ROYAL AERONAUTICAL SOCIETY
Loughborough Branch

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Bloodhound Land Speed Record
Richard Noble OBE
Project Director

Already well-known to most of the audience, the speaker was creator and driver of the Thrust2 vehicle and established a new world land speed record on 4 October 1983 when he attained 633 mph (1,019 km/hr). The record stood for 14 years, and his successor was the driver of Noble's next design, ThrustSSC (supersonic car). This was ex-RAF pilot Andy Green, who on 15 October 1997 achieved 763 mph (1,228 km/hr) and fulfilled the distinction of being the first land vehicle to officially break the sound barrier. We were reminded that Thrust2 and ThrustSSC are now displayed at Coventry's Transport Museum.

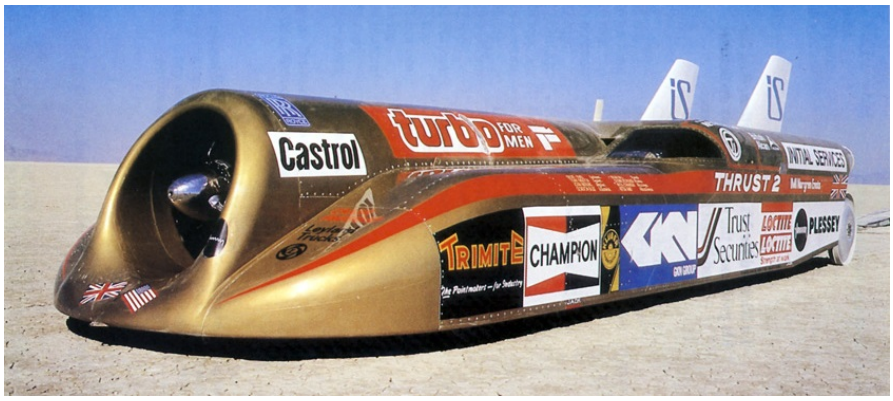
The world land speed record has barely been challenged in 20 years, and in recent weeks the only car so far known to be the likely successor, the BloodhoundSSC, has conducted its first trials at Newquay Airport. The design and development of the potentially 1,000 mph (1,610km/hr) record-breaker is attributable to the technical and driver team of the previous two record holders, and perpetuates a now long-standing partnership of specialists.

The speaker was determined to stress the vast effort needed to fulfil the ambitions involved, and to acknowledge the work also contributed by supporters and other specialists over several years of research and development. Leading up to this he chose to review what brought him to being so involved in such an enterprise, and led us along the path he started along in 1952.

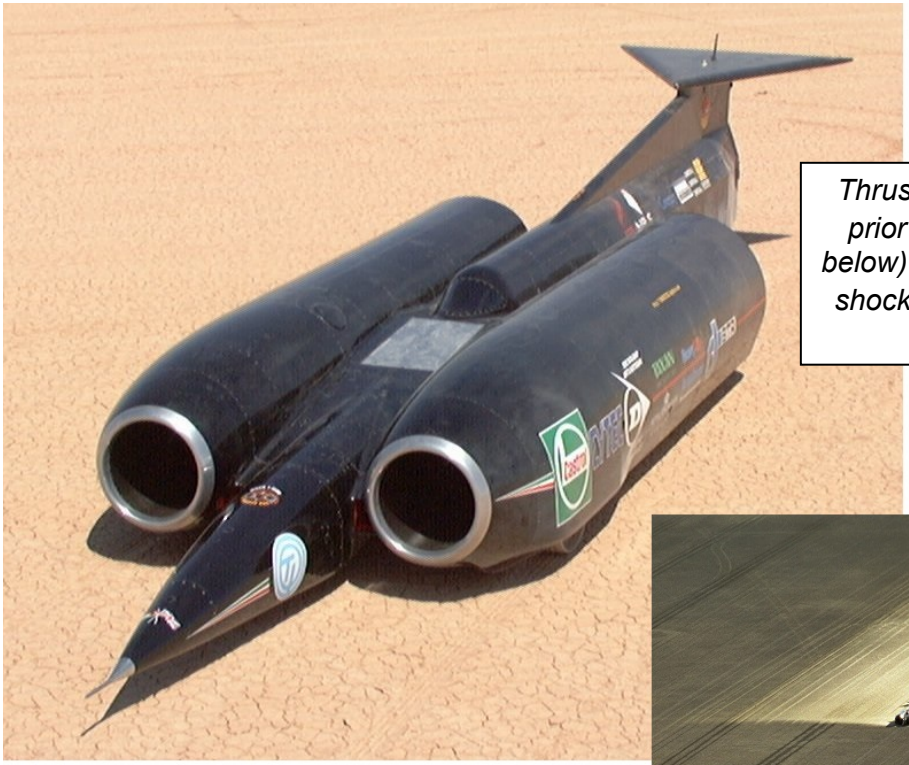
On a visit to Loch Ness, and an impressionable 6 year old, an unexpected thrill was to look up at the sleek lines of the Crusader jet-powered speedboat in which John Cobb was conducting trials to take the water speed record beyond 200 mph. Cobb lost his life later that year, on Loch Ness when he crashed at high-speed in the Crusader.

Over twenty years later Noble started to look at using a jet-propelled vehicle to attempt land speed records, and his first effort, built to his own specification, used a Rolls-Royce Derwent engine. It was in a vehicle he commented on as having, with the wisdom of hindsight, no safe correlation between the centre of pressure and the car's centre of gravity. It became uncontrollable and crashed without leaving him in peril, but providing a mere £175 scrap value memory.

He was not deterred and later acquired a Rolls Royce Avon 302 engine, as used in the English Electric Lightning, and with the assistance of designer John Ackroyd created Thrust2. This succeeded over many challengers and is the vehicle in which Richard Noble attained a new world land speed record of 633 mph (1,019 km/hr) on 4 October 1983.



The work involved in the design and development of the car had involved considerable aerodynamic investigation. Noble showed a time-line plot of the lift on the vehicle during the record run which revealed that the lift force was increasing most rapidly at the front and, at the highest speed achieved, Thrust2 was within 7mph of becoming airborne! He subsequently set about the design of a supersonic car that later resulted in the ThrustSSC. This employed two Rolls-Royce Spey 202 engines, as used in the RAF-operated McDonnell Douglas F4 Phantom. On 15 October 1997 'Pilot' Andy Green set the new land speed record by achieving 763 mph (1,228 km/hr), exceeding the speed of sound in the measured mile.



ThrustSSC on the desert prior to a run and (inset below) an aerial view of the shock wave as it attained Mach 1.0.

Three more Noble projects were to precede BloodhoundSSC.

The first was the JCB Dieselmax car, a low-drag long-body vehicle which featured two JCB 444 diesel engines with independent drive to front and rear wheels. Standard production versions of this engines are normally rated at 140bhp. For Dieselmax they were uprated by Ricardo to 750bhp using two-stage turbo charging to 6bar. It set a new world speed record of 350 mph for a diesel-powered car in 2006, and was driven by Andy Green.

For a while Noble pursued commercial opportunities in aviation and described two projects. Common to both programmes was the desire to use technology innovatively, and for good purpose: one for light aviation and the next aimed at a commercial aviation niche. The ARV-Super 2, first flown in 1985, was a two-seat design with a 77hp (57kW) Hewland AE75 3-cylinder liquid-cooled inline engine. It is a fully certificated transport category light aircraft with superplastic aluminium forward structure and forward-swept wings. The novel engine and simple structure produced a light aircraft that promised to be much less expensive to buy and operate than competitor aircraft. Even so, only about 40 examples were built in the early 1990s, due primarily to financing difficulties .

Not one to be deterred by lack of investment interest, Noble set about the development of a high-performance 400kt single-engine IFR turboprop aircraft in 2002 influenced by advanced NASA Small Aircraft Transportation thinking on distributed regional air travel. The Farnborough F1 was designed to meet the needs of time-sensitive companies and private travellers. It was a high speed design with cabin space for up to six people, capable of operating from small strips, and was aimed at offering a near door-to-door Uber service. Having a range of 1000 miles + IFR reserves and assuming 1000hrs utilization the operating cost per mile was similar to that of a Range Rover.

As UK entrepreneur interest flagged again, the project was re-invigorated by a US opportunity, and this led to the first flight of an example taking place in 2006. A decade or so later the design still shows potential but has not been committed to production. There is little to be critical about the philosophy that underpins its potential, but again it is an example of innovative engineering not winning sufficient investment approval.

Engineers are well aware that cost is always the highest priority item for any technology project, so how the BloodhoundSSC project got underway, and is closing now on its final

objectives, is a rare tale to hear. It turned out to be a fascinating example of how times have changed, and such a 'never give up easily' character as our speaker has cleared obstacles and made headway – a personal note: in an alleged season of financial austerity!

First: the design was turned from ideas into a configuration, and secondly the funding support was gathered. The overall design is attributed to Ron Ayers, an aerodynamicist with the Bristol company at the time of the Bloodhound missile programme in the 1960s. His knowledge had been invaluable for ThrustSSC and when told a 1,000 mph vehicle was in prospect he worked through the compromises of various configurations and came to the conclusion that it would be one jet engine, and that rocket propulsion would be essential. The design has to be akin to a rocket – slim cross-section and a tubular body so low-slung that it almost sticks to the ground. Following the ThrustSSC programme he again used computational fluid dynamic (CFD) methods developed by Swansea University which had been validated by rocket-powered sled model tests at Pendine in South Wales for the 1997 ThrustSSC programme - the first ever use of CFD for a performance race car. (The 1997 plot of ThrustSSC CFD results versus ThrustSSC model test data had showed a correlation that exceeded expectations.) We were amused with tales of meetings, of bombarding board rooms with briefings, and more, until the doors to almost inconceivable treasures eventually unlocked. They got access to the EJ200, the most recent military jet engine in Britain (and these were not rejects – but test engines with flying time that have completed their prime job).

Much support came in a less conventional way. It remained a technical development programme but internet-based activity tentatively pioneered in the ThrustSSC period was adopted. The team created and received assistance in managing web-sites on which they could run blogs, ask/answer questions, inform and gather data. They used the learning to build items of interest that had a vast national, and international, value and now counts an enormous number of regular web contacts. He cited the importance of the teams large scale Bloodhound lecture programme which attracted the nations specialists for valuable comment and advice . At one lecture they had explained the plan to use a hybrid rocket to provide a further 120kn thrust with solid fuel and a liquid oxidiser. A scientist in the audience immediately alerted them to the perils of the oxidiser they chose – nitrous oxide – and convinced them to make a change, which they did- to using HTP. With that done, following some 12 small scale test firings in Mojave, when the full scale motor was designed and first tested by the team, they realised that achieving both the power output and the safety would break the fragile company and specialist help was needed. About 6 months later the team were able to build a very special relationship with Nammo AS who had spent 12 years developing their hybrid motor for low earth orbit launcher application.

The key to the Bloodhound education programme came about at the suggestion of Lord Drayson, then Minister of Defence Equipment and Support at the MOD. Concerned by the MOD inability to recruit scientists and engineers into the MOD and remembering the educational stimulation created by the Cold War British aerospace industries , he invited the Bloodhound team to run the project through every school in the UK to help encourage the next generation of scientists and engineers.

With no pretensions of being leaders in education , the team invited suggestions from teachers at the BETT education show. The teachers made it clear that they wanted live performance data from the Bloodhound car into the classrooms together with appropriate apps for data management and performance prediction . Since Defence, Space or the Racecar industries had shown no interest in this , the Bloodhound team realised they had

the unique corporate social responsibility selling proposition and decided to deliver the concept.

In 2016 the Oracle Corporation US Board decided to back the project with a sizeable global programme to store and deliver the data and apps to the schools and project followers in 200 countries. In fact everywhere except North Korea and Vatican City!

The technical skills involved were what education has a need to access, and school-related STEM (Science, Technology, Engineering and Mathematics) initiatives now have unprecedented access through web-sites that are a two-way window between the public and the team. By stimulating the young and up-coming generations to know what is going on, what they can learn and use, they in turn often stimulate the team. At the core of the unfathomable number of routes that evolve through internet-related initiatives of this kind, it is hard to see anything that is bad about it. The goodness is obvious. It was a joy to hear of the 'web,' often so badly-used, and therefore so frequently maligned, being so maturely used and cherished.

He presented statistics that were almost fearful to see – in Britain alone 100,000 graduate engineers are wanted annually, and only 30,000 are forthcoming. The depth and clarity of that message delivered in the presentation was not necessarily what any attendees had expected to hear. The supply chain was investigated down to the primary school level, and it concluded that is where the stimulation is essential. The BloodhoundSSC project is now a magnet to young and inquisitive minds – 'inspire and open aspirations.' A film of recent (October 2017) test runs of the car at Newquay Airport clearly showed massive public interest. Over three days 9,500 people paid to attend and 500,000 watched video streaming: 3,600 children attended on the Education Day.

The BloodhoundSSC trial at Newquay (26 October 2017). The car reached 210 mph.

Everything is now moving forward with a momentum and clarity that the team seem assured will allow them to begin high speed trials in South Africa in time to consider the ultimate 1,000mph run to be conducted in 2020. The notes below are an early extract from their website (see link at bottom of the page):-

"HakskeenPan, right in the North Western corner of South Africa, was initially dismissed because of a large dirt road running across it and a 21m square metre covering of surface stones. However, back in 2000 a new tarmac road was built at one end of the pan and the

old dirt road became defunct …. in early November Andy Green and John Piper made another journey to Northern Cape Province. This time, the news was all good. Over 19 km long, 5 km wide, very hard and very flat (apart from the surface stones – and the dirt causeway, of course!), great access (the new tarmac road), nearby accommodation, on-site power, good communications, ideal weather: this was the location Andy Green had been chasing for over a year and a half!"

Richard records that HaskeenPan desert was found in 2008 and that, with the support of the Northern Cape Government, 1000 man-years of local labour went into clearing away a causeway road and removing 16,000 tonnes of surface stones to prepare the track for Bloodhound. The South African MTN networks company then erected 4 x 70m high transmission masts so that the huge data flow from the car could be bounced across the Kalahari desert and uploaded to the web at the Upington portal.

The presentation was thorough, stimulating and packed with information. These few words will be an inadequate primer to anyone who does want to take a deeper look into the subject - do not fail to refer to the team's (huge!) website for more details. We had a packed house and sensed a degree of satisfaction that is difficult to put into words!

Lecture notes by Mike Hirst

For more information refer to http://www.bloodhoundssc.com