

Pilot Training Development: A Historic Perspective

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Abstract

Reaching back to the moment when man first imagined what it would be like to soar in the sky like a bird, the one salient fact of that futuristic dream was that a human being would have to somehow control the airborne event. Engineers and philosophers could ponder the mechanics of flight, but once enabled; how did one safely rise and descend, turn and bank, take off and land? The genius of the Wright brothers approach to solving the puzzle was repetitive glides. Hundreds upon thousands of glides helped Wilbur and Orville learn how to maneuver their oversized kites. Armed with that knowledge and the secret to “roll” control, they set out to make history. Early on, aviating was more “seat of the pants” than “state of the art”. With the advent of the Great War, flight training was initiated on both sides of the Siegfried line. Following the war, the glut of surplus aircraft and pilots became the ingredients for thrills and eminent disasters. Government regulation predictably followed a steady stream of accidents in order to protect public safety. As new aircraft designs unfolded, so did performance and speed. Pilots were faced with challenges that had not been imagined decades before. World War II spurned a renewed pilot training frenzy. Commercial airline growth was fostered by another post war surplus of trained pilots and equipment. Organized training centers were developed. Pilots found themselves engaged in a learning curve that seemed to have no end.

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Throughout the past century of flight, pilots have constantly been faced with the requirement to learn new skills; to balance an inherently unstable craft in an unpredictable wind; to become proficient in the use of an unfamiliar piece of hardware; to rely upon a new instrument; to soar to new heights on the back of the most recent advancement in aerodynamics; to face an opponent across the expanse of a limitless sky; to handle an emergency for the first time like a seasoned veteran; and to make decisions under duress which may ultimately determine the safety of passengers and crew. People are not born with these abilities. They must be learned. That learning, that body of knowledge was developed over time and in consideration of the mistakes made by many others before them.

The Wright brothers understood that an experienced pilot would be an integral part of their success on December 17, 1903. There were few opportunities afforded to the pioneers to actually feel the air through a set of fight controls. Each attempt was a learning experience. Hundreds of glider flights prior to that magical day in Kitty Hawk tested not only the airframe but the aviator. No one knew how to fly at the dawn of powered flight; they simply had to learn by doing. David Fairchild provides a wonderful description, quoted by Seth Shulman in his book, *Unlocking the Sky*, of Glenn Curtiss' first flight of the *Juno Bug*, on July 4, 1908. "...it glided upward into the air and bore down upon us at the rate of 30 miles an hour. Nearer and nearer it came like a gigantic ocher-colored condor carrying its prey. Soon the thin, strong

features of the man, his bare outstretched arms with hands on the steering wheel, his legs on the bar in front, riveted our attention. Hemmed in by bars and wires with a 40-horsepower engine exploding behind him leaving a trail of smoke and with a whirling propeller cutting the air 1,200 times a minute, he sailed with forty feet of outstretched wings twenty feet above our heads" (Shulman, 2002, p. 141).

Not for the faint of heart, flying at relatively low speeds and low altitudes offered an envelope for the novice to recover from an accident, bruised but unbroken. It became apparent that this would not continue with the advent of new engine designs, augmented horsepower, and the resultant increase in speeds. Even experienced pilots such as Orville Wright could find themselves and their passenger in difficult circumstances. On the seventeenth of September, 1908, Lt. Thomas Selfridge, an observer aboard the *Wright Flyer*, became the first person to lose his life in a heavier-than-air aircraft accident (Brady, 2000). A structural failure in-flight had rendered the aircraft uncontrollable. Charles Grey, an aviation historian of the period, is quoted in *Unlocking the Sky*, "The Wright type biplane with the small leading plane and a method of control hardly anybody other than the Wrights could manage, killed most of its pilots and was obsolete and out of production by 1912 when many other designs were flying strongly and developing fast" (Shulman, 2002, p. 222). The Wrights were not deterred by such opinions. In 1909, they had finally won a contract with the U.S. Army. The first aircraft was delivered to the Army on August 12. The terms of the purchase agreement also specified that two officers must be trained to fly (Allen, 2002).

The Wright brothers were at last receiving the recognition they so richly deserved. Although it had been nearly six years since the first flight, Wilbur's success in France the previous year coupled with demonstrations at home by Orville had in effect elevated the two men to celebrity status. Wilbur accepted the task of training the young Army officers. College Park, Maryland was chosen as the site for the first military airfield. The Army leased 160 acres beside the B & O Railroad tracks and selected Lieutenants Humphreys and Lahm as the first students to receive flight instruction (Allen, 2002). The day before training was to begin; the new class and their instructor assembled the aircraft that had been shipped to the site by rail. "Lt. Lamm was given the honor of cranking the engine because he was in charge of the military detachment at the field" (Allen, p.16). On October 8, 1909, in mid-afternoon, Wilbur tested the aircraft by circling the field several times. Satisfied, he landed and took Lamm onboard for his inaugural lesson. Lt. Humphrey was next to fly. The College Park school was open (Allen).

Control and feel for the aircraft were the principle lessons learned. Everything was visual. Students would sit in the aircraft on the ground and simulate reactions to the instructor's verbal input. Wind - how it influenced every aspect of flight was discussed over and over. Certainly an abundance of time was devoted to ground based instruction, while flight lessons were limited to short circuits around the field. "...at a time when there were fewer than ten fully qualified aviators in the world, the only way to obtain pilots, was to train them"(Ennells, 2002, p. 24). The Wrights realized that in order to expand sales of their aircraft, they had to demonstrate *Wright Flyers* throughout the country. Pilots were needed to fly the demos and to teach. In March of 1910, Wilbur and Orville opened the first civilian flight school in Montgomery, Alabama (Ennells). Orville assumed the responsibility of running the school. He employed a

staunch approach to teaching; check the aircraft thoroughly prior to each flight with the student, fly a test circuit before the student climbs aboard, and only instruct in light wind conditions. When high winds prevented the students from going aloft, they "...practiced balancing the aircraft on the monorail. With the plane pointed into the teeth of the wind, one student acted as the operator and another as ballast, as the airplane tilted from side to side in response to the movement of the elevators and stabilizers" (Ennells, p. 27). This simulation process was incorporated into future training classes by the Wright brothers.

The Montgomery school would claim several aviation records during the summer of 1910. Walter Brookins became, "...the first and only graduate of the nation's first civilian flying school" (Ennells, 2002, p 28). Brookins was then designated to instruct in Orville's absence. On May 25th, the novice instructor and student Arch Hoxsey, initiated a takeoff at 10:30 p.m., in calm winds with a full moon illuminating the landscape. This was "believed to have been the first night flight ever attempted" (Ennells, p.28). The Brookins-Hoxsey exploit would later be modified to become the first night instructional flight. One month prior, April 23rd, Claude Grahame-White competing in the *Daily Mail* race from London to Manchester, laid claim to the first night flight. Even though he risked flying after sundown, Grahame-White eventually lost to Louis Paulhan (Brady, 2000). "It would be another twenty years before reliable attitude instruments would make their way into airplane cockpits, but it started here, on the perilous night flight from London to Manchester" (Brady, p. 86).

Later that year, inter-service rivalry intact, the Navy Department expressed an interest in aeronautics. Captain Chambers, the Navy designee for this new discipline, contacted Glenn

Curtiss with a question and a proposal. Could an aircraft operate from a ship? If so, would Curtiss be willing to provide a demonstration? “On November 14, 1910, Curtiss’ representative, Eugene Ely, flew a Curtiss land-plane from a platform hastily built on the bow of the USS *Birmingham* at Hampton Roads, Va” (Sitz, 1930, p. 5). The Navy was very impressed, but lacked funding to proceed further. Glenn Curtiss volunteered to train an officer to fly at no cost to the Navy. Lieutenant T. G. Ellyson thus became the first naval aviation student (Sitz). Curtiss relocated the company’s satellite operations to San Diego where he would instruct Ellyson and further develop his float plane technology. January 18, 1911, Ely, back again at the controls of a Curtiss aircraft, would make the first carrier landing aboard the USS Pennsylvania anchored in San Francisco harbor. A successful take off from the converted armored cruiser would be accomplished the following day (Brady, 2000).

Flight training for Ellyson began on February 4, 1911. Learning how to effectively use the rudder at varying speeds was critical for the novice pilot. Prior to receiving any dual instruction in the air, Ellyson had to demonstrate that he could control the aircraft on the ground. A series of low speed runs, leading to higher speed ground taxi sorties, were executed over the course of the next seven days. Towards the end of the week, ground runs were of sufficient speed to allow limited lift off. During these short airborne moments, the student would experience use of both aileron and throttle in order to smoothly return to the ground. By the end of the month, Ellyson had soloed (Armstrong, 1997). Ellyson cabled his superiors on March 31, “...in my opinion and in that of Mr. Curtiss, I have qualified in practical aviation” (Armstrong, p. 3). Glenn Curtiss had not only taught the young officer how to fly, he involved Ellyson in the structural design and maintenance of the aircraft. On May 8, 1911, Captain Chambers, armed

with a \$25,000 appropriation from Congress, ordered two aircraft from the Curtiss company; Naval aviation was born (Armstrong).

The Army and Navy began, during the next few years, to slowly develop meager inventories of aircraft and train a limited cadre of pilots. The Montgomery school had lasted only one season. In order to supply each company with pilots for demonstration and sales promotion, the Wright brothers and Glenn Curtis trained prospective pilots on an as needed basis in their respective home towns; Dayton, Ohio and Hammondsport, New York. The fledgling American aircraft industry was embroiled in patent disputes which hampered any reasonable expectation of growth (Mingos, 1930). European aviation appears to have been developing at a much faster rate during this period.

Great Britain and France had initiated military training programs prior to the Great War, but on a limited basis. “The French army bought its first planes in 1910 and trained 60 pilots” (Gropman, 2007, p. 4). Aircraft design had not incorporated the capability of firing a weapon or dropping ordinance. “On August 20, 1910, at Sheepshead Bay racetrack, lieutenant James Fickel fired the first shot from an airplane – a rifle at a target from an altitude of 100 feet with Glenn Curtiss piloting” (Gropman, p. 4). Early military flight training programs were extremely hazardous. “Pilots had very short life spans because aviation was so dangerous” (Reinhold, 2008, p. 57).

“With hostilities at full bore, the pressure to produce airplanes and pilots for combat resulted in unreliable machines flown by men who didn’t know how to operate them” (LeCompte, 2008, p. 48). By 1912, France had trained 968 pilots; the U.S. in comparison had only 193 qualified airmen (Gropman). “During most of World War I, pilots stood a greater

chance of being killed during training or in accidents than in combat" (LeCompte, p. 48).

Without dual controls, the student sat in the front seat and the instructor in back. Lack of standardized training led to some tragic scenarios. "In August 1914, when Germany, France and England went to war, Germany had about 1,000 airplanes, France 300 and England 250. Americas 224 planes in 1917 were nearly all obsolete in type, compared with the machines then in service in France" (Nilo, 1998, p. 30).

The English and American training methods employed were similar to the French in regard to basic training and ground school instruction. During primary training, each recruit would spend "...his month-long training in lectures on flight theory, meteorology, navigation, wireless telegraphy, and engine mechanics (LeCompte, 2008, p. 48). Once the first phase of flight training began, students would learn how to initially control the aircraft on the ground. Use of the rudder and throttle during ground operations was critical to every takeoff and landing in a trailing wheel or tail skid equipped aircraft (LeCompte).

Dual training in an aircraft also had its drawbacks. Communication was almost nonexistent. If the instructor wanted to pass information, he had to slap the side of the fuselage, cut the engine and shout commands to the student. "...you were sitting in those little Curtis[s] JN-4s in front of your instructor and you couldn't hear each other. We came in for a landing one day and he thought I had the controls and I thought he had the controls and somehow the thing sort of landed itself." (Zito, 1977, p. B1).

The French adopted a three phase system of training early on; primary, advanced and operational (LeCompte, 2008). The English began training without any standardized process (LeCompte). Each student had the benefit of his instructor's experience, but not necessarily any

of the other instructors' input. "Many instructors, though, were averse to taking risks themselves, so they taught their students primarily how to avoid getting into dangerous flight situations, rather than how to recover from them" (LeCompte, 2008, p. 48). Lack of skill and high losses of the initial training classes, moved the English toward a more standardized system. Where French and English training methodology ultimately differed was in the operational phase of instruction, especially for those selected as fighter pilots. If you were judged worthy, air combat training under the French system, dual instruction ceased from that point forward (Brady, 2000). Instructors in French schools would brief operational students, climb aboard on the wing, hold on to a strut and provide feedback during ground taxi and short hops. As to flight, since it was a single occupant aircraft, you were on your own (Brady).

American pilots had the benefit of standardized primary training back home, but were shipped to Europe for advanced and operational experience. "More than ten thousand aviators were trained and equipped. In the U.S. thirty five flying schools and fields were built and were operational" (Mingos, 1930, p. 44). The need of so many pilots during the short period of American participation in the war spoke to the attrition rate not only in the European theater, but in the training phase itself. The washout rate was very high. Mechanical failures were common (Mingos). Following the end of the Great War, each country began the healing process by reworking their financial structures. Nations were in debt. Reconstruction was necessary throughout France and Germany. Military budgets were slashed. Thousands of pilots were released from active duty to fend for themselves in a post-war economy. Curtiss JN-4D's [Jennies] were suddenly available for \$600 after 1918 (Lopez, 1995).

Aviators in the U.S. looking for work joined flying circus tours. Aviation was still a novelty and the public was very curious. Formal training for pilots reverted to more of a casual mode following the war. Those schools that remained open were financially beyond the means of most prospective candidates. Charles Lindbergh wanted to apply to the Nebraska Aircraft Corporation flying school, but lacked sufficient funds. “For five hundred dollars the Lincoln factory school offered four weeks’ work in the various departments of their factory, another week on the flying field, followed by several weeks’ training in the air” (Berg, 1998, p. 59). In his book, *The Spirit of St. Louis*, Lindbergh recounts his first solo: “When my Jenny was assembled and the paint all dry, I faced my greatest problem; for I hadn’t flown in six months, and I’d never soloed. Everybody at Souther Field took for granted that I was an experienced pilot when I arrived alone to buy a plane. They didn’t ask to see my license, because you didn’t have to have a license to fly an airplane in 1923. There were no instructors on the field, and anyway I didn’t want to spend more money on instruction” (Lindbergh, 1953, p. 437).

Lindbergh initially tried his hand at barnstorming. He was joined by hundreds of others scattered across the countryside. Pilots like Alfred Sporrer, who first flew at age 19. “He learned to fly the way everyone did in 1924; by the seat of his pants” (Spencer, 1985, p. 3). Sporrer and sidekick Arlie Emmes paired up with an OX5 powered Curtiss Canadian putting on shows and offering rides (Spencer). “We would go from town to town, landing in farmers’ fields. We were getting \$15 a ride for 15 minutes. Then as the aeroplane became a little more common, we had to go down to \$10 a ride, then \$5 a ride. When the competition got real bad, why we were taking them up for a penny a pound” (Spencer, p. 3).

The Air Commerce Act of 1926, signed by President Calvin Coolidge, was the beginning of regulatory efforts to manage the aviation industry in the United States. Prior to this legislative action, there were no rules that governed the certification of aircraft or the pilots who flew them. It was evident that civil aviation had a bright future, but prior to the Air Commerce Act, it was considered too dangerous to be taken seriously. The Act required pilots to possess a license in order to legally fly. Aircraft manufacturers had to meet certain standards before they could deliver their products to customers (Bemowski, 1997, p. 26).

The twenty year period following the cessation of hostilities in Europe has been referred to as the golden age of flight (Ehrenman, 2003). This was the time of Wiley Post, Jimmy Doolittle, Richard Byrd, Charles Lindbergh and Amelia Earhart. Private individuals and corporations funded contests: The Schneider Trophy, The Pulitzer Race, The Bendix Trophy, The Thompson Trophy, and the Orteig Prize (Lopez, 1995). Veteran pilots from the Great War had filled the few civilian flying billets throughout the country. Air races and record setting milestones were constantly in the news. “It may have been the barnstormers and the great trophy races that captured the public’s attention initially, but it was the record-breaking flights of individuals that truly distinguished this era. When Charles Lindbergh’s Spirit of St. Louis took off from Long Island’s Roosevelt Field on May 20, 1927, and touched down at Le Bourget field near Paris 33.5 hours later, the public’s fascination with flight was off and soaring” (Ehrenman, p. 26). During the four years from first solo to landing in Le Bourget, Lindbergh had gained experience as an Air Mail pilot. Many others throughout the country were following similar avenues of learning. On February 28, 1929, an amendment to the Air Commerce Act provided for the licensing of flight schools. Instructors, ground and flight were rated separately (FAA, p. 8).

The surplus of aviators created by the Great War who continued to fly on a commercial basis, had to gain additional skills on the job. Night flights, weather, and mechanical reliability continued to pose hazards to pilots and the occasional passenger. “In 1929 Doolittle made the first ever completely blind flight. Glued to a crude panel of rudimentary instruments that he’d helped develop, he crouched in a cockpit under a black hood, flying blinder than if it were night” (Perret, 1993, p. 40).

Rumblings of the renewed military buildup in Germany created concern about the condition of readiness of the next generation of pilots. In August 1938, the Civil Aeronautics Authority began operations (Anonymous, 1940). At that time, “...out of a population of 130 millions [in the U.S.], only 21,118 individuals had pilot certificates” (Anonymous, 1940, p. 80). The authority instituted experimental pilot training programs at thirteen colleges in the United States over the following year. “Of the 320 students selected for training, over 95 percent were found to have enough aptitude to complete the course in about 38 hours of flying time and 72 hours of ground instruction and to qualify with high ratings for private pilot certificates” (Anonymous, 1940, p. 80). The following year, this experiment was formalized into the Civilian Pilot Training Program (Pisano, 1988). The program’s second phase, “war preparedness – mobilization” was managed in a more centralized manner. The first phase, fraught with inefficient standards, had allowed each university to provide oversight for their individual training programs (Pisano). “Back then they didn’t have ceremonies to celebrate the solo flights. They would just tear off a piece of a shirt the pilot was wearing and write their name and the date of the flight on it...and hang it on a board of some sort” (Fortin, 2008, p. 4U).

Many graduates of the CPTP volunteered with the Army Air Corps and Naval Aviation training programs. In January 1942, the Air Education and Training Command sprang to life. The AETC was responsible for training Army Air Corps pilots, navigators, bombardiers, and all associated disciplines that supported Army aviation. During the first year of American involvement in World War II, the "...AETC graduated nearly 11,500 pilots and 600,000 technicians" (McCollough, 2002, p.1H). Training bases sprang up all over the country. Eventually, 438 AETC training bases would be operating at full strength in the United States (McCollough).

Naval Aviation training graduated 10,869 pilots from its regimen in 1942. Over the course of the following three years more than 50,000 pilots were designated as Naval Aviators (Grossnick, 1997, p. 414). The need for reliable instruments and radios had been a priority for technicians during the 1930's. By the beginning of the war, "...radios were improved and reduced in size" (Grossnick, 1999, p. 28). The Navy had a proud history of aviation training dating back to February 4, 1911 when Lieutenant T. G. Ellyson became the first naval aviation student (Stiz, 1930). The naval aviation cadet syllabus consisted of 11 weeks of pre-flight conditioning; 15 weeks of ground school intermingled with 12 weeks of elementary flight; 12 weeks of primary flight, and finally 14 weeks of intermediate flight training (Anonymous, 1943, p. 1). Upon graduation, deployment to the fleet was predicated on performance during the entire program. Aircraft assignment of choice was awarded to the top graduates. The only power that superseded this recognition for a job well done was, "the needs of the Navy" (Anonymous, p. 4).

Aviation training during World War II was a tremendous undertaking. As an instructor at the newly created training base, NAS Livermore, Captain Matt Pontz, USNR (Ret.), recalls in his unpublished, *Memories of WWII Training*, “...the discipline of a 10-hour day, 10 days work then two days off, plus a three-hour stint of night flying about once every three weeks enables me to hone my proficiency. One month I worked 89 flights, over 130 flying hours, and about twice that much time in ground work with my students” (Pontz, p. 10). The backbone of the military instructor corps at the beginning of World War II was the cadre of World War I aviators who had blended back into civilian life or joined a reserve component after 1918 (Dailey, 2004, p. 178).

“A unique contribution to U.S. aviation existed in a program at Embry-Riddle Aeronautical University, now located in Daytona Beach, Florida. Founded in 1925 in Cincinnati, Ohio, its basic mission was to train pilots. The university became an important center for setting training standards in civil aviation. Embry’s program evolved to a core aviation education and training program, to include engineering studies, meteorology, navigation, power plants, airframes, and electronics” (Dailey, 2004, p. 179). In 1943, a little farther north in Montgomery, Alabama, Free French volunteers were being molded into combat ready pilots. More than 1,400 Frenchmen were cycled through the Army Air Corps training program at Gunter Field during the following two years (DuPont, 2004). A little east of Montgomery, and perhaps sharing the same airspace from time to time, was an aviation training program that would prove to be one for the history books.

“The first full-fledged Army Air Corps pilots to graduate from Tuskegee did so on March 7, 1942. There were five – one officer and four cadets. The officer was Benjamin O. Davis Jr., a West Point graduate who had ranked 35th of the 276 in his class” (Purnell, 1989, p. 7). Racial

prejudice prevented patriots of color to train with their white counterparts. They were “... fighting not only superstition and tradition, but also supposedly scientific studies, such as one conducted by the Army War College in 1925, that claimed the brains of Negroes were 10 grams lighter than those of Caucasians, rendering them incapable of flying airplanes” (Reinecke, 1983, p. 41).

Tuskegee University was the site for training and development of African-American pilots who were to fly P-40 and eventually P-51 fighter aircraft, composing the 99th Pursuit and 332nd Fighter Squadrons. “Those who won their wings were known as *Red Tails* because of the way their planes were painted to distinguish them from those flown by whites” (Reinecke, 1983, p. 41). Approximately 1,000 African-Americans, trained at Tuskegee, were awarded pilot wings by the end of World War II. The stress on these young cadets was tremendous. “In order to appear equal, you’ve got to be twice as good” (Purnell, 1989, p. 7). The 332nd, operating out of North Africa, had the distinction of never losing a bomber under their protection to enemy fighters (Purnell). The “Tuskegee Airmen” were some of the most decorated flyers in the European theater.

Prejudice wasn’t limited to race during this period, it also included gender. In August 1943, the Women’s Airforce Service Pilots (WASP) was formed by combining the vision of two aviation pioneers. Nancy Love, who had organized the Women’s Auxiliary Ferrying Squadron in September 1942, and Jacqueline Cochran, the leader of the Women’s Flying Training Detachment, which began in November of the same year, agreed to merge their efforts in order to establish centralized training and operational aircraft ferrying squadrons (Kamps, 2003, p. 68).

Of the more than 25,000 women who applied for training, only 1,830 were selected (Kamps). From these inductees, 1,102 women pilots made it through the program and received their wings (Chaffey, 1992, p. 103). These aviators filled a critical need. Aircraft coming off the assembly lines throughout the U.S. had to be positioned for shipment overseas on both coasts. At the same time the Army Air Corps was short of experienced pilots on both fronts. The WASP's allowed their male counterparts to rotate to combat billets while effectively filling their shoes back home.

The thought of a woman taking a man's job, regardless of whether it relieved him to be more effective in the fight, was abhorrent to the male dominated society of the early 1940's. "The male instructors made training very difficult and washed out students for unnecessary things. Some of the girls entered the program with thousands of hours of flying time and still washed out. Each day of training I knew would be my last. None of us believed we would make it through" (Hoppes, 2009, p. 2). During the course of the war, it was not considered unusual if a WASP were to accumulate flight time in more than 50 aircraft types (Kamps, 2003). "The program was officially deactivated on 20 December 1944, as the USAAF began to draw down its training establishment" (Kamps p. 68).

Flight training during this period required that each student be instructed in a wider variety of subjects. Crews were now dealing with more than how to maneuver flight controls. The environmental impact on flying paralleled the advance in aircraft design. At the dawn of fixed wing flight, wind was the largest factor a pilot had to deal with. Cockpit instrumentation developed in the 1930's allowed pilots to fly in inclement weather and at night. High performance engines burning higher octane fuel, powered fighters, bombers and troop transports

to faster speeds and loftier heights. Pilots had to be trained to scan their instruments vs. scanning the horizon. Pilots had to be trained to trust their instruments vs. the seat of their pants.

Hypoxia, a deficiency of oxygen reaching bodily tissues, became a major consideration for crews operating above 10,000 feet, in unpressurized aircraft. Pilots who completed military training programs during the World War II era had to be well versed in not only how to fly, but how to survive. The sky, which had captivated the imagination of Leonardo de Vinci, was a very hostile environment less than 2 miles above the earth's surface.

Out in the Pacific theater, a new Japanese fighter, the Zero, was out performing opponents with its maneuverability and power to weight advantage. Back in San Diego, Lieutenant Commander John Thatch, attached to Fighter Squadron Three, realized that in competition with the Zero, Navy fighters would have to gain tactical advantages in order to survive (Thatch, 1992, p. 49). Traditional deployment of Navy fighters had always been in groups of 6. Thatch believed that this was too cumbersome. He began to experiment. "I used a box of kitchen matches and put them on the dining room table and let each one represent an airplane" (Thatch, p. 49). He worked on teams of 4 aircraft in various combat formations; Finger, Trail and Abeam. From the Abeam formation, he was able to devise a tactic which allowed each 2 plane section to cover the adjacent 2 plane section by continually turning towards the other section during an attack by enemy aircraft (Feuer, 2002). Intense training was required to perfect the tactic. This maneuver, later called the "Thatch Weave", allowed Navy aircraft to turn a defensive reaction into a very successful offensive tactic (Feuer, p. 23). This innovation was an instrumental part of the overall success of the U.S. Naval victory at the Battle of Midway on June 4, 1942 (Feuer).

If a pilot group developed tactical standards in combat, they would eventually be translated into the ground school curriculum back in the states. Classrooms consisted of chalk boards, hard backed chairs and loosely bound volumes of black words on white paper. Checklists and standard procedures became the rule rather than the exception. Pull down maps of operational theaters and aircraft recognition classes were drilled into student's heads. By the end of 1943, at the peak of training activity the Army Airforces Training Command had 461,656 officers, enlisted and civilians supporting instructional activity within its 438 installations (McCollough, 2002, p. 3H).

Victory in Europe and Japan dramatically reduced the need for military flight training. Bases were closed across the country. Hundreds of thousands of military personnel were discharged from active duty. As was the case at the end of World War I, the defeat of the axis powers by August 1945, created an abundance of pilots and a surplus of aircraft within the United States. Many veteran pilots scrambled to land a flying job in the rapidly expanding U.S. Air Carrier industry (Brady, 2000, p. 218). "The Douglas DC-3 became the C-47 during the war and was returned to the civilian version afterward. New variants of proven wartime airframes emerged as the DC-4 and the Lockheed Constellation" (Brady, p. 218).

The previous year, President Franklin Roosevelt signed into law the Servicemen's Readjustment Act of 1944: The GI Bill. "By 1947, veterans of World War II accounted for roughly half of all college admissions" (Hutto, 2009, p. 37). The GI Bill also paid for vocational training programs for returning veterans. This sparked a growth in civilian pilot training programs. Veterans who had worked on aircraft now had the opportunity to learn how to fly them. "...the large number of veterans with flight experience and the expanded manufacturing

plants with highly skilled workers created a feeling that the airplane would replace the automobile as a means of transportation” (Brady, 2000, p. 241). General aviation became a viable industry following the war. Its growth was tempered by economic factors during the following several decades, but this segment of the aviation industry would eventually become a major contributor to the advancement of aeronautical technology.

Flight crew training followed established guidelines set during the war years. Ground based classes were followed by “dual” instruction in the air. As the airline industry expanded, it became necessary to document individual company standards in recurrent training programs. When pilots moved from one aircraft type to another within an air carrier, they were required to learn the new aircraft and its components thoroughly; then demonstrate competency in the air. Flying expensive company aircraft for training quickly gave way to the use of simulators for the majority of instructional purposes. The first cockpit simulations had been incorporated into “Link” trainers during the late 1920’s (Training, 2007). “In 1934, the Army placed its first order for six Link trainers. Over the next few years, the Army bought thousands of trainers. During World War II, all military pilots trained in ‘the Link’” (Christensen, 2005, p. 15). Simulation technology would evolve in parallel with new aircraft development. The major airlines formed in-house training departments and purchased their own simulators. Other air carriers leased time with the majors. The sky was becoming crowded. The air traffic control system within the U.S. was in a constant state of improvement. The desire to go faster and fly higher was exacerbated with the certification of the Boeing 707. It seemed the world was actually spinning a little more rapidly than before. “Jet transition” became part of the pilot training vernacular.

In 1951 a pilot by the name of Al Ueltschi “...took a \$15,000 mortgage on my house and opened the doors to FlightSafety” (Ueltschi, 1997, p. 44). He began his commercial aviation career with Pan Am in 1926. Juan Trippe, the founder of Pan Am purchased a business aircraft to move within the United States; his airline was restricted to international operations. Al was assigned as Mr. Trippe’s personal pilot (Ueltschi, p. 37). Al instinctively understood that business aviation would need a training provider in the near future. He installed the first of many cockpit simulators in his headquarters at LaGuardia Airport. “While those simulators were a vast improvement over what preceded them, they were imperfect to say the least. They had no visual systems, their instrumentation was nonstandard and they relied on racks of vacuum tubes, which were always failing” (Ueltschi, p. 54). The jet age within business aviation was rapidly approaching. Crews needed standardized training in systems and emergency procedures. Standard procedures training began to catch on within the business aviation community.

The Federal Aviation Act of 1958 established the Federal Aviation Agency, later to become the Federal Aviation Administration. The antiquated air traffic control system of the day had to be modernized. A series of mid-air collisions in 1956 and 1958, spurned Congress into action (Happy birthday, FAA, 2008). During this time, flight training began to evolve to include factors beyond basic pilot proficiency. Business jets could travel overseas and operate in and out of airports with runways too short for commercial aircraft. The FAA stepped in to the training world in a big way in December of 1978. FAR Part 141 and part 142, spelled out how pilot training would be conducted. Currency in aircraft type was mandated. Training centers were certified (Jackson & Brennan, 1993).

Pilot training in the later part of the twentieth century had evolved into the adoption of best practices within the air carriers and business aviation operations. As with any industry, there are always those individuals who refuse to comply, but for the most part, everyone involved became part of the solution rather than part of the problem. Advances in technology within the cockpit began to increase the level of knowledge required and yet greatly enhanced safety within the operational environment. Pilots were expected to implement the principles of Cockpit Resource Management; working together as a team vs. command and control. Ground proximity warning devices, inertial reference systems, global positioning systems, flight management systems, terminal collision avoidance systems - all products of the 90's - enhanced situational awareness. The FAA instituted lower aircraft separation standards, led by the European authorities, within the U.S. airspace. Aircraft were becoming quieter to comply with local airport population demands. Basic stick and rudder skills were essentially accepted as a given. What the modern pilot was expected to do more than anything during the course of a flight was to manage the cockpit. Digital instrumentation replaced the "steam gauges" of the 60's and before. Everything was displayed electronically. All this had to be learned and retained. Technology was translated into the training environment as well. Today a pilot sits inside a classroom in front of two or more computer screens. Entire training curriculum can be downloaded onto a memory stick. Home based ground school is a reality. Level D, six axis, full motion simulators have become standard in the pilot training industry. The venerable FAA began allowing type rating pilot certification rides to be taken in simulators, decades ago. Simulators during the 80's were sophisticated enough that a pilot could earn a rating as pilot-in-command on an aircraft that he or she had never actually flown.

Tomorrow's pilots will possibly take a virtual check ride in the comfort of their own homes. Engineers are designing virtual classrooms where a ground school instructor can project schematics into the instructional environment and students can observe systems operations in three dimensions. In order to keep pace with advancements within the aerospace industry, training centers must provide simulators and ground based classrooms that reflect the future needs of their clients. Slightly more than one hundred years old, the aviation industry has certainly seen its share of milestones. From the *Wright Flyer* to the 787, one factor has always been essential to the safe operation of each aircraft: a well trained pilot.

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