HAPPY LANDINGS

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Abstract

Purdue University has enjoyed a rich and vibrant association with aviation, ranging from the work of Amelia Earhart to the achievements of Neil Armstrong. Through their dedication, its graduates have become the engineers, the aviators, and the astronauts who have helped to make American history. One such graduate who worked tirelessly to improve aviation was Ralph S. Johnson. A native of Goodland, Indiana, Johnson graduated from Purdue with a bachelor's degree in mechanical engineering in 1930, and he returned in 2008 to receive an honorary doctorate in aeronautical engineering. From the time he left Purdue to the time he returned, Johnson helped to transform aviation from a primitive, informal venture to a standardized, efficient mode of transportation. Johnson's contributions are numerous, including a method of deicing planes, a checklist that standardized cockpit procedures, and a technique of landing that is still used today—the stabilized approach. In addition to using numerous monographs and periodicals, this article also makes use of Ralph Johnson's extensive personal papers located in the Purdue Archives. The papers highlight Johnson's tenure as chief test pilot for United Airlines from 1935 to 1947, and show the challenges that he and his fellow engineers faced as the airline industry worked to create more legitimate modes of travel. Although largely forgotten as an aviation pioneer, Johnson's papers help to cement his status as an important figure in the development of the airline industry, and it is this article's goal to bring Johnson the recognition he deserves as someone who dedicated his career to the task of modernizing airplanes and the airlines.

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HAPPY LANDINGS:

The Aviation Life of Purdue University's Ralph S. Johnson

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INTRODUCTION

The 1920s and 1930s were an exciting and transformative time for aviation, as it became part of the public consciousness and its stakeholders developed new technological innovations. The media were fascinated by the achievements of pilots like Charles Lindbergh and Amelia Earhart, and they followed their every move. Along with reading about the latest death-defying stunts, the country was bombarded with images of their heroes advertising the latest products and given the chance to read about their exploits and their lives. From dazzling air races to impressive around-the-world journeys, the nation developed an insatiable appetite for flying. But even though being a pilot appeared to be a glorious occupation, the reality was far from it. Pilots dealt with primitive technologies such as Morse code radios, which could only be used on the ground, and treacherous flying conditions, like flying *through* thunderstorms instead of over them. As R. G. Grant writes, “The excitement surrounding these flights was above all fueled by risks” (2007, p. 122). While these risks created a fascination with flying, they hindered air travel becoming a viable mode of transportation.

These risks were an important reason why many pilots began the task of making aviation a safer and more efficient form of transportation. Planes were becoming faster, heavier, and more technically advanced, and it became the responsibility of the rising number of aeronautical engineers to standardize industry practices and establish an organized airline industry. As a result, the 1930s were a time when “the art of flying had grown up and become complex” (Vincenti, 1990, p. 73). The airlines were able to create a dependable mode of travel that took the public’s

safety seriously. They adapted to the ever-changing technology by utilizing the new rules and guidelines that ensured precise, reliable operations.

Into this rapidly evolving world arrived Ralph S. Johnson, a pilot’s pilot who had the foresight to realize that aviation was a constantly changing industry that always had room for improvement. Through his work, Johnson established himself as an early aeronautical engineer by being “interested in all possible new developments which could be used as aids in this business” (Addams, 1935). During the time between his graduation from Purdue University in 1930 to his retirement as chief test pilot for United Airlines in 1947, Johnson worked on numerous projects, either in conjunction with others or that he devised himself. These ranged from working on deicing systems to developing the standard landing procedure that is still used by pilots today. Johnson was active at a time when transporting passengers became a serious venture, and his contributions helped ensure that the burgeoning airline industry became a well-organized mode of conveyance. As Johnson wrote in his memoirs, “Nothing was reliable then. That’s what interested me most in aviation, so I dedicated my life to trying to eliminate unfortunate variables related to aviation, and trying to improve every facet of flying” (2005, p. 25). Although Johnson is forgotten in mainstream histories, this article will highlight his many innovations and bring him the recognition he deserves.

Figure 1 (Above). Ralph S. Johnson in United uniform (Ralph S. Johnson Papers, Folder 2, Box 3; photo courtesy of Purdue University Libraries Virginia Kelly Karnes Archives and Special Collections).

AN AVIATION LIFE

Ralph Samuel Johnson was born on June 26, 1906, in the small, rural community of Goodland, Indiana, and spent his youth on a 177-acre farm. Growing up on a farm meant hard work, and like his siblings, Johnson did his part to keep it going. Before going to school, it was Johnson's duty to get up at 5 a.m. and complete his chores. Farm life also meant that Johnson had the opportunity to fine-tune his mechanical skills, and the affinity he showed for this became a hallmark of his career. For example, he repaired farm machinery and built a car for his mother by attaching a body built of wood and sheet metal to an existing Ford chassis (Johnson, 2005). In 1924, Johnson graduated from Goodland High School and enrolled at Purdue University. To help pay for his education, he took time off occasionally and worked at the Ford plant located in Reynolds, Indiana. Because of this, it was not until 1930 that he finally graduated with a bachelor's degree in mechanical engineering, majoring in aeronautics, which did yet not have its own degree program. Johnson's education at Purdue established him as one of the first aeronautical engineers and inspired him with a love of the airplane as the perfect symbol and machine of "Modern Industrial Progress," a theme set forth in the 1929 *Debris* (p. 6), the only Purdue yearbook he kept in his archives.

Following graduation, Johnson joined some fellow graduates and took the physical for the air corps. His rugged farm upbringing paid off, as he passed the tests and spent four years in the military, becoming the personal pilot for the commander of the 8th U.S. Air Corps. Johnson intended to stay longer, but because of the ongoing Great Depression, the military was forced to make cuts in order to save money. At a time when the world was fascinated by the exploits of Lindbergh and Earhart, Johnson was more interested in using his engineering skills to improve aviation and eliminate the dangers that came with it. As he wrote in his memoirs, "My interest in aviation . . . had nothing to do with Lindbergh's flight" (2005, pp. 21–22). Instead, Johnson dedicated his career to eschewing the glamour of aviation in order to improve upon the relationship between airplanes and the pilots who flew them.

Upon leaving the air corps, Johnson looked for work with the airlines, thinking it would provide a stable source of income at a time when finding a steady job was a difficult task. He started working for the Ball brothers, famous for their glass jars, flying passengers from Lake Wawasee, Indiana, to the Chicago World's Fair. In 1934, Johnson became a pilot for National Air Transport (NAT), flying Ford Tri-Motors, the most popular all-metal airliner of the era, between Chicago and New York City. In 1935, he was named chief test pilot for the newly created United Airlines, formed from the merger of NAT and Boeing Air Transport (Spenser, 2008). As chief test pilot, Johnson's

responsibilities included the development of new engines, instruments, radios, navigational systems, brakes, deicers, flying techniques, and airframes (Johnson, 2005). His role as chief test pilot allowed him to oversee and contribute to the latest innovations that turned the airlines from simple government contracted mail carriers to the profitable enterprises they are today.

The modern airlines trace their roots to the Air Mail Act of 1925, which struck a government contract with private companies to carry the mail (Spenser, 2008). To increase revenue, the airlines began carrying passengers, and with the passage of the McNary-Watres Act of 1930, the government changed its payment method as a way to encourage the airlines to carry only passengers. Some airlines were flying more flights than needed, on little-used routes, costing the government more money than it was willing to spend (News release, 1934). With passengers as their sole source of income, the airlines were tasked with making air travel a safe and efficient mode of transportation. As Roger E. Bilstein writes, the 1930s were "an era generally characterized as one of design revolution" (2001, p. 55). The growing number of aeronautical engineers like Johnson worked to make this dream a reality, and the dedication he and his fellow engineers showed was a factor in "assisting in the design of planes that elevated aviation and air travel to a reliable, economical and mature technology" (Bilstein, 2001, p. 39).

The design revolution of the 1930s introduced numerous technological innovations that transformed planes into modern, complex machines. The planes had come a long way from the boxy, slow Ford Tri-Motors of Johnson's early years. Now the airlines were equipped with planes like the sleek, 21-passenger Douglas DC-3, which featured the latest technological advances of the day, such as retractable landing gear. In 1940, Boeing introduced its 33-passenger 307 Stratoliner, the first pressurized airliner to enter service (Grant, 2007). With the 307, passengers were now able to fly over, not through, thunderstorms. In 1942, Douglas introduced the even bigger DC-4, which could carry up to 80 passengers. With planes becoming bigger and more technologically advanced, Johnson worked to introduce new operating procedures that adapted with the changing technologies.

BATTLING THE ICE

A crucial safety aspect during the 1930s was the battle against ice build-up, which was one of the most dangerous hazards to an airplane. Large amounts of ice created potentially disastrous effects, including an increase in drag, loss of lift, change in pitch, and flutter of the control surfaces (Rodert, 1944). The most common method for removing ice was to attach boots, which were pneumatic rubber encasings, to the leading edge of the wings. These

boots were inflated with air, which broke away any ice that built up along the front of the wings when airborne. While they provided a quick, easy method of removing ice, they were far from perfect. If ice accumulated farther back on the wings, then the effectiveness of the boots was reduced significantly since they only worked on the leading edge. In addition, boots created unnecessary drag when inflated. Tests performed in 1938 by the National Advisory Committee for Aeronautics (NACA) showed that inflated boots increased drag by 100%, slowing the plane down (Leary, 2003).

In 1934, Johnson proposed a design for a deicing system that was both aerodynamic and easy to use (Figure 2). Instead of using external attachments that caused drag, Johnson's design called for outside air to be brought in through the leading edge, heated by engine exhaust, and then passed through and out the wing to heat the entire surface. At the time, it was thought that using just exhaust would provide insufficient heat, so Johnson's design called for additional fuel to be injected into the exhaust, which would heat it further. However, the extra fuel added unnecessary weight to the airplane, resulting in the design being deemed impractical (Lott, 1934). Even though his idea was rejected, the deicer

that NACA settled on was remarkably similar to Johnson's; the only difference was that there was no extra fuel used to increase the temperature. Compared to the boots, heated wings were seen as a more practical deicer since they were lightweight and housed within the airframe. Johnson served as a test pilot for the heated wing trials in 1941 (Kelly, 1941), and by 1942, a NACA subcommittee determined that heated wings were the best method available and recommended that NACA continue research into their use (Resolution, 1942).

THE STABILIZED APPROACH

Even though Johnson was busy working on deicing systems, he still was able to find time to work on his own projects. Johnson was aware that as the airlines introduced new safety features, the number of passengers would increase. In 1926, one year after the passage of the Air Mail Act, only 5,800 people had flown in an airplane. By 1938, this number was over one million (Norberg, 2003; United Airlines, n.d.). Johnson developed new flying techniques that adapted to the rising number of planes and passengers. One area in need of improvement was the landing procedure, and it was through his work with landings that Johnson earned the most recognition.

Figure 2. Johnson's proposed deicer from 1934, which used heat to remove ice (Ralph S. Johnson Papers, Folder 2, Box 14; photo courtesy of Purdue University Libraries Virginia Kelly Karnes Archives and Special Collections).

At the time, the accepted procedure for landing was to glide the plane in and stall it just before it made contact with the runway (Figure 3). This required a delicate touch from the pilot, as the difference between a smooth landing and a rough landing was a matter of inches. Even though it was in widespread use, this method of landing was ill-suited to the new generation of airliners that were entering service. Not only were planes like the DC-4 bigger; they were now equipped with tri-cycle landing gear, meaning they sat level with the ground. Tri-cycle gear also meant that planes were easier to land on two wheels, unlike their tail-dragging counterparts, such as the DC-3 (Johnson, 1948). With these circumstances in mind, Johnson introduced the stabilized approach in his 1939 training film, "All Weather Flight Methods" (Johnson, 2005).

Unlike the glide and stall method, the stabilized approach required the pilot to fly the airplane down to the runway in a controlled descent by keeping it under constant power, helping to control its rate of descent (Figure 4). Being under constant power also helped if pilots had to abort the landing and try again; they could simply apply power and go back around. The new method also allowed pilots to fine-tune their approach, as they could now choose where they made contact with the runway, compensate for the wind, and correct for any errors (Johnson, 1944a). The stabilized approach also became important in the post-World War II era, as airlines began using jets, which could not be glided in at all and had to be under constant power. Johnson's work with landing procedures helped reduce the inherent dangers of landing, and he continued

Figure 3. The glide and stall method of landing. The plane is flown in a seesaw method to lose altitude (Ralph S. Johnson Papers, Folder 3, Box 15; photo courtesy of Purdue University Libraries Virginia Kelly Karnes Archives and Special Collections).

Figure 4. The stabilized approach introduced by Johnson in 1939. The plane is flown in under constant power to lose altitude (Ralph S. Johnson Papers, Box 3, Folder 15; photo courtesy of Purdue University Libraries Virginia Kelly Karnes Archives and Special Collections).

to refine both landing and takeoff techniques over the next couple of years. By realizing that the airlines would continue to develop and prosper, Johnson helped standardize both landing and takeoff procedures as a way to prevent accidents and adjust to the increasing number of planes that would be in the air. Johnson's efforts to make landings safer and more efficient led the National Aeronautics Association to bestow its Elder Statesman of Aviation Award upon him in 1991, calling him the "father of the stabilized approach" (Norberg, 2003, p. 152).

WORLD WAR II AND THE COORDINATOR

As the 1930s closed and the 1940s began, the airline industry had become a modern, competent form of transportation. The number of passengers continued to climb as airliners became bigger and more technologically advanced. However, with the outbreak of World War II, airlines were called to duty to perform a major—yet forgotten—role in the American war effort. This role was the Air Transport Command (ATC), and like his fellow pilots, Johnson played his part. The work of the ATC allowed the airlines to apply what they learned in the 1930s and change "intercontinental air travel from a state of high-risk adventure to a matter of daily routine" (Bilstein, 2003, p. 33).

The ATC was formed in the aftermath of the attack on Pearl Harbor, when President Franklin Delano Roosevelt authorized the United States War Department to bring the airlines under its control (Larsen, 1945). The attack on Pearl Harbor caught the United States unprepared in many regards, and air transport was one of them. The military lacked a true transport plane and was forced to rely on converted bombers and passenger planes. These planes had limited cargo space and capacity, which hindered their ability to move goods in a timely fashion (Cave,

1945). By July of 1942, the ATC appeared in an official capacity, with the responsibility to ferry planes to Allied-controlled areas, transport personnel and supplies within the United States and Allied-controlled areas, return sick and wounded from the front, and train both transport pilots and maintenance personnel (Palmer, 1947). Like the other airlines, United contributed by flying transport missions across the Pacific Ocean from its San Francisco terminal and modifying planes at its maintenance facility in Cheyenne, Wyoming. Because different climates required different settings for the airplanes, it was easier to bring planes to modification centers like Cheyenne because this allowed the factories to work without having to worry about minor details that slowed production (Cave, 1945).

Johnson split his time between flying across the Pacific and working at Cheyenne. Among the planes modified was the Boeing B-17 (Figure 5), and by the end of the war, United worked on 5,736 B-17s at its Cheyenne base. The modifications performed ranged from the installation of gun turrets (Johnson, 2005) to changing where the intercom control button was located for the gunners. Instead of having to take their hands off of their guns to operate the intercom, gunners could now press a button that was mounted directly on the weapon (Cleveland, 1946). It was while working with the B-17 that Johnson executed a maneuver that helped to cement his reputation as a pilot's pilot. Upon approaching Minneapolis in 1943, he was informed that the runway was frozen over. Realizing the plane needed to be there, Johnson decided that he would have to land despite the icy runway. As the plane made contact with the ground, he increased power to one of the outboard engines, causing the plane to slowly spin around. Once the plane had spun around 180 degrees, he applied power to all four engines, bringing it to a stop. By doing this, Johnson performed what he later called "a little trick"

Figure 5. Boeing B-17. Johnson worked on these at Cheyenne and landed one backward in 1943 (Ralph S. Johnson Papers, Box 3, Folder 5; photo courtesy of Purdue University Libraries Virginia Kelly Karnes Archives and Special Collections).

Figure 6. The flight deck coordinator, introduced in 1944 (Ralph S. Johnson Papers, Box 1, Folder 4; photo courtesy of Purdue University Libraries Virginia Kelly Karnes Archives and Special Collections).

and successfully landed a B-17 backward (He landed a B-17 backward, 1965).

After spending so much time working to fly planes safely at Cheyenne, Johnson turned his attention to an area of the plane that was quickly becoming a technologically daunting array of buttons and switches: the cockpit. In 1944, Johnson introduced the flight deck coordinator, creating a device that took into account the advancing technology of planes and reflecting the airlines' desire to create a standardized system (Figure 6). The coordinator took the different phases of flight and listed them in one long checklist. Each phase was then broken down further by listing the information that pertained to whatever phase on which the crew was working. Once they were finished with one phase, they simply scrolled down to the next one and continued their work. The coordinator split duties evenly among the crew and reduced the mental strain of trying to remember all of the specific procedures and settings (Johnson, 1944b). As postwar airliners became bigger and more advanced, Johnson's flight deck coordinator became a welcome addition to the cockpit as it helped the crew responsibly handle the flood of new procedures and settings.

With the end of the war, the ATC was able to take stock of its accomplishments. Altogether, the airlines flew a grand total of eight billion passenger miles and 850 million "ton miles" of cargo for the Army and Navy (Cleveland, 1946, p. 4). United flew a total of 21 million miles while carrying 200,000 tons of men and supplies. In addition, United trained over 6,000 Army and Navy personnel combined. By the time the war ended, Johnson had logged over 2,000 hours flying transports (Cleveland, 1946). The incredible numbers posted by the ATC would not have been possible had aeronautical engineers like Johnson not spent the

previous decade standardizing their methods to achieve the best results. At its peak, an ATC transport was crossing the Atlantic Ocean every 13 minutes (Bilstein, 2003). This precision showed how far the airlines had come and how they were ready to apply their newly gained experiences to the postwar flight consumers.

CONCLUSION

Johnson stayed with United until his retirement in 1947; afterward, however, he stayed just as busy, being elected to the Wyoming House of Representatives in the 1950s, and starting his own company that fought forest fires and conducted aerial surveys for mining companies. Throughout the 1960s and 1970s, Johnson continued to put his engineering degree to use as he was awarded five patents, including one for aerial chemical dispensers (Wyoming Inventors Database, 2013). In 2008, just shy of his 102nd birthday, Johnson returned to Purdue to receive an honorary doctorate in aeronautical engineering for the "indelible mark he has made on the history of flight during a career that has spanned every facet of military, commercial, and civil aviation from the early 1930s to the end of the 20th century" (Nomination, 2007, p. 5). Johnson passed away on January 12, 2010, at the age of 103.

Over the course of his life, one that mirrored the first one hundred years of aviation, Johnson witnessed both the airlines and airplanes evolve from novel concepts to practical, advanced organizations and machines. Johnson applied an engineer's mindset to become a well-respected figure in the airline industry by seeing aviation's possibilities and turning them into practical applications. Because this was an incredibly demanding task, Johnson earned a reputation as one who could get the job done in a timely and safe fashion. Through his work, Johnson developed systematic innovations that turned complex duties into simple routines and turned the airlines into the standardized, efficient means of transportation that they are today.

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