Mach 2

Concorde magazine

Constructing Concorde

Memories from Filton

Concorde watch

Reports from Filton and Heathrow

Virtual reality

Building and flying the Concorde simulators

Issue 15
April 2018

Introduction

We begin this month's issue with a look at the immensely complex process of Concorde's construction. This work, involving many companies across the UK and France, was a masterpiece of organisation and rigorous attention to detail. Aircraft fitter Philip Cairns shares his memory of the early days; Nigel Ferris gives an insight into the painstaking co-ordination that kept the project on track; and avionics inspector Ricky Bastin follows the process to its end – the delivery of a perfect Concorde to British Airways.

We also examine the history and workings of the Concorde simulators built to train British and French test pilots and later airline crew. In particular, we are delighted to welcome former Concorde captain John Eames, who describes the simulator training course.

Finally, we say a sad farewell to Christopher Orlebar, BA Concorde pilot and regular contributor to Mach 2, who died on 24 February. As an aviator, a gentleman, and a friend, he will be greatly missed.

In this issue

Editor: Katie John

Contributing editor: Nigel Ferris

Cover photo: G-BOAD at Heathrow

Photo: Baz Glenister

Constructing Concorde

In this feature, three former workers at Filton recall the intensive labour and complex processes that brought the British Concorde fleet into being – from the first pieces of airframe arriving to the roll-out of the finished aircraft.

Assembling the aircraft

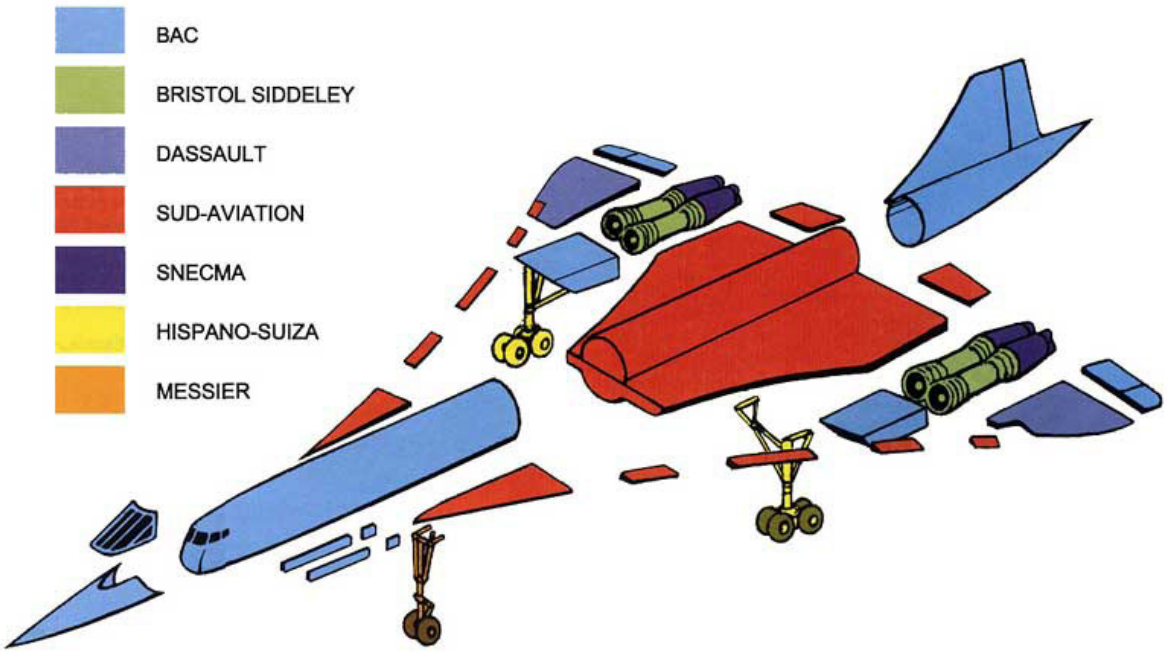
The construction process was highly complex. The main parts of the airframe were built at the two Concorde construction sites, at Toulouse in France and Weybridge in the UK. In addition, there were hundreds of other subcontractors spread across the United Kingdom and France, making every component from windshield panels to the ashtrays in the seat rests.

The parts for each aircraft were brought together in the production centres at Toulouse (for the French fleet) and Filton (for the British fleet); the airframe components were transported to the assembly sites by lorry and flown in by Super Guppy freighter aircraft.

There were several stages to building Concorde; these are listed below.

- Assembly of the central fuselage in Aerospatiale's factories, and assembly of the nose and tail sections at Weybridge.
- Assembly of the fuselage and sealing of the fuel tanks.
- Addition of the leading edges and wing tips.
- Installation of the electrical wiring system.
- Fitting of the elevons, rudder, and nose and visor assembly.
- Raising of the aircraft on jacks, and fitting of the undercarriage.
- Installation of the air intakes and engine bays, and fitting of the engines.
- Checking of waterproofing on seals and doors.
- Painting of the aircraft.
- Installation of flight deck instruments, radio and navigation equipment, and cabin fittings.

Points of origin
This diagram shows the manufacturer and country from which each of the main parts originated: BAC and Bristol Siddeley in the UK, and Dassault, Sud-Aviation, SNECMA, Hispano-Suiza, and Messier in France.
Source: concordesst.com



Building the prototype

Philip Cairns, Aircraft Fitter grade A, BAC Filton

I served my apprenticeship at the British Aircraft Corporation (BAC) site at Weybridge in Surrey, and had been working as an aircraft fitter on the VC10 final assembly, when in 1966 I applied for a transfer to BAC's Filton Division.

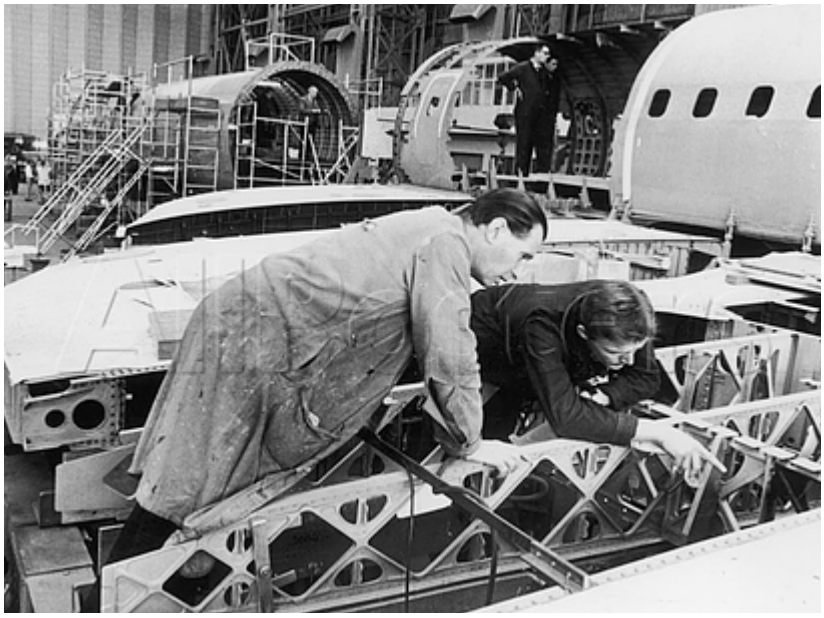
Early experience

I started work in Filton on the Concorde fuel test rig. This was a full-sized replica of the aircraft's fuel system, built to test the workings of the system in all conditions within the Concorde flying envelope, and comprised 11 tanks of mild steel mounted on a moveable platform. Initially I was put with a wise old aircraft fitter called Frank Cook. We stayed with the fuel rig until it was complete, testing pipes, valves, pumps and the tanks for leaks and operation. When all was satisfactory we handed the rig over to the flight test people.

Exacting work

I was then placed in the Brabazon Hangar and put to work on Concorde's engine bay doors. The doors were made from stainless steel and titanium, with the titanium used as an inner and outer skin over a honeycomb structure designed for strength and lightness. I joined a young team of fitters who were tasked with riveting these complicated doors after much of the door structures had been assembled.

We became quite expert at drilling titanium and in using a new type of American rivets called Cherrylocks, fitted with special pneumatic riveting guns. The rivets had to have exactly the right sized holes, the depth of the hole had to be measured with the approved measuring tool, and you had to do a test fitting for inspection purposes. Solid stainless steel rivets were used on more accessible areas of the engine doors.



Meticulous checking
Workers examine a wing section on Concorde 002 during the "low build" stage of construction at Filton. Rigorous checking was a vital part of the process.
Photo: Heritage Concorde

These needed to be put down with a sharp burst from a good 4x rivet gun; if you didn't get it right the first time, you would have to remove the rivet and do it again. All of the rivets used on Concorde were annealed rivets, and had to be used within specific time constraints (indicated by colour coding). If a batch of rivets was going to be out of time you would have to replace it with another batch, with an Inspector in attendance.

Concorde comes together

During my first two years I had watched pieces of fuselages arrive from Weybridge and Toulouse to be assembled, then saw the jigs in which the fuselages were placed being drawn together to join the pieces. This was a process that I had not seen before.

All of the joints were put together with a sealant called Viton. This sealant was used everywhere on Concorde, including inside the fuel tanks and on the flying surfaces. When the fuselages were joined, the holes to be used for the fasteners were fitted with torqueset skin pins. These skin pins were torqued at regular intervals to ensure that the joints were really good. Only when the rivets or fasteners were fitted would the skin pins be removed, one at a time. The rivets were fitted in a sequence set down on the technical drawings, to make sure that no stress was built into the assembly of the joining parts. The Inspection Department would be in attendance during the whole riveting process.

In 1968, I was transferred to the Flying Control section on Concorde 002 (G-BSST), as part of a team under a very good supervisor called Red Harris. I was thrilled to be working on an aircraft again, and had had some experience of flying controls from my VC10 days, added to which the previous two years had been a huge learning curve and had taught me a lot.

As the fuselages, wings, engine cowlings, undercarriages, fin, droop nose, and fuel equipment were assembled, Concorde finally began to become a reality. One of my first tasks on this emerging Concorde was to fit the free fall emergency release mechanism for the droop nose, starting in the flight deck. This was quite tricky as space in the flight deck was extremely limited, and other trades wanted access to it – mainly electricians. I managed to connect all the levers but fitting the pull handle was going to be difficult; eventually all the bolts were split pinned and wire locked, and the system would be checked when the aircraft was ready for electric and hydraulic power.

I thoroughly enjoyed working with the team on the flying control section, as we fitted cables, pulleys, bellcranks, levers, and the mixing chassis. The mixing chassis was a very clever bit of design, which enabled the pitch control to be mixed with roll control as Concorde had elevons to do the job that ailerons and elevators would do on other aircraft. We had a big flying control chassis under the flight deck floor; this contained relay jacks, feel jacks, and trim control for all three axes (roll, yaw, and pitch). This whole assembly was fitted as one into the forward fuselage through a large access panel.

With the rudders, elevons, and many other systems now fitted, this prototype aircraft was rapidly approaching final function and engine run time. Everyone was getting truly excited, and when the Concorde was first rolled out of the hangar many press people were there to take pictures and record the event.

Finally, after much testing of flying controls, undercarriage, electrical generation systems, fuel systems, and many other systems, the great day arrived – 9 April 1969, when Concorde G-BSST would fly for the first time to Fairford, the designated flight test centre. I had applied to go to Fairford and been accepted to be part of the maintenance team there. This would lead to many other opportunities in my ambition to become a Licensed Aircraft Engineer.

Perfection and beyond

At this point I would like to mention BAC's Filton Inspection Department. I hold them in the highest regard, although at the time of Concorde's development I sometimes viewed them with dread. The Department aimed for perfection and beyond. Work presented for inspection had to be in good order; in addition, whilst the work was being done, inspections would take place for such things as torqueing of bolts, use of correct rivets, checking of holes for size, cleanliness, and whether we had complied with the instructions on the technical drawings. The Inspectors maintained this standard right up to the delivery of aircraft to the airlines, thus ensuring Concorde's integrity.

Co-ordinating progress

Nigel Ferris, clerk, Purchasing Department, BAC Filton

I started my working life at the British Aircraft Corporation (BAC) in 1963, as a junior clerk. My first department was the Concorde Programme Office, and my boss was a chap called Geoffrey Tonkin, who was the Chief Project Officer for the Bristol Type 221. This aircraft was developed from the Fairey Delta 2 and modified to the near identical wing shape and droop nose of Concorde, used for high speed research on delta wing shapes.

In this office, we employed a system called 'PERT', Programme Evaluation and Review Technique. The Americans designed this system and used it during the design and construction of the Polaris submarines.

PERT was used to follow the progress of the project. The system was based on charts with a circle to represent each event – e.g., engine delivery, engine fitting – and lines joining these events. Each event had a designated number. Many charts were drawn, and there could be many parallel lines with operations that had no effective relation to each other, apart from being for the same aircraft, and therefore all circles would have to end at the same point. This gave me a good overall knowledge of how the project was proceeding. For example, at one time there was a programme called 'Thrust' in place with Rolls-Royce to accelerate the development of the Olympus engines. This did not produce the desired result at the right time, leading some 'wag' in the office to re-christen it 'reverse thrust'!

Keeping track of parts

My next position was in the Purchasing Department, with offices on the balcony overlooking the build in the centre bay of the Aircraft Assembly Hall (AAH). I worked on a computer system, recording the progress of parts for the aircraft. There were two types: coded and non-coded. Non-coded were parts

Aircraft Assembly Hall
This view of the hangar shows the painstaking organisation needed for the complex construction process.
Photo: Heritage Concorde

that could be bought 'off the shelf', such as nuts, bolts, washers, and rivets. Coded parts were those that had been designed and manufactured solely for Concorde. There were numerous categories, including electrical, fuel, hydraulics, fire, and air conditioning. I would liaise with the buyers and progress chasers as to the delivery prospects of all these items, and would carry out updates to the system, producing computer tabs for these people as an overall record of the early (or late, often known as TBA) delivery and availability of the parts. Again, this gave me a good knowledge of what went into the building of the aircraft. (I remember that one of the most time-consuming parts of the job was the tracking of circuit breakers – there seemed to be thousands of them.)

Structural assembly

Luckily, for an inquisitive young man with a thirst for engineering knowledge (coupled with what I had learnt from my work) and our office being in close proximity to 002, I was able to watch the build progress.

A jig was built and fixed to the hangar floor, to bring the pieces of the airframe together. Remember, this was long before the use of lasers as in today's aircraft manufacturing, which ensures minute tolerances being maintained. In my time, it was slide rules, pens, paper, manual calculation, along with genius engineers. Also worth noting, in the UK we used Imperial measurements, and the French used Metric – one tenth of an inch equates to 0.2540 cm, and one centimetre equates to 0.3937 inches. This gives some idea of the complexity of building airframe sections in France bound for the UK, and vice-versa. But these parts always matched up perfectly in the two build centres, Filton and Toulouse.

I watched as the first piece arrived and was mounted on the jig, followed by all the others until a visible airframe appeared. Each piece was attached to the next by various types of fasteners, including 'Cleco' type fasteners: in essence pre-rivets, with two contracting parts that would draw the aluminium sheets together or to the frames and ribs. These fasteners would allow the sections to be aligned, taking into account possible differences in temperatures between the sections, and therefore expansion and contraction. (If the sections were riveted together at an early stage, there could be a risk of warping, misalignment or fatigue cracks being set up that might affect structural integrity at some time in the aircraft's life.) The fasteners would eventually be removed one by one, and the final assembly rivets would be installed. The aircraft frame sometimes reminded me of a giant hedgehog or porcupine, with all the fasteners sticking out.

Another first in the life of Concorde was the use of computer tape controlled milling machines, which would fabricate large sections of the airframe from one piece of aluminium – for example, sections which included a number of windows. This assured that the section would be structurally strong and less likely to stress, fatigue or cracking in service life. This aluminium, known as RR58 in the UK, and AU2GN in France, was light and strong, able to cope with the skin temperature increases at Mach 2 and consequent expansion and contraction. (Contrary to popular belief, this temperature increase was caused by compression of the air over the skin, not friction.)

In addition to the 20 flying airframes, there were two extra built – one for fatigue testing and tested to destruction, and one for thermal heating to simulate the supersonic cycle of heating and cooling. Not to forget the fuel rig at Filton, which was built in the same shape and materials as the actual aircraft's fuel tanks and was movable in all axes, to test the distribution and fuel balance of the aircraft, along with the ability of the pumps and fuel lines to accommodate the fuel movement during flight.

Final works

After final structural assembly the aircraft was taken off the jig and placed on stands. Then began the process of installing all the equipment (some of which I had progressed), hydraulics, electrics, fuel systems, engines and undercarriages. Many times, walking through the

skeleton, I would see the multitude of wiring being installed (the ends hanging from the ceiling in plastic bags), instrument installation, and so on. Over time, I would see the engines being installed and connected up, and watch system functions, such as control surface movements, undercarriage deployment and retraction, as the aircraft moved from being bits of metal, plastic, and rubber to a fully functioning aircraft. And then came that wonderful morning when we came into work, and caught the first glimpse after she had been painted overnight. To see that gleaming white beautiful bird was breathtaking – like an apparition that had magicked itself into our lives.

On her own feet

Concorde 002 was then rolled out to begin system tests on her own feet – engine runs, taxy runs, slow and fast – until the wonderful day when 002 was pulled out to the end of the runway. The crew went on board, began their pre-flight checks, started the engines and moved out to the end of the runway facing west. Then she began to roll, the back boilers kicked in, and halfway down she reached V1, rotated and lifted into the air.

'Smokey Joe' was airborne, a tremendous sight and sound, and the beginning of an adventure which has seen me follow the aircraft ever since, in the absolute knowledge that I had seen her built and had some insight into how it was done. A true privilege, with awe and wonder that such a beautiful and advanced aircraft should show off, I felt, just for me.

Concorde emerges

002 is rolled out of the hangar for the first time – a stunning tribute to the talents and efforts of all the people who brought her into being.
Photo: George Rollo

From production to service

Ricky Bastin, Avionics Inspector, BAC Filton

I started work at BAC Filton in March of 1974, fresh out of the RAF and keen as mustard to be part of the team of thousands involved with the construction of Concorde. My own small personal role was to be that of an avionics inspector.

I soon realised that it was not so much a production line but more a giant, complex jigsaw puzzle. The shape of the Filton Aircraft Assembly Hangar (AAH) certainly didn't lend itself to a genuine production line either. It consisted of three huge hangar bays, the aircraft final assembly being carried out in the centre bay.

Bringing it all together

As most people know, Concorde was constructed in two parallel facilities, one in Filton and the other in Toulouse, with various sub-assemblies being constructed in factories all over France and the UK.

It was felt to be politically essential to have both a British and a French production line, but this resulted in a slow and incredibly expensive process. It meant that all the French bits had to be flown from Toulouse to Filton and all the British bits from Filton to Toulouse. For example, the fin, forward and aft fuselage sections (Components 30 and 24, respectively) were built in Weybridge in Surrey, the droop nose itself was built at Hurn in Bournemouth, and the engines at Patchway in Bristol, the other side of the airfield at Filton. All of these components would be shipped by road to Filton, for both the British and French aircraft. In addition to all this, the engine intake assemblies were built in one of the outer hangar bays in the AAH, so the intakes for the French aircraft would also need to be shipped by air to Toulouse.

One of the most bizarre aspects of the Filton assembly practice was that undertaken at a very small, old shed, about a quarter of a mile from the AAH and at the top of a steep

A hazardous journey
September 1973: the centre section of Concorde 206 (G-BOAA) is towed from Centre 5 to the Assembly Hall. *Photo: Heritage Concorde*

hill, known as 'Centre 5'. In here the various centre fuselage and wing components were joined into one large 'sub-assembly' structure, and this would then need to be taken down the hill to the AAH, an extremely steep and hazardous journey of several hours. The assembly would be towed down the hill religiously following a blue line painted on the roadway. Deviating even a foot from this line could spell disaster; the road was rather narrow in places. From aircraft G-BOAD onwards, this process was abandoned, the Centre 5 assembly being transferred to the centre bay of the AAH.

The construction process

There were four main stages:
1) Centre wing fuselage
2) Join of above with forward fuselage (Component 30)
3) 'Low Build', where the the aft fuselage section (Component 42) is added
4) 'High Build', where the undercarriage and powerplant assembles are added, systems installed, electrical and hydraulic power applied and all systems tested.

During the 'Low Build' stage, internals were fitted and wired and all major components, less undercarriage and powerplant, were fitted. Once all this was completed, the aircraft would be wheeled over (on temporary wheels, and looking quite comical!) to the 'High Build' position on the other side of the centre bay of the assembly hangar, where the big bits would be fitted.

The final stage would be when the aircraft would be taken outside for engine runs, as well as the compass, radio and radar systems testing and calibration.

Preparing for service

The finished aircraft would undergo her maiden flight to RAF Fairford for flight testing, due to the runway at Filton being inadequate for high-weight flight testing of Concorde, as well as local environmental concerns, being so close to Bristol city centre. I would often be based at Fairford on a temporary basis during pre-delivery test flights, and I was fortunate enough to have the first of my 120 or so flights on Concorde on G-BOAD, on November 5 1976.

When all test flying was complete, and after formal acceptance by the airline, the aircraft would be delivered to British Airways at Heathrow. In January 1977 the Fairford flight test centre was closed, so from aircraft G-BOAE onwards, the aircraft would fly to Fairford on a daily basis, where the facility would be manned for the day only, and the aircraft would return to Filton at the completion of the day's flight tests. When G-BOAE was delivered to British Airways in July of 1977, I was also 'delivered' to BA a week later, where I became part of the Concorde fleet, and for me at least, the rest is history.

The fleet takes shape
May 1974: Concordes G-BOAC (centre), G-BOAA (back), and G-BOAB (front) are pieced together. *Photo: Heritage Concorde*

Virtual reality

For Concorde flight crews, as for other commercial pilots, practice sessions in a flight simulator were a vital part of their training. Former British Airways Concorde Captain John Eames describes the simulator training for BA crew, and overleaf we look back at the history of the British and French simulators.

Simulator training

Captain John D. Eames MSc, FRAeS, Senior Pilot British Airways (retired)

Two Concorde training simulators were built: one in France and one in the UK. The French simulator, manufactured by Le Matériel Téléphonique (LMT), was installed in the Aeroformation facility at Toulouse. The British simulator was manufactured by Link-Miles and Redifon and was installed at the British Aircraft Corporation (BAC) site at Bristol Filton.

'The Cardboard Bomber'

When a pilot changes from one type to another, the first thing that must be learned is where in the cockpit to look for information and where to put the hand to change a setting. To save simulator time we constructed a simple cockpit with photographs of instruments and other controls for this purpose. We called it 'The Cardboard Bomber'. A new pilot would spend two sessions on the 'Bomber' going over cockpit safety and scan checks, as well as before take-off through transonic, deceleration and descent, and after landing checks.

The training course

The British Airways Concorde simulator course consisted of 16 four-hour details covering all normal operations and all possible failures. Later the New York noise abatement departure was added to the syllabus. Each detail was preceded by a two-hour briefing covering in detail the items that would be flown. Following the detail was a post-flight debrief.

In the simulator the training Captain and training Flight Engineer were stationed on the left-hand side, behind the Captain's seat. Each had a screen showing aircraft position and radio navigation aids. Other screens with push buttons could set the position, altitude, weather, fuel load and many system failures. For example, the simulator could, at the touch of a button, climb and accelerate from subsonic to supersonic and with the fuel correctly distributed.

Ideally, in the simulator, there would be a Captain in the left seat and a First Officer in the right seat, with a Flight Engineer in his seat. The first two hours would be flown by the Captain and covered everything as laid out at the briefing. The second two hours were then flown by the First Officer, again covering all items that had been briefed. If, by chance, there were two Captains or two Co-pilots rostered, then after two hours they would change seats so that they both flew the detail in their correct positions.

Monitoring a flight
March 2009: former BA Concorde crew members operate the simulator, now on display at Brooklands Museum, while viewers behind the cockpit watch the flight on the monitors.
Photo © 2009 Neil Walker

At the successful completion of the simulator course, a Type Rating Instructor would sign the necessary paperwork and the pilot would go to RAF Fairford to fly a real Concorde.

Refresher courses

As well as training pilots and flight engineers, the simulator was used for the six-monthly refresher and base checks that are required of all flight deck crew. The first of two days was spent flying emergency drills and procedures that had been part of the initial conversion course, and the second day completing the required flight test, which might include an instrument rating renewal.

In 2004, after Concorde went out of service, Brooklands Museum acquired the British Concorde simulator, but without the motion system. After many months of work by dedicated volunteers this is now open for paying guests to 'fly' the Concorde simulator.

The simulators

There were three Concorde simulators in all. British Airways and Air France each had their own simulator. In addition, an earlier simulator had been built in France to train the crew who flew the prototype and pre-production Concordes.

The test simulator

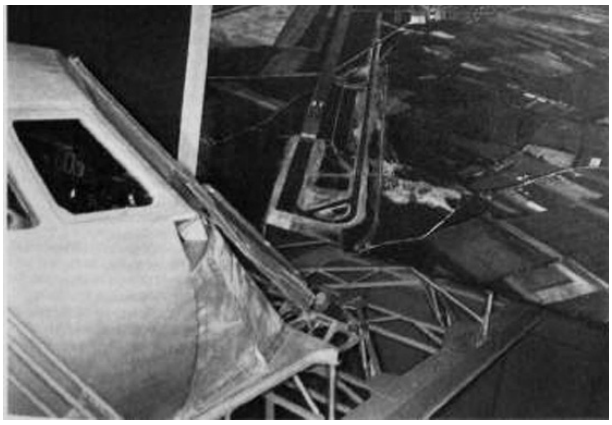
The French test simulator was built in 1966–7 by French company LMT (Le Matériel Téléphonique) and British company Redifon. Designed to replicate the functions of the Concorde prototypes, this was the first major digital study simulator developed in the world.

The simulator comprised a mobile cabin made to the same scale, and from the same materials, as the actual aircraft. The cabin was mounted on hydraulic jacks to allow movements of ±30 cm in height, plus pitch and roll.

The visualization system consisted of a flat screen on which colour images of reconstructed scenery, filmed by a camera in an adjacent room, were projected in front of the cockpit windows. The flight deck originally had a simplified version of the instrumentation but was still sufficient for test purposes; by the end of 1970, the simulator had evolved to reflect the flight deck of the production aircraft.

The cabin was linked to a monitor's station, where the simulated flight conditions and aircraft systems were controlled and 'faults' introduced for training purposes. A DDP224 digital calculator performed calculations concerning flight dynamics, bearing dynamics, engine propulsion, radio aids, hydraulic and electrical systems, and air conditioning. An analogue calculator, the RED 5000, was used to perform calculations for the simulated flight controls.

The simulator was used to study all aspects of the aircraft's performance, including possible breakdowns in specific systems. The Concorde test pilots carried out studies on this simulator before the inaugural flights of the prototypes. As André Turcat, Chief Test Pilot for Aerospatiale, said, "The simulator we had for two years before the first flight was very accurate. I could say – with a smile – that on March 2 [the day of the very first Concorde flight] we flew the simulator!"



Projected landscape
The test simulator seen from the outside; at the right of the picture, just beyond the front windows, the simulated 'landscape' can be seen projected onto a screen. *Photo: Association Virtu'Ailes*

Later, the simulator was used in the programme for certification of the aircraft, and the test pilots used it to train the first commercial flight crews. Once the Concorde fleets had entered service and the training simulator was in use, the test simulator was used for a time to study any problems that occurred with the in-service aircraft.

Air France training simulator

The training simulator is more complex than the study simulator, being an exact replica of an actual Concorde flight deck.

It has stations for the pilots and flight engineer, and for an instructor, who supervises the training and sets up simulated hardware and system failures. The simulator technicians could program the artificial fuel system for specific passenger numbers, weather conditions, day or night flying, and air traffic control situations.

The Air France training simulator was first installed at Toulouse in 1975, with fittings and controls from actual Concorde aircraft. In 1994 it was moved to the Air France base in Paris, where it was used until the fleet's retirement in 2003. It was then returned to Toulouse.

In 2006 a group called Association Virtu'Ailes was established to renovate the simulator. Their project, named Project Speedbird, involves restoring function to the flight controls, and adapting the simulator to work with more modern computers and a more realistic visual display system. Association Virtu'Ailes aim to have the renovation work vali-

dated by former Concorde captains and flight engineers.

The project team first used Microsoft's Flight Simulator program to operate the flight controls and recreate the visualization system. Finding that this program was not designed for use with such a sophisticated flight simulator, the team had to re-program MS Flight Simulator to include the necessary features.

In early 2018 the simulator was moved to the Aeroscopia museum at Toulouse, and on 2 March – the 49th anniversary of the first Concorde flight – it was opened for display to visitors. Renovation work is continuing, and the Association hope to bring more of the simulator's systems back into operation.

For further details on the French simulator, and information on visiting the simulator at the Musée Aeroscopia, please visit the Association Virtu'Ailes website: http://virtuailes.fr/134-2/

A new life
3 March 2018: visitors to Aeroscopia look inside the refurbished Concorde simulator. Work is continuing to bring the simulator's systems back to life. *Photo: Association Virtu'Ailes*

British Airways training simulator

The British Airways simulator was based at the British Aircraft Corporation's training centre at Filton. It was built in 1974–5 by leading simulator manufacturer Link-Miles of Lancing, Sussex, with Redifon Flight Simulation. The simulator entered service in March 1976.

The simulator shell was modelled to match the forward fuselage of an actual Concorde aircraft. It was mounted 15 feet off the ground on six hydraulic jacks, which enabled six axes of motion, to reproduce any movement of the aircraft.

The instruments matched those on the actual flight deck. The simulator technicians would program the system with particular fuel and passenger loads and weather features, to replicate flight conditions. They could also program in specific system and hardware failures to simulate problems and emergencies.

The simulator's visual system reproduced views out of the cockpit windows at each stage of a flight. The original system comprised a CCTV camera panning over model landscapes mounted on the wall of an adjacent room, with the pictures projected in front of the cockpit windows. In 1987 the visual system was upgraded to a panoramic system that gave pilots a 150° by 40° view and displayed a much wider range of landscapes, enabling pilots to 'fly' to many of the major airports around the world.

The simulator was decommissioned in 2004, after the Concorde fleet had been retired, and was moved to Brooklands Museum. In 2008 work began to restore it. The original hydraulic motion system had been scrapped, but the University of Surrey and the Engineering and Physical Sciences Research Council conducted a project to integrate the existing simulator cockpit with modern flight simulation software. The simulator can now be 'flown' again using the original flight controls and instruments, while detailed simulated environments are projected on to screens in front of the cockpit windows.

Visitors to Brooklands can enjoy the chance to fly the simulator themselves, with tuition from an actual Concorde pilot. For further details, and information on booking a session, visit the museum's website: http://www.concordeproject.com/simulator.html#info

Refresher course
Former BA Concorde captains Les Brodie (left) and Mike Bannister (right), and flight engineer Warren Hazelby, fly the simulator once again.
Photo © 2009 Neil Walker

Concorde watch

Concorde G-BOAB

British production aircraft

Location: Heathrow Airport, London, UK
Reporter: Katie John **Date:** 1 March 2018

I was informed that a minor bit of TLC was carried out on 1 March for G-BOAB – just pumping up the tyres as they were looking a bit flat. The crew stayed outside on this particular jaunt. Rather chilly it was too, by all accounts!

Apparently, planning of maintenance for Alpha Bravo does not go into much further detail than a list of jobs that need doing. These jobs have to be fitted in around people's normal duties. The man who looks after her has a full-time job in BA Engineering, so all work on AB has to fit around that. There are also people who look after her who go on board as and when is necessary.

On this particular morning, someone simply popped his head into the crew room and asked for a couple of volunteers to top up AB's tyres as they were looking rather low on pressure. They went out to her with the nitrogen bottles and a tyre inflater and rather gently topped up the pressures on the mains. The nose wheels looked good so they didn't touch them.

Regular maintenance
An engineer pumps up G-BOAB's tyres with nitrogen – one of the maintenance tasks that British Airways engineers carry out on a regular basis for the aircraft.
Photo: Anonymous

Concorde G-BOAF

British production aircraft

Location: Aerospace Bristol, Filton, UK
Reporter: Arran Shackell **Date:** 10 March 2018

Popular display
Visitors to G-BOAF enjoy seeing inside the aircraft as well as watching the films projected on to the side.
Photo: Arran Shackell

It's finally great to see this aircraft have a thoroughly deserved permanent home and it's brilliant how you can walk round all aspects of it. The visual displays projected on to the side of the aircraft as seen in the photograph are fantastic to watch and engaging for all ages. There's also a display with seats, cockpit mock up, uniforms, etc.

Sadly I had some major negatives/disappointments from Saturday's visit. There's now a sign on the plastic see-through panel to the rear cabin saying that no more than 5 persons are allowed in at any one time. When I questioned one of the staff about this he said it was because the floor at the rear cabin is now completely rotten and won't hold a massive amount of weight. This is due to the aircraft being left outside for X number of years holding water. The museum staff have looked into getting this sorted/repaired long term, but British Airways have said no. The outside appearance of the aircraft is faded, and in a perfect world a full repaint would be warranted but this is obviously not going to happen. The museum have asked British Airways if they can wash and polish parts of the aircraft to make it look less grubby, but they have been told no. Some letters of the registration are peeling away off the fuselage.

Good to see AF inside finally, but sadly it seems most of the damage has been done after spending 14 years outside. I visited AC in Manchester a few years back; this aircraft only spent a handful of years outside and was in perfect shape. Shame some Concordes have been neglected more than others!

In Memoriam: Christopher Orlebar

Katie John, Editor, Mach 2

I first met Christopher and his wife in 2005, when he was the speaker at a Concorde event at the Green Man pub near Heathrow. He fascinated and entertained us all with his reminiscences of his life on Concorde. I was with two friends, Perry and Simon, and we were delighted when he stopped to have a chat and a joke with us.

The following year I saw Christopher impress a very different audience when he gave a lecture on Concorde at the Design Museum in London. Since then our paths had crossed at various Concorde-themed events, at the Royal Aeronautical Society and elsewhere.

I have had many chances over the years to appreciate Christopher's sizeable store of Concorde knowledge. His excellent book *The Concorde Story*, now in its seventh edition, has been a valuable resource for my own researches. In it he gives the history of the Concorde era as well as technological information on the aircraft. Just last year he brought out another book on Concorde, more concise but still rich in detail. In addition, he did Nigel and me the kindness of sharing his personal insights into flying Concorde – first in Nigel's newsletter for the Save Concorde Group, and then as a regular contributor for Mach 2 magazine.

Christopher's writings on Concorde stand as a permanent memorial to him. Less visible, but equally enduring in my mind, will be the memory of Christopher as a person – his intelligence, charm, and quiet sense of humour. He was a fascinating person to talk to, with knowledge that ranged far beyond the aeronautical world. I send my condolences to his family, and I will remember him with a smile.

I conclude with a quote from *Hamlet* (Act V scene 2), which sums up my feelings:

"Goodnight sweet prince:
And flights of angels sing thee to thy rest!"

Nigel Ferris, Contributing Editor, Mach 2

I first met Chris Orlebar when I attended an air display at Filton, and he was there with his video camera recording the aircraft flying. I introduced myself to him, with some trepidation as to whether a Concorde pilot would want to talk to just another onlooker. How wrong I was – Chris was genuinely happy to take time to talk to me, as an equal, and fan of Concorde.

This acquaintance continued when I was a tour guide at Concorde At Filton, and he visited us a number of times. He became a very good friend, on the telephone where we would have long chats about Concorde and aviation. Chris was also very happy to escort me around Brooklands (where he was deservedly very highly respected), once by myself, and once with my son and son in law to be. This included getting us into the simulator, and other exhibits which were not generally available. Despite his limitations, he gave us plenty of time during the day, answering any and all questions. The story of his flying life was fascinating, and I could have listened to him all day.

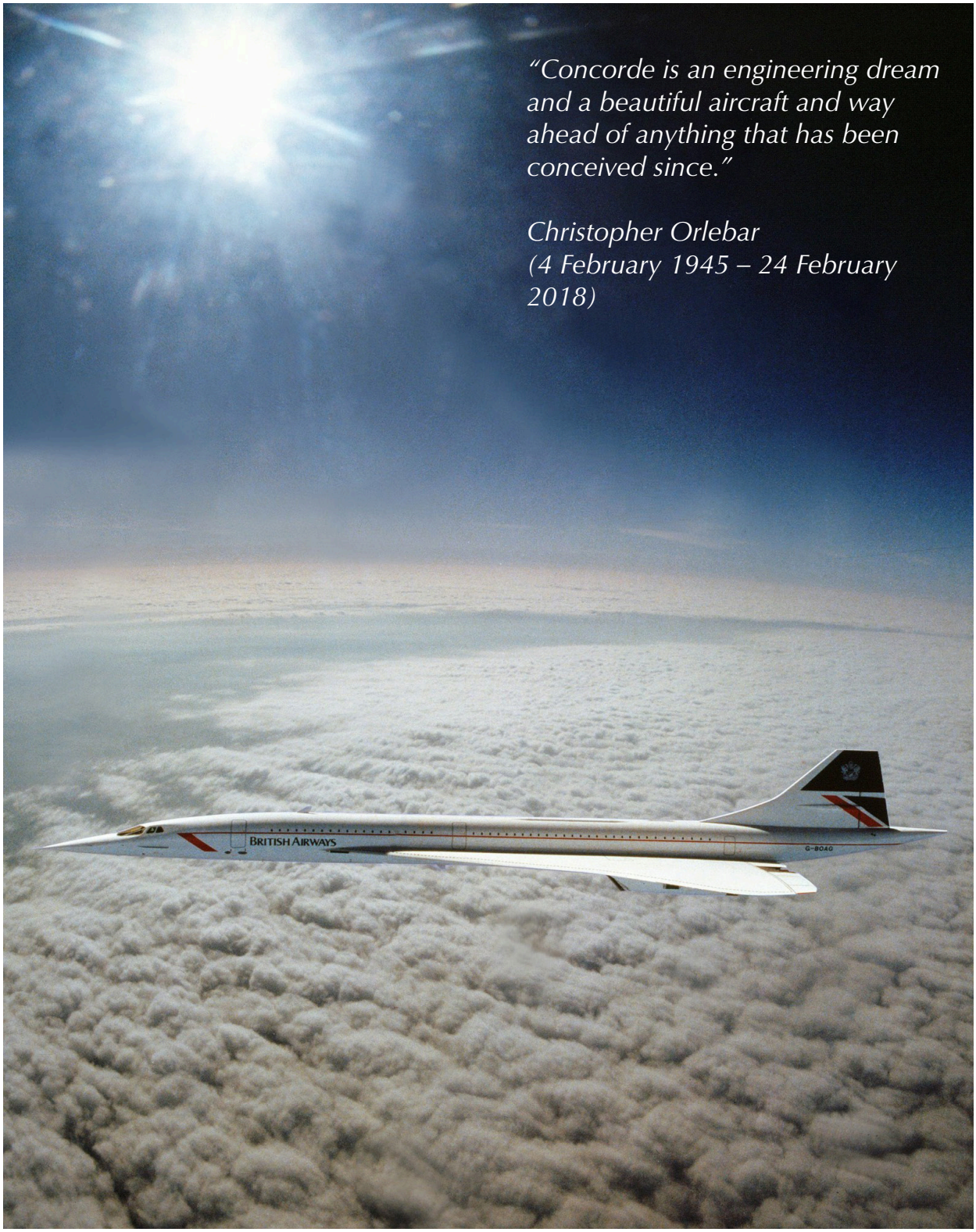
Chris also became a regular contributor to our original Save Concorde Group Newsletter, and more recently to Mach 2 magazine. The stories of his Concorde life were brilliant – and a tremendous insight into such a wonderful aircraft. We are very grateful to him for sharing with us. Chris was also the author of *The Concorde Story* (the best book available), and more recently, *Concorde*.

He was an absolute gentleman, a good friend, and a lovely man. Chris engendered tremendous respect from all who knew him, and from the aviation community. I will miss him a great deal; my thoughts and condolences are with his family at this sad time.

From Adrian Thompson, BA Concorde Captain, who flew the last BA003 flight in 2003:

Christopher lived much longer than expected; but that was so typical of him.... He and I were on the same pilots training course at Hamble and were paired together for our flying instruction. We then joined BOAC together and both eventually got our first piloting (rather than navigating) post on the VC10 fleet. Because he was the most senior of us new joiners (due to him being the eldest), he managed to get on to the Concorde fleet almost from the very beginning. He gained his Command on the Boeing 737 fleet, but soon after he was diagnosed with Parkinson's and was forced to take medical retirement. On learning that I was to join the Concorde fleet as a Captain, his words to me were "you lucky bastard"! His entire life was aviation orientated, giving lectures etc right up to the end.

Thanks to Emma Rasmussen of Speedbird Concorde for passing on this message from Captain Thompson.



Concorde G-BOAG at Mach 2
Taken from the flight deck of a Tornado chase aircraft.
Photo © Adrian Meredith

CORRECTION

Concorde G-BOAF, Filton

Further to our report on Alpha Fox, given on p.13 of this issue, we have been told that the statement given by one of the current guides, that "the floor at the rear cabin is now completely rotten and won't hold a massive amount of weight", is untrue.

Gordon Roxburgh, from the team who look after G-BBDG at Brooklands Museum, corrected the infromation as follows:

"The forward cabin aisle floor was replaced with 12mm marine ply in 2004 to allow it to take the throughput of traffic. The original honeycomb floor was designed for a few hundred passengers a week, not thousands a week!"

In addition, another member of the Brooklands team has recently examined the floor at close quarters and said that it is in good condition.

If the museum did not intend to have visitors passing through the rear cabin, it would make sense to seal off the area with a perspex screen.

Our reporter relayed what he had been told in good faith, and as editor of Mach 2 I take full responsibility for what appears in the magazine. I am, however, more than happy to publish this correction. Many thanks to all at Brooklands and Filton who supplied corrections and clarifications.

Katie John, Editor, Mach 2