Wings of Victory

Part 3

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Parts 1 and 2 discussed prewar technical development of Naval Aviation and wartime development in some areas. In this concluding article, developments in other areas are discussed.

Attack Planes

In December 1941, the fleet was equipped with the obsolete TBD *Devastator* torpedo bomber and its contemporary but modernized SBD dive-bomber. In mid-1942, the Grumman TBF *Avenger*, also built by Eastern as the TBM, replaced the TBD. The SBD fought from carriers for another two years; a more powerful engine, radar, improved armament, etc., kept it combat worthy. It typifies the endeavor described by S. Paul Johnston, a leading aeronautical research administrator: "Everything... learned from wind tunnel and structural test laboratories was incorporated in the production models in an effort to outfly and outfight the opposition."

At the time that the aviation industry was expanding, the Bureau of Aeronautics (BuAer) was increasing the number and complexity of new aircraft designs. Inevitably, there were growing pains. Thus, the three most advanced developmental dive-bombers – the Curtiss SB2C, Brewster SB2A, and Douglas SB2D – and the leading torpedo bomber, the Grumman TBF, all became so seriously overweight that their usefulness was questioned.

As a fallback for the TBF, BuAer chose the competitively designed Vought XTBU-1. Since Vought was already committed to the F4U and OS2U, BuAer persuaded Vultee to manufacture the TBU as the TBY, in a truck plant in Allentown, Pa. Engineers were scrounged throughout the industry and the aircraft was redesigned as the TBY-2. The TBY never saw combat; when production began in 1944, the TBF/TBM was meeting Navy needs.

The SB2C went into combat after long travail. Production was achieved in late 1942, but two carriers turned it down favoring the SBD. The SB2C underwent three modification programs, then VB-17 on *Bunker Hill* (CVS-17) used it in the second Rabaul strike in November 1943. They gave it a "thumbs up"; the worst was over. The SB2C replaced the SBD aboard ship in time for most of the 1944 offensives. The SB2A and SB2D (by this time converted to the single-seat BTD) were both terminated.

With BuAer guidance, Douglas then designed the XBT2D-1. To save weight, the bomb bay was omitted, an explosive bomb ejector replaced the displacing gear, and the structure was designed understrength and reinforced after structural tests.

Grumman, after working on a couple of twin-engine torpedo planes, eventually proposed a design based on the TBF but larger and cleaner, and with a jet propulsion unit in the tail; it was developed as the XTB3F-1. Martin, having completed production of an Army attack plane, undertook the XBTM-1. The BT2D, TB3F, and BTM were continued postwar as the AD, AF, and AM.

Tactical and technical considerations were both involved in combining the dive-bomber and torpedo bomber into a general-purpose attack plane. By the end of 1941, British and Japanese combat experience was leading to the conclusion that all offensive carrier planes should be capable of torpedo attack. The Battle of Midway, where our torpedo squadrons made no hits and only six of 41 planes survived, suggested otherwise. For the next two years, airborne torpedoes were weapons of opportunity. During that time, the Bureau of Ordnance (BuOrd) and the National Defense Research Council (NDRC) corrected the Mark 13 aircraft torpedo's many defects and improved it for use at moderate altitude and speed; our airborne torpedoes acquired the effectiveness ascribed to them by prewar advocates.

Several other factors were also important. Midway and other early operations also demonstrated that high-altitude bombing, the secondary mission of torpedo planes, was ineffective against ships. Torpedo planes, not being stressed for dive-bombing, came to be used for glide and toss bombing. The SB2C was capable of torpedo attack. Fighter escorts were found to be necessary, even though the SB2C and TBF were equipped with flexible guns, some of them in power turrets. Hence, the guns and gunners were eventually recognized as superfluous. Airborne radar had altered the role of carrier scouts and by mid-1945 airborne early warning was promising even greater changes.

The reasons mentioned in the previous two paragraphs all contributed to the decision to replace dive-bombers and torpedo planes with general-purpose attack planes. The process is very complex and a dozen experimental designs were initiated between 1939 and 1945 to arrive at the combination of missions.

Patrol Planes

In December 1941, the Navy had three operational and three experimental flying boats. Two experimental models were soon dropped and the third was converted to a transport. Of the operational types, the PBY had been thoroughly debugged. It was small and slow but reliable and easily serviced. The amphibian PBY-5A, which was nearing service, added to the design's versatility. The PBY was the most widely used of all patrol planes. The other two flying boats encountered severe problems. Most PB2Ys were used as transports. The PBM-3's short engine life indicated that it was overloaded and much gear had to be removed. Eventually, in the PB2Y-5 and PBM-5, more powerful engines increased effectiveness.

By a July 1942 agreement, the Navy obtained multiengine landplanes from the Army Air Force (AAF): the North American PBJ (AAF B-25), Consolidated PB4Y (B-24), and Lockheed PV (B-34). These came to be used more widely than flying boats; procurement totaled about 4,600 landplanes and 4,200 flying boats (including 1,350 for allies).

The landplanes were equipped for high-altitude bombing and had to be refitted as patrol planes; this required nearly as many man-hours as it did to build them. Thus, the PB4Y-2 was developed: twin rudders, the trademark of the B-24, were replaced by a single tail and the body was lengthened; fuel, guns, and radar were added; and the turbo-supercharger was removed. In a similar but less extensive redesign, the PV-1 was superceded by the PV-2 with greater wingspan and area.

Two twin-engine landplanes were developed: the Lockheed P2V began in February 1943 and the Martin P4M in July 1944. They used the largest engines available, the R-3350 in the P2V and the R-4360 in the P4M. The latter also had auxiliary J-33 jets. On October 1, 1946, a P2V completed a nonstop flight from Perth, Australia, to Columbus, Ohio, showing the soundness of design and concept.

Antisubmarine Warfare (ASW)

Submarine warfare was mostly ignored between the wars. ASW started from scratch in September 1939 when U-boats attacked British shipping. Aircraft were used for search. Admiral K. Doenitz, in charge of U-boats, contemptuously noted that aircraft could no more sink U-boats than crows could kill moles. This changed in August 1940 when the British began using aerial depth bombs.

In November 1940, the director of the Chief of Naval Operations' (CNO) War Plans Division listed American ASW devices and commented, "Although the list of *projects* is formidable, the list of *accomplishments* is meager." Of the nineteen projects listed, only magnetic detectors and short-wave radar with position indicator were for aircraft.

The Atlantic fleet received 1,000 depth bombs for service tests in mid-1941. General use began in the spring of 1942. During one attack, a depth bomb hit a surfaced U-boat and wedged in a grating; when an eager "Seemann" rolled it over the side, the hydrostatic fuse worked and the depth charge exploded, destroying the U-boat.

Various aircraft were used: patrol planes, OS2Us on in-shore patrol, F4F/FM fighters and TBF/TBM torpedo bombers in escort carrier-based VC squadrons, and K and M-class airships. As capabilities were developed, aircraft became effective killers as well as hunters.

Different devices helped make the aircraft a potent enemy of U-boats. Geologists used airborne magnetometers to hunt for oil in the late 1920s. In October 1941, a PBY at NAS Quonset Point, R.I., testing similar gear, detected the S-48. Project Sail, established at Quonset Point in June 1942, tested magnetic airborne detectors (MAD) under development by the Naval Ordnance Laboratory and NDRC. In December 1942, service use of MAD began in conjunction with retro-rockets which had been tested at Goldstone Lake, Calif., in July 1942.

On March 7, 1942, the K-5 blimp and S-20 sub tested a radio sonobuoy and found that it could hear a submarine three miles away and that its radio transmission was received by blimps at a five-mile range. By December 1943, practical radio sonobuoys had been designed and built and were being assigned to ASW squadrons beginning with VC-1 on *Block Island* (CVE-21).

In 1943, U-boats began staying on the surface and fighting back against aircraft. This led to increasing forward firepower and armor in ASW aircraft. For example, the twin .30-caliber forward turret in the PBY was replaced by a twin .50-caliber turret. Forward-firing rockets, introduced in late 1943, proved an effective counter.

Another important piece of equipment was the AN/ARC-1 VHF radio which facilitated airborne communications. Airborne searchlights, coordinated with detectors, helped locate surfaced submarines at night. In 1945, periscopes were installed in the PBY's radio compartment to help focus the wing-mounted light.

Helicopters

Rotary-wing aircraft trials in the 1920s and 1930s were nonproductive. Early in the war, Coast Guard aviators urged the Navy to resume tests. Receiving responsibility in February 1943, the Coast Guard conducted training and experimentation at CGAS Floyd Bennett Field, Brooklyn, N.Y. BuAer in March 1943 ordered three Sikorsky HOS helicopters; in October 1943 it ordered the HNS trainers (for early delivery); and in 1944 ordered tandem-rotor Piasecki HRPs and twin-engine McDonnell HJDs.

50 Years Ago — WW II

March 1: Support Force, Atlantic Fleet, was established for operations on the convoy routes across the North Atlantic. Its component patrol squadrons were placed under a Patrol Wing established at the same time.

March 12: Naval Air Station, Corpus Christi, Texas, was established.

March 28: The commanding officer of *Yorktown*, after five months' operational experience with the CXAM radar, reported that aircraft had been tracked at a distance of 100 miles and recommended that friendly aircraft be equipped with electronic identification devices and carriers be equipped with separate and complete facilities for tracking and plotting all radar targets.

The PBM Mariner evolved as the definitive patrol seaplane during the war.

In May 1943, the Navy watched an Army pilot land a helicopter aboard a tanker in Long Island Sound. In January 1944, a Coast Guard pilot with an HNS helicopter embarked on the British freighter *Daghestan*. Limited flying was possible on only three days during the mid-winter Atlantic crossing and a Combined Evaluation Board concluded that existing machines were not adequate for ASW.

On January 3, 1944, an HNS-1 delivered blood plasma from lower Manhattan to Sandy Hook, N.J., for survivors of an explosion on the destroyer *Turner*. In May, a Coast Guard pilot with an HNS-1 rescued 11 Canadian airmen from northern Labrador.

A helicopter was also tested as an ambulance. Rescue hoists were developed and tested, and an automatic pilot was developed. In May 1945, dunking sonar was tested. In short, the helicopter's utility as a rescue craft was demonstated, and as the war ended it was poised for ASW and other uses.

Guided Missiles

Navy pioneer guided missile development grew out of a radio-controlled target airplane begun in 1936 and used in 1938. (One result was the TDC Culver target drone of WW II.) The people involved were certain that radio-controlled aircraft would make effective weapons. To that end, a radio altimeter was initiated in 1939 and airborne television and radar guidance in 1941. The Naval Aircraft Factory (NAF) and Utility Squadron 5 were assigned Projects Fox and Dog, which involved the development and testing of radio-controlled offensive weapons. After torpedo and crash-dive attacks were demonstrated in early 1942, Admiral Ernest J. King directed that guided missiles be developed and readied for combat in decisive quantity. BuAer undertook development of TDN and TDR radio-controlled, television-directed "assault drones." BuOrd, through NDRC and the Bureau of Standards, developed the Pelican and Bat radar-directed glide bombs.

The assault drone involved NAF and air stations at Cape May, N.J.; Traverse City, Mich.; and Clinton, Okla. NAF made some drones; small companies with minimal or no aviation experience made the rest. Even so, success was achieved and the proponents vainly sought an escort carrier for a combat trial. In September 1944, a drone unit deployed to the northern Solomons and in a 30-day trial hit Rabaul and other bypassed enemy positions.

The PB4Y-1 was also used as a guided missile. Rather than risk unmanned liftoff, a pilot would fly off the explosive-laden machine, switch to radio control, and bail out. Intended against German targets, the first machine exploded over England soon after takeoff, killing the two-man crew. On September 3, 1944, a radio-controlled PB4Y hit a barracks at a German submarine base in Helgoland.

The Bat radar-directed glide bomb was used by some PB4Y squadrons in 1945. It sank at least one Japanese merchantman.

BuAer and BuOrd initiated a number of missiles in 1944 and 1945; air and surface launches and targets and numerous guidance, propulsion, and airframe systems were used. Of these, the Loon was a carrier adaptation of the JB-1, an Army version of the German V-1 Buzz Bomb. Little Joe was begun in May 1945 as an emergency counter to the kamikaze; it used a jet-assisted takeoff unit for propulsion, carried a 100-pound warhead, and had a 2.5-mile range.

Opinions vary as to whether guided missile efforts were "too little" or "too soon." The technology has proven to be much more complex than it appeared, but much sound work was done.

Power Plants

Development of engine components increased power and reliability. Fuel quality, also essential, was upgraded as supplies permitted from a performance number (roughly, octane number) of 100 in 1941 to 115/145 in 1945. In 1942, Pratt & Whitney developed a water injection system which provided a 20 to 30-percent increase in maximum power for about 10 minutes.

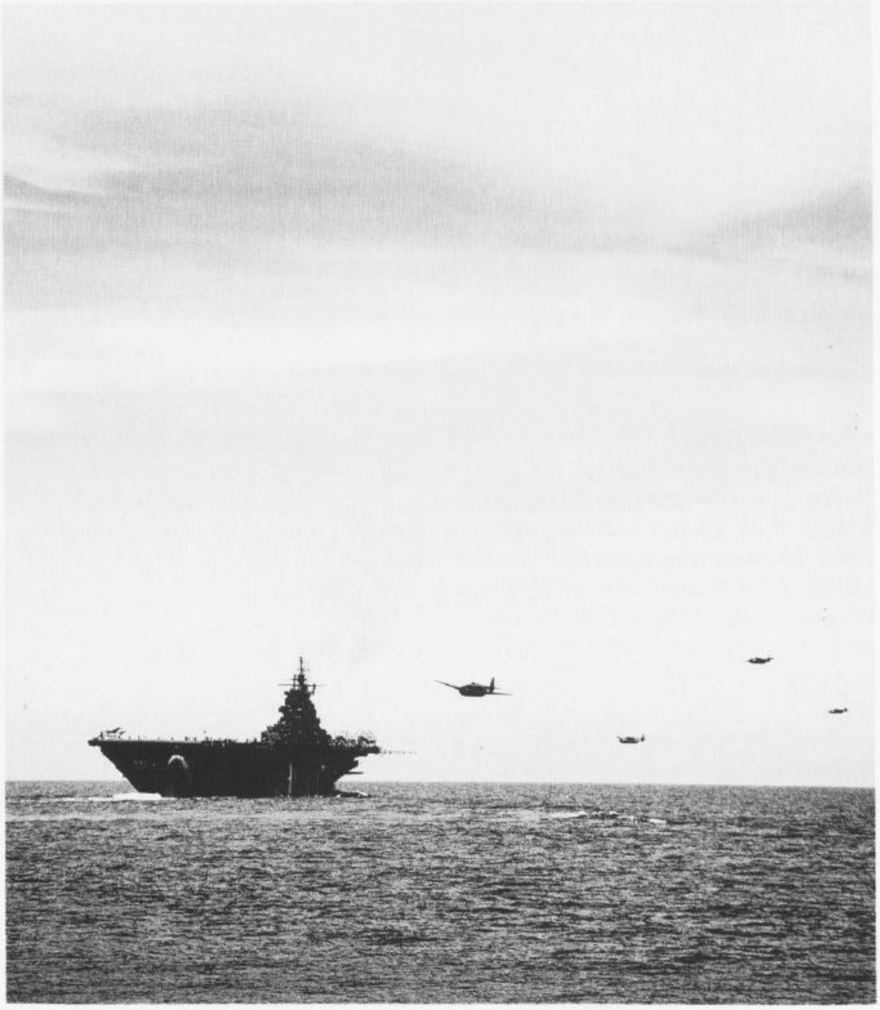
The WAC R-3350 engine used in several developmental aircraft – including the P2V and BT2D/AD – reached a high degree of development in part because of its earlier use in the Army B-29. In 1940, Pratt & Whitney began the R-4360 with 28 cylinders in four rows. Limited production was achieved by 1945 and it was used in the F2G, BTM/AM, and P4M.

Jet-powered aircraft were flown in Germany in 1939; Italy, 1940; and England, 1941. From 1938 on, the U.S. Army and Navy had sponsored rocket and jet propulsion studies. By 1941, European progress was becoming known and a National Advisory Committee for Aeronautics Special Committee on Jet Propulsion was formed. As development began, the Army and Navy recognized that their aircraft production relied on reciprocating engines and chose not to divert major aviation resources to jet propulsion. Thus, both Wright and Pratt & Whitney concentrated on piston engines while outsiders – General Electric, Westinghouse, and Allis Chalmers – worked on gas turbines.

The Army obtained British data, while the Navy sponsored Allis Chalmers' study of ducted fans and Westinghouse's study of axial flow turbo-jets. On October 22, 1942, BuAer authorized Westinghouse to build the 19A jet engine. One of these was test flown in a Goodyear FG *Corsair* in January 1944. An improved model, the 19B, powered the twin-engine McDonnell XFD-1 which made its first flight in January 1945.

Radar

In the fall of 1941, I heard rumors of a wondrous device that could fix an airplane's range, course, speed, size, and loading. Other tales were slightly



TBM torpedo bombers operate from an Essex-class fleet carrier.

less bizarre. Thus, in 1944, Commander William I. Martin (now a retired vice admiral) recalled his "initial shock of finding out that radar did not present a colored picture of the terrain...."

By modern standards, wartime radar was crude. Sets were soldered with bulky tubes, resistors, capacitors, etc. As the Navy, NDRC Radiation Lab, and radio and electrical industries developed airborne radar, they learned of the need for minimum weight, compactness, and ruggedness in carrier plane equipment.

The XAT radar, developed by the Naval Research Laboratory (NRL) from a radio altimeter, became the ASB; 25 sets were ordered in December 1941 and delivered in October 1942 as ASB-3s for experimental service. The ASB underwent constant updating and the last of the 26,000 sets obtained were ASB-8s. The ASB was used for search and bombing in the TBF/TBM and other carrier planes. A radar operator was necessary but a pilot's repeat indicator could be installed.

Some Neutrality Patrol planes had British ASV (air-to-surface vessel) radar. It used large antennas, one for sending and a second for receiving. An NRL-designed duplexer, enabling a single antenna to do both, was used in Navy airborne radar and in NRL's ASE modification of the ASV.

Microwave (or centimeter) radar, made possible by the British cavity magnetron, gave sharp definition with a small antenna. A 10-cm radar with plane position indicator was tested at Boston Airport in September 1941, and by mid-November preliminary design of a 3-cm radar was made.

The APS-2 10-cm radar was used in K-type airships in later 1942 and also in PB4Ys. The 3-cm APS-3 and 4 (the latter in a nacelle) were used for search, navigation, and bombing; the APS-6 was used for night interception; and the 3-cm APS-15 replaced the APS-2.

Airborne early warning (AEW) was begun in 1942 after Adm. King expressed a need for the Navy to "see over the hill," i.e., beyond the horizon. Cadillac resulted, a 10-cm APS-20 radar in a TBM with radar data relayed to a shipboard combat information center (CIC). Cadillac II, added in 1945, included radar and an airborne CIC in a PB-1W (Army B-17) patrol plane. The kamikaze increased their urgency and in 1945, 27 TBM-3Ws were equipped and the first land-based AEW squadron, VPB-101, was established. Neither saw combat.

With ground controlled approach, air traffic controllers used surface radar to control aircraft landing in extremely poor visibility. After an experimental demonstration in December 1942, it was used "for keeps" on New Years Day 1943 to land PBYs at Boston Airport after a sudden snowstorm closed Quonset Point.

Names of WW II Naval Aircraft

WWII naval aircraft had official names. The articles on technical development often omit these names; thus, those for principal aircraft are given below.

Aircraft	Name
F2A	Buffalo
FD/FH	Phantom
F4F	Wildcat
F6F	Hellcat
F7F	Tigercat
F8F	Bearcat
FR	Fireball
OS2U	Kingfisher
SB2A	Buccaneer
SB2C/SBF/SBW	Helldiver
SBD	Dauntless
BT2D/AD	Skyraider
TBD	Devastator
TBF/TBM	Avenger
BTM/AM	Mauler
SC	Seahawk
PBJ	Mitchell
PBM	Mariner
PBY	Catalina
PB2Y	Coronado
PB4Y-1	Liberator
PB4Y-2	Privateer
PV-1, -3*	Ventura
PV-2	Harpoon

*The PV-3, from lend-lease (British) production, was the first PV obtained and used by the U.S. Navy.

Conclusions

In looking back at WW II technical development, the most important element was the enormous number of military aircraft built. This was made possible by the American aviation industry's successful conversion from handicraft to mass production.

Qualitative superiority was almost equally important. Our carrier planes destroyed some 12,000 enemy aircraft, including 6,500 in air combat, while losing 450 planes in air combat.

The quality of American aircraft steadily improved as engineers and scientists expended great effort in improving existing equipment and aircraft designs.

Technical areas of special importance were radar, airborne and surface, and the overlapping field of antisubmarine warfare where we began from scratch.

Improved designs with which the fleet was outfitted in 1942-43 – mostly notably the TBF/TBM, F4U, F6F, and SB2C – in large measure provided the wings of victory. Other aircraft, including some whose development was begun after we entered the war, were being readied for combat at the end with promise of further improvement.

Effort in advanced areas involving jet propulsion and missiles proceeded more deliberately so as not to interfere with production of more conventional models.

By contrast, and as confirmed by postwar investigation, Germany was superior in jet propulsion, high-speed aerodynamics, bombardment missiles, and submarines (the snorkel). German interchange with the Japanese was much less complete than that between the U.S. and Britain. Japan did, however, use the Ohka (Baka – "fools bomb" we mistakenly called it), a small rocket-propelled suicide plane.

Except for accidents of timing, advanced German technology might have changed the course of the war. On the other hand, the German effort might have been more effectively applied to producing conventional weapons. Detailed examination of these used is beyond the scope of this article. As it turned out, the combination of decisions made, hard work, superior resources, and good luck favored our side.■

In the next issue: *"Fleet Organizational Developments."*