

附件一 WDL 公司簡報

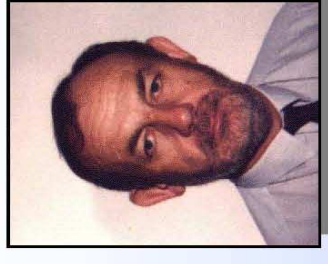


WDL

Powertrain Systems Engineering

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Overview



- WDL was formed in 2000 by Chris Whelan, a Mechanical Engineer with wide-ranging Automotive, Power Generation, Aerospace & Motorsports experience
- WDL offers a wide range of power-plant & powertrain design & analysis services
- We specialise in engine thermo-fluid systems design, analysis, test & development
- We have a client base of automotive OEMS, Tier 1 Suppliers & other engineering services providers
- By careful & selective partnering we are able to provide 'total solutions' to our customers

Activities



POWERTRAIN

- Base Engine Analysis
- Loading Calculations
 - Durability
 - Coolant Flow
 - Weight Optimisation
 - Noise/Vibration/Harshness
 - From <1kW to 500kW

Components

- Main Structure
- Running Gear
- Valvetrain
- Transmission
- Intake / Exhaust Flow
- Intake / Exhaust NVH

VEHICLE SYSTEMS

- Durability
- Noise / Vibration
- Hybrid Components (Electric Motors)

OTHERS

Materials

- Metallic
- Composite
- Plastics

Bespoke Software

- Tailored to Client Needs
- Full Support
- Windows / Unix

Expertise

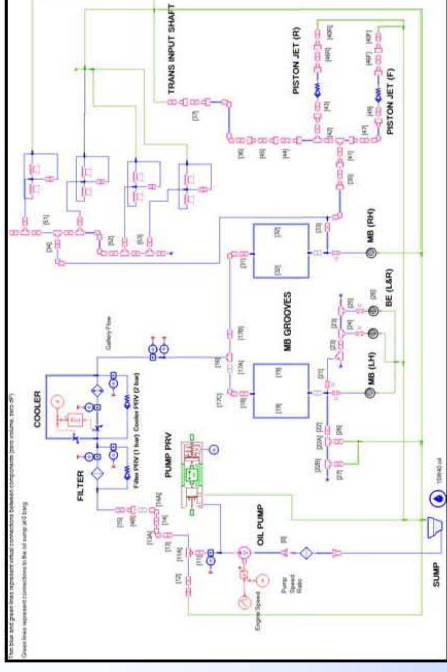


- Thermo-fluid systems
- IC engine performance & emissions
- Cooling & lubrication systems
- Air management & EGR systems
- Technology Strategies
- Programme planning & management

Capabilities



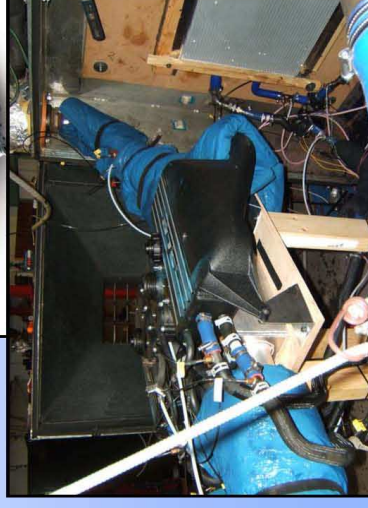
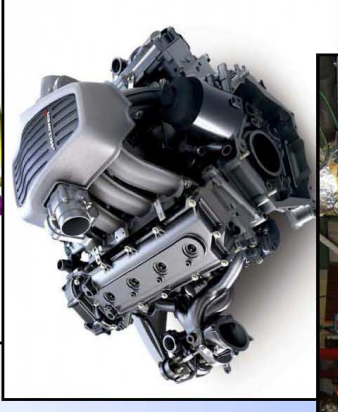
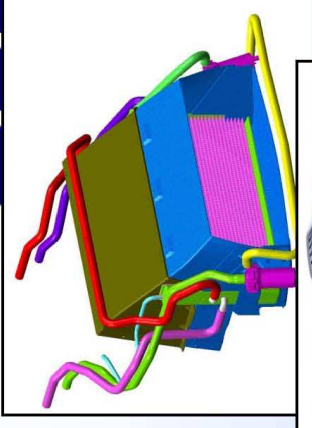
- Design:
 - Thermo-fluid systems
 - Heat exchangers
 - Turbo-machinery
 - Control systems
- Analysis:
 - 1D IC engine performance (AMESim, WAVE, GT-Power)
 - 1D thermo-fluid systems (AMESim, s/state & dynamic)
 - 3D combustion simulation (AMESim)
 - Heat exchanger performance (WDL code)
 - Turbo-machinery performance (AMESim, WDL code)
- Manufacture:
 - Prototype fluid system components (partner)
- Test & Development:
 - Component/system test & analysis (partner)



Powertrain

- Activities:
 - Performance modelling
 - Design definition
 - Emission systems analysis & specification
 - 1D Mechanical Analysis
 - Gasoline to diesel conversion
 - Cooling systems
 - Vehicle performance
- Completed Projects:
 - Integrated hybrid powertrain concept
 - Automotive diesel uprate study
 - 1D drivetrain mechanical analysis
 - Full vehicle cooling design & analysis
 - Water-cooled charge cooler design
 - Variable speed supercharger drive

WDL

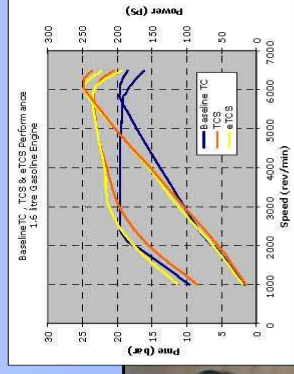
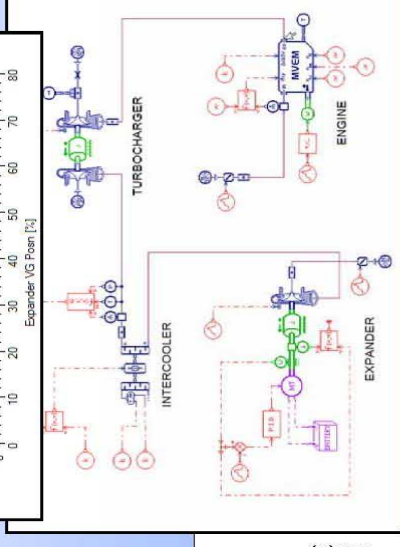
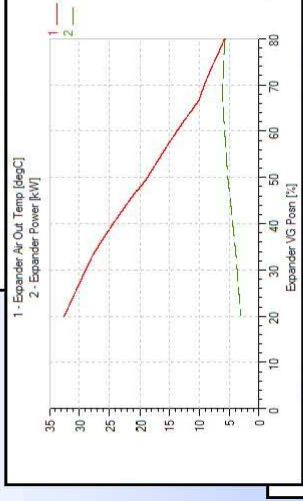
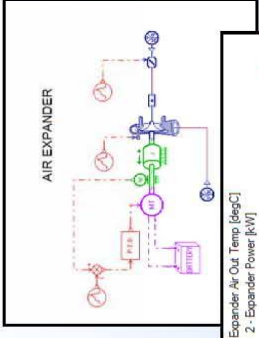


Air & EGR Systems



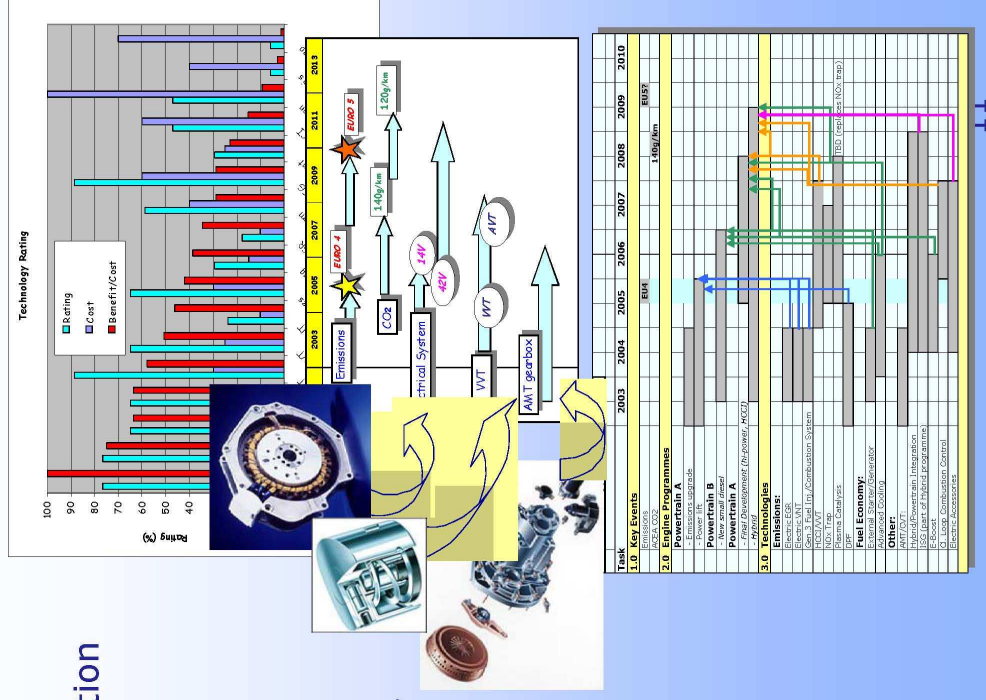
- Activities:
 - Performance modelling & design definition
 - Turbo-expander system design
 - Combined boost/charge cooling system specification
 - EGR cooler & system design
 - Heat exchanger design & development

- Completed Projects:
 - Intake turbo-expansion system concept
 - 2-stage boosting studies
 - Low temperature EGR cooler system matching
 - Integrated charge-air/EGR cooling concept
 - EGR cooler anti-fouling & corrosion resistance project
 - Tri-generation cold air concept



Strategic, IP & Collaborative Work **WDL**

- Activities:
 - Technology strategy mapping & selection
 - Collaborative programme consortium organisation
 - Patent development & support
- Completed Projects:
 - Technology assessments
 - Diesel powertrain technology strategy
 - Multi-boosting system study
 - 6 joint patents
 - After-treatment system programme management
 - Marketing strategy for new boosting technology



Typical Projects



	Customer
IC Engines: <ul style="list-style-type: none"> • Off-highway Diesel Tier 3/4 EGR system modelling • Gasoline > diesel feasibility study simulation • Advanced boosting systems study • Crank system vibration studies 	OEM OEM Tier 1 OEM
Powertrain Systems: <ul style="list-style-type: none"> • Cooling & lubrication simulation ~ automotive diesel • Charge air cooling system, high performance vehicle • 2-stage boost system & charge cooling • New concept micro-wave regenerated DPF 	OEM OEM OEM/Tier 1 OEM/Supplier
Components: <ul style="list-style-type: none"> • Combined EGR/CAC concept • Water-cooled charge cooler • EGR related IP • Heat exchanger internal coatings • Cooling component product development 	Tier 1 Tier 1 Tier 1 Tier 1 Tier 1/OEM
Other: <ul style="list-style-type: none"> • New concept compressor/expander • Exhaust energy recovery systems • Air-cycle cooling systems • Turbine design concepts • Brayton cycle concepts 	OEM Consultant WDL/UK Gov't WDL/UK Gov't Consultant



Overview of CAE at Advanced Analysis

Author: Richard Tyrrell

Advanced Analysis Ltd, Forsytes, The Street, Bury, West Sussex RH20 1PF
01798 839005

People



- **Richard Tyrrell, Director:**
 - 32 years engineering consultancy, 30 of these in analysis:
 - CV includes Ricardo, Lotus, Automated Analysis Corp.
 - Extensive technical management, analysis execution, software development experience
- **Jesus Blanco:**
 - 15 years engineering consultancy
 - Specialist in NVH analysis, noise reduction methods
 - Experienced user of ABAQUS, FEMSYS, COMET/Acoustics
- **John Concannon, Katie Evans:**
 - 8 + 6 years engineering consultancy
 - Experienced ABAQUS, FEMSYS, CATIA users

Facilities & Capabilities

SOFTWARE

Pre/Post Processing

- CADfix
- Abaqus/CAE
- FEMSYS
- Hyperworks
- FE-SAFE (Fatigue)
- In-House Software
e.g. Thermal BC's, Crank loads; Bore distortion, fatigue, noise

Solution

- Abaqus
- Hyperworks (Nastran)
- COMET/Acoustics
- MathCad
- Matlab/Simulink

HARDWARE

Computer Systems

- High Performance Workstations (XP, W7)
- 1x Main solver Machine (120GB RAM/ 16x3.2GHz)
- Offices all ADSL connected on VPN
- Secure ftp site

Via 3rd Party Partners

- WAVE, FLOWMASTER, AMESIM, GT Power
- STAR-CD/CCM+, FLUENT,
- SOLIDWORKS
- CATIA V5



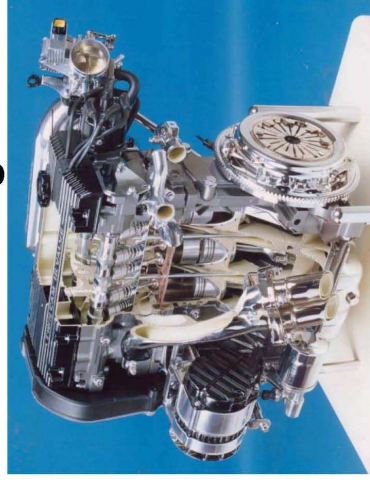
Clients

- Some current clients:
 - AET Ltd
 - Deutz AG
 - Jaguar Landrover
 - Powertrain Technology Ltd
 - Protean Electric Ltd
 - Shanghai Auto Ind Co
 - RCV Engines Ltd
 - Triumph Designs Ltd
- ... plus others.

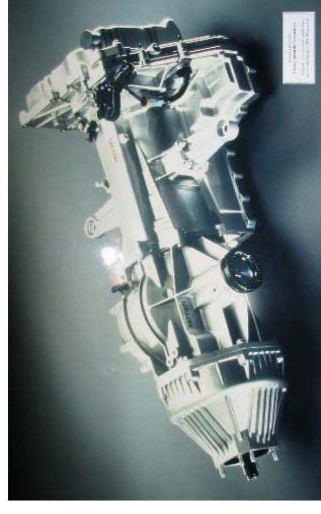
Company Profile

RDSE

RDSE was formed in 2008 by Roger Stone, a mechanical engineer with very wide powertrain experience throughout the automotive manufacturing industry



- Engine Experience:
 - Gasoline and diesel
 - Production engine programmes from Concept Design to Production
 - “Continued Engineering” – cost reduction, warranty actions, face lifts etc
 - Product strategy derivation and promotion
 - New technology development, prototyping
 - Troubleshooting
 - Project management
- Transmission Experience
 - Supercar planetary automatic introduction
 - Toroidal IVT/CVT development

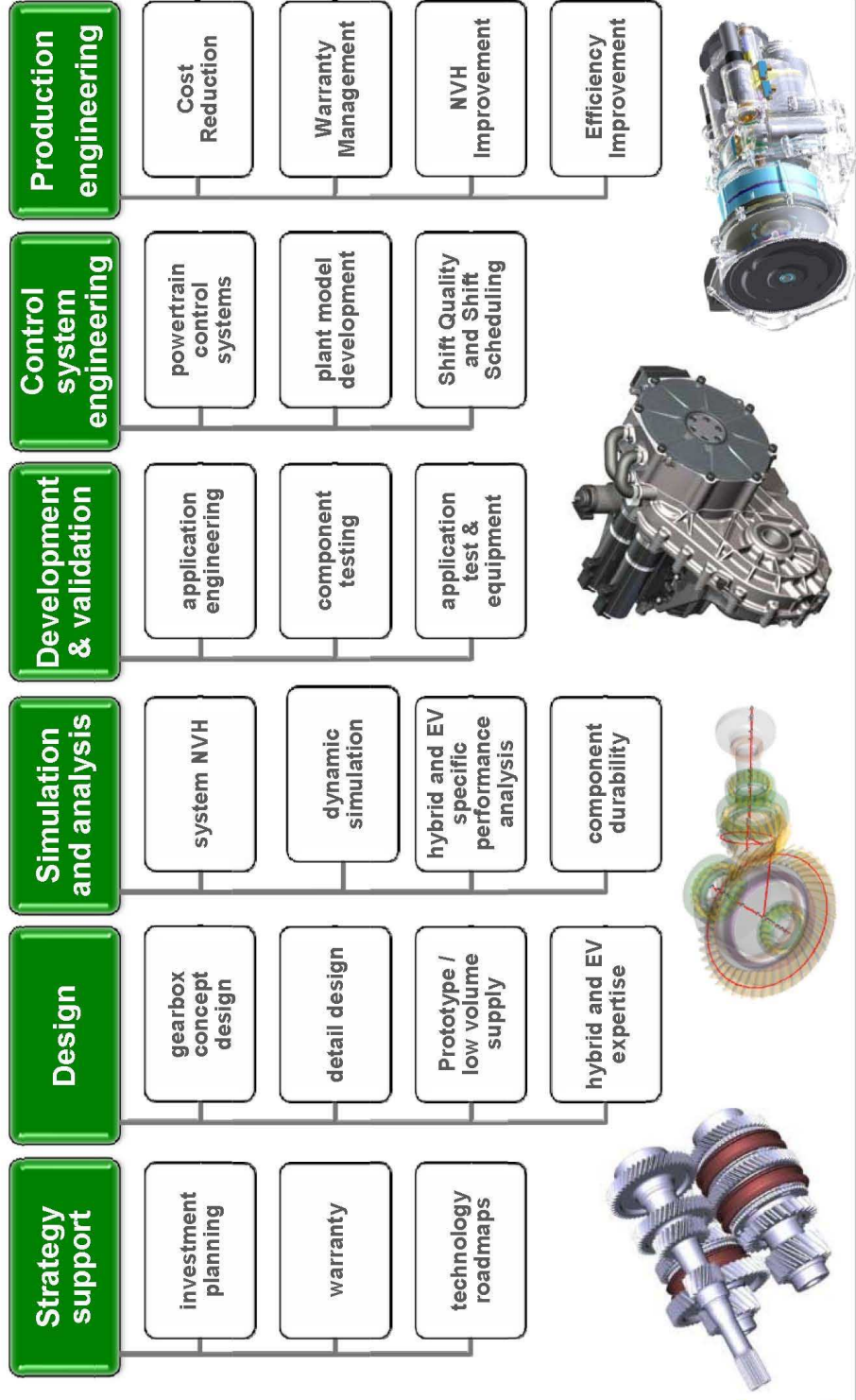


- Providing programme management and engineering advice to Camcon Automotive in the development of their innovative camless valve train system plus other applications for their zero power latching systems.
- Providing support to a major automotive materials supplier in order to help them understand the trends and underlying drivers for changes in the global automotive industry.
- Acting as a consultant to a small automotive supplier, now directly supplying a major OE in a niche market, to help them develop engineering systems consistent with a Tier 1 role.
- Providing engineering support for a leading supplier of LCV conversion kits used by many fleet operators across Europe.
- Advise a market leading European system supplier upon strategy and technical approaches for the introduction of modular systems into their product range.

Drive System Design



Company Presentation



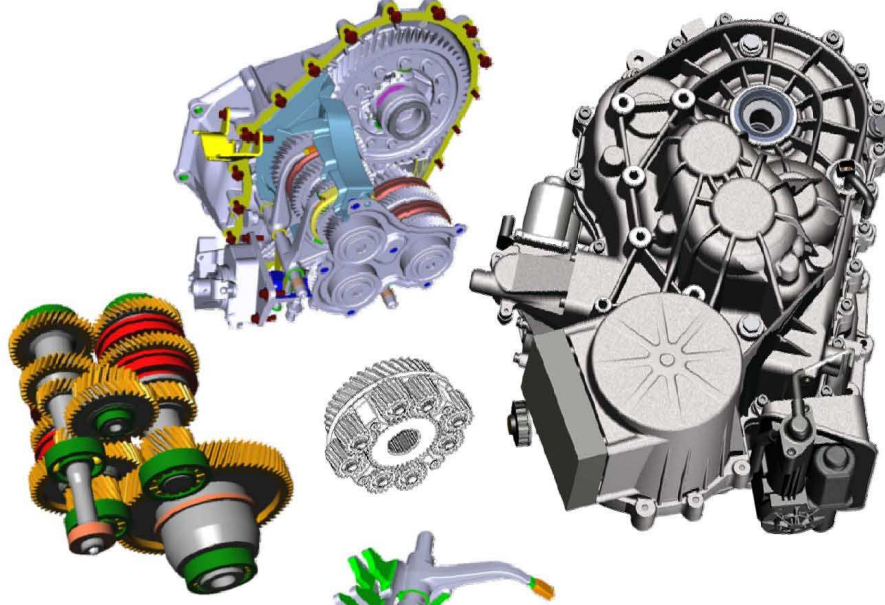
Fast Efficient Transmission Design

Concept

- Very powerful concept design tool chain
- Analysis driven design
- Avoids need for iterations
- Benchmarks for attributes

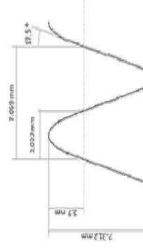
3D CAD systems

- Designer starts with scheme with gears, shafts, bearings etc. accurately predefined
- CAD Integrated dynamics and FEA
- True 3-dimensional scheming



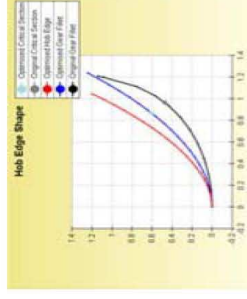
Gear Tool Optimisation

- Improvement of gear bending strength by at least 10%



Bevel Gear Design

- including machine settings for contact pattern development
- Efficiency effects of gear loads and surface sliding velocities considered
- Loaded Transmission Error incl. casing stiffness



Synchroniser Design

- Family Definition
- Concept / Production Design
- ENGAGE software
- Brass, Sintered, Carbon

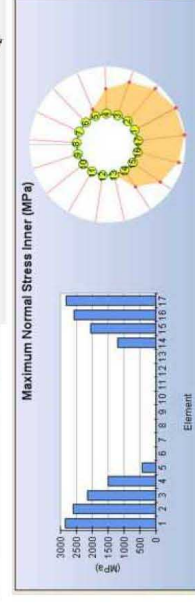


ENGAGE Synchroniser Design

Number of active cones	3
Counted	
Friction coefficient	0.036
Core angle	7
Teeth number	157
Teeth angle	15.7
Module angle	50
Engagement angle	50
Hub inertia	0
Shaft inertia	0

Low Volume Bearing Profile Customisation

- Specification of raceway profiles



Manufacturing Method / Process Definition

- Volume specific process
- Shafts (Forging, Turning)
- Gears (Hobbing, Shaping, Shaving, Grinding)
- Synchronisers (Pressings, Forgings, Sintering)
- Shift Forks (Fabrication, Forging, Casting)
- Casings (Sand Cast, Gravity die cast, Pressure die cast)



Production / Low Volume Supply

- Qualified Suppliers
- Concession Management
- Stock Management
- Build Process Definition
- Conformity Certification
- PPAP



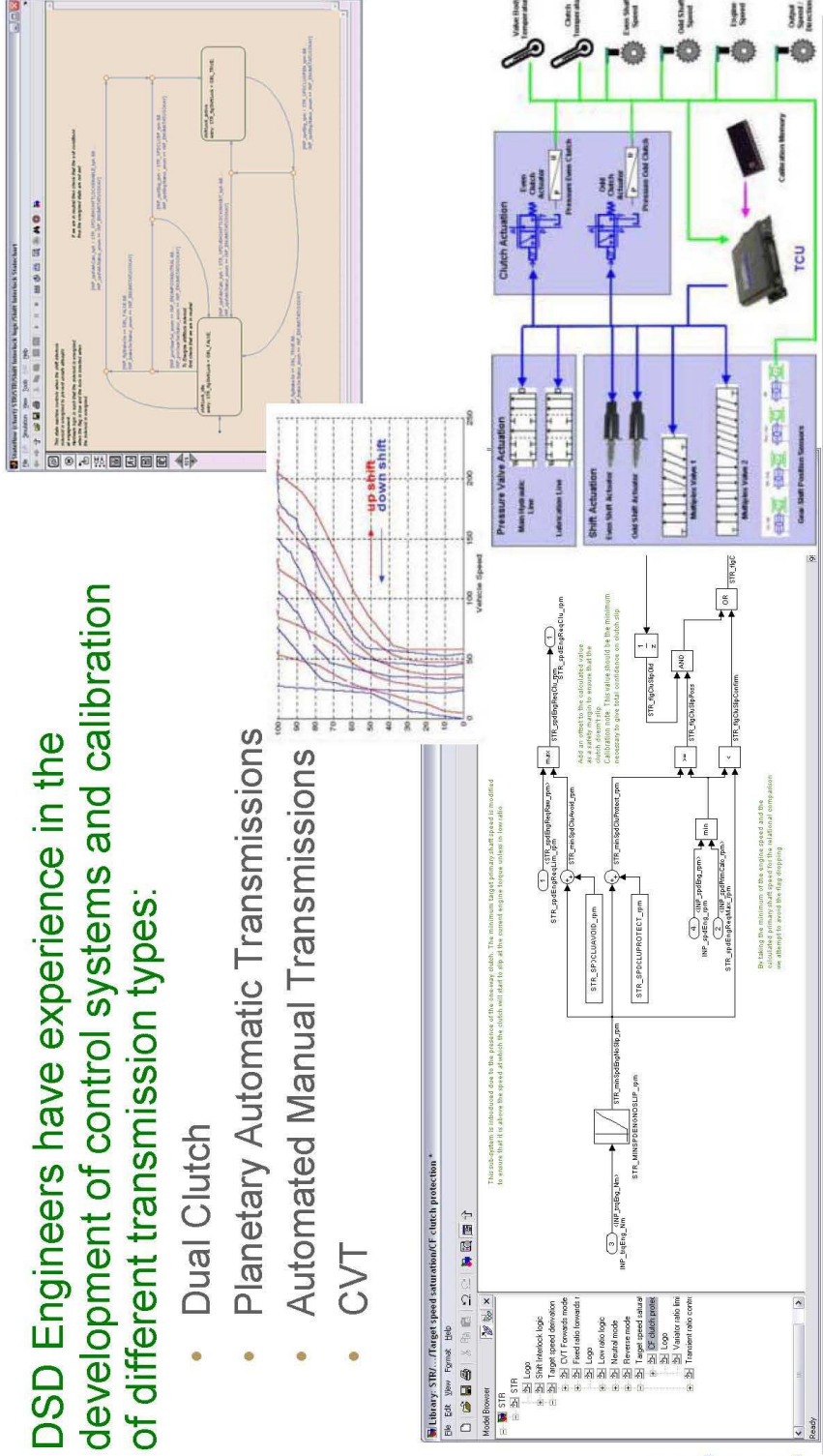
Piece Price Estimation

- Process step estimation
- Volume Piece price estimation



DSD Engineers have experience in the development of control systems and calibration of different transmission types:

- Dual Clutch
- Planetary Automatic Transmissions
- Automated Manual Transmissions
- CVT



The screenshot displays a Simulink model for clutch protection. The main window shows a block diagram with several control blocks: 'STR_SPC_LIM', 'STR_SPC_CLAWDIP', 'STR_SPC_PROTECT', and 'STR_SPC_UPDOWN'. A graph in the center shows 'Vehicle speed' (0-250) versus 'Clutch Temperature' (100-200), with 'up shift' and 'down shift' regions indicated. A hardware diagram on the right shows 'Clutch Activation' and 'Pressure Valve Activation' components connected to a 'TCU' (Transmission Control Unit). The bottom status bar shows 'Ready'.

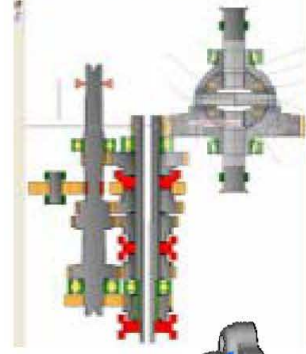
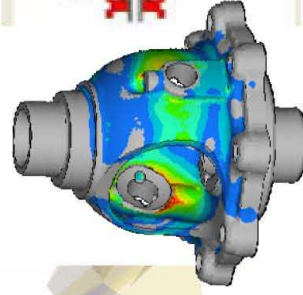
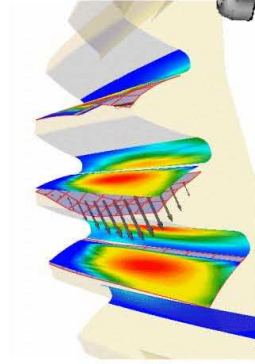
Durability Attributes

- Gears ISO 6336 load distribution factors
- Bearings DIN / ISO 281 A4 incl. derating for mis-alignment
- Shaft fatigue using FEA
- Splines rated for normal and shock

incl.



	Allowable Stress	Max Shear	Safety Factor
Input Shaft Clutch Spline	1180	406.19	2.91
3rd/5th Pinion Spline	1180	116.40	10.14
4th/6th Pinion Spline	1180	163.62	7.21
1st/2nd Synchroniser Hub	1180	218.61	5.40
3rd/4th Synchroniser Hub	1180	144.11	8.19
5th/6th Synchroniser Hub	1180	93.65	12.60
Rev Synchroniser Hub	1180	147.81	7.98



Multi-stage approach to Gear Whine

- 1 – Shaft Bearing System transmission error
- 2 – Transmission System transmission error

- Includes Casing Stiffness with CMS
- Bearing accelerations with waterfall plots

3 – Radiated Noise

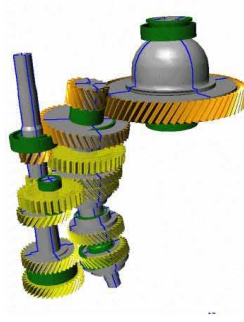
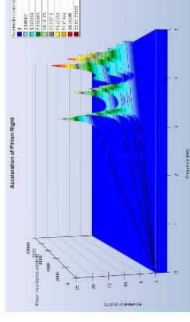
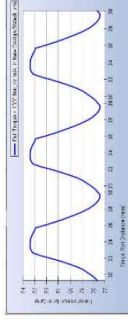
- Use LM Acoustic with Sysnoise solver to convert bearing forcing from 2 into radiated noise

4 – Powertrain Bending

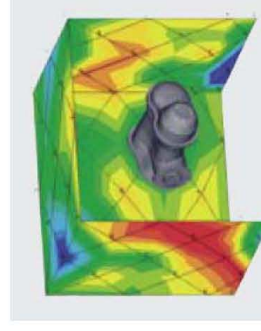
- Uses transmission and Engine FE Models to look at critical powertrain modes

5 – Full NVH simulation

- Adds additional components (e.g. subframe, suspension, chassis) then LM Acoustic and Sysnoise are used to understand modal alignment



Example transmission mode



- DVP Definition
- Test Definition
- Validation Test Management
- Efficiency / Lubrication Optimisation
- NVH Improvement
- Collaboration with testing organisations

Design Verification Plan and Report

Item	Requirement	Method	Test Case	Pass/Fail	Remarks
1	Engine oil pressure shall be maintained above 1.0 bar during operation.	Pressure sensor	Test Case 1.1	Pass	
2	Engine oil temperature shall be maintained below 120°C during operation.	Temperature sensor	Test Case 2.1	Pass	
3	Engine oil level shall be maintained between 10% and 90% of full capacity.	Oil level sensor	Test Case 3.1	Pass	
4	Engine oil quality shall be maintained above 90% during operation.	Oil quality sensor	Test Case 4.1	Pass	
5	Engine oil consumption shall be maintained below 100g/hour during operation.	Oil consumption sensor	Test Case 5.1	Pass	
6	Engine oil filter shall be replaced at 1000 hours of operation.	Filter life sensor	Test Case 6.1	Pass	
7	Engine oil pump shall be replaced at 1000 hours of operation.	Pump life sensor	Test Case 7.1	Pass	
8	Engine oil sump shall be replaced at 1000 hours of operation.	Sump life sensor	Test Case 8.1	Pass	
9	Engine oil drain plug shall be replaced at 1000 hours of operation.	Drain plug life sensor	Test Case 9.1	Pass	
10	Engine oil dipstick shall be replaced at 1000 hours of operation.	Dipstick life sensor	Test Case 10.1	Pass	



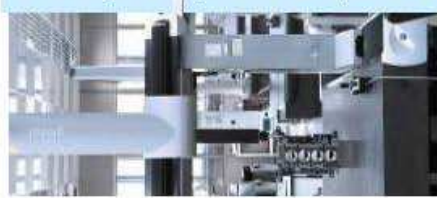


BOSMAL AUTOMOTIVE RESEARCH & DEVELOPMENT INSTITUTE

ENGINE RESEARCH DEPARTMENT

**AUTOMOTIVE RESEARCH & DEVELOPMENT CENTER
ENGINE RESEARCH DEPARTMENT BOSMAL®**

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BOSMAL Research & Development Institute has been active in the automotive sector since 1972. Currently, we provide wide range of R&D services for companies from automotive branch, both domestic and from abroad.

Year of foundation: 1972
 Scope of activities: complex design - testing services for automotive industry
 Legal status: Ltd
 Area of premises: 80 000 sq. m.
 Indoor area: 24 000 sq. m.
 Staff: about 300 employees (13 professors and/or doctors, 160 engineers and/or masters, 60 technicians and other staff)
 Location: northern part of the city, in the environs of a crossroads to the North and West

Certificate of Quality and Environmental Management System
 PN-EN ISO 9001:2009 and PN-EN ISO 14001:2005
 Accreditation Certificate of Testing Laboratory
 PN-EN ISO/IEC 17025:2005



The range of BOSMAL's services comprises:

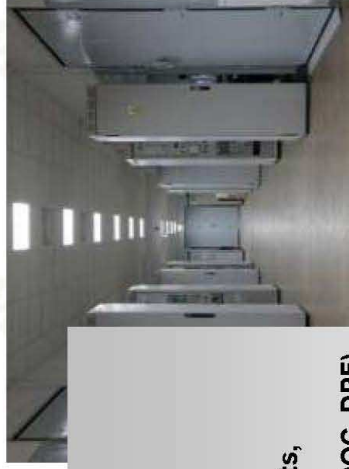
- complex research work for automotive industry in range of vehicles, their parts, assemblies and materials
- complex design - engineering- structural calculations and simulations work in area of automotive components and systems,
- production of models, prototypes and small series of vehicles, automotive products and accessories, tools and gauges.

Over 400 customers from all over the world

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<http://www.bosmal.com.pl>, bosmal@bosmal.com.pl

ENGINE TESTING

20 engine test cells (18 - eddy-current dynamometers W130 to W470 and 2 - fully dynamic dynos) for gasoline, diesel, bio-fuels, LPG, CNG testing



Engine development:

- Base engine development (Euro 5, Euro 6),
- Combustion analysis,
- Engine mapping and calibration,
- Engine vibration measurements,
- Engine noise measurements,
- Engine component temperature measurements,
- Durability and special tests,
- After-treatment systems optimisation (TWC, DOC, DPF),
- Engine parts and assemblies qualification,
- Support in launching new engines into production,
- Development of engines for alternative (special) fuels and for new markets.

Engine testing:

- Quality and COP tests,
- Support in qualification of parts from new suppliers,
- Support in product development

Fuel and lubrication oil testing:

- Alternative fuel and fuel additives development,
- Biofuels testing,
- Lubrication oil validation test.



Bio-fuels tanks



BOSMAL engine test cells are equipped with the industry-leading testing devices of Horiba-Schenck and AVL

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EXHAUST EMISSION TESTING

Emission tests (diesel, gasoline and LPG/CNG fuelled passenger cars and light commercial vehicles) according to international standards.

TWO EMISSIONS TESTING LABORATORIES
– Euro 5/6/SULEV

(ONE IN CLIMATIC CHAMBER - 35°C...+ 60°C)

- CVS and raw tailpipe testing to international standards,
- modal analysis of raw tailpipe and CVS bag diluted gases,
- air-fuel ratio and Lambda calculation,
- catalytic converter efficiency (light off) testing,
- CO2 emissions and fuel consumption measurement,
- opacity measurement,
- PM counting and continuous measurement,
- others: according to customer requirements.



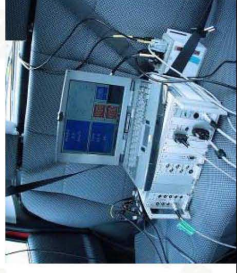
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VEHICLES ROAD TESTING

Performance and mileage accumulation tests of cars with gasoline and diesel engines (capacity app. 60 vehicles in parallel):

- Reliability Growth tests
- Fleet – EOBBD tests
- miscellaneous



Road measurements:

- fuel consumption vs driving speed
- intensity of acceleration through gears and on the certain gear
- temperature and pressure in selected systems (exhaust, engine cooling and lubrication, interior heating, breaking)
- oil consumption



Testing tracks/roads:

- urban
- extra-urban
- mountain
- motorway
- off-road
- mixed
- for traction systems testing



Vehicles tests in temperature chamber:

Temperature range: -45°C ... $+75^{\circ}\text{C}$

Dimensions: length: 870 cm
width: 710 cm
height: 315 cm

Entrance gate : width: 360 cm
height: 278 cm

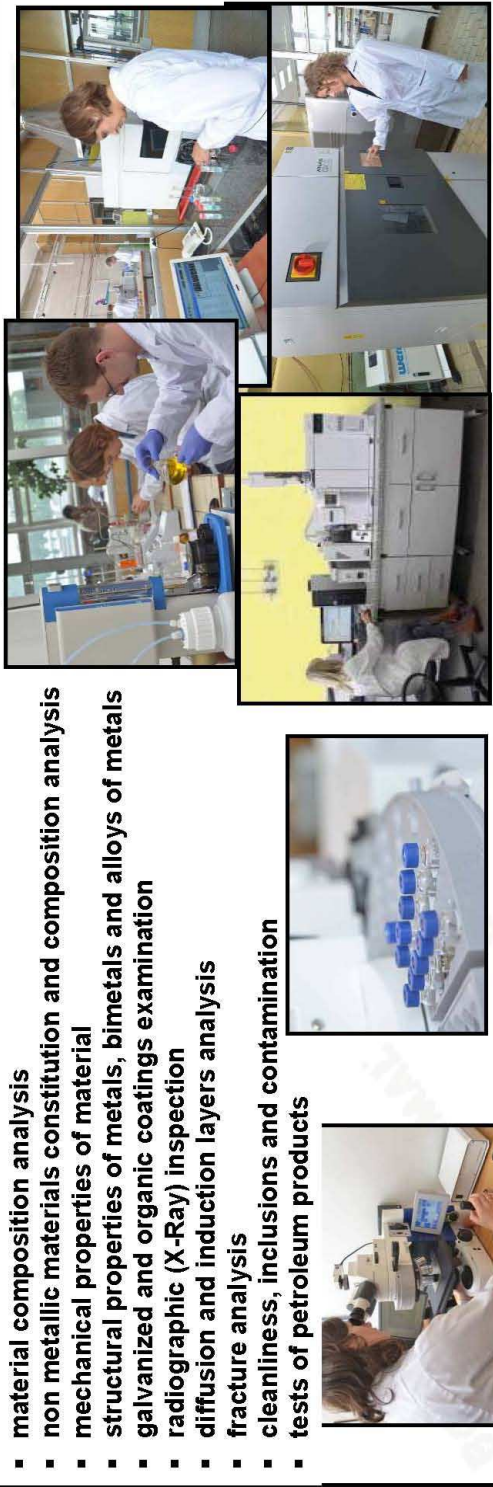


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MATERIALS TESTING

- material composition analysis
- non metallic materials constitution and composition analysis
- mechanical properties of material
- structural properties of metals, bimetal and alloys of metals
- galvanized and organic coatings examination
- radiographic (X-Ray) inspection
- diffusion and induction layers analysis
- fracture analysis
- cleanliness, inclusions and contamination
- tests of petroleum products



AUTOMOTIVE PARTS TESTING

- Measurements of environmental and industrial noise:
- Measurements and analysis of vibration of machinery and vehicles
- Durability, fatigue, vibration, torsion test of parts, assemblies and machinery
- Dynamics test of complete vehicles (up to 1500 kg) and assemblies (e.g. radiators, cooling fans, fuel tanks).
- Durability tests of gearboxes
- Tests of car brakes

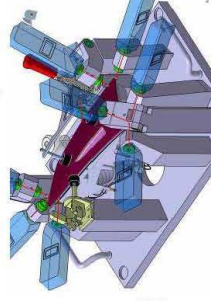
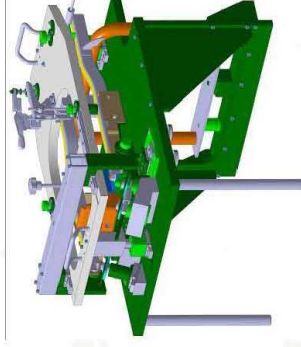
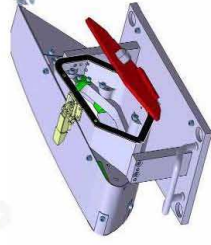
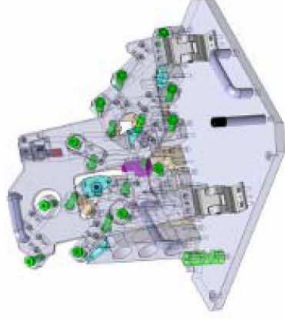


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DESIGN, PROTOTYPING AND MANUFACTURING

- Strength analysis of mechanical structures with use of finite element methods (statics, dynamics, large deformations, flow, heat transfer etc.),
- Structural and operational analysis of automotive components and automotive systems,
- Design of tooling, workshop aids and gauges,
- Production of master models, their negatives, mock-ups and prototypes,
- Production of short series of vehicles, products, automotive accessories and tools.



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Summary



- The WDL partnership offers a full range of engine & powertrain related design, development & consultancy activities
- Expertise & experience are combined to provide a high value service
- The partnership companies are flexible & easy to work with
- We work closely with our local partners to provide a high quality, cost effective service
- We hope we can work with you
- Please contact:
 - Chris Whelan: chris.whelan@wdlpower.com
 - Eddie Lee: leeden@ms34.hinet.net