

ARE YOU READY FOR THE NEW ISO 9000?

The new version of ISO 9000, vintage December 2000, seems to have slipped into the world 'not with a bang, but with a whimper'. And yet, at last some might say, ISO 9000 has finally come of age. This radically altered standard has changed its focus towards the customer and, with an insistence on only 6 to 8 procedures, looks for a more simplified documentation system. Likewise, it insists that organisations find ways to continuously improve their quality system, so that operating an essentially static bureaucracy is no longer good enough.

You might argue that the old standard included these issues to be addressed, but a certain amount of ambiguity allowed many quality systems to over emphasise documentation, and this had the effect of stifling real initiative in the quality domain. More than one chief executive has consigned ISO 9000, and, by association, all things quality, into the pigeon-hole marked 'necessary evils', and many question whether the quality systems that operate in their organisations deliver anything to the financial bottom line.

Let me quickly say that it is not all the fault of the standard; it is an issue of interpretation and misplaced emphasis by too many people involved in the quality profession. The proper operation of a well-designed quality management system will invariably result in substantial financial benefits to any organisation.

So, what's new? Well, from top to bottom, the standards has been re-thought and re-presented.

- It is based on 8 basic **Principles** of quality management
- The **Structure** of the ISO 9000 documentation has been simplified
- The **Format** inside ISO 9001 has also been radically altered

PRINCIPLES

The 8 underlying principles on which the standard is based do not actually appear in the system requirement standard, but are discussed in one of the supporting documents. Nevertheless, it is certainly important to check your quality system against these principles, which are:

- Customer Focus - basing business priorities on understanding, meeting and exceeding customer expectations
- Leadership - establishing the direction, unity of purpose and a conducive working environment within the business
- Involvement of people - ensuring that people from all levels of the organisation understand and contribute to business objectives
- Process approach - seeing activities as the use of resources to turn inputs such as data and raw materials into outputs, such as a service or product
- System approach to management - seeing the business as a system of inter-related processes
- Continual improvement - ensuring that continuous performance improvement is a permanent business objective
- Factual approach to decision making - basing decisions on objective analysis of data and information
- Mutually beneficial supplier relationships - working with suppliers to allow both parties to create value

STRUCTURE

Unlike the past, when there were 3 separate standards; ISO 9001, 9002 and 9003, there is now only one; ISO 9001:2000. It is supported by 3 associated standards: ISO 9000:2000 covers fundamental principles and vocabulary, ISO 9004:2000 is a set of guidelines for performance improvement and ISO 10011 provides guidance on auditing quality and environmental management systems.

FORMAT

The standard now consists of 8 clauses, as described in the table below. Businesses may claim exemption from parts of Clause 7 Product Realisation if, for example, they are not responsible for design and development.

Clause	Comment
1 Scope	
2 Normative Reference	
3 Terms and Definitions	
4 Quality Management System	The foundation of the quality management system. Looks at processes and their interaction and what documentation is needed.
5 Management Responsibility	How top management will run and control the quality management system.
6 Resource Management	How the organisation's resources are arranged to carry out the processes.
7 Product Realisation	Process management - how inputs such as raw materials and information are converted into outputs, i.e. products or services.
8 Measurement, Analysis and Improvement	How an organisation measures performance of the quality management system and how these measures are used for continuous improvement.

In response to such major changes, some organisations may take the view that they should completely re-design their quality system. Whilst this top-to-bottom approach may not be necessary, it is suggested that quality manuals, at least, will probably require a re-write to stay in line with the new structure and vocabulary. On the good news side, anyone with bookshelves sagging under the weight of hundreds of detailed procedures can order the paper shredder and set to work simplifying their documentation. The new standard takes the view that well trained people hold the key to operating a quality working process.

The new standard delivers other benefits; the wording has been changed to better suit service as well as manufacturing businesses and there is a clearer alignment with other standards such as ISO 14001.

In theory, we all have until December 2003 to gain certification to the new standard. However, in practice, most businesses will come under some pressure from customers and accreditation bodies to align more quickly than that.

You can obtain copies of the new standard from British Standards Online at <http://bsonline.techindex.co.uk/>

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THE FUTURE FOR AUTOMOTIVE TWO-STROKE ENGINES (Part 1)

BACKGROUND

The first successful application of a two-stroke (2T) combustion cycle was devised by Sir Dugald Clerk in 1880. Although Dr. Nikolaus Otto has successfully developed his four-cycle (4T) concept four years earlier, it was not until 1883 that Gottlieb Daimler succeeded in operating a 4T gasoline engine suitable for transport applications.

In Clerk's design there was a separate supercharger and a poppet valve in the cylinder head, a concept that was later applied to large 2T marine and commercial vehicle diesel engines. However, ten years after Clerk's first 2T gas engine, Joseph Day patented a simpler 2T design using the underside of the piston moving down to pre-pressurise the incoming charge in the crankcase before it was transferred through ducts, or ports, in the cylinder wall, to the combustion chamber.

Although one of the merits of this 2T engine compared with a 4T is its basic simplicity, the principle of operation is more difficult to understand. The four strokes of a 4T engine, summarized as induction, compression, ignition and exhaust, are accomplished with two strokes of the 2T engine, being summarized as induction/compression and ignition/exhaust. The function of the mechanically operated valves in the 4T are achieved by ports in the cylinder wall of the basic 2T engine. In theory, a 2T engine should produce twice the power output of a 4T engine of equivalent capacity, since there is double the number of power strokes per revolution. In practice, however, the exhaust port is open at the same time as the inlet charge, assisted by crankcase compression, is entering the cylinder through the transfer port. As a result, some of the inlet charge is lost through the exhaust, whilst the fresh inlet charge in the cylinder is diluted by remaining undischarged exhaust gases, with a resultant reduction in power output and an increase in fuel consumption.

It was the Day-type of 2T engine that immediately found favour as a simple lightweight power unit for early motor bicycles and tricycles, notably the Scott Flying Squirrel racing motorcycles which competed so successfully in the Tourist Trophy races of the early 1900s, and the German supercharged DKW machines of the 1920s and '30s. The first DKW car, launched in 1928, used the same design of three-cylinder 500cc air-cooled valveless 2T engine as the earlier motorcycles and became the pattern for the post-war Trabant, Wartburg and Saab 2T power units.

The same concept was then and is still widely used today in countless millions of motorcycles, lawnmowers, chainsaws, brushcutters and outboard marine engines all over the world, although environmental pressures are outlawing further manufacture of these simple but polluting engines.

HISTORICAL DEVELOPMENTS

Early improvements to improve the performance and fuel consumption of 2T engines involved the introduction of a 'humped-top' piston where the inlet charge was physically directed to the top of the combustion chamber and away from the exhaust port, reducing losses through the exhaust port. A later development was the use of angled inlet ports together with flat-topped pistons (Schnurle Loop), which achieved the same result but with an improved combustion chamber geometry. Then followed the adoption of tuned exhaust pipes and expansion chambers, which produced pressure pulses which helped to control the progress of gases through the combustion chamber, sucking out exhaust gases as well as assisting in drawing in fresh charges.

Conventional lubrication systems used in 4T engines could not be used in 2T engines where the crankcase was used for compression of the inlet charge, so 'total loss' systems were employed where all of the oil supplied to the crankshaft was consumed within the engine. Oil could alternatively be supplied by pre-mixing it with the fuel at ratios generally between 16 and 50 to 1, which necessitated the use of rolling-type bearings.

Current 2T engines, however, rely on a more positive method of controlling gas flows. Reed valves consist of flexible metal vanes which permit movement of the inlet gases in one direction only, whilst the more expensive disc valve consists of a ported spinning disc mounted between the carburettor and cylinder, where the port opening permits gas flow into the cylinder at certain preset times depending on the position of the crankshaft. Various types of exhaust valves are also used, variations in the height of the exhaust valve providing increased power coupled with flexibility.

The first 2T car engines had a specific power output of around 30 bhp/litre, at a time when contemporary manufacturers were producing 4T sports car engines with around 18 bhp/litre. In its ultimate air-cooled automotive form, developed from the highly successful Saab rally cars of the mid-1960s, the 2T engine eventually increased its specific output to 65 bhp/litre. In the 1970's, several 360cc high-revving piston-ported crankcase-scavenged 2T engines with carburettors were mass-produced by Daihatsu, Mazda, Mitsubishi and Suzuki for domestic mini cars in Japan with outputs in excess of 83 bhp/litre.

In the UK, interesting developments involving 2T engines for commercial duties included Trojan (used in a fleet of 'tea-vans') and Commer, both of these power units using unconventional mechanics which, although of technical interest, did not survive.

The most developed European 2T for a production car was

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the water-cooled engine for the Wartburg 353 launched in 1985 with electronic fuel injection. Output was limited to 50 bhp/litre to maintain fuel economy. Unable to meet German emission standards, the 992cc Wartburg 2T engine was replaced in 1990 by a 1.3 litre 4T developing 45 bhp/litre.

In the past 2T engines have always suffered from a number of key disadvantages that have limited their wide-spread adoption. These have included excessive oil consumption leading to highly visible smoke emissions, unstable combustion caused by misfiring at part load, poor fuel economy and severe limitations on the port timing control which is constrained by the piston movement. It was the combination of negative features, particularly those affecting the increasingly demanding controls on exhaust emissions, which led manufacturers like Saab to abandon 2T engines in 1968, in favour of a Ford-sourced V4 4T, and for DKW (by then part of Audi) to commission Mercedes to design a new 4T as a replacement. Those who carried on with 2T car production, notably Wartburg, Suzuki and Trabant, have since been forced to follow suit. The primary shortcomings of the 2T engine for modern applications have always been the limitations on the combustion process. The possibility of overcoming the fuel economy and emission problems by direct fuel injection into the cylinders was originally ruled out as not feasible and far too expensive to engineer.

However, although the concept of basic 2T engines was always attractive for economy motorcycles, being light, simple and offering a good power to weight ratio, it was in the competitive field of motorcycle racing that the ultimate potential of the 2T engine was realized.

In the search for ultimate power, engine characteristics became more and more extreme, with examples such as the 50 c.c. Suzuki which revved to 19,000 rpm and produced some 300 bhp/litre, although over such a narrow range that even the 14 gears provided were not sufficient.

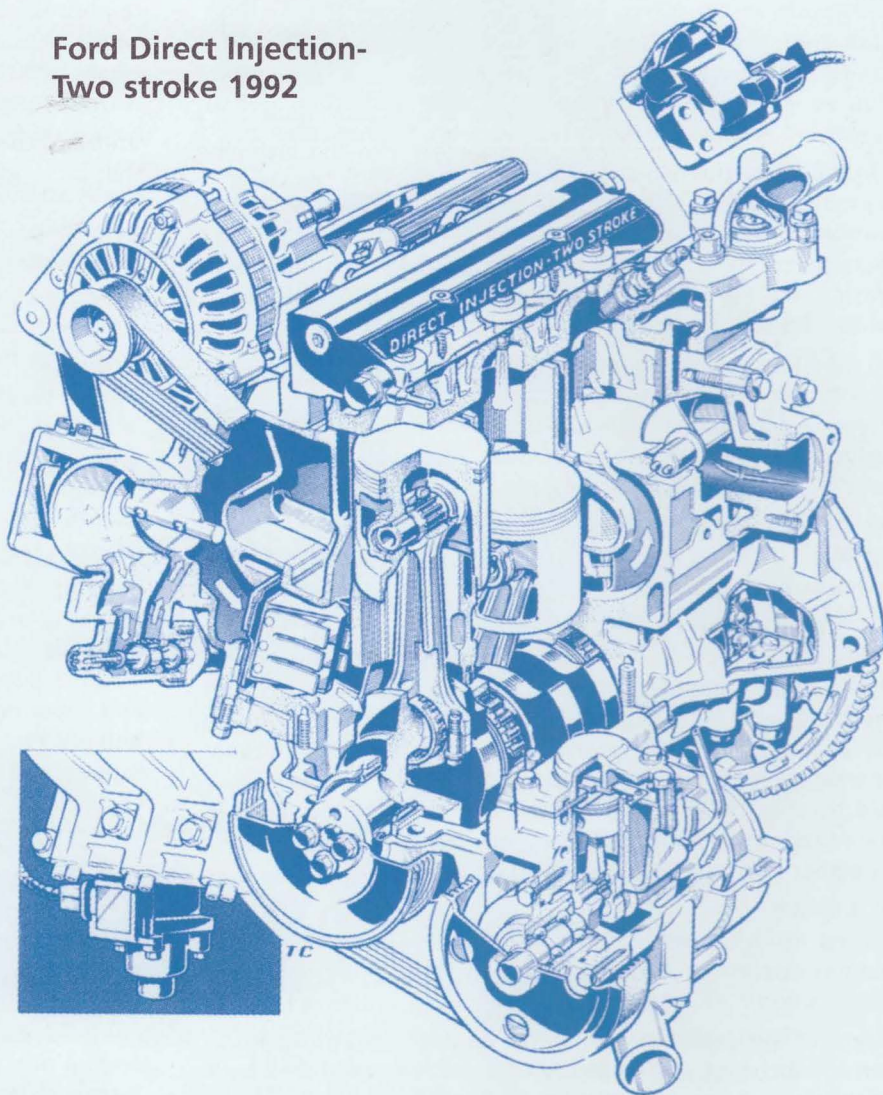
Since 1975, 2T engines have dominated motorcycle grand prix racing formulae. However, developments on the racetrack have invariably filtered down and improved road-going vehicles, and the forthcoming rule changes to accommodate 4T engines with larger engine capacities to compensate for their inherently lower specific power outputs is in recognition of the fact that continued 2T development is likely to be a blind alley which will not produce any tangible benefits for the manufacturer.

THE ORBITAL 2T ENGINE

The key advantages of the 2T technology for passenger car use are its reduced package size and weight, its greater simplicity, increased power density, smoothness and enhanced performance feel.

Due to the total elimination of the valvetrain (no camshafts, cam belts or poppet valve) and the oil pan, engine height is reduced by about 25 per cent (or around 100mm for a typical small car engine). The ability of the engine to run smoothly with only three cylinders instead of four also saves about 25 per cent of axial engine length (equivalent to around 120mm).

**Ford Direct Injection-
Two stroke 1992**



With twice as many firing pulses per revolution, a three-cylinder 2T's running refinement is similar to that of a six-cylinder 4T. Its faster response also gives it an enhanced performance feel.

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2Ts are also about 30 per cent lighter than equivalent 4T engines (equivalent to a weight saving of around 30 kg when installed). Combined with a power per litre about 10 per cent higher than 4Ts, this increases power density (bhp/kg) by about 40 per cent.

In the mid-1980s, Ralph Sarich designed a revolutionary new rotary engine and formed the Orbital Engine Company in Western Australia to produce it. Although development of his original power unit was shelved a few years later, the low-cost forced-air injection system designed for it showed considerable promise for 2T engines in which Orbital then became involved.

Previously, in the 1970s, engineers working for Ford in the USA had become deeply involved in advanced stratified charge engines based on conventional 4T principles. Subsequently, Ford researchers in Europe undertook several advanced projects involving fast, lean-burn combustion.

Orbital then entered into a joint venture with fuel system suppliers Walbro Corporation, of Cass City, Michigan, and worked closely with Ford on developing new 2T engines in Europe and the USA. After monitoring Orbital progress in the early 1980s, Ford entered into a formal development contract with a licensing agreement signed in June 1988.

In the 2T design used by Ford, ambient air was drawn into the crankshaft by the upward motion of the piston on its compression stroke through a set of self-operating reed valves. The electronically controlled forced-air fuel mixture was injected directly into the cylinder.

As the piston moved down on its power stroke after spark ignition of the compressed charge, it first uncovered the exhaust port and then the transfer port, allowing the loop scavenging of fresh compressed air to drive out all the spent gases and fill the cylinder for the next injection phase.

The Orbital mixture preparation system controlled the fuel metering and injection timing separately from the injection of mixture into the combustion chamber. The engine management computer varied the pulse width and timing of electrical impulses applied to two solenoid injector valves (a side-feed to the injector housing for fuel and a direct chamber injector for the mixture).

A fog-like spray of rich, finely atomised mixture was thus varied in its character and distribution pattern to suit the engine operating conditions and provide exceptionally clean combustion.

Many of the lessons learned in the development of the Proco stratified charge engine in the USA and advanced lean-burn technology in Europe were being applied to find new ways of increasing burn rates during combustion, something that was essential to the very short cycle time of a high-speed 2T engine.

Oil was supplied by an electrically-operated metering pump and injected immediately upstream of the reed valve

assembly. The rate of oil injection was varied by the electronic engine management system according to the load and speed of the engine.

In general the fuel/oil mixture ratio varied between about 90 and 420 to 1, reducing the oil concentration under most operating conditions to less than a tenth of that used in conventional 2T engines. This level of highly sophisticated oil injection control was developed to provide a safe margin of oil mist lubrication for the roller bearings and at the same time significantly reduce exhaust emissions.

The small quantities of oil that entered the cylinder with the induction air were burnt off in the chamber and their combustion products then oxidised by the catalytic converter, which operated without the risk of oil contamination. This eliminated the characteristic blue smoke normally associated with 2T engines. About 30 per cent of the injected oil is recovered from the crankcase floor and recirculated, giving a projected range of around 20,000 km before the supply tank needs attention.

As only the spark plugs and air filter needed replacement throughout the life of the vehicle. Ford expected that future 2T engines would thus be able to extend routine service intervals, reducing cost of ownership levels further than was possible with contemporary wet-sump 4T powertrains.

A pilot batch of 2T Fiestas were initially built for customer fleet trials and to gather service data. More than a dozen other car makers signed Orbital licensing agreements, including General Motors, Honda and Fiat. Several boat engine manufacturers also bought in, including the huge Mercury Marine.

Ford also commenced working with Orbital on several other longer term 2T projects including six-cylinder engines in both naturally-aspirated and supercharged forms. Advanced 2Ts had the potential of providing similar levels of refinement and superior performance to V12 4Ts, but without the cost and complexity of four camshafts and 48 (or even 60) valves, tappets and springs.

However, development was halted when it became obvious that the Orbital 2T engine, even with its refined operating system, would not be able to meet the increasingly stringent emission requirements that were planned for the future.

Part 2 of this article will bring developments right up-to-date; very recently there has been renewed interest in 2T engines, one of the leading motorcycle manufacturers Aprilia of Italy has just launched a scooter powered by a new 50cc Orbital 2T engine and other manufacturers have introduced novel 2T technologies, including Peugeot and Honda - all which meet the latest EURO emission standards. The Two Stroke engine isn't dead yet, the engine-developers have managed to clean its emissions up!

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