GERMAN THINKING AND BRITISH DESIGN: A CENTURY OF JOINT WORK IN AEROSPACE, 1950-2050

RAES HAMBURG

5TH NOVEMBER 2020

Dr Michael Pryce
@MichaelJPryce

Future Projects Research

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German Thinking and British Design: A Century of Joint Work in Aerospace, 1950-2050

Dr. **Michael Pryce**, Combat Air Advisor/Analyst, Future Projects Research

Date: **Thursday, 05 November 2020, 18:00**
Online: http://purl.org/ProfScholz/zoom/2020-11-05

Lecture followed by discussion
No registration required!

Voyager tanking

There is nothing more international than air, yet most histories of aviation take a very national view. In this talk a contrast will be drawn between such narrow approaches and the lived experience of aerospace engineers in Germany and Britain since the middle of the twentieth century.

The detailed exploration of V/STOL aircraft, the Tornado and Typhoon programmes and the evolution of Airbus will show the ways in which German thinking about aircraft, project management and collaboration have shaped the development of the British industry.

Although recent events may seem to challenge the future of British integration with the European aerospace industry, the talk will show that the interdependence will likely continue, and will briefly explore future prospects, such as FCAS.

Mike is a Combat Air Advisor/Analyst and has worked as a contractor at DSTL in the UK. Until 2019 he was a lecturer in Defence Acquisition at Cranfield Defence and Security at Cranfield University and ran the Low Cost by Design research network.

He received a DPhil in Science & Technology Policy at the University of Sussex and an MSc in the History of Technology at Imperial College, London.

DGLR / HAW Prof. Dr.-Ing. Dieter Scholz Tel.: (040) 42875 8825 info@ProfScholz.de
RAeS Richard Sanderson Tel.: (04167) 92012 events@raes-hamburg.de

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The **A330-200 multi-role transport and tanker (MRTT)** is refueling two **Eurofighter Typhoon**.

The Airbus A330 MRTT is a military derivative of the A330-200 airliner. It is designed as a dual-role air-to-air refueling and transport aircraft. For air-to-air refueling missions the A330 MRTT can be equipped with a combination of any of the following systems.

The A330 MRTT has a maximum fuel capacity of 111,000 kg (245,000 lb) without the use of additional fuel tanks, which leaves space for the carriage of 45,000 kg (99,000 lb) of additional cargo.

The A330 MRTT cabin can be modified to carry up to 380 passengers in a single class configuration, allowing a complete range of configurations from maximized troop transport to complex customization suitable for VIP and guest missions. Available configurations include 300 passengers in a single class and 266 passengers in two classes. The A330 MRTT can also be configured to perform Medical Evacuation (Medevac) missions; up to 130 standard stretchers can be carried. The main deck cargo configuration allows carriage of standard commercial containers and pallets, military, ISO and NATO pallets (including seats) and containers, and military equipment and other large items which are loaded through a cargo door. Like the A330-200, the A330 MRTT includes two lower deck cargo compartments (forward and aft) and a bulk area capability. The cargo hold has been modified to be able to transport up to eight military pallets in addition to civilian unit load devices (ULDs).

(https://en.wikipedia.org/wiki/Airbus_A330_MRTT)

Karl Wilhelm **Otto Lilienthal** (23 May 1848 – 10 August 1896) was a German pioneer of aviation who became known as the "flying man". He was the first person to make well-documented, repeated, successful flights with gliders. Newspapers and magazines published photographs of Lilienthal gliding, favorably influencing public and scientific opinion about the possibility of flying machines becoming practical. On 9 August 1896, his glider stalled and he was unable to regain control. Falling from about 15 m (50 ft), he broke his neck and died the next day.

Lilienthal's greatest contribution was in the development of heavier-than-air flight. He made his flights from an artificial hill he built near Berlin and from natural hills, especially in the Rhinow region.

The filing of a U.S. Patent in 1894 by Lilienthal directed pilots to grip the "bar" for carrying and flying the hang glider. The A-frame of Percy Pilcher and Lilienthal echoes in today's control frame for hang gliders and ultralight aircraft. Working in conjunction with his brother Gustav, Lilienthal made over 2,000 flights in gliders of his design starting in 1891 with his first glider version, the Derwitzer, until his death in a gliding crash in 1896. His total flying time was five hours.

At the beginning, in 1891, Lilienthal succeeded with jumps and flights covering a distance of about 25 meters (82 ft). He could use the updraft of a 10 m/s wind against a hill to remain stationary with respect to the ground, shouting to a photographer on the ground to maneuver into the best position for a photo. In 1893, in the Rhinow Hills, he was able to achieve flight distances as long as 250 meters (820 ft). This record remained unbeaten for him or anyone else at the time of his death.

Lilienthal did research in accurately describing the flight of birds, especially storks, and used polar diagrams for describing the aerodynamics of their wings. He made many experiments in an attempt to gather reliable aeronautical data.

(https://en.wikipedia.org/wiki/Otto_Lilienthal)

WORKING WITH AIR

The **rubber rope start** was - after the "running start" as it is still carried out by hang-gliders today - **in the early days of gliding**, due to the lack of other options, the usual start method. Since only a few meters height can be reached with this type of take-off, it is only useful where this low height is sufficient to slide into the slope wind, i.e. on a mountain or a dune. Historically, the first established glider flying locations were the Wasserkuppe and the dune near Rossitten (today Rybatschi). Nowadays, the rubber rope launch for high-performance gliders is no longer of practical importance, but is still carried out by enthusiasts with suitable gliders.

With the rubber rope start you start downhill against the wind (see sketch). A starting team of four to ten, and up to fourteen "rubber dogs" on the level, first tighten the rope construction at walking pace, then with momentum at a running pace. This consists of two rubber ropes each approx. 25 m long. Alternatively, the front pull ropes are inelastic and provided with knots at equal intervals, which the "rubber dogs" grapple with with non-slip gloves; A long elastic rope is then used as the main rope (often a bungee rope). Shortly before the increasing tension on the front ropes stops the helpers, the holding rope (at the tail of the glider)) is cut at the holding peg or released from a ground anchor device at the command of the start master (or the start master himself), and the aircraft takes off quickly. Nowadays, the holding peg is often replaced by a four to six-person holding team, or a holding team of around three people supplements the function of the holding peg and ensures that the aircraft can take off with horizontal wings after the tether has been cut / released. After take-off, the starter rope is disengaged from the aircraft.

The initial speed of around 45 to 50 km / h achieved with this method is not sufficient for today's heavy aircraft. In addition, much more helpers are required for a rubber rope launch than for a winch or aircraft tow, so that the cost-to-income ratio is unattractive.

(https://de.wikipedia.org/wiki/Segelflug#Gummiseilstart)

TAKEAWAY TECHNOLOGY

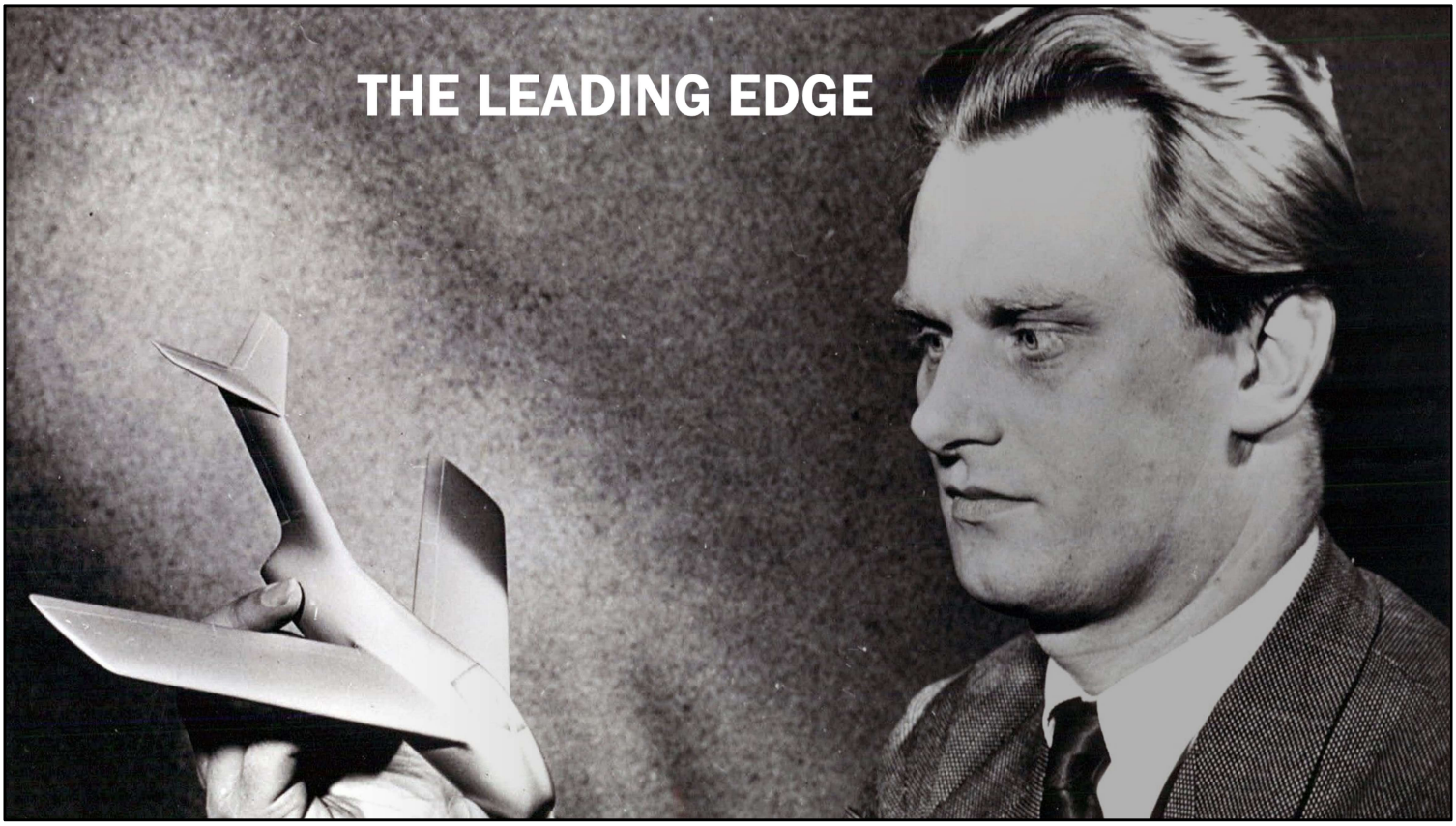
The **Fedden Mission** was a British scientific mission sent by the Ministry of Aircraft Production to Germany at the end of the Second World War in Europe, to gather technical intelligence about German aircraft and aeroengines. It was named for the Mission's leader, Roy Fedden. It visited Bad Oeynhausen, Bad Eilsen, Völkenrode, Braunschweig, Magdeburg, Oschersleben Staßfurt, Dessau, Kothen, Nordhausen, Göttingen, Kassel, Eisenach, Frankfurt, Rüsselsheim, Darmstadt, Stuttgart, Esslingen, Reutlingen, Mengen, Lindau, Freising, Munich, Rosenheim, Kochel, Oberammergau, Kolbermoor, Salzburg, Spittal, Villach, and Klagenfurt. This is much less than the fifty-two locations they had intended to visit when the Mission began.

The Mission was inspired in part by the similar American scientific mission, Operation Lusty, as well as by the German advances in jet aircraft and engines, as well as ballistic missiles, toward the war's end. It was also, in part, inspired by the desire to disarm Germany and prevent another postwar rise, like the one following the end of the First World War.(Unspoken, but also doubtless a factor, was a desire to keep Britain from becoming a second-rate nation.) In the event, the capture of German technology by both the United States and Soviet Union contributed to an acceleration of the postwar arms race.

Organized at the instruction of Stafford Cripps, then Minister of Aircraft Production, the Mission consisted of Fedden; Dr. W. J. Duncan, Professor of Aeronautics from University College of Hull, then seconded to the Royal Aircraft Establishment (RAE); J. C. King of RAE's Structural and Mechanical Engineering Department; Flight Lieutenant A. B. P. Beeton, RAF, of RAE's Engine Department; Bert Newport of Rotol, Ltd. They were assisted by W. J. Stern of the Allied Control Commission and Wing Commander V. Cross, RAF, the Mission's Liaison Officer to Supreme Headquarters Allied Expeditionary Force (as well as its translator); their two RAF Dakotas were flown by F/L Reid, RAF, and F/L Cheany, RAFVR. These aircraft each carried one of the Mission's Jeeps, which they soon learned to unload and have on the road in only ten minutes.

Everywhere the Mission went, it encountered looting by Allied troops and German civilians, and sabotage by German factory workers and the Heer (on Hitler's orders) The German scientists and technicians were, in general, very co-operative with the British interviewers, with Fedden mentioning "considerable apprehension" about their fate and some wishing to emigrate to the U.S. or Canada. (They had genuine concern about forced emigration to the Soviet Union, as many of the V-2 program scientists suffered.)

(https://en.wikipedia.org/wiki/Fedden_Mission)



Hans Multhopp, holding a model of the **Focke-Wulf Ta 183** Huckebein WW2 wind tunnel test model.

Hans Multhopp (17 May 1913 – 30 October 1972) was a German aeronautical engineer/designer. Receiving a degree from the University of Göttingen, Multhopp worked with the famous designer Kurt Tank at the Focke-Wulf Flugzeugbau AG during World War II, and was the leader of the team responsible for the design of the Focke-Wulf Ta 183 lightweight jet fighter,[which was the winner of the 1945 Emergency Fighter Competition. Emigrating to the United Kingdom after the war, he assisted in the advancement of British aeronautic science before moving to the United States, where his work for Martin Marietta on lifting bodies provided aerodynamic experience that proved instrumental in the development of the Space Shuttle.

Multhopp had chosen to emigrate to the United Kingdom in 1945, where he was quickly employed by the Royal Aircraft Establishment (RAE) at Farnborough. Aerodynamicist Martin Winter, Multhopp's assistant at Focke Wulf, accompanied his former team leader to RAE Farnborough.

During four years spent working at Farnborough, Multhopp and Winter's studies of swept-wing planforms resulted in the design of a unique high-speed research aircraft to be powered by the Rolls-Royce AJ65 Avon. The salient features included jettisonable wheels (landing was achieved with a retractable skid landing gear), a prone pilot position in the nose with the cockpit enclosure centered in the nose (four windows framed the circular intake), a T-tail and mid-mounted swept-wing, swept at 40°. The RAE supersonic research vehicle designed in 1947–1948 and intended for speeds up Mach 1.24 at 36,000 ft, may have inspired parts of the design of "Teddy" Petter's Lightning fighter. The RAE project was not funded and remained a moribund "paper project." In addition, Multhopp also developed a theory for calculating the lift distribution of wings at subsonic speeds.

In 1949, the Glenn L. Martin Company (later Martin Marietta) of Essex, Maryland made efforts to recruit Multhopp to their staff of aeronautical engineers. These efforts proved successful, and he left his position at Farnborough to emigrate to the United States.

(https://en.wikipedia.org/wiki/Hans_Multhopp)

Shorts SB5 research aircraft to provide input for the design of the English Electric P.1 (prototype of the English Electric Lightning) by testing the low speed flight characteristics of various configurations of wing-sweep required for supersonic flight.

The Short SB.5 (serial WG768) was a highly unorthodox, adjustable wing British research aircraft designed by Short Brothers in response to the UK Air Ministry requirement ER.100; to provide input for the design of the English Electric P.1 (prototype of the English Electric Lightning) by testing the low speed flight characteristics of various configurations of wing-sweep required for supersonic flight. The tailplane could be mounted either on top of the fin (T-tail) or below the fuselage. The tests ultimately confirmed that the original P.1/Lightning design was an effective configuration for high speed flight.

The contract was awarded to Short Brothers and Harland Ltd of Belfast on 2 August 1950. The machine was designed to allow three different wing sweep angles (50°, 60° and 69°). The sweep adjustment of the wings was made when the aircraft was on the ground. Two different tail plane positions (a) low on the rear fuselage and (b) on top of the fin, were also tested. The complete rear fuselage, just aft of the engine, was detachable and two alternative rear fuselages were available, one with the tailplane set on top of the fin and the other with the tailplane set below the fuselage. The tailplane angle was adjustable in flight, being electrically actuated.

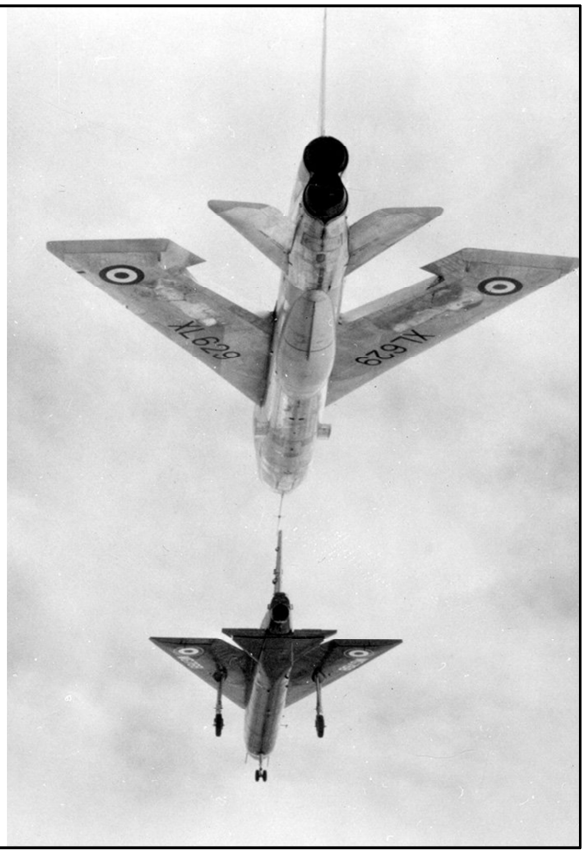
(https://en.wikipedia.org/wiki/Short_SB.5)

THE SUPERSONIC FIGHTER

"There was a German working at RAE, who had worked in the German industry during the war, who was starting to convince people that supersonic flight was really practicable.

People began to modify the original view that supersonic flight was too difficult to a view that, although there were problems, they were not insuperable."

F W 'Freddie' Page, English Electric



English Electric Lightning T4.

The English Electric Lightning is a British fighter aircraft that served as an interceptor during the 1960s, the 1970s and into the late 1980s. It remains the only UK-designed-and-built fighter capable of Mach 2. The Lightning was designed, developed, and manufactured by English Electric, which was later absorbed by the newly-formed British Aircraft Corporation. Later the type was marketed as the BAC Lightning. It was operated by the Royal Air Force (RAF), the Kuwait Air Force (KAF) and the Royal Saudi Air Force (RSAF).

A unique feature of the Lightning's design is the vertical, staggered configuration of its two Rolls-Royce Avon turbojet engines within the fuselage. The Lightning was initially designed and developed as an interceptor to defend the V bomber airfields from attack by anticipated future nuclear-armed supersonic Soviet bombers such as what emerged as the Tupolev Tu-22, but it was subsequently also required to intercept other bomber aircraft such as the Tupolev Tu-16 and the Tupolev Tu-95.

The Lightning has exceptional rate of climb, ceiling, and speed. This performance and the initially limited fuel supply meant that its missions are dictated to a high degree by its limited range. Later developments provided greater range and speed along with aerial reconnaissance and ground-attack capability.

Following retirement by the RAF in the late 1980s, many of the remaining aircraft became museum exhibits.

(https://en.wikipedia.org/wiki/English_Electric_Lightning)

Sir **Morien Morgan**, Chairman of the Supersonic Transport Aircraft Committee (STAC) with a **Concorde wind tunnel model**.

Sir Morien Bedford Morgan CB FRS(20 December 1912 – 4 April 1978), was a noted Welsh aeronautical engineer, sometimes known as "the Father of Concorde". He spent most of his career at the Royal Aircraft Establishment (RAE).

In 1948 Morgan began research into the development of a supersonic passenger airliner. In November 1956 he became Chairman of the newly formed Supersonic Transport Aircraft Committee, or STAC. STAC funded research into the SST field at several UK aviation firms though the 1950s.

During the Concorde work, Morgan tirelessly worked through problems, both technical and political, to see the project to its conclusion. Alternating with his French counterpart, Robert Vergnaud, he chaired the Concorde oversight committee from 1963 when work began in earnest, to 1966 when prototype construction was well advanced. Given the aircraft was the first of its sort, the relatively rapid progress from design to construction is notable (testing and certification took much longer, however).

(https://en.wikipedia.org/wiki/Morien_Morgan)

Concorde & A300B

The **Aérospatiale/BAC Concorde** is a British–French turbojet-powered supersonic passenger airliner that was operated from 1976 until 2003. It had a maximum speed over twice the speed of sound, at Mach 2.04 (1,354 mph or 2,180 km/h at cruise altitude), with seating for 92 to 128 passengers. First flown in 1969, Concorde entered service in 1976 and operated for 27 years. It is one of only two supersonic transports to have been operated commercially; the other is the Soviet-built Tupolev Tu-144, which operated in the late 1970s. Concorde was jointly developed and manufactured by Sud Aviation (later Aérospatiale) and the British Aircraft Corporation (BAC) under an Anglo-French treaty. Twenty aircraft were built, including six prototypes and development aircraft. Air France and British Airways were the only airlines to purchase and fly Concorde.
(https://en.wikipedia.org/wiki/Concorde)

The **Airbus A300** is a wide-body airliner developed and manufactured by Airbus. In September 1967, aircraft manufacturers in the United Kingdom, France, and West Germany signed a memorandum of understanding to develop a large airliner. Germany and France reached an agreement on 29 May 1969 after the British withdrew from the project on 10 April 1969. European collaborative aerospace manufacturer Airbus Industrie was formally created on 18 December 1970 to develop and produce it. The prototype first flew on 28 October 1972.
(https://en.wikipedia.org/wiki/Airbus_A300)

Prototype Panavia Tornado multirole combat aircraft (MRCA) **P01**.

The Panavia Tornado is a family of twin-engine, variable-sweep wing multirole combat aircraft, jointly developed and manufactured by Italy, the United Kingdom and West Germany. There are three primary Tornado variants: the Tornado IDS (interdictor/strike) fighter-bomber, the suppression of enemy air defences Tornado ECR (electronic combat/reconnaissance) and the Tornado ADV (air defence variant) interceptor aircraft.

The Tornado was developed and built by Panavia Aircraft GmbH, a tri-national consortium consisting of British Aerospace (previously British Aircraft Corporation), MBB of West Germany, and Aeritalia of Italy. It first flew on 14 August 1974 and was introduced into service in 1979 – 1980. Due to its multirole design, it was able to replace several different fleets of aircraft in the adopting air forces. The Royal Saudi Air Force (RSAF) became the only export operator of the Tornado in addition to the three original partner nations.

(https://en.wikipedia.org/wiki/Panavia_Tornado)

Eurofighter, artists impression

The Eurofighter Typhoon is a European twin-engine, canard delta wing, multirole fighter. The Typhoon was designed originally as an air superiority fighter and is manufactured by a consortium of Airbus, BAE Systems and Leonardo that conducts the majority of the project through a joint holding company, Eurofighter Jagdflugzeug GmbH. The NATO Eurofighter and Tornado Management Agency, representing the UK, Germany, Italy and Spain manages the project and is the prime customer.

The aircraft's development effectively began in 1983 with the Future European Fighter Aircraft program, a multinational collaboration among the UK, Germany, France, Italy and Spain. Previously, Germany, Italy and the UK had jointly developed and deployed the Panavia Tornado combat aircraft and desired to collaborate on a new project, with additional participating EU nations. However disagreements over design authority and operational requirements led France to leave the consortium to develop the Dassault Rafale independently. A technology demonstration aircraft, the British Aerospace EAP, first flew on 6 August 1986; the first prototype of the finalized Eurofighter made its first flight on 27 March 1994.

The Eurofighter Typhoon is a highly agile aircraft, designed to be a supremely effective dogfighter in combat. Later production aircraft have been increasingly better equipped to undertake air-to-surface strike missions and to be compatible with an increasing number of different armaments and equipment.

(https://en.wikipedia.org/wiki/Eurofighter_Typhoon)

VAK 191B VTOL aircraft, in the middle test pilot **Ludwig Obermeier** and Project Manager Dr.-Ing. **Rolf Riccius**.

The VFW VAK 191B was an experimental German vertical take-off and landing (VTOL) strike fighter of the early 1970s. VAK was the abbreviation for Vertikalstartendes Aufklärungs- und Kampfflugzeug (Vertical Take-off Reconnaissance and Strike Aircraft). Designed and built by the Vereinigte Flugtechnische Werke (VFW), it was developed with the purpose of eventually serving as a replacement for the Italian Fiat G.91 then in service with the German Air Force. Operationally, it was intended to have been armed with nuclear weapons as a deterrent against aggression from the Soviet Union and, in the event of a major war breaking out, to survive the first wave of attacks by deploying to dispersed locations, rather than conventional airfields, and to retaliate against targets behind enemy lines.

The VAK 191B suffered from a protracted development cycle, spanning ten years between inception and flight, in part due to changing requirements, partnerships changing, and the difficulty inherently associated in the development of VTOL-capable aircraft. Ultimately, during the late 1960s, VFW took the decision to demote the development program from targeting the type's production and instead only to test-fly a limited number of prototypes, using the VAK 191B effectively as a technology demonstrator and experimental aircraft to support the company's other activities and future programs. On 10 September 1971, the first prototype conducted the type's maiden flight. A total of 91 flights were performed prior to the retirement of all three prototypes in 1975.
(https://en.wikipedia.org/wiki/VFW_VAK_191B)

Hawker Siddeley P1127, first production aircraft of the Tripartite Squadron batch.

The Hawker P.1127 and the Hawker Siddeley Kestrel FGA.1 are the experimental and development aircraft that led to the Hawker Siddeley Harrier, the first vertical and/or short take-off and landing (V/STOL) jet fighter-bomber.

Development began in 1957, taking advantage of the Bristol Engine Company's choice to invest in the creation of the Pegasus vectored-thrust engine. Testing began in July 1960 and by the end of the year the aircraft had achieved both vertical take-off and horizontal flight. The test program also explored the possibility of use upon aircraft carriers, landing on HMS Ark Royal in 1963. The first three aircraft crashed during testing, one at the 1963 Paris Air Show.

Improvements to future development aircraft, such as swept wings and more powerful Pegasus engines, led to the development of the Kestrel. The Kestrel was evaluated by the Tri-partite Evaluation Squadron, made up of military pilots from the United Kingdom, the United States, and West Germany. Later flights were conducted by the U.S. military and NASA.

Related work on a supersonic aircraft, the Hawker Siddeley P.1154, was cancelled in 1965. As a result, the P.1127 (RAF), a variant more closely based on the Kestrel, was ordered into production that year, and named Harrier – the name originally intended for the P.1154 – in 1967. The Harrier served with the UK and several nations, often as a carrier-based aircraft.

(https://en.wikipedia.org/wiki/Hawker_Siddeley_P.1127)


WHAT TO FLY?

KNOWING WHEN TO STOP

JOHANNA WEBER

Johanna Weber (8 August 1910 – 24 October 2014) was a German-born British **mathematician and aerodynamicist**. She is best known for her contributions to the development of the Handley Page Victor bomber and the Concorde.

In 1939, Weber joined the Aerodynamics Research Institute (Aerodynamische Versuchsanstalt Göttingen) in Göttingen. She was part of a small theoretical team, and her initial training in aerodynamics consisted of wind tunnel corrections. Here she met and began her lifelong collaboration with Dietrich Küchemann. Weber doing the theoretical development and wind tunnel testing, and Küchemann setting the direction of their research based on his consultation with manufacturers. Over the period of the Second World War, they created a substantial body of work.

Following the capture of Göttingen by the US Army in 1945, the city fell into the British occupation zone. The British paid Weber and Küchemann to compile a monograph of their researches. These would form the basis of their text Aerodynamics of Propulsion. They also encouraged German scientists to take up six month contracts at various defence facilities in the UK as part of the combined US-UK plan (Operation Paperclip and Operation Surgeon) to acquire German services and technologies. In October 1946, Küchemann joined the Aerodynamics department at the Royal Aircraft Establishment in Farnbourough, and persuaded Weber to join him. Both of them continued to renew their six-month contracts, although both remained classed as enemy aliens, until 1953 when both were naturalized as British citizens.

(https://en.wikipedia.org/wiki/Johanna_Weber)

Vielen Dank für Ihre Zeit heute Abend.

Bitte stellen Sie Fragen

michaelpryce@hotmail.com

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