Air Marshal Graeme Alan Robertson

DEVELOPMENTS IN UK AVIATION

Let me first say what an honour it is to be asked to speak at this conference. There have certainly been some remarkable developments in the story of powered flight since 17 December 1903. To compress the events of the past 100 years into less than an hour is a daunting task, so what I want to do is pick out just some of the key moments in UK aviation during the last 100 years or so. In doing so I'm going to concentrate on a few of the people who contributed to the inspiring story of flight and, in particular, I want to look at some of the qualities they exhibited. The history of powered flight is as much a human story as it is a technical one. Man's prodigious progress owes a great deal to the characteristics of enterprise, ingenuity, innovation, vision, courage and tenacity — qualities exemplified by this man.

DOUGLAS BADER

This is the legless World War II fighter pilot, Douglas Bader. And if there is a theme running through my talk, it's one that reflects the nobility of the human spirit. But before I go any further let me make it clear that it's as a professional aviator and an amateur student of human nature — not as a historian — that I'm going to dip selectively into the past.

My story begins with three contests — contests with unique sets of rules. They were organised by a London newspaper, the Daily Mail, in the early 1900's. I'll wait while these are translated: the London to Manchester flight; the Circuit of Britain and the 'water-plane flight round Great Britain.

The pioneers of British aviation owed much to the generosity of the newspaper's founder, Alfred, Lord Northcliffe. His first prize, of £10,000, for a flight from London to Manchester (a distance of less than 200 miles), was offered in November 1906.

The journey had to be completed in 24 hours, with not more than 2 stops *en route*. At the time the money seemed safe — so much so that Punch, the satirical magazine, offered a similar sum for the first man to swim the Atlantic and for the first flight to Mars and back within a week! But such was the pace of progress that by 1910 two competitors were ready to vie for the substantial prize: an Englishman, Claude Grahame-White, *holder of British pilot's certificate no 6 incidentally,* and a Frenchman, Louis Paulhan.

GRAHAME-WHITE

Grahame-White — *this is him here* — was first to attempt the journey, on 23 April, having beforehand persuaded the authorities to whitewash the railway tracks 100 yards or so north of every junction so that he could follow the correct route to Birmingham. But gusty winds in the Trent Valley forced him down just over 100 miles from London. Overnight these same winds blew over his Farman biplane in the field where it was left untethered — *an early lesson for the engineers there!* It had to be returned to London for repairs. Four days later Paulhan began his own journey. When Grahame-White heard this he set off again from London

in his restored machine late that same afternoon. He was still some miles behind when failing light forced him to land. Knowing that his only chance of catching Paulhan — who was well over half-way to Manchester — was to fly by night, and undeterred by the obvious dangers, he set off again just before 3 am. The field was lit by lamps at either end and his friends set out to guide him using fast cars with powerful lights and huge flares lit on railway stations. By daybreak Grahame-White had almost overhauled the Frenchman. However, a faltering engine and strong winds once again forced his flimsy craft down. The more experienced Paulhan was better able to cope with such weather — his Farman was certainly in better shape — and landed in Manchester in the early morning, earning £10,000 for his journey of just 186 miles.

The second £10,000 prize was offered a month later, in May 1910. The rules this time meant covering about 1,000 miles in a week, stopping at 11 fixed control points in an anti-clockwise route around the UK, with London as the start/finish point. Such was the rapid progress being made in aviation that 30 competitors registered to enter. The race began on 22 July of the following year. After the first 20-mile stage — essentially a spectator event across London — there were only 17 competitors left. *In these early days reliability was something of a problem.* Engine difficulties and a variety of other breakdowns soon reduced the original competitors to two — both Frenchmen. Victory finally went to a naval officer, Lieutenant Jean Conneau, in a time of 22 hours and 28 minutes — an average of about 45 mph. His success was attributed largely to his naval training and map reading. Incidentally, Conneau competed under the false name of 'André Beaumont' — all because the French Navy considered sport flying an unduly frivolous activity.

The third historic flight attracted a £5,000 prize. The rules again specified a counter-clockwise race against the clock, but this time staging through coastal ports — remember these were seaplanes. There were two other important conditions: contestants had to fly British aircraft fitted with British engines. This was because at the time British aeroplane and engine constructors lagged behind their French counterparts.

BLÉRIOT

You have to bear in mind here too the enormous impact of Blériot's 37-minute trip from Calais to Dover on 25 July 1909 — *a flight that incidentally earned him a £1,000 prize from the Daily Mail. In this slide you can just make out the white cliffs of Dover in the background.*

This third competition brought together two famous names in British aviation: Tommy Sopwith, the aircraft designer, and the man he chose as his pilot, Harry Hawker (an Australian).

Hawker's first attempt, on 16 August 1913, ended in failure. After leaving the start point, Southampton Water the south coast, he flew 240 miles in 240 minutes but was affected by sunstroke by the time he arrived on the east coast. Here he was replaced by another Australian, Sydney Pickles — quite within the rules because the contest was a test of British engineering, not British pilots. However, Pickles' own attempt was aborted. He had to beach his seaplane because of rough water. So Hawker restarted his journey at 5 in the morning of Monday 25 August, carrying his mechanic as a passenger. He had to contend with haze and strong winds (particularly in the up- and down-drafts in the mountains of Scotland — *these early craft were very flimsy as you'll have noted from my slides*.) He also suffered an overheating engine, valve problems and a waterlogged float — *that's a seaplane float, nothing to do with carburettors*. To give you a feel for the enthusiasm generated for this new science of aviation, some 40,000 people turned up to watch Hawker arrive in Scotland. Behind schedule

and no doubt tired by his exertions, when he was crossing Ireland Hawker's rubber-soled boot slipped off the rudder bar and, from a height of about 50 feet, his aircraft fell out of control into a lake. It was completely wrecked but, miraculously, he emerged unhurt; his mechanic was less fortunate - he broke an arm and was badly cut. But in the time-honoured British tradition of rewarding glorious failure the Daily Mail generously awarded Hawker a consolation prize of £1,000. This recognised not only how close he'd come to completing the course successfully, it exemplified the enthusiasm for flying that Hawker's exploits had generated — *not to mention the extra newspaper sales generated too of course!*

I'll come back to the importance of competition in aviation later. Let me first draw an early conclusion about those human qualities I referred to the outset. The pre-World War I days of aviation in Britain were marked not only by the ingenuity of engineers and the courage of their pilots; they were notable too for the vision and enterprise of those prominent in public life. People like Lord Northcliffe not only helped aviation begin to prosper, they also led the public at large to recognise that aircraft were a matter of national importance. Without its founder's encouragement, and without the Daily Mail's public-spirited sponsorship, I've no doubt that progress in aviation would have been considerably slower.

The lead-up to the First World War saw further evidence of the early technical lead the French had established in Europe. Britain lagged behind to the extent that in 1911 the French could muster over 200 aircraft during army manoeuvres, whereas between them the British army and navy could manage only 12, together with 3 airships. French influence was also evident in the early British aircraft design and nomenclature: hence the BE (Blériot Experimental)

FE2B

The FE (Farman Experimental, after the brothers Henri and Maurice Farman) — *this an FE2B here* — the SE (Santos Experimental, after the Brazilian, Santos-Dumont, the first man to fly in Europe and setter of the first world speed record — 25.7 mph — in France in November 1906), and the RE (Reconnaissance Experimental). However, with the establishment of the Royal Flying Corps, on 13 April 1912, and similar recognition of the Royal Aircraft Factory at Farnborough — something which capitalised on the nation's inherent technical expertise and industrial strength — Britain at last began to catch up with her continental rivals.

SE5A

As World War I progressed, Britain also began to match the skill of its pilots with world class aircraft-aircraft like the Sopwith Camel and the SE5A *you see here*. While on the subject of these magnificent men and their flying machines.

CLAXTON

It's interesting to see read the observations of a respected contemporary writer on aviation, William Claxton. I'll pause for a moment while it's translated. ***'A very striking feature of the*** **[Royal Flying]** ***Corps is the extreme youth of the members, many of the most daring fighters in the air being mere boys of 20. The Corps has the very pick of the youth and daring and enterprise of the country'.***

I think these words are a moving tribute to the RAF's predecessor, the Royal Flying Corps.

The Royal Air Force itself was formed on 1 April 1918. But as so often happens in such circumstances, its size couldn't be sustained in the aftermath of World War I.

RAF NUMBERS

These statistics highlight the nature of the problem. They show the size of the RAF in November of 1918. In order the slide shows the number of officers, the number of other ranks, the number of women, the number of aircraft and, finally, the number of airships. It was Winston Churchill, Secretary State for War and Air in January 1919, who was largely responsible for the salvation of the new Service.

TRENCHARD

He achieved this by inviting Hugh Trenchard back to his old position as Chief of the Air Staff. Then, in a far-sighted move, in April 1920 Trenchard opened the Royal Air Force College at Cranwell, in Lincolnshire — a measure, and a training environment, that was to underpin the RAF's future. Lord Trenchard, as he later became, was to all intents and purposes the father of the Royal Air Force. He exemplified the vision that was fundamental to the development of military aviation in general and the Royal Air Force in particular.

I'll return to Cranwell later — but I'm getting ahead of myself. Let me take you back to the morning of 28 April 1910. Among the thousands who watched Paulhan land in Manchester was an 18 year-old apprentice engineer called John Alcock. By 1913 he had qualified as a pilot and had even won a weekend race at Hendon Aerodrome. That same year his imagination was fired by a new challenge. Lord Northcliffe's newspaper was now offering a £10,000 prize for a flight across the Atlantic. The original rules allowed refuelling and repair *en route* and obviously favoured flying boats. But before anyone could take up the Daily Mail's latest challenge, World War I intervened. Alcock joined the Royal Naval Air Service but was shot down towards the end of the war while bombing the Turks. By coincidence, the man with whom he was to earn lasting fame as the first crew to complete a non-stop crossing of the Atlantic was another prisoner of war, this time of the Germans — Arthur Whitten 'Teddy' Brown.

ALCOCK & BROWN

With the end of the War, by 1919 the prize for a transatlantic flight had grown to £13,000 but the rules had changed. The flight was now to be non-stop — a tremendous challenge given that the shortest distance across the Atlantic, between Newfoundland and Ireland, is some 1880 miles. The contest spawned a number of entrants and resulted in a several abortive attempts. Alcock and Brown were amongst the last to start. Their aircraft, a Vickers Vimy, finally arrived in Canada in 13 wooden crates on 26 May — 16 days after Harry Hawker and his navigator had been rescued after ditching mid-Atlantic. I should perhaps add here that the intrepid Australian was given another consolation prize of £5,000 by a generous Daily Mail. Two weeks after its arrival, the Vimy was ready for testing and then, on 14 June, Alcock and Brown finally began their momentous journey.

VIMYS OVER EGYPT

Their aircraft was a modified version of the Vimys you see here over Egypt, powered by Rolls-Royce Eagle engines.

To say that their flight was hazardous would be an understatement. Brown, who was partially disabled after being shot down — he limped. Brown was regularly forced to climb out of the cockpit to clear icing. For his part, Alcock had to cope with engine shutdowns, loss of control and the resulting near fatal loss of altitude. When they eventually reached the Irish coast Alcock saw radio masts at Clifden, a military installation, and decided to land on what looked like a smooth green field nearby. It was actually a huge bog. Men on the ground tried to wave the aircraft away but the crew merely waved back. As the aircraft touched down, its wheels dug in, it nosed over and was severely damaged. This was partially Alcock's fault. To reduce drag he'd decided against adding a nosewheel — the very feature designed to prevent the aircraft from ploughing into the ground on landing. Fortunately, both men scrambled out largely unhurt. They'd been in the air for 16 hours and 28 minutes and had created history. When they reached London they were honoured by a reception at the Royal Aero Club and immediately knighted. The flight of these two pioneers represents a triumph of engineering and an inspiring example of out and out courage.

It would be hard to overstate the influence of the Royal Aero Club (the RAC as it was popularly known) in the early years of the last century. In March 1910 the Club became responsible for the control of all private and sporting flying in the UK, as well as records and competitions — indeed, it started with the Daily Mail events — it's a function that it continues to fulfil to this day.

EARLY AIR RACING RULES

It borrowed heavily from existing sports, including horse racing, for its early regulations — as you can see from this extract here. *'No rider shall interfere with another on the course'*. Club members also included all of the most famous names in British aviation.

On behalf of the International Aeronautical Federation the RAC also organised those Schneider Trophy Races that took place in Britain. (The rules dictated that the previous winner hosted the next race.)

This competition, one of the most important international events in aviation history, was conceived by a French Government official, Jacques Schneider, in 1911 — with an original prize of £1,000. The rules were somewhat bizarre. Aircraft had to float for 6 hours and further prove their seaworthiness by travelling some 500 metres on water. They also had to land on water twice during the course of the race. The rules also dictated that after 3 consecutive wins the Trophy became the permanent property of the country concerned. Britain first won the event in 1914, then again in 1922 when a Supermarine Sea Lion II flying boat designed by Reginald Mitchell set a new speed record of 145.7 mph (213.7 kph). In 1925 the Americans earned a second consecutive win due largely to the flying skill of Lieutenant Jimmy Doolittle, who went on to earn lasting fame during World War II leading the audacious Tokyo raid. This led to strenuous efforts on the part of the Italians and the British to deny the US a third win — and in 1926 the Italians duly took the Trophy with a Macchi 39.

SCHNEIDER TROPHY WINS

It was then won three times in succession by a series of Reginald Mitchell-designed Supermarine aircraft. The speeds were 413 kph in 1927, 481.9 kph in 1929 and 498.8 kph in 1931 respectively. *There are a couple of interesting post-scripts to this slide.* In 1929 the race became a biennial event but, when the time of the 1931race approached, the British Government had discontinued its support and the aviation industry seemed similarly disinterested. Fortunately Lady Lucy Houston came to the rescue. Variously described as an extreme patriot and an eccentric millionairess, she donated £100,000 to finance a new entry. In 6 short months Mitchell modified his previous winning design and produced the S6B *you see here*.

S6B

So it was the spirit of enterprise that contributed directly to Britain bringing home permanently the Schneider Trophy. The final post-script is that the same month that this occurred, an S6B flown by Flight Lieutenant George Stainforth set an absolute speed record of 407.5 mph (597.6 kph).

I said that I would come back to the importance of competition. The significance of the Schneider Trophy competition is that it compressed 20 years of aircraft research into a mere six. It also led Mitchell to spend his final years — *he died of cancer in 1937 at the age of only 42* — pressing the British Government to use what was learned in these races to develop his design into one of the most important fighter aircraft of World War II: the Spitfire.

SPITFIRES

This reinforces my thesis that progress in aviation has stemmed from a combination of pilot skill and engineering inspiration — underwritten invariably by courage and an entrepreneurial spirit.

5 March 1936 is the next important date in our journey through the last 100 years. That was the day when 'Mutt' Summers took off from Southampton in the prototype Spitfire. The first production aircraft followed rapidly in June 1938 and, when Britain went to war on 3 September 1939, more than 2,000 Spitfires were already on order. The marriage of Mitchell's beautiful design with the formidable Rolls-Royce Merlin engine produced a world beating and, in every sense of the words, a battle-winning aircraft. More than 20,000 Spitfires in over 40 different variants were built. Although the last aircraft rolled off the production line in 1947, a number are still lovingly maintained — and flown — by the RAF's Battle of Britain Memorial Flight. *Long may this continue.*

I suggest to you that the success enjoyed by of the outnumbered RAF in the Battle of Britain owed as much to the bravery of Spitfire and Hurricane pilots as it did to the quality of their aircraft.

HURRICANES

But in terms of courage — and here I want to distinguish between spontaneous acts of bravery and courage of a sustained nature — in terms of courage, in my view there is simply nothing to compare with the that shown by the crews of the RAF's Bomber Command.

BOMBER CREWS

Their teamwork would represent a fascinating case study for human psychologists. And within Bomber Command itself, no one exemplified courage more than Wing Commander Guy Gibson — who won the country's highest award for valour, the Victoria Cross.

GIBSON

He was in the last slide, but here's a better picture. His name will always be linked with that of Barnes Wallis through their combined efforts to destroy three important German dams in the spring of 1943. Ordinary bombs simply couldn't do the job. But Barnes Wallis came up with a unique solution. He designed an immense bomb, weighing more than 9,000 lbs, which would sink before exploding.

DAMBUSTER BOMB

Its destructive power would then be magnified by the hammer effect of shock waves moving through an incompressible fluid. The problem was that to function correctly the bomb had to be dropped from no more than 60 feet, some distance from the dam, so that it would skip across the water's surface and then strike the dam. It then had to sink 40 feet before detonating. In a daring night raid against well-defended targets, Gibson and his handpicked crews destroyed both the Möhne and the Eder dams — but they had nothing left with which to attack their third objective, the Sorpe dam.

MOHNE DAM

This is a contemporary German photo of the Möhne dam. Of 18 crews from 617 Squadron who took off on the 'Dambusters' raid, two failed to reach the target and eight were lost. While it didn't produce the hoped for effect — *the same was true of Doolittle's Tokyo raid of course* — the story of this attack reinforces my belief that progress in aviation owes much to individual ingenuity, inventiveness and bravery.

The next event I want to mention also occurred in World War II; however, its origins were much earlier. They go back to Trenchard's Royal Air Force College at Cranwell. It produced Douglas Bader, whom you saw earlier, and also one of the true pioneers of British aviation — a man who can genuinely claim to be a world figure: Frank Whittle.

WHITTLE

Much much further down the scale it produced me of course! It was Whittle who, in 1928, spelt out in detail the technical requirements for the jet engine. He patented his design 2 years later but no one showed any interest, probably because the metals required had yet to be developed. In 1935 the patent lapsed - although Whittle later renewed it. It wasn't until 1936, when he obtained private backing, that he began to turn his designs into reality. Meanwhile, through the work of Hans von Ohain, an assistant to Werner von Braun, the Germans had stolen a march on Whittle. The first flight of a jet aircraft, the Heinkel He176, took place at Rachlin in Germany on 3 July 1939. Whittle's engine didn't fly until nearly 2 years later, on 15 May 1941, in the experimental Gloster E28/39. However, Whittle can justifiably claim to share the title of inventor of the jet engine.

At this point progress in aviation begins to accelerate. Towards the end of World War II, the Martin-Baker Company began their pioneering work in the field of aircrew ejection. The need for such a system was accentuated by the death of a test pilot who used the standard over-the-side technique when baling out from an early version of the Gloster Meteor.

METEOR

He lost consciousness and didn't even attempt to open his parachute. Martin-Baker is the world leader in terms of ejection seats and escape mechanisms, having saved nearly 7,000 aircrew lives *(6,975 as of 24 March — 9 this year)*, nearly half of them American. But if Martin-Baker is a household name, Bernard Lynch certainly isn't. Yet Lynch deserves the military aviation industry's admiration and gratitude. On 24 January 1945 he subjected himself to the first static live ejection test. He was fired up a ramp in controlled conditions. Eighteen months later to the day, he completed the first live ejection test from a modified Meteor aircraft, flying at 320 mph (470 kph) at 8,000ft. He subsequently went on to carry out more than 30 live ejections. In the context of this presentation it's Bernard Lynch who stands for all the unsung heroes — men of tenacity and grit — who have helped advance the cause of aviation in Britain.

The next landmark in our journey occurred in June 1948. It takes us outside the UK but it does concern the RAF. This was when the Soviet Union closed all road and rail communications with West Berlin, denying access to the British, American and French sectors. Fortunately both the RAF and the USAF were ready to mount an airlift to keep their garrisons supplied. But the two governments decided to go a step further. They agreed to supply the needs of the entire civilian population of West Berlin (over 2 million people). In an operation of unprecedented scale, the two Air Forces ferried between 4,000 and 5,000 short tons of supplies into Berlin every day. The success of Operation Plain Fair, as it was known, led the Russians to lift their blockade on 12 May 1949, after it had been running for over 10 months. Because this Operation demonstrated to the world the use of air power as a force for good in the humanitarian sense, it represents an important milestone in the history of aviation.

Like the Schneider Trophy competition before it, the Second World War also telescoped decades of development in aviation into five or six years. But in the post-War world of commercial aviation, to which I turn now, Britain and the US adopted different approaches to airliner development. The US produced 3 large propeller driven aircraft that met the newly created demand for long distance air travel: the DC3, the DC4 and the C12, better known as the Constellation. At the time it was said that the Americans listened to what the market was saying, while the British kept building aircraft no one wanted. As a result, and in marked contrast with their British counterparts, American airliners were full. But in opting to take a different route the British did develop the first jet-powered passenger aircraft, the DH 106 Comet.

COMET

When it entered commercial service the Comet created an immediate sensation — as well as considerable alarm on the other side of the Atlantic. It was simply years ahead of its time. But there were early problems. They started with two take-off accidents. No one was injured in the first, which occurred at Rome in October 1952. It was put down to pilot error. As a result, higher airspeeds were prescribed for take-off. The second accident resulted in the loss of all 11 people on board. It took place on a delivery flight from Karachi in March 1953 and was similarly attributed to an error of judgement on the part of the pilot. In the aftermath the wing leading edge was modified to increase lift at low speed and avoid the possibility of stalling

on take-off. A third accident occurred in January 1954 when the aircraft entered a violent thunderstorm just after take-off from Calcutta. It simply disintegrated in mid-air. At the time this was regarded as no more than a freak accident. It was accepted that turbulence in a severe thunderstorm could literally tear an aircraft apart; nevertheless, there was little option but to stop flying the aircraft temporarily. Despite the fact that the precise cause was unknown, 50 modifications were carried out during a 2-month grounding. It wasn't until a fourth accident, in April 1954, when a Comet departing from Rome again broke up in mid-air — resulting in the loss of all 43 on board — it wasn't until then that detailed and methodical investigations into the precise circumstances began.

I recount this sad story simply to highlight the persistence and the investigative skill of those in the aviation industry who finally isolated the cause, which turned out to be metal fatigue. The inquiry itself involved the Royal Aeronautical Establishment at Farnborough and was chaired by its Director, Sir Arnold Hall. There isn't time to go into the details here. Suffice it to say that, amongst other things, the technique involved pressurising a fuselage in a tank of water. The sort of men (and women) who meticulously researched this accident — and hundreds of others like it over the years — have done a great deal to advance the cause of flight safety in both civil and military flying. Like Bernard Lynch, they are unsung heroes and deserve our thanks.

CONCORDE

It's perhaps ironic given my earlier comments on Anglo-French rivalry, that one of the finest technological achievements in airline history, and probably the most controversial airliner of modern times — Concorde — should result from co-operation between Britain and France. Even today, 34 years after its first flight in March 1969, it remains elegant and distinctive — a masterpiece of innovative design. Concorde's future though has always been shrouded by doubts — high operating costs, high noise and smoke emissions and, most recently, the safety concerns that emerged after the Paris crash in July 2000.

On 26 January 1976, 14 years after Britain and France first agreed to build the aircraft, Concorde finally entered commercial service. But because it failed to sell, routes soon had to be consolidated. Then, in September 1979, the British and French Governments halted production after building only 16 aircraft — at a cost of $500 million each. It was the most expensive, and in some ways the most disappointing airliner the world has seen. Yet it remains to this day a shining example of the aviation industry's capabilities.

HARRIER

It's time now to return to the military field, and no aircraft uses a field like the Harrier. The origins of this novel aircraft lie in the mid-1950s. The Government's first venture into the Vertical/Short Take-Off and Landing (V/STOL) arena was Shorts' delta wing, fixed undercarriage SC1. It required four lift engines for vertical flight, together with a single engine for conventional, wingborne flight. However, practical application of this concept proved difficult. The second prototype crashed in 1963, killing the pilot.

P1127

While all this was going on, Hawkers were pursuing their own ideas in the V/STOL field — ideas that led eventually to the Harrier, via the Rolls-Royce 'flying bedstead' to the

P1127 prototype, *which you see here*. The P1127 first flew in October 1960 and employed a different approach — vectored thrust and a jet reaction control system. But we should acknowledge that it was a French engineer, Michel Wibault, who first proposed the concept of vectoring the thrust of a jet engine. *As a further aside, it was fascinating to see a similar design battle between the lift engine concept and vectored thrust played out in the recent competition between Boeing and Lockheed Martin for the lucrative Joint Strike Fighter contract.* Meanwhile, back in the sixties several countries were drafting requirements for V/STOL combat aircraft. This led to an agreement early in 1963 between Britain, the Federal Republic of Germany and the USA to purchase nine developed P1127s. These aircraft were to be used in a tripartite evaluation programme with the objective of establishing the ground-rules for the operation of V/STOL fighters. The aircraft was renamed as the Kestrel in November 1964 and subsequently took the Harrier name selected for the cancelled supersonic V/STOL strike fighter, the P1154. But the Harrier too was fortunate to escape cancellation in the 1966 Defence Review. However, by December that year the way was at last clear for negotiations on an initial production order of 60 aircraft. The rest, as they say, is history.

HARRIER IN RAILYARD

I'll offer one last fact about this remarkable aircraft. In May 1969, 50 years after Alcock and Brown conquered the Atlantic, the Daily Mail sponsored a repeat race, this time between London and New York. As before the rules were complex, involving fixed start and finish points in the heart of each city. The east-west leg was won by an RAF pilot, thanks to the versatility of the Harrier. Squadron Leader Tom Lecky-Thompson, completed the journey in 6hrs 11 minutes and 57 seconds, using a railyard for take-off and a motor bike as transport through town — yet another example of both human and engineering ingenuity.

I've spoken a lot about the past, and a lot about the spirit of enterprise and competition. It's important to recognise that both are still very much with us. In 1959 a British industrialist, the late Henry Kremer, offered a cash prize of £5,000 for the first human-powered aircraft that could fly a figure of eight around two markers 800 metres apart - the same performance level as the early Wright Flyers. However, it was some 20 years before this prize was finally claimed, by which time it had grown to £50,000.

GOSSAMER CONDOR

On 23 August 1977 it went to an American, Dr Paul McReady, who designed the Gossamer Condor. Two years later he claimed the second Kremer prize of £100,000 for the first man-powered flight across the English Channel, this time with his Gossamer Albatross. I have to say that I don't see a commercial future here. But on an occasion such as this, it would be remiss of me not to mention that, courtesy of Kremer's generosity, the Royal Aeronautical Society currently has on offer over £100,000 in prizes for three new competitions designed to further the cause of human-powered flight, mainly in the sporting field.

TYPHOON

I couldn't conclude a presentation such as this without mention of Eurofighter Typhoon. It will take the Royal Air Force, and the Air Forces of the European partner nations, into a new era in terms of performance and capability. It's a product of collaboration between Germany, Italy, Spain and the UK at Government, industry and Air Force levels. Its cockpit, designed by pilots for pilots, is quite simply the best in the world. It will employ direct voice input, hence

allowing the pilot to spend more time looking out rather than into the cockpit. The aircraft structure employs carbon fibre composites (70% surface area), lightweight alloys, titanium (12% metal) and glass reinforced plastics (12%). An unstable aircraft, it relies on a computerised control system which provides outstanding manoeuvrability, particularly at supersonic speeds. With a Mach 2 and +9/-3G capability, and an advanced weapon system, it's quite simply a world-beating swing role aircraft. But sadly it is likely to be the last fighter aircraft designed and produced in the UK.

But where in all this is the human theme here that I've followed so carefully thus far? Quite simply it lies in the vision and the persistence of those within British industry involved in Typhoon's precursor. Decades ago, and after withdrawal of the Germans and Italians, these individuals worked diligently to turn their aspirations first into the Experimental Aircraft Programme (EAP) and, ultimately, into the reality of Typhoon. There's little doubt that by keeping EAP alive British Aerospace (that was) ensured that the Ministry of Defence specification for a new agile fighter was eventually resurrected. In this context we must acknowledge too the skill and creativity of the designers and engineers who helped create this remarkable aircraft.

So what of the future? Largely because of costs, I see the UK's aviation future as a collaborative one: with the US and others on the Joint Strike Fighter project and with Europe in the Airbus consortium. The future is also certain to see much greater concentration on unmanned vehicles, on systems development and on systems integration — all in concert with increased emphasis on network enabled capability. And we have been seeing the evidence of this in the Middle East in the last few weeks.

AIRCRAFT IN FORMATION

Aviation has come a long way since 17 December 1903. We've inherited a legacy of enterprise, innovation, ingenuity, tenacity and courage — *and built some wonderful aircraft as you can see here.* There can be little doubt that these very same qualities — human qualities — will be needed in the next 100 years, no matter where future of aviation may lead**.**

ACKNOWLEDGEMENTS

The author would like to acknowledge the assistance provided by the Royal Aeronautical Society and the Royal Air Force Historical Branch in providing the photographs that accompany this presentation.