

The Cancellation

Cancellations had been hanging over the aircraft industry ever since the Labour government was elected. Uninformed sources in the government claimed that "there was too much duplication in the aircraft industry." These people knew nothing about aircraft production, and the fact that all kinds of aircraft shapes and designs had to be produced to obtain the best possible designs for the future.

So, in spite of the claim by the government that it would "sweep away the unemployment caused by the Conservatives", they caused untold loss of jobs in the aircraft industry - and in the associated industries also. In cancelling the TSR-2 and ordering - then cancelling at even more cost - American replacements, they also left the country without a bomber force to counter communist aggression.

The 'anger' aspect of the TSR-2 cancellation, and virtual destruction of the UK's aircraft industry by Wilson's government, still looms large in me (and many others involved in the project) whenever something triggers me off - forty years later!

During the 2005 RAF Museum Cosford Airshow, I was prattling away at the poor chap on the TSR-2 stand about Wilson and his Labour government's profligacy and he said resignedly "You are about the tenth person to have responded that way this morning!"

Following the TSR-2 cancellation, and further havoc in the industry created by other cancellations and 'amalgamation' into large corporations, many British technicians and engineers emigrated to America - part of the so-called 'brain drain' - and most of them did very well, thank you!

One of the technicians at Boscombe Down, an airframe fitter, ended up in senior management on the Lockheed Galaxy project. A friend in the industry, a design engineer, subsequently played a large part in designing the space shuttle and other spacecraft. That was no benefit to the UK.

I was employed by the MOD (then called the Ministry of

Aviation) and working at the A&AEE (Aircraft & Armaments Experimental Establishment) at Boscombe Down, Wilts, when the cancellation went through.

It seemed to us at the time that the final nail in the coffin of our advanced project was when the second aircraft was delivered to Boscombe Down, XR220 I think, and it was 'dumped' off its truck and damaged. Most of us 'blue collar workers' at the A&AEE thought this was caused by something that was typical in the MOD - 'too many bosses' directing the driver!

Now I am wondering if that was a deliberate act by some 'spook' acting under government orders. It was claimed by the government that the additional cost of repairing this aircraft would add extra costs to an already 'over-funded' project. I have other theories but these may be too political for this type of publication.

Thousands of workers in the aircraft industry marched on London to protest the cancellation - all to no avail. As civil servants working in the Ministry of Aviation, we were not allowed to either strike or to go on protest marches. I think some did, but not myself.

Readers who are aeroplane enthusiasts but have never been part of 'the aircraft industry' may not realise just how many companies and employees are involved with producing a new aircraft. It isn't just the airframe and engine manufacturers that are responsible for getting the thing into the air, it's a whole army of people. And many of them also lost their jobs when the aircraft was cancelled.

Items that are made by other companies include a wide range of instruments and autopilot systems, radio and radar systems, safety equipment including the ejection seats plus fire protection, electrical power generation systems and numerous electrical components such as wiring, plugs terminals, switches and so on that distribute electrical power. Also wheels, tyres, brakes, even the high quality nuts, bolts, washers and rivets, fasteners etc.

In the late 1960s, I went to work at BAC Weybridge (still 'Vickers' to the employees) and changed my career to that of a technical author. There I found a great deal of bitterness about the cancellation. Not just the loss of jobs, but the way the government cancelled it: they made damned sure it could not be resurrected.

I was told that some 'suits' from the ministry had arrived to supervise the complete destruction of the project. They would not leave until all jigs were taken out to the airfield and destroyed with oxy-acetylene cutters, and all drawings, manuals and paperwork were piled up and burned.

As a technical author of many years standing since those days, I can confirm that months, if not years, of hard work had gone into writing and illustrating the manuals. Bahh!

The Project

During my career I expended a great deal of effort on TSR.2, both in the MOD and in an instrument manufacturing company. At the A&AEE Boscombe Down I was a skilled instrument technician and, horror of horrors, employed as a civil servant in what was then called the Ministry of Aviation. I carried out bay servicing on most instruments fitted in all the aircraft operated by the A&AEE.

My fellow technicians there had two amusing nicknames for the type. One was 'Throw Some Rocks - 2', based on its ident, and the other was 'Tear-arse' based on the awesome speed it could achieve! A fitter who was also a cartoonist produced a humorous cartoon on Tear-arse, so someone may still have a copy of that.

I witnessed the first flight of XR219 at Boscombe Down. All of us at the A&AEE were anticipating this flight with great excitement, and she lifted off beautifully. Several of the subsequent flights were also seen by yours truly. The exquisite design left one with the feeling that she was flying - and ready to pounce - when standing still on the tarmac! The undercarriage spoilt the looks a little on the ground, being rather large.

Boscombe Down was 'out in the sticks', well away from civilization, and pay in the ministry was abysmal. However, because most of us were aeroplane buffs and found the work extremely interesting, we enjoyed working there.

Many of us single employees lived either in the ministry hostel just outside the gate, or in 'digs' nearby. Other employees travelled many miles to work by car. One of my colleagues drove all the way from Bournemouth every day! I spent some time in the hostel, but got fed up with the manageress - who was rumoured to be related to either Adolph Hitler or Jo Stalin...

Then I was in 'digs' locally for awhile but got fed up with listening to family rows. So, for a few months, I lived in a country pub near my workplace of Boscombe Down. It was a great life, but I couldn't afford to stay longer - drinking every night! Later I moved into a guest house.

One thing that amused me during the time the aircraft was still under flight test was the way a farmhand would come into the pub I was staying in and, in a broad Wiltshire accent, discourse on the progress of the latest aircraft under test.

He would say something like "Ear you had problems with the Tear-arse today." Mindful of the official secrets act, I would respond with "Oh, yes, and what was that?" "Starboard downlock weren't workin." My response was "And how do you know that?" The thoughtful answer - "These things get around, you know."

It has to be said that the MOD police were totally ineffective when it came to official secrets. If a worker stole a washer or a nut - they were on to him quick-smart. Visit any pub in the district and you could hear all about the latest secret projects! Photography was banned around the airfield, but you could see people with telescopes or high-powered binoculars on nearby Beacon Hill.

After the cancellation the one TSR-2 we had, XR220 (?), was left out in all weathers on the tarmac for, I think, a couple of years. This wanton act made us more angry each time we

passed the aircraft. I persuaded my boss to 'rescue' some equipment from it and removed the Air Data Computer (ADC) plus other items of instrument equipment, then placed them in a cupboard for safe-keeping. A few may still be there.

British people had a good sense of humour in those days and, although the cancellation was nothing to smile about, we did get at least one laugh out of it. A few months after the fateful decision was made to scrap the project, a circular was sent around to technical supervisors at Boscombe Down.

Enclosed was a list of all the special tools that had been bought in for servicing the TSR-2, and the supervisors were invited to tick any items that looked like they might be useful in their department. The items would be redirected to them in due course.

One of our supervisors, Harry by name, found a 'torque wrench' in the list and thought it might be useful in our instrument department. A few weeks later, a long wooden box was delivered. Inside was an enormous torque wrench with a handle about 8ft (2.5m) long: it was a wing bolt torque wrench! After that, the embarrassed supervisor was known as 'Harry The Torque!'

All New Systems

I realise it is sacrilege to write anything against the TSR.2. However, I do feel that a serious problem - which could have been overcome in time - should be aired in the interests of the truth. The problem was that virtually everything in the aircraft was 'new technology' and had to be proved during the initial flight tests. This was of course what made the aircraft so advanced for its time, but equally could have caused serious delays in development.

Most new aircraft designs include some, or quite a lot of, existing, proven, systems and equipment. But virtually every system in the TSR-2 was brand new. The new - and unique - hydraulic system was never sorted out during the flight tests that did happen. Airbrake and undercarriage retraction problems can be seen in the flight test photos that are in the public domain. The new engines were troublesome too, with one or two blowing up under test!

A New Flight Instrument

A personal desire to have some influence on the design of aircraft instruments, and the ambition to enhance my career, meant that I left the A&AEE for awhile and joined the design and development team of an instrument manufacturer located near Southampton. At last I was an instrument design engineer. This was before the cancellation.

One of the interesting projects I was involved with at this company was a very special flight instrument designed specifically for the TSR.2. However, I felt very undervalued by the company so left them and returned to the A&AEE before the instrument was accepted by the MOD - and eventually cancelled along with the aircraft.

The instrument was a Combined Speed Indicator (CSI) which displayed airspeed and Mach on a round black dial. The case and bezel were light grey, as were the aircraft's instrument panels. Our instrument had a single pointer for airspeed, and a Mach counter with a black (automatic) shutter which dropped down over the counters below Mach 0.5 or if the counter system failed. A red failure flag dropped into view, also if the system failed.

I do not have diagrams or photos of the indicator. However, the airspeed scale was expanded at low speeds and compressed at higher speeds, with the scale starting at 1 O'clock and ending at 11 O'clock on the dial. To make things easier for the pilot, the 100 knot mark was at 3 O'clock, 200 knots at 6 O'clock and 400 knots at 9 O'clock.

Curiously, although some memories are strong in my mind I cannot remember whether the instrument was servoed (remote reading) or purely barometric. It had a barometric mechanism for airspeed, but I think it received Mach information from the Air Data Computer (ADC). I'm pretty sure the Mach counters had a servo mechanism (electric motor and gearbox).

The upper airspeed and Mach number displayed were considerable but shall remain secret, in case I'm breaking the law relating them! Below Mach 0.5, the instrument had an exceptionally 'clean' face with just the airspeed scale and its

single pointer showing. Sadly, the aircraft was cancelled before the CSI was installed, and existing airspeed/Machmeters were used in the trials aircraft.

Anyone who hasn't been involved in such work would be astounded at the amount of effort the introduction of just one new type of flight instrument required. Not so much as the airframe and engine, of course, but considerable anyway. I myself learned a great deal about 'the ergonomics of instrument design', and of the problems encountered during development.

I should make the point that all design offices encounter problems with new equipment, and engineers argue about the best way to tackle them. The following problems related directly to the introduction of the TSR-2.

Two difficulties we encountered during development were to do with the electrical connector mounted on the rear of the instrument and the special, patented, dial glass system that was designed to throw light from the internal bulbs back into the instrument to reduce glare.

From the start, the drawing office had included an electrical connector secured with attachment screws with threaded holes going right through the case. I objected strongly to this, as the instrument was a barometric device with static pressure inside and would be difficult to seal effectively.

In addition to this, the internal wiring would have to be repeatedly unsoldered then resoldered at the connector each time the mechanism was removed during the initial build and test stage. So I suggested a modern bulkhead connector with a nut and 'O' ring seal which would alleviate these problems.

Our chief designer did not like my suggestion, as he only knew about 'old' bulkhead connectors which were not really good at sealing bulkheads. But he did compromise a little and instead had the rear of the instrument lengthened by one inch to provide 'blind' threaded holes for the connector attachment screws. But this extra length put the instrument outside the maximum length specified by the MOD.

Bear in mind that the TSR.2 had a sharp, pointed, nose and you will see that there was no room for 'extended' instruments. When this was pointed out to the chief designer, he responded with "Can't they bend a rib, or something?" The airframe had cost God knows how many millions to produce, so the mind boggles at his response.

Our patented glass system was touted by our American parent company as the best thing since sliced bread. So it was used in our CSI. Yes, the light from the internal bulbs was reflected back into the instrument face very effectively. But there was a 'slight problem' that it did the same with sunlight, as we found out later.

Our company salesman, DB, a very pleasant chap, pushed this glass for all its worth to the MOD. However, one sunny Summer's day, our wonder glass was to cause us all great embarrassment. The CSI was installed in a mock-up TSR-2 instrument panel at Farnborough, along with a full complement of flight instruments, then taken out on the airfield for a crowd of boffins and dignitaries to view.

The panel was on the back of a tip-up truck, and this was moved this way and that into the Sun, with the panel rotated to different vertical angles using the tipper. And, guess what? Our instrument was the only one on the panel that was completely opaque in the Sun - our beautiful dial couldn't be seen at all! American colleagues in the parent company had obviously not fully tested the system; DB said he could have buried his head in shame!

Back came our instrument to the lab and EB, my very clever engineer in charge, worked out that if the glass was bloomed inside (using a misty coating), it might fix the problem. This he did immediately and we took the instrument out on the grass alongside the adjacent runway to do an 'environmental test'.

From this I have a happy memory of lying on the very green grass on a beautiful English Summer's day, casually rotating the instrument this way and that into the Sun, which made a nice change from being stuck in the lab! Oh and, yes, blooming the glass fixed the problem.

Another minor problem was highlighted when we took the CSI to nearby Totton (Hampshire) for vibration testing. This was one specification that was very tight, as the TSR.2 was planned to fly at or near supersonic speed at low level - and there would be a great deal of vibration.

The fine copper capillary tubes in the instrument, which fed pitot pressure to a capsule, had been tied to the instrument frame with nylon tape, just like in our other aircraft instruments built for less demanding flight regimes. The vibration table was set to the required frequency and started up - and a loud clanging noise emanated from the instrument.

When we opened the case we found the copper capillary completely flattened! However, running the pipes through flexible tubing cured that problem.

As the design process progressed, we had to take the CSI to Farnborough to be flight-tested. It was installed in a Hawker Hunter trainer operated by the School of Aviation Medicine, along with other special instruments including one that had a rotatable dial. I understand about twenty NATO pilots flew the Hunter, and reported back on our instrument design.

The pilots were generally very happy with the display, except that the number '3' digits should be compressed sideways so that they could not be misread as an '8': the originals being slightly 'closed loop'. Also they requested that the decimal point on the Mach counter be moved down from the centreline of the digits to make it a standard decimal point, for example '1.0' (not giving anything away there!).

Yes, there was more to development than you might think. And remember that special instruments and systems were produced by other companies also. Incidentally, on British military instruments, the company logo on an instrument face had to be in gloss black or sometimes a faint blue on the matt black dial. This and other features are required to produce less 'cockpit clutter', and that is something good about MOD requirements.

Advanced Navigation System

I had no educational qualifications and my career opportunities were not great so, when I left the instrument company as mentioned above, I returned to the A&AEE as an instrument technician. There, one system I became involved with was the Moving Map Navigation System designed for the TSR-2 - and it was extremely advanced for its time.

I already had considerable experience in aircraft navigation equipment, as that was a particular interest of mine. So I was detailed to cover the system along with another colleague, a personal friend, on an MOD-sponsored course at Ferranti in Edinburgh. The main thing I remember about that was how delightful Scottish redheads were!

The course was considered necessary so that we could service the equipment back in the instrument department at Boscombe Down. That did not happen because of the cancellation. More time and effort wasted.

The Map Display part of the system was basically a 'dead-reckoning' Ground Position Indicator (GPI), as used in previous aircraft, updated to include a servoed 35mm colour film cassette. The map was back-projected onto a circular, translucent, glass screen and the film cassette could be removed and replaced with another, suitable for a different theatre of war.

The map display could be 'North-orientated' or 'Track-orientated' and there were subsidiary counters to show lat/long or grid position. Heading information was received from the fluxgate gyro compass, and drift angle plus groundspeed from the the Doppler radar. I think the Doppler system was planned to be 'Blue Silk', a development of 'Green Satin'.

The first-named Doppler was widely used in RAF aircraft such as Canberras and V-bombers, but only worked well over land (i.e. Green); apparently flat seas introduced errors. Blue Silk was an updated system that had improved over-water (i.e. Blue) accuracy.

The map display unit formed the centre console at the pilot's position. It had large, grey, spherical control knobs with small lumps all over them. I think they were provided for use in low-level high speed flight, with its incipient high vibration. 'Ball Resolvers' were used to compute the aircraft position and these converted two rotating inputs into one rotating output.

Side Looking Radar (SLR) was to be referred to now and then by the navigator to check the positional accuracy of the moving map system, which was updated manually if required. The SLR aerials were located in the bay behind the large access panel on the port side of the fuselage. I think the navigator also had a moving map display, but memories are a little faint on that.

I should explain that most British warplanes during WWII and on into the 1950s and 1960s avoided using external radio-based navigation equipment and instead used 'dead-reckoning' equipment which operated on the aircraft's internal sensors. In doing so, they could avoid detection. Remember that even this system was in an era long before satellites were launched.

System Gauges

Still working at the A&AEE as an instrument technician, I found that even simple instruments were to merit special attention. MOD servicing of flight and system instruments for 'our' (i.e. Boscombe Down) TSR-2s was well under way, with spares and extra test equipment drafted in. Testing of minor instruments such as pressure gauges was not as simple as you might think - with a totally new type of hydraulic system.

This system operated at an extremely high pressure and used a new type of hydraulic fluid. I can't remember whether it was 8,000psi or 10,000psi - but it was four or five times the pressure of existing systems (normally 2,000psi). And it used 'Skydrol' hydraulic fluid, the first time this fluid was used in an aircraft, I believe. An airframe fitter told me that the high pressure was required to power the much smaller jacks required for flying controls in thin wings and so on.

In the instrument section where myself and my colleagues check-calibrated all kinds of aircraft instruments, we had

'dead-weight testers' for checking pressure gauges. The gauge was connected to one side of the tester and a hand-operated capstan was wound in to increase the pressure.

A modified dead-weight tester was supplied to take the extra pressure of the new system, and was filled with Skydrol - which must not be mixed with ordinary hydraulic oil. We were given warnings about this fluid, which was to be handled with care. Can't remember why, but I think it could cause skin irritation.

Anyway, I used a red fibre washer to connect the first TSR-2 hydraulic gauge to the tester and carefully wound in the capstan. That got harder and harder to turn, as the modifications did not include help in turning the thing! I confided to my section leader that I was worried about something bursting and spraying me in the face with high-pressure Skydrol. He just grinned!

Up and up I took the pressure, heaving on the capstan then, all of a sudden, a small jet of oil burst out of the gauge connection - fortunately away from me. When I disconnected the gauge, I found that the fibre washer had returned to its powder state! So then we had to get the workshops to manufacture some special washers. But I was always a little wary of increasing that pressure...

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