an increasing R&D spend



Future Technologies

- **Powertrain: Clean Diesel, Efficient Gasoline, Hybrids, Advanced Auto Transmissions**
  - Comprehensive portfolio of fuel efficient low carbon technologies for global markets
- **Active Safety and Dynamics: Torque Vectoring and Steer by Wire**
  - Now one of our fastest growing areas of investment return

Ricardo Torque Vectoring™ technology provides class leading vehicle dynamic enhancement consistent with next generation premium brand requirements and is a successor to LSD & ELSD

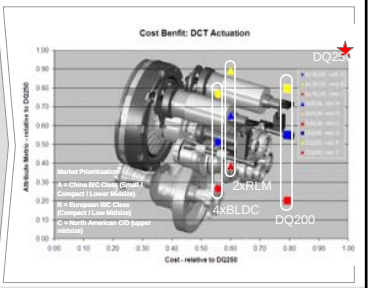


Ricardo DriveWise

- Uses Ricardo's patented Torque Vectoring™ arrangement with 2 x 200Nm wet multiplate clutch packs
- Incremental weight over passive LSD mechanicals ~5kg for 750Nm transaxle application
- Ultra compact design with minimal changes to existing package
- System Capability: Designed for 5000Nm input torque, Wheel speed (left and right) Δ = 20 %, Cross axle torque Δ achievable = 1400 Nm, Electro-hydraulic or electro-mechanical actuation

Future alternative transmission choices will emerge and force adoption of new technologies. Our eDCT programme capitalises on new technologies in order to bring low cost DCT to the mass market

- By 2020 customer attribute focus for transmissions will concentrate on fuel efficiency and shift quality
- Gap analysis of automated transmissions identifies the need for a low cost automated powershift transmission for B/C Segments
- Ricardo are developing eDCT for:
  - Transverse FWD installation
  - Input Torque: 200Nm
  - 6/7 Forward Ratios + 1 Reverse
- Key technologies
  - Linear Electric Actuator (2002)
  - Multiplexed actuation (2004)
  - Roto-Linear Actuator (2007)
  - Cooled Dry Clutch
- Results (Simulated): 7.5% fuel efficiency improvement & 21% Cost Saving relative to DQ 250



Whether a production programme, collaborative research or a technology demonstrator, Ricardo has a track record delivering programmes that set the pace of automotive technical development

HyTrans

- A collaborative R&D programme to demonstrate possible performance of low cost hybrid vehicle technology
- Includes Stop/Start technology, regenerative braking, 42V B-ISG
- Fuel consumption benefit of 15-25% over urban delivery cycle
- No reduction in payload
- Partners included: Ford, Valeo,Gates

EfficientC

- Full-hybrid diesel demonstrator developed with PSA & QinetiQ for UK Ultra Low Carbon Car Challenge
- 99 g/km CO2 (equivalent to 75mpg+)
- 30% improvement in CO2 vs. baseline production vehicle
- State of the art 288V Li-Ion battery system
- Advanced supervisory control system using Ricardo rCube controller

- "DI Boost" – US Gasoline Direct Injection V6 turbo demonstrator
- Joint collaborative R&D programme with Bosch, with Ricardo responsible for engine development and base engine calibration
- Demonstration of twin turbo G-DI GM Global V6 compared with 5.7l V8 in same vehicle
- V8 performance at SULEV with 10% fuel economy gain

?

- Tier 2 Bin 2 Emissions Programme
- Integration of latest engine & aftertreatment technology for SULEV Emissions & Maximum Driver Appeal
- Objectives include development of advanced air handling technologies, combustion systems capable of HPCC, integrated aftertreatment systems and in-cylinder combustion control
- Project conducted in collaboration with Global passenger car OEM

Ricardo's early innovation enabled it to become the worlds leading independent specialist in Dual Clutch Transmission (DCT) technology and its involvement in over 25 DCT projects

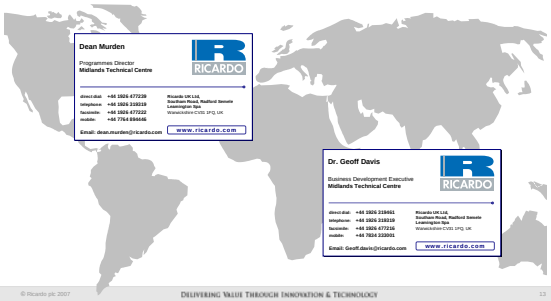
Niche Market Application - Bugatti Veyron

- Key Issues
  - Turnkey project with leading edge technology
  - Aggressive timing from concept to prototype
  - Mechanical driveline and software integration
- Ricardo Responsibilities
  - Concept design and development of transmission and driveline system
  - Manufacture of prototype and pre-production units
  - Full transmission and driveline control software system, including active rear axle
  - Design and engineering of advanced TCU
- Results Delivered
  - On target performance and delivery
  - Leading edge design solution for mechanical and software elements
  - Excellent press feedback on transmission performance

Summary

Some of our other activities…

Contact details



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