

LAST OF THE GUNFIGHTERS - **VOUGHT F-8 CRUSADER**

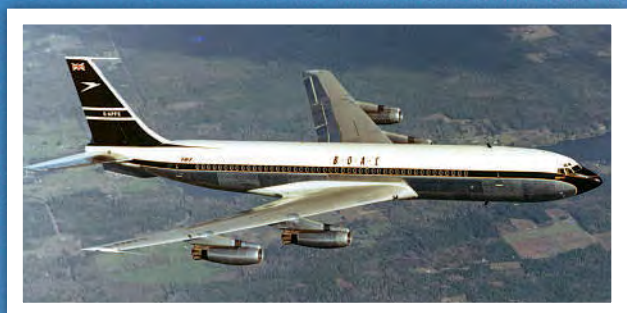
JETS



March/April 2015 £4.25

Magister

Flying the Fouga



Flag Carrier

BOAC In Detail



Ace!

Gloster's 'Gormless' Fighter



DH.108 Swallow vs X-4 Bantam

Test Beds Compared

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- BAC 1-11 RESTORED • MID SIZED AIRLINER MARKET
- JETS OF WORLD WAR TWO • MD.11 RETIREMENT



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AEROPLANE

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It was with the Hawker Demon that No 64 Squadron re-formed in 1935, and nearly went to war

ON SILVER WINGS: HARTS AND HINDS

This year celebrating its centenary, No XV Squadron spent a notable period on Hawker biplanes

ON SILVER WINGS: SWISS DEWOITINE

A magnificent Dewoitine D26 restoration salutes Switzerland's use of the French manufacturer's parasol-winged designs

DATABASE: ARMSTRONG WHITWORTH ENSIGN

One of the many British airliners that failed fully to realise its possible potential, Armstrong Whitworth's inter-war Ensign is described by Bill Harrison

GRUMMAN DUCK

Air-to-air with a very rare flyable survivor of the attack on Pearl Harbor

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DICK RICHARDSON

Memories of the Strathallan Collection and Charles Church's warbird operation, from a key figure at both

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148/15

APRIL ISSUE AVAILABLE FRIDAY 27TH FEBRUARY *

From the Left Hand Seat



As some of you may know I've been privileged to sit on the Friends of Duxford (FoD) committee for getting on towards 15 years now. During this time our members – of whom we have around 6,000 in different parts of the globe – have helped raise somewhere in the region of £1.4 million for the Imperial War Museum at Duxford.

Normally, the discussions at our committee meetings revolve around our events, lectures and the facilities we offer members at the IWM airshows but of late we've found ourselves debating something all together different... children.

You see, up until the start of this year, IWM has always admitted children to the museum free of charge, so there has been no need to create a 'junior' FoD membership category. However, large and ongoing reductions in the grant the museum receives from the government has left it with no option but to introduce admission charges for children and families.

"Great to see him excited..."

After a recent committee meeting I went for a walk around the museum's hangars and I kept running into the same family whose children, a boy and his younger sister were running around, their eyes wide open with amazement. I obviously looked like I'd been there before and 'dad' asked me if I knew where to find the SR-71 Blackbird.

It transpired that their son had seen the SR-71 on a documentary and had been pestering his parents to take him to see it for months. "We know nothing about aeroplanes," his dad confessed, "but it's great to see him this excited."

I couldn't help but smile as I remembered my own childhood visits to museums, airshows and airports. There is no aviation (or even military) history in my family either as both my grandfathers served as coal miners during World War Two and my father trained as a tool maker at the Reliant car factory to avoid a career down the pit. Yet, for some inexplicable reason, I grew up more

interested in aeroplanes than cars and to this day I still don't know one end of an engine from another (much to my father's despair!).

I will always be grateful that I had parents who – as you'll see from this month's editorial photograph – indulged my interest in aviation from a young age and spent their valuable spare time encouraging my passion. Whether it was sitting in the viewing lounge at Birmingham Airport, visiting airshows, or the regular school holiday trips to the Aerospace Museum at Cosford, my folks always went out of their way to accommodate my desire to be around aeroplanes.

Build a model

As a result, my father also developed an interest in aviation and we soon discovered that building and flying model aircraft was a hobby we could both enjoy. My father has always been good with his hands and combined with my lack of technical aptitude, this developed into the perfect dynamic where he would build, I would fly; I would crash and then dad would mend. Everybody got something out of the relationship!

I still fly models on rare occasions and it really couldn't be easier to get into the hobby these days. Gone are the days of spending months building balsa wood airframes from plans or kits and today the standard of 'almost ready to fly' kits means you can go from box to flight in hours.

This past Christmas a friend purchased one such model for his son and I'm looking forward to seeing how he progresses in the hobby. They've certainly spent some valuable father/son time assembling the aircraft and as soon as the weather improves, I wager they'll spend many happy summer evenings flying and mending their new pride and joy.

The future

I've written before about the lack of aviation opportunities on offer to youngsters these days. They can no longer experience landing from the flight deck of an airliner; security fences means there are few places they can sit and watch aeroplanes and the

shrinking military means that opportunities to 'join up' are rapidly declining.

I have genuine concerns that the aviation industry is successfully extinguishing the spark in the youngsters it needs to survive. If we want a new generation of pilots, engineers or enthusiasts, we need to start encouraging them at an early age, and the best place to do that is at home.

So please, if your children, grandchildren, nieces, nephews or neighbours show even the slightest spark of interest, please seize the moment and fan the flames. Take them to your local aviation museum, build a model with them – or maybe just give them your well-thumbed copy of *Jets* magazine! The future of aviation is in our hands and it's our job to pass on the torch to the next generation.

New year

This is the first 2015 edition of *Jets* and the team and I have some exciting plans for the year ahead. It's good to have you along for the ride.

Until next time
Blue Skies

Steve

Stephen Bridgewater
Editor



Howard Heeley / Newark Air Museum



PHOTO OF THE MONTH

The seasonal snowfall that affected much of the UK between Christmas and New Year resulted in some unusual photographic opportunities. At the Newark Air Museum English Electric Canberra T.19 WH904 sat on its tail due to the weight of the accumulated snow and is seen here as museum volunteers prepared to lower it on December 29. The aircraft is one of five Canberras (including nose sections) on display at the museum and began life as a B.2 in 1954. It was later converted to T.11 standard with the extended nose housing radar to train Javelin crew. Further radar modifications led to it being redesignated as a T.19 and it served until 1979. It joined the Newark Air Museum in 1985



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CONTENTS

INSIDE THIS ISSUE OF JETS:



6 Jet Noise

News from the Jet World

12 From the Cockpit

Flying the Fouga

An unconventional-looking, ex-military machine with a V-tail might not seem the ideal mount for fast jet aerobatics, but when Bob Grimstead took the controls, this Fouga Magister quickly won him over

18 Military History First Generation Jet Trainers

In the first of a five-part series on jet trainers, Dr Dave Sloggett looks at aircraft from the '50s and explains how post-war development programmes changed the way that pilots learned to fly fighter jets

24 Classic Airline BOAC

On Friday May 2, 1952 one of Britain's two nationalised

airlines became the world's first jet airline. Bruce Hales-Dutton looks back at the history of the British Overseas Airways Corporation

30 Technology Mid-Size Market

Airline passenger traffic is estimated to treble within the next 20 years and manufacturers are estimating a demand for 5,000 new mid-sized airliners. Kimberley Hawkins looks at the myriad of aircraft currently under development

36 Anniversary The Last Gunfighter

The Vought Crusader was the US Navy's first true supersonic fighter and its final aircraft to be designed around a cannon. Richard Freail examines the last of the gunfighters

44 Preservation Wait, wait, wait... rush!

Restoring and repainting a large aircraft is always going to be a challenge when you're operating as a charity. However, the Duxford Aviation Society





24

Tom Singfield Collection



36



Illustration Andy Hay : www.flyingart.co.uk



58



62

Caz Caswell Collection

has just completed a rapid restoration of its BAC 1-11, as Steve Bridgewater reports

46 Memory Lane

Jets is all about rekindling the memories of days gone by and we are always keen to hear from you and see the images filed away in your photo albums. This month, with the recent news that the USAF is to leave RAF Mildenhall, Mick Britton takes a nostalgic look back at the base's famous Air Fete airshows

48 Record Breakers Saigon Evacuation

The fall of the capital of South Vietnam in 1975 led to an unprecedented evacuation. Tom Pierce looks at an incredible sortie that resulted in hundreds of desperate people cramming into a single C-130 Hercules!

50 Testing Times

The latest in jet-related books and products put to the test

52 Pioneers The Gormless Ace

In the 1940s jet engines were a rare commodity and Gloster's E.1/44 was created as a single-engined alternative to its twin-jet Meteor. Although officially known as the 'Ace' the aircraft was dubbed the 'Gormless' by Gloster's Chief Test Pilot Bill Waterton. Pete London investigates why

58 Pioneers Mixed Power Pioneers

The woeful performance of the earliest jet engines initially led aircraft manufacturers to team them with piston powerplants. However, the age of the mixed-power fighter was short lived, as Kimberley Hawkins reveals

62 Classic Airliner End of an Era

Succeeding the DC-10, the MD-11 may not have

been the success story that McDonnell Douglas hoped for but it still left a mark with passengers, pilots and enthusiasts. Spencer Bennett looks at the career of this long-bodied but short-lived airliner

68 Pioneers Close, but no combat

It's commonly known that just a handful of jet aircraft were ready to see action in World War Two. However, as Frank Glass discusses, there were many more waiting in the wings

76 Classics Compared X-4 Bantam vs DH.108 Swallow

Early jet testing had its trials and tribulations. Northrop's X-4 Bantam and de Havilland's DH.108 Swallow were designed to test the handling of tailless jets at transonic speeds but, as Sebastian Morgan reveals, they suffered very different fates



Front Cover: Mike Vines

Jet Noise



João Paulo Moralez via Dave Harmsworth

Lebanese Vampire Discovered

Former Royal Air Force de Havilland Vampire FB.5 VV694 has been discovered at the School of Arts and Crafts in Dekwaneh near Beirut, Lebanon. The jet, which first flew in 1949 and was one of four sold to the Lebanese Air Force (LAF) in 1958, is being used as an instructional airframe and still wears the L161 markings from its LAF service

BA Speed Record

Strong winds in early January resulted in travel chaos across much of the UK but it did have a benefit for those flying transatlantic routes.

On January 7 a British Airways Boeing 777-300, flying as BA114 from New York to London, completed the Atlantic crossing in just five hours and 16 minutes – arriving 90 minutes ahead of schedule!

The jet averaged 647kts thanks to the surging jet stream that reached speeds in excess of 175kts, and the crew are eligible to claim an FAI speed record for aircraft in their weight category.



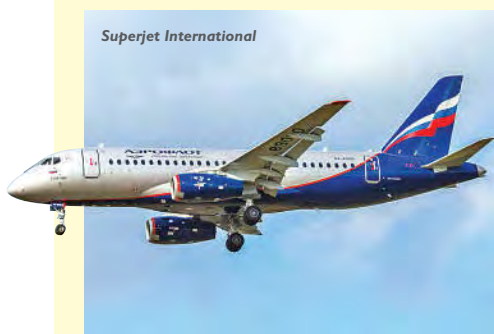
BA114 flew from New York to London in five hours and 16 minutes, averaging 647kts

First Flight - Turbine DA-50

The prototype of a new turboprop powered Diamond DA-50-JP7 took to the skies for the first time on January 19. Diamond Aircraft's CEO Christian Dries was at the controls for the test flight from Wiener Neustadt, Austria and later said: "This aircraft with this turbine engine almost flies like a rocket."

The single engined turboprop can carry up to seven passengers and is powered by a 465shp AI-450S engine built by Ukrainian company Motor Sich JSC in collaboration with Ivchenko Progress.

Right: The AI-450S engine fitted to the DA-50-JP7 is said to have a 20% lower fuel burn than similar turbine engines and is particularly fuel-efficient at medium altitudes



Superjet International

Extra Superjets for Aeroflot

On January 15 Aeroflot signed a deal with Sukhoi Civil Aircraft for 20 additional Sukhoi Superjet 100 airliners.

Aeroflot will receive the additional SSJ-100s in full specification, able to accommodate 87 passengers in a spacious dual-class configuration (12 seats in business and 75 in economy). The new aircraft will fly on short-haul domestic routes operated by Aeroflot Group subsidiaries, where the Superjet 100 has already proved highly effective.

Left: As the Russian domestic market continues to expand rapidly (Aeroflot Group's domestic traffic increased 23.6% year-on-year in November 2014), the new SSJ-100s are expected to make a significant contribution to the group's future growth

The Latest News from the World of Jets

F-35B WEAPONS TEST

A UK team including personnel from BAE Systems has completed initial handling trials on the Lockheed F-35B Lightning II carrying ASRAAM and Paveway IV weapons. Two F-35B aircraft, flown by Lockheed Martin F-35 test pilot Billie Flynn and RAF Sqn Ldr Andy Edgell, completed nine flights from NAS Patuxent River carrying 'dummy' weapons rounds. This is described as "an important step in integrating weapons onto the jet"



SWISS HORNET FOR COSFORD

Visitors to the RAF Cosford Air Show on June 14 will be treated to a stunning display of noise, power and agility from a Swiss Air Force F/A-18C Hornet. Airshow spokesperson Peter Reoch said, "This is the first time a Hornet has featured in the flying display at RAF Cosford and will hopefully be the first of many international participants at this year's event."

Dreamliner Deliveries

The Boeing 787 Dreamliner programme continues apace and on December 23 Azerbaijan Airlines received its first example. With the delivery it became the first airline in the Commonwealth of Independent States to operate the 787. Then, on New Year's Eve, Royal Air Maroc celebrated the arrival into Morocco of its first Dreamliner at the end of a 4,788nm non-stop flight from Washington to Casablanca.

February 2 also saw Boeing deliver the first 787-9 to Singapore-based low-cost airline Scoot. Scoot's chief executive officer Campbell Wilson said: "The Dreamliner represents a step-change for Scoot, allowing us to take our onboard customer experience to a new level and to greatly expand our network."

Meanwhile, orders continue to roll in with Spanish-based Air Europa ordering 14 examples of the 787-9 Dreamliners and Air New Zealand adding two additional 787-9s to its order. Air Europa now has a combined total of 22 787-8s and 787-9s on order as it continues its transition to an all-Boeing long-haul fleet.

On January 30, All Nippon Airways (ANA) announced its intent to purchase three 787-10s to expand its existing Dreamliner fleet.



Scoot's first Dreamliner departs Washington at the start of its delivery flight on February 2

Another Phantom Saved

The latest former RAF McDonnell Douglas F-4 Phantom II to be rescued from the scrapman is being prepared in readiness to move from RAF Leuchars to the Ulster Aviation Society's site near Maghaberry, Northern Ireland. F-4K Phantom FG.1 XT864 originally joined the Royal Navy in 1968 before transferring to the RAF's 111 Sqn in 1979. In 1988 a fuel truck collided with XT864 and the jet was relegated to 'gate guard' duties; however, with the imminent closure of the Scottish base it was put up for disposal. The Ulster Aviation Society reportedly paid £31,000 to save the interceptor for posterity.



RIAT Plans Firming Up

This summer's Royal International Air Tattoo, which takes place on July 17-19 at RAF Fairford is already shaping up well. The 2015 show will see the return of Vulcan XH558, which was controversially missing from last year's event. The V-Bomber will fly into Fairford on Friday, July 17 for a special 'Pit Experience Day' offering people close access to the aircraft and the opportunity to meet members of the Vulcan to the Sky team.

Other 'acts' confirmed by early February included the Swiss Air Force's PC-7 Team in the flying display and a British Airways Airbus A318 and Qatari Emiri Air Force C-130J Hercules in the static park. The latter marks Qatar's RIAT debut.

RIAT is introducing a new 'First Class Lounge' enclosure at the 2015 airshow.

For £294 per day (in addition to the show entrance fee), it offers a private marquee, garden and luxury toilets as well as 'contemporary catering and an inclusive bar available all-day.' You'll also get access to a VIP traffic route to and from the show.



A BA Airbus A318, one of the rarest aircraft in its fleet, will go on static display at RIAT on July 17-19. The A318 serves between London City Airport and New York's John F Kennedy Airport and operates with an all-business class interior comprising 32 seats, each convertible into a fully flat bed

Jet Noise



First Flight – A330-300-24T

January 12 saw the prototype 242-tonne Airbus A330-300 take to the skies from Toulouse-Blagnac Airport on its maiden flight. The jet combines an increased maximum take-off weight with improved aerodynamics to offer additional range and the new Rolls-Royce Trent 7000 powerplants offer a significant fuel-burn reduction. Launch customer Delta Air Lines is scheduled to take delivery of its first aircraft in the second quarter of this year.

Airbus

The first Airbus A330-300-24T takes to the skies on its maiden flight on January 12



Transatlantic A321neo

On January 13 Airbus launched a new version of the A321neo with a Maximum Take Off Weight (MTOW) of 97 tonnes. The move came after the company received a first commitment from Air Lease Corporation (ALC) for 30 such jets. The increased MTOW will give the new aircraft 4,000nm range – the longest of any single aisle airliner available today. This makes it ideally suited to transatlantic routes and will allow airlines to tap into new and previously inaccessible long-haul markets.



ALC has become the launch customer for the transatlantic capable A321neo

Four 777Fs for Qatar Airways

Qatar Airways has finalised an order for four 777 Freighters, valued at \$1.24 billion, that was first announced at last summer's Farnborough airshow. Qatar Airways currently operates a fleet of 37 Boeing 777-300ERs (Extended Range) and 777-200LRs (Longer Range), in addition to seven 777 Freighters

Ghanaian Military Spending Bonanza

Shortly before Christmas, Ghanaian President John Dramani Mahama announced that his government had set aside US\$300 million for the purchase of new combat, trainer and transport aircraft to support United Nations peacekeeping operations. The country has its sights set on new Embraer Super Tucano light attack/trainer aircraft as well as Mil Mi-17 and Mi-35 helicopters from Russia, Harbin Z-9 helicopters from China and at least one CASA 295 heavy-lift transport aircraft from Airbus Military. The President said the aircraft were due for delivery by the end of 2015.

Airbus Military



The Ghanaian armed forces are engaged in UN peacekeeping operations in Mali, Ivory Coast, South Sudan and Lebanon. Aircraft such as the C-295 will be invaluable

Aeroscopia Museum Opens

Aviation's past, present and future feature in the unique Aeroscopia museum, which opened on January 28 with support from Airbus.

The museum, located adjacent to Airbus' headquarters at Toulouse-Blagnac Airport in France, allows visitors to see Airbus' current production activity while exploring aviation history. Exhibits include an Aérospatiale-BAC Concorde, an AeroSpaceLines Super Guppy and an Airbus A300B – the latter having sections of transparent walls and flooring to provide views of the aircraft's systems. Visitors can also pre-book to tour the Airbus production sites at the airport by visiting www.manatour.fr



The cargo hold of Airbus' historic swing-nose "Super Guppy" transport aircraft displayed at Aeroscopia has been fitted with a video screen that plays a movie on aviation history for visitors to the museum

Starfighter Renovated

Former Japanese Air Self-Defense Force Lockheed F-104J Starfighter 46-8574 has recently returned to gate guardian duties at Chitose Air Force Base on the Japanese island of Hokkaido. The aircraft, which had been on display since 1980, was restored by JASDF forces before being returned to a plinth at the airpark adjoining the base. It now wears the colours of 203 Sqn on the starboard side and 201 Sqn on the port side. The jet flew with both these units while in JASDF service

via JASDF Chitose Air Force Base



Starfighter 46-8574 back atop its plinth following restoration in Japan

The Latest News from the World of Jets

\$2 Billion Investment at American Airlines

A year after closing its merger with US Airways, American Airlines is looking ahead to 2015 and beyond with more than \$2 billion in investment.

"Now that we have the network to compete globally, we're going to deliver a product that's better than our competitors," said Doug Parker, American Airlines chairman and CEO. "Refreshed cabins and clubs, modernized ticket counters, improved technology and new aircraft are further examples of how American is 'going for great' – providing our outstanding team members the tools they need to deliver a great experience for our customers."

These capital investments include fully lie-flat seats, international Wi-Fi, more in-flight entertainment options, a new, modern design for Admirals Club lounges worldwide, and an upgraded assortment of complimentary healthy food, cocktails and more.

The fleet will also be modernised and the airline is expecting to take delivery of 112 aircraft in 2015 and 84 in 2016, giving it the youngest fleet of any US-based network carrier. Orders include the Airbus A320 family, A350-900s, Boeing 737 MAX, 777-300ERs and 787s.



American Airlines has a backlog of A320 family aircraft. It received its first A319, illustrated, on July 23, 2013

RAF Mildenhall to Close

On January 8 the US Department of Defense announced the consolidation of some US military infrastructure in Europe, including the return of 15 sites to their host nations and saving \$500 million annually. Included in the bases being 'handed back' is RAF Mildenhall, which has been used by the USAF since the 1950s and was once home to the popular Air Fete airshow.

Mildenhall's Boeing KC-135 tankers and the 352nd Special Operations Wing (including the MC-130s assigned to the 67th Special Operations Squadron) will be relocated to Germany, and the RC-135s will be reassigned within the UK.

Meanwhile, it has been announced that the USAF will base two squadrons of F-35A Lightning II fighters at RAF Lakenheath from 2020

New Air Force One 747-8 Planned

The US Secretary of the Air Force Deborah Lee James announced on January 28 that a "fully missionised" version of Boeing's latest 747-8 had been chosen to replace the existing VC-25s (military 747s) used as the presidential aircraft.

The move was hardly a surprise as the only aircraft considered suitable for the role are the American 747-8 and the European Airbus A380.



A fleet of three Boeing 747-8 will replace the current VC-25 aircraft from 2018. The existing Air Force One aircraft are based upon the earlier 747-200

NEWS IN BRIEF

A Delta Air Lines captain was locked out of the cockpit of his MD-90 airliner on January 30 leaving the first officer to make an emergency landing. The cockpit door reportedly jammed while the aircraft was en route from Minneapolis to Las Vegas. The aircraft declared an emergency but landed safely at McCarran International Airport

The US government has reportedly brought charges against a Chinese citizen who is alleged to have attempted to smuggle F-35 Lightning II data into China. Reports suggest the documents relate to the testing of titanium used in the engine

Airbus has exceeded its targets for 2014, achieving a new record of delivering 629 aircraft to 89 airlines – eight of which were new customers. The manufacturer produced 490 A320 aircraft, 108 A330s, 30 A380s and also its first A350 XWB. Airbus also achieved 1,456 net orders from 67 customers (of which 14 are new) – its second best year ever. As a result, by year-end, the order backlog had climbed to a new industry record of 6,386 aircraft valued at US\$919.3 billion

Boeing has retained its title as the world's largest aeroplane manufacturer after delivering 723 aircraft worth \$232.7 billion in 2014. The company also grew its backlog of unfilled commercial orders to a historic high of 5,789 aircraft

News agencies in Iran have quoted a Islamic Republic of Iran Air Force spokesperson as claiming the nation now has "several squadrons" of the indigenous Saeghe (Thunderbolt) jet fighter in operation. Based on the Northrop F-5 Tiger II the Saeghe has a canted twin-fin tail and was unveiled in 2007. It was previously thought the aircraft was only at the prototype stage

The Fantasy of Flight museum reopened to the public on January 30. Based in Polk City, Florida, the museum, which was founded by Kermit Weeks, closed last year but a scaled down version will now be open on selected weekends

The Armed Forces of the Philippines has signed a 'Letter of Offer' to acquire a pair of former US Navy KC-130T tanker aircraft. The aircraft are currently at NAS JRB Fort Worth in Texas but will be overhauled before delivery in 2016

The Classic Air Force has decided to complete English Electric Canberra B.2/6 WK163 (G-BVWC) as a static exhibit after failing to secure sufficient funds to return the jet to the skies. When funds become available the restoration will recommence

Jet Noise

First Flight – KC-46

The USAF entered a new generation on December 28 when Boeing's 767-2C (KC-46) tanker performed its maiden flight.

As part of a contract awarded in 2011 to design and develop the Air Force's next-generation tanker aircraft, Boeing is building four test aircraft – two 767-2Cs and two KC-46A Tankers. The 767-2Cs will enter flight testing as commercial freighters prior to receiving their aerial refuelling systems, while the KC-46s will fly as fully equipped tankers through the FAA and military certification process.

Boeing is on contract to deliver the first 18 of 179 KC-46 aircraft to the Air Force by 2017.



The first test flight of the KC-46 tanker programme got underway at 09.29 on December 28. The Boeing 767-2C took off from Paine Field, Washington and landed three hours and 32 minutes later at Boeing Field

Yorkshire Thunder

The popular series of 'Rolling Thunder' days at the Elvington-based Yorkshire Air Museum are set to continue for 2015 with four planned during the season.

The events, commencing on April 11 to celebrate the fifth anniversary of the arrival of Nimrod MR1 XV250, include fast taxi runs by many of resident jets and propeller driven aircraft.

Other Rolling Thunder days include June 7, August 2 and August 31 when featured aircraft will include the RAF SE5a, Douglas C-47 Dakota, de Havilland Devon, Blackburn Buccaneer, Nimrod XV250 and Handley Page Victor K.2 XL231.



Handley Page Victor K.2 XL231 'Lusty Lindy' pops her brake 'chute at the end of a Rolling Thunder run at Elvington. Four events will take place in 2015

75th Boeing Jet for Thai Airways

Boeing delivered its 75th aeroplane to Thai Airways with a cargo of 1,000 woollen blankets in the 777-300ER's hold. The blankets, donated by Another Joy Foundation, will be distributed by the airline to people in need in Thailand during the colder winter months. This latest humanitarian effort, the third collaboration between Boeing and THAI, is part of Boeing's long-running Humanitarian Delivery Flights programme



Thai Airways' 75th aeroplane departs Boeing Field with its cargo of humanitarian aid

JET AGE JAVELIN

The Jet Age Museum, based at Gloucestershire Airport (Staverton), has won the Ministry of Defence tender to acquire Gloster Javelin FAW.4 XA634 from RAF Leeming [see Jets Nov/Dec 2014]. The aircraft had been serving as a 'gate guardian' at the station but is now destined for the county where it was built in 1956. This is thought to be the last remaining FAW.4 version of the Javelin and it will now join Javelin FAW.9 XH903 at the Jet Age Museum



A-10 BACK IN ACTION

Despite remaining under threat of retirement due to US budgetary constraints, the Fairchild A-10 Thunderbolt II is back in action yet again. Since late November the attack jets have been used in almost daily airstrikes against Islamic State terrorists in Iraq and Syria. Despite a compromise in the '2015 National Defense Authorization Act' that will keep the A-10 flying for at least one more year, its future is still uncertain

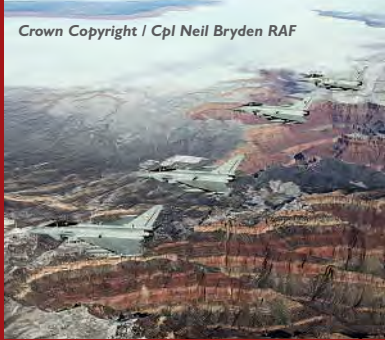


The Latest News from the World of Jets

TYPHOONS OVER THE CANYON

Eurofighter Typhoons from 1(F) Sqn RAF have deployed to the USA to take part in the most recent Exercise Red Flag. En route to Nellis AFB, Nevada the Typhoon crews took the opportunity to undertake a photoshoot over the Grand Canyon – scenery a world apart from their usual home at RAF Lossiemouth in Scotland!

Crown Copyright / Cpl Neil Bryden RAF



ETIHAD ROUNDABOUT

Once the home of the famous 'scaled down' Concorde, the traffic roundabout at London Heathrow Airport's Terminal 4 has recently become home to three large models of Boeing 787s in Etihad Airways' new livery. The airline received its first 'real' Dreamliner in December



BREITLING JETS TO TOUR USA

Having already displayed in 36 countries, the Breitling Jet Team is to take its seven Aero L-39 Albatros jets on a US tour in 2015. The team will begin its season at Sun n' Fun in Lakeland, Florida in April and then makes stops in Maryland, the Jones Beach Air Show in New York, EAA AirVenture in Oshkosh, Wisconsin; SeaFair in Seattle, Washington and the National Championship Air Races in Reno, Nevada



FINNAIR'S FIRST A350 XWB

The first Airbus A350-900 for Finnair is taking shape in the manufacturer's Roger Béteille Final Assembly Line in Toulouse, France. Finnair will be the first European airline to fly the A350 XWB and the third type operator in the world. Scheduled for delivery in autumn 2015, the aircraft is now in the fuselage section joining phase. Finnair has a total of 19 A350 XWBs on order. The aircraft will be deployed on Finnair's long-haul routes to Asia and America



Bloodhound Assembly Begins

Like many people this Christmas, the team at the Bloodhound Supersonic Car received a model kit! However, theirs comprised 3,500 components including a Rolls-Royce EJ200 jet engine (normally found in the Eurofighter Typhoon), a cluster of Nammo hybrid rockets – developed to power the next generation of space launchers and a 550bhp Supercharged Jaguar V8 engine – used to pump the oxidiser into the rocket! The team claims 100 man-years have so far been invested in the project, which is on track to challenge the 763mph Land Speed Record later this year in the South African Kalahari Desert.



Team Bloodhound hopes to reach 800mph this year, and 1,000mph in 2016

Aegean Boosts UK Services

Greece's largest airline, Aegean, is set to increase flights to/from the UK this coming summer, including new direct routes from London to Larnaca in Cyprus and Heraklion in Crete.

The flights to Larnaca will depart from Heathrow airport daily as of March 29 while the flights to Heraklion will be departing from Gatwick airport as of June 21, with up to six flights each week.

The airline will also renew its summer flight schedule to Athens from Birmingham airport and the once seasonal flights from Manchester Airport to Athens Airport are now an all year round service.



Aegean's flights to/from the UK will be undertaken by their fleet of Airbus A320neos

British Airways Recruiting

In 2015 British Airways will be recruiting pilots, including those new to flying through the airline's cadet training scheme, the British Airways Future Pilot Programme. Aimed at anyone aged 18 to 55 with no previous flying experience required, the programme opens to new applicants on February 23, 2015 and the airline hopes a recent campaign for more female pilots will encourage more women to apply.

A poll by the airline has revealed 63% of women were put off a career as a professional airline pilot when they were growing up for reasons including a lack of visible role models and being told it was a man's job.

The survey showed that 20% said when growing up, pilots were played by men on TV and in films, 20% thought women could only be cabin crew, 13% had never been on an aeroplane flown by a female pilot and 10% said they were told it was a man's job when growing up.

BA expects to have nearly 4,000 pilots by the end of the year, the most it has ever employed. More details at www.ba.com/careers



TOP FUN!

FLYING THE FOUGA

An unconventional-looking, ex-military machine with a V-tail might not seem the ideal mount for fast jet aerobatics, but when **Bob Grimstead** took the controls, this Fouga Magister quickly won him over

As the speed builds through 200kts I feel the increased pitch sensitivity, my bum lifting from the parachute pack as I press the twin pitots on this tiny nose further towards the gleaming layer of snowy stratocumulus below. With 250kts on the clock I heave the now-heavy stick to the right and when we have 20 degrees of bank I brace, pull and reverse the roll to watch our nose carve a lazy anti-clockwise circle around the sapphire sky. Shadows and sunlight race about inside our confined, matt-black cockpit while reflections of white and blue chase one another across the mirror-shiny canopy as we describe the laziest of barrel rolls.

Pulling up a little I check, relinquish the throttles and, using both hands, force the stick left against the air loads to watch

earth and sky again revolve effortlessly as we describe the easiest-ever aileron roll. We complete it five degrees nose-down, still hammering along at 250kts, but I push harder to increase the speed to 300, brace my stomach, and ease back until the G-meter reads a steady four. For what seems like an eternity (but is in fact nearer ten seconds) the unaccustomed G crushes me into the seat, my peripheral vision suffering as its nose climbs. A quick laborious glance left and right confirms the scarlet tip-tanks equidistant below the horizon. Coasting over the top our weight reduces as I relax the backpressure, throwing my heavy, helmeted head back to see the white horizon creeping forward along the canopy. Increasing the now-substantial G, I clench previously unknown aching abdominal muscles to

complete the longest, slowest, highest-G loop I ever flew.

Harry's 'Plane

On that day in 1992 the black-gloved Grimstead fist grasped the most interesting stick it had held to date. Short and purposeful, like that of the Spitfire it pivoted side-to-side about its middle, its intricately-moulded grip festooned with triggers, buttons and switches for machine-guns, rockets, inboard and outboard pylon stores as well as the more conventional radio transmit and elevator trim – or should I say, ruddervator trim – because this characterful column controlled Harry Prew-Smith's rare, red, V-tailed Fouga Magister.

Harry chose the Fouga as his first jet warbird because it seemed the most appropriate aeroplane for his skills. With



2,500 hours in his Cessna 414 he felt the 1950s Magister would be within his capabilities, being small and strong with simple systems, twin engines, reasonable speeds and the straightforward handling of an almost-straight wing. No ejection seats reduced its risk and cost and meant less to go wrong, while it needed neither ground air supply nor electrics, making it more flexible than many higher-performance types.

Once a blue *Patrouille de France* aircraft, the appropriately registered G-FUGA was Red Arrows scarlet and the only one flying in the UK. Number 45 off the production line, it first flew in March 1957. After its display days were over this 3,900-hour airframe went via Aerospatiale for ground instruction to the museum of aeronautics in Marseilles until Mike Woodley imported it. Harry bought it in 1991 to instigate an 18-month ground-up rebuild by a dedicated team of experienced Fouga engineers. Since its 720-hour engines were time-expired, they were replaced with two low-time, 200-hour ex-Belgian powerplants.

Red Rocket

The Magister is smaller and lighter than many piston twins. Its low snout, long canopy, slim double-tapered fuselage, squat trailing-link undercarriage and 110-degree V-tail immediately recalled memories of the shiny blue mounts of la *Patrouille* – although the ends of its tanks remained un-dented by the games of ‘tap-the-tip-tank’ those characters played on boring transits. Construction was clearly to a very high standard with fine flush-riveting on the thick wing skins’ upper surfaces. Harry demonstrated their strength



“The Magister is smaller and lighter than many piston twins. Its low snout, long canopy, slim double-tapered fuselage, squat trailing-link undercarriage and 110-degree V-tail are instantly recognisable”

All Mike Vines unless stated

by whipping off his shoes and walking from root to tip with neither give nor wrinkling.

As well as the obvious curiosity of the drag-reducing high aspect-ratio butterfly tails with their unusual quadrant-shaped mass-balance weights, the Fouga’s ailerons and ruddervators have small plates on their trailing edges to increase control effectiveness. The long, surprisingly thick, mid-mounted wing, a legacy of the Fouga company’s glider-producing background, minimises drag. With only 13 degrees of wing sweep, sea level maximum speed is nevertheless an exhilarating 349kts IAS (although Vne is 400kts and max Mach a surprisingly high .82). Harry used his red rocket for both business and pleasure including European touring. The standard cruise power setting of 18,500rpm gave an airspeed of 210kts which at 18,000ft equates to a true speed of 260kts for a dry-tanks range of 300nm.

Familiarisation

Because the seats are austere military metal pans (and for prudence) we each donned parachutes before climbing aboard.

Myriad instruments and switches initially make the compact, functional cockpits appear complex, but they are actually about as straightforward as they could be in a jet trainer; deliberately well-equipped with supplementary systems. The cockpits soon assume order, although the snug-fitting front one demands good house-keeping discipline with charts and let-down books. The flat left console holds circuit-breakers, lighting controls and a stubby, emergency, canopy-smashing ice-pick. Ahead of it is the controller for the simple air conditioning and pressurisation system.

An insignificant flap switch is just behind the chunky throttles with their thumb-



"Myriad instruments and switches initially make the compact, functional cockpits appear complex, but they are actually about as straightforward as they could be in a jet trainer; deliberately well-equipped with supplementary systems."

operated airbrake rocker switch. Below these are the fuel cock levers, and ahead of them are the emergency undercarriage buttons and extend/retract knob for alternate airbrake operation. After selection, both these systems are manually pumped out using a fore-and-aft lever beside one's right thigh with an extending red-topped handle like a heavy walking stick. Wheels, flaps and airbrakes are all normally moved by the 250bar (3000psi) hydraulics, but the flaps have no standby system.

The airspeed indicator reads from 60 to 600kts. To its left a twin-pointer rev-counter has needles marked G and D for gauche and droit indicating similarly enormous numbers up to 25,000rpm. Above this is the red-knobbed parking and emergency brake handle, to its right are the Machmeter, windshield



"The rear cockpit is practically identical to the front but does have one truly unique piece of hefty-looking ironmongery. This is a big black binocular periscope very solidly fixed right in front of the occupant's face to look over the front-seater's head"

alcohol de-icing pump, engine fire lights, single fuel gauge and canopy unlocked light. Normal flying instruments are supplemented by twin jet-pipe temperature (JPT) gauges. On the left, uncomfortably near the little flap switch, are the similarly small, flat undercarriage selector and its red and green lights.

"Directional control can only be achieved by differential braking"

At lower left are trim and flap position indicators, twin oil pressure and temp gauges and a dual-pointer brake and hydraulic pressure dial. An insignificant-looking (but expensive, costing £1,200 to replace) Breguet-made clock is clamped to the left windscreen stay, and the standby compass to the right one while

a big red gear unlocked light sits atop the left glareshield in one's sightline during the flare.

Invisible Helmet

The rear cockpit is practically identical to the front but does have one truly unique piece of hefty-looking ironmongery. This is a big black binocular periscope very solidly fixed right in front of the occupant's face to look over the front-seater's head.

This thing gave me a shock on my first flight – a back-seat familiarisation flip. When I started circuit work that periscope, completely forgotten during the flight, made me jump just before touchdown. With a strong crosswind I sighted over my mentor's left shoulder during the approach, only moving my head from side to side in the final stages to get a symmetrical perspective for the flare. Squinting again to the left, I suddenly realised that his helmet had become completely transparent! A quick check confirmed that, when looking straight ahead, the threshold would appear where his head had been. It took a dumbfounded second to realise that this illusion was caused by that periscope fulfilling its designed job, right in the centre of my field of view. Strange indeed to look through one's instructor's helmet – I thought it was students who were supposed to have nothing between their ears!

G-force

Two other memories from that initial sortie stick in my mind. Totally unprepared for

an unexpected 5-g demonstration loop, I realised I had been caught napping and glanced at the G-meter just in time for it to disappear as my sight blacked out. A belated attempt at abdomen-straining brought it swimming back into fuzzy focus, but that dial was all I saw during the remainder of an interminable fast-jet loop.

After a touch-and-go I was handed control at 200kts in a typically military seventy-five-degree banked turn onto downwind. I commanded right hand and feet onto stick and pedals but nothing happened. A second, more concerted attempt resulted in the jerky, laborious movement of my fist from its parking-place on my thigh, but still no foot movement. A glance at the G-meter again revealed the problem. If your feet weigh three times what your muscles expect, they will take more effort to move! One by one, I heaved them up onto the pedals, just in time to roll out downwind.

Front-seat Sortie

Back on the ground before start-up for my front-seat sortie, helmets were donned and canopies locked to keep out the engine



"Formation flying on the photographic Aztec was easier than I anticipated considering the airframe's sleekness and early jet engines' reputation for poor acceleration. Once slowed by the airbrakes one could manoeuvre close-in with great accuracy but unfortunately our limited fuel precluded much practice"



Spinning is only approved with empty tip tanks. The aircraft can hold a maximum of 214 Imp Gal giving it just over an hour's practical safe endurance



G-FUGA was a rare airshow attendee but she did visit the Classic Jet & Fighter Show at Duxford in 1996. She is seen here taxiing in after arrival PRMAVIA Collection



The diminutive Fougas awaits its next sortie. Landing such a low-slung aeroplane poses challenges to those more used to long-legged steeds



The Fougas's ailerons and ruddervators have small plates on their trailing edges to increase control effectiveness

noise. Since it carries the sole generator (and hydraulic pump), the left engine is fired up first. As the fire lights the JPT rises and a hum of gradually increasing pitch and volume begins to pervade the area. At 4,000rpm the starter is switched off, its light checked out, the fuel cock is moved all the way forward and the engine stabilises at around 7,000rpm and 400°C with the most unbelievably skull-splitting shrill, piercing, continuous shriek. If this is what we heard inside with the canopies sealed, goodness knows how it must have sounded out on the tarmac.

I carefully advanced that throttle to achieve 10,000 eardrum-battering rpm for the generator to cut in, and repeated the process with the second engine. With both stable the pressurisation was selected on to the accompaniment of popping eardrums, a whiff of hot exhaust fumes and a reduction in noise. Throttles were advanced to 13,000rpm

to start taxiing, but once rolling 10,000rpm kept us moving nicely. Lacking nose-wheel steering, directional control can only be achieved by differential braking, but this was not difficult after a few initial experimental wiggles – although even at the end of the day I still found myself pointlessly pushing the rudder pedals in the corners. Hugging the ground like a Lotus, the Magister seems to be moving faster than it really is.

At the holding point I selected flap 15, exercised the airbrakes out and back again (they take a second or so to run each way), zeroed the tail trim, turned on the heaters for the twin pitot heads and checked the cockpit for red lights, any of which means no-go. That was it.

Slowly and carefully advancing the throttles, mindful that the fuel controllers have no effect below 16,000rpm or 110kts, I wound the engines up to full power against the

brakes. Above about 17,000rpm the horrible banshee wail was replaced by a more businesslike roar accompanied by a pungent, pulse-stimulating smell of burnt kerosene through the air-conditioning, while the nose-wheel strut compressed under 1,760lbs/thrust. Checking the revs at their 22,500 maximum, with temperatures and pressures OK and no red lights, I released the brakes.

Take-off

Rather than rip-snorting acceleration we got a gentle but smooth and steady push in the back. Little dabs of left brake counteracted the gusting 30kts right crosswind for the first couple of hundred yards, but above 60kts the rudders became effective and she was easy to align just beside the centreline lights to spare us their jolting.

The nose-wheel is normally lifted at 70kts to rotate at 90, but because of the wind I

Harry used his Fougas for both business and pleasure including European touring. The standard cruise power setting of 18,500rpm gave an airspeed of 210kts which at 18,000ft equates to a true speed of 260kts





held her down to 95kts for a clean lift-off at a hundred after a run of 1,000 yards or so. Checking a positive climb and flicking up the quick-retracting gear, I concentrated on the slow process of building speed, getting the flaps in at 130kts and maintaining a gentle increase in height with steady acceleration to 170kts, when I could raise the nose for 3,000fpm to show on the VSI as she really got going.

Fougabatics

Although later Magisters had power-assisted ailerons, all controls on this early model were manually operated through push-pull rods. Aileron forces were fine at low speeds but as we went faster they became heavier; despite their balance tabs until, at 250kts, using one's biceps most efficiently, one could achieve an acceptable roll-rate of 60 or so degrees per second to the left, while backhanded right rolls were truly slow rolls. Pitch control remained light and effective at all speeds; even in the tightest turns very little back-pressure was needed.

At all speeds and in all axes, this little red wonder was extremely responsive and agile. Our Fougabatics in the clear, calm upper air were an almost religious experience. It once more confirmed my theory that low-powered but aerodynamically-sound aircraft are generally far nicer to fly than those high-powered bricks whose great drag is masked by a big engine.

The Fouga's low speed handling was every bit as genuine and benign. Having eventually been persuaded to slow down, its clean stall occurred, after lots of buffet and some aileron snatching, at a little under 90kts. With undercarriage down and full flap,



G-FUGA airborne in 1992. In 1997 the aircraft was sold to the Dutch Historic Jet Association and was eventually re-registered in France as F-GSHG. In 2007 the aircraft was damaged after a passenger inadvertently retracted the undercarriage during a touch and go. Today the aircraft can be found at the Dutch Air Force Museum at Soesterberg where it is painted in Belgian Air Force markings as MT-51



those symptoms were further exaggerated and the speed came back to below 80. The book says the aeroplane has a normal spin but this is only approved without fuel in the tip tanks. All positive G aerobatics except flicks are allowed to airframe limits of +5.5 and -3 g, and aerobatics are conducted at the constant power setting of 19,500rpm.

Like its namesake, the Miles Magister, this too is supposed to suffer an odd, unpleasant, nose-down pitching diversion with excess sideslip. I found that moderate slip angles produced no nasty consequences but was restrained from further experimentation with the admonition that the aircraft describes what sounds like a brisk departure into a fast outside flick roll with the nose going hard down to exceed its negative G limit. While fascinated, I decided not to press the point.

Ice Man

Formation flying on the photographic Aztec was easier than I anticipated considering the airframe's sleekness and early jet engines' reputation for poor acceleration. Once slowed by the airbrakes one could manoeuvre close-in with great accuracy but unfortunately our limited fuel precluded much practice.

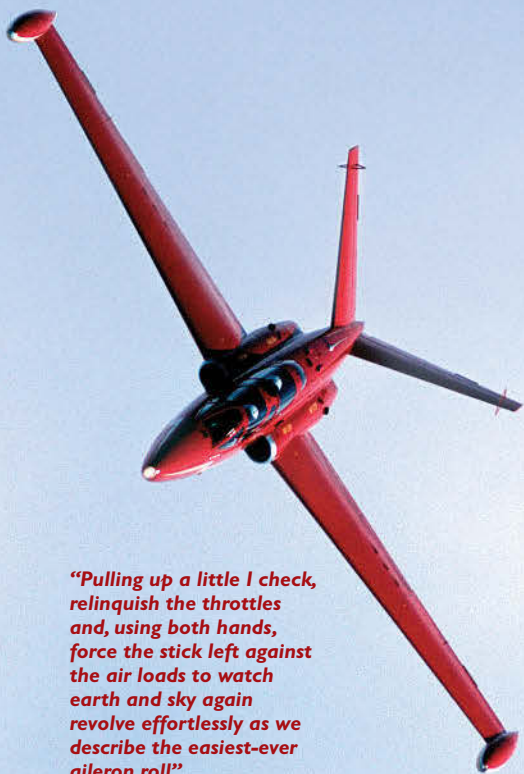
Average consumption is around 3.3 Imp Gal/min – not bad for Spitfire speeds and climb performance with twin-engine safety!

Total capacity of 214 Imp Gal gives just over an hour's practical safe endurance, but if Fouga-flying's exhilaration makes you forgetful a low fuel Bingo light warns of twelve minutes remaining.

Clean, the Fouga glided well so it was easy to throttle back both engines to idle and float home. Icing conditions should be avoided though, because the first components to suffer a build-up are the throttle-rods in the intake ducts ahead of the engines. Make a power adjustment with ice on these, and chunks will break off, getting sucked straight into the compressors to the accompaniment of loud and expensive pops and bangs. If you do encounter ice, you wind up the throttle friction and don't touch them until back on the ground. Needless to say, the manual prohibits deliberate flight in icing.

Touch-and-Go

Setting up an approach starts by controlling this clean machine's speed with the airbrakes on the 1,500-foot downwind leg. Initially I found the switch confusing, assuming it worked in the (to me, obvious) sense of up for out and down for in. Finding the opposite, at first I had to consciously think 'switch down to slow down'. Airbrake position can only be confirmed by looking at them.



"Pulling up a little I check, relinquish the throttles and, using both hands, force the stick left against the air loads to watch earth and sky again revolve effortlessly as we describe the easiest-ever aileron roll"

With the speed below 140kts, I selected 15 degrees of flap and lowered the wheels, smartly followed by increasing power to stabilise at 130kts. This is maintained until lowering full (40 degrees) flap on short final when it is reduced to 120 with a further power increase to hold it there. Neither flap nor gear causes much trim change and the Fouga turned out to be quite speed-stable.

With her rather poor power to weight ratio and low-tech engines, while being no Lightning the Fouga exhibits the classic jet characteristics of low drag, high wing-loading and slow spool-up. Even with full flap the aeroplane is quite clean, so maximum

the engines had run down to idle and there was a long delay before they wound back up again to generate noticeable acceleration for a touch-and-go, but after some practice I was able to clean-up more slickly.

Landing

On a full-stop landing the nose-wheel is carefully held off (so as not to touch the dolly-wheel in the ventral strake) down to 40-ish knots when the stick hits the back stop and the nose gently subsides. If necessary the brakes can be used pretty fiercely to minimise the roll, but I let aerodynamic drag do most of the work,

“Aerobatics are conducted at a constant 19,500rpm”

drag is used to get the power setting up into the quick-response range for a safe go-around. Similarly, the approach angle is rather shallower than for other jets at about two degrees. As in any jet, thrust controls speed and elevator maintains glide angle on a continuous curving base leg to a four-mile final at 1,000ft or a little below.

Ten feet up at the threshold I closed the throttles and made a token flare almost incredibly close to the tarmac compared with the 747 I normally flew – the sensation of speed was exhilarating at 120kts and two feet high – when the soft, forgiving undercarriage gave us a smooth, gentle touchdown.

At first I spent so long feeling for the ground

leaving them to slow us to taxi speed and steer onto the taxiway (still ineffectually prodding those rudder pedals).

Stopping our scarlet screamer on the apron, I set the park brake – despite a handbook note not to do so, since this apparently only applies to heavy-footed Gauls in hot countries. Winding down this little jet Ferrari was a tremendous anti-climax – I would love to have gone on flying it all week!

The only subsequent oddities were the (apparently quite normal) clouds of smoke exuded by the Mabore IIs on shut-down, and the speed with which the fuel truck zoomed around the corner to refill our tanks, a hint to both turbojet

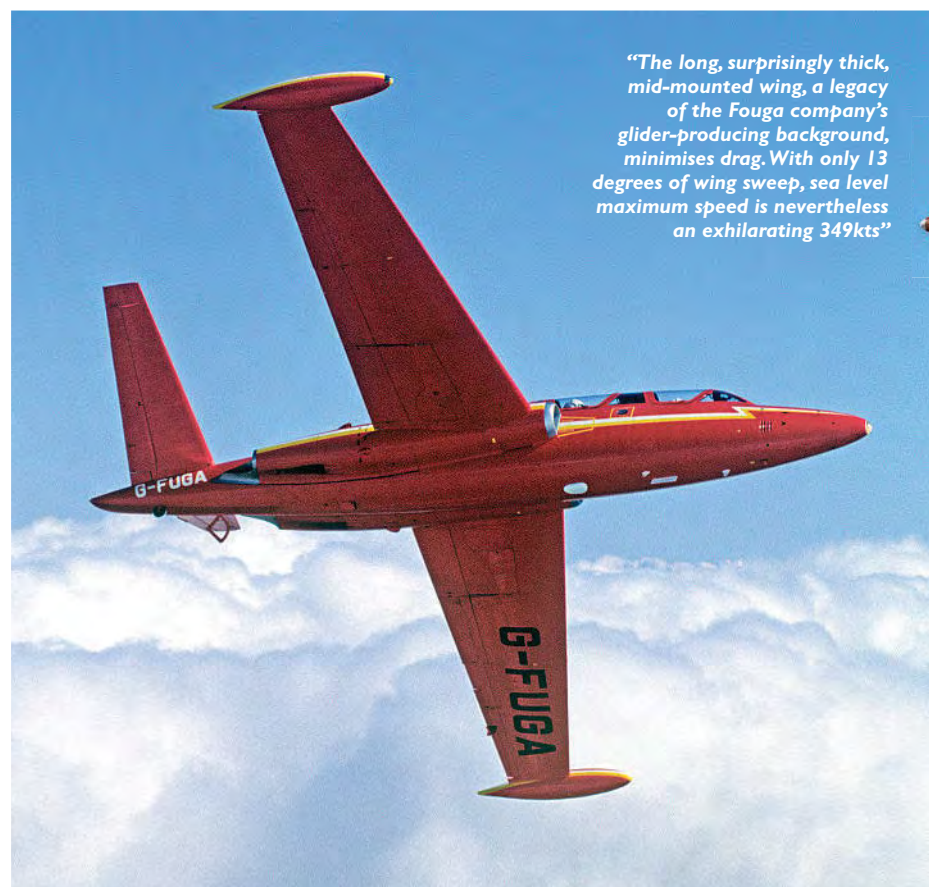
fuel consumption and Harry's enthusiastic utilisation.

The Fouga, designed as a primary jet trainer, is a very good machine for introducing pilots gently to jets' special characteristics while giving them lots of fun too. One person can pull it out, it is self-contained, and now I could start, taxi and fly it. Knowing its delightfulness, the temptation was tremendous...

Unfortunately the canopies are locked by an oddly-shaped chunky steel key, there is only one, and it stays hidden. But when I close my eyes, strain my stomach and clench my fist I can still feel the G build as the world smoothly revolves and I see that bright red tip tank carve its silent arc across the azure of my mind's sky and remember: I have flown jet aeros. I've "reached out and touched the face of God". ●



G-FUGA once served with the Patrouille de France in similar markings to this example. It was the 45th Magister off the production line and flew in March 1957. The aircraft clocked up 3,900 hours before being retired to the museum of aeronautics in Marseilles and was later imported to the UK by Aces High's Mike Woodley. Adrian M Balch



“The long, surprisingly thick, mid-mounted wing, a legacy of the Fouga company's glider-producing background, minimises drag. With only 13 degrees of wing sweep, sea level maximum speed is nevertheless an exhilarating 349kts”

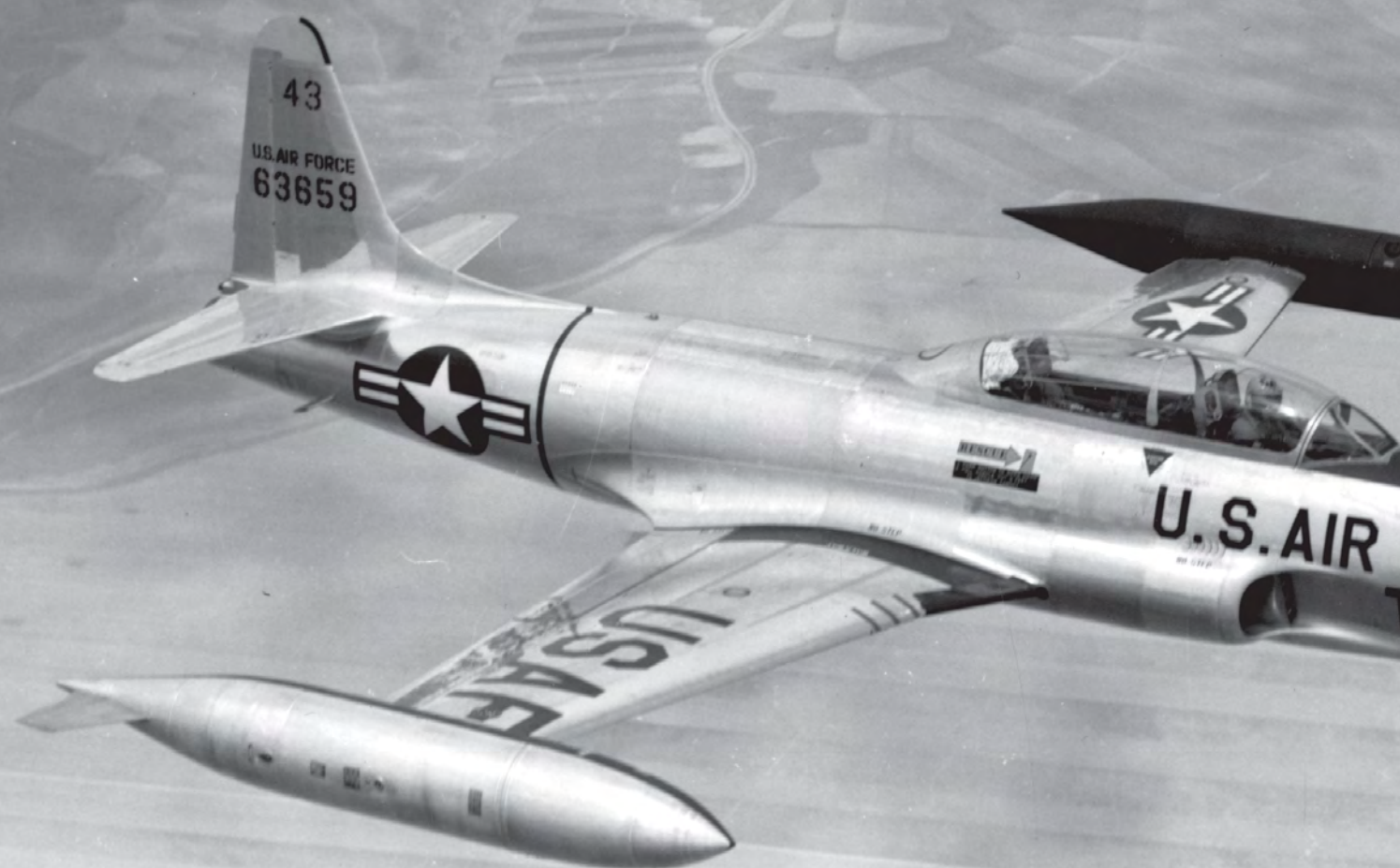
SPECIFICATION FOUGA CM.170 MAGISTER



Crew	2
Length	33ft 0in (10.06m)
Height	9ft 2in (2.80m)
Wingspan	39ft 10in (12.15m)
Wing area	186.1sq ft (17.30m ²)
Empty Weight	4,470lb (2,150kg)
Max Take-Off Weight	7,055lb (3,200kg)
Max Speed	386kts (444mph/715km/h)
Ferry Range	460 miles (740km)
Ceiling	35,000ft (10,973m)

Powerplant
Two Turbomeca Mabore IIA centrifugal turbojets (880lb/thrust each)

Armament	Nil
First Flight	July 23, 1952



FIRST GENERATION JET TRAINERS

*In the first of a five-part series on jet trainers, **Dr Dave Sloggett** looks at aircraft from the 50s and explains how post-war development programmes changed the way that pilots learned to fly fighter jets*

The rapid deployment of the first generation of jet fighters created a number of legacy issues at the end of World War Two. The first was how to train the next generation of pilots who would fly them.

Given the imminent end of the war, jet pilots were selected for their natural ability, on the basis that those seen to be excellent pilots would cope best with the new paradigm that jet-based warfare created. The speed at which the jets flew, however, and the lack of immediate knowledge about some of their flight handling characteristics, meant that this could be a hazardous change.

The second issue impacted countries which had not yet developed jet power technology. They had to quickly instigate national programmes to develop their own capabilities. But in the immediate aftermath of the war, developing advance jet fighters was a very risky and potentially expensive prospect.

Changing ways

As a result, several Western European countries such as Italy and France embarked upon the development of jet trainers that would be capable of being used in a variety of combat roles.

In France, in particular, a huge effort was put into developing a jet engine. The

success of this investment ensured that the UK would not retain a monopoly over the design of jet engines for very long. While British jet technology was behind the majority of the first generation of dedicated jet trainers, a small number did adopt the emerging French designs.

Development of the first generation of dedicated jet trainers would change the ways in which jet pilots would be trained.

Conversions

Experience with the earliest jets revealed very different handling qualities to the propeller driven aircraft pilots had been trained on, specifically the slow spool-up

The T-33's 1,274-mile range and service ceiling of 48,000ft were just two of many flight parameters that other first generation jets were unable to match



times associated with the low-powered jet engines. With a higher than expected casualty rate the immediate response was to convert a number of fighters into two-seat training versions. This allowed pilots to be nurtured through the transition rather than being thrown into the cockpit to learn alone.

Fittingly, Gloster's iconic Meteor, which first flew in 1943 and was the only Allied jet to see operational service during the war, was the first jet to be converted and produced as a two-seat trainer.

The Meteor T.7 prototype – itself converted from an F-4 – took to the skies on March 19, 1948 and 640 examples would eventually be produced for air arms around the globe.

The RAF would also employ a two-seat version of the de Havilland Vampire from early 1952. The T.11 variant was first flown on November 15, 1950 and more than 600 were eventually produced, some remaining in RAF service until the 1970s.

Lockheed

Across the Atlantic the USAF was also looking for a jet trainer and initially followed the British lead by converting a single-seat fighter. The Lockheed T-33 originated from the Lockheed P-80, which had entered service with the USAAF in 1945 after a hectic 145-day development programme. The T-33 first flew on March 22, 1948 – just three days after the Meteor T.7.



The prototype Lockheed T-33 first flew on March 22, 1948 – just three days after the Meteor T.7. It was such a successful aircraft that over 6,500 were built and a small number are still in service with the Bolivian Air Force



Experience with the earliest jets revealed very different handling qualities to the propeller driven aircraft pilots had been trained on and the higher than expected casualty rate led to a number of fighters being converted into two-seat training versions. The first two to join RAF service were the Gloster Meteor T.7 and the de Havilland Vampire T.11

It was such a successful aircraft that over 6,500 were built and a small number are still in service with the Bolivian Air Force.

Predicting that the aircraft would have that kind of longevity when it first flew would have been difficult. The design of military jet fighters was in its infancy, yet the T-33's operating parameters were unsurpassed by any other first generation jet trainer. Its 1,274 mile range and its service ceiling of 48,000ft were just two of many flight parameters that other first generation jets were unable to match.

Its rate of climb at sea level, however, was the one flight parameter that its peers were all able to match or exceed, with the Aermacchi MB-326 achieving the highest figure of 4,389ft/min. The maximum wing loading on the T-33 was also significantly higher than comparable aircraft at 63.70lb/sq ft.

Much of the performance of the T-33 was down to the 5,400lb/thrust thrust developed by the Allison J33-A-35 centrifugal compressor turbojet. This also had a good pedigree, being developed from the General Electric J31 engine, which had benefitted from exposure to Frank Whittle's original designs during World War Two. Indeed, many of the engines that powered the first generation of dedicated jet trainers all trace their lineage back to the initial development work in the UK.

The development of the engine for the T-33 was rapid. From an initial thrust capability of 1,596lb/thrust, improvements saw this quickly increase to over 4,500lb/thrust as various new iterations of the engine were developed. A higher thrust variant also powered the Lockheed T2V trainer for the United States Navy. It generated 6,100lb/

The Fokker S.14 Machtrainer was the first jet trainer developed for the Royal Netherlands Air Force. The type first flew on May 19, 1951 and entered service in October 1955



thrust, which at the time was state of the art for the kind of compressor-based turbines used by the J33-A-35.

Fokker S.14

Quick on the heels of the United States the Italians, Spanish, Dutch and French Air Forces developed their own first generation jet trainers. The Fokker S.14 Machtrainer was the first generation jet trainer

“The Magister’s V-tail configuration makes it instantly recognisable”

developed for the Royal Netherlands Air Force. Powered by a Rolls Royce Derwent 8 turbojet that generated 3,452lb/thrust, the aircraft could climb at a steady rate of 3,200ft/min. Its operational ceiling of 36,730ft placed it at the median point in a comparative table of first generation jets. Its range (590 miles) and maximum speed (395kts) were, however, modest when compared to nearly all the other jet trainers of the era.

The Machtrainer first flew on May 19, 1951 and entered service in October 1955. However, only 19 of the 20 aircraft ordered by the RNLAf entered service, one being destroyed in a fatal crash in the USA while being used by Fokker as a demonstrator. High operating costs resulted in the type being passed over for export sales and the Machtrainer was only flown by the Dutch.

Hispano HA-200

Designed by Willy Messerschmitt, the Hispano HA-200 Saeta (Arrow) was Spain's first turbojet aircraft and first flew in 1955 before entering service in 1962. A total of 212 were built, including 90 for the Egyptian Air Force, all of which could carry a mix of armament if needed. The aircraft was much lighter than its Dutch competitor and

therefore able to achieve a much greater operating range of 870 miles.

Power came from a French 1,058lb/thrust Turboméca Marboré engine that would also power the Morane-Saulnier MS.760 and the CM.170 Magister jet trainers. In 1974 the Saeta made its combat debut flying missions against Polisario Front guerrillas.

Fouga Magister

The Fouga CM.170 Magister, which first flew in 1952, would go on to be one of the most widely used jet trainers in history. It was flown by the French, Israeli and Finnish Air Forces as well as the Luftwaffe, which was the first export customer for the aircraft. Its top speed (385kts) and range (575 miles) were low compared to its peers and the 880lbs developed by each of its two Turboméca

Marboré IIA turbojets was amongst the lowest of any in service jet trainer at the time.

The Magister was introduced into service in 1956 and its characteristic V-tail configuration still makes it instantly recognisable. Designed and patented by the Polish engineer Jerzy Rudlicki in 1930 the V-tail has hinged control surfaces on the rear of the two elements to replace the conventional rudder and elevators. These are known in a classic portmanteau solution as ruddervators.

That said, detailed aerodynamic studies have shown that there are some relatively small advantages from this tail configuration in reducing interference drag. It does, however, have some disadvantages. Combining the pitch and yaw controls requires a more complex control system and can also increase the stress levels on the rear fuselage. As ever these factors are all subject to design trade-offs.

The Magister continued to be assembled in Finland up until 1967. Coincidentally, this was also the year that 147 Squadron of the Israeli Air Force used the aircraft as a



Willy Messerschmitt's Hispano HA-200 Saeta was Spain's first turbojet aircraft and first flew in 1955



Above: Only 19 of the 20 Fokker S.14 Machtrainers ordered by the RNLAf entered service, one being destroyed in a fatal crash in the USA while being used by Fokker as a demonstrator. High operating costs resulted in the type being passed over for export sales and the Machtrainer was only flown by the Dutch



Above right: The HA-200 was later developed into the HA-220 Super Saeta ground attack version



Right: The Fouga CM.170 Magister, which first flew in 1952, would go on to be one of the most widely used jet trainers in history



The initial batch of Jet Provost T.1 aircraft differed from later production variants by virtue of their long stalky undercarriage. The later T.3 also had a redesigned canopy, ejection seats and strengthened wings to allow tip-tanks

close air support aircraft against Egyptian ground targets during the Six Day War. Israeli Magisters were later employed against Jordanian armoured units on the West Bank where a number were lost to ground fire. Nine of the surviving Israeli aircraft, joined by three French Air Force Magisters, would later be transferred to the Salvadorian Air Force where they were used as both trainers and in the ground attack role.

Jet Provost

The first generation of dedicated British jet trainers was the Hunting Percival Jet Provost.

The Jet Provost had emerged to fulfil an RAF requirement for an aircraft capable of introducing 'all-jet' training to the pilot's syllabus. Initially the Air Ministry placed an order for nine aircraft and the prototype first flew on June 16, 1954 from Hunting Percival's factory at Luton.

The Jet Provost T.1s were trialled by 2 FTS at RAF Hullavington and suggested improvements resulted in four company development aircraft being built for trials and designated the T.2. The RAF adopted the aircraft in 1957 and the full production variant was the Jet Provost T.3, with a redesigned airframe and canopy, ejection seats, strengthened wings to allow tip-tanks to be carried and a noticeably shortened and strengthened undercarriage. From 1958-62 the RAF received 201 aircraft, 70 of which would later be converted to T.3A standard with improved avionics. A further 198 were ordered in November 1961, these dubbed the T.4 and benefiting from an uprated Viper 202 engine.

By the time the RAF ordered its next batch of Jet Provosts (by now known mostly as the 'JP') Hunting Percival had become part of the British Aircraft Corporation (BAC). This

final batch of 105 aircraft were substantially different to earlier airframes and boasted a pressurised cockpit, re-designed nose and windscreen and new wings. As such they were designated the JP.T.5 and deliveries would keep the type in RAF service until 1993.

The T.5 also formed the basis of the Strikemaster light attack aircraft. The strengthened aircraft had eight hardpoints below the wing and a shorter undercarriage to allow it to operate from rough landing strips. Although the 'Strikey' did not serve in the RAF it was exported widely adding to the JP success story. The Jet Provost itself was also exported widely with the T.51 and T.52 serving with nations including Iraq, South Yemen, Sri Lanka, Sudan and Venezuela.

Fiat G.80

Italy's Fiat G.80 made its first flight on December 9, 1951 but sadly never entered production. This was remarkable given the



The Fouga Magister was flown by the French, Israeli and Finnish Air Forces as well as the Luftwaffe, which was the first export customer for the aircraft

The Fouga Magister's characteristic V-tail configuration makes it instantly recognisable. There are aerodynamic advantages to this format but also logistical disadvantages involved in the complex control systems



The Jet Provost T.3 was also a sales success with purchasers including the Kuwaiti Air Force who operated the T.51 export variant



The RAF received 201 Jet Provost T.3s, 70 of which would later be converted to T.3A standard with improved avionics. A further 198 were ordered in November 1961, these dubbed the T.4 and benefiting from an uprated Viper 202 engine

type's capabilities.

With a significant wing area of 270sq ft, its wing loading was comparable to the Lockheed T-33 whilst its top speed was 491 kts. It did, however, have a slightly lower service ceiling at 41,000ft. It was also a heavy airframe, weighing in at 9,700lbs empty and having a maximum take off weight of 15,432lbs; by far the heaviest of the first generation of dedicated jet trainers.

The aircraft was Italy's first indigenously-built jet aircraft and was designed by Giuseppe Gabrielli to be both a tandem-seat fighter

and dual-control trainer. It was a conventional low-wing monoplane with engine intakes on both sides of the fuselage. The initial G.80 was powered by the de Havilland Goblin engine whereas the subsequent G.82 variant featured a longer fuselage to house the 5,000lb/thrust Rolls Royce Nene engine. The Aeronautica Militare, however, was not convinced by its performance and chose to order neither the G.80 nor the G.82. Undeterred, Fiat refined the G.82 for entry in a NATO competition to select a standard jet trainer. Once again it was rejected.

Aeromacchi MB-326

However, all was not lost for the Italian aerospace industry as the Aeromacchi MB-326 proved to be a far more successful proposition. First flown on December 10, 1957, the MB-326 was able to achieve a maximum speed of 435kts and had a service ceiling of 41,000ft and a range of 1,035 miles.

MB-326 was hugely successful. Purchased by more than ten countries it was also built under licence in Australia, Brazil and South Africa. In total more than 600 were assembled. Ironically this success arose in part because of the dire state of the Italian economy at the end of World War Two. The Aeronautica Militare simply could not afford to develop both a supersonic aircraft and a jet trainer and hence focused on developing an aircraft that could double as a jet trainer and serve in an operational theatre as a low-cost fighter-bomber.

The specification from which the MB-326 arose was – even by the standards of the first generation jet trainers – quite modest. A climb rate of 3,000ft/min was easily overachieved; as was the target for the maximum speed of 380kts. To simulate realistic air-to-air engagements the airframe was also designed to withstand 7G manoeuvres.

The first aircraft was powered by a Bristol

“The majority did not provide a basis for evolution and were usurped by new designs”

Its empty weight was nearly half that of the G.80 at 4,930lbs, primarily because of its lightweight alloy structure. Its engine thrust, however, was also half that available to the G.80 at 2,500lb/thrust. The wing area was also smaller at 204.5sq ft, which brought down the wing loading figure to 40lb/sq ft.

From an export viewpoint, the Aeromacchi

Siddeley Viper 8 engine that produced 1,753lb/thrust but as modifications to the airframe took their toll in terms of additional weight, the engine was upgraded to the Viper 9 which generated an additional 150lb/thrust. That, however, was not the end. On September 22, 1953 the second prototype of the aircraft flew with the Viper



Italy's Fiat G.80 made its first flight on December 9, 1951 but sadly never entered production. This was remarkable given the type's capabilities



The Fiat G.80 was powered by the de Havilland Goblin engine whereas the subsequent G.82 variant featured a longer fuselage to house the Rolls Royce Nene. The Italians chose to order neither the G.80 nor the G.82

11 engine, which added a step change in thrust going up to 2,500lb/thrust.

As it entered service the MB-326 started to collect an impressive array of records. In August 1961 it was to claim the height record at 15,489m (50,816ft).

The MB-326 was also to be pushed further by one of its test pilots, Massimo Ralli. In February 1966 he took the aircraft to 39,370ft in 10 minutes and 53 seconds – an average climb rate of 3,622ft/min. Months later Ralli took its speed up to 475kts over a 9.16 mile course. Arguably this was the best of the first generation of dedicated jet trainers. All round, it set a very high standard and was much enjoyed by those pilots who flew it.

Aero L-29 Delfin

Whilst all this development work carried on at a pace in the west, the Warsaw Pact countries quickly adopted the Aero L-29 Delfin (Dolphin) as their standard jet trainer. It was given the NATO codename 'Maya' and was Czechoslovakia's first indigenous jet when it took to the skies on April 5, 1959.

By this time many air forces in the west were already starting to look towards their

second-generation jet trainer requirements but the L-29 was based on a simple design. Its manual flight controls and large flaps made it a docile aircraft and it was able to climb at a respectable 2,755ft/min to its relatively low service ceiling of 36,100ft.

The Delfin was powered by a Motorlet M-701 C 500 turbojet that generated 1,960lb/thrust and was able to operate from unprepared airstrips. It was also popular with the trainees and instructors that flew it.

In total, over 3,600 L-29s were built, with the final aircraft coming off the production line in 1974. Many were adapted for close air support roles and in 1973 the L-29 saw action with the Egyptian Air Force in the Yom Kippur War, attacking Israeli tanks in the Sinai Desert. In the late 1980s the jet trainer was also involved in the Nagorno-Karabakh War, but it suffered high losses with 14 out of 18 aircraft being lost to Armenian air defence systems. Various derivatives were also developed, such as the L-29R reconnaissance version, and at its peak Delfins were being flown by students of more than 20 air forces around the world. Today the Czech jet remains in service with at least six air forces.



The Italian Aeronautica Militare could not afford to develop both a supersonic aircraft and a jet trainer and hence focused on developing an aircraft that could double as a jet trainer and serve in an operational theatre as a low-cost fighter-bomber. And so the MB-326 was born

Multi-taskers

The L-29, like a number of its peers, managed to fulfil dual roles. Whilst designed primarily as jet trainers, they also proved adept at providing close air support in a number of relatively small regional wars - despite their relatively poor payload carrying capability.

Rapid advancements in jet technology, however, meant that many of the first generation of jet trainers would quickly be replaced in the West by an emergent second generation that could fly faster, climb more quickly and carry increased payloads.

Some of the first generation aircraft were also able to provide the platform for the second era jets, such as the on-going development of the Jet Provost. However the majority did not provide a basis for a natural evolution and were usurped by new designs. But whatever the outcome, the first generation of jet trainers did create a whole new cadre of young fighter pilots who would go on to fly the second generation of jet fighters. ●

From an export viewpoint, the Aermacchi MB-326 was hugely successful. Purchased by more than ten countries it was also built under licence in Australia, Brazil and South Africa. In total more than 600 were assembled including 16 for Tunisia, one of which is seen here



In total, over 3,600 L-29s were built and today the jet remains in service with at least six air forces



BOAC

**CARRYING
THE FLAG**

On Friday May 2, 1952 one of Britain's two nationalised airlines became the world's first jet airline. **Bruce Hales-Dutton** looks back at the history of the British Overseas Airways Corporation



Above: Only a handful of Comet 1s were built, five of which crashed. The Mk 1A had a reinforced structure and the single Comet 3 included a stretched fuselage and oval windows to remedy the pressurisation issues. The revised Comet 4 with trans-Atlantic capability had risen, phoenix-like, from the ashes of the original variant and BOAC ordered 19 of them, including G-APDR. This aircraft was later sold to Mexicana but returned to the UK in 1973 for scrapping

Left: Captain Majendie and his crew pose for the cameras on May 2, 1952. They were about to enter the history books when their Comet (G-ALYP) took off on the world's first commercial jet flight



It was at 15:12 on a day which had been largely overcast that Captain A M Majendie, head of the British Overseas Airways Corporation's Comet fleet, lifted G-ALYP off Heathrow airport's runway to begin the world's first commercial jet flight.

A sudden burst of sunshine illuminated the historic moment which was savoured by a large crowd of spectators. Sir Geoffrey de Havilland, boss of the company that had conceived and built the Comet, was there,

as was John Cunningham, the test pilot who, three years earlier, had proved the aircraft was a winner. Also present were some of the men who had designed the graceful new airliner.

For BOAC that first jet service was probably the high point of a 75-year life which had included plenty of other significant events. Among them was the world's first trans-Atlantic jet service, yet when it was time to begin the supersonic age BOAC had become British Airways and was unable to chalk up a unique double.

Genesis

BOAC was established 76 years ago in 1939 just after the start of World War Two but it could trace its heritage back 20 years and the end of another war. Air Transport and Travel had started regular services between London and Paris using converted de Havilland bombers and was soon joined by other operators. But by 1924 these small airlines flying between Britain and Continental destinations were finding it hard



War had broken out before BOAC began operating and the airline spent the next six years flying whatever it could acquire from the RAF, including this Vickers Warwick seen in a mix of military and civil markings. G-AGFK began life as BV256 and joined BOAC in 1943. It later rejoined the RAF and flew with 52 Sqn

changes. In doing so the committee gained the approval of C G Grey, opinionated editor of *The Aeroplane*. He called the report "the most sensible official document that has yet been issued on civil aviation."

New MD

The announcement of a full-time chairman led to the abrupt departure of Imperial Airways' managing director, the respected but autocratic George Woods Humphery. Ironically, the new man was a friend who'd been best man at his wedding. John Reith had been the director general of the BBC and was known as the architect of British broadcasting as much as for his austere Presbyterian outlook.

Yet even this had apparently not prepared him for his first experience of Imperial Airways. He'd been directed to an old furniture store behind London's Victoria Station and, having climbed "a dark and narrow staircase", found himself in a passage between wooden partitions "peering at the doors and wondering which to try first." Then, Reith wrote later: "Here it was – a bit of paper with 'Managing Director' written on it. From Broadcasting House to this!"

But it didn't take him long to get the measure of his new charge. Chairing his first annual meeting he pulled no punches. Equipment deliveries had been "shockingly late", he said, and the airline was operating aircraft that should "long ago have been replaced." He also questioned the 'buy British' policy that had been imposed on the airline by the government.

Reith was in no doubt about the answer to the airline's troubles. Privately he told the government he would resign if it wasn't nationalised. In November 1938 air minister Sir Kingsley Wood announced that it would be merged with British Airways as a single public corporation.

Wartime Operations

When the British Overseas Airways Corporation formally came into existence in November 1939 it was hardly the most auspicious time to start a new airline. Merging the two companies created extensive difficulties for the new management. Not the least of these was that all its aircraft, most of which had previously been dispersed to the West Country, were initially placed under direct Air Ministry control. Many of its staff including pilots had been called up for military service, too.

The new corporation began operations on April 1 1940. But without John Reith. His lobbying for a job that made better use of his talents had paid off and prime minister Chamberlain appointed him minister of information. He was succeeded at BOAC by Clive Pearson.

Although it was to play a key role during the coming war, it was initially far from well-equipped. For the next six years it operated a mixture of inherited types, including the Shorts C and G-class flying boats, whatever it could acquire from the RAF.

The German occupation of Europe and Italy's entry into the war had a major impact on BOAC's operations although services to Africa, the middle and Far East and Australasia continued. Flying boats operated to West Africa via Lisbon to meet a trans-

to compete with continental rivals enjoying government support.

After disproving the statement by Air Minister Winston Churchill that civil aviation could fly by itself, the struggling British carriers were merged into one. The grandly titled Imperial Airways duly received a public subsidy to operate services on European and Empire routes.

But by the mid-1930s Imperial Airways was finding itself under pressure. New airlines had sprung up to offer competition. They were merged in 1936 to form British Airways which had more operational freedom than Imperial Airways and was able to operate efficient US and German-built equipment.

Imperial Airways was also criticised for its management style and dated approach to industrial relations. There were concerns, too about its safety record and the adequacy of the infrastructure it was using.

In November 1937 the government appointed a committee under Lord Cadman of the Anglo-Iranian Oil Company to investigate the situation. As expected, Cadman was highly critical of the airline's management and called for profound



Passengers and press board Comet G-ALYP on May 2, 1952 ahead of the first commercial jet flight. Less than two years later 'Yoke Peter' would lie at the bottom of the Mediterranean sparking the grounding of BOAC's world famous jet fleet



Wartime saw BOAC flying a number of Short C and G-class Empire flying boats, most of which had been inherited from Imperial Airways



BOAC emerged from the war with a hodgepodge of types including the Short Sunderland. The airline converted a number of these into Hythe-class airliners with accommodation for 24 passengers, including sleeping berths for 16. In February 1946 the first of these, G-AGJM, made a 35,313 mile route survey from Poole to Australia, New Zealand, Hong Kong, Shanghai and Tokyo in 206 flying hours.



The caption on this original July 18, 1946 image reads: "Lady Winster, accompanied by Lord Winster, Minister of Civil Aviation, today christened with the name 'Falkirk' the first of the fleet of Handley Page Halton aircraft which will go into service shortly with the British Overseas Aircraft Corporation. Left to right: Sir Victor Tait (Technical Director Handley Page), Captain DD Haig (co-pilot), Eng Officer HV Maycock, F/Steward JC Coulsell, Nav Officer DH Morris, Radio Officer GA Battye, Captain WG Buchanan, Sir William Walsh, Sir Frederick Handley Page, Mr James Strachan (Provost of Falkirk), Mr Robert Lyle, Town Clerk of Falkirk"

African service. This in turn connected with the Horseshoe Route from South Africa to Australia. Japan's conquest of Malaya and Singapore brought more changes and obliged BOAC, in association with Qantas, to operate a regular 3,500-mile non-stop service between Ceylon and Perth.

Even more risky were the flights to and from Sweden. Military types in civil markings including Armstrong Whitworth Whitleys and de Havilland Mosquito IVs flew the 800 miles carrying personnel and newspapers from Leuchars, Scotland to Stockholm, bringing back vital ball bearings. More than 1,200 flights ran the gauntlet of interception by German fighters.

Trans-Atlantic operations were no less hazardous. BOAC helped establish the organisation that ferried American-built aircraft to the UK and when it was subsumed into the RAF to become Transport Command, the airline took responsibility for the Return Ferry Service, flying crews back across the Atlantic. Between 1941 and September 1945 1,750 trips were made.

Relations between the corporation and the Air Ministry remained difficult with constant bickering and intrigue, according to one account, and were not eased by the formation of Transport Command. In 1942 most of the airline's board resigned. A virtually new board did little to ease the situation.

Post-War

BOAC emerged from the war with a hodgepodge of Dakotas/DC-3s, Liberators, Ensigns, Lockheed twins and Mosquitos, Sunderlands and C/G-class flying boats with a dozen or so miscellaneous types. It was a fleet hardly suited to the world of post-war commercial aviation. The corporation was hoping for a more unified fleet but its new Lancastrians and Yorks arrived in dribs and drabs.

Meanwhile, Clement Atlee's Labour administration, which had succeeded the wartime coalition, had inherited a civil

aviation policy based on nationalisation even though its main architect, Churchill's air minister Viscount Swinton, had envisaged the injection of private capital from rail and shipping companies. What emerged was three nationalised airlines with BOAC as the flagship. Indeed, for a short while British European Airways operated as a division of BOAC.

Aircraft Shortage

In May 1946 a BOAC Lancastrian had the distinction of operating BOAC's first service from the new London airport opened west of London in May 1946. But an aircraft shortage following the grounding of the troublesome Avro Tudors was a key factor in BOAC's 1947 acquisition of the short-lived state-owned British South American Airlines.

BOAC now had 175 aircraft of 18 different types, but the requirement to buy British was becoming increasingly difficult to observe. Government permission was sought to acquire US-built aircraft; BOAC wanted 30 Lockheed Constellations but was allowed to buy just six. And the Treasury ruled that it couldn't finance them out of dollar earnings. The first Constellation entered BOAC service in July 1946.

With the new aircraft envisaged by the wartime Brabazon Committee still some way off Britain was short of hard currency, particularly US dollars, to meet BOAC's capacity needs. To overcome the problem BOAC acquired 22 Canadian DC-4 conversions with Rolls-Royce Merlin engines. Known as Argonauts they were noisy but were pressurised and, with the

Below: By the late 1940s BOAC operated 18 different types but the requirement to buy British was becoming increasingly difficult to observe. Government permission was sought to acquire US-built aircraft; BOAC wanted 30 Lockheed Constellations but was allowed to buy just six. The first entered BOAC service in July 1946. G-AHEN, seen here in the cruise, flew the first BOAC Constellation transatlantic flight on April 16, 1947



Constellations, formed the backbone of BOAC's fleet into the 1950s.

By 1949 its last remaining wartime aircraft, a Liberator, had flown its final passenger service. The stop-gap Lancastrians continued as freighters. The Avro Yorks, also Lancaster-derived, were soon to go too as BOAC received its first post-war British aircraft. The Handley-Page Hermes arrived in 1950 and went into service on the African routes. But the aircraft's graceful lines did nothing to overcome BOAC's dislike of the type and two years later it was superseded by Argonauts.

Luxury Travel

Meanwhile the appointment as chairman in 1949 of the energetic Sir Miles Thomas was followed in 1951 by BOAC's first annual profit. Until then its financial performance had not been impressive with £38 million of taxpayers' cash – more than three times the subsidy required by BEA – being pumped in to cover BOAC's deficits.

London-New York services (with a stop at Prestwick) operated by another US-made type were inaugurated in December 1949 and became a daily operation the following February. The blunt-nosed Boeing Stratocruiser set new standards for luxury travel: with its sleeping berths, dressing



mid-1950s, oil rather than fuel consumption was the big worry for crews.

Comet Confidence

Yet there was a new mood of confidence. The old-fashioned aircraft had now largely gone and BOAC was poised to become the first jet airline, something it had been looking forward to since 1946 when it placed its first orders for the Comet.

The inaugural passenger jet service in May 1952 is now recognised as one of the most significant events in aviation history. Going via Rome, Beirut, Khartoum, Entebbe and Livingstone, the services reached Johannesburg in 23hr 36min, leisurely by today's standards but almost half the previous time to cover the 6,725 miles (10,760 km).

The airline was conscious of its role in advancing British prestige. Capt Majendie,



Top: BOAC acquired 22 Canadian DC-4 conversions with Rolls-Royce Merlin engines. Known as Argonauts they were noisy but were pressurised and, with the Constellations, formed the backbone of BOAC's fleet into the 1950s

Above: In October 1954 Stratocruiser maintenance was transferred from Filton, Bristol to Heathrow so that all engineering work was now conducted at one point

1954 a London-bound Comet broke up in flight soon after taking off from Rome. Yet such was the confidence in the Comet that the news was received with incredulity. After a thorough examination nothing untoward was found and the rest of the aircraft were back in service by the end of March.

Then in April another BOAC Comet, on hire to South African Airways, disappeared near Sicily. The fleet was grounded pending a full investigation. To cope with the sudden withdrawal of 20 per cent of capacity – at time when traffic was rising – further Constellations and Stratocruisers were acquired. Now there were 16 of each and even the unloved Hermes made a brief return. The South American service was withdrawn for six years from April 1954. That October, Stratocruiser maintenance

“Military types in civil markings brought back vital ball bearings”

rooms and lounge reached via a spiral staircase, the Stratocruiser was certainly a far cry from the draughty Lancastrian. Consequently the Monarch trans-Atlantic services became legendary.

But these were also the days when trans-Atlantic travel was an adventure. Icing was an ever-present threat as was mechanical failure. The complex piston engines of the day were far less reliable than the later jets. With the ultimate piston-engined airliners, the Douglas DC-7Cs which BOAC operated from the

who commanded the first leg of the first Comet service, declared before the departure from Heathrow: “We are very glad to have the honour of launching this service. We are also very proud to be using this British aeroplane.”

The time saving achieved by the Comet, coupled with its impressive regularity created a halo effect for BOAC. By 1953 the African services had been joined by parallel operations to India, Singapore and on to Tokyo. But then came disaster. In January

The Handley-Page Hermes arrived in 1950 and went into service on the African routes. But the aircraft's graceful lines did nothing to overcome BOAC's dislike of the type and two years later it was superseded by Argonauts



London-New York services were inaugurated in December 1949 using the Boeing Stratocruiser. Here crowds of interested onlookers queue to tour G-ALSO as British European Airways Bristol Sycamore G-ALSR arrives. Presumably this was some type of airshow or public event...



The complex piston engines of the 1950s were far less reliable than the later jets. With the ultimate piston-engined airliners, the Douglas DC-7Cs which BOAC operated from the mid-1950s, oil rather than fuel consumption was the big worry for crews Caz Caswell Collection



In 1952 BOAC introduced the world to jet travel, but two years later a series of accidents brought doubt upon the revolutionary Comet and the dream came crashing down. It transpired the Comet 1, illustrated here by the prototype G-ALVG wearing BOAC colours, had pressurisation problems and the fleet was grounded

was transferred from Filton, Bristol to Heathrow – London Airport as it was still known – so that all engineering work was now conducted at one point.

Such measures enabled the airline to weather the storm. But BOAC retained its faith in the Comet. The revised Comet 4 with trans-Atlantic capability had risen, phoenix-like, from the ashes of the original variant and BOAC ordered 19 of them.

On October 4, 1958 BOAC launched trans-Atlantic jet services. Just over three weeks later Pan-American followed with its Boeing 707s but nothing could detract from BOAC's achievement. It was also the first airline to operate a jet service to the Far East (Tokyo)

the following year. Comets also operated on routes between London and Sydney and Johannesburg and also for the resumption of South American services in 1960.

707 Service

In the Bristol Britannia BOAC also had the world's first long-range turbo-prop airliner, although its protracted development and teething troubles meant it was heavily delayed. Had it entered service 18 months earlier its impact on air transport history might have been profound. As it was the Series 100 Britannia went into service on the Johannesburg route in February 1957. The bigger 310 followed, on London-New York, just before Christmas.



The Britannia brought regular non-stop trans-Atlantic services and represented a major advance but only for a short time.

BOAC was now looking forward to launching Boeing 707 services. It had received government permission to buy 15 aircraft in 1956 in the wake of the much criticised cancellation of the promising Vickers V.1000 following the airline's failure to support it.

In 1958, however, BOAC ordered 35 of the same manufacturer's VC10 with options on a further 20. But its actions in ordering then rejecting an aircraft whose sales chances were blighted by the airline's demanding requirements created further bad feeling.

Yet the airline was gaining in popularity with passengers. The 707 went into service on London to New York and Los Angeles in May 1960 and March 1961; BOAC was hailing the 'Rolls-Royce 707' in recognition of its British-made Conway turbo-fan engines. BOAC was now carrying more North Atlantic passengers than any other airline except Pan Am, having just overtaken TWA. Steady growth took passenger numbers from 36,000 in 1950 to 254,000 in 1960.

Expense and Pomposity

But traffic declined again. In 1961 BOAC had a third more capacity than in 1960 but traffic was only 9% up with just 5.5% more revenue. The book value of the fleet, particularly the Comets, Britannias and stop-gap Douglases



Above: In the Bristol Britannia BOAC had the world's first long-range turbo-prop airliner, although its protracted development and teething troubles meant it was heavily delayed. Had it entered service 18 months earlier its impact on air transport history might have been profound. G-AOVD, seen here at Cambridge in 1958, crashed near Christchurch, Dorset on Christmas Eve 1958 killing two of the five crew and all seven passengers. The pilot had been attempting to land in thick fog Adrian M Balch Collection

Left: BOAC received government permission to buy 15 Boeing 707s in 1956 in the wake of the cancellation of the Vickers V.1000. The Rolls-Royce Conway powered 707 went into service on the London to New York route in May 1960. G-APFF, seen here at Manchester in 1964, was later passed to British Airways and British Airtours before returning to Boeing in 1981

Adrian M Balch Collection

DC-7Cs, had fallen. By the end of the 1961/62 financial year the deficit reached £64 million.

In 1962 BOAC and the Cunard Steamship Company created BOAC-Cunard to operate many British trans-Atlantic air services including those to Bermuda and the Caribbean. But although the financial position improved the government remained critical of BOAC's management. The board was re-organised and a new chairman, Sir Giles Guthrie, was appointed with fresh ideas about the future direction.

Staff numbers were reduced and unprofitable routes cut; record profits were unveiled in 1965. But BOAC had been obliged to pay compensation to Vickers following a reduction in the VC10 order. The first of 12 standard aircraft went into service in April 1964 on the West African route, while the first of 17 Super VC10s started on the North Atlantic a year later.

Although there were no teething troubles with an aircraft that became popular with passengers, Guthrie's reservations had been justified: the VC10 was significantly more expensive to operate than the 707. Further 707s were ordered so that by the end of the 1960s eight -336s were in service including three freighters. There was another key development in November 1968 when the £47 million BOADICEA computer complex was opened.

At this time BOAC staff considered themselves a cut above their counterparts

in BEA. In this sense the difference between the airlines was "quite marked," according to Kevin Hatton. He worked for both and was to become a senior British Airways manager before running Britannia Airways and GB Airways.

He says: "Many BOAC people were Oxbridge graduates who'd come from well-heeled families in contrast to the BEA grammar school boys." He adds: "I would say BOAC's management was quite pompous. Very pompous in some cases."

Former RAF pilot Gil Gray had wanted to join BOAC in the 1950s but was put off

The airline had been officially involved with the project since 1962 when it had booked delivery positions. The airline had misgivings about the SST's economic viability but after much discussion and the promise of a subsidy eventually agreed to order five. This was announced by aerospace minister Michael Heseltine in May 1972.

But they were never to be operated by BOAC. The government-appointed Edwards Committee, established to consider the shape of British air transport in the '70s called for the nationalised carriers to operate under a single board. This was

"BOAC was looking forward to launching Boeing 707 services"

by the length of time to get a command: 18 years against ten at BEA. "That seemed a long time but it was better than BOAC," Gray says.

Final Years

The 1970s opened with the expectation of new aircraft. The first of the airline's wide-body aircraft went into service in 1970. BOAC had ordered six of the newly-launched Boeing 747 'Jumbo Jets' in 1966 and doubled it in November 1968.

Even more exciting was the prospect of the supersonic Anglo-French Concorde.

accepted by the government and the unified British Airways Board held its inaugural meeting in January 1972.

The next step wasn't long in coming: that July it was announced that BOAC and BEA would merge. On March 31 1974 the two were officially dissolved: after 34 years BOAC had passed into history.

Historian Robert Higham summed up Britain's premier long-haul airline when he declared that its story had been one of "continuity, struggle and success against many odds, both foreign and domestic."

It was, though, a true flag carrier. ●



In 1958 BOAC ordered 35 Vickers VC10s with options on a further 20, but this was later slashed. The first of 12 standard aircraft went into service in April 1964 on the West African route, while the first of 17 Super VC10s started on the North Atlantic a year later. G-ASGO, seen here in the cruise, was hijacked on March 3, 1974 and landed at Schiphol, Netherlands, where it was set on fire and damaged beyond economic repair



In 1962 BOAC and the Cunard Steamship Company created BOAC-Cunard to operate many British trans-Atlantic air services including those to Bermuda and the Caribbean. G-ASGF is seen here at Manchester's Ringway Airport in July 1966. It was later sold to the RAF as a spares source



The first of the airline's wide-body aircraft went into service in 1970. BOAC had ordered six of the newly-launched Boeing 747 in 1966 and doubled it in November 1968. G-AWNA was one of the first 'Jumbos' to join the airline when it arrived in April 1970 and is seen here at Heathrow shortly after delivery. Caz Caswell

Mid-Size Market

Airline passenger traffic is estimated to treble within the next 20 years and manufacturers are estimating a demand for 5,000 new mid-sized airliners. Kimberley Hawkins looks at the myriad of aircraft currently under development

The rise in fuel prices in recent years has seen a number of airlines opting to trade in their small regional jets and upgrade to mid-sized aircraft in an attempt to increase the number of 'bums on seats' in each aircraft and lower the seat cost per mile.

Meanwhile, the proliferation of 'hub and spoke' operations using large airliners such as the Airbus A380 have also created an increased need for medium sized aircraft to transfer passengers to their end destinations.

For the past two decades, airlines wanting an economic mid-sized aircraft were effectively limited to the Airbus A320 family or the tried and tested Boeing 737. But with competition hotter than ever, the 'big two' manufacturers have had to radically alter their products to vie with the newer, more fuel

efficient and technologically advanced airliners on the drawing board around the globe.

Airbus' A320 family first flew in 1987 and more than 6,300 examples had been built by the end of 2014. Additions soon included the A321 (first delivered 1994), the A319 (1996), and the A318 (2003) and the type pioneered the use of fly-by-wire and side-stick controls in commercial aircraft. Deliveries have consistently outpaced those of the 737 since 2002 but Airbus has long considered a replacement. The so-called Airbus NSR (New Short-Range aircraft) or A30X was instigated a decade ago but in 2010 the manufacturer announced that an all-new design is unlikely to be constructed before 2024.

Upgrading the Airbus

Instead, Airbus has focused its attentions on refining the existing A320 family, beginning with the introduction of 7ft 10in-tall 'sharklets', claimed to reduce fuel burn by up to 4% over longer sectors by decreasing

wingtip vortices and drag. This could correspond to an annual CO₂ reduction of around 700 tonnes per aircraft. The first example flew in 2012 and Sharklets are now also offered as a retrofit option.

However, the Sharklets form just part of Airbus' aim to create a new, more fuel efficient, version of the A320 and via its latest A320neo (New Engine Option) Airbus claims it is "providing the minimum change with maximum benefit."

The programme began in December 2010 and the new aircraft combines Sharklets with a choice of two new generation engines – CFM International's LEAP-1A and the PurePower PW1100G-JM from Pratt & Whitney – and other changes to decrease weight and increase performance and comfort.

The new family of jetliners (comprising the A319neo, A320neo and A321neo versions) offer improvements resulting in a per seat fuel burn saving of 20% compared to A320ceo airliners, along with an additional 500nm of range, reduced engine noise and lower emissions.



The Boeing 737 MAX also utilises a patented winglet design to reduce fuel burn. This artist's impression shows the 737 MAX 8 in the colours of CIT Aerospace, one of the many lessors to order the latest version of the 737 Boeing



Above:The Airbus A320neo prototype takes to the skies for the first time on September 25, 2014. The aircraft looks set to dominate the mid-sized market along with Boeing's 737 MAX Airbus

Right:The A320neo boasts 7ft 10in-tall blended winglets dubbed Sharklets. These reduce fuel burn by decreasing wingtip vortices and drag and are also now available on earlier Airbus designs Airbus

Below:The prototype A320 was powered by the Pratt & Whitney PurePower PW1100G-JM engine but the aircraft is also being offered with CFM International's LEAP-1A Airbus



Since the programme was launched the A320neo family has received more than 3,000 firm orders from 60 airlines around the globe and Airbus says it plans to deliver 4,000 A320neo airframes over 15 years.

The latest variant to join the family is the A321neo, which has a range of 4,000nm – the longest of any single-aisle aircraft – making it ideally suited to transatlantic routes. Deliveries are expected to begin in 2019.

To the MAX

It is likely the main competitor to the A320neo family will be Boeing's 737 MAX, which was launched in August 2011 but has yet to fly.

The MAX family is powered by CFM International LEAP-1B engines and design 'tweaks' include Boeing's Advanced Technology Winglet that will result in less drag, especially on longer-range flights. Work has also been undertaken to reduce or remove drag around the wing and engines.

According to Boeing, the MAX "will build on the Next-Generation 737's popularity and reliability while delivering customers unsurpassed fuel efficiency in the single-aisle market."

The aircraft closely resembles the existing Next-Generation 737s that have been in service for two decades and will ultimately be available in MAX 7, MAX 8 and MAX 9 variants, which are based on the 737-700, -800 and -900ER, respectively. The latest

version to be announced is the 737 MAX 200; a 200-seat variant based on the 737 MAX 8.

Boeing claims the MAX 8's fuel use "is expected to be 8% per seat lower than the future competition" and that development is on schedule with "firm configuration" achieved by July 2013 and first flight scheduled for 2016. Deliveries to 55 customers are scheduled to commence in 2017 – 50 years after the first 737 took to the skies.

E Jet

Brazilian company Embraer's E-Jet was originally launched at the 1999 Paris Air Salon and more than 1,100 had been produced by the end of 2014. The smaller E170 and E175 form most of the current product line while the E190 and E195 are stretched versions with different engines and

a larger wing and horizontal stabiliser.

With a successful product range and an established customer base, Embraer set about updating the aircraft in November 2011 when it launched the E2 project.

The planned 88-seat E175-E2, 106-seat E190-E2 and 132-seat E195-E2 will all feature new more efficient Pratt & Whitney PW1000G Geared Turbofan engines with larger diameter fans while design studies are also being undertaken to evaluate a new aluminium or carbon fibre wing.

Skywest Airlines will become the first airline to receive the E175-E2 variant and ILFC will become the launch customer for the E190-E2 and E195-E2. Deliveries of the E175-E2 are on schedule for 2020 and the E190-E2 is expected to enter service in the first half of 2018.

"The Boeing 737 Max 8's first flight is scheduled for 2016"



The 737 MAX is currently offered in three main variants with the MAX 7, 8 and 9 designed to replace the 737-700, 800 and 900 airliners, respectively Boeing

By the end of 2014 some 270 E2 jets had been ordered by operators based in the USA, China and India.

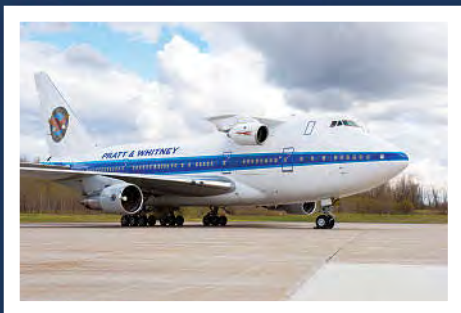
CSeries

Beating the A320neo, 737MAX and Embraer E2 into the air was a serious competitor from Canadian manufacturer Bombardier Aerospace. The 100-149-seat Bombardier CSeries first took to the skies on September 16, 2013, although the project can trace its history back to the mid-1990s and has been subject to numerous delays and set-backs, flight-testing is said to be progressing well.

The CSeries benefits from the use of 70% 'advanced materials' (46% composite materials and 24% aluminium-lithium) which Bombardier claim gives the aircraft a 15% lower seat-mile cost than comparable aircraft.

The new jet also features larger windows than the competition and offers the highest overhead bin volume per passenger in its class.

Power comes from two of Pratt & Whitney's new PurePower PW1000G engines



Many of the mid-sized jets – including the Irkut MC-21, Bombardier CSeries, Mitsubishi MRJ and Airbus A320neo – are being designed around the Pratt & Whitney PurePower turbofan engine. The powerplant made its maiden flight on April 30, 2012, mounted on this Boeing 747SP test bed Pratt & Whitney

Below: India's Air Costa placed a firm order for 25 Embraer E190-E2 jets in February 2014. To date 270 E2 jets have been ordered in total consisting of 150 E175-E2s, 70 E190-E2s and 50 E195-E2s Embraer



The E2 range of Embraer E Jets is based upon the existing fleet of E170, 175 and 195 airliners but will benefit from new more efficient engines and possibly an aluminium or carbon fibre wing Embraer

and the CSeries' maiden flight was also the first flight for this revolutionary new engine.

In January 2014 Bombardier announced that the 100-125-seat CS100 (formerly the C110)'s entry into service with launch customer SWISS (a subsidiary of Lufthansa) would be delayed until the second half of 2015 while the longer, 120-140-seat CS300 (formerly C130) is scheduled to follow six months later. The CS100 will take over from the Avro RJ100 in SWISS service and according to Bombardier, it will consume up to 25% less fuel and be twice as quiet to the human ear than the 'Whisper Jet' it replaces.

Japanese jets

Japan's Kawasaki YPX is based on the Kawasaki P-1 aircraft now under development for the Japanese military and is expected to seat between 100-150 passengers. The engine choice has not yet been made but Kawasaki says it hopes to offer up to 15% operating savings over the existing Boeing 737-700.

The YPX is being designed with five-abreast seating in the economy cabin and

an elliptical cross-section. The manufacturer claims economy seating would be 18in wide as standard.

While the YPX has yet to leave the drawing board, the competing Mitsubishi Regional Jet (MRJ) was rolled out in October 2014 and performed its first engine runs on January 13, 2015. It is expected to fly this summer.

The MRJ is designed to accommodate between 70 and 90 passengers and is being manufactured by a partnership between Mitsubishi Heavy Industries and the Toyota Motor Corporation. Four versions are planned using two different fuselage lengths. The MRJ70 will have a passenger capacity of 70-80 while the larger MRJ90 will house 86-96 seats.

The initial design was unveiled at the 2007 Paris Air Salon and called for an airframe constructed almost completely of composite materials but a rethink in September 2009 resulted in just 10-15% of the MRJ being constructed from carbon fibre. Procuring the Pratt & Whitney PW1217G engines also resulted in further delays.

Current plans call for ten aircraft a month





The CSeries is destined to enter service, with launch customer SWISS, in the second half of 2015 *Bombardier*

to be produced from the purpose-built factory at Komaki Airport from 2016 with deliveries to launch customer All Nippon Airways to begin a year later. Orders stand at 223 with 184 further options – all for the larger MRJ90 variant.

Chinese competition

The Comac (Commercial Aircraft Corporation of China) Advanced Regional Jet (ARJ) 21 is a key part of the Chinese government's aviation development plan to cater for both internal and export orders and is believed to reuse some of tooling provided by McDonnell Douglas to enable the license

testing until investigations were completed.

As of the end of 2014 some 312 ARJ21s have been ordered. Launch customer Chengdu Airlines was due to receive its first aircraft by the end of 2011, but delays have meant this is yet to happen. The first production aircraft flew on June 18, 2014 and certification is on-going.

Breaking the duopoly

While it is easy to criticise the delayed development and slightly 'retro' look of the ARJ21 some industry pundits consider the aircraft to be a 'practice' session for Comac; proving techniques and systems in readiness



The completed Mitsubishi Regional Jet was rolled out in October 2014 and performed its first engine runs on January 13, 2015 *Mitsubishi*

The basic design and dimensions of the C919 are very similar to the Airbus A320 and the aircraft will come in two variants – a standard machine with a 2,200nm range and an extended-range version capable of flying 3,000nm. Power will come from the CFM International LEAP-1C engine.

Comac says the C919 is on schedule to make its maiden flight in 2015 and it intends to produce five pre-production examples per year in 2016 and 2017. The first

“Bombardier’s CS100 will be twice as quiet to the human ear”

production of the MD80 airliner in China.

However, the ARJ21 Xiangfeng ('Soaring Phoenix') differs from the MD80 by virtue of an all-new supercritical wing, which has 25 degrees of sweep and is said to have been designed by Ukraine's Antonov Design Bureau. It is also fitted with winglets to improve aerodynamic performance.

Six development examples have flown since 2008 but in November 2010 an ARJ21 wing failed during static testing and the Civil Aviation Administration of China limited the aircraft's flight envelope during its flight

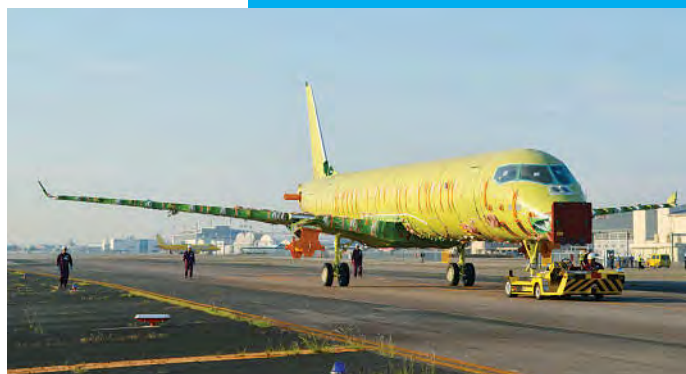
for its own in-house design.

The C919 is a planned family of 158-174 seat airliners that is intended to compete against Airbus' A320neo and Boeing's 737 MAX. It will become the largest commercial aircraft designed and built in China since the defunct Shanghai Y-10. More importantly it forms part of China's long-term goal to break Airbus and Boeing's duopoly.

The C919 has been designed as a 'scaleable' design that can easily be stretched to create the twin-aisle C929 and C939, which offer 300 and 400 seats, respectively.

Below left: The prototype Bombardier CSeries airborne during its maiden flight on September 16, 2013 *Bombardier*

Below: The Mitsubishi Regional Jet was originally envisaged as a completely composite aeroplane but now just 10-15% of the aircraft is believed to be constructed from kevlar or carbon fibre *Mitsubishi*



The Comac ARJ21 Soaring Phoenix may look like an MD80 but it differs by virtue of an all-new supercritical wing designed by Ukraine's Antonov Design Bureau. It is also fitted with winglets to improve aerodynamic performance Comac



deliveries are now projected for 2018 and Comac says it plans to eventually ramp up production to 150 airframes per year. It says it foresees a demand for 2,300 aircraft.

Russian revelations

With a renewed interest and investment in its aviation industry it is perhaps unsurprising that Russia is also hotly pursuing the mid-sized jet market.

Heading up the Russian campaign is the Sukhoi Superjet 100, which has been flying since May 19, 2008 and in service since 2011.

The jet was originally planned to be produced in three variants dubbed the RRJ-60, RRJ-75 and RRJ-95 – numbers corresponding the amount of passengers carried. However, the aircraft were later rebranded as the Superjet 100 (ex-RRJ-60), the Superjet 100/75 (RRJ-75) and Superjet 100/95 (RRJ-95).

The smallest variant was eventually postponed and all sales to date have been for the Superjet 100/95. While it is unlikely that the Superjet 100/75 will be developed, other stretched versions are planned.

Sukhoi claims the Superjet 100/95 has 6 to 8% lower operating costs than the Embraer 190 as well as a lower purchase price of just \$35 million.

Development began in 2000 and two years later Sukhoi Civil Aircraft and Boeing signed a Cooperation Agreement to work together on the design. Five years later Sukhoi signed a contract with the Russian government to receive 7.9 billion Rubles of research and development financing and the aircraft progressed quickly.

The aircraft is constructed at sites across Russia and assembled at Komsomolsk-on-Amur. Even its engines (the 18,000lb/thrust SaM-146) are produced in Russia after development by



Some reports suggest the Chinese Comac C919 is scheduled to fly during 2015 but so far no photographs of the new airliner have appeared. The Chinese media has reported that the type will incorporate 3D-printed aluminium wing spars Comac



The prototype Sukhoi Superjet takes off on its maiden flight on May 19, 2008 Sukhoi

the French-Russian PowerJet joint venture. In fact more than 30 foreign partnership companies are involved in the project.

After a variety of delays the aircraft finally entered service with Armavia on April 21, 2011 but the airline soon filed for bankruptcy and returned its two aircraft to Sukhoi. The Superjet 100 is currently in service with Aeroflot (26) and Mexico's Interjet (12) along with smaller operators

SPECIFICATION	Airbus A320neo	Boeing 737 MAX 8	Embraer E175-E2	Bombardier CSeries CS100
CREW	2	2	2	2
CAPACITY	189	162-175	97-114	108-125
LENGTH	123ft 3in (37.57m)	129ft 8in (39.50m)	106ft 0in (32.30m)	114ft 8in (35.00m)
HEIGHT	38ft 7in (11.76m)	40ft 4in (12.30m)	32ft 7in (9.98m)	38ft 0in (11.50m)
WINGSPAN	117ft 5in (35.80m)	117ft 10in (35.90m)	85ft 4in (26.00m)	115ft 0in (35.10m)
WING AREA	1,320sq ft (122.6m ²)	1,320sq ft (122.6m ²)	783sq ft (72.7m ²)	1,209sq ft (112.3m ²)
EMPTY WEIGHT	142,000lb (64,410kg)	98,495lb (44,676kg)	TBC	73,400lb (33,300kg)
MAX TAKE-OFF WEIGHT	174,000lb (78,927kg)	181,200lb (82,191kg)	97,730lb (44,330kg)	130,000lb (58,967kg)
MAX SPEED	444kts (511mph/828km/h)	454kts (522mph/842km/h)	470kts (541mph/870km/h)	470kts (541mph/870km/h)
SERVICE CEILING	39,000ft (12,000m)	41,000ft (12,500m)	41,000ft (12,500m)	41,000ft (12,500m)
FERRY RANGE	4,300 miles (6,900km)	3,595 miles (6,658km)	3,595 miles (6,658km)	2,950 miles (5,463km)
POWERPLANT	Two Pratt & Whitney PW1100G turbofans (35,000lb/thrust each) or Two CFM LEAP-1A turbofans (32,900lb/thrust each)	Two CFM LEAP-1B turbofans (32,900lb/thrust each)	Two Pratt & Whitney PW1700G turbofans (15,000lb/thrust each) or Two Pratt & Whitney PW1900G turbofans (22,000lb/thrust each)	Two Pratt & Whitney PW1500G turbofans (18,900lb/thrust each)
LAUNCH DATE	December 1, 2010	July 20, 2011	June, 2013	July 13, 2008
FIRST FLIGHT	February 22, 1987 (A320) September 25, 2014 (A320neo)	April 9, 1967 (737) Estimated 2016 (737 MAX)	February 19, 2002 (E-Jet) Estimated 2017 (E-Jet E2)	September 16, 2013 (CS100)
AIRCRAFT ON ORDER*	5,145	3,839	270	243
AIRCRAFT DELIVERED**	0	0	0	0



such as Gazpromavia and Lao Central Airlines. A total of 56 are now in service with a backlog of 262 on order.

Irkut MC-21

Elsewhere in Russia the Irkut and Yakovlev Design Bureau have teamed up to work on the MC-21 (Magistralny Samolyot 21 veka/'Airliner of the 21st Century').

The programme is expected to create a range of three short-range and mid-range airliners with a capacity of 150-212 passengers – all based on the stillborn Yak-242 project. In fact there are unconfirmed reports that the project could be renamed as the Yak-242 before it eventually takes flight.

The standard MC-21-300 is designed to seat 180 passengers in single-class configuration and Irkut hopes to follow this with the 150-seat MC-21-200 and 212-seat MC-21-400. Extended-range models are also planned but the smaller 132-seat MC-21-100 has been cancelled to avoid competition with the Sukhoi Superjet 130.

Irkut has stuck with the dream of creating a mostly composite airliner and unlike its Russian cousin, the MC-21, is set to take advantage of American engine technology via the Pratt & Whitney PW1000G. The manufacturer claims this lightweight airframe, modern aerodynamics and efficient engine will combine to give 15% less fuel burn than the A320neo and a 20% reduction in operating costs.

However, as has become vogue for the majority of mid-sized airliners the MC-21

has suffered a much delayed gestation period. Plans originally called for a maiden flight in 2014 and deliveries by 2016 but the MC-21 has yet to leave the design board.

Orders currently stand at 175 with 101 options. This includes 35 examples powered by the Russian PD-14 turbofan on order for the Russian government.

It seems a given that the Airbus and Boeing designs will retain their stranglehold on the market, but it has been a long time since they've met such stiff competition. At this rate the airline passengers of the future may just find themselves strapping into an ever more diverse range of aircraft... ●

Above: Unlike so many of the projected mid-sized airliners, the Sukhoi Superjet has already entered airline service. Will this give the advanced Russian design an edge over market favourites such as Airbus' A320neo and Boeing's 737 MAX? Sukhoi

Above left: Mexico's Interjet has so far taken delivery of 12 of the 30 Sukhoi Superjet 100 airliners it currently has on order Sukhoi

Below: The Irkut MC-21 is scheduled to be a mostly composite airliner and is set to take advantage of American engine technology. Artists' impression depict the aircraft resembling a scaled-down Boeing 767 Irkut



Kawasaki YPX	Mitsubishi MRJ-90	Comac ARJ21-900	Comac C919	Sukhoi Superjet 100	Irkut MC-21-300
2	2	2	2	2	2
93-150	92	78-90	156-174	68-88	152-198
TBC	117ft 4in (35.80m)	109ft 9in (33.46m)	127ft 7in (38.90m)	86ft 9in (26.44m)	136ft 2in (41.50m)
TBC	34ft 4in (10.50m)	27ft 8in (8.44m)	39ft 2in (11.95m)	33ft 9in (10.28m)	37ft 9in (11.50m)
TBC	95ft 9in (29.20m)	89ft 6in (27.28m)	117ft 5in (35.80m)	91ft 2in (27.80m)	117ft 9in (35.90m)
TBC	TBC	859.6sq ft (79.86m ²)	859.6sq ft (79.86m ²)	904sq ft (84.00m ²)	TBC
TBC	49,800lb (22,600kg)	55,016lb (24,955kg)	92,815lb (42,100kg)	55,300lb (25,100kg)	TBC
TBC	87,303lb (39,600kg)	89,300lb (40,500kg)	170,400lb (77,300kg)	77,000lb (35,000kg)	167,950lb (76,180kg)
478kts (550mph/885km/h)	448kts (515mph/828km/h)	470kts (541mph/870km/h)	450kts (518mph/834km/h)	469kts (541mph/870km/h)	TBC
39,000ft (12,000m)	41,000ft (12,500m)	39,000ft (11,900m)	39,700ft (12,100m)	41,000ft (12,500m)	TBC
2,647 miles (4,260km)	1,037 miles (1,670km)	1,401 miles (2,255km)	2,532 miles (4,075km)	1,833 miles (2,900km)	3,107 miles (5,000km)
TBC	Two Pratt & Whitney PW1217G turbofans (15,600lb/thrust each)	Two General Electric CF34-10A turbofans (17,057b/thrust each)	Two CFM LEAP-C turbofans (25,000b/thrust each)	Two PowerJet SaM146 turbofans (31,000lb/thrust each)	Two Aviadvigatel PD-14 turbofans (31,000lb/thrust each) or two Pratt & Whitney PW1428G turbofans (31,000lb/thrust each)
2007	June 2007	March 2002	October 2010	March 2000	March 2008
N/A	Estimated 2015	November 28, 2008	Estimated 2015	May 19, 2008	Estimated late 2015
0	223	312	430	416	341
0	0	0	0	85	0



THE LAST GUNFIGHTER

THE VOUCHT F-8 CRUSADER

The Vought Crusader was the US Navy's first true supersonic fighter and its final aircraft to be designed around a cannon. Richard Freail examines the last of the gunfighters



The second prototype XF8U-1 Crusader BuNo 138900 first flew on September 30, 1955 – the same day as the first production F8U-1. The aircraft is seen here in formation with an example of Vought's earlier F7U-3 Cutlass

A casual observer, looking across the decks of an aircraft carrier at the end of the 1940s or early 1950s would likely witness a mix of prop and jet-powered fighter aircraft on deck. The former were serving out their twilight years while the relatively new jets were still in their infancy. The United States Navy's (USN) transition to jets – commencing in 1947 with the introduction of the McDonnell F1H Phantom – was, as elsewhere, a slow and painful process. Slow, as important lessons about design and operating procedures were discovered and fed back to be incorporated into the next aircraft and painful due to the numerous losses of aircraft and personnel in accidents. Against this backdrop of a mostly unsuccessful early jet programme, the USN continued to push the boundaries forward in its search for effective fighter aircraft.

Supersonic Jet

In September 1952 the Navy issued a Request for Proposals (RFP) seeking, for the first time, an aircraft that could achieve the speed of sound in level flight. As well as Mach 1.2, other stipulated parameters

included a climb rate of 25,000/min and a landing speed of 100kts; it was also to carry four 20mm cannon as its primary armament.

Although eight manufacturers were initially involved, Vought was one of the few with real carrier-based aircraft experience. What, however, was likely to count against the company was its recent record. While its piston-engine F4U Corsair had ultimately proved itself to be a highly successful machine, Vought's foray into jets was, so far, lamentable. The F6U Pirate, its first jet, had been evaluated as unsuitable for operational use and the F7U Cutlass, with over 300 constructed, suffered numerous issues and rarely went to sea. Quickly nicknamed the 'Gutless Cutlass', amongst its many problems the F7U was drastically under-powered and its engine flamed-out in rain. Making effective use of the new engine and airframe technology was very much a case of trial and error. Many other early jets also proved disappointing – it was not just the preserve of Vought!

Last Chance

Twenty-one proposals were received including developments of existing airframes,



F-8E Crusader 150912 from Marine fighter squadron VMF(AW)-212 – the Lancers – aloft in 1965. The aircraft is armed with AIM-9D Sidewinder missiles and was assigned to Attack Carrier Air Wing Sixteen (CVW-16) aboard the USS Oriskany during deployment to Vietnam. USMC Captain MW Lutes was at the helm when this image was taken. On October 2, 1967 the jet crashed near Da Nang Air Base in South Vietnam and 1st Lt Patrick Ott was killed (US Navy)

but in May 1953 the Navy announced that Vought had won giving rise to the jibe that this project would be 'Vought's Last Chance'.

The design team was led by Vought engineer John Russell Clark and its submission, designated V-383 for the fighter and V-392 for the reconnaissance version, represented a bringing together of all the then available technology from within the company and external sources, such as the National Advisory Committee for Aeronautics (NACA).

The airframe was built around the Pratt and Whitney J57 powerplant which produced 10,900lbs/thrust dry and 14,500lbs/thrust with afterburners. A high-mounted wing with 42° of sweep and five degrees anhedral was employed and in order to achieve the high angles of attack (AoA) required for take-off and landing, Vought introduced an innovative variable-incidence design. The wing could be raised 7° by a hydraulic actuator when required, with the centre section protruding out of the upper fuselage into the airstream, changing the wing's angle of attack. Simultaneously, the ailerons and leading-edge slats, which were interconnected, lowered by 25° and the inboard flaps by 30° to increase the camber and provide greater lift. Such a wing arrangement enabled the Crusader to land at a lower speed but with forward visibility maintained for the pilot.

The rest of the airframe also employed recent innovations with the fuselage area-ruled and benefitting from advances in metallurgy: titanium, which was light, strong and resistant to saltwater corrosion, was extensively used alongside magnesium alloy. All-moving stabilizers were fitted, with slight dihedral, and the undercarriage retracted into the fuselage.

Primary armament was four 20mm Colt Mk 12 cannon, two either side of the forward fuselage, with 144 rounds per weapon – the last US fighter so designed and thus gaining the sobriquet 'Last of the Gunfighters'.

Additionally, two AIM-9 Sidewinder air-to-air missiles were to be fitted on cheek rails, one either side of the fuselage, aft of the cockpit and thirty-two 2.75in unguided rockets in a retractable pack under the fuselage.

Two Prototypes

In June 1953 an order was placed for three XF8U-1 prototypes, allocated Bureau of Aeronautics numbers 138899-138901, although only the first two flew – the third (901) was cancelled but was constructed as an engineless airframe and used for static tests. The first aircraft (138899) was ready for flight testing by February 1955 and was moved to Edwards AFB. Experienced air force test pilot and Vought's chief of flight testing, John Konrad, flew the aircraft on March 25, 1955 for its maiden flight. It was airborne for 52 minutes and achieved supersonic flight with ease. Over the next five years the first prototype completed 508 flights and when retired in 1960 was donated to the Smithsonian Institute. It is currently under restoration at the Seattle Museum of Flight.

Vought was always full of confidence about the Crusader programme, so much so that on September 30, 1955 both the second prototype (138900) and the first production F8U-1 aircraft (140444) took to the air on the same day. The second prototype completed 460 flights before being scrapped.

During the early testing of the F-8 by company and military pilots, five airframes were lost: three pilots, including Konrad, survived but two, undertaking high-speed tests, were killed.

Right: The YF8U-2NE prototype first flew in June 1961 and gave the Crusader an air-to-ground capability. Here the aircraft demonstrates its two under-wing pylons, which had the ability to carry a total of 4,000lb of bombs, missiles or rockets. This aircraft was later converted to the sole F8U-1T two-seater



The Crusader was a true Cold War warrior and as well as shooting down 19 MiGs they intercepted countless Russian bombers, such as this Tupolev Tu-95 Bear caught overlying the USS Oriskany (CVA-34) US Navy



On April 3, 1956 the fourth pre-production F8U-1 (140446) embarked on the USS Forrestal for deck handling trials. A day later Duke Windsor performed the type's first catapult take-off

First Squadrons

Although early test flights revealed that the XF8U-1 had an inclination to 'crab' at high altitudes, testing went relatively smoothly although problems such as a weak undercarriage and guns that jammed under high-G manoeuvring would surface in due course.

Later known – following the tri-service designation system introduced in 1962 – as the F-8A, the production F8U-1, of which 318 were built, was almost identical to the prototypes. After the initial few





This line up, believed to be at the Yough factory circa 1958, includes a variety of F8U-1, F8U-1E and F8U-1P Crusaders

deliveries the engine was uprated to provide 16,200lbs/thrust with afterburners and with the 1955 USN requirement that its aircraft have AAR capability, a retractable refuelling probe was fitted in a blister on the port side, just aft of the cockpit.

The first Crusaders reached the test and evaluation squadron, VX-3, at NAS Atlantic City in December 1956 and, two years after first flying, became operational with VF-32

at NAS Cecil Field in March 1957. West Coast naval squadron VF-154 was next and became the first to undertake a carrier deployment, on the USS Hancock (CV-19), in late 1957. The first USMC squadron to receive the aircraft was VMF-122 at MCAS Beaufort in December 1957.

By 1960 over half of the USN's 30 carrier-based fighter squadrons and many USMC units flew the Crusader. Detachments of photo-reconnaissance F8U-1Ps (RF-8A) were embarked on all attack carriers and three USMC squadrons flew them as well.

Early Crusaders

The photo reconnaissance F8U-1P (RF-8A) first flew in December 1956 with 144 being constructed. It entered service the following September with VFP-61 at NAS Miramar, deploying to the USS Midway in December 1957. The lower half of the front fuselage was squared-off to accommodate the installation of five cameras and to compensate the upper fuselage was area-ruled, resulting in a slight hump on the fuselage ahead of the wings.

The F8U-1E (F-8B) retained the specification of the previous marks but gained new electrical equipment, including an AN/APG-67 radar giving a limited all-



Photo-reconnaissance F8U-1P 144612 from VFP-62 'Fighting Photos' prepares for take off. The aircraft was lost on April 8, 1963 while embarked on the USS Saratoga. It had been photographing a Russian trawler when it crashed into the sea killing pilot Lt John 'Richard' Richardson

weather capability. It first flew in September 1958 and 130 were built.

Flying in August 1957, the prototype F8U-2 (F-8C) represented the first real changes to the original airframe, with 187 built. An uprated engine (16,900lbs/thrust and able to achieve Mach 1.7) was fitted, requiring additional cooling for the afterburners in the form of two air scoops on the upper tail cone aft of the fin. The ejection seats were replaced with Martin Baker units and two ventral strakes were fitted to combat the yaw identified in early flight testing. The ability to carry four Sidewinder missiles was provided although this was seldom utilised in practice due to weight and performance trade-offs. The first production model flew in the late summer of 1958 and entered service with VF-84 in January 1959.

All-Weather

Intended as a night fighter with a limited all-weather capability, the F8U-2N (F-8D) had improved avionics and radar together with another engine boost, to 18,000lbs/thrust with afterburners. Improvements included the Approach Power Compensator (APC) which was designed to make carrier landings safer by providing some automation in maintaining approach speeds. The fuselage belly rocket pack was dispensed with and additional fuel carried instead. The first of 152 of this model flew in February 1960 and entered service with the USN's VF-111 in 1961.

The final production variant for the USN was the F8U-2NE (F-8E). Fitted with an improved and larger APQ-94 search and fire control radar, it gained better all-weather ability. Additional avionics for the Bullpup missile, although seldom carried, resulted in a hump in the centre wing section. The Crusader suddenly gained an air-to-ground capability with two underwing pylons able to carry a total of 4,000lbs of bombs, missiles or rockets. F8U-1 (143710) was modified as the YF8U-2NE and flew in June 1961. A total of 286 examples of this model were delivered from September 1962. The last came off the production line in mid-1964.



A pair of F8U-2NEs from VF-33 prepare to launch from the USS Enterprise in 1964 US Navy

F8U-1E Crusader 145540 was almost devoid of markings when photographed prior to its delivery to the US Marines. It later served with VMF-312 but was struck off charge in 1964



The 'Twosader'

The same airframe (143710) used as the prototype for the F8U-2NE (F-8E) was again converted, flying as the sole two-seater in February 1962. A second cockpit was installed immediately behind the original, with the rear seat being raised 15in above the front and full controls fitted. The undercarriage of 143710 was modified to make it suitable for short or rough field landings and brake 'chutes were installed. Two of the 20mm cannon were removed but the other armament remained. Performance was very close to the single-seat aircraft.

Initially designated the F8U-1T and, unofficially, the 'Twosader' by Vought, this was subsequently changed to TF-8A in late 1962.

Vought, hoping for both home and foreign two-seat sales, despatched the TF-8A to the 1962 Paris Airshow. It also spent two weeks at the British testing facility at Boscombe Down being flown by RAF and RN pilots. Vought even proposed a Spey-powered version to fulfil requirements for both a land and carrier-based fighter/strike aircraft and to overcome UK political issues. However, unfortunately for Vought, in 1964

"The Crusader suddenly gained an air-to-ground capability"

the British opted for the Spey-powered F-4 Phantom. The news was not good at home either: defence budget changes ended any possibility of the USN obtaining the two-seat Crusader.

The TF-8A was subsequently used by the Navy's Test Pilot School at Patuxent River and then NASA. The latter utilised a number of other Crusaders including an F-8A for Supercritical Wing tests between 1971-3 and an F-8C from 1972-85 for Digital-Fly-By-Wire experiments. For the TF-8A, however, the move to NASA was not the end of its role as a trainer.



Remanufactured

When the Crusader was under development in the early 1950s, no airframe fatigue life was laid down. As a guesstimate Vought expected each airframe to last around seven years in front-line service. But in 1956, the Navy ordered that investigations be conducted to determine the fatigue-life criteria for its jet fleet and by 1958 it had been set at 2,000hrs for the F-8 Crusader.

As the mid-60s approached, the war in Vietnam was intensifying. The USN decided to retain its long-serving 27C class of smaller

On October 21, 1961 F8U-1 Crusader 145357 crashed while in service with VF-11 'Red Rippers'. Its pilot Lt John T 'Terry' Kryway was landing while landing aboard the USS Franklin D Roosevelt as the ship cruised south of the Dominican Republic in rough seas. The shipped pitched up just at the jet was landing causing the arrestor hook to break off and the starboard undercarriage was damaged. He ejected and was picked up seconds later by the alert helicopter. He suffered only minor injuries



An RF8U-1P Crusader from VFP-62 lands back aboard a carrier during the early 1960s demonstrating its variable incidence wing to good effect



CRUSADER NUMEROLOGY

Original Designation	Number Built	Post-1962 Designation	Number Rebuilt	New Designation
XF8U-1	2	XF-8A	0	N/A
F8U-1	318	F-8A	0	N/A
F8U-1E	130	F-8B	61	F-8L
F8U-1P	144	RF-8A	73	RF-8G
F8U-1T	1*	TF-8A	0	N/A
F8U-2	187	F-8C	87	F-8K
F8U-2N	152	F-8D	89	F-8H
F8U-2NE	286	F-8E	139	F-8J
F-8E(FN)	42	N/A	0	N/A
TOTAL	1261		446	

*The F8U-1T was converted from the prototype YF8U-2NE



Although assigned to photo reconnaissance unit VFP-63 when photographed outside the 'Top Gun' facility at NAS Miramar in 1974 Crusader 150318 is actually an F-8J fighter variant. Built in 1963 it served with VF-131 and various Marine Corps units before joining VFP-63. On September 24, 1975 the pilot ejected safely after the aircraft encountered control problems at 18,000ft *Caz Caswell Collection*



The Marine Corps band plays to welcome Major John Glenn as he taxis F8U-1P 144608 in after landing at Floyd Bennett Field, Brooklyn, New York on July 16, 1957. He had just flown from NAS Los Alamitos in 3 hours, 23 minutes, 8.4 seconds and averaged 725.25mph during the first supersonic transcontinental flight. The purpose of 'Project Bullet' was to test the sustained capability of the F8U at near maximum power over a long distance. The Crusader's average speed was faster than the muzzle velocity of a .45-caliber bullet, hence the project name. This aircraft was later lost while attempting to land on the USS Oriskany in the South China Sea on December 13, 1972. The pilot ejected and was recovered

marks but involved strengthening airframes, wings and undercarriage, fitting uprated engines and underwing pylons for drop tanks, together with improved avionics, radar and navigation systems. The F-8D gained a full night-fighter capability while the F-8E was fitted with blown flaps and other improved lift devices together with a larger stabilator. The Crusader's fatigue-life was renewed and set at 4,000hrs. Such significant airframe modifications resulted in each variant being re-designated so, for example, the F-8B became the F-8L (see table for full details), representing the third designation the Crusaders had held since being constructed.

Combat

The first operational deployment of the Crusader was in July 1958 to Lebanon when VF-32, flying F8U-2s (F-8C) from the USS Saratoga, supported a marine amphibious landing.

Below: Crusader 147060 was built as an F8U-2N and was later converted to F-8H standard. It served with VF-124 and VF-201 before being retired to the bone-yard in 1976. Two years later it was transferred to the Philippines as '305'

USN RF-8As from VFP-62, supported by additional USMC aircraft, were used extensively during the Cuban Missile Crisis in October 1962 to provide photographic evidence of the deployment of Soviet missiles and equipment, and their eventual withdrawal. These missions, codenamed Blue Moon, were extremely hazardous and were achieved by flying extremely low and at maximum speed. Flown mainly from land (NAS Key West), but also from carriers deployed in the region, they routed to Cuba and then into NAS Jacksonville where the film was processed. Over the course of the operation 160,000 images were obtained and all of the Navy and Marine pilots involved were decorated.

The F-8 made its most significant mark in air-to-air combat, first engaging with the enemy MiG-17s in April 1965. In the two-year period between 1966-68 Crusader pilots shot down 18 MiGs, adding one more in 1972, to finish with a kill-loss ratio of 6.3:1 – the best of any aircraft in the conflict. But, despite the 'gunfighter' tag, only two kills were scored solely with guns; in the modern dogfight the missile was now supreme.

French Navy

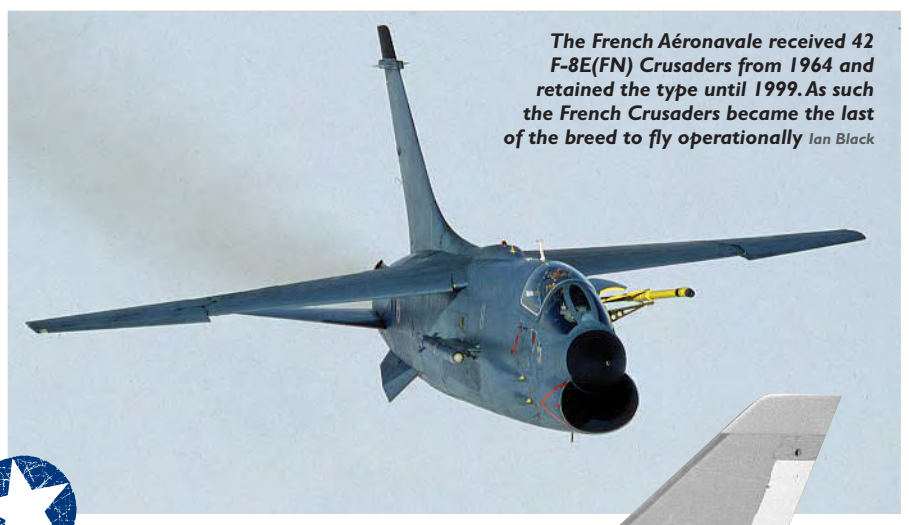
The Aéronavale was seeking a carrier-based fighter but the F-4 Phantom and similar types were too large and heavy. Following trials of the F-8 aboard the Clemenceau and Foch,

"Between 1966-68 Crusader pilots shot down 18 MiGs"

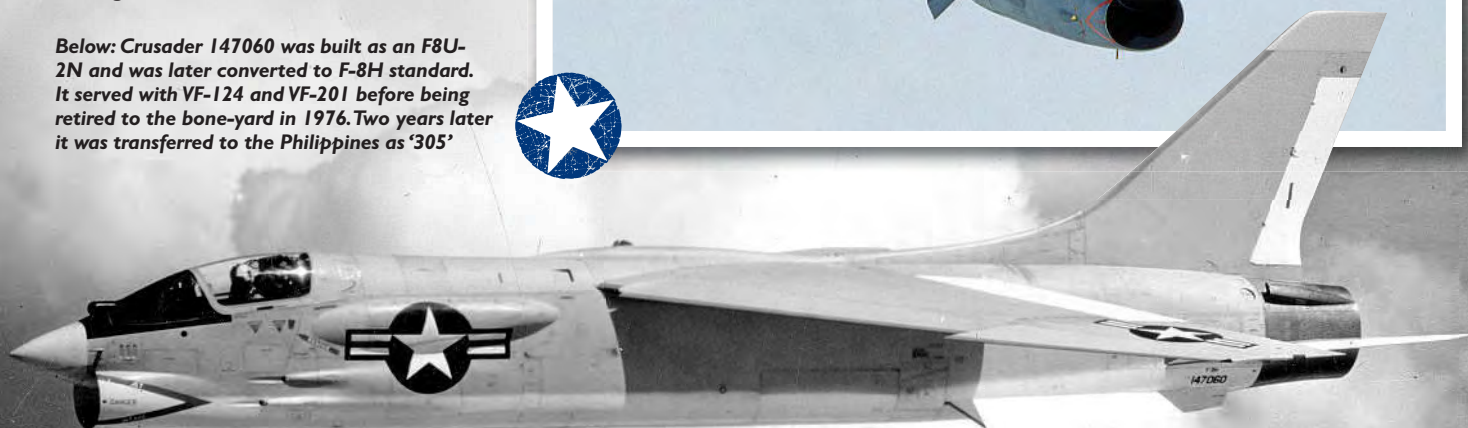
The conflict that saw the significant deployment of the Crusader was, of course, Vietnam. Nothing written in this short article can do justice to the trials and tribulations and achievements of those who flew and maintained the F-8 in that war. From 1964 until the end of the decade, the USN and USMC Crusaders comprised over half of the available carrier-based fighter aircraft in the Gulf of Tonkin. They were used for combat air patrols, photo-reconnaissance escorts, flak suppression, close air support, anti-shipping against Torpedo Boats and ground support – the latter flown from ships by the Navy and from land by the Marines.

the French ordered 40 single-seat and six twin-seat Crusaders in 1962, but when the trainer was cancelled by Vought the order was changed to 42 single-seat fighters. Designated the F-8E(FN), these were the last Crusaders to be built. Flotille 12F received its first aircraft in October 1964 and 14F in March 1965.

The minimum landing speed of 113kts was too high for the French carriers and work was undertaken to reduce it. An extensive revision of the wing included using including Boundary Layer Control (BLC) and extending and extending the droop of the leading edge slats to 44° inboard and 55° outboard, and the ailerons and flaps to 40°, thereby reducing the landing speed to 90kts.



The French Aéronavale received 42 F-8E(FN) Crusaders from 1964 and retained the type until 1999. As such the French Crusaders became the last of the breed to fly operationally Ian Black





F8U-2N Crusader 147055 joined VF-111 in 1962 and was later converted to F-8H standard. It was transferred to the Philippine Air Force in June 1978 as '324' and is seen here in Basa in November 1980 Adrian M Balch



In 1962 the prototype F8U-2NE was converted into the sole two-seater. Initially designated the F8U-1T and, unofficially, the 'Twosader', this was subsequently changed to TF-8A. It was destroyed after an engine failure on July 1978

The F-8E(FN) retained the four cannon but utilised French-made Matra missiles in place of the Sidewinders. Their exhaust initially caused damage to the stabilators, but this was solved by adding titanium strips to the leading edges.

The French aircraft received various updates including new wings in 1969 and then, in 1989, 17 Crusaders were refurbished to extend their operating life, designated by the French as the F-8P.

During their service French Crusaders undertook operational deployments to Djibouti (1974 and 1977), the Lebanon (1983), Libya (1984) and the former Yugoslavia (1993).

The Philippines

In the 1970s the Philippine Air Force was seeking to purchase new fighter aircraft and was offered refurbished Crusaders by the US Government as it was felt that more modern aircraft might prove too costly and complex to operate and maintain.

Vought was given the contract to refurbish 25 ex-USN F-8Hs taken from storage at Davis-Monthan AFB. They were delivered together with ten non-flying airframes for use as spares. Once these

spares were exhausted the Crusaders were grounded in 1988 and stored in the open air. However, when Mount Pinatubo erupted in 1991 they were irreparably damaged.

The deal also required the USA to train the pilots and so the twin-seat TF-8A was recalled from NASA, still resplendent in its blue and white scheme, to assist with this task. Unfortunately, in July 1978 it suffered engine failure near Dallas, Texas and the instructor and student ejected safely but the unique 'Twosader' was destroyed.

"Out of Fighters..."

The final front-line USMC F-8s were retired in 1969, to be followed by many of the USN Crusader fighter units. By 1972 just four squadrons remained to serve on until 1976. By the time they were done the fighter version had also retired from reserve units. All that remained were the Navy's photo-reconnaissance RF-8Gs which served on the front-line with VFP-63 until 1982 and with reserve units VFP306 until 1984 and VF-206 until March 1987. Elsewhere, the Philippines Air Force F-8s were grounded in 1988, but the French Navy kept a number in operational service until 1999.

Of the 1261 Crusaders which were manufactured, it is stated that over 1100 were involved in accidents or other incidents by the time it retired from service. These required over 700 pilots to eject from their aircraft and 186 lost their lives. Sadly, such losses of men and matériel were not unusual for the early days of military jet flying.

Despite this, the F-8 Crusader provided the USN with a quantum leap in abilities at a crucial time in the development of carrier-based jet aircraft and proved itself as the 'MiG Master' in a major conflict; it was regarded as an outstanding aircraft by those who flew and maintained it. ●

SPECIFICATION VOUGHT F8U-2NE (F-8E) CRUSADER



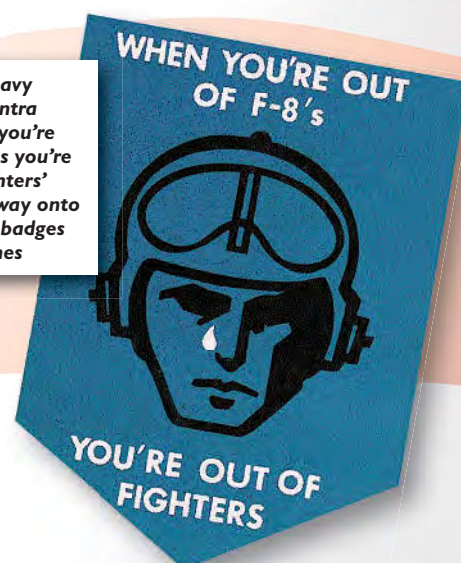
Crew	1
Length	54ft 3in (16.53m)
Height	15ft 9in (4.80m)
Wingspan	35ft 8in (10.87m)
Wing Area	375sq ft (34.8m ²)
Empty Weight	17,541lb (7,956kg)
Max Take-Off Weight	29,000lb (13,000kg)
Max Speed	1,065kts (1,225mph/1,975km/h)
Service Ceiling	58,000ft (17,700m)
Ferry Range	1,735 miles (730km)
Powerplant	One Pratt & Whitney J57-P-20A afterburning turbojet (18,000lb/thrust)
Armament	Four 20mm Colt Mk 12 cannons and hard four hardpoints for 4,000lbs of bombs, rockets or missiles
First Flight	March 25, 1955 (XF8U-1) June 1961 (XF8U-2NE)

Artwork: Andy Hay / www.flyingart.co.uk

Below: F8U-1E Crusader 145438, in the background, shows just how different the later XF8U-3 Crusader III (foreground) was to its earlier cousins. It was designed as a competitor to the F-4 Phantom II and although based on the Crusader it shared few of its parts. To deal with Mach 2-plus flight it was fitted with large vertical ventral fins under the tail which rotated to the horizontal position for landing



The US Navy pilots' mantra of 'When you're out of F-8s you're out of fighters' made its way onto countless badges and patches





French Crusaders were modified to reduce their landing speed to 90kts. This work included boundary layer control and extending the droop of the leading edge slats, trailing edge flaps and ailerons. Aéronavale F-8E(FN)s retained the four cannon but utilised French-made Matra missiles in place of the Sidewinders. In 1989 some 17 Crusaders were refurbished to extend their operating life, these designated by the French as the F-8P. During their service French Crusaders undertook operational deployments to Djibouti, the Lebanon, Libya and the former Yugoslavia *Ian Black*







WAIT, WAIT, WAIT... RUSH!

REPAINTING DUXFORD'S ONE ELEVEN

Restoring and repainting a large aircraft is always going to be a challenge when you're operating as a charity. However, the Duxford Aviation Society has just completed a rapid restoration of its BAC 1-11, as Steve Bridgewater reports

When British Airways BAC 1-11 G-AVMU made its final flight to Duxford on March 4, 1993 it had flown a total of 40,279 hours and made 45,540 landings. 'Mike Uniform' had been donated to the Duxford Aviation Society (DAS) and, resplendent in the markings of its last operator, it has spent the last 23 years on outside display at the Imperial War Museum's airfield.

Now, two decades on, it was time to bring her back to her former glory. The BAC 1-11 was one of Britain's more successful airliners of the period and the type served with countless airlines. As such, the choice of colour schemes available to DAS was vast but, as Chairman David Garside explains: "We returned G-AVMU to its British Airways Landor scheme partly because it was donated to us by them, partly because we think it looks good in that particular livery and partly because it is our only

British Airways aircraft. As such it brings DAS's British Airliner Collection up to date."

Renovation

British Airways generously donated some of the paint (both primer and grey) to the volunteer-led restoration but for health and safety reasons BA staff were not able to do the work using the DAS equipment.

The sheer size of the airliner meant that the only space available at Duxford to paint it was in the conservation area within the AirSpace hangar. However, this space is in great demand so the preparation and priming was conducted in the open air during the latter part of 2012.

"We had been anticipating access to the hangar during the winter of 2012/13"



Years of exposure to the weather and pollution from the nearby M11 motorway had taken their toll on G-AVMU's paint Steve Bridgewater

Taking pride of place on 'Airliner Row' at Duxford, G-AVMU now looks factory fresh once again. The aircraft was one of 18 BAC 1-11-510EDs ordered by BEA, the launch customer for the stretched Series 500. It made its maiden flight on January 19, 1969 and was operated by BEA and British Airways Steve Bridgewater





“The team was allocated a 10-day window at short notice”

and fin of the VC10 would be welcomed with open arms! Likewise anybody able to donate suitable paint would be a godsend. “During the coming summer we would like to at least repaint the upper fuselages of

explains David. “However, this didn’t prove possible due to other commitments but access was agreed for January 2014. Then, the hangar sustained storm damage over the winter and when the repairs were completed the area was fully booked with other events throughout the year. It was therefore January 2015 before access became possible again.”

Having waited patiently for their ‘slot’ in the conservation area the team looking after G-AVMU was allocated a 10-day window at short notice in January. It really was a case of wait, wait, wait... rush!

Volunteers

“With the cooperation of the IWM we put together a programme of work and a duty roster using DAS volunteers to paint the aircraft in the space of 10 days” continues David. “Thanks are due to Project Manager Chris Giles for his excellent organisation and to the volunteers themselves, who came when they said they would and worked extremely hard and with great professionalism.”

The paint was rolled on as there are no facilities in AirSpace for spraying and the final details (such as the ‘County of Dorset’ name) were hand painted or applied with decals. The aeroplane was rolled outside again on January 26 and is almost complete with just a few decals left to apply – and British Airways has promised to produce these on behalf of DAS in due course.

What’s next?

With the BAC 1-11 all but complete, what’s next for the DAS volunteers? “Our next priority is to repaint the Trident and VC10,” David reveals. “Hopefully we may gain access to AirSpace again, but that will not be until next January and in any case the VC10 will probably have to be repainted outside due to its size.

“In fact, any reader who is willing to provide and erect scaffolding to enable us to access and safely work on the tailplane

Above: Priming was undertaken outside and was completed in late 2012. Delays beyond the control of DAS meant it would be January 2015 before the aircraft was finished Steve Bridgewater



In just ten days G-AVMU was transformed back to her former glory by DAS volunteers





Above: For many visitors Air Fete provided a unique opportunity to see the resident Lockheed SR-71A Blackbird in person. The 1987 show included 64-17964 in the static park and 64-17973 in the flying display, both of which were from Det 4 of the 9th SRW. On May 24, 1987, just a day after the show, the pilot of 64-17973 overstressed the aircraft while on a mission. It recovered safely to Mildenhall and temporary repairs were needed before it was flown back to the USA for deep inspection on July 22. The aircraft never flew again



Right: The 1996 Air Fete included the unusual sight of a MiG-29 in formation with a pair of F-15 Eagles. The late '90s saw an influx of former Cold War foes to British airshows and the 1996 Air Fete included a pair of German MiG-29s and a pair of Slovakian Fulcrums – the latter including aircraft 0921 which is seen here with its American cousins

MEMORY LANE

Jets is all about rekindling the memories of days gone by. As part of this we're keen to hear from you and see the images filed away in your photo albums. This month, with the recent news that the USAF is to leave RAF Mildenhall, Mick Britton takes a nostalgic look back at the base's famous Air Fete airshows

Right: The flightline on the spectator side of the airfield was a unique feature at Air Fete and enabled photographers to capture aircraft being prepared for display, such as this Canadian CF-188 Hornet of 416 (Lynx) Sqn seen at the 1994 show



Below right: When 43 Sqn's Phantom FG.1 XV587/G appeared as the display spare at the 1985 Air Fete, it must have been one of the last examples still wearing the original tactical camouflage scheme. The aircraft survived until 1993, when it was eventually scrapped

Below: Hawk T.1A XX312, which attended the 1995 Air Fete, was 100 Sqn's flagship and was adorned with special markings. Of note is the centreline store, which was a device to increase the radar signature of this small aircraft for its target facilities role. XX312 was flown into storage at RAF Shawbury in May 2012



Right: This impressive static line-up of RAF fighters, headed by 151(R) Sqn Hawk T.1A was staged at Air Fete 1989 and also included 111(F) Sqn F-4 Phantom XV582 'Black Mike'. After retirement the Phantom was stored indoors at RAF Leuchars but the aircraft was disposed of late in 2014 and is believed to be destined for preservation at Bruntingthorpe, Leics

Below: Among the stars of the 1982 Air Fete was Lightning F.6 XS895 from 5 Sqn at RAF Binbrook. Unlike many of its brethren which found their way into museums after the type retired, XS895 was eventually destroyed on the Pendine Sands Range



Below: The 'I'll be Seeing You' nose-art on Boeing B-52H 60-0024 seems an apt sign-off for RAF Mildenhall. The aircraft, which was part of the 416th Bombardment Wing out of Griffiss AFB, New York is seen visiting the 1990 Air Fete, just five years before the 416th was disbanded as part of the post-Cold War drawdown. In the background can be seen some of the hundreds of buses which converged on Air Fete from all corners of the UK and beyond, attracting bus spotters to the gates of the base!



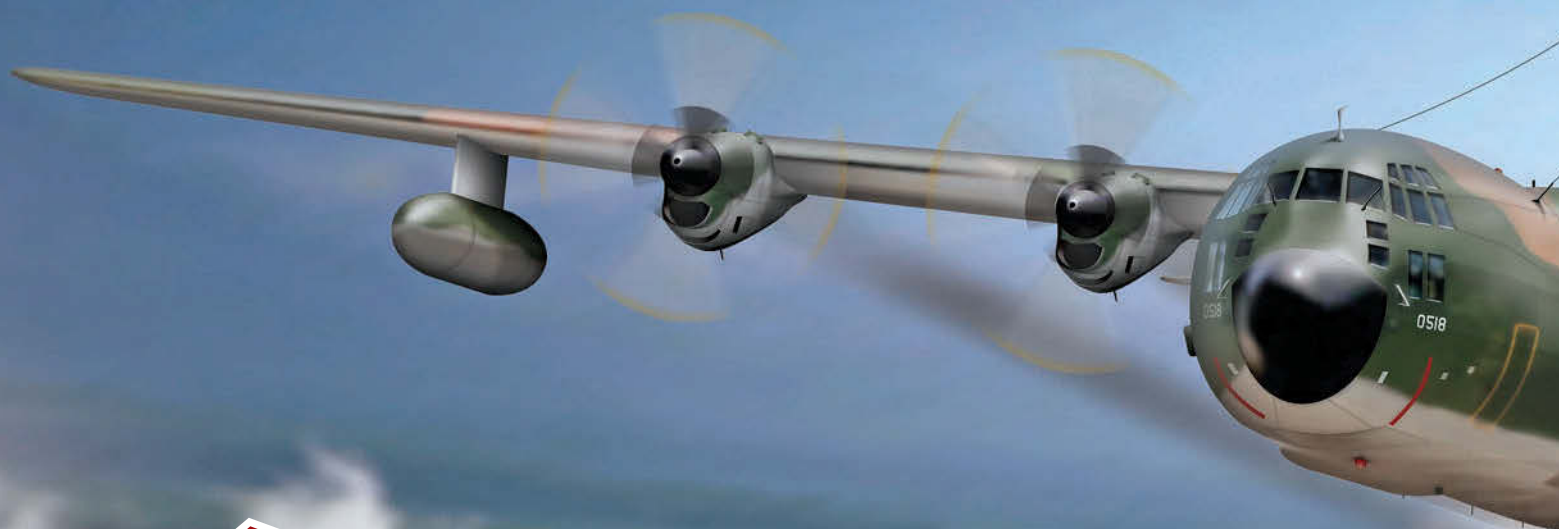
Below left: RAF Hawker Hunters were once a familiar sight at British airshows and Air Fete was no exception. In this case Hunter T.7 XL573 came from 237 OCU, where it was used to give Instrument Rating training to the unit's Buccaneer pilots. It is seen at Air Fete 1985. After retirement in 1994, XL573 was sold into private hands and became G-BVGH. It is now based at Exeter Airport

Above: Blackburn Buccaneer S.2 XV352/U was one of many recently returned Gulf War veterans on display at Air Fete 1991. The Buccaneer, like the majority of Gulf War aircraft exhibits, appeared complete with weathered desert camouflage mission marks and nose art. XV352 was named Tamdhu in honour of a Speyside malt whiskey! The aircraft was retired in 1994 and scrapped four years later although her nose section is preserved in the museum at the former RAF Manston

Left: 1990 saw a number of RAF squadrons celebrating their 75th anniversaries by applying special paint schemes. Air Fete 1990 included the all black Tornado GR.1 ZA591 from 16 Sqn. The squadron had formed in 1915 and served for much of World War Two as a reconnaissance unit. Post war, it was disbanded and reformed several times as a fighter and bomber squadron using Vampires, Venoms, Canberras and Buccaneers. It received the Tornado in 1984 and used it until 1991 when it received the Jaguar. Today it flies the Grob Tutor at RAF Cranwell



Right: Another special-schemed jet at the 1995 Air Fete was 360 Sqn's Canberra T.17 WD955. It marked the unit's final appearance at the show, as the RAF Wyton unit was disbanded shortly after. Today, WD955 is preserved at the Norsk Luftfartsmuseum in Bodo, Norway



SAIGON EVACUATION

*The fall of the capital of South Vietnam in 1975 led to an unprecedented evacuation. **Tom Pierce** looks at an incredible sortie that resulted in hundreds of desperate people cramming into a single C-130 Hercules!*

On April 30, 1975 the city of Saigon, the capital of South Vietnam, was captured by soldiers from the People's Army of Vietnam and the so-called Viet Cong (the National Liberation Front of South Vietnam).

By mid-afternoon North Vietnamese troops had raised their flag over the South Vietnamese presidential palace and the government had capitulated.

The move brought to an end the 19-year-long Vietnam War but it also resulted in a mass exodus of refugees.

With the writing on the wall, the evacuation of almost all the American civilian and military personnel in Saigon, along with tens of thousands of 'at risk' South Vietnamese civilians began in the weeks running up to the attack.

From late March the US Embassy began

to reduce the number of US citizens in Vietnam and all dependents and non-essential personnel were encouraged to leave the country either by commercial flights or the USAF's Military Airlift Command (MAC) Lockheed C-141 Starlifters and Lockheed C-5 Galaxy aircraft.

Tragedy strikes

On April 4, a C-5A crashed while carrying 250 Vietnamese orphans and their escorts – 153 of whom were killed. The tragedy led to the Galaxy fleet being grounded and MAC being restricted to just Starlifters and the smaller C-130 Hercules.

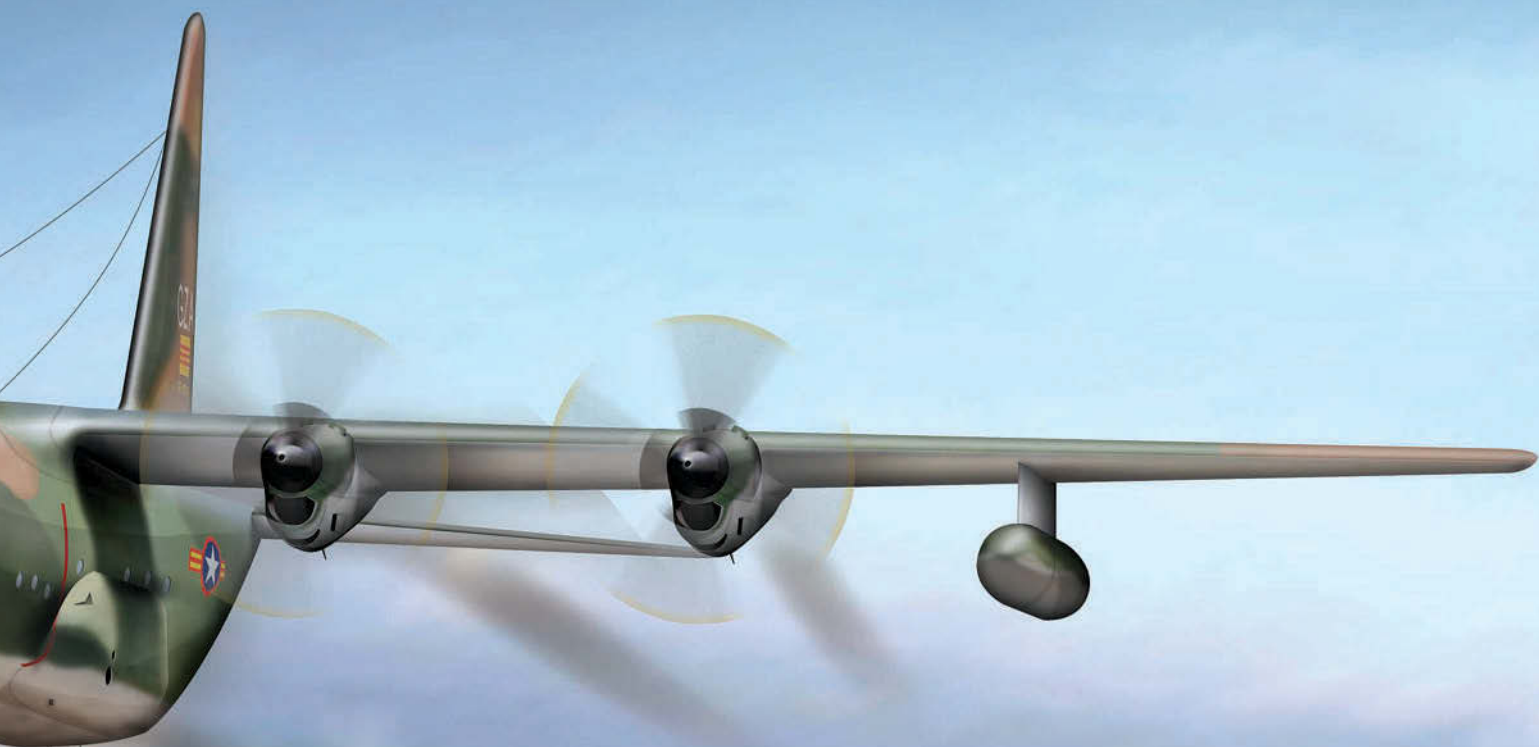
Procedures meant each evacuee needed a seat and a seatbelt so, rather than filling the capacious cargo holds, each C-141 was limited to 94 passengers and each Hercules would carry 75.

Commercial carriers also continued to fly out of Tan Son Nhut Airport, but with decreasing frequency and on April 25 the FAA banned them completely. However, the on-going fall of cities across South Vietnam led to ever-greater numbers of desperate evacuees searching for a flight to safety.

Lifting the limit

By now 20 Starlifter and 20 C-130 flights per day were flying from the city to Clark AFB on Guam. Furthermore, the earlier limits had been lifted and Starlifters were flying with up to 316 evacuees and the Hercules were often carrying more than 240.

On April 27, North Vietnamese rockets hit Saigon for the first time and it was decided to restrict evacuation flights to the more manoeuvrable C-130s. A day later three Vietnamese People's Air Force Cessna



A-37 Dragonflies bombed Tan Son Nhut Airport, destroying several aircraft.

Attacks continued through the night and a decision was made to increase movements the following day to evacuate 10,000 people.

Rocket attack

At 03.30 on April 29, a rocket hit a guard post on the airfield, killing Marine Corporals McMahon and Judge. They were the last American ground casualties in Vietnam. Half an hour later C-130E Hercules 72-1297 was destroyed by a rocket while taxiing to pick up refugees. The crew, from the USAF's 776th Tactical Airlift Squadron, evacuated the burning aircraft on the taxiway and immediately climbed aboard a neighbouring C-130A.

Record breaker

That C-130A was 56-0518, the 126th Hercules built, and it had joined the USAF inventory on August 23, 1957. In November 1972 it had been given to the South Vietnamese Air Force as part of the Military Assistance Programme and now it found itself at the centre of a warzone.

By the small hours of April 29 more than 100 aircraft had been destroyed on the flightline at Tan Son Nhut, many of which were still burning, and 56-0518 was one of the last flyable C-130s.

As the crew of the recently damaged C-130E ran aboard their rescue craft, their eyes fell upon an amazing sight. Here, packed tightly into the cargo hold, were hundreds of panicked South Vietnamese for whom the aircraft represented a final ticket to freedom.

There were so many people aboard the 'Herc' that the loadmaster could not close the rear cargo ramp but the pilot, Major Phuong, had a brainwave. He slowly began to taxi forward and then hit the brakes, causing the passengers to fall forward off of the ramp, which could then be closed!

The aircraft taxied straight out and set off down the 9,000ft runway. Unsurprisingly it took every inch of the tarmac plus all the available 1,000ft overrun to get airborne and later calculations revealed 56-0518 was at least 20,200lbs overweight. The C-130 stayed in ground effect until it gained enough speed to begin a shallow climb.

It should have taken 80 minutes to reach their destination at U Tapao in Thailand but after 90 minutes it became evident that the crew was lost. A map was finally located and they realised they were over the Gulf of Slam. Three and a half hours later they finally landed!

The crew taxied in at U Tapao and witnesses looked on in shock as 452 people disembarked from the aircraft – 33 of whom had been in the cockpit alone! A C-130 had never before carried so many passengers, and has never done since.

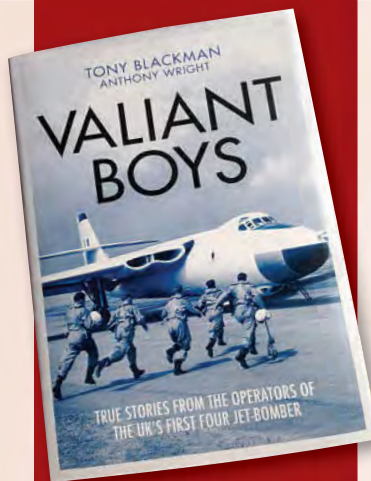
Hercules 56-0518 had been the last fixed wing aircraft to escape Saigon and at 07.00 on April 29 Operation Frequent Wind, the largest helicopter evacuation of all time commenced. Over the next 48 hours more than 7,000 personnel would be helicoptered out to US warships anchored off Vung Tao.

Survivor

Major Phuong's Hercules was later returned to the USAF and assigned to various Air National Guard units until it was retired in June 1989. Thankfully it was selected for preservation and can now be found on display at Little Rock AFB in Arkansas.

Testing Times

The team puts the latest jet-related products to the test



BOOK

Valiant Boys: True Stories from Operators of the UK's First Four-Jet Bomber

Tony Blackman & Anthony Wright
Grub Street
192 pages, hardback,
B&W & colour
ISBN 9781909808218
£20.00

After *Lightning Boys* (1 & 2), *Vulcan*, *Hunter*, *Buccaneer*, *Victor* & *Jaguar Boys*, where next for the series offering genuine insight into squadron life?

Well, the Vickers Valiant, so often an unsung member of the V-Force, is the latest aircraft to receive the treatment and join the 'Boys' franchise.

Following on from the success of his *Victor Boys* and *Vulcan Boys* books, Tony Blackman is the perfect author to complete the V-Force trilogy. Once again the book is a fascinating collection of personal accounts by aircrew and ground crew and tells the story from the aircraft's birth to its premature death from fatigue. There are tales of testing atom bombs in the Australian desert, dropping hydrogen bombs in the middle of the Pacific and, as a complete contrast, attacking airfields with conventional bombs in Egypt during the very brief and abortive Suez campaign.

BOOK

Hawker Siddeley Aviation and Dynamics 1960-77

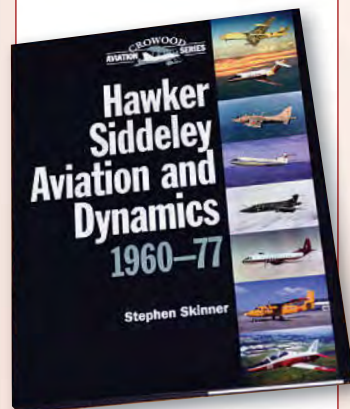
Stephen Skinner
Crowood Press
208 pages, hardback,
B&W & colour
ISBN 9781847977397
£29.95

Hawker Siddeley's history can be traced back to 1912 and the formation of the Sopwith Aviation Company by Tom Sopwith, which metamorphosed into Hawker Aircraft after World War One. During 1934-35, Gloster, Avro, Armstrong Siddeley, Armstrong Whitworth and others were taken over to create the Hawker Siddeley Group.

Hawker Siddeley would go on to produce some of the most important aircraft and missiles of the *Jets* era, including the Harrier, Buccaneer, Nimrod and Hawk as well as the Sea Dart missile and HS748 airliner. Its collaborative projects included the European Airbus and various satellite programmes.

Hawker Siddeley was subsumed into British Aerospace in 1977, but some of its products still remain in service to this day. This is their story as well as that of the 'legacy' aircraft the group took over post-war.

The development and history of each type is discussed in detail and the book is copiously illustrated with 220 colour photographs and 85 black & white images.



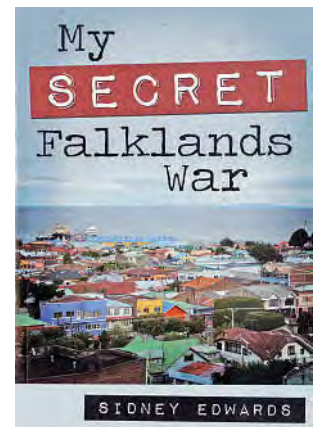
BOOK

My Secret Falklands War

Sidney Edwards
The Book Guild
96 pages, hardback,
B&W & colour
ISBN 9781909716278
£7.99

A former fighter pilot, fluent in Spanish and with Diplomatic and Intelligence experience, Wg Cdr Edwards was peacefully mowing his lawn on Easter Sunday, April 1982, a week after Argentina's attack on the Falklands, when he was summoned to RAF Northwood, the Joint Forces HQ for the UK's operation to retake the Falklands.

Given a comprehensive briefing on the situation in the Falklands and in Argentina, he was told that he would shortly be deployed on covert duties in Chile to act as a direct link with the military. Such was the secrecy that he was unable to tell his wife where he was going. On arrival in Santiago, he was soon involved at a high level with Chilean Air Force Generals and their Intelligence Officers. It was explained that it was not in Chile's interests should Argentina beat Britain as it was felt that Chile would be next attacked



over a long-standing dispute covering southern territory.

Arrangements were made for ELINT Nimrods to use Chile's San Felix Island, and also to use Concepción at night when public access was restricted. All this took place in great secrecy with an almost James Bond air, and the author tells his most interesting story convincingly. Maps show Chile's peculiar shape, with the north large but tapering right down to the foot of South America with its borders with Argentina.

A fascinating look at behind the scenes activity during the Falklands War at a bargain price.

BOOK

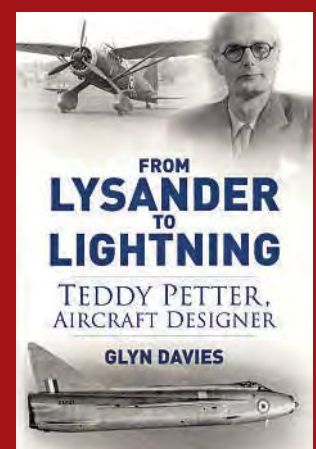
From Lysander to Lightning

Glyn Davies
The History Press
160 pages, softback,
B&W & colour
ISBN 9780752492117
£14.99

The biography of Teddy Petter looks at the aircraft he was involved in designing, ranging from the World War Two Westland Lysander, Welkin and Whirlwind through to iconic jets including the English Electric Canberra and Lightning and Folland Gnat and Midge.

Petter joined Westland in 1929 at the age of 21 as a graduate apprentice and the company's chief test pilot, Harald Penrose, tried to get him interested in flying but found his judgement

hopeless. However, on the design side Petter became successful. Most who worked with him found it difficult at times, but there is no doubting his genius. An interesting study of a great designer.



BOOK

Blue Diamonds: The Exploits of 14 Squadron RAF 1945-2015

Michael Napier
Pen & Sword
324 pages, hardback,
B&W & colour
ISBN 9781473823273
£25.00

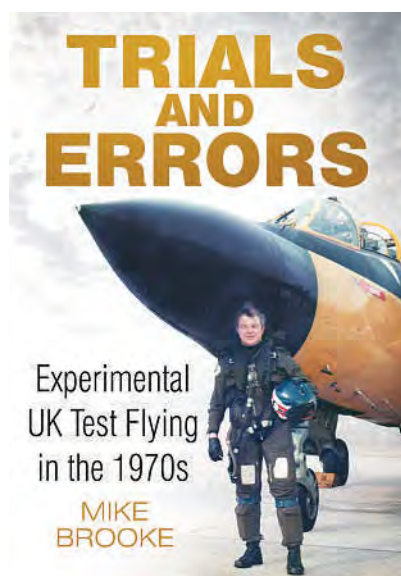
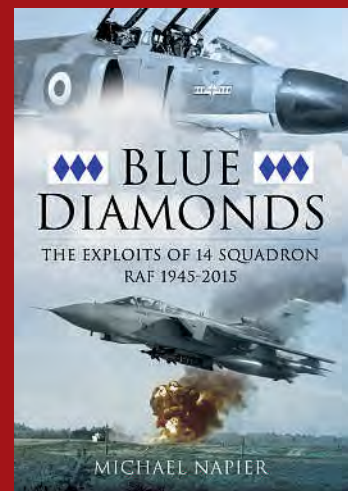
In the seven decades since World War Two, the RAF's 14 Squadron has operated a wide array of aircraft types (Mosquitos, Vampires, Venoms, Hunters, Canberras, Phantoms, Jaguars and Tornados) in a fascinating variety of roles. For

much of this time, the squadron was based in Germany at the front line of the Cold War, but it also participated in the Gulf War in 1991, in operations over Iraq from 1991-2009, in the Kosovo conflict in 2000 and latterly during the war in Afghanistan, initially with the Tornado GR4 and then with the Shadow R1. Today the squadron operates in great secrecy in an Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR) role.

Having had access to log-books, contemporary diaries, maps and photographs, as

well as oral and written accounts from a large number of ex-squadron members, Michael Napier has been able to produce as complete an account as is presently possible of 14 Squadron's operational history in the second half of the twentieth century and the opening years of the twenty-first.

It is an engaging read and liberally illustrated with archive images of people, 'planes and places. There is also a selection of well produced colour side-view illustrations of the types operated by the squadron over the period.



BOOK

Trials and Errors: Experimental UK Test Flying in the 1970s

Mike Brooke
The History Press
192 pages, paperback, B&W & colour
ISBN 9780750961608
£14.99

This book really offers a behind the scenes look at the inside story of an RAF test pilot.

Mike Brooke's successful RAF career had taken him from Cold War Canberra pilot to flying instructor at the Central Flying School in the 1970s. His next step was the demanding training regime at the UK's Empire Test Pilots' School. His goal: to become a fully qualified experimental test pilot.

Trials and Errors follows Mike's personal journey during five years of experimental test flying, during which time he flew a wide variety of aircraft for research and development trials. He later returned to ETPS to teach pilots from all over the world.

By the time Mike had finished he had been promoted to Wing Commander and took command of flying at RAE Farnborough. He retired with 7,300 flying hours on 140 types of aircraft of all classes except seaplanes.

This book is a sequel to Mike's previous titles *A Bucket of Sunshine* and *Follow Me Through*; it is an equally enjoyable read.

DVD

Royal International Air Tattoo Official 2014 Souvenir DVD

The Media Group
115 minutes, colour
£19.95

www.airtattooshop.com

If you're getting withdrawal symptoms from the British airshow season this winter there's no better way to prepare yourself for 2015 than to look back at the souvenir DVDs produced for some of last year's events.

Among the best on offer is the official film from the 2014 Royal International Air Tattoo at Fairford. The show included 224 aircraft from 32 air arms representing 26 nations.

Of course the Red Arrows' 50th display season is featured prominently but so are aircraft as diverse as the Airbus A400, Boeing Chinook, the Sukhoi Su-22 duo and the Estonian AF Aero L-39 Albatros.

A particular highlight of this DVD are the well produced interviews with crews and pilots of aircraft such as the Dutch F-16, Boeing Poseidon and the Red Arrows – the latter pleasingly covered by 'Red 1' Jim Turner and members of the ground crew who keep the team flying.

Much use is made of in-cockpit minicams (including the Su-22s!) and there is added bonus footage filmed during the arrivals and departures including rarities such as the Greek A-7 Corsairs that made their final RIAT appearance in 2014.

Sit back, turn up the heating, load the DVD and pretend you're back at a summer airshow!



BOOK

More vintage years of Airfix box art

Roy Cross,
Crowood Press,
128 pages, hardback, colour
ISBN 9781847978202
£35.00

Hands up who has ever constructed an Airfix model...? And how many readers didn't gaze longingly at the box art through shop windows in their younger years, counting their pocket money in the faint hope of affording the kit you'd been dreaming of for weeks?

The 1960s and early 1970s might be called the vintage years of Airfix, when some of their best and most popular kits were produced. For ten years up to 1974, renowned artist Roy Cross produced some of the stunning paintings that appear on the boxes of Airfix kits of the era. Roy set the standard for such artwork, to the extent that many are still used today, four decades later. Roy Cross's *The Vintage Years of Airfix Box Art* contained a host of the paintings he prepared for Airfix, but the unearthing of many more images in old Airfix files has enabled this entirely fresh look at Roy's work to be presented. Thus the remainder of Roy's ten years' work for Airfix is reproduced here. Some 180 of the iconic paintings are produced in this large format (280x305 mm) book and subjects such as the Vought A-7 Corsair, HS Kestrel, Folland Gnat, Super Mystere, Lockheed Tristar, Ilyushin Il-28 and BOAC 747 sit alongside earlier aircraft, ships and vehicles – including the Bond Bug.

This book has taken pride of place on the book shelves at *Jets Towers* – and not least because the editor's father was involved in the development and building of the Bond Bug!

Highly recommended.



GLOSTER'S E.1/44

THE GORMLESS ACE

*In the 1940s jet engines were a rare commodity and Gloster's E.1/44 was created as a single-engined alternative to its twin-jet Meteor. Although officially known as the 'Ace' the aircraft was dubbed the 'Gormless' by Gloster's Chief Test Pilot Bill Waterton. **Pete London** investigates why*

During June 1942 a meeting took place at the Air Ministry's Adastral House in Kingsway, London, convened mainly to examine delays in the Gloster Aircraft Company's emerging twin-jet fighter programme. Among those attending were representatives of the Ministry of Aircraft Production (MAP) and the Air Staff. But the meeting also agreed on the need for a separate single-engined jet-powered interceptor: a second project from Gloster, named the Ace.

The firm's first jet fighter, the Meteor, had been shaped in response to Specification F.9/40. Work on its initial powerplant, the W.2 series designed by Frank (later Sir Frank) Whittle and his small Power Jets company, encountered various technical problems; hardly surprising with such a truly ground-

breaking project. But delays were also caused by sub-contractor issues, and because some of Whittle's work was passed to the larger Rover Car Company. Rover's activities, intended to speed up the programme, dropped seriously behind schedule while without Whittle's permission, the company tampered with his engine's design.

Single Thrust

Despite the W.2's slow progress, and although the early turbojets' modest power output meant the Meteor needed two engines, Gloster believed future turbojets would be created of much greater thrust, allowing development of single-engined interceptors. During the spring of 1942 the company approached MAP with a proposal for a small single-engined jet fighter, partly

as a contingency against further setbacks in powering the Meteor, but with thoughts in mind too of the turbojet's potential.

MAP viewed Gloster's scheme enthusiastically. That summer the company received a draft of experimental Specification E.5/42, though the W.2 wasn't adopted. Stipulated instead was the jet engine being developed by de Havilland: the H.1, designed by Frank Halford.

By late 1942 the W.2 was still only available in ground-only form; the first flight of a W.2-powered Meteor (DG205/G) eventually took place on June 12, 1943. But by then too, the de Havilland Engine Company's progress with their own jet engine had been such that Meteor DG206/G, H.1-powered, was approaching flight readiness. In January 1943 Contract

Main: Ace TX148 presents its plan view, showing the tapered lines of its wingform as well as the later tailplane, together with a somewhat tubby fuselage

Right: Gloster's Canadian test pilot Bill Waterton carried out the E.1/44's maiden flight but disliked the aircraft, dubbing it the 'Gormless'



SB.26736/C.23a placed with Gloster identified three single-engined H.I.-powered jet prototypes to E.5/42, serialled NN648, NN651 and NN655; the mature Specification was issued during March.

Priorities

George Carter, Gloster's Chief Designer since 1937, took overall charge of the project. For a time though MAP feared effort diverted to the E.5/42 aircraft might delay the Meteor programme; Gloster's design office resource had previously come under scrutiny. MAP felt Armstrong Whitworth might be recruited for detail work on E.5/42 but Gloster aggressively resisted the idea, pointing out that in terms of jet aircraft expertise they were way ahead of other British manufacturers. In the face of such vigorous opposition MAP withdrew its scheme and Gloster continued with both designs.

As it turned out, following the take-over of Rover's engine work by Rolls-Royce at the end of 1942, W.2 development picked up momentum. Earlier fears felt by some in MAP of having to cancel the entire Meteor programme fortunately receded. The first production Meteor F.1s arrived with No.616 Squadron during July 1944.

In the meantime Gloster had pressed on too with their de Havilland-powered jet. The project started life at the company's Bentham site, a short distance from its Hucclecote

base in Gloucestershire. Early in 1943 Gloster produced figures indicating an estimated service ceiling of at least 48,000ft, and a top speed exceeding 426kts at 30,000ft. A pressurised cockpit would be fitted while projected armament at that time consisted of two 20mm cannon with provision for two more, all positioned beneath the nose. Royal Aircraft Establishment at Farnborough assisted with wind-tunnel testing of a 1:4.5 model of the design, results of which were generally favourable.

Tinkering and Revisions

However, progress toward a first flight was slow. The programme was constantly afflicted by amendments and revisions, as copious

altered type, under the new Specification E.1/44 against Operational Requirement OR.157. Top speed required increased to 560 mph at all heights up to 30,000ft, while the height at which rate of climb became under 1,000ft/min was to be not less than 45,000ft.

For the pilot's protection a bullet-proof windscreen and armour "against German 20mm armour-piercing ammunition ... at a range of 100 yards" were to be provided. Armament was set as four 20mm Hispano Mk.V cannon with a total of 760 rounds. Endurance at economical cruising speed and 30,000ft was to be a minimum of 2 hours.

The powerplant specified was de Havilland's H.2 engine, developed from the H.1, for which Gloster was to assume

"It proved impossible to alter the airframes any further"

refinements were explored and some incorporated. To an extent this was unavoidable; the revolutionary technology of course subject to change. But as the vital Meteor became stable and its production ramped up, perhaps too there was a temptation at Gloster to tinker with the less urgent E.5/42.

By mid-1944 the aircraft had changed vastly from its original form. During May MAP reissued the requirement to reflect the

a maximum power at sea level of 4,000lb/thrust. One airframe was to be fitted with provision for automatic observer and performance-measuring equipment. With the three original aircraft cancelled, the revised examples received new serials (SM801, SM805 and SM809); they were ordered under Contract SB.27324/C.23a.

Since the time of Gloster's original E.5/42 design, Rolls-Royce too had been busy. Under



The E.1/44 displays its wide-track undercarriage in a head-on view at Moreton Valance in 1948

Rolls the W.2 engine morphed into the Derwent, while the company began designing its RB.40 centrifugal turbojet intended to produce 4,000lb thrust. Remarkably quickly Rolls also developed a follow-on engine: the RB.41, later named the Nene, for which first bench runs took place in October 1944. The Nene soon reached 3,000lb/thrust and eventually achieved more than 5,000lb/thrust.

GA.2 Ace

Gloster replaced the E.5/42's H.2 engine with the RB.41. Their new aeroplane's nomenclature, formerly company designation P.190, became the GA.1 in line with SBAC practice. It also acquired the name 'Ace', though this doesn't seem to have been used officially. As the programme continued though, so too did the mass of modifications being introduced; finally it proved impossible to alter the airframes any further: SM801 and SM805, partly-completed, were halted and later abandoned. The third airframe, SM809, became the first GA.2; its build began toward the end of 1944.

In January 1945, again Gloster received an amended contract; that time for three additional GA.2 aircraft: TX145, TX148 and TX150. All would be fitted with the Nene RN.2, and incorporate the design amendments accumulated under the previous iteration. The

Top left: The first Ace to see the light of day was SM809, which was rolled out in July 1947, here revealing its patchwork rear end and the design's original rudder configuration. The aircraft never flew as it was involved in a road accident while being transported to Boscombe Down

Top right: Ace TX145 at Moreton Valance, seen with a modified rudder and a rather smarter scheme than its unfortunate predecessor

following year two large pre-production Ace orders dated April 29 and July 2 were placed for batches of 20 aircraft serialised VP601-VP620 and VR164-VR183 respectively, against Contract ACFT/117/CB.7(c). These examples were referred to as the GA.4. But the buyer – by then the Ministry of Supply (MoS) – seems to have been muddled in its thinking; the second order was cancelled less than a month following award.

RAE Farnborough continued its assistance with wind-tunnel testing, using both models and full-size assemblies. Early in 1945 the Ace's longitudinal and directional characteristics were explored with five variations of thrust spoilers in the jet-pipe nozzle. The deviations in stability and trim caused by the changes were considered small. To assess the effects of adding underwing fuel tanks and stores, a 1:4.5 scale model was again employed, and once more the conclusions were favourable. Following the

decision to change the engine, Farnborough also helped evaluate the GA.2's revised intake ducts. Ditching characteristics too were examined, and it was found that in model form the Ace behaved more favourably than many piston-engined fighters.

Final Design

But it was July 1947 before the first GA.2, SM809, finally appeared. Perhaps this bears out the concerns over Gloster's available development resource; maybe too, in the post-war world and with the Meteor so dominant within the company, impetus simply dropped away from the Ace programme. SM809 was rolled out to the Ministry's cameraman wearing a particularly messy look, painted in various patches of different-coloured primer and with no markings.

The Ace's overall structure was of light alloy and stressed skin, though parts of the wing were of steel. The fuselage was constructed from five sections: nose, cockpit, centre, aft and tailcone portions. This approach was intended to allow sub-contract modular production. Within the nose area were the camera-gun, main electrical panel, nosewheel bay and provision for the four-cannon fixed armament. Ammunition was stored in bays either side of the cockpit. In the upper

equipment area forward of the cockpit were accumulators and the VHF radio.

The cockpit glassware consisted of a three-panel armoured windscreen using flat sheets, with an electrically-operated aft-sliding and jettisonable bubble hood. A spade-grip control column was fitted and all controls were manual, actuated using push/pull rods; no ejection seat was installed. Below the cockpit aft of the pilot were the jet intakes, their profiles referred to in the aviation press variously as cheek, nostril and more prosaically, semi-circular.

“SM809 was rolled out wearing a particularly messy look”

Behind the pilot, between the two air intake pipes leading to the Nene was the main fuel tank. Further tanks were located in the centre section and fuselage sides around the aft of the engine. Access to the main tank was through a removable circular panel in the upper fuselage decking, behind the cockpit. Total fuel capacity was 428 Imp Gal, which it was planned could be augmented by underwing 100 Imp Gal drop-tanks.

The fuselage centre section was arranged around reinforced frames, to which the nose and cockpit sections were secured using four longeron attachment points. Here too the Nene was positioned, accessed through a substantial dorsal panel. The rear fuselage and jet pipe area, of semi-monocoque arrangement, were riveted to the centre section.

Wings and Tail

The Ace's unswept but tapered mid-set wings were constructed in four sections, two inner and two outer, based around a high-tensile steel central main spar, aft of which was an alloy auxiliary spar. Closely-spaced ribs were employed, while a stainless steel skin was adopted back across the wing to the web aft of the main spar. The remaining skin was light alloy.

Flaps and ailerons were attached to the rear spar, the ailerons equipped with spring tabs, while vented airbrakes were fitted together with underwing dive recovery flaps. The main members of the tricycle undercarriage, hydraulically-operated and inward-retracting, had a noticeably wide

gait while the non-steerable but castoring nosewheel retracted aft. All three units employed Dowty oleo-pneumatic shock absorbers with Dunlop pneumatic brakes.

Fin and tailplane construction was mostly light alloy, but the fin's upper portion was of wood to insulate the VHF surface aerial. The rudder was fitted with a mass-balance, while the fuselage-mounted tailplane employed no dihedral; elevators were equipped with spring tabs. Aft of the rudder protruded an anti-spin parachute container; the parachute opened and jettisoned electrically.

‘Gormless’

In preparation for its first flight, toward the end of July 1947 SM809 was dispatched by Queen Mary-type transporter vehicle to Aircraft and Armament Experimental Establishment (A&AEE) Boscombe Down. But during the journey catastrophe struck when the trailer jack-knifed, and the Ace was badly damaged; subsequently it was written off.

With SM809 gone, perhaps the second aircraft was completed faster than might otherwise have been the case. Unfortunately though, taxiing trials in September 1947 with

Gloster's test pilot, Squadron Leader William Arthur 'Bill' Waterton, revealed a nose-wheel wobble which made TX145 oscillate from side to side. While in the workshop to cure the shimmy a fault was found in the undercarriage mechanism, which having retracted the main wheels could have caused an inability to lower them. By February 1948 TX145 was taxiing once again but Waterton took a dislike to the aircraft, later assessing it as lethargic and dubbing it the 'Gormless'.

During March the second Ace arrived safely at Boscombe, wearing an overall silver scheme apart from which its only visible difference from SM809 was the absence of a rudder horn balance.

Test Trials

TX145 first flew on March 9, 1948, piloted by Waterton, the first time he'd flown a brand-new prototype. It was a short flight; the red warning light for the starboard main undercarriage came on, indicating it hadn't properly retracted.

Waterton rocked his aircraft to try to free up the leg and get all three members down; the light stayed on. Boscombe's tower advised that through binoculars it appeared the undercarriage was fully lowered. Noting the lack of asymmetric drag Waterton gingerly brought the Ace in; as he touched down, the light turned green and he rolled

Ace TX148 accompanies Gloster's prototype Meteor F.8 VT150 on a photoshoot, summer 1949. The common tail arrangements of the two aircraft are clear via Pete London



Ace TX145 taxiing in after a sortie at Moreton Valance, with its cockpit hood slid aft



The diminutive Ace was a pretty aeroplane but lacked performance and the ability to evolve



TX148 displays the modified anti-spin parachute container which extended aft of the tail pipe

safely to a stop. The wheel had been down all the time, the only fault in the light's circuitry.

Subsequent early flights examined performance; top speed came out at around 539kts while the rate of climb was deemed acceptable. The cockpit hood jettison system was assessed in Boscombe's blower tunnel, before TX145 returned for minor modifications to Gloster at Moreton Valance, the ex-RAF airfield south of Hucclecote used since 1943 for Meteor flying.

But handling problems emerged caused by the Ace's tail configuration, particularly turbulence around its tailplane. Wind-tunnel tests of a new tail layout were conducted at

arrangement; it was subsequently adopted for the F.8 and other variants.

Already Obsolete?

But what of the Ace itself? Its performance was found to be not significantly better than that of the later Meteors: less than 35kts faster at sea level; initial rate of climb slower than the fighter versions; service ceiling around the same. Back in 1946 Gloster had suggested the Ace could be re-engined with Rolls-Royce's AJ.65 (later the Avon) as their Project P.199, which would have improved matters; however, it was concluded the adaptive work would be too great and the idea had withered.

"In development terms the Ace was virtually sterile"

Farnborough, the revised assembly consisting of a taller fin on which the tailplane was mounted, a bullet fairing smoothing the fin/tailplane junction. Test results were excellent and the new tail was cut into the third GA.2, TX148, then being built.

By January 1949 TX148 was complete and later that year made its maiden flight from Boscombe, featuring somewhat enlarged air intakes and a bigger anti-spin parachute container which protruded over the jet pipe. Its altered tail configuration was so successful that it was taken up by the Ace's older brother. Reconfigured Meteor F.4 trials aircraft RA382 tested the

A greater disadvantage though lay in its lack of potential; while the Meteor adapted and grew to meet many roles, in development terms the Ace was virtually sterile. Under Specification E.23/46 a modest effort was begun to expand its capabilities, with the addition of a small bomb load, but the work doesn't seem to have progressed far. Adding to its woes, by the time the Ace finally appeared jet fighter airframe technology had moved ahead in leaps and bounds.

During December 1949 TX145 was transferred to RAE Farnborough. By then the remaining pre-production order had long been cancelled. TX148 arrived at

Farnborough two months later and both Aces were used by RAE for trials, including assessments of various flying control systems and runway braking-parachute development.

Fame and Misfortune

For TX145, a diversion took place with a cameo appearance in the film *No Highway*, which starred James Stewart and Marlene Dietrich. Released in 1951, the movie's plot centred on feared structural deficiencies of the fictitious 'Rutland Reindeer', a large piston-engined airliner, and attempts to solve its problems by eccentric boffin Stewart. After its brief foray into cinema, TX145 returned to Farnborough.

TX150, the fourth GA.2, received the revised designation GA.3 after plans were made for it to receive a de Havilland Ghost. However, the aircraft was never completed and work stopped at the end of 1949. Instead it was used for structural tests, and eventually found its way to the College of Aeronautics at Cranfield.

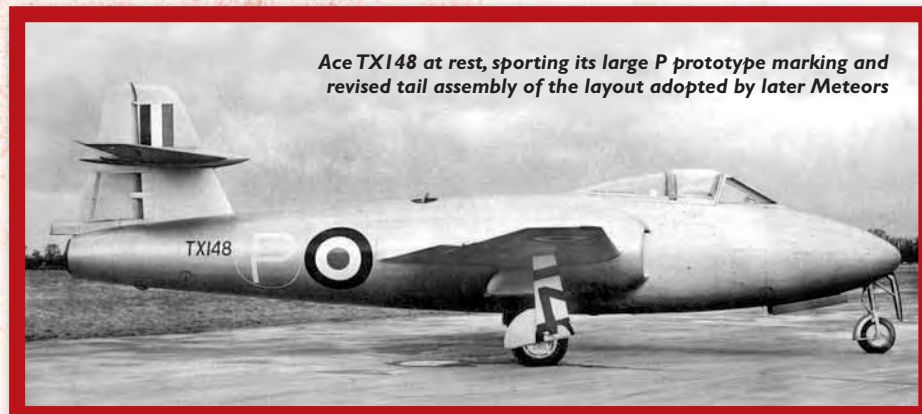
During November 1950 TX145 suffered a flame-out at Farnborough and in the resultant landing sustained minor damage; repaired, two months later it developed a nosewheel fault and along with TX148 fell into disuse. Finally, in September 1951 both aircraft were dispatched to the Proof and Experimental Establishment (P&EE) at Shoeburyness in Essex, where they were subsequently destroyed by gunfire. TX150, no longer wanted by Cranfield, was scrapped during 1956. ●

SPECIFICATION GLOSTER E.1/44 ACE



Crew	1
Length	38ft 0in (11.59m)
Height	11ft 8in (3.56m) [TX148 = 12ft 1in / 3.68m]
Wingspan	36ft 0in (10.98m) [TX148 = 38ft 11in / 11.86m]
Wing area	254sq ft (23.60m ²)
Empty Weight	8,260lb (3,755kg)
Max Take-Off Weight	11,470lb (5,214kg)
Max Cruise Speed	539kts (620mph/998km/h)
Ferry Range	410 miles (660km)
Service Ceiling	44,000ft (13,400m)
Powerplant One Rolls-Royce Nene RN.2 centrifugal turbojet (5,000lb/thrust)	
Armament	Four 20mm Hispano cannon
First Flight	March 9, 1948

Artwork: Andy Hay / www.flyingart.co.uk



Ace TX148 at rest, sporting its large P prototype marking and revised tail assembly of the layout adopted by later Meteors

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MIXED POWER PIONEERS

The woeful performance of the earliest jet engines initially led aircraft manufacturers to team them with piston powerplants. However, the age of the mixed-power fighter was short lived, as Kimberley Hawkins reveals

The first generation of jet engines offered the opportunity to revolutionise flight, but development was slow. Turbojet powerplants tended to burn a great deal of fuel and although they had comparatively high levels of power during high-speed flight, their acceleration was poor. As a result, take-off distances were long and this was a particular problem for naval aviators, for whom carrier operations dictated the length of runway available.

Fireball

The US Navy was the first to experiment with mixed-power aircraft, with a 'conventional' piston engine to provide

acceleration and a jet engine to provide thrust during the cruise and combat.

The Ryan FR-1 Fireball [see *Jets*, May/Jun 2014 pp72-73] was the first to be ordered and 66 were delivered by the end of 1945. However, the aircraft's top speed was no better than the best piston fighters of the era and the Navy soon began the hunt for a replacement.

American Goblin

This time they approached Curtiss, which had produced the successful Helldiver dive-bomber for the service.

The New York manufacturer set about designing a large aircraft, which it hoped would become the fastest fighter of its era. Dubbed the XF15C, the new design

combined a 2,100hp Pratt & Whitney R-2800 18-cylinder two-row radial engine with a 2,700lb/thrust Allis-Chalmers J36 turbojet.

The J36 was a licence-produced version of the British de Havilland H1-B Goblin, as used in the early Vampire fighter. Designed by Frank Halford, the Goblin also powered the Saab 21R, Fiat G.80 and de Havilland Swallow but Allis-Chalmers had been contracted to produce the engine for the Lockheed P-80 Shooting Star. Ultimately, the Allison J33 (based on Whittle's W.1 engine) was chosen for the P-80, after Allis-Chalmers ran into lengthy delays.

Mixed Power

In the XF15C the Allis-Chalmers J36 was mounted just behind the wing, with the

With its prominent air intakes atop the rear fuselage, the first XP-81 poses for the camera after its Rolls-Royce Merlin engine had been replaced by the turboprop for which it was first designed

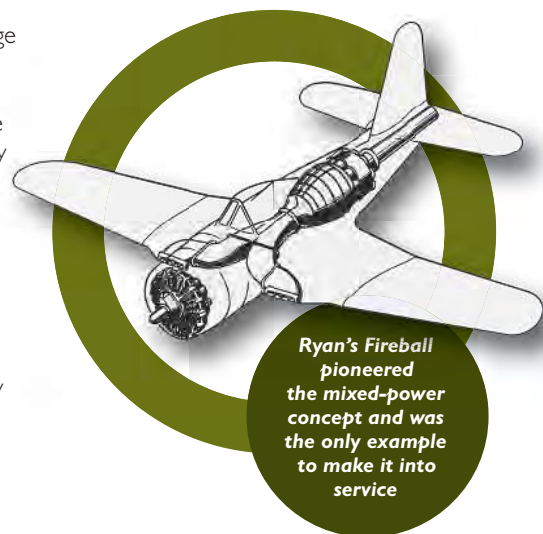


exhaust pipe in the middle of the rear fuselage – thus avoiding the long and inefficient tail pipes used on some other jets. However, apart from the radical use of a jet engine, the remainder of the XF15C design was distinctly conventional. It had low-mounted wings with the pilot sitting just above the leading edge. Preliminary designs also called for a low-set horizontal tailplane, so only the jet exhaust pipe set it apart from its contemporaries.

The US Navy was sufficiently interested in the design to order three prototypes on April 7, 1944 – at the time it was, in theory at least, the Navy's fastest fighter with a projected top speed exceeding 407kts.

The first prototype made its maiden flight on February 27, 1945, albeit without its jet engine, which had yet to be delivered. The aeroplane performed satisfactorily and flight-testing continued once the Allis-Chambers J36 was installed in April, although the prototype crashed during landing on May 8, 1945.

A second prototype took to the skies two months later on July 9 and a third soon followed. However, both were soon grounded for modifications including the addition of T-tails.



Ryan's Fireball pioneered the mixed-power concept and was the only example to make it into service

Cancelled

Although the aircraft now showed much promise, the Navy had lost interest in the mixed-power concept and cancelled further development in October 1946. Of the two remaining prototypes, one was scrapped and the other eventually found its way to the Quonset Air Museum in Rhode Island, where it remains today.

Air Force attempts

However, the US Navy was not the only American air arm to experiment with the mixed-power concept and the USAAF had already been exploring its possibilities.

Just a month before the Navy ordered the XF15C, the Air Force contracted the Consolidated Vultee Aircraft Corporation to build a single-seat, long-range escort fighter that combined use of both a turbojet and a turboprop engine.



The McDonnell XP-67 Moonbat was the conceptually advanced prototype of a twin-engine, long-range, single-seat interceptor aircraft for the USAAF. It was beset by problems and designers toyed with the idea of adding auxiliary Westinghouse turbojets in the aft nacelles to boost the performance given by the Continental XIV-1430 inverted vee engines. This promised a 434kt top speed but the USAAF rejected the proposal. The project was eventually cancelled after the prototype was destroyed by an engine fire.

The first XF15C prototype demonstrates its original low-set tailplane. The fighter combined a 2,100hp Pratt & Whitney R-2800 18-cylinder two-row radial engine with a 2,700lb/thrust Allis-Chalmers J36 turbojet





Left: The second and third XF15C prototypes flew in the summer of 1945 and differed from the first by having T-tails. Although the aircraft now showed much promise, the Navy had lost interest in the mixed-power concept and cancelled further development in October 1946

Below: The sole Sukhoi Su-5 was fitted with a Klimov VK-107 engine as well as a VRDK motorjet. The latter could boost the aircraft's speed by 54kts for up to three minutes at a time



Whereas the Navy's attention was focused on acceleration and take-off performance, the USAAF was more interested in combining the high-speed capability of the jet engine with the endurance offered by the propeller.

The XP-81 was therefore designed to use a General Electric TG-100 turboprop engine in the nose driving a four-bladed propeller and a GE J33 turbojet in the rear fuselage. The turbojet would be used for high-speed dashes and combat.

Merlin swap

Although the first XP-81 was ready to fly by January 1945, development problems with the turboprop engine meant it was not delivered on schedule.

Consolidated Vultee therefore took the decision to mount a Rolls-Royce Merlin (scavenged from a P-51D Mustang) for the initial flight tests – this conversion process being completed in less than a week!

The XP-81 was then shipped to Muroc AFB where it performed its maiden flight on February 11, 1945. The aircraft demonstrated good handling during trials although the

decision was made to enlarge the vertical tail to improve directional stability.

YP-81

Based on the success of the project, the USAAF ordered 13 YP-81 development aircraft – these differing from the XP-81 by virtue of their lighter and more powerful GE TG-110 turboprop engines. They also had the wing moved rearwards by 10in to improve handling and gained armament in the shape of six .50 cal machine guns or six 20mm cannon.

The majority of the engineering work had

unable to produce its designed power and the YP-81's performance was no better than the Merlin-powered XP-81.

The two aircraft continued flying until 1947 but were eventually retired as photography targets on a bombing range. Today they both survive in storage with the National Museum of the United States Air Force at Dayton, Ohio.

Soviet Sukhoi

The latter days of World War Two also saw the Soviet Union undertaking trials of

“The YP-81's performance was no better than the Merlin-powered XP-81”

been completed before the war ended in August 1945 and the project was cancelled.

Nonetheless, Consolidated Vultee pressed on with the project and finished the second prototype, complete with the planned TG-100 turboprop. Flight testing resumed on December 21, 1945, but although this represented the first flight by an American turboprop-powered aircraft the TG-100 was

a mixed-power interceptor – essentially driven by a desire to counter the German Messerschmitt Me 262.

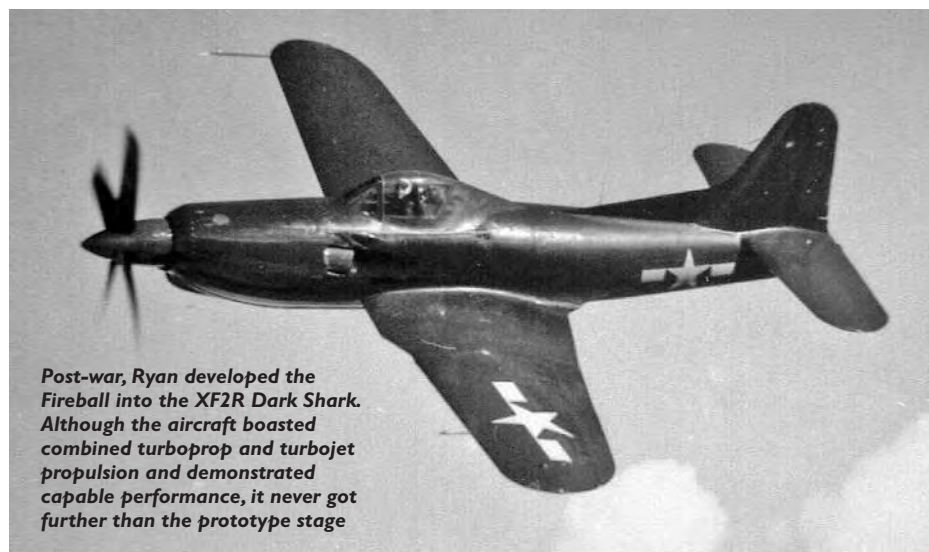
Unlike the USA, the USSR still lacked a production-ready turbojet engine so efforts concentrated on combining a piston-powered aircraft with a jet or rocket to provide short bursts of speed in combat.

Pavel Sukhoi seized the challenge and his design bureau created the I-107 (later renamed the Sukhoi Su-5) in 1944. The small, 35ft span fighter was of all-metal construction and combined a 1,650hp Klimov VK-107 piston engine with a rear mounted VRDK motorjet. The jet was powered by a driveshaft from the VK-107 and could provide an additional 54kts of speed for up to three minutes at a time.

The Su-5 first flew on April 6, 1945 and was later fitted with a laminar flow wing that enabled it to reach 428kts.

The USSR chose not to purchase the Su-5 and the project was cancelled on October 18, 1945 after just one example had been produced.

Although the XF15C, XP-81 and Su-5 all showed promise the war's end and rapid developments in jet technology meant they were no longer required. The era of the mixed-power fighter had come to an end. ●



Post-war, Ryan developed the Fireball into the XF2R Dark Shark. Although the aircraft boasted combined turboprop and turbojet propulsion and demonstrated capable performance, it never got further than the prototype stage

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END OF AN ERA

THE LAST PASSENGER CARRYING MD-11

Succeeding the DC-10, the MD-11 may not have been the success story that McDonnell Douglas hoped for but it still left a mark with passengers, pilots and enthusiasts. **Spencer Bennett** looks at the career of this long-bodied but short-lived airliner



N111MD, the prototype MD-11, was rolled out in November 1989 and took to the skies for the first time on January 10, 1990



N211MD was the second MD-11 to fly and was used as a demonstrator by McDonnell Douglas

Delta Air Lines' N804DE departs Manchester in the late 1990s en route to Atlanta. The aircraft was built for Delta in May 1992 and it served the airline until 2004 when it joined World Airways. In 2008 it was retired and sold to UPS who had it converted to a freighter. It continues in that role today as N295UP Martyn Cartledge



KLM MD-11 PH-KCD touching down at Amsterdam Schiphol Airport on November 11, 2014 marked the end of passenger carrying flights for the wide body tri-jet from a period spanning over 25 years. The last scheduled flight had taken place on October 25 from Toronto to Amsterdam but KLM advertised three farewell enthusiast charters to mark the final passenger flights by this iconic aircraft

Although the go ahead for the MD-11 was given in 1986, McDonnell Douglas had been considering an improved version of the DC-10 as much as a decade earlier. Two stretched versions of the DC-10 were under consideration with a view to marketing an aircraft that could carry more passengers over longer distances whilst also looking to reduce wing and engine drag.

By 1979 the DC-10-6X programme was being proposed with upgrades to the existing DC-10 in three different versions. The DC-10-61 was planned to be a high capacity airliner with a fuselage stretch of 40 feet when compared to the earlier DC-10 models. If configured in a single economy class, the aircraft was planned to carry up to 550 passengers. The DC-10-62 was being proposed for longer routes and

would feature a shorter fuselage extension of around 26 feet with a passenger capacity of between 350-440 passengers. Finally, the DC-10-63 would combine the longer fuselage of the -61 model with the larger improved wing of the -62 model.

However on May 25, 1979 whilst departing Chicago O'Hare airport bound for Los Angeles, American Airlines flight 191 lost its left engine on take-off and crashed claiming 273 lives. This added to negative publicity for the type, which had

model and particularly the effects that winglets could have on overall performance. A Continental Airlines DC-10 was leased and fitted with winglets to conduct additional research. This programme became known as the MD-EEE (Ecology-Economy-Efficiency) and over time ended up as the MD100 proposal.

Again, the proposal was for two different variants but due to a combination of the negative publicity, a downturn in the industry, plus newer aircraft types being offered by competitors, orders for the DC-10 had

“First flight was made by the appropriately registered N111MD”

suffered a high profile fatal accident in 1974 when a Turkish DC-10 had crashed just outside Paris. Then in November 1979, an Air New Zealand DC-10 crashed into Mount Erebus on a sightseeing flight, killing all on board. The DC-10's reputation was seriously damaged and, when added to a downturn in the aviation industry, the DC-10-6X programme was stopped.

New Proposal

By 1981, McDonnell Douglas were again considering improvements to the DC-10

ground to a halt and in 1983 the company once again ceased working on a new model.

The production line was kept in business in 1984 thanks to orders from the US Air Force for the military tanker KC10A, plus orders were consistent for the single-aisle MD80 family of airliners. The second hand market for DC-10s proved to be strong and this convinced McDonnell Douglas that there was sufficient demand for an improved version of the DC-10 and in 1984, for the first time, the new variant was designated as the MD-11.



Above: Alitalia operated ten MD-11s including I-DUPE, which joined the fleet in November 1991. In 2003 it was placed into storage but a year later was reactivated. In 2005 it was flown to Venice for conversion to freighter configuration and then operated until 2009 when it was returned to lessors Pegasus. It was later leased to Cargo Italia as EI-UPE until 2013 when it joined Centurion Air Cargo as N987AR. It is seen here in June 1992 taxiing for departure at Milan *Caz Caswell Collection*



Above right: JAT Yugoslav Airlines had been expected to become the MD-11's launch customer but outbreak of civil war in Yugoslavia meant the aircraft were never delivered and Finnair received the first example on December 7, 1990. It would go on to receive eight examples, including OH-LGC which was photographed at Toronto on June 14, 1995. It was retained by the airline until 2008 and after a period in storage it was converted to a freighter and transferred to Nordic Global Airlines *Caz Caswell*



Germany's LTU International Airways operated a fleet of four MD-11s including D-AERW, seen here departing Strasburg. The aircraft joined the airline from new in July 1992 and served until November 1998 when it was sold to Swissair. In 2002 it was flown into storage at Mojave before being converted to a freighter for TransMile in 2005. It initially flew as N71WF but later changed to a Malaysian registration as 9M-TGR. In 2011 the aircraft was sold to FedEx, which continues to operate it as N642FE *Caz Caswell Collection*

McDonnell Douglas initially drew up plans for two different versions of the new airliner. The MD-11X-10 was based on the original DC-10-30 airframe, offering a range of around 6500 nautical miles and a maximum take-off weight (MTOW) of 580,000lbs. The MD-11X-20 had a longer fuselage so was capable of carrying more passengers over a range of around 6,000nm.

Lengthy Process

As the DC-10 production line gradually came to an end, McDonnell Douglas used the time to consult with airlines to fine-tune the designs for the new aircraft and

available to airlines at this point including a long-range variant, a freighter and a passenger/freighter combi.

On December 30, 1986 the MD-11 was officially launched with 52 firm orders and 40 options over three differing versions (passenger, freighter and combi). The launch airlines were Alitalia, British Caledonian, Dragonair, FedEx, Finnair, Korean Air, Scandinavian Airline System, Swissair, Thai and Varig plus two leasing companies.

Assembly of the first aircraft began on March 9, 1988 and a first flight date was projected for March 1989 but, as is often the case with new airliners, problems with

Five aircraft were involved in a flight test programme, which would entail over 2000 flying hours including a 16.5-hour flight over the North Pole and on October 8, 1990 the MD-11 received its type and production certification from

"MD-11 B-150 crashed in Hong Kong whilst landing in a typhoon"

by July 1985 plans were being modified but still with two variants of differing fuselage lengths. A year later and the final design modifications had been made with the fuselage length being a stretch of 18ft 7in over the DC-10-30 plus the addition of winglets. With several airlines having made commitments to place orders, there was great optimism around the programme. A number of options were being made

manufacturing, suppliers and industrial actions delayed the schedule.

The world got its first views of the new aircraft when McDonnell Douglas officially rolled the aircraft out in November 1989 and following ground tests, the aircraft took to the skies for the first time on January 10, 1990. The first flight was made by the appropriately registered N111MD - which ultimately became N601FE with FedEx.



the FAA, initially with the General Electric CF6-80C2 engine option – the Pratt and Whitney PW4000 engine option receiving certification in December 1990.

In Operation

The launch customer was planned to be JAT Yugoslav Airlines – an existing DC-10 operator; but due to the outbreak of civil war in Yugoslavia the aircraft were never delivered and Finnair became the new launch customer; taking delivery of a passenger variant on December 7, 1990.

The first revenue flight took place on December 20, 1990 on a flight from Helsinki to Tenerife in the Canary Islands and other airlines including Delta Airlines and American Airlines started receiving their first aircraft soon after and putting them into revenue service.

However, fairly quickly, the aircraft's performance was put under scrutiny as airlines were discovering that the proposed targets for range and fuel burn were not being

Below: KLM were the last airline to offer passenger flights on the MD-11. The airline operated ten MD-11s, including PH-KCC seen landing at Heathrow on April 2, 1995. It was retired on April 7, 2014 when it departed Amsterdam en route to San Bernardino, California where it has been sold for spare parts *Adrian M Balch*



China Eastern took delivery of five MD-11s, including B-2171 seen taxiing for departure at Brussels in July 1992. The aircraft had been delivered in 1991 and in April 1993 it was involved in a serious incident when the leading edge wing slats were inadvertently deployed while in cruise flight. The captain manually controlled the aircraft as it went through several violent pitch oscillations and lost 5,000ft of altitude. Two passengers were killed and 149 passengers and seven crewmembers received injuries. It re-entered service but in 2006 it was converted to freighter configuration for China Cargo Airlines. Four years later it joined SkyLease Cargo as N951AR *Caz Caswell Collection*



Delta Air Lines received 17 MD-11s. This example is seen landing at Manchester in the early 2000s at the end of the regular flight from Atlanta *Martyn Cartledge*



A Malaysian Airlines MD-11 rolls out onto final approach at Hong Kong's Kai Tak Airport in November 1996. The airline operated 12 MD-11s most of which were later transferred to World Airways

PRMAVIA Collection



met. American Airlines, one of the primary customers, was unimpressed and negative feedback led Singapore Airlines to cancel its order for 20 aircraft, doubting that the MD-11s could operate on their long-haul routes.

American Airlines were specific in their criticism of the aircraft and the performance of the Pratt and Whitney PW4000 engines. When fitted with Pratt and Whitney

PW4000 engines, the MD-11 was supposed to have a range of 7000 nautical miles with a payload of 28,000kg but American found that with the phase 1 drag reduction in place at that time, a fully loaded aircraft only had a range of around 6500 nautical miles or could only achieve 7000 miles with a reduced payload of around 22,000kg.

Usurped

McDonnell Douglas and their suppliers quickly began making the improvements to the aircraft but were now facing stiff competition from Boeing's 777 and Airbus' A340. Singapore Airlines opted for the Airbus A340 to replace their cancelled MD-11 order and McDonnell Douglas received further bad news as more orders were lost with Air Europe collapsing and British Caledonian were bought out by British Airways – which then cancelled its existing order for the MD-11 and opted for the Boeing 777 instead.

Financial difficulties at McDonnell Douglas led to a merger with Boeing in 1997 and the MD-11's days appeared to be numbered with Boeing's 777 aircraft proving more successful. The production line continued for around a year whilst orders were fulfilled but with the order book empty, in 1998 the decision was made to bring the production of the MD-11 to a close.

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Accidents

Although it had a better safety record than the DC-10, the passenger MD-11 was involved in some accidents, with its darkest day coming on September 2, 1998 when Swissair MD-11 HB-LWF crashed into the Atlantic Ocean off the coast of Nova Scotia, Canada following an electrical fire onboard. All 229 passengers and crew perished.

Another well publicised incident occurred on August 22, 1999 when Mandarin Airlines MD-11 B-150 crashed at Hong Kong Chep Lap Kok whilst landing in a typhoon. Hitting its right wing on the ground, the aircraft flipped over, eventually coming to rest upside down. Amazingly 312 of the 315 passengers and crew survived.

Popular Abroad

In its passenger variant, the aircraft flew for a variety of different airlines with Varig of Brazil ultimately having the largest passenger fleet of 23 aircraft. The aircraft was sold to airlines across the globe but was more popular in Asia and North America than in Europe. Five of Europe's national Flag Carriers operated the aircraft – KLM, Finnair, Alitalia, Swissair and Sabena, although the aircraft also saw service with charter operators such as LTU and Martinair.

In Asia the aircraft was particularly popular, seeing service with many airlines including China Airlines, China Eastern, Eva Air, Garuda Indonesian, Japan Airlines (JAL), Korean Air, Mandarin Airlines, Thai and Philippine Airlines.

Japan Airlines (JAL) designated its MD-11s with the title 'J-Bird'; each aircraft was named after a rare bird with an image of the bird and its name appearing on the winglet.

World Airways offered its aircraft for lease and this saw MD-11s operating for short periods of time for Aer Lingus, El Al, Monarch Airlines, Malaysian Airlines and Avianca.

The aircraft was also employed in a VIP configuration by two operators – Saudi Royal Flight for members of the Saudi Royal Family and Mid East Jet on behalf of Asasco Aviation, although both aircraft are now stored.

Dwindling Use

By 2004 the majority of airlines which initially ordered the MD-11 for passenger use had replaced them with newer aircraft such as the Airbus A330/340 or the Boeing 777.

Some airlines, such as China Eastern and Korean Airlines converted their passenger

MD-11s to freighters whilst others sold their aircraft to cargo airlines to be similarly converted.

From the mid 'noughties' the MD-11 was still in passenger service with several airlines – Varig of Brazil flew their aircraft until 2007 when the aircraft were retired and leased to another Brazilian airline – TAM Brazil, which became a new MD-11 operator flying their aircraft to European destinations such as Milan, Frankfurt and Paris.

Finnair – the launch customer for the MD-11 – flew their passenger fleet up until February 22, 2010 with the final flight operating from Delhi to Helsinki. The aircraft were then converted into freighters with some being sold to Aeroflot and some continuing to fly for Finnair. That



Above: Brazilian airline Varig operated the largest fleet of MD-11s and flew many of their aircraft until 2007 when they were retired and leased to TAM Brazil. However PP-VOP, which was leased from GPA from 1991 to 2000, was returned to the lessor and converted to a freighter for Gemini Air Cargo as N701GC. In 2008 it was transferred to Centurion Air Cargo, becoming N701GC. In October 2009 it was damaged while landing in Uruguay, but was returned to the air as N988AR – again for Centurion Air Cargo. On October 13, 2012 it was damaged landing at Viracopos in Brazil and was eventually scrapped. It is seen here at Zurich in June 1992. *Caz Caswell Collection*

Below: American Airlines' MD-11 N1753 powers out of Heathrow on July 27, 1992. The aircraft was one of 19 to fly with the carrier and served from 1991 to 1996. It then passed to FedEx who converted it to a freighter. It was reregistered as N586FE and named Dylan and continues to fly with the cargo line to this day. *Adrian M Balch*





Japan Airlines operated ten MD-11s including JA8585, seen here making a characteristically tight turn onto the runway at Hong Kong's Kai Tak Airport in November 1996. The aircraft survives with UPS as N270UP PRMAVIA Collection

left just World Airways and KLM as the two remaining airlines flying passengers on MD-11 aircraft.

World Airways aircraft saw a variety of use as, in addition to the leases mentioned earlier, the airline operated a lot of ad hoc charters – many for military contracts. The airline ceased flying on March 26, 2013 which then left KLM as the world's final operator of the passenger MD-11.

“Some airlines converted their passenger MD-11s to freighters”

By 2013, KLM's fleet of MD-11s was reduced to six aircraft which flew on the scheduled services from Amsterdam to Montreal, Toronto and Los Angeles in the summer season; although by October of the same year the fleet had been reduced to just four aircraft. Towards the end of October 2013 KLM confirmed that they planned to retire the MD-11 from passenger service by October 2014, with the final flight planned to be a return leg from Montreal.

Final Send-Off

In mid-October 2014 KLM provided a nice touch by painting one aircraft, PH-KCE, with special 95th anniversary stickers and two others, PH-KCB and PH-KCD, with special titles celebrating KLM's long association with McDonnell Douglas and

listing all the types that had flown for KLM.

PH-KCB was assigned to fly the last ever scheduled passenger MD-11 service on October 25 when the aircraft flew from Toronto to Amsterdam as flight KL692. The airline had, however, announced plans in mid-September to mark the retirement of the MD-11 with three special enthusiast charter flights from Amsterdam to take place on November 11. Tickets were priced at EUR 111 per person and were

quickly booked by enthusiasts from many different countries, all eager to be on these final historic flights. PH-KCD operated all three hour-long flights, with the very last touching down at Amsterdam Schiphol at around 16.30 local time.

An interesting and unexpected final opportunity was advertised by KLM in

Below right: Saudi Arabian Airlines operated four MD-11Fs as well as a pair of MD-11s in VIP configuration for use by the Saudi Government – the latter included HZ-HM7, seen here visiting Geneva in May 2005. The aircraft is now in storage PRMAVIA Collection

Below left: Martinair operated seven MD-11s including PH-MCR, which joined the airline in 1995 on lease from Yamasa Lease. It is seen here landing at Amsterdam's Schiphol Airport Martyn Cartledge

conjunction with a Dutch accommodation website, where a competition was run for winners to spend a night onboard an MD-11 parked up at Schiphol!

Two aircraft departed Amsterdam for storage in the Mojave Desert in December 2014, and PH-KCD followed on January 11.

The MD-11 may not have been the success story that McDonnell Douglas hoped for but it certainly left its mark with passengers, pilots and enthusiasts, who will all miss seeing this iconic aircraft parked at passenger terminals across the world, although the aircraft is still operating as a freighter for various airlines around the globe. ●

SPECIFICATION MCDONNELL DOUGLAS MD-11



Crew	3
Passengers	293-410
Length	202ft 2in (61.62m)
Height	57ft 9in (17.60m)
Wingspan	169ft 6in (51.66m)
Wing area	3,648sq ft (338.9m ²)
Empty Weight	283,975lb (128,809kg)
Max Take-Off Weight	630,500lb (286,000kg)
Max Cruise Speed	520kts (587mph/945km/h)
Ferry Range	7,873 miles (12,670km)
Service Ceiling	43,000ft (13,000m)
Powerplant Three General Electric CF6-80C2D1F turbofans (61,500lb/thrust each)	
First Flight	January 10, 1990

Artwork: Andy Hay / www.flyingart.co.uk





CLOSE, BUT NO COMBAT

THE JETS THAT COULD HAVE CHANGED THE COURSE OF THE WAR

*It's commonly known that just a handful of jet aircraft were ready to see action in World War Two. However, as **Frank Glass** discusses, there were many more waiting in the wings*

When peace broke out across the world in the summer of 1945 and the dust began to settle, it soon became obvious that the era of the piston-powered military aircraft was almost over.

The Messerschmitt Me 262 had become the world's first operational jet fighter in June 1944 and Gloster's Meteor had followed it into service just a month later. It would be just a matter of weeks before the Luftwaffe's Arado 234 'Blitz' took the title of the first operational jet bomber and as 1945 dawned the USAAF and US Navy joined the ranks of jet operators, albeit the mixed power half jet/half piston Ryan Fireball in the case of the Navy.

Familiar faces

Much has been written about the Me 262's potential against the Allied bomber fleets that ran amok over occupied Europe in 1945 and Hitler's dogmatic insistence that this new jet fighter be used as a fighter bomber, stifling its potential as a high speed interceptor. Likewise, the stories of Meteors in combat with V-1 flying bombs are the stuff of legend.

In the last issue of *Jets* the Heinkel 162 Salamander, which entered service in February 1945, was discussed in some detail

but this 'people's fighter' was a poorly built and ill-proven last ditch attempt at stopping the onslaught by the RAF and USAAF.

Pioneers

It was Germany's Luftwaffe that lays claim to the world's first jet flight when the Heinkel 178 took to the skies in August 1939. Although this was purely a flying test bed, Ernst Heinkel did develop the twin engined He 280 in 1940 as a fighter jet and nine examples of this unusual aeroplane had been completed before Hitler cancelled the project.

It would be May 1941 before Frank Whittle's Power Jets engine would make its maiden flight, this being in the first of two Gloster E.28/39 test beds. This, in turn, would spawn the highly successful Meteor but it is easy to forget those manufacturers and nations that were also trying hard to put jets into the skies.

Italian first

While much is made of the E.28/39's pioneering jet flights in the UK, often overlooked is the fact that it was beaten into the skies by not just the He 178 and He 280 but also an unusual aircraft from Italy.

The Italian pioneer can trace its history back to 1931 when Secondo Campini



The Gloster Meteor may have been the only Allied jet to see operational service and one of the best selling jets of its decade, but there were plenty of other unsung aircraft from the period

submitted a thesis on the potential of jet propulsion to the Regia Aeronautica. A year later he demonstrated a jet-powered boat and in 1934 he finally got permission to develop an aircraft to prove his concept.

By modern standards the aircraft is best described as a 'ducted fan' rather than a pure jet and used a 900hp piston engine to drive a three-stage variable-incidence compressor, which forced air into a combustion chamber where it was mixed with fuel and ignited to create thrust.

The system was blighted by poor fuel economy and low power but Campini approached the Caproni aircraft factory to



Lessons learned from the inadequacies of the P-59 led Lockheed to produce the P-80 Shooting Star

build the two prototypes.

On August 27, 1940, test pilot Mario De Bernardi took the Caproni Campini N.1 into the skies for the first time and claimed it reached 200kts at barely half throttle.

The Italians proudly showed off their new 'jet' to the world and as the secretive Germans had not yet announced the 1939 flight of the He 178, the Fédération Aéronautique Internationale incorrectly awarded Campini with the honour of creating the world's first jet aeroplane.

The aeroplane was certainly innovative but its limitations were many and the type never entered service, although one example was shipped to the UK after the war for study by the Royal Aircraft Establishment.

American debut

Next to enter the jet set were the Americans, whose Bell XP-59A flew for the first time on October 1, 1942.

US Major General 'Hap' Arnold had been given a demonstration of the Gloster E.28/39 during a visit to Britain in April 1941 and he later requested the blueprints for the Power Jets W.1 engine. By September, General Electric had been contracted to produce a version of the engine and Bell Aircraft had been tasked with building a fighter to use it.

The design for the XP-59A was finalised by the following January and by March, long before the aircraft had flown, 13 pre-production aircraft had been ordered.

However, the new type had a number of problems and although Bell eventually completed 50 production Airacometes and six pre-production versions, the type never saw combat and was only assigned to the 412th FG to familiarise pilots with the handling and performance characteristics of jet aircraft. They had all been retired before the end of the decade.

The honour of becoming America's first jet fighter to be used operationally fell to the Lockheed P-80 (later F-80) Shooting Star.

Using the lessons learned from the P-59 project, Lockheed designed, built and flew the P-80 in just 143 days but although it first flew on January 8, 1944 the type was still not ready for operational service in World War Two. It would be the war in Korea that saw the USA's first jet combat but by then the straight-winged F-80 was outclassed by swept-wing aircraft such as the MiG-15.

Bell was awarded a contract to produce a long-range jet escort fighter in late 1944 and using its 'Model 40' interceptor as the basis and retaining the general layout of the P-59, the XP-83 took to the air on February 25, 1945. Powered by a pair of General Electric J33-GE-5 turbojets, one in each wing root, the tubby fuselage was left free for fuel tanks and armament. However, apart from range, the XP-83 was inferior to the P-80 and the project was cancelled in 1947.

The USAAF also explored the possibility of using jet engines to power bombers as far back as 1943. In October 1943 Douglas Aircraft submitted a futuristic bomber proposal to the Air Force dubbed the XB-42. Its piston engines were buried within the fuselage, thus allowing an aerodynamically clean wing. The airframe appeared ideally suited for jet propulsion and Douglas were convinced to modify the aircraft to use a pair of 4,000lb/ thrust General Electric J35-GE-3 turbojets. Although the modified XB-43 Jetmaster was ordered in March 1944, it would be post-



The Italian Caproni Campini N.1 was initially declared the world's first jet aeroplane when it flew on August 27, 1940, although the Heinkel He 178 had secretly flown by this point

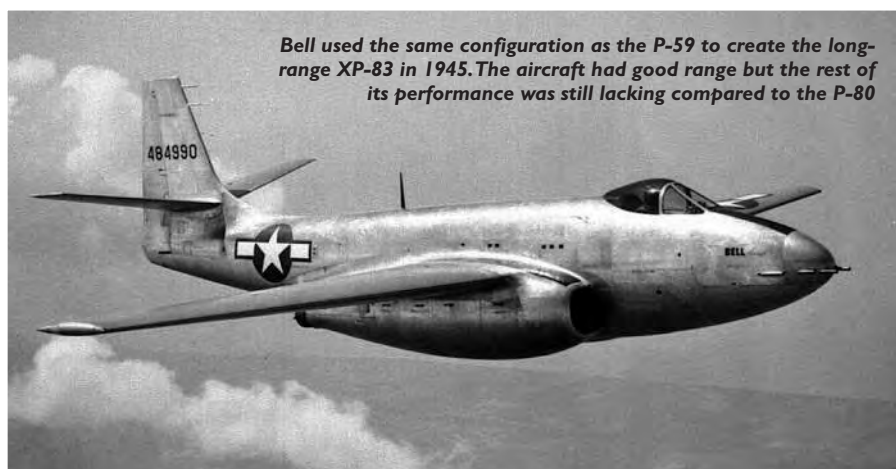


Although the Bell P-59 was the USA's first jet fighter, its performance was found to be worse than some piston-powered aircraft already in service

war before the aircraft would fly. Just two were built before the project was cancelled.

Naval aviators

The US Navy also explored jet technology and its first foray into propeller-less flight came in January 1945 with the McDonnell



Bell used the same configuration as the P-59 to create the long-range XP-83 in 1945. The aircraft had good range but the rest of its performance was still lacking compared to the P-80



The USAAF explored the possibility of using jet engines to power bombers as far back as 1943 and the Douglas XB-43 was ordered a year later. Just two were built before the project was cancelled

FD Phantom. McDonnell was invited to cooperate with the Navy in the development of a shipboard jet fighter in early 1943, using a choice of turbojet engines under development by Westinghouse.

Engineers evaluated a number of engine combinations, including one with eight 9.5in diameter engines, before settling on a pair of 19in diameter Westinghouse 19XB-2B powerplants. These were buried in the wing root to keep exhaust ducts short, offering greater aerodynamic efficiency than the underwing nacelles used on aircraft such as the Meteor and Me 262.

When the prototype was ready to fly only one engine was complete, but such was the



Above right: The US Navy ordered 100 McDonnell FD Phantom jets after the prototype had flown in January 1945. This was later slashed to 60 but the aircraft would become the first purely jet-powered aircraft to land on an American aircraft carrier

Right: The Nakajima J9Y Kikka was Japan's only jet-powered aircraft from World War Two. It was damaged on its second flight and before it could be repaired Japan had surrendered



confidence in the aircraft that the maiden flight took place with just the one engine! It would go on to become the first naval aircraft to exceed 435kts (500mph) and the first purely jet-powered aircraft to land on an American aircraft carrier.

The Navy ordered 100 FD-1 aircraft in March 1945 but the end of the war saw the order slashed to just 60, these powered by two of the 1,600lb/thrust Westinghouse J30-WE-20 engines. The later availability of more powerful engines led to the aircraft being radically developed into the F2H Banshee.

Mixed power

Other early US 'jet' designs focused heavily on the mixed-power concept. The first of

these was the Douglas XBTD-2 Destroyer, which flew in May 1944 and was based on the Navy's existing Destroyer dive bomber. The prototype combined the existing 2,300hp Wright Cyclone engine with a Westinghouse 19B turbojet in rear fuselage to give an additional 1,500lb/thrust but the combination did not provide sufficient improvement to warrant further development and just two were built.

A month later the mixed-power Ryan Fireball took to the air and 71 would eventually serve with the US Navy until a new generation of jets surpassed its performance. [Ed: see *Jets* May/Jun 2014 for a full article on the Fireball]. Undeterred by the limited potential of the mixed-

power concept, both the Navy and USAAF explored the options with the Curtiss XF15C and Consolidated Vultee XP-81 [see page 58] but the future for both air arms lay with jets.

Japanese jet

The Japanese military attaché to Germany had witnessed the Messerschmitt Me 262 flying in 1944 and the Imperial Japanese Navy requested Nakajima to develop a similar aircraft as a high-speed bomber. The design needed to be built by unskilled labour and as Japan began to prepare to defend its home islands, there was a need for the aircraft to have removable wings so it could be hidden in caves or tunnels.

The resulting aircraft bore a strong resemblance to the Me 262, but was much smaller and had straight wings rather than swept. Power was to come from the Ne-10 centrifugal turbojet but tests revealed it would not produce sufficient thrust and the project stalled until a new axial flow turbojet could be produced, based on the German BMW 003.

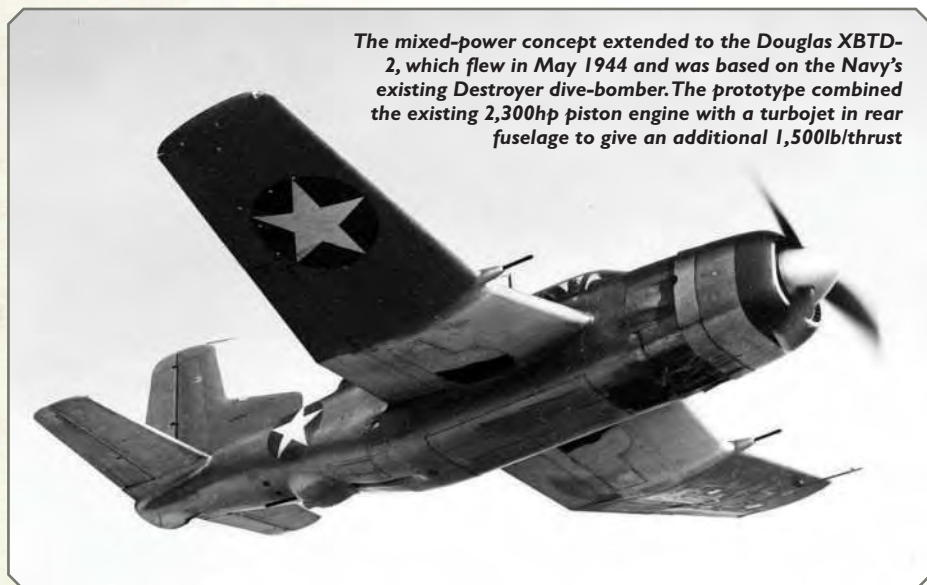
Dubbed the J9Y Kikka, the new fighter bomber began taxi tests on June 30, 1945 and was later transferred to Kisarazu Naval Airfield for its maiden flight. On August 7, Susumu Takaoka took the aircraft aloft for a 20-minute flight that went well apart from very slow acceleration on take-off. For the second test flight, four days later, rocket assisted take-off (RATO) units were fitted to the aircraft but these had been mounted incorrectly and forced the tail to hit the ground. The Kikka eventually overran the runway and into a ditch. Before it could be repaired Japan had surrendered and the war was over.

German innovation

The German Luftwaffe-developed Messerschmitt Me 328 began life in 1941 as 'Project P.1073' – a simple and cheap escort fighter constructed mostly from wood. It was intended to be carried aloft or towed behind a bomber before igniting its engine and breaking free to protect the larger aircraft if needed. Power was to come from Argus pulsejets or a Junkers Jumo 004 turbojet.

The idea was dropped in August 1942 but

The mixed-power concept extended to the Douglas XBTD-2, which flew in May 1944 and was based on the Navy's existing Destroyer dive-bomber. The prototype combined the existing 2,300hp piston engine with a turbojet in rear fuselage to give an additional 1,500lb/thrust



with the tide of the war turning the project was reactivated 18 months later as the Me 328. This time the aircraft was deemed suitable as either a suicide weapon or a disposable bomber to be flown by volunteers from 5/KG200, the so-called Leonidas Squadron. In the end just nine examples were built before the project was shelved in favour of the Fieseler Fi 103R Reichenberg.

The Reichenberg was a manned version of the V-1 'Doodlebug' flying bomb and designed to fulfil a similar role to the Japanese Ohka. The original V-1 was modified into the Fi 103R version by virtue of adding a small cockpit atop the fuselage, just ahead of the pulsejet engine. The cockpit had a plywood bucket seat and only basic flight instruments and the pilot sat below a Perspex canopy and behind an armoured front panel. The wings were fitted with hardened edges to cut through barrage balloon cables.

The aircraft was designed to be dropped from below a Heinkel He 111 bomber and officially pilots were instructed to jettison their canopy and bail out just before impacting their target – but the chances of bailing out from immediately in front of a burning pulsejet must have been negligible.

Around 175 examples were constructed/converted but only a handful of flight tests had been completed before Werner Baumbach assumed command of KG 200 in October 1944 and shelved the project. He managed to convince Hitler that suicide missions were not part of the German warrior tradition.



The Fieseler Fi 103R Reichenberg was a manned version of the V-1 'Doodlebug' flying bomb and designed as a suicide bomber. It was never used in anger



By January 1944 the Soviets were aware of successful British and American jet aircraft projects and that the Germans were about to deploy jet and rocket-propelled aircraft of their own. The MiG-13's VRDK booster engine forced air into a stainless steel combustion chamber where fuel was sprayed from seven nozzles and ignited to exhaust out the variable rear nozzle. The aircraft used a conventional 1,650hp Klimov piston engine but after take-off a clutch was engaged to transfer power from the propeller to the compressor in the VRDK. It boosted power output to 2,500hp but could only run for ten minutes. Just twelve were built

Other last-ditch German attempts at self-defence included the Heinkel He-162, which was designed to be cheap to build and capable of being flown by pilots with

were allegedly taken from crashed USAAF Consolidated B-24 Liberators!

Power came from four Junkers Jumo 004 engines, two of which were hung below

"De Bernardi claimed the NI reached 200kts at barely half throttle"

minimal training. For such a simple aircraft it proved to be the fastest of all the jets to see service in World War Two.

Advanced technology

Also from 1944, the Junkers Ju 287 was a much more complex beast. The four-jet bomber was designed to provide the Luftwaffe with an aircraft that could outrun enemy fighters and its most notable feature was its forward-swept wing. It was felt that the concept (suggested by Dr Hans Wocke) would provide extra lift at low airspeeds.

Construction of the first prototype began in early 1944 with the aeroplane 'borrowing' elements from other designs. The fuselage came from a Heinkel He 177 A-5, the undercarriage was from a Junkers Ju 352, the tail was from a Junkers Ju 388 and – astonishingly – the nosewheels

the wing in a conventional style and two were mounted in nacelles on the side of the forward fuselage.

Subsequent aircraft were planned to be powered by Heinkel-Hirth HeS 011 engines but development problems led to them being replaced by six BMW 003 engines clustered three below each wing.

The programme was halted in July 1944 to concentrate on other more conventional bombers, however; Junkers was given permission to test fly the already completed prototype. Siegfried Holzbaur took it into the skies on August 16, 1944 and reported

Below: The Sud-Ouest SO.6000 Triton was the first French jet aircraft to be manufactured and design actually began as a clandestine project under German occupation in 1943. Post-war five examples were built, the first of which flew on November 11, 1946





Above left: The Junkers Ju 287 was a high-speed four-jet bomber that was most notable for its forward-swept wing

Above: The unorthodox Henschel Hs 132 was a German dive-bomber powered by a BMW 003 jet engine. The pilot was to fly in the prone position to reduce the effect of G forces but the Soviet Army overran the factory as the prototype was nearing completion

Left: Nine examples of Ernst Heinkel's twin engined He 280 were completed before Hitler cancelled the project in favour of the Me 262



mostly good handling characteristics, but noted in-flight flexing of the main-spar.

The programme restarted in March 1945 with the Luftwaffe issuing an order for 100 examples per month as soon as possible. A second prototype was almost ready to join the flight test programme by the time

“Chances of bailing out from a burning pulsejet were negligible”

the Junkers factory was overrun by the Red Army in late April 1945. It and a third prototype were later test flown in the USSR.

Intended to pioneer the use of variable geometry wings, the single-seat Messerschmitt P.1101 was developed in response to the Luftwaffe's July 15, 1944 Emergency Fighter Programme, which sought the second generation of jet fighters for the Third Reich.

The aircraft had a swept wing which could be adjusted on the ground between 30, 40, and 45 degrees. The P.1101 was to be powered by a single HeS 011 jet engine and Messerschmitt proffered it could break the sound barrier in a slight dive. However, the worsening war situation led to a lack of funding and the prototype was constructed using the wings from a Me 262 and landing gear from the Bf109 along with other scavenged parts.

By the time American forces discovered the prototype on April 29, 1945 it was approximately 80% complete. It was shipped to the USA where Bell Aircraft studied it prior to building its X-5 test bed – which would be the first aircraft capable of varying its wing geometry while in flight.

Flying wings

The P.1101 was not the only German aircraft destined to play an important role in post war America. The Horten Ho 229 was a jet-powered flying wing designed by Reimar and Walter Horten in response to Hermann Göring's call in 1943 for a bomber capable of

meeting the “3×1000” requirement; namely to carry 1,000kg (2,200lb) of bombs over a distance of 1,000km (620 miles) at a speed of 1,000km/h (540kts). It was to become the first pure flying wing powered by jet engines.

Based on their experience with flying wing gliders, the Horten brothers were



The Horten Ho 229 was designed in response to Hermann Göring's call in 1943 for a bomber capable of meeting the “3×1000” requirement. It was to become the first pure flying wing powered by jet engines

able to complete an unpowered version of the Ho 229 by March 1944 and a jet-powered version followed it into the skies in December. A second example flew on February 5, 1945 and the aircraft was found to have unexpected ‘stealth’ capabilities [see *Jets* Nov/Dec 2013].



The Messerschmitt P.1101 was designed to have a ground-adjustable swept wing. It would be pivotal in the development of the Bell X-5 – which would be the first aircraft capable of varying its wing geometry while in flight



Jack Northrop's XP-79B only flew once and was to crash while performing aerobatics. The test pilot bailed out but fell to his death after he was struck by the aircraft

Towards the end of the war, the US launched Operation Paperclip in an attempt to capture advanced German weapons research and keep it out of the hands of the Soviet Union. Included in the stash of captured aircraft was a Ho 229, which was sent to the USA for evaluation.

However, the Germans were not the only ones exploring the flying wing concept during World War Two and Jack Northrop had been experimenting with his piston powered N-1M since 1940. He would later use much of the Horten technology to forward the progress of large flying wing bombers but he had already been developing the XP-79 high-speed rocket powered interceptor since 1942 – well before the Ho 229 was commissioned.

In January 1943 the USAAF issued a contract for two prototype XP-79s and a glider variant (dubbed the MX-324) took to the air on July 5, 1944 to prove the concept.

It soon became obvious that the monoethyl aniline and red fuming nitric acid powered rocket motor would be overly corrosive so Northrop redesigned the XP-79 around a pair of Westinghouse J30 turbojets – and the XP-79B was born.

As with so many promising designs the war was over by the time the XP-79B took flight on September 12, 1945. Sadly, test pilot Harry Crosby was killed during the maiden flight when the aircraft entered a spin. He bailed out but was hit by the aircraft and fell to his death. The project was cancelled.

Britain also explored the flying wing concept during the war years, with Armstrong Whitworth Aircraft proposing a six-jet-powered flying wing that could be used as a bomber or airliner. Testing of an unpowered version (the AW.52G) began on March 2, 1945 with the glider towed aloft behind an Armstrong Whitworth Whitley.



The Arado 234 Blitz would become the world's first jet-powered bomber and would be one of the most prolific jets of World War Two

The aircraft proved its worth and the company received a contract to produce a pair of jet-powered AW.52 prototypes.

The first prototype flew on November 13, 1947, powered by two Rolls-Royce Nene engines and this was followed by the second on September 1, 1948.

On May 30, 1949 the first prototype crashed after elevator flutter caused large pitch oscillations. The pilot, J O Lancaster, ejected and became the first British pilot to do so in anger.

The World War Two jet era spawned countless unsung heroes and examples of missed potential, but it also marked a changing point in aviation history, which has never looked back since. ●



The Armstrong Whitworth AW.52 traces its history back to the war years but was not to fly until late 1947

JETS OF WORLD WAR TWO

TYPE	NATION	FIRST FLIGHT	OPERATIONAL	NO BUILT
Heinkel He 178	Germany	August 27, 1939	n/a	2
Caproni Campini N.1	Italy	August 27, 1940	n/a	2
Heinkel He 280	Germany	September, 22 1940	n/a	9
Gloster E.28/39	UK	May 15, 1941	n/a	2
Messerschmitt Me 262	Germany	July 18, 1942	April 1944	1,433
Bell XP-59A Airacomet	USA	October 1, 1942	n/a	66
Gloster Meteor F.1 / F.3	UK	March 5, 1943	July 1944	238
Arado 234 Blitz	Germany	June 15, 1943	August 1944	210
de Havilland Vampire F.1	UK	September 20, 1943	March 1945	244
Lockheed P-80 Shooting Star	USA	January 1944	January 1945	539
Messerschmitt Me 328	Germany	February 1, 1944	n/a	9
Horten Ho 229	Germany	March 1, 1944	n/a	3
Douglas XBTD-2 Destroyer*	USA	May 1944	n/a	2
Ryan Fireball*	USA	June 25, 1944	March 1945	7
Junker Ju 287	Germany	August 16, 1944	n/a	3
Heinkel He 162	Germany	December 6, 1944	February 1945	320
Fieseler Fi-103R Reichenberg	Germany	September 1944	n/a	175
McDonnell FD-1 Phantom	USA	January 26, 1945	August 1947	62
Consolidated Vultee XP-81*	USA	February 11, 1945	n/a	2
Bell XP-83	USA	February 23, 1945	n/a	2
Curtiss XF15C	USA	February 27, 1945	n/a	3
Mikoyan-Gurevich MiG-13*	USSR	March 3, 1945	n/a	12
Sukhoi Su-5*	USSR	April 6, 1945	n/a	1
Nakajima Kikka	Japan	August 7, 1945	n/a	1
Douglas XB-43 Jetmaster	USA	May 17, 1946	n/a	2
Northrop XP-79B	USA	September 12, 1945	n/a	1
Sud Ouest Triton	France	November 11, 1946	n/a	5
Armstrong Whitworth AW.52	UK	November 13, 1947	n/a	2
Henschel Hs 132	Germany	n/a	n/a	4
Messerschmitt P.1101	Germany	n/a	n/a	2

* = Mixed power aircraft

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The Northrop X-4 Bantam aloft in 1950. The aircraft was a single-seat, low swept-wing, tailless aircraft designed to obtain data on the stability and control of tailless aircraft at high subsonic speeds NASA



X-4 Bantam vs DH.108 Swallow

TAILLESS
TEST BEDS
ON TRIAL

Early jet testing had its trials and tribulations. Northrop's X-4 Bantam and de Havilland's DH.108 Swallow were designed to test the handling of tailless jets at transonic speeds but, as Sebastian Morgan reveals, they suffered very different fates

The third and final DH.108 Swallow was VW120. The aircraft first flew on July 24, 1947 but was lost in a fatal accident on February 15, 1950 when it broke apart during high-speed trials, killing Sqn Ldr J Stewart Muller-Rowland



In the late 1940s, with rapid progress being made towards supersonic flight, much thought was being given towards the best configuration for an aircraft capable of breaking the sound barrier.

There was a train of thought that a tailless design would avoid the interaction of shockwaves between the wing and stabilisers that were believed by many to be the source of the stability problems at transonic speeds.

Evaluation of captured German Messerschmitt Me 163 Komets had contributed much to this theory but the rocket-powered

aircraft was hazardous to fly and there was a need for dedicated test aircraft.

Mail-plane

In the UK the task fell to the de Havilland Aircraft Company which gave the design role to chief designer Ronald Bishop and project manager John Carver Meadows Frost in October 1945.

The aircraft was to test the tailless concept as part of company founder Sir Geoffrey de Havilland's desire to meet a requirement set out by the 1943 Brabazon Committee for a jet-powered transatlantic mail-plane.

Frost and his team considered a number of mail-plane formats including a twin-boom design, similar to the company's existing Vampire fighter but powered by three Goblin turbines. A canard version was also envisaged but it was felt that a 24-seat tailless aircraft powered by four Rolls-Royce Ghosts would best suit the job.

Impressed with the proposal, the Air Ministry requested further work and issued Contract SB.66562 in late 1945 to create two tailless swept-wing research aircraft designated the DH.108. These single-seaters were roughly half-scale models of the

projected jet transport and to hasten the programme (and reduce costs) the aircraft would be based on the Vampire F.I. The fuselage pods of TG283 and TG306 were taken from the first Vampire F.I production run and converted into DH.108s. The first aircraft would investigate low-speed characteristics, the second high-speed aspects.

The DH.108 was dubbed the Swallow by the Ministry of Supply and although the name stuck it was never adopted by de Havilland.

Swept-wing

The swept-wing form was agreed between de Havilland and the Royal Aircraft Establishment (RAE) at Farnborough and the aircraft was fitted with an automatic observation system that would measure aerodynamic and structural data during flight, including stick forces, levels of oscillation and aerodynamic pressures.

The 39ft-span wings were all metal, each incorporating leading edge sweep of 43° 47' and 25° of sweep at the trailing edge. This provided a wing area some 15% greater than the Vampire donor aircraft. They were of symmetrical section and tapered from root to tip but had no dihedral. Since the DH.108 had no tailplane or elevators, its trailing edge ailerons became elevons, providing lateral and longitudinal control. Landing flaps were also provided and each wingtip had small skids to protect in the event of wings strikes.

Reservations

The new type was built under utmost secrecy by de Havilland's Experimental Department at Hatfield. However, the RAE was already forming reservations about the tailless concept and suspected it would develop a Dutch Roll (a combination of rolling and yawing) at low speeds. In answer to these concerns de Havilland added wooden slats and anti-spin parachutes but failed to fit the recommended ejector seat as it felt it would cause unacceptable delays.

Change of mission

By early 1946 de Havilland had change of heart over the jet airliner market and decided to focus attention on its conventional DH.106 Comet jetliner.

It was felt the tailless swept wing was still too unproven and de Havilland could seize a market lead by creating a jet powered airliner with a more orthodox layout.

Nonetheless, as a pure research programme the DH.108 continued, partly to prove the swept-wing concept for the company's emerging DH.110 fighter (later the Sea Vixen).

Roll out

In April 1946, just seven months from the start of work, the first DH.108 (TG283) was rolled out at Hatfield. A few days later the aircraft was dismantled and transported by road to RAF Woodbridge where flight-testing could be undertaken in secret.

Taxi testing began in mid-May and on May 15, TG283 took to the skies for the first



Above: Swallow TG306 first flew from Hatfield on August 23, 1946 and a month later was one of the stars of the first post-war SBAC display, held at Radlett airfield in Hertfordshire

Right: Swallow TG283 was the first DH.108 to take to the skies. On September 27, 1946 Geoffrey de Havilland Jnr was killed when the aircraft broke up in flight



time. Chief test pilot Geoffrey de Havilland Jnr, second son of the company's founder, flew the aircraft for around 30 minutes and despite a mild pitch oscillation and a degree of elevon buffeting he reported almost vice-free handling despite its unusual controls.

During subsequent testing, speeds were gradually increased to 304kts – the limit dictated by the wing slats – and a brief trial was made with the wings given dihedral, although this was soon removed.

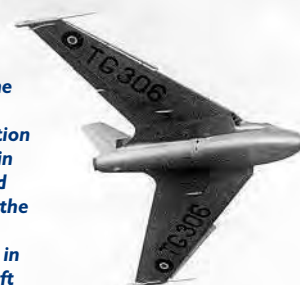
The original undercarriage was also temporarily replaced by a longer-stroke Sea Vampire undercarriage, which reduced the approach speed to around 95kts by allowing a greater landing incidence.

High-speed Swallow

The second DH.108 (TG306) was designed to evaluate the concept's high-speed handling and featured several modifications learned as a result of flying TG283. Key among these was the fitting of retractable slats in place of the fixed units to enable greater flying speeds. Small dive recovery flaps were also fitted and the canopy was reinforced to cope with the higher speeds. Power came from a 3,350lb/thrust Goblin 3.

TG306 first flew on August 23, 1946, once again with Geoffrey de Havilland Jnr at the controls. Testing revealed the expected pitch down tendency at high speed was less than anticipated and the aeroplane proved to be

TG306's fine aerobatic demonstration at Radlett in 1946 served to confirm the company's confidence in their aircraft



an excellent aerobatic mount – something that was demonstrated to good effect at the 1946 SBAC Airshow at Radlett, Herts.

Tragedy strikes

It soon became obvious that TG306 was capable of flying well above the current official air speed world record of 535kts and de Havilland decided to go for the title.

The aircraft was smoothed to make it as aerodynamically 'clean' as possible; the anti-spin parachutes were removed and the dive-brakes fixed shut before the aircraft was painted to achieve a highly polished finish surface.

On September 27, Geoffrey de Havilland Jnr took the aircraft aloft from Hatfield for a



Even the much modified VW120 is easily identified as a member of the Vampire family. Here the research aircraft is joined in flight by TG278, the fifth production Vampire F.I. This Vampire would go down in history for achieving the world altitude record of 59,446ft on March 23, 1948



de Havilland decided to go for the speed record in 1947 and TG306 quickly received further modifications including reinforcing to its canopy

practice over the Thames Estuary. He climbed to 10,000ft and dived to check the aircraft's handling at high speed but suddenly, as he sped through 6,500ft the Swallow broke up.

An examination revealed the wings had failed at their root attachments as the result of a violent outside loop. A post-mortem revealed Geoffrey had died of a broken neck.

Third Swallow

More investigation into the tailless aircraft was clearly needed and the Air Ministry authorised the construction of a third DH.108.

The fuselage pod from Vampire FB.5 VW120 was selected to be modified and the aircraft extended by 2ft 3in to accommodate a 3,750lb/thrust Goblin 4 engine. It also benefited from a streamlined nose, fully-automatic slats and powered controls. An ejector seat was also fitted.

The aircraft flew for the first time on July 24, 1947 in the hands of the company's new chief test pilot, Gp Capt John Cunningham and test flying was shared between Cunningham and Sqn Ldr John Derry.

The following April, Derry took VW120 into the record books when he shattered the world speed record by 35kts and achieved 605.23mph.

Supersonic

Further testing revealed loss of roll control and pitch problems as the aircraft reached supersonic speeds, yet Derry pushed the aircraft through the sound barrier for the first time on September 6, 1948.

He had not planned to exceed Mach 1 and the flight had been intended to collect data at speeds around Mach 0.96. However, the controls became heavier and eventually so immovable that only after closing the throttle was control regained. Later analysis of the flight data recorder showed the aircraft had inadvertently reached Mach 1.02 in the dive. VW120 had become the first British aircraft to achieve supersonic flight.

Soon afterwards the aeroplane was handed over to the Ministry of Supply at Farnborough, where it joined TG283 for further testing.

End of the line

Sadly, on February 15, 1950 VW120 broke apart during high-speed trials, killing Sqn Ldr J Stewart Muller-Rowland, who failed to eject.

The accident's cause was never fully determined and while an investigation pointed to a faulty oxygen system that incapacitated the pilot, a later coroner's report confirmed that the pilot died from a broken neck.

As if losing two aircraft was not bad enough, the sole remaining Swallow was also lost in a fatal accident on May 1 after it entered an inverted spin during sideslip testing. Sqn Ldr George Genders jettisoned the canopy and bailed out but he was too low for his parachute to open. The Swallow

had claimed its third life.

The radical Swallow was both Britain's first swept-wing jet and its first tailless jet. It was also the first British aircraft to break the sound barrier and achieved speed records among the 480 flights performed by all three examples. However all three Swallows were ultimately destroyed in crashes, in each case claiming the life of its test pilot.

American answer

Undeterred by the British tragedies, US authorities decided the supersonic tailless jet concept required further analysis.

Acutely aware of the Swallow programme, the USAAF saw the potential in having a similar testbed for its own use. Due to Northrop's track record of producing flying wings – including the pioneering N9M and the large YB-49 bomber – Jack Northrop's company had been given sole procurement status for the USAAF requirement and on June 11, 1946 was awarded a contract to produce a pair of X-4 research aircraft. Arthur Lusk was immediately assigned the role of chief project engineer and set about creating the new aircraft, which was soon christened the Bantam.



VW120 presents its graceful and unique planform to the camera



Showing its Vampire ancestry to good effect, TG306 formates on the cameraship in late 1946



Above left: de Havilland boffins prepare the Swallow for another test flight



Above right: VV120 was more streamlined than earlier Swallows. It benefited from a streamlined nose, fully automatic slats and powered controls. An ejector seat was also fitted

Unlike the Swallow, the aircraft was not destined to explore the sound barrier or set speed records and test flying would regimentally look at behaviour in the transonic speed range rather than expand performance envelopes. It was simply designed to prove or disprove the theory that a tailless aircraft would reduce shockwave interaction between aerodynamic surfaces.

Project Skylancer

Jack Northrop had begun investigations into high speed tailless flight in early 1946 under Project Skylancer and this drew upon the on-going development of his prone-pilot-position XP-79B fighter.

Like the XP-79B, the new X-4 would be powered by a pair of 1,600lb/thrust

“VV120 had become the first British aircraft to achieve supersonic flight”

Westinghouse turbojets but in order to achieve high speed from these low-powered engines, the resulting aircraft would need to be particularly compact.

As such the X-4 was just 22ft 3in long with a wingspan of 26ft 10in yet it contained all the test instrumentation and enough fuel for a 45-minute flight. The X-4 was actually one of the smallest X-Planes ever constructed and it is said that all maintenance could be conducted without the need for a stepladder!

With the exception of its tailless design, the Bantam was relatively conventional. It was of all-metal construction with a wing skinned in magnesium. The leading edge was swept by 40° 34' and the wing housed both elevons and split flaps that doubled as speed brakes. The fuselage was mostly of aluminium construction and was topped with a large bubble canopy offering excellent visibility.

The head start resulting from their Project Skylancer experience meant Lusk and his team had completed a full-scale mock up by November 1946 but the National Advisory Committee for Aeronautics (NACA) later insisted the fuel capacity be reduced in order to allow space for additional test equipment.

Construction continued apace and the first example (46-676) was completed by June 1948. The second airframe (46-677) followed about a month later and the aircraft were examined by representatives from both NACA and the USAF.

The board called for changes to the fuel

system, gear locks and the control system – the latter a result of the death of NACA test pilot Howard Lilly a few months earlier in a Douglas D-558-I. As such, delivery of the airframes to Muroc dry lakebed for flight-testing was delayed from July to November.

Fraught flight

After a series of engine and taxi tests, 46-676 took to the skies with Northrop test pilot Charles Tucker at the controls.

Tucker had been selected for the job not

just because of his jet experience but also due to his small stature, which made access to the tiny cockpit easier! By the time the X-4 was ready he had already flown the XB-35 and YB-49 flying wing and completed the stall programme on the latter, including spinning trials!

On December 15, 1948, Tucker made three take-off attempts but all were aborted because of yaw/controlability problems. Later that day he tried one more time, using

Right: The X-4's design allowed it to be broken in two, aft of the engines, for servicing and instrumentation work NASA



The first Northrop X-4 to be completed was 46-676, which first flew on December 15, 1948 NASA

judicious braking to keep the aircraft straight.

Writing many years later he recalled: “I pulled back on the stick, and the airplane leapt off the ground and began to climb at a very high angle. I pushed the stick forward, and the nose immediately dropped almost straight down. The airplane had been so fast when I rotated that it had literally shot straight up. If it hadn’t done that, I wouldn’t have had enough altitude to recover from the dive that followed and would have dug a very deep hole in the desert floor.”

Tucker was now airborne in an unstable aeroplane and any attempt to change pitch resulted in an almost immediate, violent vertical climb or dive. The X-4 was so sensitive that he chose not to raise the landing gear and could only keep the aeroplane straight and level by “holding the stick in both hands and clamping my hands between my knees.”

It took 30 minutes to make the 180-degree turn back to the runway and to Tucker’s surprise the aeroplane “just flew onto the lakebed.”

After landing the centre of gravity was moved slightly forwards and the rudder movement was doubled. While this work was being completed 46-677 arrived at





In this 1952 photograph NACA test pilot Joe Walker (left) is seen discussing test points to be flown on the X-4 aircraft with NACA research engineer Donald Bellman NASA



However, Northrop refused to take the aircraft above 260kts and it later transpired that the landing gear up-locks were similar to those fitted to the XF-89, which had failed during test flights.

Additionally, NACA had refused to hand over X-4 wind tunnel spin data to Northrop, causing the manufacturer to forbid Tucker from stalling the Bantam. NACA eventually instructed Northrop to install spin 'chutes and it would be November 1949 before both X-4s were modified with up-locks and 'chutes.

Both aircraft continued to fly but on January 26, 1950 46-676 made its tenth and final flight. It was retired and used as a spares source to keep its younger sister in the air.

The first phase of flight-testing was eventually completed on February 17, 1950 during which the aircraft had reached Mach 0.86 at 30,000ft. The only potential problem encountered was a tendency to pitch up at 6.5G as the aeroplane reached transonic speeds.

Left: The X-4 was a simple design with few vices although it was plagued with instability throughout its life NASA



Muroc AFB and was prepared for flight, however winter rains flooded the lakebed and further testing was postponed until April 27, 1949 when 46-676 took to the skies for its second flight. The changes resulted in much-improved handling, but a fuel problem led to the flight being cut short and it would be May 5 before it flew again. Yet again the sortie was abandoned, this time due to oil pressure problems, and NACA began to question the project's slow progress. It therefore called for Northrop to concentrate on the second prototype, which also happened to be more compatible with NACA's aims thanks to different test equipment that recorded far more parameters.

Second Bantam

The second X-4 performed its maiden flight on June 7, 1949 again with Charles Tucker at the controls. By July 21 it had completed six more sorties.



NACA trials

On May 1950 both X-4s were accepted from Northrop by the USAF, who in turn immediately passed them on to NACA.

Phase II of the testing programme then began in earnest with 46-677 modified to analyse its stall stability and performance. As such it was fitted with a multitude of cameras as well as strengthened rudder controls to counteract the forces encountered during sideslips and spins.

The structural work was completed by July and on August 18 the X-4 made its first flight under NACA ownership. Capt Charles 'Chuck' Yeager was at the controls.

Over the next two months the aircraft would make 19 sorties with both Yeager and Major Frank Everest splitting the flying. Other test pilots would eventually join the programme, including John Griffith (who pushed the X-4 to Mach 0.88 on his first flight) and Scott Crossfield whose first sortie included a full aerobatic regime that resulted in a double flameout!

Pitch down

On January 24, 1951 Crossfield pushed the jet to Mach 0.92 for the first time and noted that the porpoising pitch oscillations that other pilots had reported above Mach 0.87 diminished in amplification but increased

Above: The X-4's blown canopy provided the pilot with an excellent field of view NASA

Right: NACA High Speed Flight Station fleet in March 1952. Clockwise from far left: Douglas D-558-I, Convair XF-92A, Bell X-5, Bell X-1, Northrop X-4 and Douglas D-558-I NASA



The NACA High-Speed Flight Research Station's X-4 aircraft in flight during 1950 NASA



Above left: Colour photographs of the X-4 in service are hard to come by but this 1948 image shows 46-676 being readied for flight at Muroc AFB NASA

Above right: The X-4's two Westinghouse J30-WE-7/9 turbojets were fed air from a pair of inlets either side the diminutive fuselage NASA

Below: Today 46-677 can be found at the National Museum of the USAF at Wright Patterson NMUSAF



in frequency above Mach 0.92. Crossfield would later take the X-4 to 42,300ft – the highest it would ever reach, but the aircraft's tendency to pitch up still caused a problem. More seriously, the aircraft also showed a tendency to 'hunt' about all three axes. This combined yaw, pitch and roll, which grew more severe as the speed increased.

By June 1951 the aircraft was suffering from maintenance issues so it was withdrawn from service for an overhaul. NACA engineers also took the opportunity to undertake modifications to try to alleviate the pitching problem.

“Scott Crossfield pushed the X-4 to Mach 0.94 – the fastest it would ever fly”

Their answer was to increase the thickness of the magnesium wing's trailing edge by inserting wooden blocks between the speed brake halves and forcing them to remain open by five degrees above and below the wing. The theory was that a thicker leading edge would delay the onset of porpoising from Mach 0.88 to 0.91.

The aircraft took to the skies again on August 20, this time with Walt Jones at the controls. He found it was possible to accelerate to Mach 0.92 without any pitch problems. Engineers therefore chose to extend the 'blunt trailing edge' theory to the elevons and balsa wood was cemented to the trailing edge increasing the thickness by 50%

Walt Jones flew the aircraft for the first time in this configuration on May 19, 1952 and elevon control at higher speeds was found to be much improved, although porpoising still occurred at Mach 0.91.

On September 22 Scott Crossfield pushed the X-4 to Mach 0.94 – the fastest it would ever fly. Shortly afterwards a tug was accidentally backed into the aeroplane and it would be grounded until March 1953 for repairs.

Retirement

Flight testing continued until July 1953, by which time the programme had conducted 82 sorties.

Further flights were planned but recurrent fuel leaks and other maintenance woes resulted in the X-4 being grounded permanently.

On March 10, 1954 Bantam 46-677 and the scavenged hulk of 46-676 were returned to the USAF and transported to the Wright Patterson AFB for the USAF Museum. Today 46-677 can still be seen on display at the museum and 46-676 can be found at the USAF Academy in Colorado Springs.

Both the Swallow and the Bantam achieved a remarkable amount in their short careers, even if the majority of it was disproving theories rather than expanding the flight envelope. Aircraft designers were thus able to avoid this tailless dead end. ●

SPECIFICATION DE HAVILLAND DH.108 SWALLOW



Crew	1
Length	TG283: 25ft 10in (7.87m) TG306: 24ft 6in (7.47m) VW120: 26ft 9.5in (8.16m)
Height	9ft 8in (2.95 m)
Wingspan	39ft 0in (12.00m)
Wing Area	327.86sq ft (30.46m ²)
Empty Weight	8,940lb (4,055kg)
Max Take-Off Weight	TG283: 8,800lb (3,992kg) TG306: 8,960lb (4,064kg) VW120: 9,200lb (4,173kg)
Max Speed	558kts (677mph/1,090km/h)
Ceiling	35,425ft (10,798m)
Ferry Range	730 miles (1,175km)
Powerplant	TG283: One de Havilland Goblin 2 centrifugal turbojet (3,100lb/thrust) TG306: One de Havilland Goblin 3 centrifugal turbojet (3,350lb/thrust) VW120: One de Havilland Goblin 4 centrifugal turbojet (3,750lb/thrust)
Armament	Nil
First Flight	May 15, 1946 (TG283) August 23, 1946 (TG306) July 24, 1947 (VW120)

SPECIFICATION NORTHROP X-4 BANTAM



Crew	1
Length	22ft 3in (6.78m)
Height	14ft 10in (4.52m)
Wingspan	26ft 10in (8.18m)
Wing Area	387.5sq ft (36.00m ²)
Empty Weight	5,507lb (2,500kg)
Max Take-Off Weight	7,820lb (3,550kg)
Max Speed	542kts 535kts (616mph/991km/h) (624mph/1,004km/h)
Service Ceiling	42,300ft (12,900m)
Ferry Range	365 miles (676km)
Powerplant	Two Westinghouse J30-WE-7/9 turbojets (1,600lb/thrust each)
Armament	Nil
First Flight	December 15, 1948 (46-676) June 7, 1949 (46-677)



NEXT ISSUE

COMING UP IN THE MAY/JUNE 2015 ISSUE OF *JETS*



Starfires over North Korea

The Lockheed F-94 Starfire entered operational service in May 1950 and two months later the Korean War began. Warren Thompson charts the career of one of the USAF's unsung jet fighters

Warren Thompson Collection



Andover

Fifty years on from its maiden flight Richard Freail looks at the Hawker Siddeley Andover and the HS 748 from which it was developed

Flying the Baby Bus

The Airbus A320 is one of the most modern airliners in service. Scott Germain takes readers aloft for a check flight in the 'baby bus'



Stop Gap Bomber

The Short SA.4 Sperrin was one of life's understudies. From inception it was viewed as a stop-gap and by the time a prototype appeared its technology was seriously behind the times. Yet the Sperrin was docile, trouble-free and flew beautifully, as Pete London reveals



Babak Taghvaei Collection

Ukrainian Midas

Babak Taghvaei looks at the development, production and service of the Ilyushin Il-78 Midas aerial refuellers

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