RCEA (SUSSEX)

An Association for Retired Professional Engineers

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The varied and successful life of a 'failed' engineer

A talk by Richard Sykes

This afternoon I am going to tell you a few stories about my working life, mainly as a mechanical engineer, working largely with internal combustion engines. It lasted 54 years from first job to retirement and was not that boring that it can be fully described in a 1-hour talk. So, I will tell you about a tiny fraction of the interesting engineering projects in which I have been involved along with a few observations regarding human behaviour and the lessons I learned.

I am an intruder in this association because I am not a chartered engineer. In fact, I have no qualifications on paper apart from a few O-levels and a cycling proficiency certificate.

I always wanted to be a mechanical engineer.

I attended Brighton Hove & Sussex grammar school as it was then and took my O-levels.

To gain entry to the Mechanical Engineering course, at what was then Brighton Technical College, I had two choices, either stay at school for 2 years to obtain A levels or undertake a special one-year intensive course at the technical colleges of either Worthing or Lewes, as I did.

The original Brighton Technical College

After that year I was accepted at what had been renamed Brighton College of Technology but still based in the lovely old redbrick building opposite The Level. There were no results published and no paper certificate (from Lewes). Did one college phone the other and say this chap is OK?

After one year the college of knowledge moved up the road to the new building at Moulsecoombe and within another year or so it changed to Brighton Polytechnic and is now Brighton University.

One of the great things about the Mechanical Engineering Diploma course was that we were also taught practical engineering. Each week there was half a day running engines of various types to conduct experiments and another half a day learning how to use machine tools and other skills, such as several types of welding.

Later when I attained positions where I was asking others to undertake particular tasks, I never had anyone tell me it was impossible or too difficult because they knew that I was perfectly capable of doing it myself. It also enabled me to quickly spot when a new design was difficult to make or mend.

There were many distractions in my life at that time, and I failed my exams after the second year of the three-year course and left with no qualifications, although I suppose I must have learned quite a lot.

I had always been particularly interested in internal combustion engines and not far from where I was born and bred was the internationally renowned firm of Ricardo & Co Engineers (1927) Ltd (as it was then) so I knew I wanted to work for them. One day I rang the number and said I wanted a job. The rather surprised telephone receptionist asked if I was applying for a particular job that had been advertised. When I explained, she took my name and contact details and that was the last I heard for three months.

One day I received a telephone call from the general manager who said he had a vacancy, but it was at the lowest level of engine tester and if I would like to accept that, could I come in the next day.

That was the very start of 20 years at Ricardo where I was gradually promoted to my level of incompetence, that being a position more to do with management than engineering. On the way I learned a huge amount from the many older experts in various departments who showed patience in answering my questions, often nothing to do with the project on which I was supposed to be working. I fondly think of it as attending the University of Shoreham-by-Sea.

One occurrence that stuck in my mind for ever was an example of how some accountants see the world differently to most humans. For many years Ricardo had made and sold a limited number of single cylinder research engines known as the E6. The raw castings were bought and held in the stores and whenever any machinist or engine fitter had a lull in their normal paid work, they did a bit of work on parts for an E6 instead of standing around doing nothing. So, effectively much of the work involved in making this saleable item was done without it costing the company any more than the normal wage bill. When the accountant looked at it he saw that the work done was being booked to the production of an E6 and therefore the part that was returned to the stores had a higher value and, because the total value of stock was now higher than desired, it needed to be reduced. His solution was that machinists and fitters without normal work should no longer work on parts for E6 engines but do nothing and book to waiting time.

As you progress through a career you gradually learn more and become more competent but sometimes there are occurrences where there is a sharper increase in ability. Some of the greatest advances I made in my own abilities have come when I did not have the comfortable cushion of cleverer people around me to help, usually when I was at a client's premises on my own.

The first experience was when my immediate superior and I made a visit to Ducati Meccanica Motorcycles in Bologna, supposedly for just two days. To fully understand the valve gear malfunction of one of their engines, it needed some tests which would take longer. On the second day my colleague announced that he was going home as planned and I had to stay until it was resolved. I knew very little about valve train dynamics but had to learn very rapidly and supervised the modifications and tests, as well as being able to ask for food in Italian.

Over the years I have come across some very odd people, but one of the strangest was a new employee who had really impressed the Personnel manager (he would be called HR director now) with his claimed qualifications.

The first alarm bell rang in my head when he noticed two volumes of a very detailed reference book on my desk and remarked that he had read them both. That's weird, I thought, as most engineers do not read these books throughout, they only look at one relevant subject and, even then, often struggle to understand it.

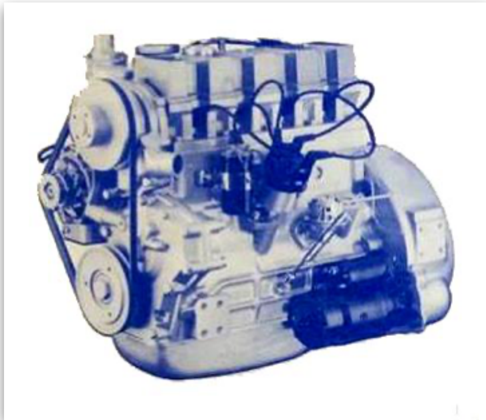
I showed the new employee a motorbike on the rolling road in the emissions laboratory and explained that to practice driving the US driving cycle he had to keep the speed pointer on the target line of the drivers aid and change gear or brake as marked.

After the signal to start he shut his eyes, bent down, opened the throttle fully and kept the bike in 1st gear without any attempt to follow the target speed line. I quickly switched it off before the engine distributed its parts around the room.

When I questioned the background of this rather strange recruit, the personnel manager said I was being very unfair and biased against the new chap and that I must learn to get on with other people.

In 1980 I was sent to the states for a few days, to Teledyne Continental Motors in Muskegon, Michigan.

Ricardo had designed for them their first ohv engine to replace their very old 4-cylinder side valve engines used in fork lift trucks. Someone had the idea to turbocharge this engine to see if it could replace the old 6-cylinder version rather than creating a new engine family, which is what they actually ended up doing. Their initial results were very disappointing, so they had asked for help.



The TCM ohv engine

Unfortunately, the day I arrived at the factory was the first day of a strike by all the shop floor workers. Only middle management and above were there in their smart suits.

It was very clear that the carburettor and induction system was not nearly big enough to flow the amount of air required, and the compression ratio had not been lowered so it was knock limited over the whole speed range.

There was a separate issue in that the Corporation president and his entourage of senior executives were due to make an official visit to the plant the following week.

I suggested to my host that we could do quite a lot. Next day all of the sharp suits had been replaced with blue jeans and check shirts.

While some of them set about painting everything, I sketched up a new inlet manifold, went with the development engineer to the local Harley Davidson dealer to buy a large carburettor, and worked out a way of machining some pistons to increase the bowl volume.

I taught some of the managers how to weld, operate lathes, milling machines and grinders and they loved it, being able to do something practical and see the immediate results of their labours. Within about four days we had built a modified engine and were able to run a power curve which fortunately exceeded the target, and within a further day or so everything was ready for the presentation to senior corporate executives.

One of the experimental Volvo LCP cars

It seems Ricardo was always trying to send me away because the following year I was sent to Volvo Car Corporation in Gothenburg. A department of the West German Gov had created a project called Auto 2000 to encourage development of efficient cars for year 2000, then well into the future.

Volvo decided to do the same. They had designed a lightweight, streamlined car and commissioned Ricardo to design a lightweight 3-cylinder DI diesel engine which had a Magnesium cylinder block, something that this experimental project proved was not a good idea.

The frame of the Volvo LCP car

The Volvo Project Director asked for a Ricardo engineer to attend for 2 weeks to ensure that the installation of the engine in the car went smoothly. The photo that shows the bare frame was taken later but is indicative of how far the build had progressed when I arrived. There were parts scattered all over the experimental build workshop with very little having been assembled.

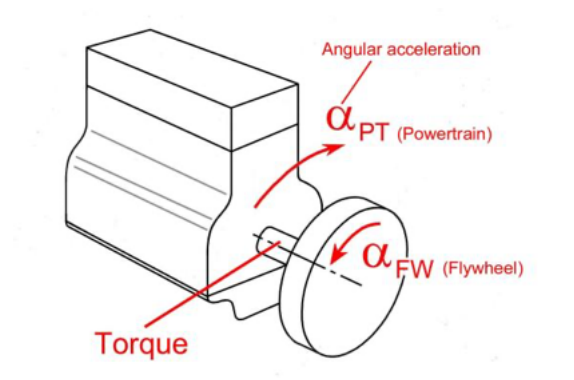
I designed engine mounts, a gear lever system, cooling system pipes and many other interfaces. Rolf Mellde, the Volvo director in charge, asked Ricardo if I could stay a little longer and I ended up staying for 2 years BASED (see below) in Gothenburg, eventually as the engineer in charge of all Powertrain matters for the project. This photo shows me working on a second type of engine tried out during the project. An Elkomotor made by Elsbett and company in Southern Germany.

Adjusting the controls of an ElkoMotor

The manufacturers claimed a maximum power of around 90 PS (Pferdestärke), the German term for "horse strength”, a unit almost identical to imperial horsepower (hp) but slightly lower (1 PS ≈ 0.986 hp)) but I was fairly sure that was being very optimistic.

We had one engine fitted into a VW golf, which one quiet weekend I took to the very straight and flat road near to our office and carried out a series of acceleration/run down tests.

From such tests it is possible to derive a power curve and the resulting one showed both the power and torque to be around 2/3 of that claimed, forcing Elko to admit to their lie.



Equal and opposite torques

There are some good advantages of a 3-cylinder engine over a four, but a fundamental problem of 3-cylinder engines is Torque recoil at low speeds due to a nearly constant rotational inertia. The flywheel is constantly being accelerated and decelerated and there is an equal and opposite torque reaction on the engine cases which causes the engine to rock backwards and forwards around the crankshaft axis. With an in-line engine it is possible to use soft engine mountings to reduce the transmission of vibrations into the car, but with a transverse engine this torque is in the same direction as the drive shafts so soft mounts cannot be used because then when the clutch was engaged the engine would try to wrap itself around the drive shafts.

The contra rotating flywheel mounted on the front

I was asked to solve it, and my first idea was soft engine mounts with a telescopic torque reaction link between the top of the engine and the body structure that had little resistance at idle speed but locked up above the clutch engagement speed to provide the necessary torsional stiffness for drive.

The next idea was to cure the vibration at source, so I designed an extra contra rotating flywheel driven off the front at 2.5 times crankshaft speed via an epicyclic geartrain. It was incredibly smooth and you could literally stand a coin on edge but the howling from the gear train was completely unacceptable.

Earlier I used the term Based in Sweden because I often had to travel.

There were two aims of this project. The first was to make a novel car and the second was an experiment in project management which was basically to get on with it!

If there was a problem with a supplier’s parts, we did not arrange a convenient meeting in several weeks’ time. As soon as the problem was identified the engineer travelled to the supplier’s premises and stayed until it was resolved.

For about a year I had to keep a packed bag by my desk as I never knew which country I might be in that night. I would set off for Landvetter Airport and by the time I arrived, flight and hotel tickets would be waiting for me.

My return to day-to-day life at Ricardo’s base wasn’t very happy. The department head, who never liked my way of working, gave me a job of mopping up dirty oil from beneath an engine on a test bed.

A few days later he told me that I was not much use as I had forgotten the Ricardo way of doing things!

I wondered what to do next and the answer came when I was approached by a recruitment agency who asked if I would like to move to a part of Aston Martin, something I was rather dubious about initially.

However, the offer of 50% more salary and the fact that property prices in the Milton Keynes area were less than half of those in Sussex, persuaded me, and I joined what was then named Aston Martin Tickford on 1st April 1986.

This was a fairly new company having been created when Aston Martin went through one of its regular periods of financial difficulties in the late 1970s. At that time, it was jointly owned by Peter Livanos and CH Industrials.

Peter Livanos, whose family had the largest merchant shipping fleet in Greece wished to continue making fast luxurious cars and didn't really need any profit. However, CH Industrials definitely did, so they created a company to sell the services of the engineers to other car manufacturers. To do so they resurrected the name Tickford which had not been used for some time after David Brown bought the Tickford coachworks company in Newport Pagnell and moved the Aston Martin production to that site.

I joined as an engine development engineer, but my business card showed no title.

At a very early conversation with my immediate superior he said, "Don't take too much notice of titles as in this small company people will rise to whatever level of which they are capable".

There was no rigid reporting structure involving performance reviews and no scheduled career progression. Most people seemed to be more interested in getting on with the work than in their status or title.

There is an old saying that in the land of the blind, the one-eyed man is King. And so it was that within less than a year I seemed to be the person making many of the technical decisions concerning engines, with a couple of teams of engineers carrying out the day-to-day tasks. In that time, we had progressed from 2 to 13 test beds with far more instrumentation than had been seen before.

I had many technical confrontations with the person who had the title of chief engineer - engines. He had been an Aston Martin employee and had progressed from a very enthusiastic mechanic but with a rather limited technical education and had some very odd ideas why things happened. For example, he insisted that an Aston Martin powered car that raced at Le Mans lost power every time it ran under a cloud.

At Tickford we were fully aware that nearly all of the work we obtained from the OEMs was because we had significantly lower charge out rates than the longer established companies. We had to continually devise ways of minimising costs while not sacrificing capability and I thought one example may be of interest.

This concerns the mounting of an engine onto a test bench and connecting it to a dynamometer. Most companies would demand all information about the engine from the client and fully design every part, then make it. All of which could easily cost £5000 even in those days.

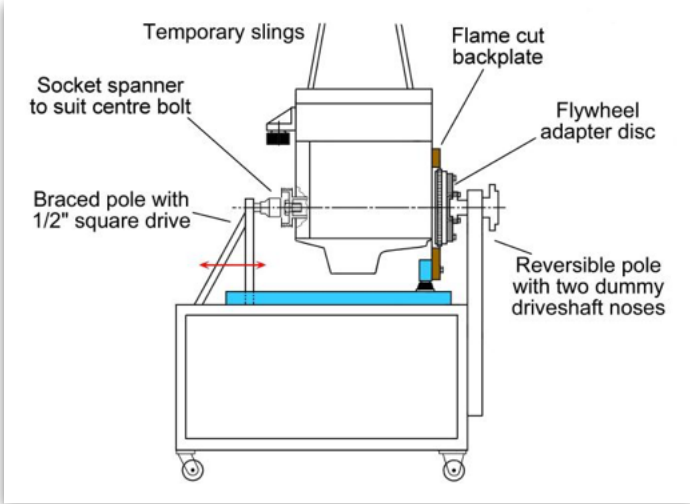
There is not much point in aligning everything perfectly as engines are flexibly mounted, so we used drive shafts that only needed to be within +/- 2.5mm

I designed a rigging trolley to mount the engine on the pallet (blue) in the correct location, but to do so as quickly and cheaply as possible.

The flywheel adapter disc was the only part machined accurately and located the back end against a dummy drive shaft nose.

At the front was a frame carrying a ½" drive from a socket set at the correct height to which was fitted a socket spanner to suit the front nut or bolt.

At the back was a rear mounting plate, flame cut from ½" hot rolled steel plate. The mounting holes to match those in the back of the block were drilled in line by a special gadget fitted to a hand drill. The side or front engine mounts were finished by night shift joining everything with metal in their spare time when they weren't taking readings on running engines. Often it was all done in 24 hours.



The rigging trolley to mount engines on the pallet

As the company grew it became necessary to introduce systems to define what an engineer wanted the technicians to do, keep records of what had been done and give authority forthose carrying out the work to book time and materials to the relevant job number.

Some proposals were so complicated and unwieldy that they could have come from Brussels but, in the end, I got my way and introduced **one** common form for any task. The originator could request anything to be done or made but had to specify it so that it could be done without further instruction should the originator have fallen under a bus. Phrases such as 'carry out verbal requests' were banned. So too was the term ASAP as this could mean anything from 'I need it urgently' to 'whenever you have time to fit it in.'

The form had to be quickly approved by someone with appropriate spending authority and when the work was completed it had to be signed by the person who performed the work as requested or, if not, a brief description of the variation. Thus, one piece of paper complied with all the requirements, many years before the quality industry tried to take over the world.

We mainly worked for the well-known car manufacturers who were concerned that neither the press nor any competitor could obtain information about forthcoming products, so security was important.

One of our directors came up with the idea that everyone should have a security badge on a lanyard around their neck, just like big companies. I have always thought that they are largely worthless as I have never seen anyone look closely at one to check its validity. In a small company where everyone knows each other on a first name basis it is not of any benefit, especially when the only people who didn't have security badges were the new employees because their photographs hadn't been taken and the badges not prepared. This stupidity lasted just a few weeks before it was abandoned.

For the first few years most of our work was under contract to Austin-Rover as it was briefly called. One of the most interesting (and useful to us) projects was to test all sorts of induction system configurations on a 1.6 litre 16-valve engine which never saw production.

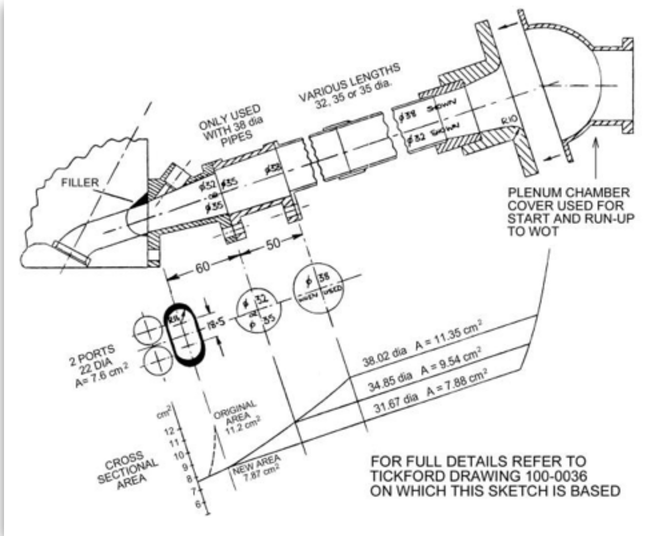
We quickly drew up and made a kit of parts with lengths in a geometric progression so we could test the maximum number of configurations with the smallest amount of hardware.

At the same time Austin-Rover were having all these systems modelled in an engine simulation program at NEL so that the results could be compared, and they could get a feel for correlation (or not) between theory and practice.

We learned a tremendous amount including some surprising things.

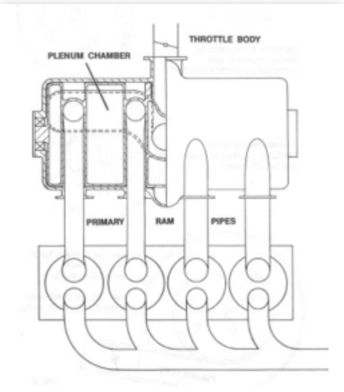
Having tested many different diameters and lengths of straight intake runner we then investigated the effects of bends by making some of around the optimum size with bends that varied in both angle and radius of curvature.

Contrary to common opinion most results indicated that they were as good as the straight pipes.



Typical experimental intake runners

Partly as a result of all that we had learned at a client's expense, we designed and patented a variable geometry induction system that was able to optimise primary wave and inertia ram plus the Helmholtz resonance of the complete intake system for any engine speed.



Tickford Variable Induction System

It involved a rotatable drum incorporating inlet tracts to change lengths and internal volumes.

I wrote and presented a paper on this at a seminar about Variable Geometry Engines organised by the IMechE in Mid-1991.

During the tea break, I was sat next to one of the several stereotypes amongst the IMechE members that attended such meetings in those days. He wore a tweed jacket with leather elbow patches, and, in a very plummy voice, he said that he found my paper very interesting and asked how long I had been a member.

When I replied that I wasn't he said, "In that case we must sign you up immediately" and

rushed off to get the application forms.

He stood over me while I started filling them in and when it came to listing my qualifications, I had to admit I only had a few O-levels. At this point he snatched the forms way and said" I don't think we want your sort".

Back at base, the Austin-Rover work then switched to performance, economy, and emissions development on the K series engines, the lovely little lightweight engine that was very good in its original form before they started increasing its swept volume.

For the first year or so we were the only site carrying out such work on the 8 valve (K8)

engines as A-R's own facilities at Longbridge had not been completed.

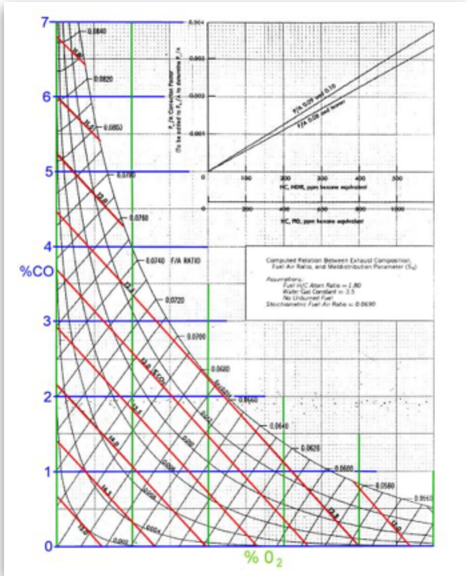
We had regular weekly meetings and one day, when preparing to go to Longbridge, I must have appeared to be rather demanding when one of the test bed engineers was rather late in processing all the information. Just before I left, he handed me an A4 envelope and said, "everything is in there".

When I opened it in front of our clients, there were about 20 sheets of blank paper. Fortunately, I was sufficiently aware of everything going on that I was able to remember most values and sketch the relevant graphs.

One of my concerns was the waste if testing continued, producing invalid results, due to faults with the test equipment or the engine itself.

The most common of these was incorrect exhaust gas emission readings due to air leaks in the sample lines.

The validity can be checked by cross plotting the readings of Carbon Monoxide, Carbon Dioxide and Oxygen on an Eltinge chart. We had large scale graphs made with a transparent overlay onto which the proportions of the three gases could be marked with a chinagraph pencil for each test point, but it requires the technician to actually do it.



An Eltinge chart

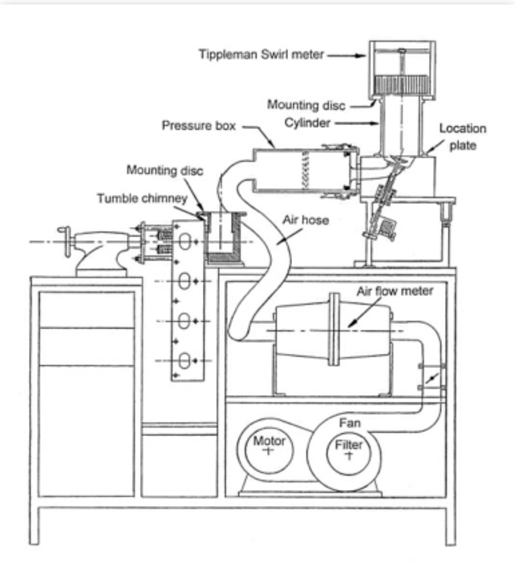
With one of my brighter colleagues, we worked out a way that the gas analyser bank could automatically compare the proportions of the three gases and raise a simple alarm such as a big red light if a fault occurred.

We offered all the formulae and other information to the manufacturer of the gas analysers so they could write it into the software, but they wanted something like half a million pounds to do it, so it never happened.

This was one of the great missed opportunities as it could have saved all their customers a huge amount of money.

We had much more success than ever imagined with our air flow rig for testing ports.

I had learnt all about the methods when at Ricardo, and with that background and some novel ideas I designed a compact Air Flow bench, not much different in size to a domestic cooker.



The Air flow bench

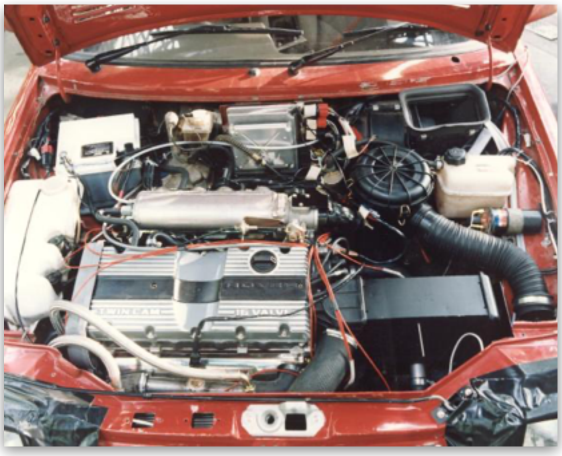
We bought the accurate airflow and swirl meters from my old employer and Austin-Rover supplied the concept designs of the adapters used to connect the cylinder heads to the rig during tumble testing.

We soon found that small discrepancies in the sharpness of edges and other tolerances could have a significant effect on the results and the parts hitherto fabricated out of sheet aluminium were not good enough.

To fully machine metal adapters would be very expensive and time consuming, so we came up with a semi-modular system where the unique components for each cylinder size were machined from big blocks of PVC by a local company that specialised in making parts out of plastics. They were used to cutting plastic at huge feed rates that prevent any local region of plastic from melting.

We created a generic drawing whereby all the dimensions were related to the cylinder size and all we had to do to obtain a new sized adapter was to email the supplier with the cylinder bore diameter and we could collect the new part in a very short time, sometimes just three hours if they were not too busy. The ability to test ports very quickly and accurately generated a lot of work for many clients.

Later it resulted in us making a complete flow bench system for Ford US who reckoned that our equipment was the only one that gave results that correlated to real engine combustion characteristics.



Engine of the turbocharged Metro

One small but very interesting unofficial project that we carried out was to experimentally install a turbocharged 1.4 litre K16 engine in an old Metro.

The engineer in charge of K series development at A-R had saved some of his budget to use for interesting projects that were not necessarily very official. At Longbridge they had made a few experiments on turbocharging the K16 but it was far from fully developed. For example, the power curve could only be achieved on the test bed by manually opening the wastegate the appropriate amount for each speed because Garret AiResearch, the suppliers of the turbocharger, could not provide a suitable prototype wastegate capsule for many months. It did not take much effort to discover that Helical Springs of Lytham St Annes were making customised wastegate actuators for the go-faster market and could produce them to any desired specification within a few days.

Having got the engine under some sort of control, the next issue was the maximum torque, which was far too much for the Metro's bought-in transmission as used in the Citroen AX. If the maximum boost was set to match the torque limit the maximum power was well down on the potential for this engine so we needed a varying boost across the speed range.

We came up with a solution with the help of a company in Buckingham, Detection Techniques, who had started making metal detectors then moved into hacking into engine management systems and supplying modified control strategies that they sold under the Superchips name.

A new wastegate actuator was fitted to naturally limit the boost to prevent excess torque and a pulsing valve (borrowed from a SAAB 99 Turbo) was interposed between the actuator and the boost sensing pipe at the compressor outlet. Detection Techniques designed and made an electronic box that changed the duty cycle of the pulsing valve according to engine speed.

With a few dynamometer runs and some small modifications to the electronics the system, although not perfect, was good enough to build a car that could be tested without immediately breaking the transmission.

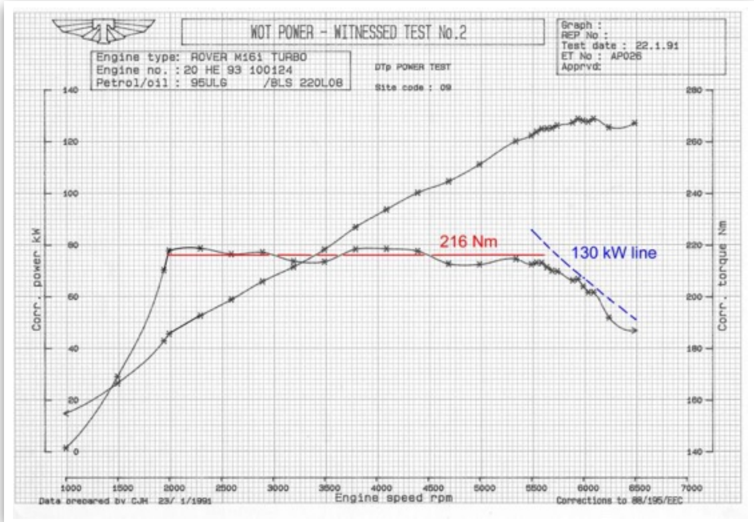
The car was taken away to be tested at Gaydon, the Austin-Rover Technical Centre at that time. A then-current rumour said that there was a Rover Vitesse chase car which saw 145 mph on the speedometer and the Metro was still disappearing into the distance.

It was deemed that the vehicle was fundamentally dangerous in its current form, and it would never be possible to provide adequate brakes within the small wheels. It is believed that this car was dismantled and scrapped fairly quickly, before it could hurt someone.

Around 1989 we were asked to engineer the first Turbocharged version of the Rover 820 which used the 2 litre 16 valve M series engine. This was a couple of years before Rover did their own version using their later T series engine.

Once again, the transmission had a torque limit, this time of 216 Nm but Rover wanted to achieve a power of 130kW, for diplomatic reasons just a tiny amount below that of the Honda V6 used in the 827.

Not only did this mean an absolutely constant torque all the way across the speed range to 5750 rev/min but the Rover marketing department wanted this performance no matter what ambient pressure and temperature existed. We managed to fulfil this desire by controlling the boost at any given speed until a target mass airflow was achieved. I created the logic and strategy then Lucas wrote the coding which they integrated into their engine management system. Unfortunately, the control wasn't perfect because of the hysteresis of the pneumatic wastegate actuator.



Power and torque curves of the M16T engine

One consequence of the flat torque characteristic was that it didn't give the driver the normal feel of acceleration. It was similar to taking off in a jet-propelled aircraft in that after the initial push, one's body got used to the feeling and lost the sense of continued acceleration. The unfortunate result was several prototype cars arrived at corners far faster than the driver realised and had to be helped back on the road.

It was all working out rather splendidly until it came to the witnessed power curve for vehicle homologation. The Department of Transport rules stated that the performance had to be corrected for atmospheric conditions, and they couldn't cope with an engine that self-compensated. We had to wait for a nearly standard day when there was negligible correction to be applied.

I mentioned earlier about the need to spot invalid tests before too much time and money were wasted.

It became very apparent that we needed to teach the technicians more about how engines work so they could notice when tests were not going well.

The management made it quite clear that this could not cut into productive operating time so I started writing and presenting a series of 1-hour talks which were performed in two sessions, one before the 2 p.m. shift change and the other after so all technicians could attend just outside of their normal working time.

It was quite amazing how popular these talks became. In the end, nearly 60% of the staff including chassis and body engineers were attending in their own time.

A few years later we had started working for Ford and became quite friendly with the engineers. One of the cleverest left to become a lecturer at Loughborough University and, knowing about my engine talks, asked me to do a few lectures for a MSc course for Ford graduate engineers. It slightly amused me that I, with no qualifications, was teaching a room full of graduates.

My lecturer friend then moved to the University of Central England (now part of Birmingham City University) where he asked me to do something similar and that led, in turn, to some more talks to groups from industry.

After the Rover work declined our major customer became Ford. During 1992-3 the biggest slice of the Dunton research centre budget was allocated to investigations of the Orbital two-stroke engine that was extensively promoted by that company, and who managed to persuade several big motor manufacturers to take options on a licence.

I was given the task of adding to or modifying every one of Ford's extensive suite of engine validation tests to account for any possible differences between their usual four stroke engines and the Orbital.

An example was the Alpine descent test which came about because the total loss lubrication system was load dependent. We reasoned that if the car started at the top of a very long hill, it would be possible to travel many miles at a moderate to high engine speed, but with closed throttle and hence minimal lubricant flow. So, I had to invent a test procedure to simulate this and see if the engine seized or wore itself out. I often wonder if by doing such a comprehensive job, it contributed to the demise of the project.

There were several trips to Australia at this time, not only to Orbital in Perth but also to Melbourne as Tickford had become Ford Australia's performance partner.

Engine bay of Ford Falcon XR6

I was heavily involved in designing special components to up-rate the 4 litre straight six engine for the first XR6 model Ford Falcon which involved creating a novel cam design method to overcome some issues with the valvetrain at high speeds. The resulting engine was incredibly good value. It had something like 97% of the performance of the 4 litre Jaguar AJ6 which had twin camshafts and four valves per cylinder and cost about three times as much to make.

All our major projects had code names, and this was Harrier, being a pun on a type of bird of prey (not Falcon) and also a name used for cross-country runners hence a vague connection with sport and speed.

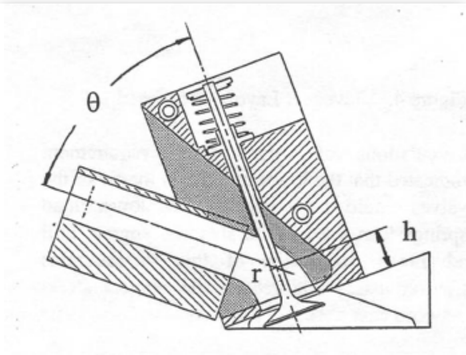
We were also working for Ford Advanced Engines in Detroit for whom we made a five valve per cylinder conversion of their 2.5 litre V6 Duratec engine amongst many other projects. I wrote and presented a paper on this at the SAE congress in 1995 which detailed several very interesting discoveries we made with that configuration, concerning potential charge stratification, burn rate and ability to produce maximum power with stoichiometric (ie perfectly chemically complete and correct) Air Fuel ratio.

This project name was even more obscure. Starting with 5 valves per cylinder we toyed with variations on PENTA (from Greek) then QUIN (from Latin) which led to the Manfred Mann song The Mighty Quinn so it ended being named project Eskimo.

The 5 valve per cylinder Duratec

For this project we had to learn more about the trade-off between air flow and air motion generated by the inlet ports. By this time most engine research organisations were using Computer Aided Design to create the shapes of inlet ports and then have these machined into dense fibre board by CNC machines to form a flow box, as the test piece is called.

We could not afford the time nor money of this approach, so I came up with a cheap and cheerful alternative.



The variable inlet port model

One part of the aluminium test piece was the combustion chamber, the valve seat, the valve and its guide. The other part was a straight section of port. These were joined by linkages such that the straight port could be set at various angles to the valve stem and the intersection height could also be varied. Everything could be separated along the common centre line and having set the geometry, each half was laid on a plywood board and the region between the straight port and the valve seat filled with stone plaster, a harder material than plaster of Paris.

When this had set, a router with a hemispherical cutter was used to create the desired radii joining the two regions together, guided by pegs in the board. With this simple equipment we were able to create and test up to four configurations in a day, and the many results led to a great understanding of the interaction of the various features.

Interestingly, many years later when my colleague who had carried out most of the work, and I were both working at MAHLE Powertrain, a very similar study of the effects of geometrical features in a bifurcated inlet port was undertaken with every configuration modelled in CAD and machined perfectly at great expense.

We were rather gratified to find that the overall results were very similar to those we had found many years earlier with much cheaper methods.

There is a perception amongst the majority of the public that engineers are nerdy and humourless people but as most of us know, that is certainly not true.

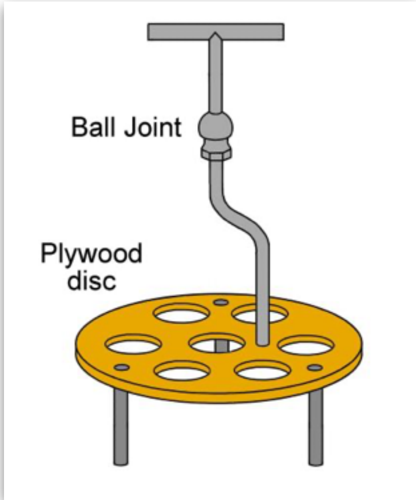
Tickford was a great place to work. We worked hard and fast but there was a continual flow of witticisms.

In the early days we had only one PC in the whole company, but a very bright guy who knew about such things. Whenever he was busy stealing software, he used to sit at the computer wearing a pirate's eyepatch.

In the engine development office we had a bad joke box instead of a swear box, the very substantial proceeds of which went to charity. I decided that those who judged how bad the joke was should be called the Joke Box Jury, which in itself cost me a few quid.

A couple of stories about the test bed technicians demonstrates they were no better.

At one time, I became slightly annoyed at the amount of coffee being spilt on the shiny resin floors of the test cell control rooms. On investigation it transpired that it was common practice for one technician to fetch several coffees from the vending machine on a simple tray and often spillages occurred. My engineering solution was to design and make a cup carrier comprising a disc with six holes around one central hole which was suspended from the handle by a ball joint. The inspiration came from my boyhood memory of the swinging drinks holder in the captain's cabin of the Cutty Sark at Greenwich. With any number of cups from 1 to 7 a balanced pattern could be achieved and as the carrier swung the liquid surface remained flat relative to each cup. Great, I thought that problem had been solved permanently.



The swinging cup holder

However, after a month or so the coffee spillages started again so I went to see if my cup carrier had been broken. The carrier was fine, but the technicians had become so fascinated by it they had started a competition to see who could swing the thing right over through the inverted position without spilling anything.

Another amusing incident occurred for which I wish I had a photo. I needed to thermally insulate something so obtained some two-part polyurethane expanding foam. Late one evening the night shift started messing around and not realising just how much it expanded, mixed rather a lot of the two liquids together. Of course, it suddenly started to expand like a huge loaf of bread rising in the oven.

At that point the company chairman walked down the test bed corridor on a surprise visit to see what went on out of normal hours.

The technician involved quickly threw the expanding foam into a dustbin and when the lid started to rise, he sat on it. However, that didn't stop it and as he was being questioned by the boss, he gradually rose towards the ceiling on a column of foaming plastic.

My work wasn't all about turbocharging, but a third project of interest was the first Ford Focus RS which we started working on in the year 2000. As usual the brief was to achieve the required performance with the minimum change to parts but also to ensure it could be processed on the engine and vehicle production lines.

I spent several days with a couple of designers at the Bridgend engine plant to ensure that all the changes could be accommodated. Such visits concentrate the mind. When the Iron Block Zetec line was installed, it was designed to run at a station time of 17 seconds, so every operation had to be completed in 15 seconds before the engine moved to the next station. The only exception was the cylinder head machining station where two parallel tracks allowed double the time, still only 30 seconds.

One of the issues we had was that the exhaust manifold and turbocharger, when fitted to the engine, would have projected outside the standard shipping crate so it had to be added at the engine dress facility next door to the vehicle assembly line in Saarlouis, Southern Germany. This is where they add the alternator, power steering pump and air conditioning compressor to the base engine as required for the vehicle specification.

Here they had to match the speed of the main vehicle line which was building a car every 37 seconds. Clearly, fiddling about doing up half hidden nuts with a ring spanner was not an appropriate idea. We were warned that if our modified vehicle caused any disruption to the line then each standard vehicle lost would equate to $1000 and if the line shut for a day, then the plant would be fined an additional $1million by Ford headquarters.

I have so many more stories about my times at Tickford, but to tell all would take several weeks. It all came to an end when the chairman and major shareholder, who had led the successful management buyout some years earlier, wanted to retire, and the company was eventually sold to Prodrive.

Prodrive was, and is, a company very much focussed on image and the first thing they did was to send in a team to tear down any emblem or picture on a wall that had any reference to Tickford and then proceeded to paint most things in their corporate colour of white. A literal whitewash!

It was not long before we all received the first official communication about how to behave under the new regime, but the content was slightly unusual, and to my mind, didn't really help the engineering side of the business. It specified the type face and point size of any document that was to be written and that if two or more sheets had to be clipped together then the paper clips had to be white not silver.

I lasted a few months before the personnel department found a way of making every one of the established senior engineers redundant.

One of my colleagues had moved to TWR (Tom Walkinshaw Racing) based in Oxfordshire and I was invited to join them.

My job during the next year was heading up the team designing a family of engines for the Iran Khodro Company. Back in those days the US and EU treated Iran as a country that was friendly enough to do business with.

The idea was for them to manufacture modern efficient engines to power a new national car that would gradually replace the Paykan (closely based on the 1966 Hillman Hunter) and therefore save oil which could then be exported.

Incidentally Iran now produces more cars than either the UK or Italy.

I decided that the main engine to start the family should be a three cylinder of around 1.3 litres, but although we carried on down this route, I knew there was a large body of opinion within the customer that it couldn't be right because no other car manufacturer was going this way. We were obviously too far ahead of the game.

My immediate boss, the business manager, and I visited Tehran twice and found all the people absolutely charming. They set up all sorts of management structures, gave people titles and offices but never made any firm decisions. In the end they continued as before and bought designs and tooling from the PSA group.

After around a year at TWR it all came to an end when a judge in a high-profile court case made some very disparaging remarks about Tom Walkinshaw's business practices and his whole empire collapsed like a house of cards.

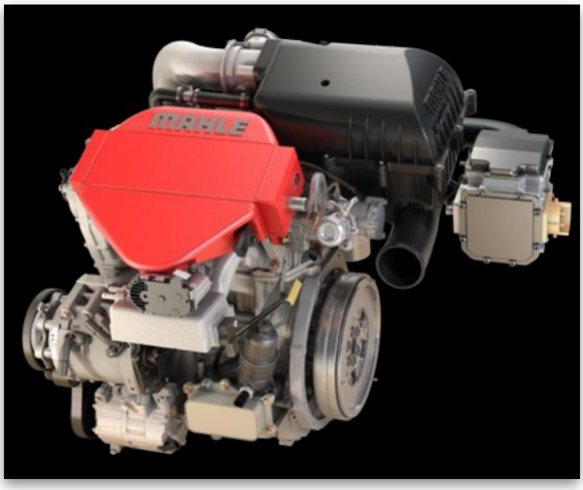
After that redundancy I was out of work again for some six months, not being able to find a suitable job. I was seriously thinking about stacking shelves at Tesco.

Fortunately, some colleagues who had moved to Cosworth Technology in Northampton suggested to the Chief Designer that I might be useful. Eventually I did join them in 2002 and stayed until I finally retired when I reached seventy-five.

That company started as the road engines side of Cosworth and had been bought by Audi. When I first joined, I was asked if I wanted to be a project manager. However, I said that firstly I knew nothing about their management and accounting systems and that secondly, I was far better at technical matters than anything else.

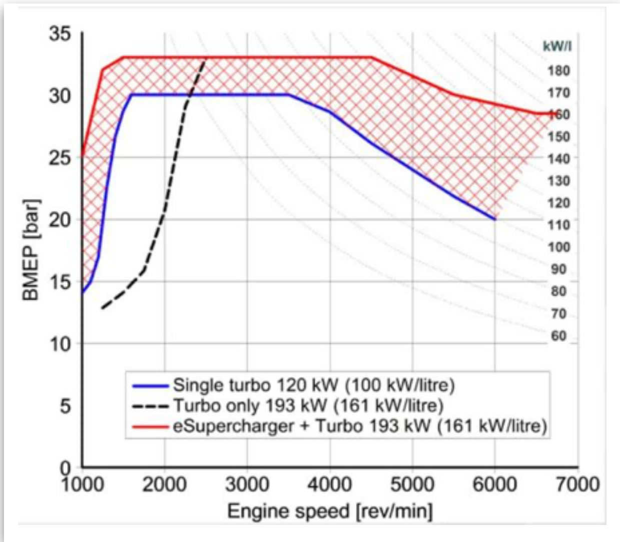
To their credit they created a special post and title of Technical Specialist – Engines, which had the same pay and status of a senior project engineer, but I had no responsibility for financial matters or man management. I was the only person in the company to have all the fun and no responsibility!

This continued after the ownership changed from one German company to another and it became MAHLE Powertrain. I was a sort of internal consultant but didn't have to wait to be asked. I was able to poke my nose into any design work and try to guide the design teams by logical explanation of how things work.



The MAHLE Powertrain Downsizing engine

One of the projects in which I had quite an influence was our so-called Downsizing Engine which demonstrated what could be achieved by a small engine with high boost to give the performance of a much larger engine, but with better fuel economy. Strangely this turned out to be a 1.2 litre, 3-cylinder engine because it was the best technical solution, although for slightly different reasons than the engine we were proposing to the Iranians many years earlier.



Torque curves for the downsizing engine

The initial specification for the base engine was a maximum cylinder pressure of 120 bar, but since I had significant experience of mission creep, I encouraged the designers to make it quite a bit stronger. I also spent hours with the CFD guys optimising the cylinder head cooling in an attempt to make it less likely to knock. This was just as well as over the years the boost has been increased and in its latest version it is now producing 193kW (259 bhp) and 33 bar bmep across a wide speed range.

The range extender

For the last few years most R&D money was being funnelled towards electrification, and I was very much involved in the design of a neat little range extender incorporating a twin cylinder engine and integrated generator.

Having had considerable experience of things going wrong, however unlikely, I had been involved in many

Failure Mode and Effect sessions connected with our own projects and when a would-be battery pack manufacturer asked for help in thinking about possible failures, I was sent to take part.

Their employees didn't seem to understand that the idea was to consider every possible mode of failure then rank them. Time and time again I heard them claim that something was so unlikely it wasn't worth writing down.

The time came for a practical test to be done in the car park at MIRA. They set up one of their battery packs with video cameras to record what happened when they intentionally overheated one battery pouch. They were somewhat surprised when the lid shot several metres into the air, all the video cameras were destroyed and there was a bit of a hole in the ground.

In my last ten years at MPT, I did not need to be with the design teams constantly and ended up writing a sort of book with a chapter on how to design each and every system of an internal combustion engine. This came about because it was recognised that old, experienced engineers would not be around for ever.

For many years, the idea of writing down knowledge at Cosworth Engineering and its successors had been proposed but each time it had been vetoed by senior management for fear that an employee could take the knowledge to another employer or start up themselves, as indeed Ilmor had done.

The solution was to keep the information on computers and only available to employees who were securely logged in to the company's IT network.

As far as I know, the information is still available and just occasionally the engineers access relevant sections.

It might come in very useful if it is realised there are not sufficient resources on this planet to provide batteries and electric machines for all the transport needs of the world and there is a modest resurgence of interest in internal combustion engines, but no old grey-haired engineers who remember what we used to do.

Richard Sykes

End of Newsletter Supplement