



ORBITAL
A Global Force in Innovative Powertrain Solutions



Orbital Overview

Orbital is a leading international developer of engine technologies. It is based in Perth Western Australia with offices, subsidiaries and partners around the world. Its principal development centre, in Perth, is a world class facility with a capability unparalleled in the Australian region.

Extensive design, manufacturing, development and testing facilities have been built up over a period of some 25 years to support Orbital's leading edge and world class engineering expertise.

Customers, in all fields of engineering, are being offered access to this exceptional capability through Orbital's Engineering Services on a contract or consultancy basis. Focused and responsive teams are dedicated to providing creative solutions to our customers in a wide range of engineering fields.

Orbital has developed a unique vertically integrated

environment, enabling solutions for real customer problems to be intelligently developed in a streamlined and efficient manner. Orbital has developed and established an extensive infrastructure in engine design and modelling (2D and 3D), numerical analysis, computational fluid dynamics, combustion and fuel system development, rapid turn around prototyping, and engine management system software and hardware design to mention just a few. Access is available to fully equipped engine emission and performance dynamometers, NVH test cells, engine durability cells, engine and vehicle environmental cells, vehicle emissions chassis dynamometers, and mileage accumulation dynamometers.

To ensure that Orbital's output meets the world's most stringent standards, Orbital Australia Pty Ltd has adopted the Total Quality Management philosophy and is certified to the ISO9001:2000 standard.

an exceptional team



delivering creative solutions

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Engineering Design

Our mechanical engineering team has a broad experience base covering many diversified fields in mechanical design. Although our core business is designing and developing internal combustion engines and two fluid direct fuel injection systems, Orbital has an engineering staff experienced in the design of complex assemblies and castings involving earth moving equipment, mining and mineral exploration, munitions, aeronautics, hydraulic presses and guillotines, pneumatic and hydraulic systems and railway equipment. A flow-on from our core business is a wide experience in production processes and also design for production and assembly.

This broad experience base coupled with the latest CAD, CAE and CAM facilities has resulted in Orbital being a world renowned top class design house.

CAD System

Orbital primarily uses Unigraphics and Pro/Engineer 3-dimensional (3D) solid-modelling CAD software to design mechanical components and assemblies in a 3D virtual environment. Orbital also has Catia and Solid Works licenses and expertise.

We are able to accept CAD data in native Unigraphics, Pro/Engineer, CATIA format or Parasolid data.

StepAP203, StepAP214 and IGES translators are available to facilitate the transfer of data to and from other CAD systems such as SDRG I-DEAS and an FTP server provides a convenient, fast mechanism for moving CAD data to and from customers sites anywhere in the world.

The Design Process

Brainstorming sessions carried out during the initial phases of the design process involving the pooling of ideas results in the resolution of difficult design problems with innovative solutions.

Designs can be carried out in the context of the assembly, ensuring correct inter-component relationships. Mating features can be readily validated and any assembly problems eliminated in the early stages of the design.

Our design service can also include an assembly study to determine and recommend the use of special processes and techniques. If necessary experiments can be designed or test assemblies produced to simulate real world conditions in our extensive testing laboratories. Jigs, fixtures or other special tooling can be designed as required.

Design reviews can be carried out with the customer prior to final drawing sign-off. A full Failure Mode and Effects Analysis study and report service is also available if required.

Customers are kept informed of progress as the design evolves. This can include receiving (by E-mail) shaded images of the assembly which the customer view dynamically. A full animation service is available for assemblies with moving parts so that the intended function can be demonstrated before hardware is produced.

Designing in 3D produces a range of downstream benefits that are not possible if a more traditional 2D approach is

used. For example component models:

- Fully replicate the actual part
- Are accurate and true to form in every detail
- Can be used to generate hardware using various rapid prototyping processes
- Can be added into assemblies to verify or determine factors such as configuration, clearances, weight and practicality
- Enable components and assemblies to be tested before manufacture by performing numerical analysis on the virtual parts.
- Can be used to create tool paths for CNC manufacturing processes.
- Can be used to generate photo realistic rendered images for marketing purposes.

Component Definition

Component and assembly drawings that are associative to the models are produced either to AS1100, ANSI Y14.5M or ISO standards. We produce drawings to world class quality with functional dimensioning and full use of geometric tolerances.

All components and assemblies are designed and drawn with full focus directed to manufacture and cost. Assemblies undergo a tolerance accumulation study that includes geometric tolerances to ensure component interchangeability and that the assembly will function as intended.

Assembly drawings can be produced showing either all components in their assembled condition or in an exploded condition to facilitate component identification. Any special assembly sequence or technique is described together with the tooling required.

All components and assemblies can be allocated item numbers and an indented Bill Of Materials can be supplied if required.

Numerical Analysis

Our comprehensive design service can include full analysis involving stress computation, finite element analysis, computational fluid dynamics, noise, vibration and harshness measurements, lubrication requirements, inertial effects, heat transfer etc. All results are compiled into a report with recommendations.

Rapid Prototyping

We utilise rapid prototyping techniques to enable a customer to assess the visual impact or "feel" of the product or to shortcut the casting process. Machining and metrology requirements for prototypes are catered for in our Manufacturing Department guaranteeing fast turnaround.

At Orbital we provide the complete design service. We are responsive to customer requirements and our intention is to provide the best and most cost effective design solution.



Modelling, Simulation & Analysis

Orbital's Numerical Analysis Group combines the unique expertise of seasoned professionals with the world's best software packages and our SGI supercomputer to provide invaluable computational modelling services. Almost any mechanical or fluidic process can be modelled.

Orbital offers a wide range of modelling capabilities using a diverse range of software tools. These techniques have been applied across a range of applications, primarily automotive engineering, but increasingly in a range of non-automotive fields such as mining and building services.

Key modelling and analysis capabilities include:

- Structural, thermal, magnetic field, electric field and acoustic finite element analysis (FEA) on complex structures with two-way coupling to computational fluid dynamics (CFD) and non linearities, such as contact, material behaviour and geometrical changes.
- CFD analysis on large geometrically-challenging models with moving and sliding meshes, incorporating multiphase fluids, combustion, reactions and radiation.
- Mechanical dynamic simulation of multiple rigid and/or flexible bodies with complex interactions between mechanical components (coupled to FEA and CFD).
- A range of more specialised modelling skills such as electromagnetic's, neural networks and engine combustion.
- One-dimensional CFD for engine tuning studies and fuel system optimisation using WAVE and FINJECT.
- Parameterised solid geometry modelling and meshing facilities. Advanced post-processing and reporting graphics, including animation and video production.

Powertrain and Vehicle Engineering

In the areas of powertrain and vehicle engineering, Orbital's Numerical Analysis Group provides a range of value-added services:

- Virtual prototyping to predict the gas flow inside an engine and allowing observation of a wide range of physical phenomena, including time-varying pressure distribution and instantaneous gas velocities.
- A multi-valve four-stroke engine CFD model can run within a few days on a multiprocessor computer server, providing the combustion engineer with results only one to two weeks after having the first concept idea - a huge step forward for productivity.
- Lagrangian and volume of fluid two-phase modelling

techniques to model direct injectors.

- One-dimensional CFD (using tools such as WAVE/FINJECT from Ricardo) for engine combustion and fuel system modelling.
- Fully integrated engine thermal and structural FEA studies to help in the design of pistons, heads, blocks, gaskets and cooling circuits.
- Vehicle simulation involving the prediction of fuel consumption and emissions over specified driving cycles, and performance prediction based on vehicle data and engine test maps.

Non-Automotive Applications

Orbital has applied its modelling and analysis expertise in a wide range of non-automotive industries. For example:

- Working conditions in a nickel smelting building were improved by modelling the heat, dust and SO₂ generated and exhausted.
- The smoke and heat created by a fire in a multi-storey department store was modelled to ensure air control strategies allowed time for occupants to escape safely.
- The Australian fast ferry building industry has benefited from using Orbital to predict the resistance and wave making characteristics of proposed hulls.
- An exhaustive stress and fatigue analysis of an LNG transport tanker helped to reduce weight and give the client confidence about the life of this "giant vacuum flask".
- Down Hole Technology used Orbital to carry out the detailed engineering for its novel bit-changing system.

Star-CD

Orbital uses a leading general purpose CFD software package called Star-CD and related software. Orbital staff have highly developed Star-CD skills and are well placed to provide analysis services to a wide range of industrial sectors and applications. Star-CD is particularly strong in solving problems involving moving geometry, and is the most widely used CFD code in the automotive industry. As high-end users of this comprehensive software for over 10 years we well placed to provide these services.

For information on how Orbital can help you with Star-CD please contact us.



Manufacturing

Orbital has world-class facilities for prototype manufacturing, giving us the ability to design and machine any model shape to customer requirements. Manufacturing services include CNC tool path generation, complex 3D machining of mould and die cavities and rapid prototype manufacture using advanced high-speed CNC machining.

Customer concepts or designs are transformed into tool paths using CAD software. A direct numerical control link between the CAD systems and the CNC machine enables very complex shapes to be generated. The tool path verification software, Vericut, enables the tool path to be verified off the machine resulting in shorter lead times and improved quality.

To ensure that Orbital's output meets the world's most stringent standards, the Orbital (Australia) has certification to the ISO9001:2000 standard.

Machining Centres

Mori Seiki SV-50 Vertical Machining Centre

- 10000rpm spindle speed
- 32m/min rapid traverse
- Tool carousel holds 20 tools
- Working surface 1100 x 600
- Positional accuracy 0.005
- Advanced function high speed machining using 64 BIT processor

Mori Seiki SV 500B Vertical Machining Centre

- 10,000 rpm spindle speed
- 32m/min rapid traverse
- Tool carousel holds 30 tools
- Working surface 1320 x 600

- Positional accuracy 0.005
- Advanced function high speed machining using 64 BIT processor
- 4th Axis machining
- Capable of NURBS control

Haas HS-1 Horizontal Machining Centre

- 10,000 rpm spindle speed
- 12.7m/min rapid traverse
- Tool Carousel holds 24 tools
- Working surface 660 x 356
- Positional accuracy 0.005
- 2 Pallet CNC lathes

Tsugami Mercury Turret lathes

- Turn and profile accurately to 0.005
- Consistent repeatability of 0.005
- 10 Station Turning
- 2 station cross drilling on turret head
- Fanuc system 10T
- Automatic bar feeder

Mazak Quick Turn 10N

- Component probe measurement system
- Tool probe measurement system
- Turning capacity 250 dia x 350 long
- Face and side milling capability
- 16 tool carousel
- Maximum spindle speed 4200rpm



Inspection and Metrology

Our extensive metrology laboratory has a large variety of measuring equipment that enables inspection of a wide range of components. It is located in a "clean" room, which is temperature and humidity controlled and has a full compliment of manual and computer controlled equipment. It is one of only a handful of such facilities in Australia to be an integral part of a manufacturing company, thus allowing Orbital to measure and maintain quality control of all customer products to the highest standard and with a fast turnaround response.

Reports and supplier source warrants can be provided and tailored to customer needs. To ensure that Orbital exceeds the world's most stringent engineering standards, Orbital Australia Pty Ltd is certified to the ISO9001 standard.

Facilities

Zeiss Coordinate Measuring Machine (MC850)

- All linear, geometric and spatial dimensions can be measured in manual and CNC mode
- CNC programs can be written for any component
- 2D and 3D capability and the ability to compare directly to CAD files
- The measuring window is 850 x 700 x 600mm Accuracy <8um

Talyrond 300 Roundness Measuring Machine

- A highly accurate roundness measuring machine with automatic centering and leveling facility
- Roundness can be measured to <0.5um, and cylindricity, straightness, squareness, form, concentricity, run-out and radial dimension are < 1um over 500mm length with radial difference < 25mm
- A CNC program can be written for any component
- The measuring window is 300 mm diameter x 500mm long
- Maximum weight for parts to be measured is 50kg

Form Talysurf 120 Surface Measurements Machine

- Can be used in manual and CNC mode
- The raw data can be manipulated and stored on disk
- Surface trace <120mm long with a form deviation of <1mm can be measured and analysed
- The stylus arm can measure items up to 700mm high

- Parameters such as Ra, Rq, Rt, Rti, Ry, Rtm, Rz-DIN, Rz, Rv, Rp, Rpm, S, Sm, delta-q, lambda-q, R3z, R3zi, R3y, Lo, Rsk, Rku, tp%, high spot count, Htp, Pc, Pk, Vo and R&W parameters can be recorded
- Form Talysurf can measure components up to 700mm high

Profile Projector

- Magnifications 10x, 20x and 50x are available
- The screen is 320mm in diameter
- Accuracy is =<10um

Tesa 'Micro-Hite 2

- The Tesa Micro-Hite is a microprocessor controlled, programmable height gauge
- As a single axis measuring device it is suitable for measuring lengths in the form of external, internal, depth and distance dimensions, as well as determining form and positional errors e.g. straightness and flatness
- The software program for single or two coordinate measurements allows the calculation of angular and positional dimensions of bores, in Cartesian and polar coordinate systems
- The positional relationship from bores, slots and surfaces to each other can be determined
- Parts up to 900mm can be measured to the accuracy < 4um and repeatability < 1 um

Tesa Modul

- With this precise electronic length measurement device, measurements to an accuracy of 0.01um can be performed.
- It can be used for performing gauge block calibration.
- Floating Carriage Micrometer:
- Effective diameter of male threads, thread gauges, cylinders and length measurements can be inspected.
- The measuring window is up to 100mm in diameter and 220mm in length with an accuracy <2.5 um.

Calibration

Calibration of specialized equipment to recognized standards including:

Calibration Item	Standard	Calibration Item	Standard
Gauge blocks	AS1457	Lever clocks	AS2103
Vernier calipers	AS1984	Plunger clocks	AS2103
Sine bars & tables	BR3064	Angle plates	BS5535
Micrometer external	AS2102	Parallels	BS906 (part 1 & 2)
Micrometer internal	AS2101	Plug gauges	AS B129 BS1044
Micrometer depth	BR6468	Surface plates	AS1004
Male screw gauges	AS2710 BR919		



Test and Proving Facilities

The engine and vehicle test facilities at Orbital are equipped with a wide range of modern, industry-standard test equipment. Accuracy of measurement is closely controlled and all equipment and personnel operate under strict ISO9001 quality assurance guidelines. The facility comprises eighteen Engine Testcells, five Emissions Chassis Dynamometers, four Mileage Accumulation Chassis Dynamometers and five General Testcells, configurable for a range of applications from compressor testing to outboard engine testing.

Data Acquisition

The Low Speed data acquisition system is capable of logging 1024 channels @ 2Hz. Each input channel is configurable for thermocouple, voltage, or current input.

The High Speed logging system, for combustion and thermodynamic analysis, is configurable for a maximum of 64 channels split into 16 simultaneous logs of 4 channels each. A 16 bit ADC resolution makes it possible to measure and display, Coefficient of Variance and Indicated data in real-time. Crank-angle domain resolved data is acquired at a 1° sampling rate, while time domain data is acquired at a sampling rate of 150kHz.

Engine and Vehicle Test Area capabilities:

- Environmental Test Facilities consisting of a complete engine development test cell with temperature control from -35° to +50°Celsius and humidity control from 20% to 90% above +20° Celsius and a vehicle cold chamber with temperature control from -35° Celsius to ambient temperature.
- Engine Development Test Cells feature a comprehensive range of tools used to optimise engine fuel economy and emissions performance. Engine thermodynamics and combustion characteristics can be studied using proprietary Single Cylinder Research Engines. All data can be acquired in either the time or crank-angle resolved domains.
- Engine Durability Test Cells to evaluate the mechanical durability of engine and exhaust after-treatment components, for the evaluation and development of lubricant and additive packages while operating unmanned over 24hr transient cycles.
- NVH Engine Test Cells to conduct Noise, Vibration and Harshness evaluation and development of engine and gearbox systems in a test-bed environment.
- Marine and Recreation Testing Facilities to assess performance and emissions of outboard and personal water-craft engines.
- Motorcycle Emissions Chassis Dynamometer Facilities for testing of vehicle performance, fuel consumption, emissions and durability.
- Wet test cells for fuel system and component development including fuel and air injector, fuel pump and fuel system testing, particle size analysis (using Malvern Mastersizer MAM 5000), component and fuel systems design validation and durability testing.
- Mileage Accumulation Chassis Dynamometers which provide a means of quickly accumulating high mileage on vehicles driven to user-configurable drive cycles for mechanical and emissions durability evaluation without the need for drivers and test tracks providing a high degree of consistency of results.
- Vehicle Emissions Chassis Dynamometer Facilities supporting a full range of vehicle emissions testing for both gasoline and diesel, including catalyst efficiency and drive-cycle modal analysis. The emissions test laboratories offer testing to the relevant standards for all internationally recognized driving schedules including:
 - Australian Design Rules 27A, 27B, 27C, 37/00, 37/01, 79/00, 79/01.
 - Australian Standard AS 2877 - 1986 Fuel Consumption of Motor Vehicles Designed to Comply with Australian Design Rules 37 and 40.
 - Australian Design Rule 30 - Diesel Smoke Test.
 - EC 96: "EURO 2" - ECE-R-83/04 (96/69/EC & 98/77/EC, European Directive)
 - EC 2000: "EURO 3" - (2001/1/EC, European Directive).
 - ECE-R 101 - (80/1268/EEC amended by 93/116/EEC & 1999/100/EC, European Directive) - Fuel Consumption Testing.
 - US Federal Test Procedure - City Cycle (FTP75, EPAIII) and Highway Fuel Economy Test (HFET).
 - Japanese 11 Mode and Japanese 10.15 Mode.
 - FTP75, ECE-R15, ECE-R40 and ECE-R47 motorcycle and moped driving schedules applicable to the national standards for country of origin.
 - CFR 40-91 - Marine Spark Ignition Engine Emission Test Standard.



Engine Management Systems

Orbital's control and application expertise covers automotive vehicles, motorcycle marine and recreational vehicles. The challenges both for engine control and application vary considerably within this range emission constraints, testing, and the end user environment are all different.

Orbital's control group have taken products with no ECU control to having state of the art direct injection technology onboard. Working along side the OEM's from concept to production. We apply a structured approach to solving problems and supplying a quality product through following a defined product path.

The list of customers and products that have utilised Orbital's services during development and/or production phases is rapidly growing, some examples of which are listed below.

Strategy/Algorithm development

Orbital has extensive experience in analysing problems and developing solutions for engine control. The group has a depth and breadth of experience achieved from working over such a diverse product range Activities range from modelling of physical problems to complex on engine/vehicle experiments from which data is gathered and algorithms developed. The application of electronics and complex control systems on previously simple products has allowed Orbital and its customers to have "value add" features, such as the "learning key" a strategy enabling a personal watercraft to be speed limited to allow less experience riders the ability to operate the watercraft safely. Strength of the group at Orbital is to think laterally and not be constrained by historic paradigms.

The group has developed and specified control systems for:

- Direct injection 2 stroke marine engines
- Direct injected 2 stroke motorcycle engines
- Port injected 4 stroke motorcycles engines
- Direct injected 4 stroke automotive engines

Typical systems would be

- Airflow control, AFM, speed density, altitude corrections and adaptations
- EGR mass flow control
- ETC control and safety strategies when running drive by wire

- PID structure
- Model based structure, NOx model, de-sulphation model
- Adaptive control, rear O2 sensors, TPS set-up, fuelling compensation
- Diagnostics, EOBD, OBD2

To compliment these in-house activities Orbital has established relationships with world leaders in the area of EMS such as Delphi and Siemens VDO .

Calibration/emissions testing and analysis/catalyst application

The engine management system (EMS) at Orbital is seen as integral to the total application. A holistic approach is taken to dealing with the total system, hence the reason that calibration, emissions analysis and catalyst applications are captured within the same group. This approach has lead to this group achieving the following stringent vehicle emissions standards: Euro IV, Euro V, ULEV II.

Calibration, ranges from sensor calibration to system physical parameters, eg volumetric efficiency, emissions models. Steady state mapping of parameters affecting the combustion process. Transient calibration which affect emissions performance, engine stability and driveability. Calibration of specific algorithms, eg idle controllers, closed loop controllers.

Emissions testing and analysis. Considerable experience in meeting future emissions legislation throughout the world. Using the extensive facilities at Orbital the control group have the ability to tailor calibrations to pass legislated emissions targets whilst delivering to the customer, enhanced fuel consumption and good driveability. Evaporative emissions control and calibration including developing novel solutions for direct injection.

Catalyst development and application is conducted in partnership with leading catalyst suppliers, such as Johnson Matthey. Orbital has developed and applied catalyst systems from oxidation only system, to TWC (three way catalysts) systems, to state of the art lean NOx storage catalysts. Specific engine control strategies have been developed to enhance catalyst performance and work on optimising the performance cost equation.

Environmental activities, including hot fuel handling, hot start and driveability and cold start.

Mercury DFI	Control System development/specification and application. First application of air assisted direct injection technology in the market place
Bombardier-Rotax GTX DI & RX DI	Control System development/specification and application/Calibration
Aprilia SR50 & Scarabeo	Control System development/specification and application. Orbital have also developed 4S port injection control systems for motor scooters
Tohatsu TLDI	Control System development/specification and application/Calibration
DI4S vehicle development programs- including internal and external customers	Control System development/specification and application/Calibration/ catalyst application.
EMS suppliers	Control system specifications



Applied Combustion and Thermodynamics

Orbital is well recognized as a world leader in the field of combustion and gas exchange design, knowledge, application and development for both 4-stroke cycle and 2-stroke cycle internal combustion engines. In particular, Orbital has advanced capabilities in the design and application of combustion control to effect fuel consumption and exhaust gas emissions.

Considerable experience has been attained from various combustion development programs including 1, 2, 3, 4, 6 and 8-cylinder engines for global markets.

Orbital combustion and gas exchange design and development process can start from fundamental design incorporating the use of 1-D and 3-D CFD, fundamental development utilizing Single Cylinder Research Engines to prototype multi cylinder engines in optimising compression ratio or valve timing requirements for fuel consumption torque characteristic.

The complex nature of the combustion event dictates that the manipulation of variables to affect these outcomes is a highly specialized area of expertise.

Key capabilities include:

- Combustion System Design
- Combustion System Development
- Combustion System Optimisation for Various Market Requirements
- Combustion Modelling Expertise - 1D WAVE, 3D CFD
- Naturally Aspirated and Boosted Engine Development
- Inlet and Exhaust Manifold Design and Development
- Inlet Manifold Distribution Optimisation (Air & exhaust gas recirculation)
- Inlet Induced Motion Optimisation
- Gas Exchange System Design and Development
- Valve Lift Profile Optimisation
- VVT Optimisation & Calibration
- Engine Calibration Expertise
- Fuel Injector Type & Targeting Optimisation (multi-point and direct injection)
- Automotive and non-Automotive, four stroke cycle and two stroke cycle
- Gasoline and Diesel Engines

Facilities:

- Orbital operate a number of engine dynamometer development test cells with crank angle resolved cylinder and manifold pressure measurement and recording capability. Full exhaust gas analysis along with general pressure and temperature measurement and recording systems are incorporated into the development cells. These systems are integrated such that real time indicated and brake data along with real time engine related data providing the test cell technician with current engine performance allowing precise experimental data to be quickly collected.

- Highly developed cylinder pressure measuring techniques along with extensive knowledge of how to utilise the cylinder pressure transducers ensuring accurate outputs. Considerable level of confirmation and correlation achieved with Orbital's many customers.
- High-speed data logging capability to 150 kHz.
- The development test cells running Single Cylinder Research Engines have integrated engine-services systems facilitating a significant range of customer specific engine coolant and lubrication operating temperatures.
- Orbital's in-house developed routines are available for investigations into for example:
 - Heat release analysis.
 - Indicated torque analysis.
 - Full thermodynamic (energy balance) analysis.

Customer specific routines can also be incorporated if required.

- In-cylinder or manifold endoscope and high-speed camera capability. Combustion confirmation for Single Cylinder Research Engine Direct Injection investigations. Inlet manifold investigations for manifold injected engine spray impingement and positional development.
- Drive cycle fuel economy and emissions estimations from test cell data.
- Single Cylinder Research Engines, Orbital have 3 SCRE engine bases available for fundamental combustion and gas exchange development.

High Output Engine Development:

Orbital can provide the expertise and facilities to develop the full load performance of engines for high output versions of base passenger car engines, truck engines, and engines utilised in motor sports. This can include the following services:

- Engine pumping loss development and optimisation
- Combustion duration development and optimisation
- Inlet port shape and flow capacity development
- Inlet and exhaust valve size and flow capacity development
- Inlet valve combustion chamber face shrouding development
- Inlet and exhaust manifold development and optimisation
- Engine torque characteristic development
- Valve timing development and optimisation
- Compression ratio optimisation
- Complete exhaust system development
- Full load air fuel ratio and calibration development and optimisation



Fuel Systems

Orbital has expertise in the development and application of fuel systems to a wide range of internal combustion engines and applications including; 2-stroke and 4-stroke automotive engines, 2-stroke outboard motors, 2-stroke (Direct Injected) and 4-stroke (Port Injected) scooters and motorcycles and fuel processors for fuel cells. The expertise attained through the experience of taking several products from concept through to production ensures that Orbital is well able to meet customer engineering requirements in the area of fuel systems development.

Key capabilities include:

- Fuel system specification
- Fuel System design
- Fuel system development
- Fuel system prototype manufacture
- Fuel system optimisation for various applications
- Fuel system modelling expertise 1D, 3D, dual fluid sprays, multi-component fuel, magnetic circuits, structural analysis
- Fuel injector nozzle and spray pattern development
- Fuel regulation and pulsation damping
- Fuel injector spray characterisation (spray photography and particle size)
- Fuel metering characterisation (linear range, fuel flux, injection system transient response)
- Injection system NVH reduction
- Injection system control strategies and software

development

- Fuel systems on-engine testing (e.g. combustion stability, emissions performance, injection system deposit sensitivity, injection system icing sensitivity, injection system NVH and transient fuelling level response)

Key facilities include:

- Fuel systems test laboratory including fuel metering measurement, spray photography, droplet size measurement, injection rate measurement, transient response measurement
- Environmental chamber for engine dynamometer and vehicle tests, including icing sensitivity of fuel systems
- Engine dynamometers suitable for automated test cycles e.g. for evaluating injection system deposit sensitivity
- Engine dynamometers suitable for assessing the effect of injection system development on engine performance, emissions, fuel consumption and combustion stability
- Vehicle dynamometers suitable for assessing the effect of injection systems on vehicle performance, emissions and fuel consumption
- Engine and vehicle dynamometers suitable for long term durability testing
- In-house machining and technician resources for prototype manufacture, assembly and test
- In house metrology facility



Noise Vibration Harshness

NVH group at Orbital has the capabilities to supply services to the automotive as well as the non-automotive industries in the areas of measurement, testing, product development and noise and vibration control. The NVH expertise is gained by highly qualified personnel from numerous successfully completed projects and is supported by world class facilities and equipment.

NVH Capabilities

Engine Testing in Semi-Anechoic Test cell

- Noise and vibration audit and system development under real operating conditions,
- Complete engine or single components,
- Engine ancillaries,
- Intake and exhaust systems,
- Orifice noise
- Shell noise, and
- Insertion / transmission loss.

NVH Test Room

- Vibration development
- Noise development
- Structural Modal analysis

Drive-by And Tailpipe Noise Development

- Noise development,
- Test site suitable for development work

NVH Design Guidance

- Input at Design stage
- Design reviews including comparative evaluation of configurations

Vehicle Testing

- Vehicle interior noise and vibration development,
- On chassis dynamometer (MACD),
- Access to road test sites

Facilities

- Semi-Anechoic Engine Test Cell
- NVH Test Room,
- Drive-by And Tailpipe Noise Measurement Site

Equipment

- Hewlett Packard HP 3566/7A 4 Channel FFT Analysers (2)
- Microphones,
- Sound Level Meters,
- Accelerometers,
- Pressure (Low) Transducers For Intake And Exhaust Measurements
- Four Channel Digital Cassette Recorders
- Two Channel Digital Cassette Recorders
- Vibration Shaker For Modal (Not Durability)

Software

- HP Noise And Vibration Data Acquisition And Signal Processing Software Including Real Time Third Octave Analysis and Order Tracking Analysis
- LMS CADA PC Modal Analysis Software
- Exhaust/Intake System Acoustic Modeling Software

Examples of NVH Development

Automotive

- 2-Cylinder, 3-Cylinder, 4-Cylinder, and 6-Cylinder Engines
- Over Six Different Demonstrator Vehicles, and
- Supercharger noise sourcing.

Motorcycle and Scooter

- Air Cooled And Water Cooled Customer Applications
- Demonstrators
- Customer Application Advice

Specific Systems and Components

- Compressors
- Injectors
- Combustion Systems
- Exhaust Systems
- Intake Systems

Industrial

- Vibration Data Acquisition and analysis for liquefied natural gas semi-trailer



Electronics

Orbital's extensive electronics capability provides for services such as data acquisition, hardware and software design, integration, manufacture, testing and diagnostic tools from initial development through to fully industrialised products. These services can be applied to a wide variety of products from internal combustion engine control systems and associated auxiliary devices to any product requiring a means of electronic control or monitoring.

The list of customers and products that have utilised Orbital's services during development and/or production phases is rapidly growing, some examples of which are listed below:

- Mercury Optimax range (RTOS)
- Bombardier-Rotax GTX DI & RX DI (ECM, RTOS & CS)
- Aprilia SR50 & Scarabeo (ECM, RTOS, CS & Dealer Diagnostic Tools)
- Tohatsu TLDI (ECM, RTOS & CS)
- Various DI4S development programs- including internal and external customers (ECM, RTOS & CS)
- Data Acquisition Systems (DSP, Unix & Win Applications)

Orbital Electronics can provide consulting services on an 'as needs' basis or as a whole to encompass a complete program from concept through to implementation.

Hardware

- Orbital has extensive experience in designing embedded hardware such as Engine Control Modules (ECM) for development and production, as well as data acquisition and peripheral devices. This experience provides a comprehensive foundation for other embedded hardware designs.
- Design & Simulation
- Protel, MathCAD, PSpice
- Product Analysis
- Prototyping & low volume manufacturing (in-house)

To compliment these in-house services Orbital has established relationships with manufacturers such as Motorola, Delphi, Mitsubishi Electric, Megatech and Australian Arrow to provide production volume, quality, cost competitive products.

- Specification and Design for Production
- Production manufacturing capability via external relationships

Software

Orbital has over 60 years combined experience in

software development. Orbital has developed Real Time Operating Systems (RTOS) and Control Systems (CS) for many embedded applications like engine control and high-speed data acquisition systems, as well as fully integrated desktop applications for Microsoft windows. These applications employ low-cost 8 bit micro-controllers, to state of the art 32 bit micro-controllers.

The development of control software requires significant knowledge of a total operating system. The Orbital Software Group works intimately with the Control Systems Group and Hardware Group to provide a total control package.

Software capability

Operating & Control Systems

- C, Assembler (HC08, HC11, Power PC, 68000, Intel, Motorola TPU)
- Examples Mercury Optimax, Tohatsu TLDI, BR GTX & RX DI, Aprilia SR50 & Scarabeo

Data Acquisition

- Asynchronous multiple-channel high-speed combustion analysis (0.5 degree crank angle sampling) using embedded DSP systems.

Windows (Win32) Applications

- Microsoft Visual Basic, Microsoft Visual C++, using Win32API in C and/or Microsoft Foundation Classes (MFC)
- Examples Calibration Suite, Configuration Management Tools, Data Acquisition System

Database applications

- SQL and Jet data access for storage and retrieval of acquired data, processed data and for management of data acquisition and EMS configuration information.

Engine Management System Components and Integration

To further compliment the engine management system services offered by Orbital, additional expertise is available to assist in the development of specifications, selection and evaluation of components and the integration of a complete system. These services extend to sub-system design such as crank position target wheels and associated sensors.

- Hardware Specification
- Sub-System Design
- Component selection
- Hardware Evaluation
- System Integration



IP Management

As a world-renowned developer and licensor of Intellectual Property, Orbital has developed a unique infrastructure and skill base in respect of Intellectual Property management and exploitation that has serviced our internal requirements for many years. Our company has engaged in patenting and licensing activities in both the national and international arena and has developed specialised expertise in the identification, protection and exploitation of new technologies.

Orbital's expertise and facilities are applicable to external parties across a wide range of areas including the mechanical, electrical and other general engineering disciplines. Transportation (automotive, motorcycle and marine), industrial, mining, defence and medical are representative of some of the applications in which Orbital has been involved in from time to time.

Orbital is able to offer its patenting and licensing capabilities and expertise on a stand-alone basis, or in conjunction with the advanced engineering service capabilities which are also available through the company. This latter option offers a unique opportunity to those customers that are not only seeking innovative product development or technical solutions, but also recognize the potential to leverage such developments and solutions through intellectual property portfolio development and licensing programs.

If you have an engineering, design or manufacturing

problem and are seeking an innovative and cost effective solution, please contact us to discuss how we can serve your needs.

Intellectual Property Asset Management

Orbital's Intellectual Property Asset Management group is responsible for managing Orbital's vast portfolio of patents and patent applications, trademarks, trade secrets and confidential information. As the developer and licensor of its OCP™ Combustion Technology, Orbital's workforce, processes and systems are well established to facilitate the creation, capture, protection and exploitation of innovative technical solutions. Some examples of such processes and systems include:-

- Invention identification and related structured decision making processes;
- International patent/literature searching and investigation capabilities;
- Database management tools for maintaining up-to-date patent portfolios;
- Infringement review and searching expertise (including reverse engineering capabilities);

Orbital's own practical experience in establishing and dealing major international licensees ensures a focused and practical approach to your business needs.



Diesel Vehicle Emissions Capability

DYNAMOMETER

The dynamometers main features are;

- 20" (508mm) Twin roller Froude CD60
- Flywheel Inertia Simulation from 567 to 2,325 kg with electrical inertia simulation for intermediate inertias.
- Computerised control system Speed, load and ramp control
- "Drivers Aid" with "tram" lines and error count.
- Full electrical inertia simulation during acceleration and cruise conditions.
- Load control up to 1,660N from 0 to 130 km/h
- Power absorption up to 60kW from 130 to 160 km/h
- Permissible axle loading up to 2 tonnes.
- Plot to screen or data logger.
- Parasitic loss and coast down calibration

Road-load curve fitting up to 3rd order polynomial.

Torque measurement calibration accuracy of +/- 0.25% of point.

Road speed calibration accuracy of +/-1% FSD.

GAS ANALYSIS SYSTEM

Carbon Monoxide analysers incorporate automatic CO₂/H₂O interference compensation to within 3ppm (with 3%CO₂ in H₂O vapour).

Analysers have a basic accuracy of +/-1% FSD. This parameter includes non-linearity, hysteresis and drift errors over an 8hr period.

The analysers are calibrated prior to sampling using BOC "beta" standard calibration gases. These gases are referenced to BOC "Alpha" standard gases.

The calibration gases are certified to an accuracy of +/- 0.2% absolute, traceable to national standards.

Analyser Linearity, NO_x converter efficiency and general maintenance is carried out fortnightly, linearity checks are performed at two month intervals and major servicing takes place bi annually.

Cell consists of two independent CVS systems one for Diesel and one for Gasoline. Diesel and Gasoline have separate sample handling systems and share the same common dilute emissions bench.

Diesel CVS system consists of a Horiba 254mm diameter (10") primary dilution tunnel and critical flow venturi. Present maximum CFV is 600cfm (18m³/min). Dilution rates can be increased and/or a secondary tunnel utilised. Particulate sampling is via Horiba DLS 9200 with 2 or 3 phase sample capability with primary and secondary filtering, 6bags covering up to 3 test phases. Filter conditioning and mass measurement conducted in temperature and humidity controlled facility. Mass measurement via microbalance to ADR (ECE) and US-EPA, CFR specifications.

System now has well established accuracy and correlation with other vehicle test labs.

LOGGING AND TEST MANAGEMENT SYSTEM

This cell is run from an in-house designed and built test system.

The system encompasses the logging of bagged CVS tests, as well as the modal logging of all gas analysers and generic instrumentation (vehicle temperatures, pressures etc).

The system also generates the calculated results for CVS tests.

The test data is generated through Orbital's facility-wide database, with a single centralised method for the identification and storage of test results.

The data generated can be accessed and exported to generic PC formats.

Orbital also has utility programs for accessing and further processing of vehicle test results from user's PC's, again working from the single primary database.

CELL WEATHER STATION

The weather station consists of ambient temperature, humidity and barometric pressure measurements. These parameters are linked to the logging/emissions test system.

EMISSIONS SAMPLING SYSTEM	Beckman Feed Gas & Tailpipe		Horiba Dilute	
	Ranges	CalibGas	Ranges	Calib Gas
Carbon Monoxide (High Range - NDIR)	2%,10%	CO/N ₂		
Carbon Monoxide (Low Range - NDIR)			100,1000ppm	CO/N ₂
Carbon Dioxide	5%,10%	CO ₂ /N ₂	1%,2%,5%	CO ₂ /N ₂
Hydrocarbon (FID)	10*,100,1K,10KppmC	C ₃ H ₈ /AIR	10,30,100,300,1K,3k,10k,30KppmC	C ₃ H ₈ /AIR
Oxides of Nitrogen (CLD)	100,250,1K,2.5K,10Kppm	NO/N ₂	10,30,100,300ppm	NO/N ₂
Oxygen (MPA)	5%,10%,25%	O ₂ /N ₂		
Methane (GC with FID)			10,30,50ppmC	CH ₄ /AIR

* Tailpipe only



Diesel Vehicle Emissions Capability (continued)

Critical temperature measurements are made using "A" Grade, Band 2 PT100 Platinum Resistance Temperature Detectors (RTD's). The overall accuracy of these sensors is optimised by calibrating them down to 0 50 degC at +/- 0.5%FSD.

The cell barometric pressure sensor (Vaisala 2186AC3AAA20) is calibrated between 900 1020 mbar absolute within a calibration accuracy of +/-1% FSD.

Relative humidity is measured using a General Eastern Instruments, Chilled Mirror Hygrometer (Dew-10). This instrument is calibrated between 0-100% RH within an accuracy of +/- 1% FSD.

ADDITIONAL TEST EQUIPMENT and FACILITIES

In addition to the above, Orbital can provide additional equipment (for an extra cost) on request such as;

- Hot FID for measuring raw HC emissions.
- Particle size analyser
- Opacimeter
- GC measurement of air toxics (excluding aldehydes), specifically gaseous hydrocarbons and N2O. Note that gas samples can be sent for off-site analysis of aldehydes.

VEHICLE AREA

Temperature controlled soak area. Vehicle maintenance area including vehicle hoists.

VEHICLE WEIGHT PLATFORMS

Vehicles are weighed using 2 x GEC Avery weigh platforms. The calibrated range of each platform is 0 600 kg to a certified accuracy within +/- 0.1% FSD.

