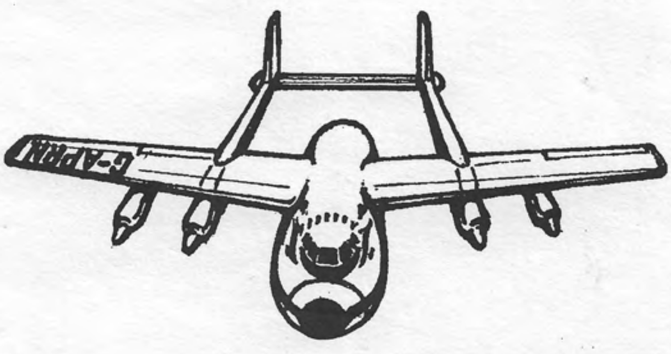
Warwickshire Industrial Archaeology Society

THE RISE AND FALL OF COVENTRY'S AIRFRAME INDUSTRY

A Profile of Sir W. G. Armstrong Whitworth Aircraft Ltd.,
With personal Reminiscences



Researched and prepared
For the
Warwickshire Industrial Archaeology Society
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J. F. Willock

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FOREWORD

The history of the manufacture of aircraft in Coventry has been long and not a little chequered. During national emergencies several firms were involved. Only one, Armstrong Whitworth, built civil and military machines over an extended period. Consequently, this profile of the industry in Coventry concerns itself very largely, though not exclusively, with the activities of Sir W G Armstrong Whitworth Aircraft Ltd and its successors, Whitworth-Gloster Aircraft and Hawker Siddeley Aviation. Armstrong Whitworth (AWA) from its formative years constructed good, sturdy and practical, if somewhat uninspiring, designs. Latterly it also carried out pioneering work on guided-missiles and space-vehicle research and there were extensive contracts with the Atomic Energy Authority. Advanced design-studies continued at the Whitley factory until its closure in 1968.

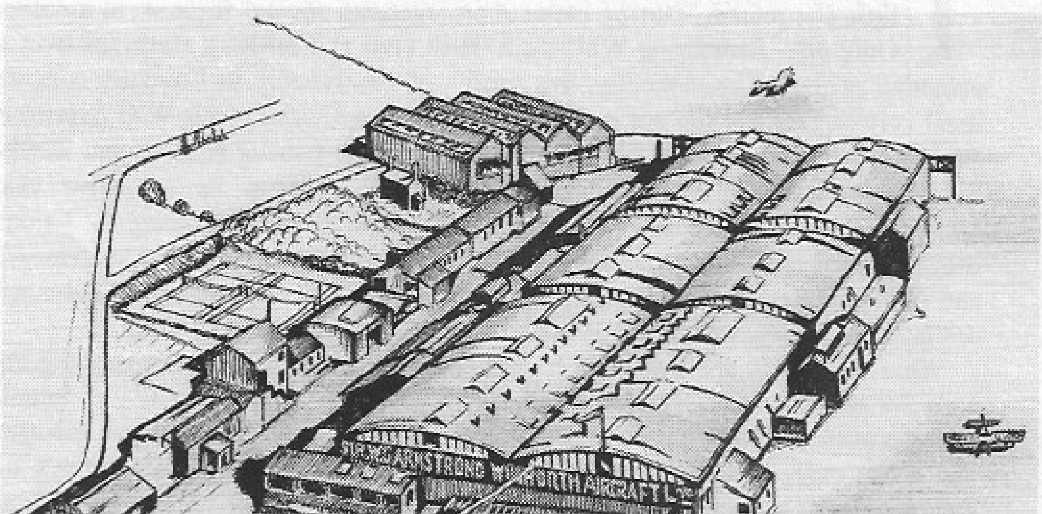
What follows is not a detailed history, more a profile of the company together with the author's reminiscences of the period 1961 to 1968 when he was initially an apprentice and later an employee at both the Baginton and Bitteswell factories. The views expressed are essentially the author's own. Any errors are entirely his. This document in no way constitutes an official, or type by type history, as this has been adequately covered elsewhere. No attempt has been made to document the activities of aero-engine manufacturers in Coventry, except where they affect AWA. A thorough study of the Coventry aero-engine industry is long overdue, particularly in view of the recent closure of Rolls Royce Parkside and impending rationalisation at Ansty.

In many respects the history of aircraft manufacture in Coventry mirrors that of the machine-tool industry, in that it came, it flourished, and it went! In both industries, many generations of skilled personnel were trained in Coventry to the greater good of the city and the nation as a whole, both in times of peace and national crisis.

THE BEGINNINGS IN COVENTRY

Sir W G Armstrong Whitworth Aircraft was originally incorporated in Newcastle as an aviation division of the famous armaments and shipbuilding empire of the same name, situated on Tyneside. It had been a proud boast of the parent company that it was the only organisation in the world capable of building and arming vessels completely. Other firms such as Vickers and Krupps produced armaments, but did not build ships. The aviation division was formed, therefore, from a company with an international reputation, renowned for the excellence of its products. Although a number of aircraft were produced during the first world war, they were not particularly distinguished and history has largely forgotten them.

During the 1914-18 war, the Siddeley Deasy motor-company in Coventry had been producing a number of military aeroplanes. They included the well-known and successful RE7, RE8 and DH9. At the end of the war, the head of the Siddeley Deasy company, John Davenport Siddeley, decided to expand his flourishing motor-car business and combine with the Newcastle-based aviation organisation to form the Armstrong Siddeley Development Company Limited, a holding company based at Parkside, Coventry. Subsequently, in 1920, after yet another change of name, the aviation division of the company became Sir W G Armstrong Whitworth Aircraft Limited, situated on the London Road. The *Sphinx* trademark was adopted, and this became the company's logo for many years. This was accompanied by the slogan *Pioneers of Progress*.



The AWA plant at Whitley, Coventry, as it was in 1928

The infant AWA was headed at this time by S Hiscocks as General Manager, with H M Woodhams as Chief Inspector. We shall hear more of Mr Woodhams later. Opportunity was taken at this time to acquire the RAF airfield at Whitley, and a factory was set up there in 1923. The Chief Designer was John (Jimmy) Lloyd who led a technical team based at the Parkside headquarters.

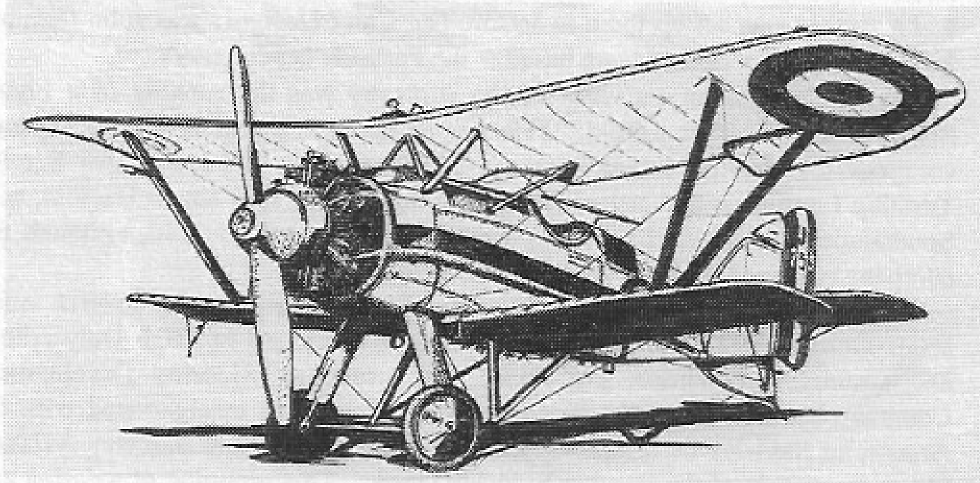
One of the earliest activities of the company was the running of a Flying School at the Whitley airfield. This was so successful that in 1931 a separate company was formed to administer it. The company was named Air Service Training Limited, and shortly afterwards it moved to a new site at Hamble, near Southampton. AWA relinquished direct control over it in 1940, although the company remained within the Hawker Siddeley Group.

John Siddeley, being a very astute businessman, made several other acquisitions in 1927 and 1928, which brought AV Roe Ltd, High Duty Alloys and Crompton Parkinson Ltd under the Armstrong Siddeley Development Company banner. Later, in 1935, Hawker Aircraft Ltd amalgamated with the Armstrong Siddeley Development Company to form Hawker Siddeley Aviation Ltd, a forerunner of the Hawker Siddeley Group. This grouping of aviation and industrial interests, which now included AWA, Armstrong Siddeley Motors, AV Roe, Hawker Aircraft, HDA and Crompton Parkinson was fortunate in view of the subsequent and rapid rearmament programme that was necessary to meet the growing international crisis. All these companies contributed greatly to the war effort, initially with Hurricane fighters from Hawker Aircraft and subsequently Whitleys and Lancasters from AWA and AV Roe. This pooling of resources was crucial in another respect, in that it kept alive, in the twenties and early thirties, relatively small organisations whose order books were hardly burgeoning in a time of economic depression and lack of official interest.

THE INTER-WAR YEARS

During the inter-war years Armstrong Whitworth produced a large number of aircraft designs, both civil and military. The majority of these, which are too numerous to detail here, did not result in any substantial orders for the company, although there were one or two notable exceptions. Perhaps the most significant military aeroplanes of this period, designed and manufactured by AWA, were the **Siskin** and the **Atlas.**

The **Siskin** was a single-seat biplane fighter in the classic mould, powered by an air-cooled radial engine. AWA initiated the design as a private venture. It was to be a fairly conventional machine of wooden construction with an ABC Dragonfly engine. The aircraft showed promise (although the engine was absolutely awful) and extensive development was undertaken. What emerged was an altogether different, all-metal machine, a type of construction on which AWA was later to capitalise. The definitive RAF version was the Siskin Mark III, which went into production in 1923 against Air Ministry specification 8/29. Equipped with an Armstrong Siddeley Jaguar Major geared and supercharged engine, this aeroplane entered service with a number of front line units including, No 29, 41, 43 and 111 Squadrons. Altogether 214 aircraft were delivered. Siskin IIIAs were also produced, under sub-contract, by a number of other companies, including the Bristol Aeroplane Company, Blackburn Aircraft, Gloster Aircraft and Vickers, indicating, during lean times, a fair degree of work sharing within the industry as a whole.



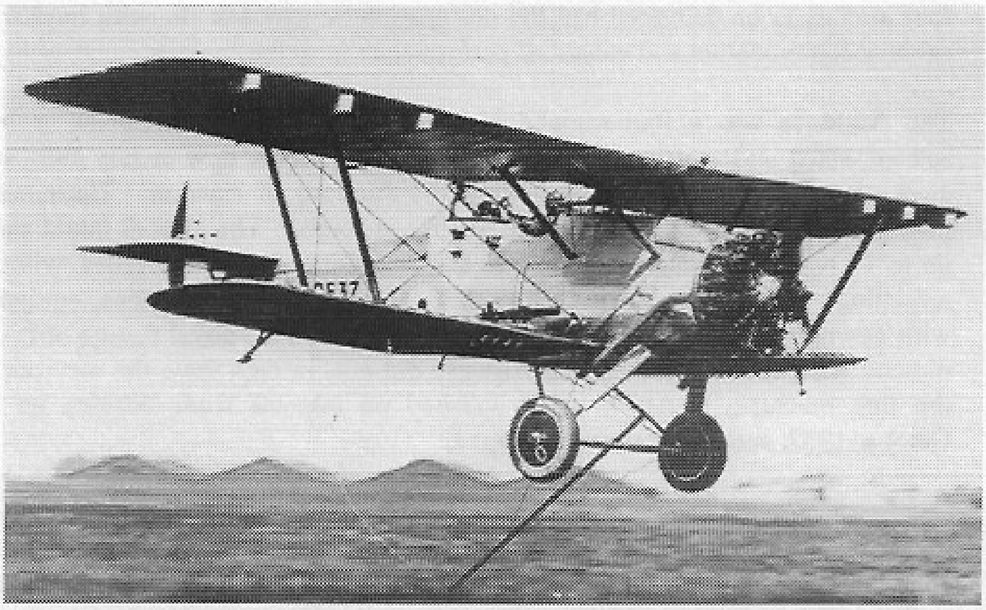
Siskin III of No 111 Squadron which was the second RAF Squadron to be so equipped. Flying Officer Frank Whittle flew this type of machine whilst attached to 111 Squadron at Hornchurch, Essex

It is interesting to relate that when flying Siskins with 111 Squadron a certain Coventrian (or perhaps it should be Leamingtonian?) almost prematurely ended his career whilst indulging in low-level aerobatics. This officer was none other than a youthful Frank Whittle, who was 'carpeted' and very nearly court-martialled for the offence, which was carried out with a co-conspirator in the vicinity of Canvey Island. Local residents complained to the police and the Air Ministry became involved. The RAF wanted to disencumber itself of Whittle and the matter only died down when the complainants formally withdrew all charges. If Whittle had been dismissed from the service for this misdemeanour, would the jet-engine have been pioneered and developed in quite the same way in this country?

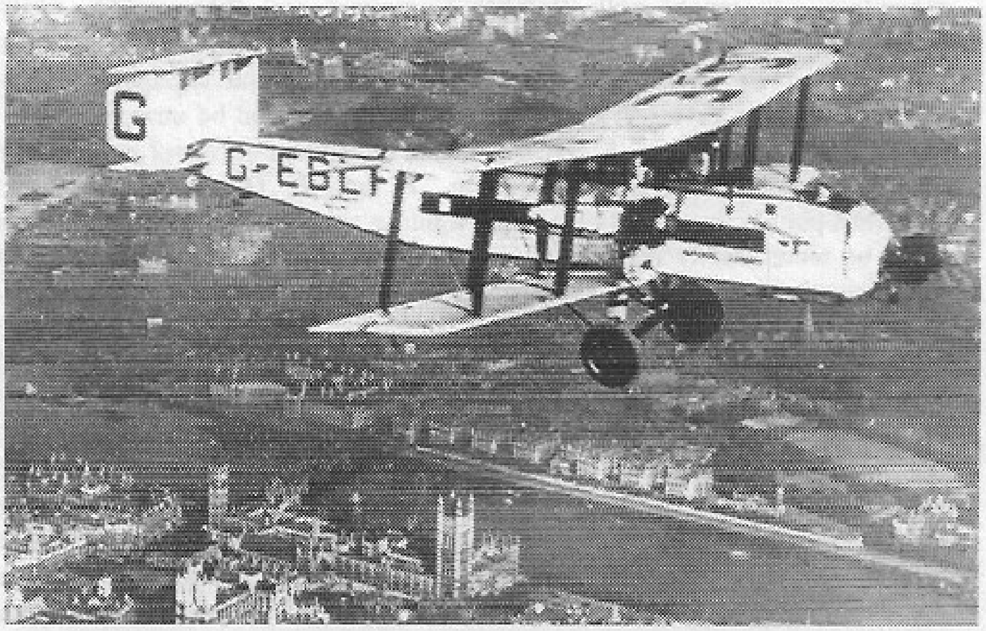
The **Atlas** was the second private-venture aeroplane, designed by AWA, that resulted in large orders. Conceived as a two-seat, Army Co-operation aeroplane, against specification 30/24, the prototype made its first flight on the 10 May 1925, with Captain Frank T Courtney at the controls. Powered by an Armstrong Siddeley Jaguar III, radial air-cooled engine, the successful first flight of the Atlas attracted sufficient official interest for significant orders to be placed. Ultimately, AWA went on to build 449 aeroplanes for the RAF. In addition to these aircraft, the company supplied a number of foreign countries with the same type. They included the air forces of China, Greece, Japan and Turkey. The first prototype, registered G-EBLK, was also used by the company for testing the effectiveness of the Townend Ring form of engine-cowling. A number of Atlas aircraft were adapted to perform specific duties, such as dual-control trainers and day bombers; and in one case a float-mounted machine, J 9998, was supplied to the High Speed Flight at Calshot, for use as a general purpose transport. With regard to this aeroplane, AWA also designed and manufactured the floats.

Another military aeroplane, in this instance not actually designed by the company, but produced in volume, at Coventry, was the **Hart.** This was a

Hawker Aircraft design, which became the standard light day-bomber of the RAF. The first was produced in 1933 and in the end 453 were delivered. The Gloster Aircraft Company, also under sub-contract to Hawkers, constructed 72 Hart Trainers. This was yet another case of work-sharing within the Hawker Siddeley Group.



The Atlas 1 Army co-operation aircraft with its message pick-up hook extended



Argosy 1 G-EBLF City of Glasgow flying over the Palace of Westminster

With regard to civil aircraft the two most successful designs for the period under consideration were the **Argosy I** of 1926 and the **AW 15, Atalanta** of 1932.

The **Argosy I** was a 3-engined, biplane airliner, supplied to Imperial Airways for use on their Continental routes. The first flew in 1926 and production eventually totalled seven machines. Although looking somewhat dated, this aircraft was a great commercial success, although one accident with fatalities is recorded. Once again, Armstrong Siddeley Jaguar engines were used. The last four aircraft to be delivered had the designation Argosy Mk IIs, with improved cabin accommodation and enhanced performance from the engines.

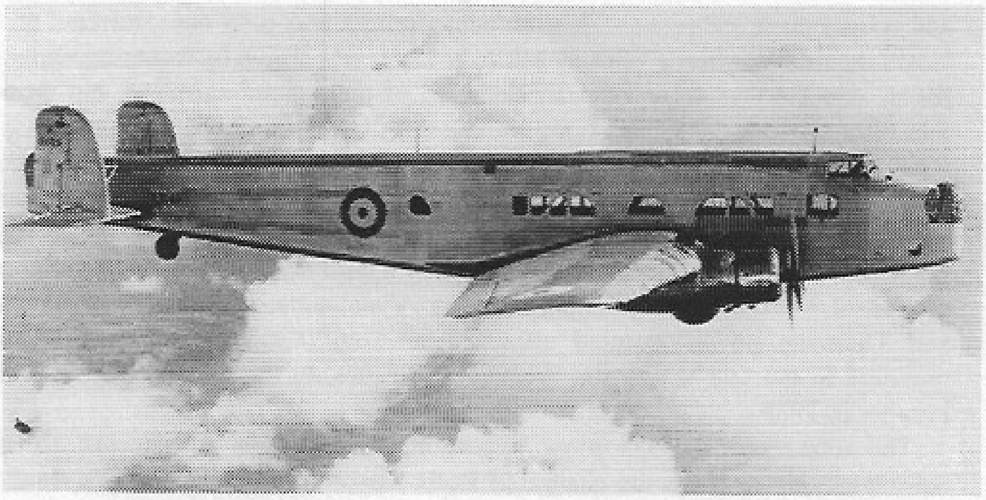
The **Atalanta** was a four-engined high-winged cantilever monoplane with a spatted, fixed undercarriage. The first machine, G-ABPI, flew in July 1932 and eight aeroplanes were supplied to Imperial Airways of London. These were predominantly used on their Cairo-Cape Town routes. The aircraft could carry up to 17 passengers and three crew to a maximum range of 660 miles, without refuelling. Armstrong Siddeley Double Mongoose (Serval) engines, equipped with Townend rings, were the chosen power-units with the novel feature of being directly wing mounted. Imperial Airways did not, in fact, have the services of the first machine, G-ABPI, which crashed on take-off from Whitley on 20 October 1932, and was severely damaged.

PREPARING FOR WAR

The **AW 38 Whitley** bomber is such a large part of the AWA story that an entire volume could be written about it. However this has yet to be undertaken by any serious aviation journalist. This is very surprising considering the radical features embodied in the aircraft's design, and its exemplary war record with Bomber Command and subsequently, Coastal Command. The Whitley has tended to be overshadowed by the exploits of the Wellington, Halifax and Lancaster in popular myth and legend. There is a tendency today to perceive things in a manner that would be unrecognisable to those present at the time. A case in point is the almost universal belief that the Spitfire won the Battle of Britain alone. In fact, the Hurricane, the far more numerous partner, bore the brunt of the fighting, was the better gun-platform and could be more readily repaired after damage. The truth is that both machines complemented each other and the battle could not have been won without *both* of them.

So it is with the Whitley. 'The Flying Barn Door', as it was rather unkindly dubbed, was an aesthetically unappealing aeroplane that despite certain technical limitations, rudimentary navigational aids, inexperienced crews, and appalling weather, first took the war to the enemies of Britain. The Whitley was the first British aircraft to fly to Berlin, the first to drop bombs on German soil, and the first to fly across the Alps and attack targets in Italy. With Coastal Command the Whitley was the first Allied aircraft to destroy a U-boat unaided. These are significant milestones that should have assured the aircraft of a more prominent place in aviation history. Perhaps the absence of a single surviving aircraft, out of the 1,814 built, may have something to do with it. However, fragments of a Whitley fuselage are preserved and may be examined at the Midland Air Museum at Baginton, Coventry.

The origins of the Whitley can be traced from its immediate predecessor the **AW 23**, a twin-engined bomber and transport designed to Air Ministry specification C26/31. This aircraft had two important technical features that were to be incorporated in the Whitley. They were, a retractable undercarriage and a box-spar wing. The AW 23 also pioneered in-flight refuelling.



Precursor of the Whitley, the AW 23 Bomber/Transport designed to meet Air Ministry Specification C 26/31

On 17 March 1936, the Whitley prototype, K 4586, with its retractable undercarriage, box-spar wing, and all-metal construction took to the air from the Whitley airfield in the capable hands of A C Campbell-Orde, AWA's Chief Test Pilot. In placing the Whitley among its aviation contemporaries, it is significant that Britain's most modern first-line fighter of the period, the Gloster Gladiator biplane, complete with its fixed undercarriage, fabric-covered structure, and four 0.303 inch machine guns, did not begin to reach the RAF Squadrons until July 1936. The Hawker Hurricane prototype had flown only in the previous October, and the prototype Spitfire on 5 March 1936.

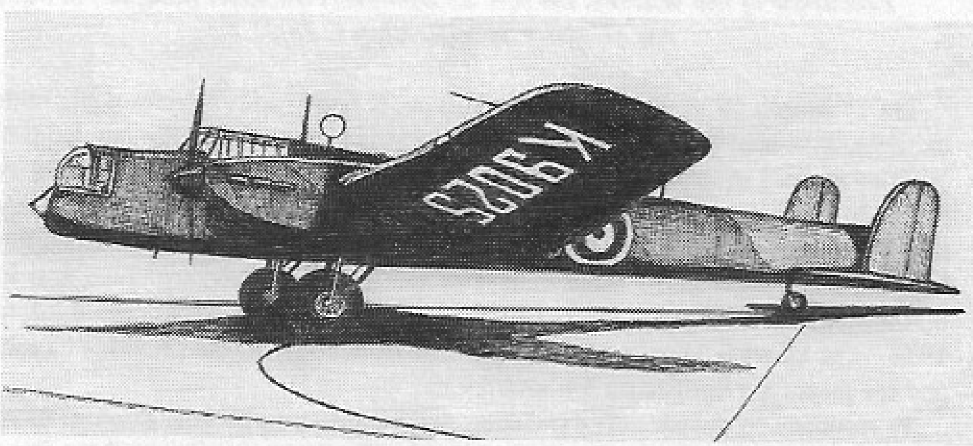
In response to the aircraft expansion programme a large new shadow-factory was planned for location at the civic airfield at Baginton, on the southern fringes of Coventry. This factory was completed in 1936 and initially consisted of a long assembly-hall for the production of Whitleys. Eventually, with the demands of wartime being so great, the plant at Baginton became virtually twice its original size.

With its turreted defensive armament and other advanced features the Whitley was in the forefront of aviation thinking. It was also designed with an eye to ease of manufacture. Standardised parts and material sections were a fund-amental part of the concept. The prototype Whitley and Mks I, II and III production machines were all fitted with Armstrong Siddeley Tiger engines.

When the Whitley was conceived, flaps were not a common feature, and to provide sufficient lift and control during landing the angle of incidence of the wings was quite large in relation to the horizontal centreline of the fuselage. As a consequence, the thrust-lines of the engines had to be inclined downwards. These features imparted a very peculiar, nose-down, attitude to the aircraft in flight. The fuselage, wings and engines conveyed the impression that they were all going in different directions and that none was an integral part of the whole! Hence the term 'Flying Barn Door'. Flaps were subsequently fitted, but the angle of incidence of the wings, and thus the flying attitude, remained the same throughout aircraft's life.

Constructed around its box-spar wing, the Whitley was an immensely strong and solidly built aeroplane. This inherent strength was fully demonstrated on 28 November 1939, when a Whitley MkV, N 1377, was struck by lightning whilst in flight. Both wings were virtually denuded of their metal skinning, but despite this Pilot Officers Gray and Long nursed their badly damaged machine back to their station at Bircham Newton. For this act of conspicuous bravery both Officers were awarded the DFC. The flat-sided fuselage was built in three sections and was of monocoque construction, skinned with Alclad sheeting. Early marks of the Whitley had the company's own design of manually operated gun-turret, but this was replaced on the Mk IV and subsequent machines by Nash and Thomson power-operated units. With four 0.303 inch Browning guns mounted in the rear turret, the Whitley was probably the best protected British bomber in 1939.

The next, and perhaps most important, modification to the Mk IV and subsequent aircraft was the change to Rolls-Royce Merlin engines as a result of which the overall performance of the Whitley improved significantly.



A Whitley BIV, K 9025, built in 1939. This machine was destroyed at RAF Kinloss in April 1942 when an engine failed during take-off

Number 10 Heavy Bomber squadron based at Dishforth, Yorkshire, was the first unit to receive the new bomber. At the outbreak of war in September 1939, the RAF had under its command, at No 4 Group, six operational squadrons of Whitleys. On the first night of the war 10 Whitleys from Leconfield dropped 13 tons of propaganda leaflets on selected targets in Germany. These so-called 'Nickel' or 'Bumphlet' raids, as they were christened, were not only hazardous but also deeply unpopular with aircrews. 'Bumphlet' raids were mounted for some time, until the Government at last realised that Germany was not going to be beaten into submission by paper. Bombing operations then started in earnest. After two and a half years of war and many raids on Germany, Austria, Czecho-slovakia, Poland and Italy, including participation in the first 1000 bomber raid on Cologne, the Whitley was withdrawn from active service with Bomber Command in April 1942.

Whitley aircraft also took part in several notable airborne operations including *Operation Colossus* on 10 February 1941, when paratroops were dropped into Italy with the objective of destroying the Tragino aqueduct. This task was accomplished by the raiding party. A year later on 27-28 February 1942, Whitleys of 51 Squadron carried C-Company of the 2nd Parachute Regiment on the famous Bruneval raid. It will be recalled that this audacious operation had the objective of capturing a complete *Wurzburg* radar installation, on the French coast, 18km north of Le Havre. This operation was a total success.

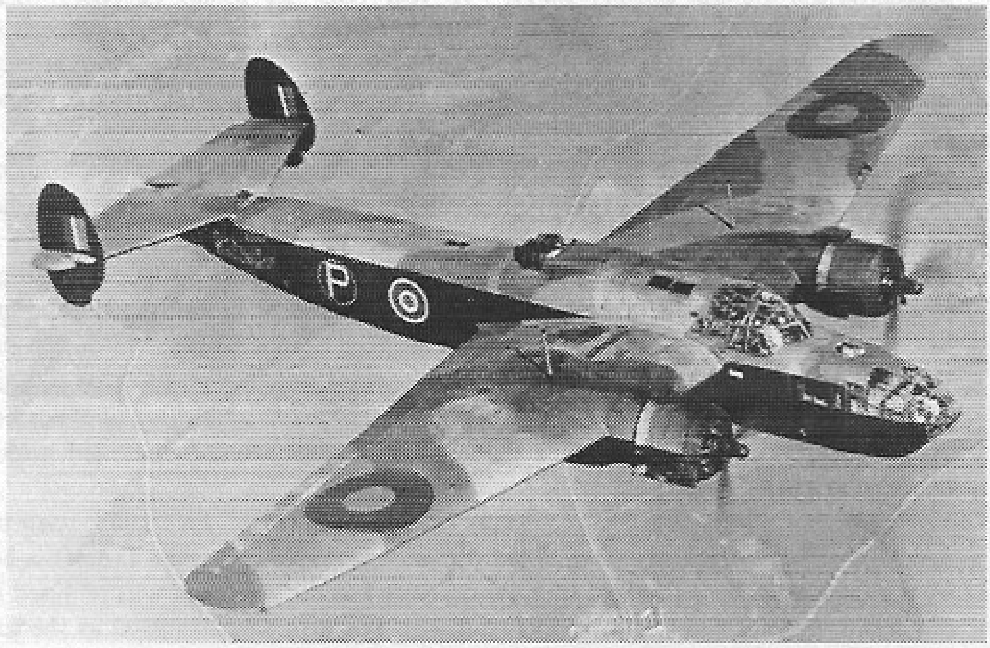
Although Bomber Command had dispensed with the services of the Whitley, its operational life was far from over. Since the autumn of 1940, the aircraft had been used for maritime reconnaissance with Coastal Command, and because of its relatively good range it was considered a suitable stopgap for this operational requirement. Whitley Mk V machines were modified to accept the long-range, Mk II Air-to-Surface-Vessel Radar, and when so equipped were re-designated Whitley Mk VIIs. A Mk VII of No 502 Squadron notched-up the first definite 'kill' with the new radar, when U-boat 206 was destroyed in the Bay of Biscay on 30 November 1941. Other roles undertaken by the Whitley included glider-towing, freighting, and clandestine activities.

Production of the Whitley terminated at Baginton on 12 July 1943, with the final and 1,814th machine being rolled off the assembly-line. This aircraft, a Mk V, registered LA 951, was not actually delivered to the RAF but was retained by the company as a test-bed machine. LA 951 was subsequently used as the tow aircraft for the AW 52G Flying Wing Glider.

Before continuing with the wartime activities of AWA it should be mentioned that the company designed and built two further types of aircraft in the immediate pre-war period. One was a civil airliner, the **Ensign**, the other was the **AW 41 Albemarle**, a reconnaissance bomber and general-purpose aircraft.

The **Ensign** was a large, 40-seat, 4-engined transport specifically built for Imperial Airways of London. It was a high-wing monoplane having the gigantic wingspan of 123 feet. The wing configuration necessitated a very tall under-carriage with wheels of 6ft 3in diameter. Apart from the Beardmore Inflexible aircraft, this was probably the biggest undercarriage that had been fitted to a British machine up to that time. The engines originally installed were Armstrong Siddeley Tiger IXs, but these were eventually supplanted by Wright Cyclone radials of 950 hp each. Fourteen machines were eventually supplied, although the war intervened and spoiled the chances of commercial success. The war also took its toll of the 14! Seven were destroyed, two whilst in German captivity. At the end of the war, the remaining seven machines were considered beyond economic refurbishment and were broken up. Thus ended the career of a promising aeroplane.

The **Albemarle** was an AWA-designed aeroplane, which first flew in March 1940 and had been conceived from the outset with a view to reducing the need for strategic materials in its construction. In place of aluminium alloys, steel and wood were substituted, and a long list of sub-contracting companies was drawn up to build the machine. Apart from prototypes, AWA had no further involvement. The majority of the work of testing and assembly was carried out at the works of A W Hawksley Ltd (a Hawker Siddeley Group Company) located at Brockworth, Gloucestershire. The Albemarle, which was extremely versatile, had a tricycle type undercarriage, the first RAF aircraft to be so equipped. Six hundred machines were built.



An AW Albermarle GTI. This particular machine was retained by AWA as a prototype for the STI version

Reverting to the mainstream AWA story, the pressure was on the company to produce the Whitley in volume for the RAF. During May 1940, the Ministry of Aircraft Production (MAP), at that time headed by Lord Beaverbrook, decided to allocate 'top priority' to only **five** major aircraft types, to facilitate delivery of the necessary machines to the Services. One of the selected 'top priority' aircraft was the Whitley. Thus AWA became one of the most important aircraft manufacturers in the country. It has been suggested by one author, in a work published a decade or so ago, that during the war years AWA was not a strong industrial organisation, and incapable of changing readily to another production type! The author of this paper is unsure how this story gained credence and hopes to persuade the reader, through facts, figures, and the following narrative that this statement is totally without substance. In fact, AWA went on to produce Whitley and Lancaster aircraft *simultaneously* through the Baginton shops: it built over **18%** of all Lancasters supplied to the services, a figure exceeded only by the much larger Avro concern, and a greater variety of sub-types of Lancaster than any other organisation in the manufacturing consortium.

It is also a matter of record that such was the priority allocated to AWA's war-work that Prime Minister Churchill visited the Baginton factory on Friday 26 September 1941. In connection with this visit it should be stated that John Colville, (later Sir John Colville), Churchill's Secretary, remarked in his diary for that day: "*We toured the Armstrong Siddeley factory, where aircraft parts and* *torpedoes are made, and the PM had a rousing reception..... The Whitley bomber factory is a hotbed of communism and there was some doubt of the reception the PM would get."* The photographic evidence of that visit, which the author has seen, suggests that Churchill was accorded a warm welcome at Baginton, with elements of the Home Guard present, and Sir Frank Spencer Spriggs, H M Woodhams, and C K Turner-Hughes in attendance. One particular photograph shows Churchill in characteristic pose, with his hat hoisted on his walking-cane to the obvious delight of the AWA workforce. It perhaps should be noted that Churchill did not always receive a rapturous reception wherever he went and his visits to the blitzed East End of London, and elsewhere, were occasionally met with open hostility from some of the population.

The visit of the Prime Minister Winston Churchill to AWA Baginton on 26 September 1941. (l to r) Sir Frank Spencer Spriggs (Chairman Hawker Siddeley Group), the PM, H M Woodhams (General Manager), and C K Turner-Hughes (Chief Test Pilot)

In fact, Colville went on to record that Churchill did receive a good reception at Baginton, although he concludes his diary note by stating that full Whitley production was not achieved until after the Soviet Union had entered the war. One suspects that many factors may have been at work other than just politics. The aircraft industry had been required to expand very rapidly due to the threat of war. It had taken on many thousands of largely unskilled employees and it had been necessary to change both working practices and manufacturing techniques. That so much was achieved in such a short space of time was miraculous. The Prime Minister, upon leaving AWA on 26 September 1941, went on to Birmingham to see Spitfire production at the Castle Bromwich Factory.

'Hotbed of communism' or not, AWA endeavoured to deliver the aeroplanes required by the RAF. Several preserved letters from the MAP to the General

Manager, H M Woodhams, highlight the sense of urgency of that period. Beaverbrook's letters, invariably hectoring in tone and notable for their brevity, could occasionally be complimentary.

One letter to H M Woodhams dated 25 August 1940, stated:

"Dear Mr. Woodham,(sic)
The report shows you did not work your plant from Saturday evening until Sunday night. No doubt there is some good reason for this. But I should like to know it. We want all the production we can get now, particularly from key factories such as Armstrong Whitworth. Yours sincerely, (signed) Beaverbrook."

Another from Beaverbrook dated 4 September 1940 read:

"Dear Mr.Woodham,(sic)
I constantly hope that manufacturers will exceed the production programme. I regard it as a minimum upon which they can build greater things. I am disappointed to see that Armstrong Whitworths (sic) can only produce 39 Whiteleys (sic) during August against a programme of 40. But I am sure that the September figures will show a great improvement. I have every trust and confidence in the efforts you will make.
Yours sincerely, (signed) Beaverbrook."

And finally a letter dated 27 February 1941, stated:

"Dear Mr.Woodham, (sic)
I hasten to pass on to you joyful tidings which have just reached me. Your works at Baginton have been selected as one of the key aircraft works at which a permanent guard of one fighter aircraft will be stationed. The duties of this machine and its pilot will be confined to protecting the works against an attempt by the enemy to attack it from the air. And I am confident that your workforce will rejoice with me in a substantial addition to the defence of the factory. Much depends on their labours for the Royal Air Force. Now the Air Force intervenes to increase the security in which those labours are conducted. Yours sincerely, (signed) Beaverbrook."

Perhaps Mr. Woodhams should have pointed out (although I expect he was far too busy to bother with such trivia) that his name was Woodhams with an 's' and he was building Whitleys not Whiteleys!

One is led to the conclusion that by-and-large AWA's management cannot have been too bad and in all probability was more than equal to the task that lay ahead. If the company had been as weak as has been suggested, the management team would have been replaced on the insistence of Beaverbrook. This actually happened elsewhere on 17 May 1940, when, during a telephone conversation with Beaverbrook concerning the lack of Spitfire production from the Castle Bromwich factory, Lord Nuffield, speaking from Cowley, half-heartedly offered his resignation. A dangerous thing to do with a man like Lord Beaverbrook! Nuffield's resignation was readily accepted, and he went! A new management team from Vickers was installed at Castle Bromwich, with a directive from Beaverbrook to get Spitfire production moving!

Colonel J J Llewellin, Beaverbrook's successor at the MAP, wrote quite differently to AWA in May 1942, complimenting the firm on the completion of 12 urgently required Whitley bomber conversions to freight-carriers, ahead of schedule. These civil registered machines, operated by British Overseas Airways Corporation, were used for various activities, including flying important supplies into beleaguered Malta. Other operations, it is believed, included the 'Ball-Bearing' run to Sweden. Ultimately a fleet of 15 Whitleys was operated by BOAC. By and large, the Whitley was far too slow and vulnerable for such roles, and they were soon replaced by more suitable aircraft such as the Mosquito.

THE LANCASTER AND LINCOLN

The **Lancaster's** fame is such that one is almost at a loss to suggest that anything further can be written about its history. It is one of those aeroplanes, like the Spitfire, that has become truly legendary. However, the Lancaster's immediate predecessor the Manchester, the aircraft from which the famous offspring derived, was an abject failure.

The **Manchester** was a twin-engined heavy bomber designed by A V Roe & Co to meet Air Ministry specification, P13/36. Roy Chadwick, Avro's chief-designer, in his quest for an aerodynamically clean design, had selected the Rolls-Royce Vulture 'X' configuration, 24-cylinder piston-engine, to power his new creation. This new engine had the promise of being very powerful. Only two would be required per machine. That was the theory! Unfortunately the Vulture was probably the worst engine Rolls-Royce put into production. It was fairly complex (being basically two Kestrels placed together, one being inverted) and had all 24 cylinders working on a single crankshaft. The included angle between the adjacent cylinder-banks was 90 deg instead of the more normal 60 degrees.

The Vulture suffered from big-end bearing-failures, con-rod failures, cooling problems, and other defects. Most of these problems were resolved, but Rolls-Royce was very heavily committed to the Merlin and did not have the resources, at that stage in the war, to eliminate all the Vulture's deficiencies. The Manchester went into production and saw limited service, but the unreliability of the engine made it very unpopular with its crews. Surprisingly enough, having bombed targets in Germany the crews wanted to return home! Unfortunately the Vulture engines did not always permit this to happen!

Realising the Manchester's failings, A V Roe decided to rework the basic airframe and employ four new power-plants instead of the two Vultures. A new centre wing section was developed, and with other airframe refinements the prototype Manchester III flew on 9 January 1941, powered by four Rolls-Royce Merlin engines. The aeroplane was transformed, a new name was sought, and the **Lancaster Mk I** was born.

It is interesting to note that the Germans had a very similar problem with an aeroplane called the Heinkel He 177, Greif (Griffin). The configuration of this aircraft resembled that of the Manchester, in that there were two large, 24-cylinder Daimler-Benz DB 606 or 610 piston-engines. These engines had a slightly different layout to that of the Vulture, in that each installation comprised two separate (and handed) 12-cylinder units, geared together driving a single four-bladed propeller. These engines gave an inordinate amount of trouble, partly due to poor design of the installations. Other causes, such as inefficient fuel injection-pumps, fuel leakages from injection-pump-lines, inefficient oil-pumps, inadequate exhaust-manifolds, drive-shaft vibration, and the lack of an effective firewall, exacerbated the difficulties. Mid-air fires were commonplace! The reputation of the He 177 was so bad that the machine was unofficially dubbed the *"Luftwaffenfeuerzeug"* or, literally, Air Force Fire Lighter! After investigations, the Reichsluftfahrtministerium or RLM, at Rechlin, the German equivalent of Farnborough, listed **56** possible causes of fire. Eventually the Germans adopted a similar solution to that taken by Avro, but it took them an extremely long time and the Greif was no Lancaster. It is of interest to note that one of these large Daimler-Benz power units is preserved in the U K and may be seen at the Science Museum reserve collection at Wroughton near Swindon, Wiltshire.

The Manchester was scheduled to be built by a number of large concerns, including AWA, but due to the aircraft's poor record these plans were abandoned. However, with the success of the prototype four-engined Lancaster, large scale-production plans were reinstated and AWA had a crucial role to play.

A Lancaster II (DS 771) with four Bristol Hercules engines. Three hundred machines of this Mark were built solely by AWA

As an insurance against a lack of Rolls-Royce Merlin engines, which by now were being used on many types of allied aircraft, AV Roe considered a design proposal for a Lancaster with four radial engines. The very reliable and powerful 14-cylinder Bristol Hercules sleeve-valve piston-engine was considered a suitable alternative power unit, and two prototype Lancasters were constructed with these engines fitted.

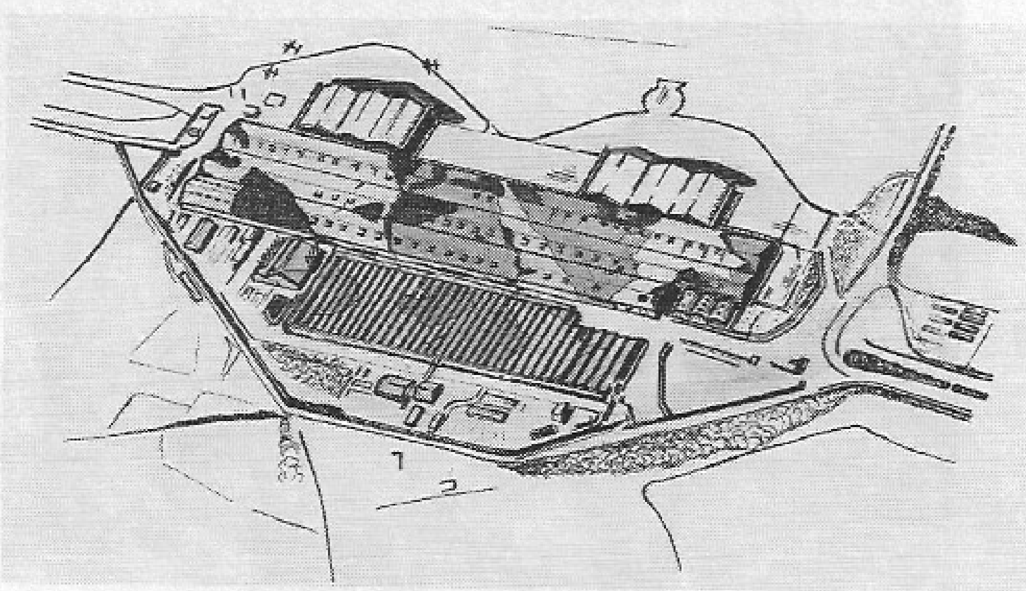
The generally satisfactory outcome indicated that should the supply of Merlin engines fail, the Lancaster could still be supplied to the RAF. At this juncture the project was handed over to AWA at Baginton, for production in quantity of what was now known as the **Lancaster Mk II**.

Thus the first Lancaster sub-type built by AWA was the **Mk II,** with Bristol Hercules radial engines. Three hundred aeroplanes of this mark were built, the first machines passing through the Baginton shops in 1942. In fact AWA was destined to be the only manufacturer of the Mk II. When it became apparent that the supply of Merlins would be assured, especially after Packard and Continental in America had joined the manufacturing programme, the need for the 'insurance' Lancaster evaporated.

Sir Stafford Cripps on a wartime visit to Baginton. Also pictured are H M Woodhams and Sir Frank Spencer Spriggs. A radial-engined Mark II Lancaster nears completion in the background

AWA went on to build a further 1,029 Lancasters, comprising 919 **Mk I** and 110 **Mk III** aircraft. This brought the grand total of AWA-produced machines to 1,329. The last Lancaster of all to be supplied to the Services was an AWA-produced Mk I, which was delivered on 2 February 1946. It is perhaps pertinent to give the production figures for other organisations in the Lancaster manufacturing consortium. They were as follows: AV Roe, 3,670; Metropolitan-Vickers, 1,080; Vickers Armstrongs (Castle Bromwich), 300; Vickers Armstrongs (Chester) 235; Austin Motors, 330 and Victory Aircraft Limited, Canada, 430. The grand total therefore, for all Lancasters, including AWA's figures, was 7,374. There is virtually no disagreement amongst most aviation experts that the Lancaster was probably the best bomber produced by any of the combatants during the second world war.

The contribution AWA had made to Whitley and Lancaster production, and thus to Allied victory had been very significant. Far from being a weak organisation incapable of producing more than one specific type, AWA had managed some 60 factories, large and small, spread across the country and all dedicated to the production of bombers. Figures for 1944 indicate that at that time the company employed 12,873 people and had 2,380,875 sq ft of productive floor space. Apart from Baginton and Whitley, AWA operated further installations at Bitteswell, Sywell, Leicester, Nuneaton, Northampton, Swindon and Hamble. In Coventry, the Ordnance works in Smith Street had assisted in the production of Whitleys. Whitley bombers had also been repaired at Bonniksen's airfield just outside Leamington, although at the time of writing it is not clear if this facility was under direct AWA control.



An aerial view of the Baginton Factory drawn from a photograph taken at the end of the second world war. Later additions included Administration Offices and a large canteen

In 1944, under direction from the Ministry of Aircraft Production, AWA took control of the Swindon factory of Short Brothers, manufacturing the **Stirling** bomber. Whilst under AWA management this plant produced 108 Stirlings. This is further incontrovertible evidence, if any were actually needed, that AWA was not the weak and incompetent organisation that has been suggested. Stirlings, the first of the 4-engined 'heavies', were used extensively during the latter stages of the war as towing aircraft for the Airspeed Horsa gliders carrying the British 6th Airborne Division into Normandy on D-Day. Stirling aircraft subsequently performed a similar duty during the Arnhem offensive.

The immediate post-war period was a difficult time for the aircraft industry as a whole and AWA was no exception. The industry had expanded very rapidly to meet the threat from the Axis and with victory it had to contract, it could be argued, even more quickly. Virtually overnight, contracts were terminated or drastically curtailed. True, Japan had yet to be defeated, but the European war was over. AWA continued to carry out work on Lancasters for some time, including conversions and repairs. Fortunately, another aeroplane appeared just in time to swell AWA's depleted order-book. The new aeroplane was the **Lincoln.**

The **Lincoln** was, in effect, a very much modified Lancaster, designed by A V Roe to meet Air Ministry specification B14/43. In fact, the early Lincolns, Mks I and II, were originally known as Lancaster IV and V, respectively.

Once again, confounding the myth that AWA was incapable of producing a new production type, the company was given a contract to supply the new bomber. Although AV Roe built some Lincolns, AWA built the majority. The machine had been conceived specifically with the war in the Pacific in mind. However, before it could become operational the war with Japan ended. Although the immediate need had receded, AWA continued to manufacture the Lincoln until March 1951, when the final and 281st, was delivered. The Lincoln remained in front-line service with the RAF until the advent of the new jet-powered V-bomber force. Gaydon, in Warwickshire, became the first operational V-bomber station on 1 January 1955. The reformed No 138 squadron stationed there was the first to operate the new Vickers Valiant nuclear bomber. The author can remember in the mid-fifties, at the height of the cold war, how the sound of these bombers could easily be discerned in Leamington every evening, as they took off from Gaydon for unknown destinations.

AWA POST-WAR

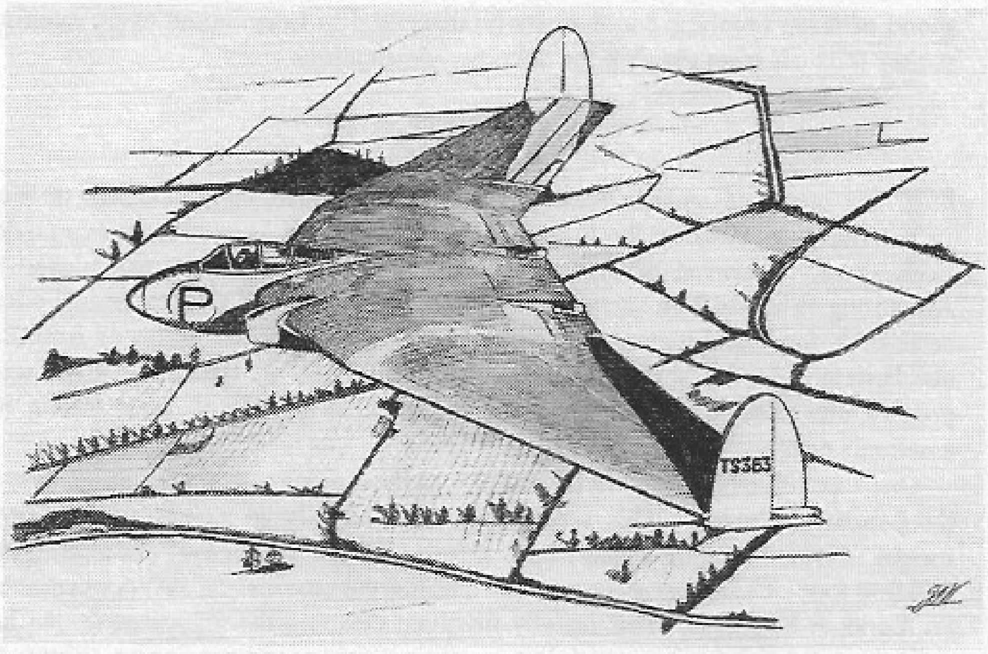
The causes of, and the Western Allies' responses to, the blockading of West Berlin in 1948 by the Soviet Union are too well known to be expounded here. However, what may not be so well known is the part played by Armstrong Whitworth in sustaining the lifeline. By far the greatest contribution, in aircraft, food, and materials, was that made by the United States of America, but Britain did play a very major part. Aircraft of all types and sizes were pressed into service to deliver to the beleaguered people of West Berlin the essentials of life.

One type of aircraft used in the airlift was the Avro **York,** a civilian version of the Lancaster bomber. This aeroplane was essentially an airliner used to carry freight. Twenty-nine thousand flights were made into Berlin by York aircraft and 230,000 tons of supplies were carried. During the emergency, AWA overhauled 86 Yorks at Baginton. This usually involved cleaning the aeroplane (some had carried coal), disinfection, stripping, repair, servicing, and repainting. The turn-round time was usually very short, often less than three days, including Air Ministry inspections. A very creditable effort by the employees of AWA.

The AW 52 Flying Wing

It has often been stated that the **AW 52** was the world's first jet-propelled Flying Wing. This is probably incorrect. The Germans with the turbojet-powered Horten Ho IX V2, all-wing machine, made successful flights at Oranienburg, north of Berlin, in 1944, and plans had been prepared for the Gothaer Waggonfabrik to produce this type in quantity as the GO 229 Fighter-Bomber. The war ended before these plans could reach fruition. The United States, at the conclusion of the war, became the main beneficiary of this advanced German research. The centre-section of the uncompleted Horten Ho IX V3 was removed to America and is preserved in the US National Air and Space Museum, Silver Hill, Maryland.

AWA began design work on the **Flying Wing** in 1943, initially as a project into the development of laminar-flow wings and boundary-layer control. Laminar-flow wings are aerofoil surfaces with extremely low levels of aerodynamic friction. They are designed primarily to maintain a very smooth flow of air (the boundary-layer close to the aerofoil) over the surface of the wing for as long as possible, thus delaying the onset of turbulence. Wings of this type are very difficult to construct and demand high standards of conformity, workmanship, and finish. The smallest of excrescences on the surface of the aerofoil will destroy the boundary-layer and nullify any advantages. Conventional aerofoils normally have their maximum thickness at a point about one-third chord from the leading edge, whereas laminar-flow aerofoils usually have their maximum thickness at about the mid-chord position. Based on this work, the AW 52G glider prototype, RG 324, was built to a scale 0.6 full size. The first 'free' glide flight occurred on 2 March 1945, and lasted 25 minutes.



The first prototype AW 52 Flying Wing, registration No TS 363

On 13 November 1947, Britain's first jet-propelled Flying Wing, registered TS 363, took to the air with test pilot Eric Franklin at the controls. A second machine, TS 368, later joined the test-flying programme and this aircraft was subsequently transferred to Farnborough for research into airflow behaviour.

However, the first prototype jet-powered machine was involved in a historic aviation 'milestone' on 30 May 1949. The aircraft got into difficulties and of necessity its occupant, J O Lancaster, used the Martin Baker ejection-seat to vacate the aircraft. This was the first occasion on which an ejection-seat had been used in an emergency, and Lancaster survived the incident. TS 363 crashed at Leamington Hastings and was totally destroyed.

The AW 52G glider prototype survived as a static exhibit for many years, outside the main administration offices at Baginton. This historic machine was eventually broken-up; in the author's opinion an act of mindless vandalism.

The AW 55 Apollo

The **Apollo** was designed by the company to meet the need for a short to medium-haul airliner. Two prototypes were built, together with a static-test airframe. On 10 April 1949, the first prototype, VX 220, took to the air piloted by E G Franklin with W H Else as co-pilot. Four Armstrong Siddeley Mamba axial-flow turboprop-engines provided the power. This was the first aircraft in the world to fly with such an engine installation.

Using the first prototype airframe, AWA conducted extensive trials into the effects of cabin pressurisation and fatigue. In addition, some of the earliest water-tank testing using a full-size Apollo cabin, was carried out. Water-tank fatigue-testing would later be used by De Havilland during investigations into the Comet crashes. The Apollo was an elegant, some would say beautiful, aeroplane which had the misfortune to be in a competitive market at the same time as the Vickers Viscount. The Viscount went on to be one of the most commercially successful civil aeroplanes to be built in Britain after the war. It is unfortunate that the Apollo could not have shared in some of the financial rewards. It was this inability of AWA to penetrate the civil aviation market that was to have serious implications for the company a decade or so later.

THE JET ERA-METEORS, SEA HAWKS, JAVELINS AND HUNTERS

The **Gloster Meteor,** which saw very limited action at the end of the war, mainly against flying-bombs, was the first Allied operational jet-propelled aircraft. Although Frank Whittle had run the world's first gas-turbine at Rugby in April 1937, Britain had been very slow to exploit the potential of the turbojet-powered aeroplane.

This was not the case with Germany. By the end of the war the enemy had several very advanced types of jet-propelled aircraft at both production and advanced development stages. These included the Arado Ar 234 Blitz Series, Gotha GO 229, He 162, He 280, and the Me 262 to name but a few. They also had several rocket-propelled designs including the Me 163 fighter, which was used in combat against Allied bombers. It was very fortunate for the Allies that the war ended when it did!

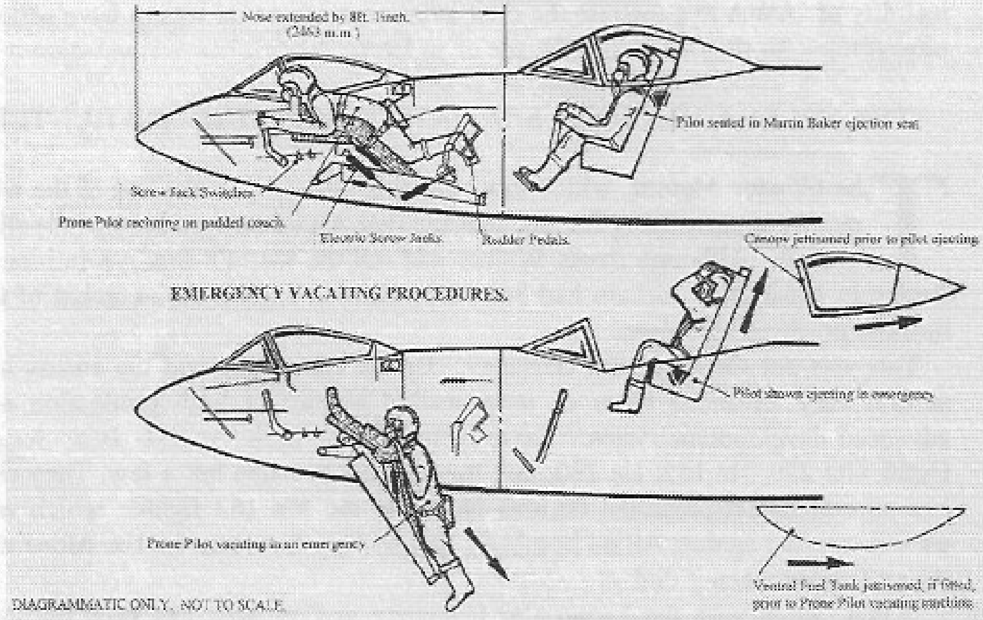
AWA, along with the Jaguar Car Company in Coventry, had been building Meteor units under sub-contract to the Gloster Aircraft Company (GAC) since 1946. Eventually in 1949, AWA was requested to build 45 Meteor **Mk 4** aircraft complete, for the RAF. This contract was completed in April, 1950. Further sub-contracts from GAC followed, including a requirement for 429 **Mk 8** machines, an order completed in March 1953.

The Prone-Pilot Meteor

Towards the end of the second world war, numerous advanced aircraft designs were prepared by the German aviation industry. One particular proposal, the Gotha P60 Series for a jet-propelled heavy fighter, accommodated the two members of its crew in the prone-position. However, the project never progressed beyond paper. The war ended before any further development could be undertaken.

The **Prone-Pilot Meteor** emanated from a requirement from the Royal Air Force Institute of Aviation Medicine at the Royal Aircraft Establishment. This was for a research aeroplane, specially adapted, to gather data on the effects of G-forces on the pilot during high-speed manoeuvres. Information was required in order to assess a Bristol Aeroplane proposal for a rocket-powered, prone-pilot, delta-winged, interceptor fighter. It was accepted at the time that the prone-pilot position would confer several advantages over a normally seated pilot.

AWA took on the project and selected the final Mk 8 Meteor, WK 935, from the Baginton assembly-line for the necessary modifications. This standard Mk 8 machine had been provided with an extended nose section of about eight feet, grafted onto the existing fuselage. Into this section was fitted a second cockpit, where the additional pilot was accommodated in a prone-position, on a specially designed padded couch. The prone-pilot could precisely adjust his reclining position with the aid of a number of electrically operated screw-jacks. A duplicate set of flying controls was fitted, the rudder bar being located at the foot of the couch and the remaining controls operated by the pilots hands and forearms. Both cockpits were unpressurised.



The Prone Pilot Meteor showing emergency escape procedure

In an emergency, the normal procedures for baling out were impossible for the prone-pilot. Therefore a section of the fuselage floor, together with the pilots couch, was designed to hinge downwards, depositing the prone-pilot, feet-first, into the air-stream beneath the aircraft. The exact sequence of evacuation for the prone-pilot was as follows. On pulling a lever, the pilot caused the rudder pedals to move away freeing his feet. The ventral fuel-tank would be jettisoned and the nose-wheel, if in the 'down' position, would be forced up by compressed air. Pulling a second lever allowed electrically operated arms to actuate, forcing the lower part of the couch into the air-stream. Operating a third lever released the pilot's harness, allowing him to fall free of the aircraft. The prone-pilot's parachute would then open automatically, by means of a barastat. The minimum safe escape-altitude was set at 400 feet. The conventionally positioned pilot, in an emergency, would have vacated the aircraft using his Martin Baker ejection-seat.

The Prone-Pilot Meteor first flew in February 1954, and an extensive programme of test flying was undertaken by AWA and the Institute of Aviation Medicine at the RAE. The tests revealed that the prone-pilot could stand considerably more G-force than his normally seated colleague, who was also required to wear a pressure-suit to prevent him blacking out during high-speed manoeuvres. It was established that the prone-pilot could effectively handle the aircraft during take-off, landing, and normal flight. However, upward and forward vision were restricted. Different pilots, of course, had varying views on the Prone-Pilot Meteor, but the consensus was that the prone-position was generally comfortable, but lacked 'a seat of the pants' feel of man and machine in total harmony. In due course, the Institute published a report that concluded that the prone-pilot position was entirely practicable if aerodynamic consid-erations made it necessary. Nearly 46 years have elapsed since these trials were concluded and no military aeroplane has yet come into production with the pilot accommodated in the prone-position. However, that may be just round the corner! The prone-pilot Meteor, WK 935, is preserved at the Aerospace Museum at RAF Cosford, Shropshire.

Meteor Night Fighters Mk NF 11,12,13,14

Armstrong Whitworth was given sole design and manufacturing responsibility for all the Meteor Night Fighters Mk N F 11-14 inclusive. Initially the company was handed a contract to develop a two-seat night-fighter to Air Ministry specification F 24/48 based on the Meteor airframe. Gloster Aircraft had also completed some design studies in this area and the work was subsequently handed over to AWA.

The **NF 11** resulted directly from the Meteor T7 two-seat training aeroplane, an example of which AWA had converted to night-fighter standard in September, 1949. At the end of May 1950, the first true prototype NF 11 flew, with Chief Test Pilot Eric Franklin at the controls. An extensive flight-testing programme was undertaken, including spinning and under-wing fuel-tank jettisoning trials. Although the basic airframe was that of a Meteor, so much development had been done that the aeroplane was, to all intents and purposes, a new type. The first production NF 11 was supplied to the RAF in October 1950. Deliveries continued until May 1954, when the 338th and final machine left the factory. A peak production figure of 32 machines per month had been achieved. In addition to the RAF, the airforces of France, Belgium and Denmark had also received the NF 11.

The **NF 12** Meteor was basically a refined Mk 11 which included a slightly different bullet-fairing to the fin-tailplane junction, a longer nose-fairing to house the latest APS 21 radar equipment, and more powerful Rolls-Royce Derwent 9 engines. All this added up to a faster aeroplane, a maximum speed of 0.81 Mach being achieved with the production/prototype machine. The first flight of the NF

12 WS 590, was on the 21 April 1953, with E G Franklin again at the controls. Eventually 100 machines equipped 11 Squadrons of the Royal Air Force.

A tropicalised version of the NF 11 resulted in the **NF 13** Meteor. Externally the aircraft was very similar to the NF 11. Internally there were radio-equipment changes, and the installation of a cold-air unit in the cockpit. Only 40 aircraft were constructed and these were supplied to two RAF Squadrons, No 39 and 219, attached to the Middle East Air Force. A small number were also supplied to the Egyptian Air Force.

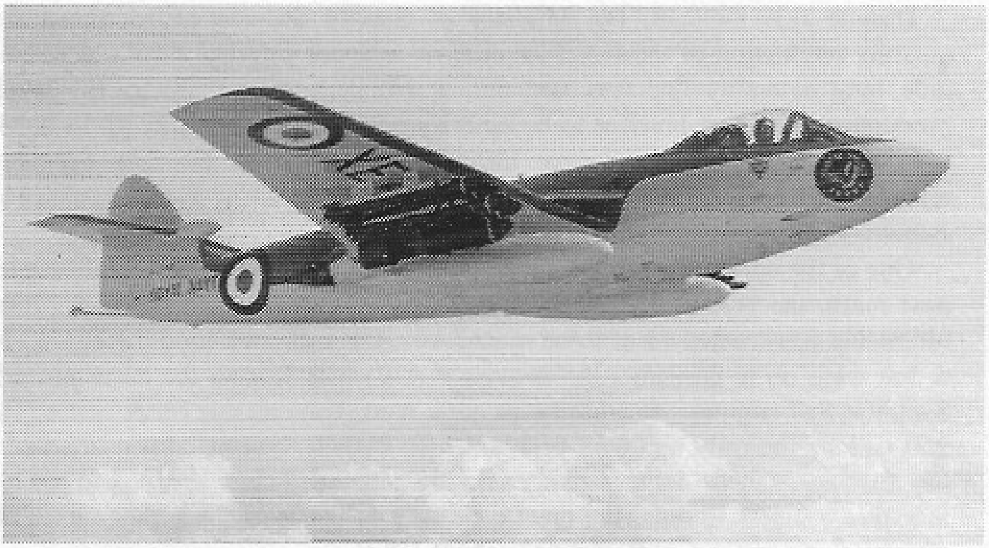
The final nocturnal Meteor was the **NF 14,** the prototype of which started life as a modified NF 11. The most obvious external changes to the aircraft were firstly, the extended nose and secondly, the cockpit canopy, which was now a new two-piece clear-blown moulded unit. All previous Meteor night-fighters were equipped with side-hingeing, heavy-framed canopies, but the NF14 introduced the electrically operated, rearward-sliding unit which provided a big improvement in visibility. The prototype NF 14 first took to the air from Baginton on 23 October 1953, with W H Else at the controls. One hundred NF 14 s were subsequently delivered to the RAF, the last machine leaving AWA on 26 May 1955. The Meteor nightfighter had reached the end of its practical development, although AWA continued with conversions and other related work for several more years. The author can recall working on Meteor ventral fuel-tanks, in the old Baginton 188 shop, in about 1963-64. An all-yellow ex-Aeroplane and Armament Experimental Establishment NF 14 is exhibited at the Midland Air museum.

AWA and the Sea Hawk

The **Sea Hawk** was essentially an aeroplane conceived by the Hawker Aircraft Company. However, in 1953, because of Hawkers heavy commitments with the Hunter, AWA assumed total responsibility for design and manufacture of the Sea Hawk. It took the basic design and considerably developed the machine's potential, adding cabin-pressurisation, power-controls, anti-G systems and an extensive range of externally carried stores. It has been suggested that had Hawkers retained control of the Sea Hawk this would have greatly assisted them in the development of the Hunter. This may well be true, but hindsight is a marvellous thing and Hawkers, being a relatively small manufacturing unit, did not have the capacity at the time to deal with *two* new designs.

The Sea Hawk was a single-seat, shipboard fighter/fighter-bomber, fitted with a single Rolls-Royce Nene turbojet engine. Powered wing-folding was installed and all other associated equipment necessary for carrier operations. Four hundred machines were produced for the Royal Navy. Deliveries commenced in February 1953. The final deliveries were completed in December 1955, on schedule, despite certain difficulties that had arisen with Hawkers during the execution of the contract.

In 1956, further orders were received from several foreign Navies, including 14 for the Indian Navy, 68 plus spares for the West German Air Arm and 22 plus spares for the Royal Netherlands Navy. This brought the grand total of all Sea Hawks to 504, plus spares. A Sea Hawk FGA 6 fighter can be seen at the Midland Air Museum, Coventry.



Sea Hawk FGA 6, XE 456. This particular machine was demonstrated at the SBAC Exhibition at Farnborough in 1956

The Gloster Javelin F (AW) Series

AWA became involved in building the **Javelin** some time after the Hawker Hunter. However, because the Hunter continued to be rebuilt and refurbished at the factory at Bitteswell, long after work on the Javelin had ceased, it will be more convenient to discuss the Javelin first.

It was in the late 1940s that the Gloster Aircraft Company submitted a number of proposals for a two-seater, day and night-fighter to Air Ministry specifications F43/46 and F44/46. It is not known when the company started to consider the delta wing configuration for what was to be its last aeroplane, and the world's first all-weather fighter.

The route by which the final specifications were established is far too labyrinthine for this paper. Suffice it to say that they were eventually issued in June 1948. Among the exacting requirements was a minimum flying time of two hours, and a time not exceeding 10 minutes from engine 'switch-on' to reaching an altitude of 45,000 feet.

Although of unconventional appearance, the prototype was structurally fairly orthodox and was made of predominantly light alloys. It was equipped with two Armstrong Siddeley Sapphire 2 turbojet engines, each of 9,000 lb thrust. The first prototype was built primarily at Gloster's Hucclecote factory, before being removed to the company's Moreton Valence airfield, in July 1951, for completion and initial test work. The prototype Javelin, WD 804, first flew from Moreton Valence on 26 November 1951, with W A Waterton at the controls. A considerable amount of test-flying was performed with this aeroplane before a serious incident occurred on 29 June 1952, when Waterton, who was flying the machine at high speed, experienced a loss of both elevators due to serious flutter. Displaying great courage, Waterton elected to pilot the machine down, and despite some damage to the aircraft he stepped out unscathed. For his courage in saving the aeroplane, and the vital flight-recorder, Bill Waterton was awarded the George Medal. Soon afterwards the second prototype joined the flight-testing programme.

Despite this incident, the Ministry of Supply decided to go ahead with quantity production of the GA 5 Javelin, on a 'super-priority' basis. A quarter-mile long assembly line was laid out, at Hucclecote, specifically for Javelin production. The first Javelins to be built by AWA were a quantity of 38 F(AW) **Mk 4** aircraft, and these were ultimately supplied to No 141 Squadron, temporarily based at RAF Horsham St Faith, Norwich. Deliveries commenced in January 1957.

One of the concerns with the Javelin was its limited range. To improve it, the next mark, the F(AW) **Mk 5**, had increased fuel-capacity in the wings. AWA ultimately constructed 44 of these machines. AWA did not build the F(AW) Mk 6, but went on to construct the heavier F(AW) **Mk 7,** with the more powerful Sapphire Sa7 engines. In addition to other modifications this Mark carried two, 250 gallon, ventrally mounted fuel-tanks (so called, 'bosom' tanks) attached to the fuselage. These large tanks could be jettisoned and AWA had quite a lucrative business in repairing great quantities of them; as the author can testify, after working on them at Baginton in about 1964.

Some Javelins of this mark were retrospectively fitted with in-flight refuelling probes, which were installed on the starboard side of the aeroplane at cockpit-level. This 20-ft appendage projected beyond the aircraft and had an appearance reminiscent of a medieval knight's jousting lance! AWA built 57 F(AW) Mk 7 aircraft. They were the last Javelin sub-types to be constructed at Coventry and Bitteswell. (GAC went on to build the F(AW) Mk 8 and modify some existing aircraft up to Mk 9 standard). In all AWA constructed 139 Javelins. Although it is only the author's opinion (which may not be worth a great deal) he has always considered the Javelin as something of a heavyweight, 'clod-hopper' of an aeroplane, somewhat lacking in *finesse*. When the refuelling-probe was added, it confirmed his worst opinions! A preserved Gloster Javelin F(AW) Mk 5, is exhibited at the Midland Air Museum, Coventry. This Coventry-built machine, registered XA 699, completed only 789 flying hours before being withdrawn from service.

AWA and the Hawker Hunter

If the Javelin was something of a 'clod-hopper', the **Hunter** was an aeroplane of an altogether different calibre. It is more than 50 years since the prototype Hunter first flew and on that day a 'thoroughbred' was born, a classic aeroplane in every respect. If the Vickers Viscount was the civilian success of the British aircraft industry post-war, the Hunter must surely be rated as the military equivalent. With a total of 1,972 new Hunters constructed at Kingston, Blackpool (Squires Gate) and Coventry, not to mention 574 conversions, the aeroplane was brilliantly successful. With nearly all the world's major air forces it fulfilled several roles: fighter, fighter-bomber and ground-attack aircraft. Indeed it continues to serve, with distinction, with some of them.

The gestation of the Hunter was quite prolonged, which was as much to do with the shortcomings of the Rolls-Royce Avon RA7 turbojet as the aircraft itself. Compressor-surging under certain conditions, particularly when firing the Aden cannons, seemed to afflict the early Avons, and it was most fortunate that the Armstrong Siddeley Sapphire engine was available as an alternative. Although the Avon was, initially, a troublesome engine, the problems were sorted out by Rolls-Royce and it was the better of the two engines in the Hunter.

Rather like the Javelin it is difficult, now, to pinpoint when and how the design of the Hunter was first conceived. Eventually, out of the many proposals, came the Hawker P 1067. This design culminated in a single-seat, single-engined turbojet fighter with moderately swept-back wings and tail surfaces to meet Operational Requirement, OR 228. Eventually three prototypes were ordered; the first two being Avon-powered and the third equipped with an Armstrong Siddeley Sapphire engine. Work on the first prototype, WB 188, proceeded steadily at Richmond Road, Kingston, and it was not until 27 June 1951 that the aircraft was transferred to Boscombe Down for flight-testing.

The first flight of the Avon-powered P1067 prototype took place on 20 July 1951 with Neville Duke at the controls. The flight was uneventful, although it was noted some of the 'stick' forces were high. As has been related, the Hunter took quite a time to settle down into a viable proposition for production. A large amount of test-flying was needed to solve a whole host of problems. The first production aircraft was the F1 (which AWA did not build).

AWA's first contribution to the Hunter production programme was the **F2.** Coventry built 45 of these machines with the Sapphire Mk 101 engine. Two RAF Squadrons, No 257 and 263, were equipped with them. In order to improve the rate of climb, the F3 Hunter incorporated the Avon RA 7R with reheat. This modification did result in an improvement, although the aeroplane still fell short of Operational Requirement 228 in this respect. The F3 aircraft did not go into production. Although the Hunter F4 was produced in volume by Kingston and Blackpool, AWA did not produce this mark. Coventry, however, went on to manufacture 105 **F5s.**

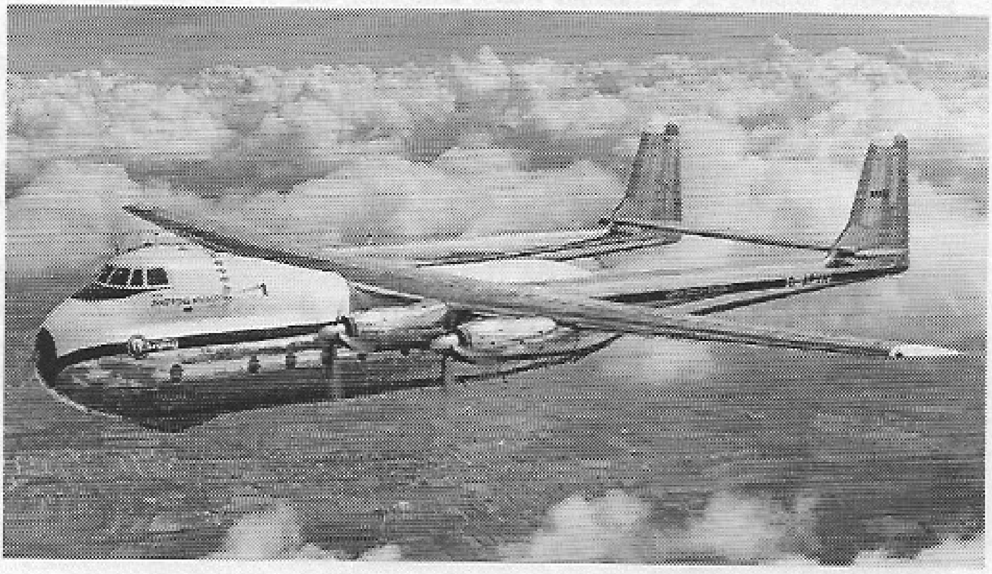
With the introduction of the **F6,** with the Avon Mk 203 or Mk 207 engine, the Hunter was becoming an extremely capable aeroplane, with most of its faults eliminated. Of course, additional operational requirements meant that the aircraft had to be constantly adapted to accept heavier loads, external stores and weaponry. AWA built 128 machines of this mark, the last being delivered on 29 March 1957. This brought the total of new-build Hunters constructed at Coventry to 278 machines. Hunters were also licence-built in a number of countries including Holland and Sweden

The Hunter was a very robust aeroplane, which probably explains its longevity. The author of this paper well recalls working on these machines in about 1966 at Bitteswell. Some of them were possibly well over a decade old at that time and after refurbishing had years of potential life ahead of them. A number of Hunters, **FGA 59**s it is thought, refurbished to pristine condition at Bitteswell, were returned to the Jordanian Airforce just prior to the 'Six Days War' in June 1967. It was disappointing to learn, a few days later, that our handiwork had been destroyed on the ground, without even a little bit of a fight, by the Israeli Airforce. If the Hunters had not been caught 'cold' they may have given a good account of themselves. Iraqi Hunters however, put up a good performance against the Israeli Airforce in the 'Six Days War'.

A preserved, Coventry-built, Hawker Hunter F6A, may be seen at the Midland Air Museum, Coventry.

THE AW 650 & 660 ARGOSY FREIGHTERS

The design of the **AW 650 Argosy Series** was initiated in September 1956, when the company perceived the need, in world markets, for a heavy transport/freighter aeroplane. Previous overtures to the Ministry of Aviation for a military-transport aircraft received no approval. Consequently, the company went ahead, on its own initiative, with the civil aeroplane.



AW 650 Argosy G-APVH had its first flight on 20 July 1959, and was supplied to Riddle Airlines of the USA as N6504 R in1961

The design-team, led by E D Keen, produced a slightly unusual, although not unique solution, to meet the design-parameters. The aeroplane that emerged was a pressurised, large-bodied, high-wing, 4-engined turboprop, with twin booms and *empennage*. The fuselage had a capacious hold, with large doors at front and rear, permitting simultaneous loading and unloading of cargo. This feature greatly reduced 'turn-round' times. The floor of the hold was designed to accept standard-size pallets and was fitted with the company's Rollomat handling-system which permitted palletised loads to be moved manually into position with relative ease.

Four Rolls-Royce Dart 526 Turboprop engines were fitted and provision was made, within each of the twin booms, for water-methanol tanks to be carried. Water-methanol, together with fuel, can be injected into aero-engines for short periods. This increases volumetric efficiency, giving the augmented power which is particularly necessary when aeroplanes are operating from elevated, high-temperature, airfields.

The **100 Series Argosy** aircraft employed the 'safe-life' form of wing construction, with rubber, 'bag' type, fuel-tanks. Indeed the wing as a whole was little changed from that of the Lancaster. With E G Franklin at the controls, Argosy G-AOZZ, first took to the air at Bitteswell, on 8 January 1959. Eventually the aeroplane gained its full CAA (British) and FAA (American) provals, and the way was open for world sales. The Argosy made its public debut at the Paris Air show in June 1959, to be followed by appearances of G-APRN and G-APVH at Farnborough in the following September. Unfortunately, world sales were very limited. Only 10 machines of the 100 Series were built. Seven aircraft initially went to Riddle Airlines of Miami, Florida, and three were supplied to BEA. Riddle subsequently transferred their machines to Capitol (five) and Zantop (two) and all these aircraft were used on the extensive LOGAIR routes across the USA.

The **222 Series Argosy** featured an entirely new form of wing, which included, 'wet-wing' integral fuel tanks allied to a 'fail-safe' type of structure. A 'wet-wing' may be described as a structure that contains its fuel without resort to bag tanks, or other containing devices. The wing is itself the fuel-tank. Although not particularly new, this method of wing manufacture only really became a production possibility with better sealing-agents and integrally-machined wing-skins. The 'fail-safe' concept of the 222 Series wing was born out of progressive thinking, which postulated that should a structural member fail in flight there would be sufficient redundant structure in the airframe to prevent a catastrophic failure of the aircraft as a whole. This wing, therefore, with its two key features, the 'wet wing' and the 'fail-safe' structure, was quite a manufacturing challenge!

The author of this paper never worked on the construction of the 'integral' wing, as it became known. He is quite pleased that he did not! The manufacture of the wing involved fitters climbing into the structure through small apertures in the top surface, contorting themselves into the working-position where they were obliged to drill or rivet in a confined space for, perhaps, several hours at a time. Working in the centre sections was a comparative luxury, since the aerofoil section was deep, but ingress into the outermost wing-panels called for small supple individuals, with dedication and no sense of claustrophobia! The sealants employed were also not particularly user-friendly, to use a modern phrase. All in all, working on the 'integral' wing was an experience to be avoided, if possible. It is believed that whilst workers were operating within the wings there was always a member of safety-staff standing by, to effect a rescue! In an emergency using an axe on the upper surface of the wing was permitted, but not on the lower surface.

The 222 Series machines also featured enlarged freight-doors to accept the slightly bigger 108 inch standard cargo-pallet. Five Series 222 aircraft were initially purchased by BEA, the only customer. A sixth aircraft was purchased later by BEA, to replace a machine that was lost in Italy. Subsequently, BEA sold four of the Argosy 222s to a Canadian airline, Transair Ltd of Winnipeg. Three further machines remained unsold and were stored at Bitteswell prior to being scrapped. Rather a depressing end for a useful type of aeroplane.

An AWA 650 Series 101 aircraft, G-APRL, is on view at the Midland Air Museum, Coventry.

The **Argosy AW 660 C Mk 1,** was a military version of the civil 100 Series machine, with certain modifications. This aircraft resulted from a military specification Operational Requirement 323, but official approval to proceed was not given until after the first civil Argosy had flown.

The main changes to the airframe included a strengthened fuselage floor, completely redesigned front and rear fuselage sections, modifications to fuel tanks and engine-installations, and the provision of flight-refuelling equipment. Rolls-Royce Dart RDa8 Mk 101 turboprop engines, were specified. A thimble-nose radome, at the front of the aircraft, housed weather-detecting radar.

The biggest change in the design was the provision of 'clamshell' doors to the rear fuselage, for access of vehicles and for dropping supplies from the air. It should be noted that when open, the lower part of the clamshell doubled as a ramp to permit military vehicles to gain access to the hold. In order to secure aerodynamic cleanliness, a considerable amount of effort went into obtaining the optimum shape for the doors. To test the configuration in flight, and after an extensive series of wind-tunnel tests, a full-size set of doors was built and grafted on to civil Argosy G-APRL. Flight-trials dictated that slight lengthening of the doors was required. This was accomplished by the addition of fairing structures at the appropriate positions. These trials, which began in July 1960, were completed by early 1961. Whereas on the civil Argosy the aircraft was provided with a side-hinged, front-fuselage door, on the AW 660 machine the door was deleted and a new fixed-nose section of fuselage was substituted.

AW 660 C Mk1 Argosy XN 814. This machine was the first of 56 military transports supplied to the RAF. Extensive development work was carried out by AWA using this machine

The Argosy C Mk 1 could carry 54 fully equipped paratroops, or a maximum payload of 29,000 lb for a maximum range of 345 miles. The first C Mk1 off the production line, registered XN 814, flew from Bitteswell on 4 March 1961, piloted by Eric Franklin with Bill Else acting as co-pilot. Ultimately 56 Argosy C Mk 1s were supplied to RAF Transport Command, the first machines going to No 114 Squadron at Benson in Oxfordshire.

For AWA, this contract for the C Mk 1 was the last significant order for new aeroplanes the company was to receive. When the author joined AWA as an apprentice at Baginton in 1961 everything was 'buzzing', and the company was probably at its post-war zenith in volume of work, variety of projects, and numbers of employees. Optimism for the company's future was ill-founded, however. It was not to last.

Various developments and trials were carried out using some of the production C Mk 1s. Perhaps the most bizarre, and one that was greeted with incredulity by some of the workforce, was the requirement to fit a bombsight and external stores-pods to the lower fuselage of Argosy XN 814, prior to tests as a specialist bomber. Another project in 1965 required the installation of a 'Buddy Tanker' flight-refuelling pack to the same aircraft, with the object of creating an in-flight refuelling aircraft. This modification included the installation of large fuel-tanks into the hold and the addition of a white torpedo-shaped pod, fitted externally on the rear port-side, to contain the hose and reeling mechanism. The work was carried out predominantly at Bitteswell, in the T2 Type hangar that was situated about half-way between the New and Old Sites.

The author well recalls, about this time, how he and a group of fellow apprentices were playing football outside the T2 hangar, well past the normal lunch-break. They all thought they were safe, as the T2 was fairly isolated, or so they thought! However, the New-Site manager went past in his car, on the perimeter-track, and they knew they had been caught. Subsequently, they were 'invited' to an interview with the manager and suitably chastised. His concluding remarks were to the effect that, "He, in all probability, would have done the same as them, in their position, but he would not have been caught." They all took their punishment like men and that was an end to it! The manager was held in high esteem by the author!

Reverting back to the Argosy story, probably the last 660 C Mk 1 to pass through the Baginton shops was a machine that had crashed into the sea when either landing or taking off at Aden. Although the aircraft was not particularly badly damaged, the effects of sea-water on the airframe had taken their toll. Extensive refurbishing was required, not just to the airframe itself but also to a large proportion of the systems. These were removed, refurbished, tested, and replaced as necessary. The author worked on this aircraft at various stages of its passage through the Baginton and Bitteswell shops, finally helping to install the 'bag' fuel-tanks and part of the fuel-systems when he was at Bitteswell Old Site. This aircraft finally rejoined the RAF, refurbished and as good as new.

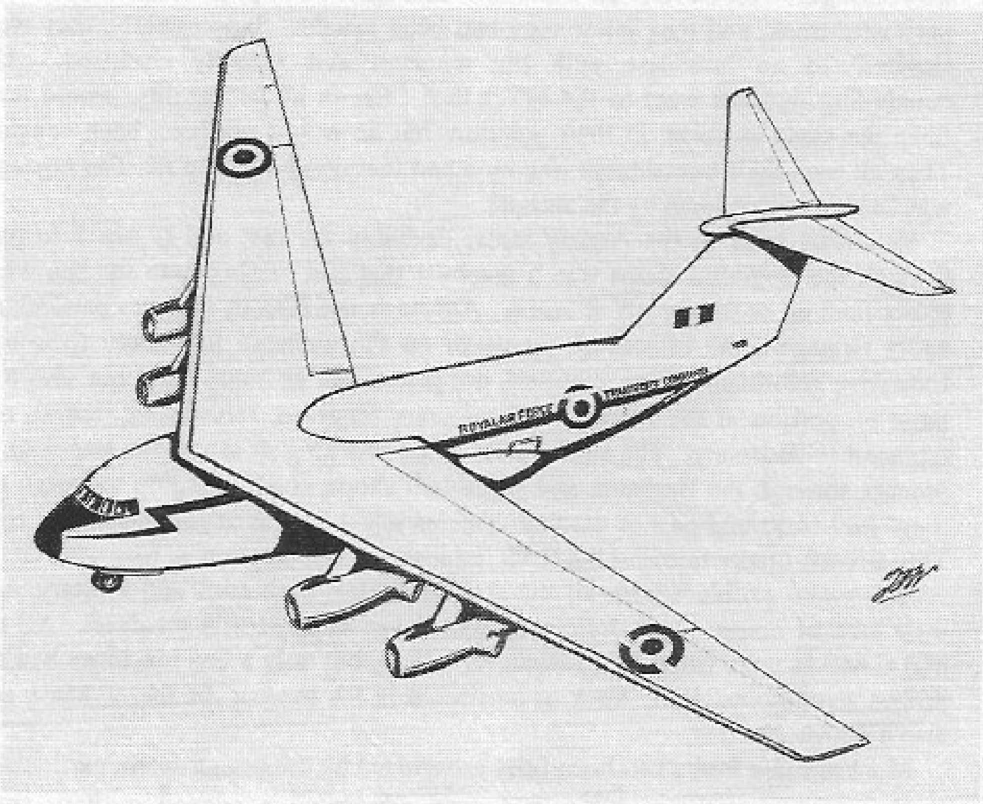
The major problem with all the Argosy Series, both civil and military, was their lack of range. This deficiency was never satisfactorily resolved. All the 660 C Mk 1s were fitted for in-flight refuelling, but only a few machines had the probes actually installed. Lack of headroom in the hold of the 660 C Mk 1 was also a drawback.

Most of these faults had been fully recognised by the design-team, particularly in the military version. AWA had even advocated a revised military specification, with the designation AW 660 Series 3, to the Air Ministry before the 660 C Mk 1 production was initiated. This proposal received little official interest from the Air Ministry, so the RAF was lumbered with what the Government was prepared to pay for!

THE AW 681 STOL TRANSPORT

It has already been mentioned that the AWA design-team had advocated to the Air Ministry a revised military freighter, with the designation AW 660 Series 3. This proposal had received the official 'cold shoulder'. However, the Air Ministry was revising, in quite a major way, Operational Requirement OR 351, for a heavy transport-aircraft, to a new turbojet-powered, STOL specification. Consequently, AWA submitted a totally new design designated the **AW 681.**

Subsequently, with its AW 681 tender, AWA won the design-competition for OR 351, and was given a contract to proceed. (Perhaps an explanation to the reader is necessary here: STOL is the acronym for Short Take Off and Landing, and VTOL is the acronym for Vertical Take Off and Landing). Within the envelope of the AW 681, AWA considered a number of proposals for both STOL and VTOL aircraft. Design-work commenced on the new machine, loftings were well under way, and a wooden mock-up of the AW 681 was at an advanced stage in the old 188 shop at Baginton. The future was bright, or so it appeared.



An aeroplane too far! An impression of the (HS) AW 681 STOL Military Transport as it would have looked in RAF service. This aircraft was cancelled in 1965 with disastrous consequences for Armstrong Whitworth in Coventry

However, in October 1964, a new Labour administration came into power. One of its first acts was to review certain aspects of defence-spending. This included key aerospace projects, including the British Aircraft Corporation's TSR 2, and Hawker Siddeley's HS (AW) 681 and P1154 Supersonic VTOL Fighter. Early in February 1965, the cancellation of the two Hawker Siddeley projects was announced, with a 'pending' decision being held over the TSR 2. The actual cancellation of the TSR 2 was made with a few well chosen words contained within the Budget delivered on 6 April 1965.

Whilst the fate of the TSR 2 was featured endlessly in the national Press, and acres of newsprint were devoted to the pros and cons of the decision, very little informed debate surrounded the other casualties, which included the AW 681.

Perhaps, on reflection, it is not hard to see why the popular Press concerned itself exclusively with the TSR 2. The aeroplane actually existed, it had flown, and it was glamorous! By contrast the AW 681 was just a few lines on paper and metal. It existed, but only as an 'inert' wooden mock-up. It was also a rather portly, unglamorous, freighting aeroplane, being built in some obscure place called Baginton in the dark hinterland of the Midlands (where dragons, possibly, still lurked!) The TSR 2 on the other hand was being built at Weybridge in Surrey: very stockbroker! Putting these, perhaps partisan, feelings to one side for the moment, the effect of the Labour Government's decision upon *all* those concerned, directly and indirectly, was devastating for the industry as a whole; and devastating for Coventry in particular.

To be absolutely fair to the British Aircraft Corporation, the outcome of the TSR 2 cancellation was massive restructuring, large scale redundancies, and the closure of the BAC factory at Luton. A particularly galling aspect of the affair was the provision in the TSR 2 contract that all aircraft under construction, together with the wooden mock-up, manufacturing jigs, tools and fixtures had to be destroyed. This absolutely ensured that there would be no resurrection of the project. Government-funding was also refused in connection with the flight-development programme, using the three completed prototypes. BAC wished to continue doing further flying with the machines to assist them with the Concorde project. This did not happen, with incalculable loss to the British aircraft industry. One TSR 2 prototype airframe suffered a particularly ignominious fate, being used by the Army for target practice at the Shoeburyness gunnery range. Two TSR 2 prototypes are preserved. One is exhibited at Duxford and the other at Cosford. The final cost to the British taxpayer in broken contracts, redundancies, and procurement of replacement foreign aircraft must have been astronomical.

The Government, having sounded the death-knell of the airframe industry in Coventry, spent its pounds-sterling on a lower specification 'off-the-peg' machine, in the shape of the Lockheed Hercules from the USA. The Hercules transport has had to undergo extensive modifications over the years to keep it up to the RAF's operational requirements. Some of these modifications were carried out by Marshalls of Cambridge.

In a very recent newspaper report it has been stated that certain difficulties are being experienced with the latest version of the Hercules military transport, the C130J. Twenty-five machines of this mark are currently on order for the RAF at a cost of £1 billion. The problem appears to be one of safely dropping para-troops from the rear side-doors. Excessive turbulence from the powerful six-bladed propellers apparently tends to force the paratroops together under the fuselage, with the possibility of dangerous collisions. This seems to be a pretty fundamental fault for a military transport!

Perhaps the aircraft's manufacturers, Lockheed-Martin, and the MOD should investigate the trials undertaken with the AW 660 C Mk 1 in 1961. These trials, carried out at Boscombe Down, revealed that paratroops left the Argosy side-doors very cleanly. At the time of writing the C130 J has **not** been approved for static-line parachute jumping!

With the AW 660 production programme winding down and only very limited orders for the AW 650 Series, it was inevitable that something drastic was going to happen to the Baginton factory. AWA did have a certain amount of aircraft and other work, which will be discussed later, but this was not sufficient to keep a plant the size of Baginton in operation. The factory covered an area in excess of 1.25 million square feet of space: it had design, drawing and administration offices, publicity offices, drawing stores, laboratories, an X-ray department, machine-shops, a precision machine-shop, a toolroom, a jig-erection department, press-shops, router-shops, tinsmiths, coppersmiths, spot-welding facilities, heat-treatment facilities, a plating shop, a plastics department, a Redux bonding facility with Autoclave, a drop-hammer shop, a wood-shop, stores of every description, a small foundry and very large assembly halls for the erection of aeroplanes. Behind all this, of course, there existed a multitude of service providers, including canteens, kitchens, maintenance departments, boiler-houses, compressor-houses, an apprentice-training school, surgeries, and fire and security services. Most of these were to go when the Baginton factory finally closed, in December 1965.

Some facilities were transferred to Whitley, and some to Bitteswell, but the heart of the company had been torn out and AWA would no longer be a major aeroplane manufacturer with its own autonomous design and manufacturing capability. Prior to leaving for Bitteswell, the author of this paper can recall walking round those cavernous, empty assembly halls and pondering on the thousands of aircraft that had been produced and the countless thousands of people who had built them.

OTHER AIRCRAFT WORK

In the years prior to the closure of the Coventry factory, AWA did have a certain amount of other aircraft work, at both Baginton and Bitteswell. Perhaps the most significant was the sub-contract manufacture of De Havilland **Trident** components.

The Trident was a civilian airliner, designed by the De Havilland Aircraft Company of Hatfield, Hertfordshire, a member of the Hawker Siddeley Group. As its name implies, it had three engines. The object was to build an aircraft, very much tailored to BEA's requirements for European and similar medium-haul routes. Unfortunately BEA kept changing its mind. As a result, although technically quite advanced, the aircraft was flawed precisely by the specifications to which it had constantly to adapt. Sales potential in world markets was therefore very limited. It is perhaps pertinent to add that its near contemporary and competitor, the Boeing 727, a similar three-engined aircraft, holds the record for the most numerous airliner in aviation history with well over 1,000 machines constructed.

De Havilland's had adopted a very safety-conscious approach when designing the Trident. All the important systems were triplicated. The Trident was also equipped with an automatic landing-system. It was the first aircraft in the world capable of landing automatically, without the pilot being involved. The three

Rolls-Royce Spey engines were all situated at the rear of the airframe, leaving a structurally and aerodynamically 'clean' wing. A multitude of 'high-lift' devices festooned the wings, including droop leading-edges, extending flaps and other aerofoil sections. AWA at Baginton assembled most, if not all, of these 'high-lift' aerofoils, as well as the centre-engine intake-ducts, horizontal stabilisers, and other components.

Another of the Trident's innovations was the use of the chemically-machined skin, which was employed extensively on aerofoil sections. Also many components tended to be machined from the solid, rather than fabricated from sheet-material. The author's involvement with the Trident was largely confined to the droop leading-edge. This long aerofoil component may possibly have been unrepresentative of the aeroplane as a whole, but it always seemed to be in a constant state of flux, with modification, after modification, after modification. In addition, some of the tooling was not always quite as it should have been. The writer ventures to suggest that this was not a unique situation, and that other units were subject to similar annoyances.

Perhaps the author's judgement on the Trident is slightly prejudiced by an incident that occurred whilst he was working as an apprentice on the droop leading-edge. He was performing a drilling operation (yet another modification), using an extension (long) drill. He should not have been using this type of drill bit at all and consequently, at several points, touched with the point an adjacent and extremely thin 'beak-skin', irreparably damaging it. The writer, in all honesty, was not aware of his stupidity and merrily continued with his work. The droop leading-edge, which was almost finished, had up to that stage, involved many man-hours' work and probably cost a fortune.

The next day was his Tech Day. The day following was hell! Even at the best of times his ganger (leading hand) was not the most popular man on the Baginton site: now he had every excuse to make himself thoroughly objectionable! He was not at all pleased! Anyone would have thought that the component was his own property! The young apprentice acknowledged his error and put it down to experience, or lack of it! He felt at the time that it was a big fuss about very little and that the skins could easily be replaced. His observation was, and still is, 40 years later, that it was a very small skin, on a very 'second-rate' aeroplane! Fortunately there was life after the Trident leading-edge section, with its martinet leading hand!

AWA had been involved with Avro designed aeroplanes for many years, including of course Lancasters, Lincolns and Yorks. Before it finally closed its hangar-doors for good it was involved with three more Avro aeroplanes.

Shackleton, the748 Series and the Vulcan

The **Shackleton** was a maritime reconnaissance aeroplane, whose design was based on the experience gained with the Lancaster and Lincoln. Although AWA never built complete Shackletons it did manufacture certain components, and went on to service and modify entire aircraft at Bitteswell. Perhaps the most lucrative and long-lived of all the Shackleton contracts was wing-refurbishing, which was carried out at Baginton and Bitteswell over many years.

The work involved the removal and the replacement of the front and rear spars, and other repair work. The Shackleton was a venerable aeroplane that was asked to soldier on for far longer than was appropriate. According to recent press reports its much vaunted and very expensive replacement, the Nimrod, is still experiencing problems with its avionics equipment and is astronomically over budget!

The **Avro 748** was a twin-turboprop airliner for short/medium-haul flights and was built in both civil and military versions. As far as the author can recollect, the only major component built at Coventry was the rudder, although it is possible that his memory is at fault.

In recent years, the **Avro Vulcan** has become something of a cult aeroplane, achieving a degree of celebrity bordering on that of its famous predecessor, the Lancaster. However, when the Avro engineering staff started to consider the design, 'cult status' was naturally not on their agenda. The objective was to design an effective, high-altitude, sub-sonic bomber, capable of delivering conventional and thermo-nuclear weapons on target. Although the aeroplane that emerged was unorthodox (to say the least), it was structurally entirely conventional.

The Vulcan was the second of a triumvirate of aeroplanes that was to become the V-bomber force. The first was the Valiant, the last the Handley-Page Victor. Whilst the Valiant and Victor were fairly conventional-looking, the Vulcan was a gigantic delta-winged aeroplane, the largest of this configuration then built. Unlike the Javelin, (the other delta-winged aeroplane discussed in this paper), the Vulcan did not have a conventional tailplane and associated elevators. It was equipped with a particular device called an Elevon, which combined the normally quite separate functions of ailerons and elevators into one multi-functional flying control. The wing-mounted Elevons could be used in *unison,* up or down as an elevator, or, *alternately* up or down as a conventional aileron. For such a large aeroplane, the Vulcan was extremely agile and endowed with a rapid rate of climb.

Over the years, AWA had a deep commitment to the Vulcan, initially supplying components from Baginton and subsequently performing extensive repairs and servicing to aircraft at Bitteswell. Amongst other components, Coventry produced rudders, engine nacelles, and rear fuselages. Although the original concept of the Vulcan was that of a high-altitude, high-subsonic nuclear bomber, with the ability to attack targets in the Soviet Union or other Warsaw-Block countries, events made this strategy questionable.

In 1962, whilst conducting an aerial spying-mission over the Soviet Union, a very high-altitude Lockheed U2, piloted by Garry Powers, was brought down by a new generation of Soviet SAM (Surface to Air Missile). Apart from the political ramifications, which were considerable, this indicated that high-altitude and high-speed intrusions over the Soviet Union were increasingly untenable. It is not the intent of this paper to go through the convoluted strategies that were developed to counter these improvements in Soviet Air Defence, other than to say that the role of the V-bomber force changed from one of a high-altitude capability to that of very low-level interdiction.

These drastic changes had a great effect on the aeroplanes themselves, if not the crews. Without exception, the Valiants, Vulcans and Victors had been designed for high-altitude bombing. Because of the newly-enforced operational requirements, they began to suffer. The first to go was the Valiant. Serious cracking in the wing-spars was detected and there were only two options; expensive repairs, or scrapping. The Valiants were scrapped. Although the Vulcan was a tough aeroplane, it too began to suffer from the rigours of low-level flying. The Avro-Whitworth Division of Hawker Siddeley Aviation, at Bitteswell, now took on the task of keeping the Vulcans flying at low-altitude.

One area of concern was an intensively riveted section of the wing called the butt-strap skins, which was prone to cracks. Whilst the machines were at Bitteswell these suspect components were replaced. The Olympus engines were also withdrawn and replaced with up-rated units. Canopies and ejection seats were always removed, refurbished, and replaced. Quite frequently the paintwork was peeling badly and had to be re-done. The paint shop was situated in a part of hangar No 6, on the Old Site. To gain access to the Old Site necessitated the Vulcan crossing the A427 Lutterworth road. This was accomplished with a minimum of fuss and disruption to traffic. Passing the modern site today, it seems absolutely inconceivable that Vulcans and other large aeroplanes were moved with such expedition.

Aviation enthusiasts in the Midlands are well served with preserved Vulcan Bombers. One, XM 655, which is maintained to a ground engine-running standard, is located at Wellesbourne airfield. The other Mk II XL 360, is a static exhibit at the Midland Air Museum, Coventry. It was reported to the author, by an enthusiast, that XM 655 is in a very good state of repair and could be flown. The author is sceptical. To maintain an aircraft such as the Vulcan to certificate of airworthiness standards requires considerable expertise, and a **lot** of money! But of course anything is possible!

The Red Arrow's Gnat Trainers

The final aircraft the author came across at Bitteswell was the Folland **Gnat** two-seat trainer belonging to the Red Arrows Aerobatic Team. He clearly remembers the private display put on by the team for all the Bitteswell personnel, before it handed its aircraft over for extensive refurbishing. These diminutive aircraft, so small they almost resembled toy aeroplanes, looked very strange in the Bitteswell hangars. The extensive use of coloured smoke dyes for aerobatic demonstrations had made quite a mess of the rear fuselages, and this had to be thoroughly removed before any servicing could be carried out. The Gnats were fully refurbished at Bitteswell, and finally given resplendent new paintwork to exhibition-standard. The writer seems to recollect that the crests on the front fuselage were hand painted by the skilled staff, and were not merely transfers.

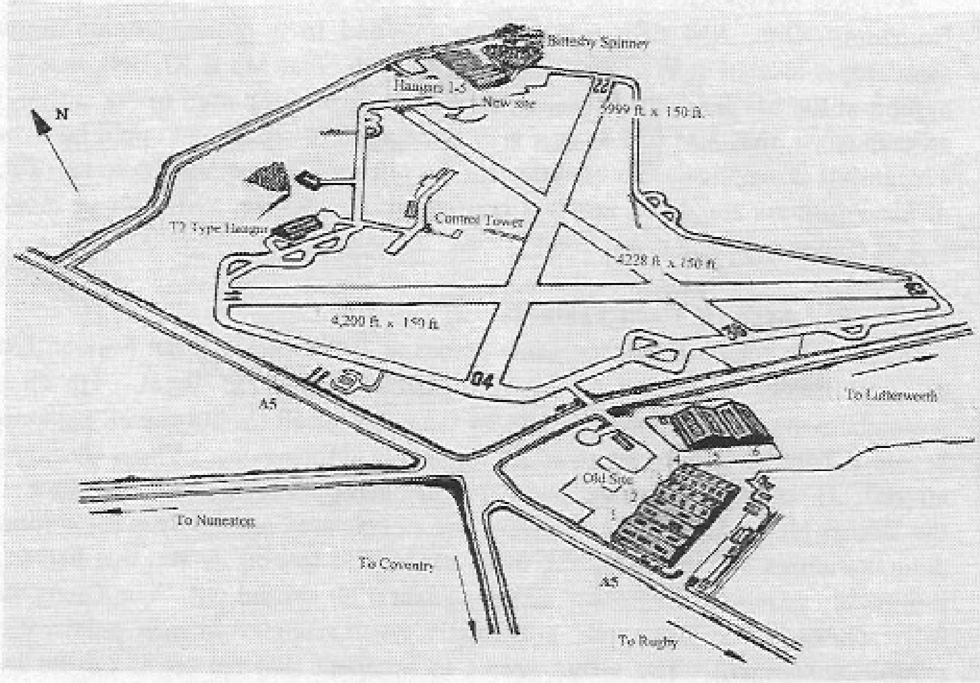
BITTESWELL AIRFIELD

Although Bitteswell is just in Leicestershire, and therefore theoretically outside the scope of this paper, it is so inextricably linked with the Armstrong Whitworth story that no reasonably comprehensive history of the company could be written without constantly referring to it. Some details may interest the reader, therefore, if only from the point of view of modern Industrial Archaeology, since the airfield, its runways and hangars, are now all but submerged beneath modern warehouses. The only sign of the aviation industry is in the names of roads that criss-cross the site. (Hunter Way and Vulcan Avenue, for example).

Located at the junction of the A5 and A4303 (A427) roads, approximately two miles West of Lutterworth, Bitteswell airfield was constructed to the standard wartime pattern, during 1941 and 1942. In 1942 it was used as a satellite airfield for Bramcote. In 1943 it became a satellite for nearby Bruntingthorpe. During 1944 it reverted back to being a satellite for Bramcote. Throughout this period several successive RAF Operational Training Units (OTUs) were there.

Armstrong Whitworth had started to use Bitteswell from late 1943, as a flight-test airfield in connection with the Lancaster production-programme. The RAF finally left in July 1946. Armstrong Whitworth continued to use the site, and many famous marks of aircraft were to make their first flights from it during the next three decades.

In 1956 the Company purchased the airfield and its facilities from the Air Ministry. Progressive development and improvements were carried out. The three concrete runways, the longest being 5,999 feet, were equipped with high-intensity sodium-lighting, giving the airfield an all-weather capability.



Bitteswell airfield circa 1968

The control-tower was provided with the necessary VHF and UHF radio equipment. For those not familiar with the airfield, there were hangars at approximately opposite ends of the main runway. Those nearest the A427 Lutterworth Road were known as the Old Site. Undoubtedly some if not all of these dated back to war. At the extreme opposite end of the main runway was the New Site, which consisted of five hangars in two separate groups of three and two. Scattered around the moderately wooded New Site were numerous wartime buildings which in the writer's time, in the mid 1960s, were utilised for various ancillary activities, including Radio Room, Instrument Test Laboratory and Maintenance Shop. The author spent some of his time in the Instrument Test

Laboratory, which had been transferred directly from Baginton when that factory closed in 1965. Approximately half-way between the two sites was located the solitary T2 Type hangar previously mentioned.

It is recorded that turbojet sound suppression-pens were installed at Bitteswell. The author is not sure exactly where. Moreover, he can personally testify that the Vulcan engine test-runs were conducted in the open, without any sound suppression devices whatsoever. As the Olympus engines fitted to the Vulcan were amongst the most powerful and certainly the noisiest engines in the Western World at that time, the surrounding countryside always knew about it! Standing under a Vulcan, on a full power engine ground-test was an experience not to be missed, but perhaps never to be repeated, unless of course you were a glutton for punishment. Most of the youthful apprentices were!!

After the rather regimented atmosphere of unending production at Baginton, not to mention the occasional brush with a martinet, as discussed previously, Bitteswell was like a breath of fresh air. Most apprentices hankered after some sort of billet there. Some preferred the Flight-Shed or the Vulcans, on the New Site; others, including the author, preferred perhaps the final-assembly at the Old Site. Whilst superficially the Flight-Shed, may have sounded *the* place to be, the writer for the most part found his stint in it generally rather boring. It was a case of rather too many people and not enough work. The older hands, naturally, had the pick of the work and there was not a great deal left.

However, the Flight-Shed did have its compensations. A very competitive table-tennis club flourished at lunch-times and a few individuals became quite skilful. These matches were played with a fervour bordering on fanaticism, usually inside the hangars, underneath any aircraft that happened to be in the way! Smashes and top-spin returns were made with some of the skills of a Johnny Leach (or so some thought), usually under the wings of Vulcans and Argosys to the great interest of the audience. Occasionally, a match was temporarily suspended or, even more seriously, abandoned if a stray ball disappeared into a Vulcan intake or up a Hunter jet-pipe and could not be quickly retrieved! The writer often wonders whether *all* those missing table-tennis balls were found!

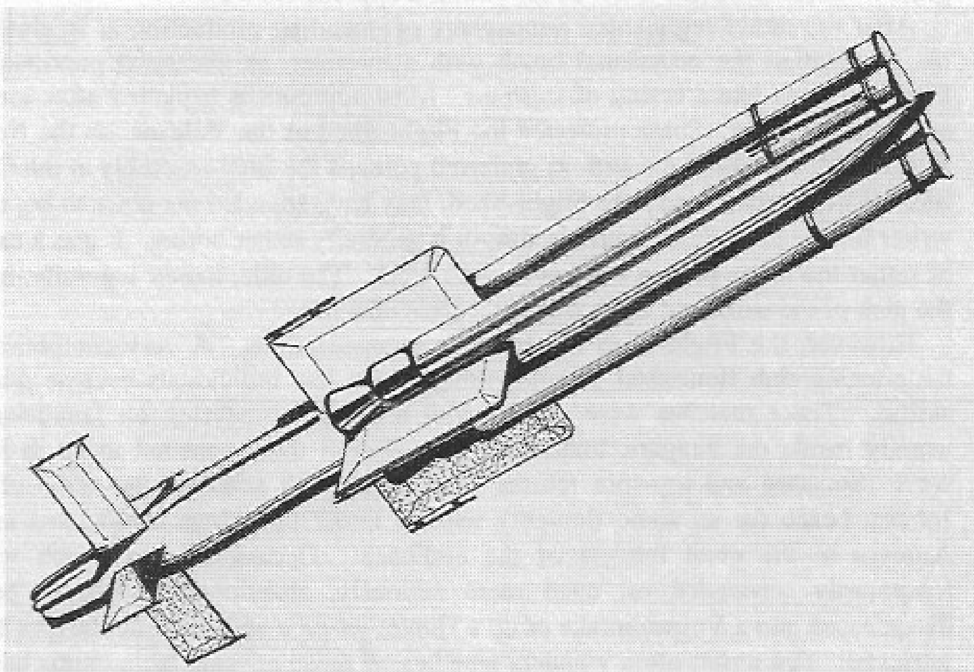
The writer of this paper left Bitteswell in November 1968, and therefore has no first-hand knowledge of events after that date. It would seem that under the Hawker Siddeley banner it continued to repair and service Vulcan and Shackleton aircraft for another 17 years. However, this was inevitably a road to nowhere. Deprived of an autonomous and creative design-headquarters, and with a contracting aircraft industry, Bitteswell was inevitably going to lose out to the bigger companies. It was frequently claimed by some of the pundits, "who knew about these things", that Bitteswell, being one of the few well-equipped airfields actually owned by the Hawker Siddeley Group,would survive. Para doxically, it may have that very fact that ensured its demise! Land, as we all know, is valuable. It can be sold for money!

Bitteswell eventually closed its hangar-doors for the last time in 1985. With that act ended just under half a century of aircraft manufacture on the site. From that airfield had departed many famous aeroplanes, some of which defended the country, or assaulted its enemies, and others of which had embarked on peaceful and profitable commerce.

WHITLEY, GUIDED MISSILES AND OTHER WORK

Shortly after the end of the second world war, AWA started to consider the possibilities of other projects to keep its factories in work. It appeared to the Board that there were opportunities in the relatively new sphere of guided weapons.

After preliminary work on propellants AWA was given a contract, in 1947, to supply a number of experimental missiles suitable for vertical deck-launching from vessels. Before these plans had matured, however, the project was cancelled; but parallel work had been going on with another missile, which would result in the ultimately successful Sea Slug ship-to-air missile.



Sea Slug ship-to-air missile

In 1949, with the future for missile work seemingly more assured, the AWA Board decided to reopen the Whitley site (which due to the diminished amount of aircraft after the war had been closed down and placed on a care-and-maintenance basis). As a result, AWA progressively started to improve the facilities at Whitley, for the express purpose of the development and production of missiles. Under W S Lockwood, the Works-Director, the site was developed into probably one of the finest centres in the UK for guided-missile research, development, and production. The installations included design offices, research laboratories, a number of wind tunnels up to Mach 3.0 capability, climatic laboratories, dynamic laboratories, electronics departments, and a host of other facilities.

AWA worked closely with a number of other companies, including, Sperry Gyroscope, GEC, EMI and IMI, on the development of the Sea Slug. This co-operation was to result in perhaps one of the most successful surface-to-air missiles ever developed. Test-firings of the Sea Slug were carried out at two main ranges, Aberporth in South Wales and Woomera in South Australia. These tests produced extremely high rates of effective 'kills' when the missiles were fired against 'live' aircraft targets. Shipboard trials were carried out from HMS Girdle Ness, in the Mediterranean.

The Sea Slug was subsequently adopted for deployment on a variety of ships in the Royal Navy. It was in fact the first operational surface-to-air missile to be used by the Navy. Its successor, the Sea Dart, another AWA-designed missile, still serves aboard Royal Naval vessels.

Whitley also undertook other missile-work, including the modification of American guided-missiles allocated to NATO forces in Europe. These missiles included the Nike/Hercules and Nike/Ajax series. In addition, sub-contract work was carried out by AWA for other U K missile manufacturers.

Advanced Research

Reference has already been made to the wind-tunnels at the disposal of AWA at Whitley. There were five of them ranging from the original 1928 low-speed, flow-study installation, to the transonic/supersonic tunnel with a working section capability of 0.3 to 3.0 Mach. This wind-tunnel commenced operation in 1955 and was used to test both aircraft and missiles. Under the direction of Dr W F Hilton, it was also used for research into the design of space-vehicles. Attached to the wind-tunnel section, and included in the same building, were model-shops, photographic facilities, design-offices and computer-rooms. Indeed in the late 1950s, AWA was probably a world-leader in the study of advanced aero-dynamics. A very finely detailed 1/15th scale model of the AWA transonic-supersonic wind-tunnel is preserved in the Science Museum reserve collection at Wroughton, Wiltshire.

Beryllium

Beryllium is a metal that has certain properties that render it eminently suitable for high-temperature applications. These may be summarised as: extremely stiff (40% stiffer than steel); similar coefficient of linear expansion to stainless-steel; similar conductivity to aluminium; high melting-point; low density (similar to that of magnesium); good dimensional stability; corrosion-resistant; non-inflammable, and non-radioactive.

Against these advantages, however, are certain difficulties: it is a very expensive metal (at 1960 prices, £60 per lb); and after 1945 it could be extracted only in small amounts. When reduced to fine particles it presents a considerable hazard to health.

Notwithstanding these difficulties, AWA decided to lay down a Beryllium machining plant at Whitley, with a view to providing the nuclear industry with certain components manufactured from this new 'wonder' material. Typical components included the 'cans' that contained the uranium fuel slugs in the reactors of nuclear power-stations. The plant commenced production in 1960.

Planning of the new machine-shop involved a considerable amount of preliminary work. An entirely sealed working-area, complete with air-locks, was provided together with special changing-rooms equipped with showers, and extraction and filtering equipment capable of providing an atmosphere superior to that required by clinical standards. The air extracted from the machine-shop was passed through positive filtering-systems, before being passed back to the atmosphere through a 120 foot high chimney. All regulation clothing, worn in the process area, was laundered daily in a special laundry attached to the machine-shop. Special precautions were also taken to ensure that the safety-measures would not be breached if a fire occurred. A laboratory, situated at Baginton, was set up to monitor samples of the air taken from the machine-shop. Baginton was selected to avoid any possibility of cross-contamination of the samples. It was reported, at the time, that for every £1 that was spent on manufacturing plant, £3 was spent on protecting the health of employees.

The machines themselves were totally enclosed in cabinets, with the controls being manipulated through gloved apertures. The author is not aware of the specific types of machines used in the Beryllium machine-shop, save one, depicted in a photograph, which purports to be of a Herbert No 7 turret-lathe. It is possible that special-purpose machines were installed, but the author thinks this is unlikely and suggests that only standard machine-tools were used.

Unfortunately, the Beryllium shop had an extremely short life and the writer has not been able to discover the precise date of closure. Apparently Beryllium did not fulfil all of its promise. The whole project must have been a hugely expensive and disappointing exercise. It is understood, however, that the heat-shields on the Apollo command-modules are made from Beryllium, which is able to dissipate heat efficiently.

This brief history of the Beryllium plant concludes the description of activities carried out at Whitley. Upon closure of the Baginton plant in 1965, Whitley continued to function for a short time under the Hawker Siddeley Dynamics banner. However, in 1968 it too finally closed. The final chapter of the history of AWA in Coventry was concluded. The company, throughout its long and proud history had truly been '*Pioneers of Progress*'.

ATOMIC ENERGY CONTRACTS

Although the brief flirtation with Beryllium had been very expensive and somewhat unrewarding, AWA did have other very lucrative contracts with the Atomic Energy Authority over a number of years. It was in 1957 that the company realised that the nuclear industry had potential for growth, and decided to use its expertise and extensive machining facilities to capture this new market.

A component consumed in large quantities by the nuclear industry was the uranium rod-carrier. Universally known throughout AWA as the Fin-Can-Barrel, this was a magnesium-alloy extrusion, approximately 4 feet long, very extensively machined with complex and varied fin patterns on its external surfaces, to allow for sufficient cooling of the rod when it was in the reactor.

AWA supplied many thousands of these carriers and a sizeable portion of the Baginton machine-shop was kept very busy in manufacturing them. From the author's recollection, two carriers were machined simultaneously on special-purpose machines of AWA's own design and manufacture. The author cannot recall the exact mode of machining but suggests it may have been on the master copy and tracer principle. AWA supplied the Fin-Can-Barrel until 1965.

It is possible that the Fin-Can-Barrel was also manufactured at Whitley, but this seems unlikely, as supply to the Atomic Energy Authority seems to have ceased with the closure of Baginton in 1965.

EXPLOSIVE FORMING

Another technique that AWA investigated was High-Energy-Rate Deformation, or more succinctly, Explosive Forming. In this process the work-piece, usually a flat sheet of material, was lowered into a tank of water which was surrounded by a blast wall. An explosive charge was then positioned at a carefully predetermined distance from the work-piece and then detonated. The water greatly amplified the force of the explosive charge and formed the work-piece into an approximate parabolic curve or, if a die was used, into the die form. This technique exploited the principle that a material could be easily worked if high-energy levels were achieved in a very short space of time. (milli-secs) AWA carried out these experiments, in the early 1960s, at an isolated location on the Baginton airfield!

Although the technique appeared to have some scope for development and was considered by several firms, in both this country and the USA, the potential dangers and impracticalities of the process inevitably doomed it. The USA persisted with the process for some time, and the authoritative *'Machinery'* magazine reported that one-piece tank-turrets were formed using this process.

ANCILLARY DEPARTMENTS

It seems invidious to select for particular mention just three departments out of the many at AWA, but in doing so it is hoped to convey something of the range of skills that was necessary to put an aeroplane or guided-missile into the air.

Precision Machine Shop (PMS)

The precision machine shop was located within the main-machine shop at Baginton. It was set up in 1954 primarily to provide the means of manufacturing wind-tunnel models, in various materials, to extremely fine limits of accuracy. To achieve and maintain the necessary accuracy, the machine-shop was insulated and thermostatically controlled. Considerable care was taken in the selection of machines, and also the inspection and measuring equipment.

There were numerous tales of prodigious feats of accurate machining, performed in the PMS. By and large they can probably be discounted, 'as just very good stories'. However, very accurate work was certainly carried out, both for AWA itself and for many other customers in the aviation industry.

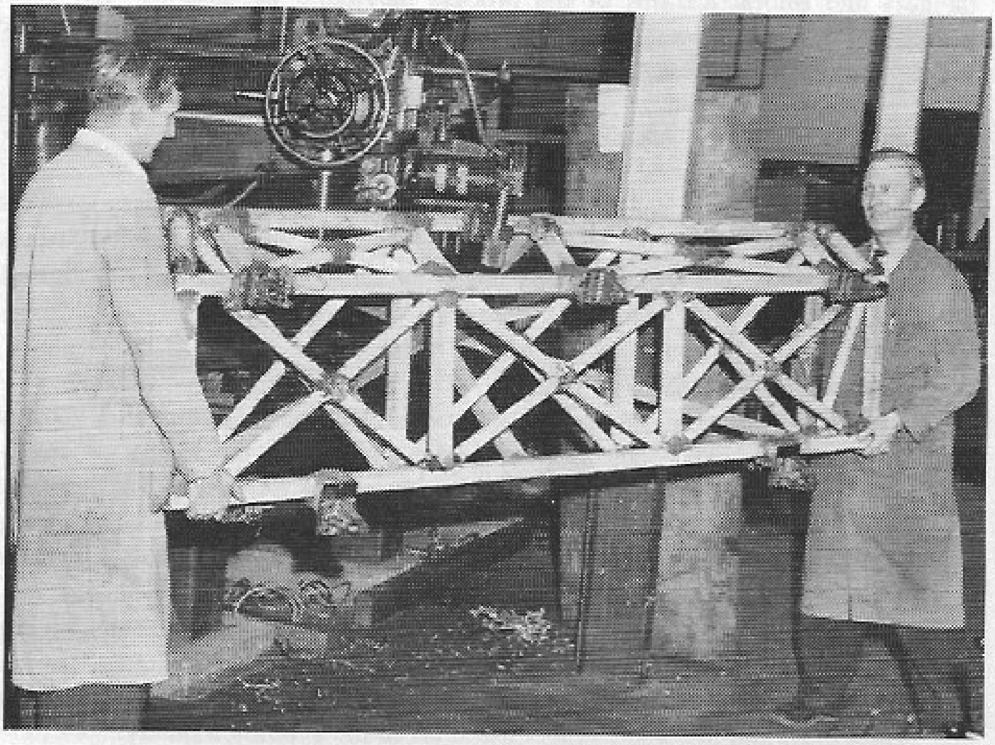
When Baginton closed in 1965 a number of machines from the PMS were transferred to Bitteswell for inclusion in a small machine shop being formed in No 1 hangar, Old Site. Amongst those selected was a Kearney & Trecker, Milwaukee vertical rotary-head milling-machine. This was an extremely unusual and versatile miller. The writer has never seen another example.

Injection Moulding Department

Baginton was also the location of the Injection Moulding department, which was formed and equipped by the company to provide a range of plastic mouldings for a whole host of purposes. Some of the larger injection moulding machines had been designed and built by the company itself. The author remembers operating one of these for a few weeks during his apprenticeship. The injection-moulding department was located on an elevated floor, high-up in the roof of the assembly shops. Readers will probably be aware that injection-moulding is essentially a heat-process, and the writer was in the department in high summer! It was *very* warm. He enjoyed his stay, but was pleased to move on to cooler pastures!

Plastics Department

The Plastics Department at Baginton had a wide variety of tasks, from the manufacture of Perspex canopies to the provision of plastic-tooling and sealants. It was found that the relative ease with which plastic tooling could be produced significantly reduced the normal lead-time for new projects. Consequently, very many tools, of every description, were either completely manufactured from plastic or had a considerable amount of plastic in their composition. Simple bend-blocks, drill-jigs, stretch forming blocks, rubber-press-tools and tools with particularly awkward shapes frequently had plastic in their construction.



AW 650/660 Interchangeability Gauge constructed from glass-fibre tubes and used in conjunction with Fuselage Main-Assembly Jigs (see text)

As an example, the Interchangeability-Gauges used in conjunction with the AW 650/660 Main-Fuselage Assembly-Jigs were a lattice-structure, composed of fibre-glass tubing, assembled with epoxy putty and fibre-glass bandage, to which machined-steel location points were attached. This gauge, if constructed from steel tubes, with welded joints, would have been more expensive to fabricate and subject to possible distortions during welding. It would also have been very much heavier to handle.

Another area of tooling to which the plastics department contributed its expertise, was the stretch-forming block. Stretch-forming is a process whereby a sheet of material, aluminium alloy say, is physically formed and given a degree of 'stretch' around a fixed block, whose working-face is contoured to the form of the finished aircraft skin. To achieve this, for a large skin say, required a machine of very sizeable proportions indeed, equipped with gigantic hydraulic limbs and gripping chucks that could manipulate the material in every conceivable direction. The machines installed at Baginton were manufactured by the Hufford Corporation, of Redondo Beach, California, USA. The writer still feels a 'buzz' when that name is recalled. AWA had four such units, two small A10 machines, on which the author worked for a short time and loved absolutely every minute of it, and two very much larger A30 and A46 machines. If the author recalls correctly, the A46 machine was sunk in a gigantic, concrete-lined pit, possibly 5 feet deep by 40 feet diameter.

The stretch-forming blocks had traditionally been made from steel and because of their very large size could be extremely expensive to manufacture. However, with a view to minimising costs, other combinations of materials and methods were tried, with varying degrees of success. The method of manufacture that was finally adopted was with a steel and reinforced concrete substrate, into which all the necessary Hufford machine-fixings had been formed and onto which was moulded the epoxy resin working face with the requisite finished skin-contour. This method of stretch-form-block manufacture was very successful, relatively cheap, and very quick to produce. Many skin-forming tools for the AW 650/660 transport aircraft were manufactured in this manner.

The writer must quickly add, before he is corrected by anyone who knew the Baginton stretch-forming processes, that there was a further machine at Baginton in addition to the Huffords. This was called the Erco, and instead of having a fixed-block, like the Huffords, it had a moving block which rose up, on a horizontally mounted platen, against the gripped and stationary sheet-material. The principle was exactly the same as the Hufford machines, but the mode of operation was the exact reverse.

Before we leave the stretch-forming process, with its resin-coated forming-blocks, the author would like to mention that when a skin was being formed, and under load, it occasionally broke, sometimes with a resounding **Bang.** On the first occasion this was very disconcerting, and calculated to wake-up any dreamy and inattentive apprentice!

In addition to canopies and tooling, the plastics department also produced glass-cloth laminated components of all descriptions. These components included radomes, tail-fin fairings, dielectric surfaces, access panels and many other items, for a wide variety of airframe-applications.

The plastics department also dispensed sealants, mastics, adhesives, and other similar materials. The writer recalls, when working on the Trident Leading Edge section, having to visit the plastics department regularly, usually twice a day, to obtain a number of pots of white sealing-compound for use in conjunction with the hot-air ducts contained within the Leading Edge. The sealant had a usable life of about two hours. Consequently expeditious working was required. (By way of explanation, the hot-air referred to was bled from the engines and ducted along the entire leading-edge of the wing, to enable it to be de-iced).

AWA PERSONALITIES

The following is a list of the more prominent personalities, connected with AWA, at some point during its life. It is purely an arbitrary selection and is arranged alphabetically.

A Campbell-Orde, was the company's first Chief Test Pilot. He joined AWA in 1924, and had effectively became Chief Test Pilot by 1928. He piloted the Whitley prototype K 4586, on its first flight from Whitley airfield, on 17 March 1936. He left the company in 1936 to take up a position with British Airways.

C S Emery, was a member of the Board of Directors, serving under H M Woodhams. He joined the company in 1937 as Sales Manager and was responsible for selling AWA's aeroplanes worldwide. He became Sales Director in 1953, and retired from the company in 1960.

E G Franklin, was AWA's last Chief Test Pilot and remained with the company until the closure of Baginton in 1965. An ex-apprentice of the company, Franklin later joined the RAF, but on release returned to AWA. Eric Franklin was the first pilot to fly the AW 52 Flying Wing, the prototype Apollo, VX 220, the Meteor NF11 prototype, the AW 650 Argosy prototype, G-AOZZ and the first AW 660, XN 814.

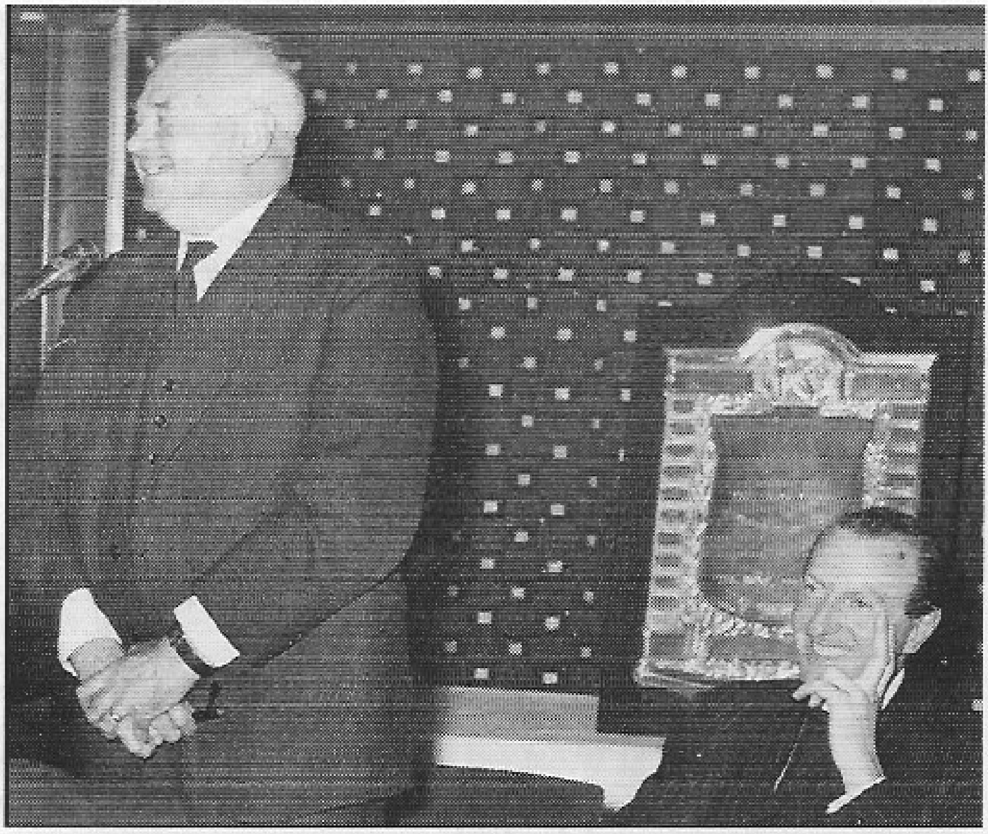
E D Keen, held the post of Chief Designer from 1955 to 1963. During that time he was responsible for the design of the Argosy AW 650/660 Series. He was appointed to the Board as Director and Chief Designer (Aero) in 1959.

J Lloyd, was AWA's Chief Designer from 1923 until 1948. During his tenure, John (Jimmy) Lloyd was responsible for the design of many notable aeroplanes, including the Siskin, Atlas, Whitley, Flying Wing and Apollo. He was appointed Technical Director, a post he held until 1955. He remained on the main Board until his retirement in 1959.

W S D Lockwood, CBE., joined AWA as a designer, eventually becoming Works Manager in 1940. Mr. Lockwood was appointed to the Board in 1950. He was largely responsible for the creation of the guided-missiles division at Whitley from 1949 onwards. Under his Directorship the Whitley research and development facility became a centre of excellence in the British Aviation Industry. His CBE was awarded for services to that industry.

Rt Rev S Phipps MC, may at first sight seem an odd inclusion amongst AWA's personalities, but Simon Phipps was at the company for a brief period whilst Industrial Chaplain to the Bishop of Coventry. He worked on the shop-floor at Baginton (believed to be in the maintenance department), held an Amalgamated Engineering Union card, and espoused the views of the Labour Party. He was revered by all at AWA, not least by the apprentices at whose Annual Dinners he attended as an honoured guest. He was Industrial Chaplain at

Coventry for 10 years. In 1974 he was made Bishop of Lincoln, a position he held until 1986. His views were frequently controversial, but his fervent wish was to bring the church and industrial society closer together. His book *God on Monday* (1966) expounded this philosophy.



Two noted AWA personalities at an Apprentices' Dinner. At the microphone is WSD Lockwood CBE, Managing Director, Whitley Missile Division. Seated to his left is the Rt Rev Simon Phipps who at the time was Industrial Chaplain to the Bishop of Coventry

Although an Old Etonian and Cambridge-educated, Phipps seemed to have an affinity with ordinary working people, whether that was in Coventry or elsewhere, rather than ministering just to the great and the good. It is sad to report that during the preparation of this paper (2001), the Rt Rev Simon Phipps, one-time AWA worker, one-time Bishop of Lincoln, died aged 79 years.

Sir John D Siddeley CBE, 1st Baron Kenilworth of Kenilworth, was the founding father of what was to become the large and multi-faceted Hawker Siddeley Group. John Davenport Siddeley was born in 1866 and started his engineering career in 1892 in the drawing offices of the Humber Cycle Company, Coventry. Eventually, after several moves, he became General Manager and subsequently Managing Director of the Deasy Motor Company. A supremely able businessman, John Siddeley became the dominant personality in the

Siddeley Deasy and Armstrong Siddeley organisations. He was instrumental in the formation of the Armstrong Whitworth Aircraft Company in Coventry.

John Siddeley was knighted in 1932, retired from business in 1936, and was created Baron Kenilworth, of Kenilworth in 1937. He died in 1953.

C K Turner-Hughes, took over as Chief Test Pilot from A Campbell-Orde on the departure of the latter to British Airways in 1936. To Charles Turner-Hughes, or 'Toc H' as he was frequently known, fell the big responsibility of testing the wartime production of the Coventry factories. It was Turner-Hughes who had the misfortune to be test-flying a Whitley in the vicinity of the AP Lockheed Leamington works one day during the war, when the unfortunate aircraft came under a very spirited attack from the factory's anti-aircraft defences. His comments on this incident are, perhaps understandably, not recorded! In this huge task of production-testing Whitleys and Lancasters, Turner-Hughes was ably assisted by E S Greenwood, who subsequently became Chief Test Pilot to the Gloster Aircraft Company. Turner-Hughes retired from test-flying in 1946. For a time Turner-Hughes resided in Lillington, at the old Manor House. A friend of the author's, who was a boy at the time, remembers him as being full of fun and without the slightest trace of self-importance.

H M Woodhams CBE joined AWA as Chief Inspector in 1923 from the De Havilland Aircraft Company. In 1938, Mr Woodhams was appointed General Manager, a position he was to hold throughout the very busy and difficult wartime years. Herbert Woodhams was awarded the CBE in 1944 for wartime services to the aircraft industry. He became Managing Director in 1950 and Chairman of the Board in 1959. He relinquished his duties to W S D Lockwood and retired in 1960. H M Woodhams was, for over 20 years, the dominant personality at AWA, who guided the company in its formative, wartime, and post-war years. He was, in fact, **Mr AWA.**

THE AWA APPRENTICESHIP SCHEME

When the writer joined AWA in 1961, the apprenticeship scheme was very well developed, with a structure to suit the varying aptitudes and abilities of each apprentice. On entering the company every would-be apprentice had to undergo a probationary training period in the training-school. In the author's time, the training-school was located in the corner of the Baginton main machine-shop, adjacent to the plastics department. Subsequently it moved into a new free-standing building on the apron of the airfield.

Once in the training-school, the apprentice would be initiated into the various arts of mechanical engineering; beginning with basic fitting, using files, hand-tools, and measuring instruments. Subsequently, he progressed to the various standard machine-tools to increase his knowledge and skill. Various test-pieces had to be satisfactorily completed and approved by the instructors.

Having come through his probationary training, the apprentice would be indentured to the company. Usually, at about same time, he would leave the training-school for the shop floor. This was the beginning of a planned progress, lasting five years, through the manufacturing shops and offices of the company. His precise route depended on the type of apprenticeship. A technical apprentice, for example, would probably pass through every shop-floor department, including possibly the machine-shops, before entering the various technical offices at Baginton and Whitley. A craft apprentice would probably follow a similar path to his technical colleague, except that he would not go into the technical offices. Craft-apprentices were further divided into Machinists and Fitters, which meant that more time was allocated to their respective disciplines. The author for example, being a fitter-apprentice, did not enter the machine-shops, but spent more of his time working with aircraft.

A typical route for a fitter apprentice, might have been as follows: boys' details, mens' details, press-drill-router, sub-assembly, erection, final assembly, flight-shed, inspection, instruments and management services. This was the precise path followed by the author. Whilst following his apprenticeship, the apprentice was required to attend technical-college at least one day per week. Depending upon the course he might also have to attend technical-college at least one evening per week.

Apprentices had access to all the normal sporting facilities. In the author's time, these were very energetically pursued by some, with soccer, rugby, cricket and athletics fixtures against other Coventry Apprentice Associations. The writer has to admit he was indolent in such matters.

Apprentices were kept informed of news and events by means of the Association's magazine, *'The Sphinx'*, which was nominally published every quarter. Occasionally, however, due to the paucity of material, it only appeared perhaps twice or three times a year. As the writer was the Editor of this magazine for approximately two years, he was all too aware of the difficulties of production, notwithstanding the very considerable resources placed at his disposal by the company. It was very much the usual story, of everyone wanting a magazine but no one wishing to contribute!

Without doubt the AWA apprenticeship-scheme gave young men (there were no female shop-floor apprentices in those days), a very good grounding in aeronautical engineering. The writer only wishes he had been more attentive, and learned a good deal more from his 'master.' But what's new?

AIRCRAFT ENGINEERING IN COVENTRY

Coventry's manufacturers contributed considerably to the aviation industry during the 20th century. Whilst Coventry is primarily associated with the motor-car, this is a slightly skewed perception. Many companies in the city produced engines, wheels, and a range of components for the aviation industry. In the first world war, for example, the **Humber Company** produced the Bentley BR Series of Rotary Engines (designed by W O Bentley of car fame) for fighter-aircraft. By common consent this was the best rotary engine to be manufactured during that conflict.

The **Alvis** also, from 1935 onwards, was a notable producer of high-quality aero-engines. (Alvis tended to select the most marvellous classical Greek names for its range of air cooled piston-engines and these included, Pelides, Alcides, Maeonides and Leonides). A feature of Alvis engines was the use of low-pressure fuel-injection, which was not common on British reciprocating-engines. During the war the Alvis produced many components for Rolls-Royce Kestrel, Merlin and Griffon engines. Rather like AWA in the war years, it managed a large number of satellite factories right across the country. These manufactured aero-engine parts, De Havilland variable-pitch propeller-hubs, and related components. Under a wartime directive from the Ministry of Aircraft Production, Alvis was authorised to carry out development and servicing work on American-built aero-engines in use with the RAF. After the war, generally for use in helicopters but occasionally for other applications, Alvis produced the very successful Leonides and Leonides Major range of radial engines. The company had aero-engine test-facilities situated at the edge of the Baginton airfield.

Whilst discussing aero-engines, we must not forget one of Coventry's greatest engineering names, **Armstrong Siddeley**. It is not proposed to add any further comments about this famous company, other than to say that its history ***needs*** to be chronicled. The **Dunlop Company** also had an aviation division within the city providing wheels, braking-systems and other components for many British aircraft.

Although strictly speaking not a Coventry company, **Automotive Products** at Leamington Spa had an Aviation Division, which supplied hydraulic components of all descriptions to the aircraft industry. The AP archives show a considerable involvement with AWA, particularly in the supply of undercarriages and systems for the Ensign and Whitley. The tricycle undercarriage for the Albemarle was also designed and manufactured by AP. It will be remembered that this was the first tricycle undercarriage to see service with the RAF. Post-war, AP supplied undercarriages and hydraulic components for several notable aircraft, including the Brabazon, Caravelle, and Trident. The **Borg & Beck Company**, a Division of AP, supplied clutches to Alvis for use with the Leonides Helicopter engines. AP subsequently transferred its Aviation Division to Speke, near Liverpool, and renamed it Lockheed Precision Products.

Finally, the writer must mention the **Standard Motor Company**. From 1942, the Standard built a considerable number of Mosquito aeroplanes under sub-contract to the De Havilland Aircraft Company. It is thought that the final figure was 1,066. These aeroplanes were flown from Ansty.

The above *resumé* is not a comprehensive list, and is included merely to illustrate the wide variety of products that Coventry produced for the once important aerospace industry.

A FINAL WORD

That Armstrong Whitworth was one the great engineering concerns of this country there can be little doubt. How was it then that a company of this stature could be so destabilised as to fall after just one political decision in 1965? In 1961 there were approximately 200,000 people employed in the British airframe industry, in perhaps 20 reasonably large companies. This figure was quite separate, of course, from the aero-engine industry, which had approximately 70,000 employees, in six major companies.

Unfortunately, the composition of the industry had little changed from that at the end of the second world war. The figures for people employed may have been different, but the number of companies still trying to build aeroplanes and engines was about the same. An independent observer in 1945 may have taken the view that some rationalisation of the industry was necessary then. It had not taken place to any extent even in 1960.

The industry was still dominated in the late 1950s by larger-than-life personalities such as Sir Roy Dobson, Sir Tom Sopwith, Sir Frank Spencer Spriggs, Sir Sydney Camm, Sir Frederick Handley-Page, Sir Geoffrey de Havilland, Sir George Edwards and Lord Hives, to name but a few. Each had a vested interest in maintaining the *status quo* and retaining his own particular share of the market. Business was good and the Government was still buying military aeroplanes in reasonable quantities. On the other hand the civil-aeroplane market was not too buoyant, except perhaps for the Viscount. The Comet, although technically brilliant and the world's first turbojet airliner, had suffered several disastrous mid-air structural failures, which had all but broken the De Havilland Aircraft Company and had allowed Boeing to gain a toe-hold with its 707.

Meanwhile the Conservative Government was beginning to rethink its policy towards procurement of military aircraft. The bombshell came with the notorious 1957 Defence White Paper, promulgated by Duncan Sandys. This document stated, *inter alia,* that except for the Lightning interceptor, the defence of the United Kingdom would in future depend on guided-missiles. The RAF would consequently largely cease to function as a manned fighting-force. The V-bomber Force would be retained, as an interim manned offensive deterrent, but the piloted fighter would have no place in the new RAF. Time has shown what a fatally flawed piece of strategic thinking this was. It would be just as flawed even today! All the world's major airforces in the year 2001 still have manned aircraft at the heart of their respective offensive/defensive capabilities, despite the increased deployment of intercontinental ballistic missiles. There is no reason to believe that this situation will fundamentally change in the foreseeable future. Manned aircraft have great tactical flexibility, guided missiles do not.

The Sandys edict had an almost immediate effect on a number of companies, including Saunders-Roe, with its SR 53 and SR 177 rocket/turbojet-powered interceptors, and Gloster Aircraft with its thin-wing supersonic Javelin replacement. Orders for the Hawker Hunter were reduced, resulting in the closure of the very large Blackpool, (Squires Gate) factory. To other companies with military contracts the implications were all too apparent. AWA's position was no different from the rest. Although it was a founder member of the Hawker Siddeley Group, which made up just over half of the British airframe industry, the group itself was a fairly loose federation of companies, each with its own autonomous structure. It was quite obvious that this fragmented approach was going to have to change.

Outside the group, the other major airframe-manufacturers, namely Vickers-Armstrong, English Electric, and the Bristol Aeroplane Company, were also looking towards alliances and on 1 July 1960 the British Aircraft Corporation officially came into existence to embrace them. Thus, in 1960, Britain had two major airframe groupings, with a few peripheral companies, such as Westland, Fairey, Handley-Page and Short left outside. Westland did in fact form a smaller group, after taking over the aviation interests of Fairey and Saunders-Roe. Handley-Page as a separate company went into liquidation in 1970. Short, however, still exists as an independent company within a larger group.

Whilst these larger groupings did to some extent delay the inevitable large-scale rationalisation, it did not save some firms, notably Gloster, which merged with AWA to form Whitworth-Gloster Aircraft on 1 October 1961. Gloster, however, continued to wither on the vine, and the end finally came for the great firm in April 1964 with the sale of the Hucclecote factory. It should be noted that Gloster, throughout its long and distinguished history, had been (with the exception of its beautiful Schneider Trophy Racers) exclusively a manufacturer of military aeroplanes. After the White Paper it had nothing to fall back on. The parallels with AWA were inescapable. The Coventry company had also supplied mostly military aircraft, with merely the occasional successful civil aeroplane. With the commercial failure of the Argosy Series, AWA was plainly vulnerable.

As we have noted earlier, these portents became reality on the 2 February 1965, when the then Prime Minister Harold Wilson announced the cancellation of the HS (AW) 681, HS P1154, and a 'review' of the TSR 2. It is doubtful however whether AWA, even without the 1965 cancellation, could have continued as an autonomous design and manufacturing organisation indefinitely. Aeroplanes, both civil and military, were becoming increasingly more expensive to develop and put into production. Throughout the industry, indeed throughout the world, co-operation was becoming essential. It is said that even Boeing, the world's most commercially successful aerospace-company, had to build about 1,000 civil airliners before it started to make money. Without restructuring, the British aviation industry could not compete against such might.

Eventually, in 1977, the two big groups of British aviation did become a single entity, as British Aerospace. International co-operation is now very much the way forward, with Airbus in world-wide civil markets and Eurofighter destined for the European air-forces. Whilst the situation may not be ideal and nationalistic tendencies may occasionally surface, the strength gained from large-scale international co-operation is indisputable, and possibly the only way to compete with the American aviation giants.

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Prefabricated aluminium-alloy, post-war emergency housing.

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The writer had three main objectives in the preparation of this paper. Firstly to provide a companion work to Arthur Astrop's *The Rise and Fall of Coventry's Machine Tool Industry,* published in October 2000 on behalf of the Warwickshire Industrial Archaeology Society. Secondly, to document with personal reminiscences, the history of the Airframe Industry in Coventry, with particular reference to AWA. Finally, to subject to closer scrutiny certain comments that have appeared in print about AWA. Using primary documentary sources, published and unpublished material, company production figures, and first-hand knowledge, the author has attempted to give an impartial assessment of AWA, particularly through the wartime and post-war years. Whether all of these objectives have been achieved remains to be seen and the author welcomes any constructive criticism which might increase the fund of knowledge on this once important industry in Coventry. The author would like to acknowledge the kind assistance of the Churchill Archives Centre, Churchill College, Cambridge, and particularly Lady Margaret Colville, for permission to quote from Sir John Colville's diary entry for 26 September 1941. Kind assistance was also furnished by the Warwick County Records Office, where the AP photographic Archive is now deposited.

The Public Records Office at Kew was helpful in connection with the Ministry of Aircraft Production/Beaverbrook letters to H M Woodhams The author is also indebted to his old friend Robin Taylor for reading the manuscript and making many helpful suggestions and amendments with regard to the text. Indeed Robin, as a boy, knew Charles Turner-Hughes and was thus able to provide an unexpected source of information on this prominent AWA personality. Arthur Astrop assisted greatly in preparing the paper for publication, and his technical expertise from the world of publishing was invaluable and much appreciated. Thanks are also due to Mike Hurn for invaluable assistance in arranging the illustrations in the text, and to Richard, the author's son, for the use of his computer and the assistance he gave when new technology frequently got the better of his father.

Finally, but certainly not least, the author must especially thank Albert Whitehouse whose encyclopaedic knowledge of AWA and its personnel is unique. Albert gave freely of his time and archives and the author is particularly indebted to him. The finished work would have been the poorer without his kind assistance.

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Private Collection, *MAP Letters to H M Woodhams covering the period May 1940 to May 1942 inclusive.*
Warwick County Records Office, Warwick, *AP Photographic Archive,* Deposit CR 3581.

Museums containing AWA Aircraft and Artefacts

Science Museum, Reserve Collection, Wroughton Airfield, Swindon, SN4 9NS.
Royal Air Force Museum, Cosford, Shifnal, Shropshire, TF11 8UP.
Midland Air Museum, Coventry Road, Baginton, Coventry, CV8 3AZ.

APPENDIX

The following list is for those aircraft and missile types designed and manufactured by AWA. It is arranged in chronological order, based on the date of the first flight of each particular machine.

Newcastle Years: FK.1, FK.2, FK.3, FK.5, FK.6, FK.8, FK.9 Quadruplane, FK10 Quadruplane, FM4 ArmadilloX19 and the Ara.
Coventry Years: Siskin,* Sinaia,* Awana, Wolf, Atlas, Ape, Argosy (1), Ajax, Starling, Aries, A W 16, A W 15 Atalanta, Scimitar, A W 19, A W 23, A W 38 Whitley, A W 29, A W 27 Ensign, A W 41 Albemarle #, A W 52G (Flying Wing Glider), A W 52 Flying Wing (Turbojet), A W 55 Apollo, Meteor(Night Fighters), Meteor (Prone-Pilot), Sea Hawk series, A W 650 Series 100 Argosy, A W 660 C. Mk.1 (Military Argosy), A W 650 Series 222 Argosy, and A W 681 S T O L Military Transport to OR 351, (mock-up only).
Guided Missiles: Seaslug, Sea Dart.
*Siddeley-Deasy Company.
Production delegated to Gloster Aircraft Company/A.W. Hawkesley Ltd., Brockworth, Gloucestershire.

The following list is for those aircraft types built, modified, or repaired by AWA, for which they did not have original design responsibility. It is arranged in approximate chronological order.

Newcastle Years: BE2a/c and Bristol F2b.
Coventry Years: RE8,* RT1,* De Havilland DH10*, Hawker Hart, Avro Lancaster series, Short Stirling,# Avro Lincoln series, Avro York, Avro Shackleton Series, Gloster Meteor-series, Hawker Hunter series, Gloster Javelin series, Avro Vulcan series, Avro 748/ 748 M.F., De Havilland Trident and Folland Gnat (Red Arrows).
*Siddeley-Deasy Company.
Production managed by AWA at Shorts Swindon Factory, from 1944.

The following is a list of other aircraft projects with which AWA was involved: Hawker Hurricane (laminar flow wings), Douglas C54B Skymaster (modification of aircraft for use as personal transport by Winston S. Churchill), Bristol 188 (stainless steel research aircraft), Rolls-Royce Engine Cowlings for 707 and B A C 111.

Airships: Built under direction of AWA, Newcastle: SS (Non-rigid), Dirigibles, R25, R29, and R33.

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