Boeing Y1B–9A bomber escorted by Boeing XP–26.

Courtesy U.S. Air Force History Office

Air Corps Experimentation in the Interwar Years—A Case Study

By JAMES D. PERRY

American military aviators wrestled with the implications of airpower in the interwar years. After its establishment in 1926, the Army Air Corps investigated new technology, organizations, and tactics. Experiments took place in many contexts—during annual maneuvers and at the initiative of commanders in the field—with multiple purposes, including gaining publicity for the Air Corps. While these experiments were effective, the Air Corps had no mechanism to analyze, disseminate, or institutionalize lessons learned. Consequently, many had to be relearned after Pearl Harbor. This article examines experiments on two basic missions, interception and precision bombing.

Air Corps experiments were designed on both a top-down and a bottom-up basis. Annual service and joint maneuvers were organized from the top down. The Office of the Chief of the Air Corps (OCAC) planned maneuvers, frequently referring problems to the Air Corps Tactical School (ACTS) for further study. Such experiments had the least scope for open-ended exploration since OCAC had to negotiate with other parties such as the Navy. However these top-down experiments served a secondary purpose by stimulating the industrial base. Liberal orders for prototype

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aircraft for use in experiments helped implement the Air Corps Act in 1926 which promoted the creation of design and engineering staffs by aircraft companies.

Meanwhile, commanders in the field designed and executed bottom-up experiments. Since the Air Corps was small, its officers knew one another well and conducted wide-ranging debates at ACTS and through correspondence on airpower employment. Moreover, operational tempo was low and there were few of what today are known as military operations other than war. There was also ample opportunity to conduct experiments and explore new technology. Bottom-up experiments proved more exploratory than top-down annual maneuvers.

Interception Experimentation

Air superiority was considered to be a prerequisite for attack and bombardment missions. In 1920 Billy Mitchell asserted that pursuit—clearing the skies of enemy bombers—was "the most important branch of aviation" and calculated that an air force should consist of 60 percent pursuit, 20 percent attack, and 20 percent bombardment.[1] Maneuvers at this time confirmed that daylight attack and bombardment would be hampered without control of the air. Official doctrine concluded that bombers opposed by enemy fighters required friendly escorts.

In the late 1920s, however, the outlook for the Air Corps began to change. Maneuvers held in 1927–28 were one-sided demonstrations and staff exercises, not experiments. Recognizing the merits of an opposition force, the Air Corps conducted the first two-sided maneuver in 1929. This and subsequent annual maneuvers pitted pursuit against bombardment, and some officers involved drew broad conclusions about the superiority of the latter.

The 1929 maneuvers consisted of a meeting engagement between a small opposition force in Columbus, Ohio, and a larger friendly force in Dayton. In the opening phase the opposition and friendly forces struggled for air superiority, attempted to interdict ground troops (represented by colored canvas panels), and attacked the enemy rear. ACTS umpires flew with both opposition and friendly forces, adjudicating losses by means of simple numerical rules.

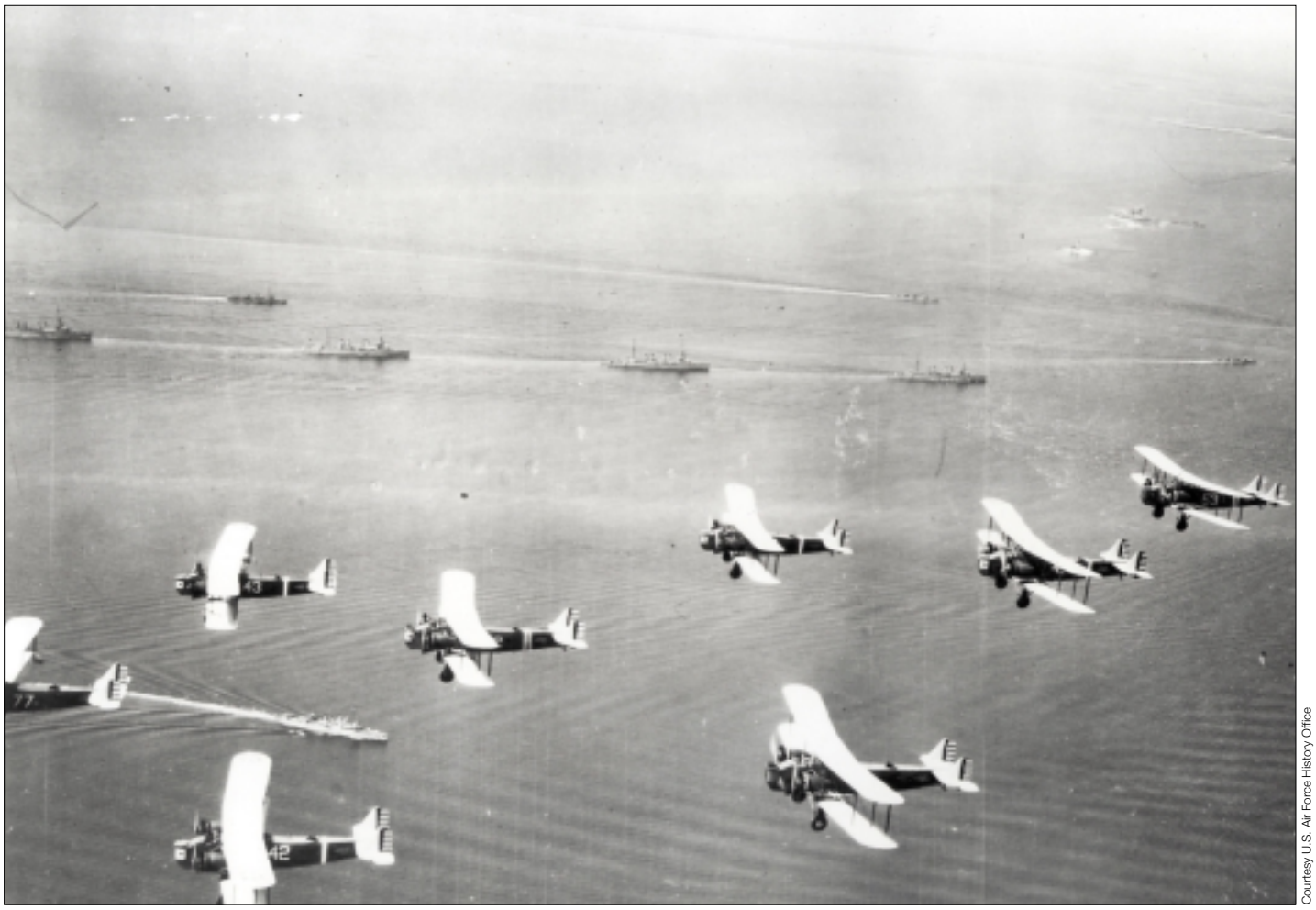
Major Carl Spatz (who later changed the spelling of his name to Spaatz) noted that frequently "bombardment and attack planes were able to reach objectives without being seen by pursuit."[2] Pursuit was repeatedly surprised by bombardment, and the chief umpire and assistant ACTS commandant, Major Walter Frank, concluded that the air force of the future would be primarily offensive.


Carl Spatz.

There is considerable doubt among the umpires as to the ability of any air organization to stop a well organized, well flown air force attack. . . . The difficulty that pursuit had, not only in attacking, but in finding some of the missions that were sent into hostile territory during these maneuvers, would make it appear that a well planned air force attack is going to be successful most of the time.[3]

The 1930 maneuver focused on the defense of San Francisco against a combined ground and naval assault by an alliance of European powers and Japan. In the scenario, opposition forces seized a foothold in Pennsylvania and damaged the Panama Canal, then bottled up the Pacific Fleet in San Francisco Bay and invaded California. The mission of the friendly force was to concentrate at Mather Field, attack opposition ground forces at Stockton, and defend San Francisco against opposition naval attack. Some 130 fabric-covered biplanes were assembled for the exercise.

The Assistant Secretary of War announced that one purpose of the maneuver was to "test methods of radio communication . . . between planes in the air." The Air Corps wanted to know whether bombardment and attack planes could send SOS calls to planes many miles away. Previous maneuvers had revealed an inability of escort planes to locate attacking bombers and indicated that radio should solve this problem.[4] The major accomplishment of this maneuver was maintaining continuous radio contact between a bombardment squadron and its escorts for the duration of a simulated bombing mission. The Chief of the Air



Courtesy U.S. Air Force History Office

Joint maneuvers off Long Island, May 1930.

Corps, General James Fechet, personally directed the maneuvers of escorts from a LB–7 bomber.

Beginning in 1930, the tide turned strongly in favor of bombers which enjoyed priority in terms of limited funding. Bomber technology soon surged ahead of fighter technology. New B–9 and B–10 bombers—streamlined, all-metal monoplanes with retractable landing gear—could outfly fighters. Further experiments appeared to support bombardment over pursuit, and the theory that daylight bombing required no escorts assumed the status of dogma. Sadly, conclusions reached during a time of rapid technological change were not revised in light of new evidence and were not fully abandoned until their failure in the skies over Europe in 1943.

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The Air Corps held its maneuvers in 1933 near Los Angeles, which had many airports and thus could simulate wartime dispersal of aircraft. Brigadier General Oscar Westover commanded General Headquarters (GHQ) Air Force (Provisional), formed to control all the forces involved. The exercise emphasized radio control over dispersed units. Westover explained to the staff that the objective was to "find the right way to handle the GHQ air force" and that he wanted a fair test. Each day units stood by for operations orders, which Westover issued by radio from his plane or his command post.[5]

During the exercises, three bombardment groups attacked Riverside and Los Angeles from San Diego. Three dispersed pursuit groups defended but relied upon information relayed from an observation group on patrol between San Diego and Los Angeles. Unfortunately, the observation group could not report contacts fast enough.

Several observation crews saw the bombers and radioed in reports at once. Still the planes continued, reaching their destination just before the pursuers caught up. With long wave radio sets it became necessary for observation planes to radio reports to the ground command at March Field. These reports were then relayed to the pursuit commander on the proper wave length. The process took over four minutes, long enough that the pursuers were late making contact with the bombers.

Pursuit failed again on May 17. On May 24, however, two bombardment groups attacked Pomona and San Bernardino, where two dispersed pursuit groups defended. In order to simulate an intelligence net, bombers reported their course, speed, and position periodically to the fighters. This enabled the pursuit commander to intercept one bombardment force well before it reached its objective and the other as it prepared to bomb its target.

Westover's report, however, ignored the impact of intelligence and radio communication while emphasizing the speed advantage bombers enjoyed over fighters:

The modern trend of thought is that high speed and otherwise high performing bombardment aircraft . . . will suffice for the adequate air defense of this country. The ability of bombardment aviation to fly in close formation and thus to insure greater defense against air attack . . . warrants the belief that no known agency can frustrate the accomplishment of a bombardment mission.[6]

The Air Corps not only trusted the merits of bombers over pursuit, but questioned the need for bomber escorts. Spatz believed escort fighters could never be as fast as interceptors because escorts would require a heavy gas load. The ACTS majority view was that "engineering reasons" precluded escort fighters from keeping pace with bombers and maintaining the capability to combat hostile interceptors (nevertheless, it recommended developing escort fighters as a matter of policy in November 1933.) Moreover, Lieutenant Colonel Henry ("Hap") Arnold concluded that pursuit equipment and tactics must be revised. He wrote that increased speed meant that interceptors could generally make only one pass against bombers, then reform for a long stern chase. Meanwhile, the bombers would reach the objective which had major implications: "If my premises are correct, it is obvious that pursuit tactics must be revamped or the pursuit passes out of the picture."[7]

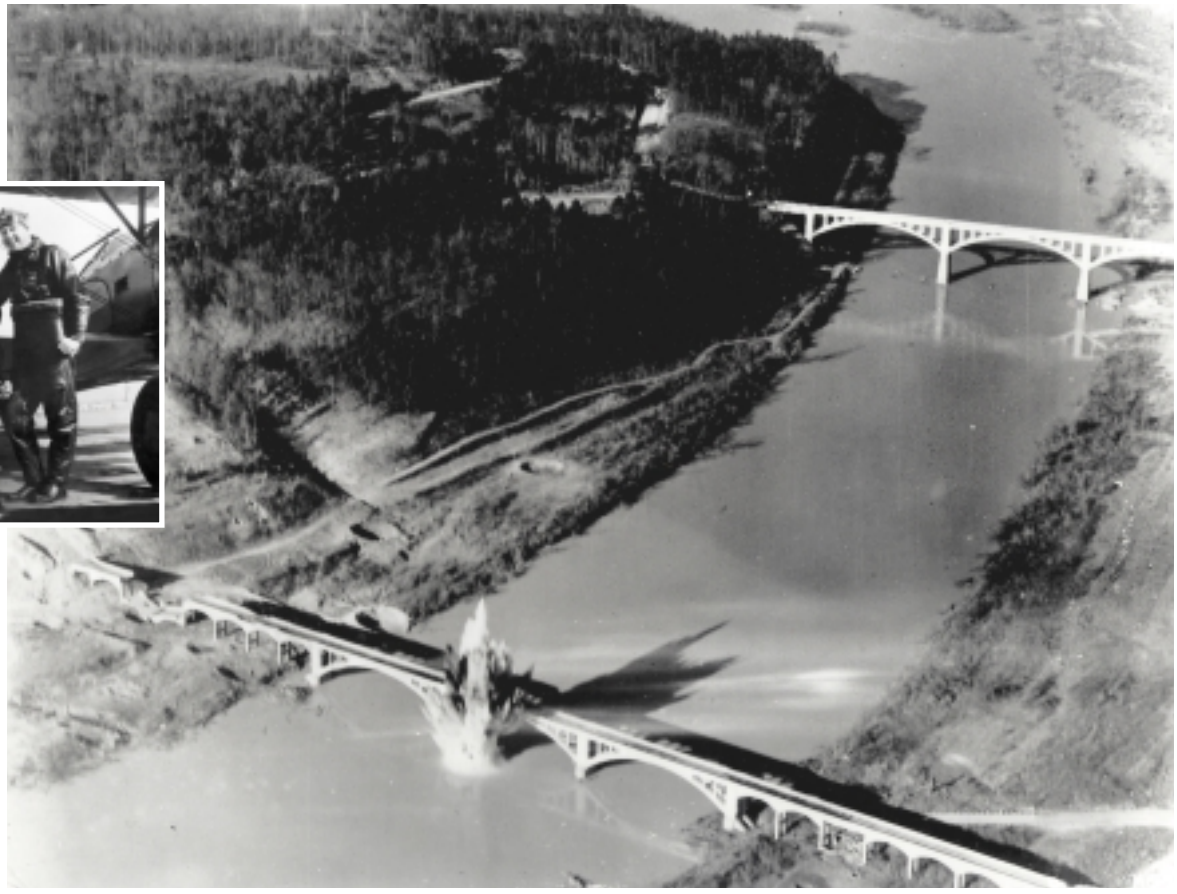
Arnold circulated his ideas throughout the Air Corps. On reaching the school, they aroused the indignation of a pursuit instructor, Captain Claire Lee Chennault, who wrote an eight-page

Henry ("Hap") Arnold.

rebuttal to Arnold who wrote back to ask, "Who is this damned fellow Chennault?"

Chennault felt the Air Corps rigged maneuvers in favor of bombers in the 1930s: "All sorts of fantastic and arbitrary restrictions were placed on fighters in maneuvers that were supposed to simulate honestly conditions of actual combat."[8] He alleged that the maneuvers pitted obsolete fighters against modern bombers. The fact that a certain fighter could not intercept a certain bomber was useless, according to Chennault. What the Air Corps needed was a list of necessary improvements in pursuit equipment and tactics. He claimed that the maneuvers placed too many limits on pursuit tactics—partly because no pursuit pilots were involved in planning maneuvers. Most importantly, intelligence-gathering—"a loose network of spotters who reported vaguely by telephone"—was inadequate. Interception using such a system was like looking for a needle in a haystack.

Captain Chennault "talked so loud and long about the necessity for an aircraft warning net, and providing radio intelligence to the defending fighters in the air, that another air force maneuver was held in 1933 at Fort Knox, Kentucky."[9] It tested his proposed air defense warning system. A line running between Indianapolis and Cincinnati divided the friendly forces based at Dayton



Bombing bridge over Pee Dee River, North Carolina.

Claire Chennault (center).

Courtesy U.S. Air Force History Office

and opposition forces located at Fort Knox. The former forces flew fast, modern bombers while the latter had slow, fabric-covered biplanes. Three regiments of antiaircraft artillery supplied guns, searchlights, and observers.

Chennault's warning system represented the heart of the exercise. It covered a 120 degree-wide sector centered on Fort Knox and radiating out towards Dayton with 69 observation posts at regular intervals. When planes were spotted, they telephoned fighter control at Fort Knox with the number, altitude, and course of the aircraft using a simple three-word code. This information was then plotted on a map. Opposition observation planes circled over the friendly base at Dayton, which had no defenses. These planes relayed their intelligence through a radio-equipped transport near Cincinnati.

Prior experience had shown that fighter control must receive messages within four minutes or pursuit would not be able to intercept. In this exercise, however, almost 1,000 messages were sent in an average time of 2.7 minutes. The opposition pursuit group commander kept his planes on strip alert and issued the scramble order via a public address system. Information was updated by radio while the fighters were in the air. Clear, fast, precise reporting enabled the opposition to intercept friendly forces by day and night and at all altitudes. Most interceptions occurred between 25 and 50 miles from Fort Knox, and some bombers were intercepted more than once per mission.

In this exercise Chennault claimed that, "bomber boys set up a deafening clamor, blaming 'unfair conditions,' and began limiting the freedom of action of the defending pursuit force." But it was apparent that pursuit could intercept attacking bombers, given timely information, and that bombers required friendly escorts to prevent heavy losses and mission failure.

This maneuver constituted the basis for Chennault's textbook, *The Role of Defensive Pursuit*, which outlined a system that he later implemented in China. However he lamented that the lessons of this maneuver were "calmly ignored by the bomber boys who controlled the development of the Air Corps at that time and who were hell-bent for the Douhet air force of bombers only."[10]

This criticism is not entirely fair. The Air Corps continued to experiment with interception techniques, but the debate shifted from whether pursuit could intercept bombardment to whether it could press home the attack. Chennault had shown that pursuit could intercept, but the advocates of bombardment claimed that it could be effective against heavily defended bombers.

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In another experiment at March Field in 1934–35 the bombers reported their positions when passing certain points to simulate a ground observation net. P–26A biplanes flew against fast B–12 bombers and 26 interception problems were studied. This measured "the time required [for pursuit aircraft] to issue orders and clear the airdrome" and "reach various altitudes." Moreover, Arnold examined "the many echelonments and altitudes used for attacking elements, their relative positions with respect to the bombardment, and the order of attack by the elements." It proved more difficult to find appropriate measures of effectiveness for tactical problems, but he suggested the wider use of gun cameras to determine if pursuit aircraft could down bombers in a defended formation.

The experiments, however, did not change Arnold's view on interception. He continued to consider it "extremely doubtful if single-engine pursuit planes . . . can prevent a formation of modern bombardment planes from reaching their objective or destroy the planes either en route to or returning from their objective."[11]

Major B.Q. Jones reached entirely different conclusions. In 1935 two composite groups, each with a pursuit and a bombardment squadron, flew against each other in simulated combat for 27 days. Each combat aircraft was equipped with a gun camera, and the results were used to find "field exercise aces."[12] Jones found bombers were usually attacked before reaching the objectives. Gun cameras revealed 194 bombardment planes were hit by pursuit, whereas 121 pursuit planes were hit by pursuit and 76 by bombardment planes (the exact number of sorties is unknown). This experiment even found the correct solution to the problem of insufficient pursuit range—the use of fuel tanks. While experimentation identified a critical technology in 1935, the Air Corps failed to perfect drop tanks until 1943. It clearly demonstrated the effectiveness of interceptors and the need for fighter escorts, but a truly effective long-range fighter escort was not in service until 1944.

A network of observers participated in an exercise in May 1937. Timely reporting enabled pursuit to intercept successfully, and cameras verified the results. In this exercise the P–26 pursuit aircraft had only a marginal speed advantage over B–10 bombers. Interception was difficult, even given adequate information, and P–26s usually managed only one pass at bombers. Pursuit found that rear attacks were too exposed to defensive fire, and side attacks were too difficult to execute. The best pursuit tactic—as the *Luftwaffe* discovered six years later—was the head-on long-range attack. Again, experimentation offered an opportunity to predict and defeat (through incorporation of chin turrets on B–17s) an enemy tactic long before the onset of hostilities, but the Air Corps did not institutionalize the proper lessons.

Precision Bombing

In 1927 North Carolina donated a reinforced concrete bridge across the Pee Dee River to the Army for experimentation. LB–5 bombers flew twenty missions a day against the bridge for five days. The target span was some 20 by 400 feet, and aircraft bombed from altitudes of 6,000 to 8,000 feet. Despite clear weather and no wind, the results were disappointing. On the first two days sand-filled practice bombs scored only two hits. Further hits and near misses with 300- and 600-pound demolition bombs did little more than chip the concrete. Eventually the bombers scored six hits with eighteen 1,100-pound bombs and destroyed the span.

During the operation the commander, Captain Asa Duncan, developed the dropping-on-the-leader technique. He found that when planes flying in formation released their bombs on a signal from the lead plane, they had a better chance of hitting targets than when flying singly or in pairs. This technique would prove invaluable during World War II. But accuracy remained a problem. It had increased five-fold between 1918 and 1927, though the experiment proved precision bombing was not yet a reality. Consequently, Fechet urged the development of a precision bombsight.

The need for a high-altitude sight only became apparent after a decade of experimentation. Aviators generally believed that low-altitude bombing was more accurate and destructive. In 1929 ACTS instructor Lieutenant Kenneth Walker studied this issue. When he asked ordnance officers and commanders for their views, they indicated that low-altitude bombing was highly inaccurate because of ricochets and navigational errors. Walker forwarded his finding to Fechet, who ordered an experiment at Aberdeen Proving Ground, where bombers flying at 150 feet achieved extremely high accuracy only when bombs penetrated buildings and stopped before

detonating. The problem with low-altitude bombing included the fact that bombs rolled, skidded, tumbled, and detonated on their sides with reduced effects.

Low-altitude delivery also reduced destructive power. Walker studied the Pee Dee River Bridge bombing, where both delayed- and instantaneous-fuzed bombs were used. Delayed-fuzed bombs, which buried in the earth, were many times more destructive than those that detonated on the surface. Moreover, since kinetic energy increased with the square of velocity, the best way to increase destructive power was not by adding mass, but by increasing the height from which bombs were dropped. Walker concluded that delayed-fuzed bombs dropped from high altitude would be most effective of all.

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Walker also learned that antiaircraft fire made low-altitude bombing more dangerous. As planes gained altitude, the accuracy of bombing and antiaircraft fire decreased; but the accuracy of antiaircraft fire decreased more rapidly. The experiments provided justification for the doctrine of high-altitude, daylight precision bombing, which crystallized between 1930 and 1932.

When Walker reached these conclusions, however, the technology to execute high-altitude precision bombing (the Norden sight and the B–17) did not exist. But he and fellow bombardment advocates refused to tailor doctrine to existing capabilities. Instead, doctrine drove developments in technology. Walker knew where he wanted to go and trusted American ingenuity to get there.

Lieutenant Colonel Clarence Tinker investigated bombing techniques at Muroc Dry Lake in 1936. His group with 27 planes tested different formations, altitudes, and speeds. Three methods of dropping bombs were employed: individual, on the leader by salvo, and on the leader in train. A precision target (300 by 30 feet) was etched in the lakebed, and the group practiced by making attacks on moving targets (three trucks simulated a ship moving at 30 knots). After each run the bomb patterns were plotted and the results compared with photos taken from bombers. The group achieved excellent accuracy from 12,000 feet: "The target was within the pattern of the bombs on every mission." Moreover, the group found "the pattern from the stepped-down formation was almost exactly the same size as the formation itself" and bombardiers had to aim in front of the target to place the center of the pattern over the center of the target.[13]

In 1938, Lieutenant Colonel Harvey Burwell also experimented at Muroc. His group flew nine B–18s, with thirty-two 100-pound bombs each, to attack a target which was 900 x 2,400 feet. Flying in formation at 12,000 feet, the planes released bombs in train on the leader's signal, thus achieving a sufficiently wide distribution on the target. Burwell saw advantages and disadvantages to this technique. Every plane would not need an expert bombardier, the formation would provide protection from enemy fighters, and distributing many bombs would compensate for inaccuracy. On the other hand, the formation would be an excellent target for antiaircraft, and Burwell advised using this technique only at high altitudes.

Between 1930 and 1938 the Air Corps dropped over 200,000 bombs, mostly from 4,000 to 11,000 feet, and very few from over 16,000 feet. Drops generally took place under optimum conditions—clear weather, low speed, no enemy opposition, and against targets clearly marked on the desert floor. Yet the accuracy was less than stellar. The average circular error probable from 15,000 feet varied from 254 to 442 feet, and the record was 215 feet.[14] Nevertheless, Air Corps belief in strategic bombing remained undiminished, and data derived from experiments was used to formulate *Air War Plans Division/1,* the basic air planning document of World War II.

Learning Lessons

The Air Corps generally failed to learn from experiments conducted overseas in the 1930s. While American military attachés viewed *Luftwaffe* maneuvers, access to their reports was limited to the Air Corps G–2 and certain members of the General Staff. In the Spanish Civil War, reports were received from both sides, but efforts to collect, analyze, and disseminate data were slipshod. Information from various sources in China indicated that unescorted Japanese bombers suffered catastrophic losses.

"Hap" Arnold and Frank Andrews believed that inertia in the War and Navy Departments prevented thorough analysis of air operations in Spain and China. However, they only wanted to comment on the misuse of airpower to convince the War Department of the need for a strong bomber force. In short, even though foreign experiences were highly germane, data collection was unsystematic and analysis was neither rigorous nor objective.

No lessons were learned from other services. Navy experiments revealed that high-altitude bombing lacked accuracy, and dive bombers emerged as the preferred platform. The Marine

Martin B–12 bomber from March Field, July 1934.

Courtesy U.S. Air Force History Office

Corps actually used dive bombers in combat in Haiti in 1919 and Nicaragua in 1927, but there is little or no indication that the Air Corps learned lessons from those expeditions.

The lack of a systematic approach to experimentation during the interwar period resulted in an incomplete realization of airpower potential and caused heavy casualties early in World War II. The failure was partly due to the times. The Air Corps lacked a discernible enemy which could be attacked from the continental United States. Germany and other nations innovated successfully when faced with concrete operational problems (such as attacking Czechoslavakia, Poland, and France). The Navy could construct realistic plans and experiments around the problem of conducting carrier or amphibious warfare against Japan. Unfortunately, consideration of the correct problems for the Air Corps—defeating Germany from British bases and Japan from island bases—would have been unthinkable in the 1920s and 1930s. Instead, the Air Corps posed improbable coalitions of European powers allied with Japan. Experiments designed on that basis did lead to innovation in mobility but could not yield optimum results in pursuit or bombardment. If national strategy is the basis for realistic experimentation and subsequent innovation, Air Corps experimentation reflected the lack of an energizing national strategy.

Experiments with precision bombardment took place under optimum conditions and did not require the Air Corps to deal with flak, smoke, clouds, or enemy fighters. The doctrine of high-altitude, daylight precision bombardment was not tested to the breaking point—partly because that would have questioned the *raison d'être* of the Air Corps. Challenges to the prevailing orthodoxy (such as that made by Chennault) were suppressed, and no effective opposition team was created.

There was no rigorous mechanism to evaluate data from the past, other services, or abroad. The experiences of World War I were not thoroughly analyzed and were forgotten. Contemporary events such as the wars in Spain and China and the activities of the Navy and Marine Corps were not systematically studied, and any such information was subject to preconceived notions. Many bomber enthusiasts maintained that unescorted bombers could penetrate enemy defenses despite the Japanese experience in China, German experience in Spain, British experience from 1939

to 1941, and in some cases even American experience after December 7, 1941.

The Air Corps must be commended for developing both doctrine and organizations and for thinking about the future before technology could implement theory. It recognized that a revolution in military affairs was underway and determined to explore principles governing the use of airpower. If the Air Corps had limited itself to the realm of the technologically possible or to coastal defense and cooperation with ground forces, then theories, organizations, plans, and aircraft for successful strategic bombing during World War II would never have been developed.

Air Corps experimentation produced leaders and organizations between the wars. Officers such as Spatz, Eaker, Chennault, Walker, and Kenney were encouraged to innovate and consider the future, and their experiments yielded valuable experience. Experimentation with organizations led to the creation of GHQ Air Force, the prototype for the numbered air forces of World War II. Finally, the experiments suggest some lessons for today.

Exploration and discovery must precede validation. The primacy of bombardment became dogma too quickly. The Air Corps spent much of the decade validating this truth and was not receptive to additional exploratory data provided by innovators like Chennault.

Innovative ideas do not respect rank. Walker and Chennault had good ideas; the Air Corps should have listened to both men, not just Walker. Junior officers like Duncan and Jones obtained important results while exploring their new technology freely in the field.

Failure must be an option. During precision bombing experiments Walker was permitted to engage in trial and error. He was not punished for the latter nor forced to give up too soon because technology could not yet support a promising concept.

Institutions are as important to innovation as individuals. Interwar experiments provided answers to many important problems, but the answers were not collected, analyzed, disseminated, or internalized. This was as much a failure of Air Corps institutions as of individuals. **JFQ**

NOTES

[1] Wesley Frank Craven and James Lea Cate, *The Army Air Forces in World War II: Volume I, Plans and Early Operations, January 1939 to August 1942* (Chicago: The University of Chicago Press, 1950), p. 36.

[2] *The New York Times*, May 26, 1929, p. 17 (Spaatz changed his name in 1938).

[3] Robert F. Futrell, *Ideas, Concepts, Doctrine, A History of Basic Thinking in the United States Air Force, 1907–1960* (Maxwell Air Force Base, Ala.: Air University Press, 1971), p. 64.

[4] *Air Corps Newsletter*, March 31, 1930, pp. 75–77.

[5] Maurer Maurer, *Aviation in the U.S. Army, 1919–1939* (Washington: Office of Air Force History, 1987), p. 292.

[6] Futrell, *Ideas, Concepts, and Doctrine*, p. 68.

[7] DeWitt S. Copp, *A Few Great Captains* (New York: Doubleday, 1980), pp. 104–05.

[8] Claire L. Chennault, *Way of a Fighter: The Memoirs of Claire Lee Chennault* (New York: G.P. Putnam's Sons, 1949), pp. 18–26.

[9] Ibid., p. 22. On Chennault's experiment, see also Copp, *Captains*, pp. 105–06.

[10] Chennault, *Fighter*, p. 23.

[11] Maurer, *Aviation*, p. 363.

[12] Copp, *Captains*, p. 169.

[13] *Air Corps Newsletter*, August 15, 1936, p. 6.

[14] Stephen L. McFarland, *America's Pursuit of Precision Bombing, 1910–1945* (Washington: Smithsonian Institution Press, 1995), p. 97.