



The Life & Times of the Avro Vulcan, a British design icon

Dr Robert Fleming FRAeS

www.vulcantothesky.com



British Prime Minister
Winston Churchill

USA President
Harry S Truman

Soviet Union
President
Joseph Stalin

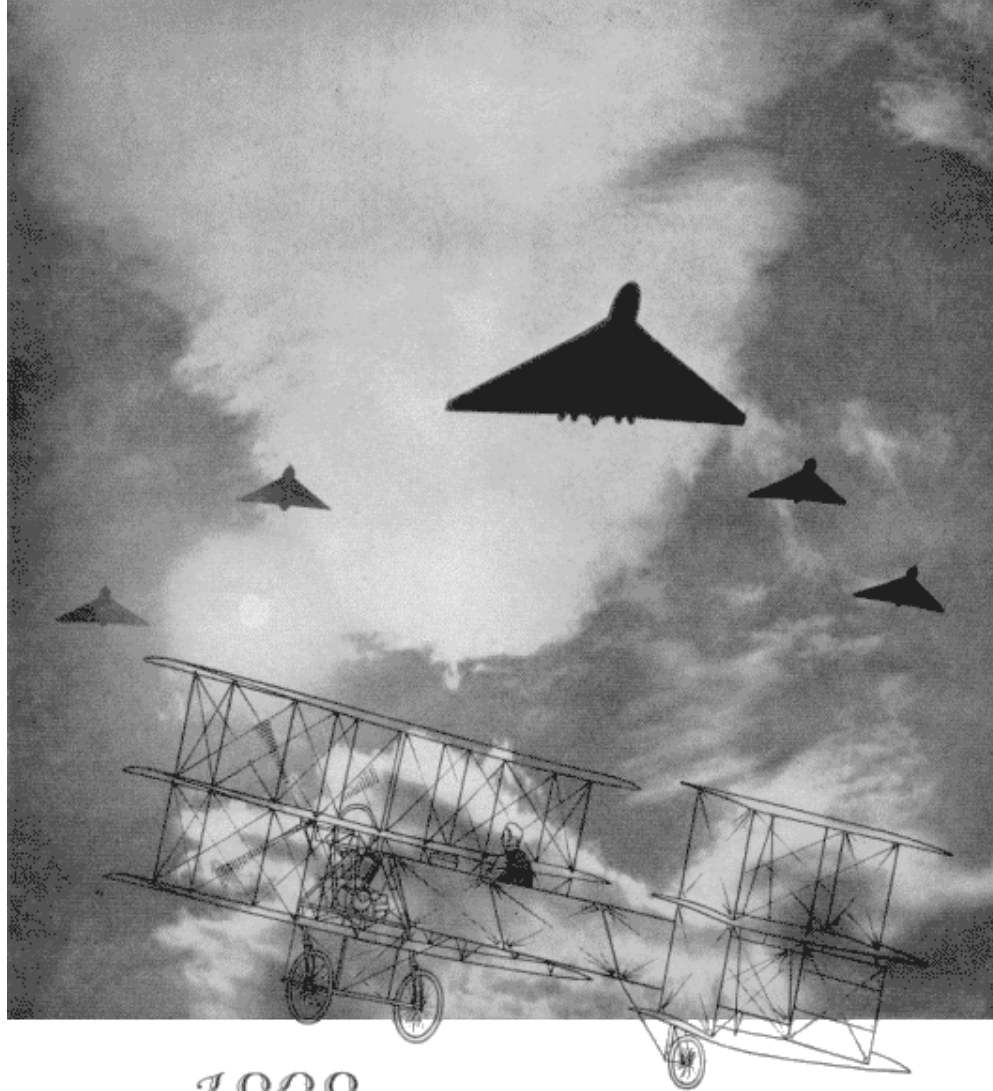
Potsdam July 1945 – the start of the Vulcan’s story. Within a month, the USA had dropped two atomic bombs on Japan, and Tory Prime Minister Churchill had lost a General Election in a landslide to the Labour Party’s Clement Atlee, who by the end of August 1945 had proposed to the Cabinet that the UK develop its own atomic bomb. Meanwhile Stalin was tightening his grip on Eastern Europe, and adopting the doctrine of political expansion. President Truman opposed this expansion, leading to the Cold War.



This is Britain's first production atomic bomb. Code named "*Blue Danube*", it had the same explosive power as those dropped on Japan – about 16,000 tonnes of conventional high explosive. The RAF's three V-Bombers – the Vickers Valiant, the Handley Page Victor & the Avro Vulcan – were each designed to carry this huge device to Russia, in response to a Soviet nuclear attack – the strategy of deterrence was born.



The prototype full-scale Avro Vulcan VX770 first flew on 31st August 1952, and spectacularly appeared in public at the Farnborough Airshow just a few days later. This picture is from the 1953 Farnborough airshow, and shows VX770 leading the four 1/3 scale Avro 707 research aircraft & the 2nd prototype VX707.



1909

The first *all British* aeroplane...

In July, 1909, Mr. A. V. Roe led all other British aircraft manufacturers by designing, building and flying the first aeroplane ever to have every component, both air-frame and engine, British made—the Roe 1 Triplane. (You can still see it in the Science Museum at South Kensington.) Today Avro continues to lead all others with the revolutionary Delta Planform, so successfully demonstrated in the mighty Avro Vulcan bomber.



A. V. ROE & CO. LIMITED / MANCHESTER

Member of the Hawker Siddeley Group | Pioneer . . . and World Leader in Aviation

Here is an advertisement for A V Roe Limited from the early 1950's, extolling British leadership in aircraft design and manufacturing, as exemplified by the Avro Vulcan.

2009 is the 100th anniversary of the 1st flight of the first *all British* aeroplane, the Roe 1 Triplane



In all, Avro supplied 134 Vulcans to the Royal Air Force.

The final version of the Vulcan, the B.Mk2, had gracefully-curved leading edges added to its 34-metre delta wingspan, making a beautiful, instantly-recognisable design.

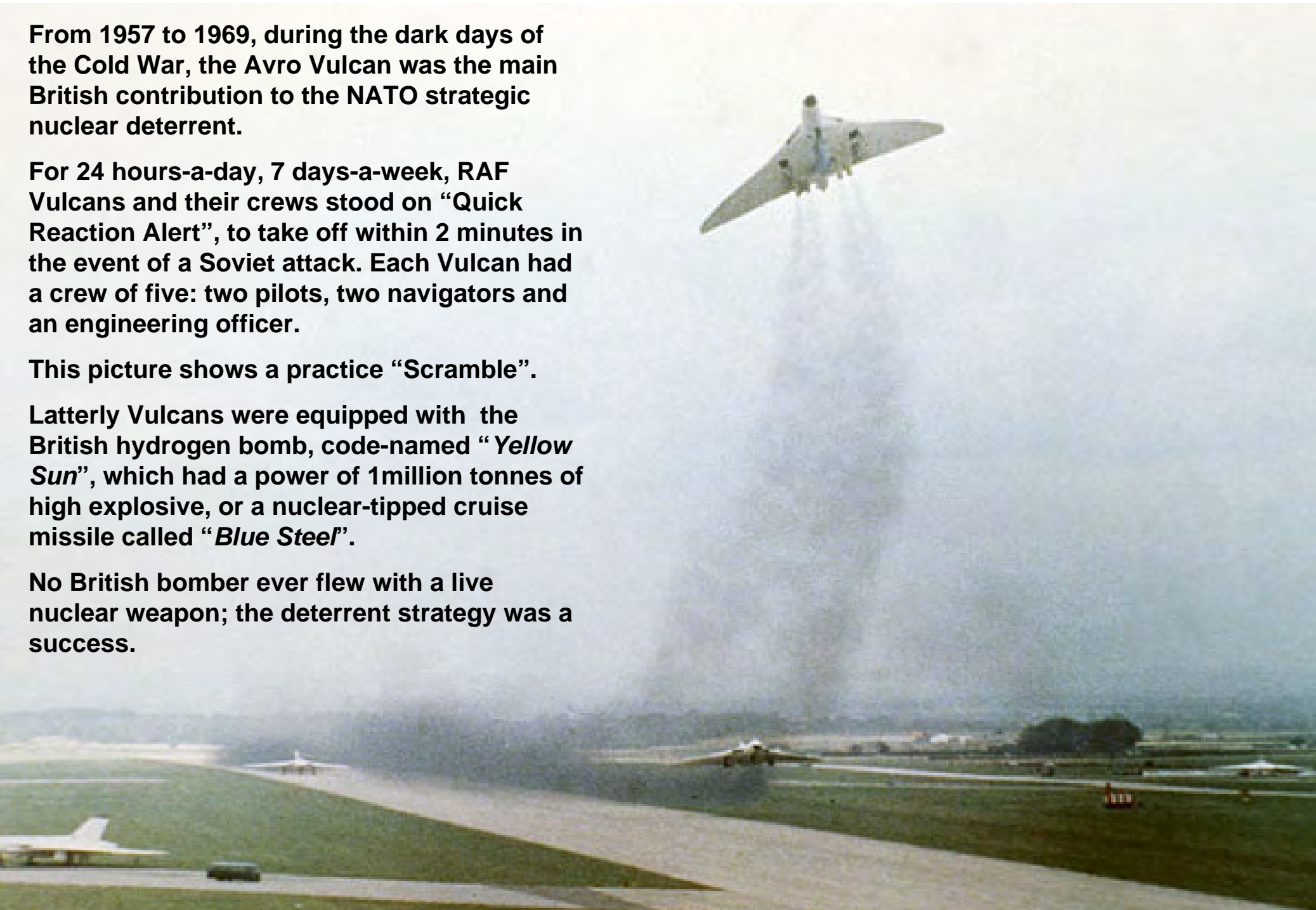
From 1957 to 1969, during the dark days of the Cold War, the Avro Vulcan was the main British contribution to the NATO strategic nuclear deterrent.

For 24 hours-a-day, 7 days-a-week, RAF Vulcans and their crews stood on “Quick Reaction Alert”, to take off within 2 minutes in the event of a Soviet attack. Each Vulcan had a crew of five: two pilots, two navigators and an engineering officer.

This picture shows a practice “Scramble”.

Latterly Vulcans were equipped with the British hydrogen bomb, code-named “*Yellow Sun*”, which had a power of 1million tonnes of high explosive, or a nuclear-tipped cruise missile called “*Blue Steel*”.

No British bomber ever flew with a live nuclear weapon; the deterrent strategy was a success.





In 1969, the RAF handed its strategic deterrence responsibilities to the Royal Navy's Polaris submarine fleet. Vulcans flew on through the 1970's as tactical nuclear and conventional bombers, but the design was so strong and adaptable that some aircraft were converted to entirely different roles. This picture shows a Vulcan carrying a Concorde Olympus engine for tests. Other Vulcans were converted into Maritime Reconnaissance and Air-to-Air Refuelling roles. However by 1984, all but two Vulcans had left RAF service.



2nd Bombing Mission "Black Buck Two" 3rd May 1982

The image is a high-angle aerial photograph of the Port Stanley airfield. A long, dark runway runs diagonally from the upper left towards the lower right. Several rectangular buildings and other structures are scattered around the airfield. Two black rectangular boxes are drawn over the image to highlight specific areas. The upper box is labeled "2nd Bombing Mission 'Black Buck Two' 3rd May 1982" and contains several small, dark, circular marks. The lower box is labeled "1st Bombing Mission 'Black Buck One' 1st May 1982" and contains a single dark mark in the center of the runway. A blue arrow points from the text "1st Bomb hits centre of runway" to this mark. A small circular structure is circled in black in the lower right quadrant of the airfield.

1st Bombing Mission "Black Buck One" 1st May 1982

1st Bomb hits centre of runway

The only time the Vulcan was used in anger was during the South Atlantic Conflict in 1982, when Vulcans, each supported by 13 Victor air-to-air refuelling tankers, flew 7 missions from Ascension Island to the Falkland Islands. The 1st "*Black Buck*" sortie, with the Vulcan armed with twenty-one 450kg conventional bombs, placed one bomb in the centre of the runway at Port Stanley airfield, proving its vulnerability and causing the Argentine invaders to change their plans. These raids captured the world record at the time for the longest-ever bombing mission: a return journey of nearly 8000 miles (12,500km), taking 15 hrs 45 mins.



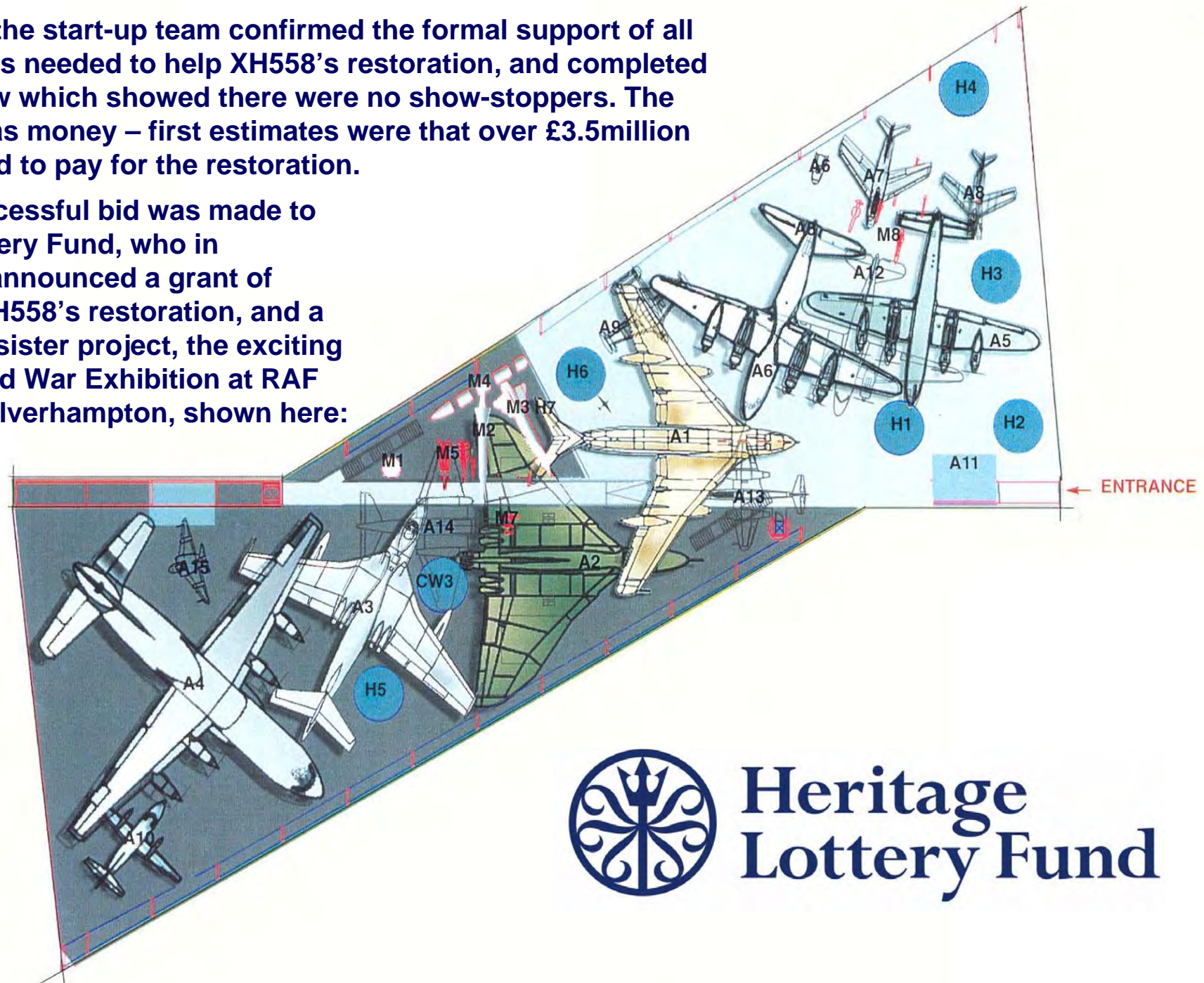
This is Avro Vulcan XH558 on 1st July 1960, painted in “anti-flash” white, during her delivery flight from the factory at Woodford, near Manchester, to RAF Waddington near Lincoln. XH558 was the first Vulcan B.Mk2 to be delivered to the RAF, and she is now the oldest complete Vulcan in the world.



XH558 was also the last Vulcan to leave RAF service, flying on from 1986 to 1993 as the single RAF Display Vulcan, a career of 33 years. Her final flight was on 23rd March 1993 to Bruntingthorpe Aerodrome in Leicestershire, having been sold off by the Ministry of Defence to C Walton Ltd, a family firm who purchased and maintained her, with the thought that one day, she might be returned to flight. In 1997, a small team headed by Dr Robert Fleming started to put together an audacious plan to return her to flight, but it was clear from the start that the project would be technically challenging & enormously expensive. Never deterred, the team set off down the path that led to XH558's return to the air.

Over 1998-2000, the start-up team confirmed the formal support of all the manufacturers needed to help XH558's restoration, and completed a technical review which showed there were no show-stoppers. The real challenge was money – first estimates were that over £3.5million would be required to pay for the restoration.

Eventually a successful bid was made to the Heritage Lottery Fund, who in December 2003 announced a grant of £2.7million for XH558's restoration, and a large grant for a sister project, the exciting new National Cold War Exhibition at RAF Cosford near Wolverhampton, shown here:

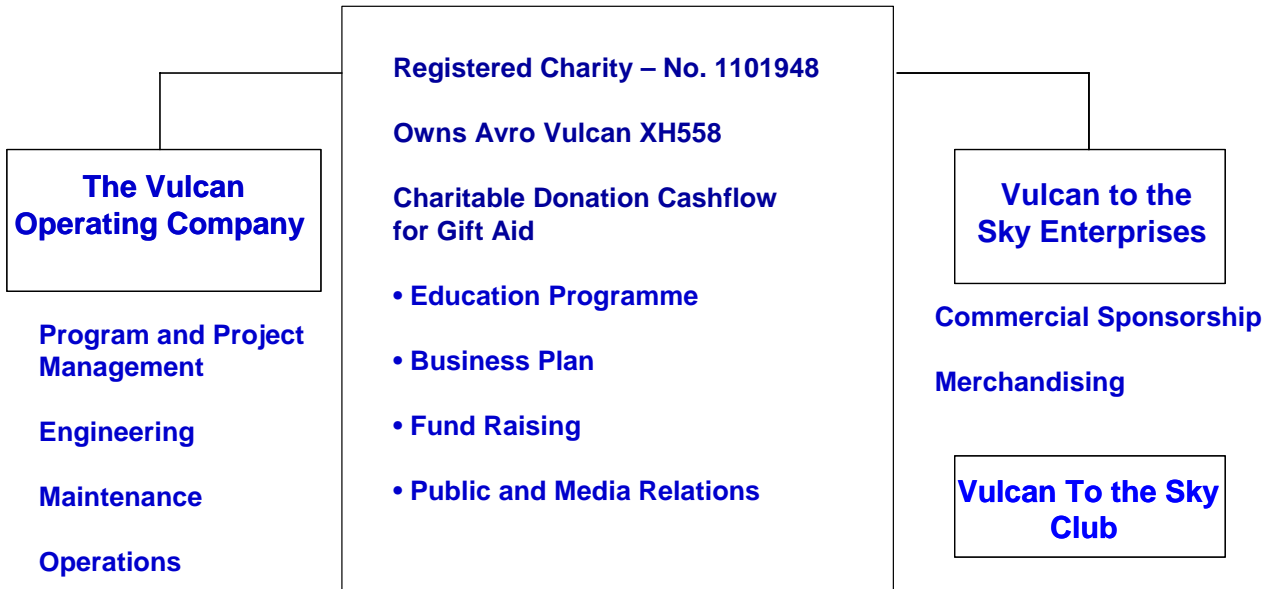


This is the engineering project team in the hangar at Bruntingthorpe Aerodrome alongside XH558, which was purchased for the Nation by the Vulcan to the Sky Trust, a Registered Charity, in March 2005. The team, some of whom worked on Vulcans in the RAF, eventually started work on the aircraft in August 2005.



WARNING: RISK OF INJURY DO NOT ENTER

Vulcan To the Sky Trust



Major Manufacturers, including:

- Beagle Aerospace
- Chesterfield Cylinders
- Dunlop Aircraft Tyres
- Eaton Aerospace – FR-HiTemp
- GKN Aerospace – FPT Industries
- Goodrich – Lucas Aerospace
- Honeywell – Normalair
- Irvin-GQ
- Kidde Graviner
- Martin Baker
- Meggitt – Dunlop Aerospace
- Messier-Dowty
- Rolls-Royce
- Smiths Aerospace
- Ultra Electronics



Engineering & Airworthiness Authority



Original Constructor (successor to Avro)



Rolls-Royce

Powerplant Design Authority

In addition to the Vulcan to the Sky team, many hundreds of people from all around the United Kingdom have contributed to the return of XH558 to flight. This is a list of some of the companies and organisations that have been involved, most of them undertaking significant amounts of work free of charge or at cost.



Olympus Fuel System

As an example, here is the team from Goodrich Engine Controls, who overhauled the Fuel Systems from each of the Trust's eight Rolls-Royce Olympus turbojet engines. This work was done at no charge.



On 31st August 2006, XH558 rolled out of the hangar for the first time in 7 years. This had coincided with an critical funding crisis, but in the last 3 weeks of August, the Trust, with the drive, energy & enthusiasm of XH558's supporters in the Vulcan to the Sky Club, managed to raise over £1.3million to save the project.

Here is Vulcan XH558 in her hangar at Bruntingthorpe in March 2007, about three-quarters of the way through the two year programme of work to restore her to flight. You can see that the rudder on the fin and the elevon control surfaces on the rear of the wing have all been re-fitted. On the top of the wing, the metal skin has been peeled back to expose the main structure of the wing which provides it with its great strength. Some of this structure was corroded and had to be replaced. At the bottom left in their protective bags are three of the Rolls-Royce Olympus engines, each of which can produce 8.5 tonnes of thrust.





Dr Robert Pleming

Baroness Thatcher

Gerald Howarth MP, Shadow
Defence Minister, & aide to
Baroness Thatcher

Air Chief Marshal Sir Michael
Knight, OC No.1 Group RAF
during the South Atlantic
Conflict

The Vulcan to the Sky Trust has been pleased to welcome many visitors, but one of the most important was Baroness Thatcher, who was British Prime Minister during the South Atlantic Conflict in 1982. Thatcher visited XH558 in March 2007, as part of the 25th anniversary commemorations of the Conflict. She met for the first time some of the Vulcan aircrew who had flown “*Black Buck*” missions to the Falklands.



After extensive tests, XH558's Olympus engines were started up for the first time in August 2007. A further two months of testing on the ground followed, to ensure that XH558 was 100% ready for flight.



Finally, 15 years after its last flight & with over £7million spent, Vulcan XH558 roared into the air again on Thursday 18th October 2007, a perfect day for flying. An unforgettable day for the Vulcan to the Sky team.

Some Press Cuttings from the following day...

30 | News

The Times



THE TIMES Friday October 19 2007

Vulcan flies again after restoration

BRUNTINGHORPE A Vulcan bomber, a relic of the Cold War era, undertook its first flight for 14 years yesterday.

The Avro Vulcan XH558, which can reach speeds of up to 645mph, completed a 20-minute test flight after a 16 million restoration. The bomber was the last of the aircraft to fly in 1993 when it was put in a hangar at an airfield in Bruntingthorpe, Leicestershire. It was the first time that an aircraft of the Vulcan's complexity had been given an extended overhaul and then returned to flight, meeting all current aviation standards, said the "Vulcan to the Sky" Trust.

Sun



THE iconic Vulcan bomber gets a warm welcome back as the last airworthy one takes to the skies yesterday for the first time in 14 years.

The plane — a vital part of Britain's prime nuclear deterrent during the Cold War — has undergone a £6million restoration.

The Avro Vulcan XH558 wowed crowds as it reached speeds of 645mph and soared 3,000ft into the air during the 20-minute test flight at Bruntingthorpe airfield, Leics.

Captain Al McDielen said: "It was a tremendous privilege to fly a Vulcan again."

Martin Withers, who piloted one of the jets on the famous Black Buck missions in the Falklands War, worked on the Vulcan to the Sky project. He said: "It played such an important role."

WARM VULCAN BACK!

Daily Telegraph



After a £6m facelift, Vulcan rules the skies again

A VULCAN bomber took off for the first time in 14 years yesterday.

The Avro Vulcan XH558 was the last of the model to fly in 1993 when it was retired to an airfield in Bruntingthorpe, Leics. After a £6million restoration project it was returned to flight. The 645mph monster flew for about 20 minutes burning fuel worth more than £1,000, according to *The Daily Telegraph*.

Readers of *The Daily Telegraph* helped to raise more than £300,000 towards the restoration while the property developer Sir Jack Hayward donated £500,000. It is the first time an aircraft of the Vulcan's complexity has been overhauled and returned to flight, said the Vulcan to the Sky Trust. With a characteristic screeching roar, the plane rose into the sky at Bruntingthorpe watched by supporters, sponsors and engineers. Just over 20 minutes later, and to widespread relief, co-pilots Al McDielen and David Thomas landed.

Sgt Ldr McDielen said: "It was a tremendous privilege to fly it again."

Daily Mail, Friday, October 19, 2007

The Lord of the Skies

After a £6m restoration, the last airworthy Vulcan roars back to life



RESTORATION OF THE XH558

- Over 6 tons of spares removed
- 12 miles of wiring replaced
- Flying controls replaced
- 4 new Rolls Royce Olympus 702 engines
- 47 mission systems (including bombing systems) replaced with modern GPS

AVRO VULCAN FACTFILE

- Wingspan: 111ft
- Max speed: 645mph
- Range: 4,600 miles
- Fuel: Engines burn five tons an hour
- costing £30,000.
- Payload: Nuclear bomb or 27 x 1,000 lb bombs
- Crew: Five

WITH a thunderous roar, the last airworthy Vulcan bomber takes to the skies after a £6million restoration project.

The awesome sight of the mighty Cold War aircraft lifting off with its four Rolls Royce engines booming, brought spontaneous applause from hundreds of onlookers yesterday.

It was an emotional moment for members of the charitable trust who have worked for eight years to return the Vulcan to the skies for the nation.

Their labour of love was financed by £2.7million from the Heritage Lottery Fund and a similar amount from the public, who responded to an appeal.

The aircraft — serial number XH558 — was built in 1960. The rest of the 136 Vulcans that served with the RAF between 1957 and 1994 have either been scrapped or are part of a round-the-clock standby to deliver nuclear weapons to the Soviet Union.

In its Cold War heyday, the Vulcan was on devastation to the Soviet Union.

During the Falklands War five to record-breaking 8,000-mile flights were made from Ascension Island and back to bomb Port Stanley's runway. Most Vulcans were retired by the mid-Eighties, but XH558 carried on with airshow duties for the RAF until 1992 when it was bought for £25,000 by David Walton, owner of Bruntingthorpe airfield in Leicestershire. It was later sold to the Vulcan to the Sky Trust.

Yesterday it successfully completed its first flight without a hitch, piloted by Squadron Leader Al McDielen, 62, said: "It was an absolute delight to fly just as I remember."

David Wilkes

Daily Mail



The news of the return of the Vulcan to flight spread right around the world.

Here, celebrating in Ethiopia, is one of our wide range of supporters: a Gelada Baboon, who has the shape of a Vulcan on his chest as a natural marking!

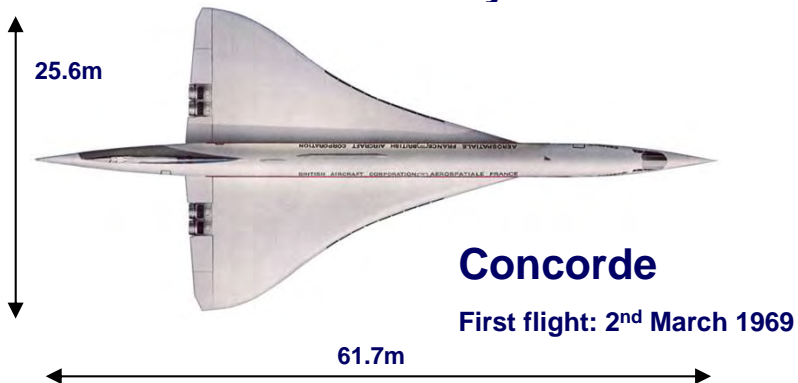
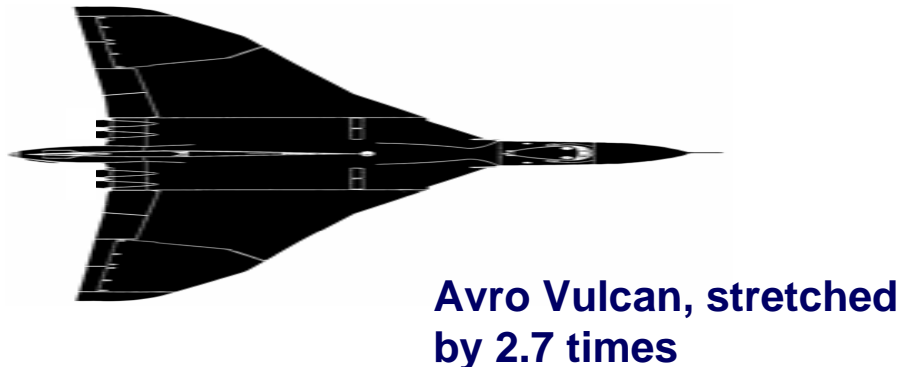
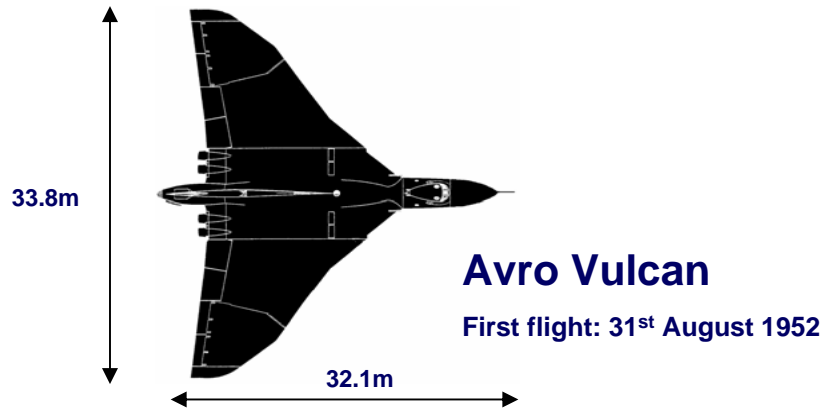
XH558 takes-off on a test flight past Bruntingthorpe Village on 6th May 2008

Telling the story of the Cold War

Inspiring a new generation of the young in design & engineering

As well as flying Vulcan XH558, the Vulcan to the Sky Trust has some major educational objectives: helping people to understand the history of the Cold War (1946 – 1991), and inspiring the young in technology.

The Avro Vulcan, an aircraft years ahead of its time



This is the X-48B, a 3-metre wingspan scale model of a new design of more environmentally-friendly aircraft known as “blended wing body” aircraft. The model was built by Cranfield Aerospace to a Boeing/NASA design for wind-tunnel tests in 2006. A bigger 11-metre version has subsequently been flown in the USA. Note how similar its shape is to the Vulcan, which was designed over 60 years previously.

At the Science Museum, London, now:

DAN DARE & the BIRTH OF HI-TECH BRITAIN



- Free
- Opening Dates
Wed 30 Apr 2008 - Sun 25 Oct 2008

Dan Dare's rocket fleet roars high over Venus to trounce his arch foe – the power-mad Mekon. Meanwhile, back on Earth, another extraordinary future is unfolding – one which laid the foundation for Britain's hi-tech consumer society. After 1945, though war-weary and broke, Britain found huge pride in wartime advances such as radar, penicillin and the jet engine. Discoveries like these were now tipped to kick-start world-beating industries, bring prosperity and bankroll the emerging welfare state. In an age before globalisation, products from rockets to radios sprang from local roots. Together they reveal a fascinating 'lost world' of British design and invention – a glimpse of a time when the TV in the corner was a Murphy, not a Sony. This exciting new temporary exhibition explores the role played by technology in creating post-war Britain. Some of the things you can find on display, include the Bloodhound guided missile, a Rolls Rapide twin-tub washing machine and the famous Dan Dare himself.

And at the Victoria & Albert Museum, later this year:

Cold War Modern: Art & Design in a Divided World, 1945-1975

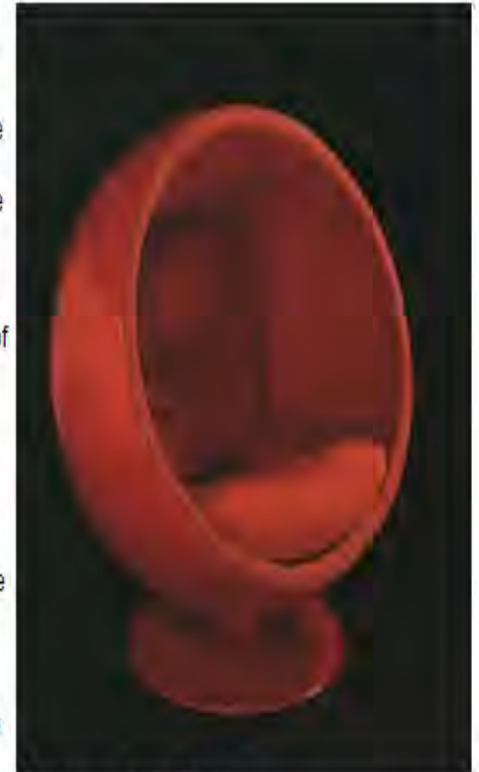
27 September 2008 – 11 January 2009

Admission charge will apply

The Cold War era was one of high tensions and exceptional creativity, which touched every aspect of life from everyday goods to the highest arenas of human achievement in science and culture. From the space race to the arms race, the technology of the period had a profound effect upon everything from the arts of protest to the design of the home.

Concentrating on the highly volatile years from 1945 to 1975, the exhibition will examine the key themes of the period including the task of reconstruction in Europe after the war and the rise of consumerism. The strong influence of the Cold War upon popular culture will be shown through graphics, fashion, film and product design.

Art and design during this period played a central role in representing and, sometimes challenging, the dominant political and social ideas of the age. The exhibition will showcase remarkable works by internationally renowned artists and designers alongside the forgotten figures of the Cold War era, including rarely seen objects from Eastern Bloc countries.



Eero Aarnio Globe Chair

XH558 takes off at Farnborough International 2008 on Friday 18th July, the star of the show. See a video of the display at <http://uk.youtube.com/watch?v=u6Hxty0swbE>



Honouring the Past, Inspiring the Future

Avro Vulcan B.Mk2 XH558, the only flying Vulcan in the world, returned to air displays in July 2008

To keep XH558 flying at air shows & to deliver our inspirational educational activities, the Vulcan to the Sky Trust has to raise £1.6million per year.

We are now totally reliant on donations from the public and on sponsorship.

If you enjoyed this presentation, please make a donation, or join our Supporters' Club, by visiting:

www.vulcantothesky.com

If you would like to discuss sponsorship, please email:

michael@greenwayseditions.com

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