MACH 2

Concorde magazine

Maintaining Concorde

The pursuit of excellence

A life at Filton

From first take-off to today

Issue 11
August 2017

Introduction

In this issue, the focus is on the engineers who kept Concorde flying in perfect safety and at the peak of her capacities. Former BA engineer Pete Comport looks back at the complex, rigorous schedule of checks carried out to ensure that every component and system was operating as it was designed to do.

We also have updates from Filton and Toulouse. We have news from Aerospace Bristol, who held an inaugural dinner, attended by HRH the Princess Royal, in their Concorde Hangar for G-BOAF in July. Nigel Ferris recalls his experinces as a volunteer in the original "Concorde at Filton" visitor centre; he also reports on his part in a forthcoming BBC programme featuring Alpha Fox, to be shown later this year. Lastly, Katie John gives an account of the recent ceremony at Toulouse to inaugurate a new exhibition space, to celebrate the French Concorde "family".

In this issue

Editor: Katie John
Contributing editor: Nigel Ferris

Cover: Concorde undergoing maintenance, Heathrow (Photo: Peter Jordan / Alamy)

My Concorde life

Contributing editor Nigel Ferris recounts the latest chapter in the story of his life with Concorde – the chance to share his "bel oiseau blanc" with TV viewers in a programme to be shown on the BBC.

I was contacted by the BBC with a view to appearing on a planned programme to be shown on BBC4, entitled 'A Supersonic Journey'. On Thursday May 4th I met with the film crew outside Flight Ops at Filton – camerman, sound recordist, and the producer Alastair McKee, and we were taken to the rear of the huge Assembly Hall, where I was asked to perform (!) for the camera.

A witness to history

My interview entailed me talking about my working life at BAC Filton during the time of Concorde's design and construction. Hesitatingly at first, I soon got into my history (succumbing to my usual verbosity when talking about 'Le Bel Oiseau Blanc').

My working area was in the offices on the mezzanine in the centre bay of the hangar, and I was able to see 002 being assembled from the first piece on the jig, to structural completion, systems installation and testing, roll-out, and the first flight. All this I explained in a highly passionate way. Then we moved out onto the runway, about one third of its length (not far from where G-BOAF touched down on her final flight), where I talked more about the aircraft, the test flight, the Vulcan FTB, the Bristol type 221 and more.

I think I spoke to camera for about 30 minutes in total, with Alastair 'egging me on' to show how much of an effect Concorde, the project and its legacy had on me – and indeed the world of commercial aviation – as well as my memories of 27 years of service, and how she became an Icon for the 20th century. (No doubt my contributions will be edited down to a few seconds).

The BBC crew were fascinated to learn that the early designers of Concorde would make paper delta aircraft models, go into the car park at lunchtime and see which flew best! The film crew then decided to make their own models, and fly them from the runway. But it was windy, so the test results would not perhaps have helped in the original design of Concorde.

Shooting outdoors
The BBC crew prepare for filming on Filton's runway. The Brabazon hangar is just visible in the distance.
Photo: Nigel Ferris

Concorde today

I also spoke of the day (Tuesday 7th February this year) when Concorde Alpha Foxtrot was moved from her compound across to her new home. A bittersweet moment – Concorde rolling on her wheels, but heading to her final resting place. No doubt you have probably seen this before, but here also is a link to my video shot on that day: https://www.youtube.com/watch?v=Shq9aiyILzc

On Tuesday June 13th I was asked to go to Filton again for some follow-up filming. There were about twelve of us, including Doug Newton and Philip Cairns (from Heritage Concorde), and Ted Talbot, who was an aerodynamicist and later chief design engineer. We were filmed (a few times) as we walked into Concorde's new hangar, being asked to go 'Wow' (as though we had never seen her before!) as we saw Alpha Foxtrot. We walked around the aircraft (the first time I had been up close and personal since the visitor attraction (CAF) was closed in 2010), and as usual marvelled at her grace and technical genius. The cameras followed us around, recording our off the cuff comments, and our memories of her time as the most wonderful aircraft ever to fly.

Maintaining Concorde

Pete Comport, former Concorde engineer with British Airways

Like all commercial aircraft, Concorde had a maintenance regime. The aircraft was subject to the same principles of airworthiness management as any other large jet.

Limits were set on when airframe, engines, systems, and components of the aircraft were to be cleaned inspected, repaired, replaced, modified, and/or tested; these limits were set by the manufacturer and on occasion modified by technical experts who made up part of BA Engineering's Technical management team.

Service check
A British Airways Concorde at Heathrow undergoes one of its regular maintenance checks. A jack has been positioned under one wing for support.
Photo: Jetinder Sira

Planning the work

Together the team would implement and modify the Aircraft Maintenance Schedule (AMS). Concorde technical engineers would meet to update the schedule on a regular basis, and the Concorde planning team would add further tasks to the schedule. All became a list of work to be completed as part of Concorde's maintenance programme.

Sections in the AMS covered all the elements of the aircraft technical spectrum, each system having its own unique code and sub-code aligning to a reference in the maintenance manual. Elements would include how to prepare the aircraft for maintenance (jacking the aircraft up, for example), cleaning to inspect the airframe as well as how to inspect (in forensic detail), and testing of each system, engine component, or airframe structure.

The AMS told you what components had to be maintained, divided into individual sections covering every component and system. Some examples are a lifejacket's ultimate life before removal, cabin seat inspection for structural integrity and comfort, engine turbine blade integrity inspections, fuel tank inspection for leaks, testing the emergency landing gear lowering system, and testing the auto land system.

Some components would have limited life dictated by duration of time (calendar date since made, fitted, tested, or overhauled). The life of other components might be governed by flight operating hours, or number of cycles pressurised. Typically, for landing gear, maintenance was governed by the number of landings made; engines by how many times and hours operated; and system testing by a combination of total hours operated as well as landings and cycles used. Complex components such as landing gears had components that had a finite life, after which parts were scrapped.

As well as completing these safety tasks the AMS had a domestic (airline-driven) part. The cabin required special attention to maintain the highest operating and comfort standards. Cleaning the exterior of the aircraft was also included in this section.

All these maintenance tasks had to be fitted into a plan sequenced together into a maintenance event. This would be monitored by engineering planning team and shift managers counting down to the time the aircraft had to be put on the ground. With 7 aircraft operating, the fleet invariably had 1, 2, or possibly 3 aircraft on scheduled maintenance. During the height of commercial operations, shift managers and Concorde planning worked together to schedule the individual aircraft flying programmes to meet these maintenance events.

In addition to the routine maintenance tasks, the aircraft would often have to undergo modifications. During the 1980s Concorde's flight recording system was substantially modified as a result of an accident to an Airbus in the USA, increasing the parameters recorded to include all flying control surface positional data. The 1990s saw structural modifications for life extension, and modifications of the air intake wiring to increase maintenance redundancy.

Many tasks would be grouped together and completed at Inter (intermediate) checks and Major checks. Generally most modifications were also scheduled with the Inter check.

Inter checks

Safety-critical systems and components, emergency systems, and flight-critical equipment are typical items that were checked every Inter check. Equipment needing regular overhaul included emergency escape slides, fire extinguishing bottles,

and life-critical components such as oxygen cylinders. Systems used as back-up, such as standby instruments, fuel, flying control, hydraulic, and air conditioning systems, were also among the many systems tested to strict schedules.

The Concorde Inter checks were planned many months in advance – they needed to be, as hangar space and flying schedules dictated a detailed operational plan, thereby allowing charter operation sales, new services (e.g., Barbados) and/or any special VIP operations such as Prince Charles and Princess Diana's honeymoon flight to take place.

The smaller Inter 1 checks were completed yearly, planned to run over the winter months. Inter 1 and 2 checks typically took 10–18 days to complete. The planning and shift managers' task of orchestrating the larger Inter checks was more challenging, as it was more likely that an unforeseen maintenance task would disrupt the plan.

An example of this could be when the fuel tanks were tested for leaks after rectification had been completed. Typically the aircraft was checked for any fuel tank seepage over a 24-hour period first, just prior to the start of the Inter and post all structural rectification of wings and trim fuel tank areas as well as the resealing of fuel tanks for seepage (a task not to be underestimated).

Concorde's capacity to expand and contract with flight presented a challenge in many ways. The author remembers discussing keeping the fuel tanks free from leaks with the crew of another famous aircraft, the SR72 "Blackbird" spy plane (on the occasion of its visit to TBB before the Farnborough air show). Problems of expanding airframes and massive changes of skin temperature were common to both aircraft. (I took the US "Blackbird" team around Concorde; they marvelled at the fact that you could sip champagne at Mach 2 without wearing a G suit!) It was clear during our conversation that engineers of supersonic aircraft shared a common understanding of the detailed knowledge needed to keep these complex machines in the air.

Major checks

The Major checks were planned over 1 year in advance of the start date. At 90+ days' duration, they required significant Concorde engineering knowledge and project management by the lead licensed engineers and shift managers.

Ready for inspection
Concorde undergoing a Major check; stripped of paint, and with engines, elevons, and leading-edge panels removed. *Photo: John Dunlevy*

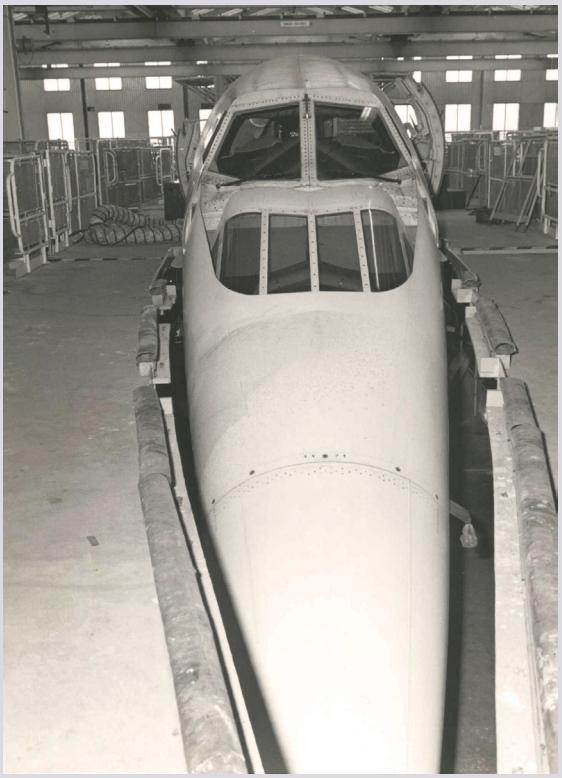
Docking the aircraft

During Major checks, Concorde was placed in a two-storey, purpose-built dock to enable the teams to access every part of the aircraft.

Docking Concorde in the Major Dock was a time-consuming process. In the first instance, it was an exacting task to align the aircraft correctly to ensure safe operation by the engineers, with sufficient clearance to avoid aircraft damage.

Docking generally took place after the aircraft had been de-fuelled. It took around 4 hours to set up the aircraft for the check. Preparations included lowering the nose and visor, then jacking the aircraft. All docking had to allow for clearance for the landing gear when undercarriage testing took place.

The upper (mezzanine) level of the dock was used to store the seats. (Galleys and toilets were removed for refurbishment elsewhere.) In addition, the Majors shift manager's control office was adjacent to the flight deck on the right-hand side of the mezzanine level. The various work stations with the Maintenance work cards were placed around the Major docking.



Mezzanine level
G-BOAB positioned in the Major Dock. Work platforms extended around the aircraft to allow access to every part of the airframe.
Photo: Pete Comport

Ground level
The lower level of the dock housed most of the work stations. The height allowed clearance for free movement of the nose and the landing gear.
Photo: Pete Comport

Typically, these maintenance inputs took significant time to complete, with complicated interdependencies across several different engineers' disciplines or operating systems. For example, many systems had to be restored post component changes and rectification, but before any power of any kind was plugged in: electrical power was first restored, then hydraulics, but not before flying controls were rigged; fuel could only be put on when the trim tank work was finished. This entailed detailed communication, handovers, and plans. As a shift manager you could spend a couple of hours just drawing out the plan for the aircraft finish date; with this completed you could then manage the rest of the fleet flying plan, selecting certain

Stripped bare
The cabin with carpet and fittings removed to expose the airframe shell. Some of the floor panels have been removed to allow inspection of the wiring inside. *Photo: John Dunlevy*

aircraft to fly more often than others to make sure each aircraft didn't run out of flying hours before maintenance downtime was needed.

Initial tasks

Typical engineering activities at the start of a Major check would involve fuel tank seepage testing (filling every tank to full, leaving for a 24-hour period, then inspecting for seepage). Next followed cabin strip-out, including removal of all seats, floors, hat racks, galleys, and toilets; freight bay strip-out; and flight deck strip-out, including crew seats, instruments, system computers, stowages, and the many flying control power units under the flight deck floor. Hundreds of access panels on the airframe were removed for inspections, along with all the wing and tail leading edge and fairing panels (held with hundreds of titanium screws), flying controls, engines, engine intakes, reverser assemblies, air conditioning and hydraulic systems, as well as all landing gears. All were removed and many dismantled for inspection.

Inspections and repairs

Once these tasks had been done, extensive cleaning of the exposed structure was completed to allow the detailed inspections of structure, pipes, wiring, etc. Miles of piping and wiring would be inspected over a number of weeks. Hundreds of hours of inspections were needed to ensure the continued airworthiness of the aircraft.

The workload was often divided into shift responsibilities as there were three shifts working across the Major. One Airframe team might be responsible for wings, inspecting and rectifying the wing fuel tanks (which included the difficult task of spending many hours inside fuel tanks stripping, cleaning, and resealing to exacting standards). Other airframe teams were responsible for cabin interior, airframe exterior, tail and flying controls, undercarriages, intakes and reversers, and engines. Avionics were divided into instruments/autopilot, and electrics including intake controls and radio/radar. The Upholstery team had their own tasks and worked with all lead engineers. A typical plan for the Major might have around 1000 task groups, with many depending on several lead engineers co-ordinating their work across the disciplines so that the aircraft rebuild could progress in a sequenced way.

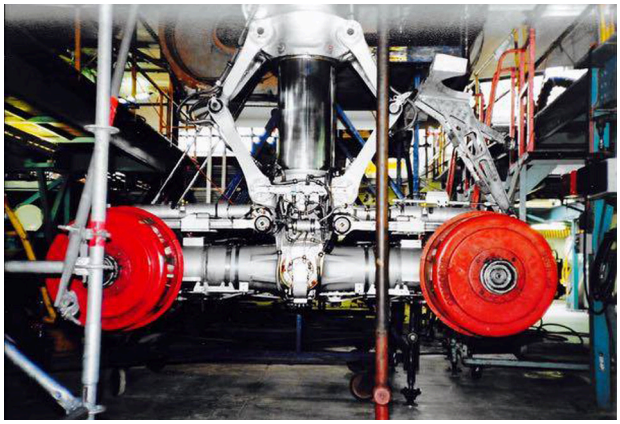
Every task was detailed on instruction task cards printed in different colours, detailing who could certify the airworthiness of that task. The lead licensed engineers would be required to record the results of all inspections. Each engineering discipline (Airframe, Engine, Avionic, Radio) had their own work stations placed around the aircraft docking. These stations were the hub for controlling all work. Until the inspections were completed, the total size of the task would remain unknown; to gauge the length of the Major check, planning and shift managers would use estimates of how much rectification and repairs were needed, based on the last "largest" check. The general rule was that for every one hour of "known/planned" work, 2–3 hours of post-inspection rectification work might occur. (The Boeing 747 had roughly the same ratio.)

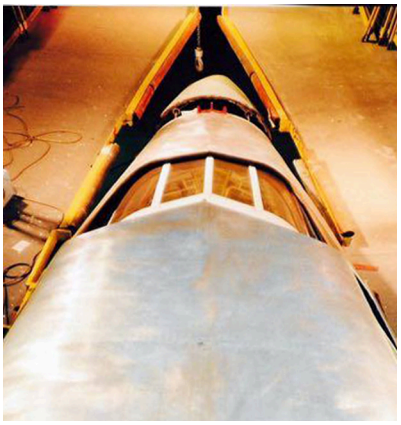
After the inspections, a new plan was made by the shift manager and lead engineers, with an estimate of how long the aircraft would be in maintenance. Spare part availability often changed this plan.

Re-building the aircraft

Once the rectification was complete, the re-build of the aircraft could start in earnest – events such as the re-establishment of electrical power to the aircraft followed by hydraulics "On", activation of flying controls followed by rigging the controls, and

Landing gear
Main undercarriage bogie with wheels removed and red protective covers over the brake units. While the aircraft is jacked, the undercarriage can move freely. *Photo: John Dunlevy*





Disassembled nose
A view from above along the nose; the radome has been partially detached from the main "droop snoot".
Photo: John Dunlevy

re-build of other systems like air conditioning. The engines would be re-fitted and of course, if the undercarriage had been removed, all the main gear assemblies would be re-fitted. Before the undercarriage was replaced, the Avionics team would carry out special procedures to test various systems, simulating the state of the aircraft as if the undercarriage was in place. (Many systems had several modes of operation, depending on the aircraft being in "air" or "ground" mode.)

At this point in the check the aircraft was very much in operational mode, with many complex systems undergoing highly specialised and detailed testing. All of this work would be done whilst the aircraft was perched on 3 main jacks and a tail steady, with a lot of staging around it. This was a safety challenge; with systems in "air" mode, parts could move without warning. To avoid injury to personnel or damage to the aircraft, several men were in constant contact with the lead engineer, who would be on the flight deck whilst operating the system under test. Each time a hydraulic system was powered, aircraft staging and personnel safety checks would have to be completed.

Once all the systems had been tested fully, final checks such as the auto land function test could be completed. This test involved a great deal of simulation of the aircraft's sensory systems for airspeed, altitude and radio height, localiser, and glide slope. Effectively the aircraft was put into the same situation as it would be at the point of engaging the auto land on approach on to a Cat 3 A runway landing guidance system, at around 180 knots simulated, 2500 feet radio altitude. From that point on, the engineers simulated a complete landing procedure, testing all the auto land activities and responses, and ensuring the test met the exact requirements for safe operation, down to disconnect and throttle closure after landing.

Return to flight

At this stage, the aircraft was ready to come off jacks. Next came the fuel "ON" leak test – waiting 24 hours after the 80 tonnes of fuel was put in the wing and trim tanks.

On completion of the fuel testing, the aircraft was towed to the Concorde de-tuners, where it was reversed into four "sound muffler" tubes, allowing the engines to be tested to full throttle and afterburner (brakes applied and chocks needed). You only ever tested one afterburner at a time, but could have inboard or outboard engines at high thrust to balance the inevitable pull to one side as full thrust kicked in (a "character building" experience when there was ice on the ground!).

The final task of the Major was to verify that you had a full record of the work. This meant checking thousands of cards, to make sure that every task (routine and defect) was accounted for and certified. Lastly, the final certificate of release for service was signed.

While not an airworthiness requirement, the chance to fly a "shakedown flight" with our flight crew management colleagues was not to be missed. Who wouldn't want to fly at 71,000 feet on the edge of space, at Mach 2+, with a cup of tea in your hand – although no champers on this flight!

Engine run
Concorde G-BOAE positioned in the Concorde engine de-tuners for test runs of the engines and reheats, 1980.
Photo © Steve Fitzgerald / Wikimedia Commons

Schedule of maintenance checks

	Ramp check	Service check	Inter check	Major check
Scheduled occurrence	Before and after each flight	Every 175 hours	Every 1,100 flight hours (about once a year)	Every 12,000 flight hours
Duration		2 days	10–18 days	90+ days
Team	Minor maintenance team	Minor maintenance team	Major maintenance team	Major maintenance team
Main tasks	• Replacing multi-track flight recorder • Lights: checking illuminations, warning lights, cabin signs, emergency lights inside aircraft; checking navigation, landing, and anti-collision lights on exterior • Battery: checking volts/amps and acid levels; replacing every 3 months • Engines: checking oil, hydraulic, and electrical couplings; taking samples of engine oil for testing every 50 hours	• Airframe: general zonal inspections of the fuselage including covering flying control surfaces, wings, tail intakes, doors; interior condition checks (damage/wear and tear) • Safety flight system testing (flying control standby system) • Systems inspections and tests: air data, navigation, autopilot, fuel control/trim, cabin temperature control, intake control, centralised warning control • Hydraulics: taking samples of hydraulic oil for analysis; general inspections of hydraulic pipes and connections, hydraulic leak testing • Engines: changing oil scavenge filters; changing engine oil if needed; inspecting heat shielding and insulation; visual examination and boroscope examination of engine interiors	• Deep inspection and cleaning of airframe, fuel system, hydraulics, electrical racks and cabling • Interior stripped: flight deck instruments, and cabin fittings and floor panels, removed for inspection; internal wiring inspected • Engines: removed to allow inspection of cabling • Landing gear: aircraft mounted on jacks to allow free retraction and extension of gear • Fuel tanks: drained and opened to check wiring and sealant • Detailed system testing of all systems	• Engines, nacelles, buckets, elevons, rudder sections, undercarriage, doors, nose cone removed for inspection and modification/repair as needed • Interior stripped: flight deck instruments, and cabin fittings and floor panels, removed for inspection; internal wiring inspected • Any major tasks carried out, such as replacing cabling and connectors in engine nacelles • Detailed testing of all systems; re-rigging of flying controls, checking/calibration of flight recording system • Any structural modifications carried out (e.g. strengthening of fuselage crown area in late 1980s) • Paint stripped; aircraft exterior cleaned, then new paint applied • Aircraft undergoes test flight(s) before return to service

Concorde watch

Concorde G-BOAF

British production aircraft

Location: Filton, UK
Reporter: Katie John/Nigel Ferris

Date: 20 July 2017

On 20 July 2017, Aerospace Bristol celebrated the inauguration of the Concorde Hangar housing G-BOAF (Alpha Foxtrot). The event was marked by a dinner at which the guest of honour was Her Royal Highness the Princess Royal, Patron of Aerospace Bristol.

Professor Ian Gray, Chairman of Aerospace Bristol, thanked the Princess Royal for attending, and noted her interest in science, technology, and engineering – all subjects integral to the new museum.

During her visit, Her Royal Highness toured the museum site and met many of the supporters and volunteers who have worked on the project to create the new museum. These Aerospace Bristol volunteers, having contributed more than £1m worth of their time, were recently given The Queen's Award for Voluntary Service – the highest award for UK volunteer groups. The Princess Royal presented the award to Oliver Dearden and Kenneth Ricketts, who represented the 150 volunteers.

The new museum will guide visitors on an immersive journey through more than a century of aviation achievements, starting in the earliest days of powered flight, and focusing on the major role played by the airfield and works at Filton. The stunning centrepiece will be Concorde Alpha Foxtrot, designed and built at Filton – the last Concorde to be built in the UK, and the last Concorde to fly.

As well as an exhibition centre, the new museum will house archives and will establish learning programmes to encourage young people to opt for careers in the aerospace industry. The Concorde Hangar is now open for corporate and private events, and for exhibitions.

For further news, please see the museum website: https://aerospacebristol.org

Appeal for funds

So far, supporters and donors have raised £17 million for the new museum – but a further £2 million is still needed to complete the project. Aerospace Bristol is appealing for further support from all those who wish to help preserve and restore Bristol's aviation heritage.

New donors are invited to become involved by:
- Joining the "Concorde club", and sponsoring a seat on a "Concorde trip" to New York or the Bay of Biscay (https://aerospacebristol.org/join-the-concorde-club)
- Sharing your Concorde stories (which will be published on the website via an on-line map)
- Giving a one-off donation (https://aerospacebristol.org/donate/).

Inaugural dinner
HRH the Princess Royal addresses the guests gathered under the body of Concorde G-BOAF.
Photo: Aerospace Bristol

Promoting Alpha Foxtrot

Mach 2 Contributing Editor Nigel Ferris recalls his time showing off Alpha Foxtrot at "Concorde at Filton". Running from 2004 to 2010, the exhibit featured an in-depth guided tour of all parts of Alpha Foxtrot. He is still passionately promoting Concorde today, both at Filton and further afield.

From 2006 to 2010, I worked as a tour guide for Concorde at Filton, showing visitors of all kinds around, under, and inside the aircraft. It was a memorable time – being able to share my knowledge and passion with the visitors, most of whom had never been that close to Concorde.

There were many technical questions, most of which I was able to answer in an understandable way. One time while pointing out the chines on the side of the nose, one lady asked, "Were they there to stand on to clean the windows?" No way a dumb question – rather, an illustration of the interest Concorde generated in people. Again, when pointing out the heated masts under the fuselage, and explaining they were outlets for water from the galleys and the toilets, another visitor said: "Oh – supersonic poo!" Classics.

We formed a close group of guides during our time at CAF. The scope of knowledge that we had enabled us to cover all the aspects of Concorde – with engineers, past BAC employees, Rolls-Royce employees, and 'ordinary' people with bits and pieces of information gleaned over the years, and a love of the aircraft. We were rarely stumped when asked questions – if one of us did not know the answer, somebody else would. The tour would have 3, maybe 4 sessions, depending on the numbers attending – underneath detailing the 'oily' bits, in the cabin describing the flight, and in the cockpit showing the myriad of controls, knobs, switches, gauges, etc., and what they did. All these tours given by people who wanted to share their knowledge and experiences. It was our view that we, the 'A' team, gave the best possible day out.

We have continued this friendship ever since 2010, and now go by the name of 'Foxy's Filton Flyers'. The group is ably led by Paul Evans, a Welshman who uses his innate passion to promote Concorde. He slipped naturally and seamlessly into this role, and we all respect him highly.

We have made a visit to Concorde G-BOAC at Manchester on the 22nd of April (see previous issue) – thanks due to John Hepple of the Runway Visitor Park (http://book.manchesterairport.co.uk/manweb.nsf/content/runwayvisitorpark). During this visit, we felt for our very good guide Geoff, who must have felt trepidation taking existing tour guides around his aircraft, knowing we might put him right or add to his knowledge. But he was terrific.

We also have a trip planned for G-AXDN at Duxford (http://das.org.uk), kindly arranged by Graham Cahill of Heritage Concorde (http://www.heritageconcorde.com) for the 12th August, and to Toulouse to see F-BVFC in April 2018.

Knowledge and passion
Right: Nigel (far right) with fellow volunteers at "Concorde at Filton", and next to Concorde Captain Christopher Orlebar. Above: controls on the flight deck – just one area that the volunteers could explain in depth.
Photos: Paul Evans

Concorde F-BVFC

French production aircraft

Location: Musée Aeroscopia, Toulouse, France
Reporter: Katie John **Date:** 25 June 2017

On Sunday 25 June I flew to Toulouse to attend the inauguration of the new "Espace Concorde" exhibition, based close to the Airbus facility at Toulouse/Blagnac airport. I was attending at the kind invitation of Louis Paulus, head of the French group Cap Avenir Concorde, which organises conferences and events on the theme of Concorde.

The Concorde family

The day started at the Ailes Anciennes historic aircraft collection, with an event to commemorate representatives of all the groups that contributed to French Concorde operations: flight crew, cabin crew, engineers, and development personnel. Cap Avenir Concorde had prepared plaques to honour each of the representatives of the French Concorde "family", to be displayed in the Espace Concorde exhibition.

The first plaque was presented to André Chaumeton and Camille Combis, members of the team who carried out the flight tests with F-WTSS (prototype 001). They recalled the inaugural flight with 001; the aircraft responded extremely well, although Commander André Turcat had had to cut the flight short as some alarms sounded on board. A speech was read out from test flight engineer Jean Pinet, who was unable to be present; he paid tribute to the two men's reassuring presence as the final element in the team who prepared Concorde for action, and their readiness to receive feedback from the flight crew after test flights. The two men, though advanced in years, shared lively jokes with each other and the other attendees – I didn't catch what they were saying but they looked like great company! M. Combis spoke very warmly of Concorde, and said with some feeling that "if it hadn't been for Concorde, there would have been no Airbus".

Representing the cabin crew were Nicole Menneveux and Claude Monpoint. M. Monpoint, Chief Steward for Air France, recalled his initial responsibility for training the first Concorde cabin crews – in particular, having to work out how to cope with the restricted cabin space and short flight times. Crews

Three icons of the air
Concorde F-BVFC (Fox Charlie) stands outside the Musée Aeroscopia, between an Air Inter Caravelle and an Airbus A400M. *Photo: Katie John*

A happy encore
Members of the French "Concorde family" gather under Fox Charlie's wing for photographs. Among the group are former Air France Concorde pilots Béatrice Vialle (centre, white dress) and Captain Jacky Ramon (centre, brown jacket); Concorde stewardess Nicole Menneveux (behind Captain Ramon); and some of the engineers and designers who brought Concorde into being.
Photo: Katie John

had to work at high speed, but still retain their personal touch, as well as be fluent in other languages – notably English, to cater for their mainly American passengers. He described Mlle Menneveux as the archetypal Concorde stewardess; having worked with Air France from 1963 to 1992, she served on Concorde from 1975 to her retirement. She completed 4,902 flight hours on Concorde, turning down the chance to become "Chef de Cabine" in order to stay with the aircraft. Still poised and elegant, as well as charming, I could see why this lady was such an asset to the Air France Concorde crew.

There were at least two Air France Concorde pilots present. Béatrice Vialle, the sole female Concorde pilot for Air France, was honoured with a plaque and a speech from Mme Odile Chartier, who belonged to a local light aircraft pilots' group. Mme Chartier outlined Béatrice Vialle's career, from being just the tenth woman to qualify as an Air France pilot to her 3 years of service on Concorde, from 2000 to 2003, which included 250 hours of supersonic flight. Mme Vialle, in response, said that flying Concorde had been the high point of her life, and said that she would be happy to inspire young girls to become pilots like her – even, perhaps, supersonic aircraft pilots!

Finally, ground engineer Jean-Michel Rougier was honoured with a speech from Hubert Protin, Senior Maintenance Production Manager for Air France. M. Rougier had worked with Concorde for 27 years, and M. Protin paid tribute to his tenacity and skill at solving even the most difficult problems with Concorde's systems.

After the speeches there was one minute's silence to commemorate all those – passengers and colleagues – who had perished in the crash at Gonesse on 25 July 2000.

Fox Charlie up close

We were then taken to the Musée Aeroscopia to see Concorde F-BVFC. To reach the aircraft we had to pass through the main building, where I was able to see the Super-Guppy and snatch a quick shot of development Concorde F-BTSB. Fox Charlie was standing on the tarmac outside, in company with a very smart Air Inter Caravelle.

Fox Charlie looked immaculate – dazzling in the sunshine, after his recent re-painting. The interior was not accessible, but from the outside the aircraft looked very well cared for. The Concorde personnel lined up for photographs under the wing. I was able to talk to Captain Jacky Ramon, whom I had previously met many years ago at Duxford and then at Toulouse in 2009. I also met Dudley Collard, a British aerodynamicist who had worked on Concorde's development.

Cap Avenir hospitality

For lunch, we were taken by coach to a local auberge. I was honoured to be seated next to Béatrice Vialle, and – in my halting French – to talk to her for a while. She was great company, and very gracious. I also had the chance to speak with Patrick Dabas, Vice-President of the Ailes Anciennes conservation group, who was keen to hear about the conservation work taking place at Brooklands and other sites in the UK.

The final event of the day was a talk from Claude Monpoint about his experiences working with Concorde. He said that the aircraft had been the link that tied together the whole "Concorde family"; there had been no division between the flight crew and the ground crew. He remembered chief test pilots André

Turcat and Jean Franchi, and flight engineer Michel Retief, as being passionate about Concorde.

A short film was shown of Fox Charlie's final flight, from Charles de Gaulle back to his birthplace at Toulouse, on 27 June 2003 – almost 14 years ago. Emotional crowds lined the airport fence at Paris to see the aircraft depart. Some of the spectators were interviewed; a few were in tears. Henri Perrier, former head of the Concorde programme at Aerospatiale, said sadly, "We won all the battles to get Concorde into the air, into New York, then back into the air after the crash – but we can't win every battle".

Louis Paulus brought the day to a close, thanking everyone who had participated. He also thanked Mach 2 magazine for publicising the event in the UK, and said he was very keen to do further work with British Concorde groups. In addition, he recommended that people visit the Musée Delta at Orly, near Paris, to view the work being done on Concorde F-WTSA.

I ended the day with M. Paulus and his wife Suzanne, and friends of theirs. We returned to Ailes Anciennes, where M. Dabas showed me round their collection (which includes the double-decker Breguet Sahara aircraft and the "flying banana" helicopter). After a lovely supper with M. and Mme Paulus, I returned to London the next morning – delighted by my day, and looking forward to further cross-Channel co-operation in future.

Author's note: In fact, these new links are already being forged! See previous article for information on the forthcoming visit by "Foxy's Fliers" to Toulouse next April.

Further information

Cap Avenir Concorde: http://www.capavenircon-corde.com

Musée Aeroscopia: http://www.musee-aeroscopia.fr

Ailes Anciennes: http://www.aatlse.org/?p=accueil

Musée Delta (Orly): http://museedelta.free.fr

The shape of the future?
The foyer of the Aeroscopia museum building, with a model of a possible successor to Concorde – named "Avion à Grande Vitesse", or AGV.
Photo: Katie John

International heritage
The Ailes Anciennes viewing park includes fascinating aircraft from around the world, including the Breguet Sahara "Deux Ponts" and Breguet 941 STOL aircraft, plus a MiG, Hunter, Vampire, T-33 Shooting Star, and F100D Super Sabre.
Photo: Katie John

Engine surge

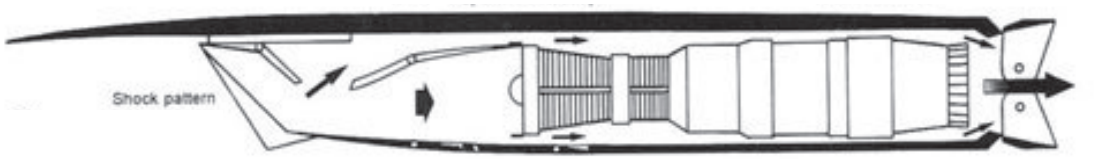
Nigel Ferris looks briefly at the alarming – although mercifully rare – condition of engine surge, and how it could affect Concorde. In the box below, he asks whether Concorde could (in extremis) fly on one engine; his query is answered by former BA Concorde flight engineer David Macdonald.

Engine surge results from a reversal of the air flow through a jet engine. It can occur when the air supply is insufficient to satisfy the engine demands.

In Concorde's case, it was most likely to result from disturbance of the air flow through the engine intakes. In 12 feet, from intake lip to engine face, the airflow was slowed by 1000 mph in 1/100th of a second, increasing the pressure by a factor of 5, and in the process contributed 75% of the power plant's total thrust. (The overall compression ratio of the power plant was around 80:1.)

With Concorde's paired engines, if one suffered surge, the intake, engine, and primary and secondary nozzles control systems (nearly a ton in weight in all) had to ensure that the disturbed airflow did not impinge on the other engine, to cause surge in sympathy – by spilling the incoming air from the surging engine. When the Mach number passed 1.6, it was not possible to prevent the incoming airflow adversely affecting this second engine. Therefore, above Mach 1.6, Concorde was certified aerodynamically as a twin-engined aircraft!

Air flow through engine
This image shows normal air flow through Concorde's air intakes, engines, and nozzles during supersonic cruise. Disturbance of this air flow could lead to an engine surge.
Image: Source unknown



Tech log

Q *Was it possible for Concorde to remain in flight if only one engine remained working?*
Nigel Ferris

A Reply from David Macdonald, former BA Concorde flight engineer:
In my logbook there will be a number of 3-engine hours and a number of 2-engine minutes. In the Flight Crew Operating Manual there is a major piece of writing concerning how best to handle flight with no engines at all, but it remains silent on the concept of single-engine flying – and so we might take comfort from that omission!