Blind Landings

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Pilot and writer Antoine de Saint-Exupéry, in his classic novel *Night Flight*, told of a French mail pilot and his radio operator who, surrounded by storms while flying between Patagonia and Buenos Aires, were unable to find a place to land. The pilot’s supervisor, driven by the need to conquer the distance between isolated cities, had ignored the worsening weather and insisted that the mail go through on time. Saint-Exupéry did not recount their deaths; instead, the two men simply vanished from the narrative. Their fictional deaths, like the real deaths that occurred all too frequently in the first thirty years of the aerial enterprise, were counted as merely two more casualties in the struggle to bring about aviation’s great future.

Saint-Exupéry’s novel reflected Charles Lindbergh’s own experience. Lindbergh was flying for a mail contractor one night on the St. Louis–Chicago run in 1926 and became lost in a dense fog. When he was nearly out of fuel, he descended as close to the ground as he dared given the unknown terrain and dropped a parachute flare that he carried for such occasions. He hoped that the flare would illuminate the ground, permitting him to land in a convenient field, but it did not. Using the last of his fuel to climb as high as he could, he jumped out, relying on his parachute to save his life. The next day, he rescued the gasoline-soaked mail from the plane’s wreckage, which a farmer had found a couple of hundred yards from his house. This happened to Lindbergh twice that year.

His experience was not unusual. Virtually all mail pilots in the 1920s had to make forced landings, using holes in the clouds to try to find any field big enough to land their aircraft in to circumvent a crash. A report generated by the Post
Office’s Air Mail Service in 1925 detailed the magnitude of the problem. Between July 1924 and July 1925, the mail service’s pilots made 750 forced landings, 554 of which (77 percent) were caused by the weather.\(^3\) That report’s recommendations set the next decade’s research agenda for the Army Air Service, the airlines created by privatization of the air mail in 1925, the regulatory authority created the following year, and the National Bureau of Standards’ radio laboratory.

Before 1940, researchers called it the “blind” or “fog” landing problem. Inventors, engineers, and scientists of diverse backgrounds proposed literally hundreds of technological solutions. These ranged from the suspension of lit balloons as markers above airfields to the use of high-powered X-rays as guidance beams. The balloon method was popular with British researchers in the 1920s; happily, the U.S. Army Signal Corps checked with radiation specialists before seriously exploring the X-ray proposal. Also popular with inventors were systems based on the perceived ability of infrared light to penetrate clouds and fog, systems using underground cables (and some with the cables held above the surface on poles), acoustic systems, and radio beam systems.

The sheer diversity of proposed solutions to the blind landing problem suggests how large it loomed. Most proposals came from private individuals who submitted them to the Army Air or Signal Corps in the hope that one of the agencies would find their idea worthy and develop it. Several proposals received significant attention from the Corps’ investigators, but few were actually developed into functional prototypes. This book will explore some of these prototype systems. I have not been able to locate documents relating to every prototype, including one that gave important service during World War II. These historical orphans, whose existence is known but whose development I cannot document, will deserve mention in later chapters, but this book is built around documented development efforts. That means, in essence, that it is a history of government-funded development projects, primarily in the United States but also, to a lesser extent, in Western Europe. The majority of these projects followed directly from the recommendations made in the Post Office’s reports, and hence we can trace much of the infrastructural development of commercial and military aviation to the Post Office’s airmail experiment in the 1920s.

Not all blind landing work stemmed from the airmail experiment. World War II produced important techniques and technologies as well. The vast air war the Royal Air Force and the Army Air Forces pursued in Europe relied heavily on the technologies devised to solve the airmail carriers’ problems while inspiring many more, some of which were made available after the war to civil aviation interests. The infrastructure necessary to support all-weather flying in the United States is
thus a product of what a more conspiracy-minded scholar might call a “military-postal-industrial complex” that was joined in the late 1930s by two universities, Stanford and MIT.  

The goal that the Air Corps, the Post Office, and, after airmail privatization, the airlines shared was all-weather operations. They, the privately financed Guggenheim Foundation for the promotion of Aeronautics, and the National Bureau of Standards all exchanged knowledge and equipment to reach that goal. While the United States Navy also pursued blind landings, it kept its research secret and hence had little impact. The same is true of French work. During the 1920s, France pursued a much different set of technologies in secret, permitting only the barest of descriptions to be published and thus having no influence at all in the United States. Germany, in contrast, openly adapted American research after 1932, when it was largely freed from Versailles Treaty constraints. After World War II, U.S. technologies were adopted as the world standard, eliminating the diversity of techniques that marked prewar aviation.

Histories of aviation are often written as quest narratives, and the extant histories of blind landing research are of this type. James Hansen has criticized historians of “going native” when studying aviation and reinforcing the master narrative of linear development and untrammeled success. Failures are thus typically forgotten. The blind landing story has been told in this way in the past. But such an approach disguises a far more interesting story. While blind landings have been achieved, they have not become routine. Instead, the tremendous effort that went into solving the blind landing problem produced an infrastructure capable of supporting almost all-weather operations. Yet the goal, completely blind landings, remained elusive at the end of aviation’s first century despite substantial advances in precision operations. This book thus will investigate a seeming paradox: while scientists and engineers developed systems increasingly able to provide reliable blind landings, pilots and regulators became less and less convinced that routine blind landings were either feasible or even a good idea. The result was that equipment intended to produce blind landings was installed worldwide but was used for a lesser purpose.

This book is both a history of the technologies of blind landing and a history of the idea of blind landings. It will trace the technologies of blind landing—at least some of them—through the cycle of invention, testing, improvement, negotiation, and adoption, while also following the gradual collapse of the concept of “blind landings.” Through following these two threads, this book seeks to explain why the quest for blind landings failed.

When I first began looking into the history of aircraft landing aids, to use the
post–World War II term, I was struck by the use of the terms “blind flying” and especially “blind landing” in the popular aviation magazines and newspaper articles of the interwar period. Living at the tag end of the twentieth century, and jaded with the knowledge that blind landing was simply not done, the idea of attempting it struck me as both dangerous and silly. The safe thing to do if bad weather is predicted at your destination or along your chosen route is stay home, as generations of prospective pilots have been taught in ground school. To facilitate that obvious bit of wisdom, the first piece of national aviation infrastructure built in the United States was an aviation weather network, constructed during the middle 1920s. Yet something drove fliers like Saint-Exupéry and Lindbergh to ignore wisdom and challenge the weather anyway. Understanding why they did so is our first task.

Aviation was the first form of transportation to seek perfect all-weather operations, at least in any organized way. Automotive pioneers made no attempt to make cars and trucks capable of blind driving, no sane sea captain sailed into port in a fog—that’s what anchors are for—and trains quite literally stopped in their tracks when weather became so bad that the engineer could no longer see. These other forms of transportation had one advantage over airplanes in dealing with the weather in that they could stop and wait it out. Once airborne, an airplane must always be in forward motion. Circling to wait out the weather was an option for aircraft, but only within the limits imposed by fuel, as Lindbergh’s story suggests. Hence one could argue that safety motivated the development of blind landing systems, but that argument runs afoul of my earlier safety point: if one’s primary concern is flight safety, one stays firmly on the ground. Since safety issues could be resolved by not flying, safety was not the sole motivation behind the development of blind landing systems.

Saint-Exupéry’s novel suggests both of the primary reasons aviation pioneers sought to achieve blind landings: profit and progress. The profit motive is fairly obvious. Aircraft that sit on the ground produce losses, not profits. One subtext of Saint-Exupéry’s story is the pressure to perform the airmail supervisor placed on his men, both pilots and mechanics. In the United States the Post Office was the original source of the drive to beat the weather. While the Post Office itself was not a profit-seeking enterprise, its leaders intended the airmail service to become profitable so that it could be commercialized, thus forming an economic basis for commercial air service on a national scale. Bad weather interfered with the potential for profitability. Successful commercialization meant that the weather’s effects on aviation had to be mitigated through some technological means. While the weather also interfered with trains, which the airmail pioneers
considered their primary competition, the interference was much less. This was because visibility at ground level is almost never completely absent, while solid overcast at a thousand feet or so is quite common.

Perhaps more important to the profit motive, however, was aviation’s “dirty little secret”: the airplane was not, in a practical sense, faster than trains were when airmail service began. While airplanes might cruise at 100 mph and the iron horse steamed along at only 40 mph, the train still won because aircraft had to stop at night and for bad weather. Trains could travel round the clock, while a wintertime airplane flight had only eight hours of daylight and spent about an hour of that on the ground getting fuel. Worse, mail pilots often found that they might be able to land in worsening weather but not take off again, introducing another sort of delay. Realization that the airplane was actually slower than the railroad was quick in coming. The Post Office tried several remedies beginning in 1920, but the most successful was a string of beacons, in reality extremely bright searchlights on rotating platforms, that it erected during 1923–24 to construct a transcontinental airway able to support round the clock flying. Mail pilots flew from searchlight to searchlight, and most of the original group of mail pilots died doing it. Yet the searchlights fixed the “night flying” problem well enough so that the airmail could beat the trains in good weather conditions.7

Once the Post Office had proven night flying possible and profitable, it privatized the airmail, contracting with groups of entrepreneurs to provide airmail service over the Post Office’s old routes. These entrepreneurs founded the airlines that dominated U.S. commercial aviation through deregulation in 1978. The Post Office provided a deliberately generous subsidy to the airmail companies to ensure the service thrived. The Post Office’s leaders also chose and assigned routes to expand service and prevent excessive competition. Finally, it structured the mail contracts to encourage airmail companies to carry passengers. Passenger service, in turn, demanded that the airlines achieve a much greater consistency of operation than the Post Office did. The mail cared very little if it arrived a few hours late due to bad weather or wound up in a different city than expected. Passengers accustomed to scheduled rail service were much less forgiving. Because the Post Office’s, and airlines’, goal was the creation of economically self-supporting scheduled passenger service, routine blind landing assumed substantial economic potential.

But the dependence of the air carriers on government subsidies (which continued in the United States into the 1950s) raises two other questions. What motivated governments to create these businesses in the first place and, in the second place, to keep them afloat financially? There are several parts to that question,
and they all revolve around the western notion of “progress,” especially the technological kind.

Three historians have discussed the modernist notion of “progress” in the context of aviation, from very different approaches. The first of these is Robert Wohl, who has examined western society’s response to the airplane before 1918. He shows that Americans and Europeans responded to the airplane with enormous emotion once it had, beyond a doubt, been proven true by the Wright brothers’ highly publicized demonstrations in 1908. Wohl calls the enthusiasm that the Wrights’ efforts generated a “passion for wings.” That passion inspired artists, architects, poets, and writers to present the airplane as a cultural symbol, while other young men, and a few young women, devoted their lives to promoting the new technology through air shows, races, and attempts to set speed, distance, or altitude records. Some people gave up otherwise successful careers to pursue the airplane. Briton T. E. Lawrence, who gained fame as the leader of an Arab uprising against the Ottoman Empire during World War I, gave up his officers’ commission and the life of celebrity his exploits had earned him to become a private in the Royal Air Force, believing that “the air is the only first-class thing our generation has to do.”

The airplane’s ability to break free from the earth, if only briefly, enabled it to become the vessel for long-held hopes for human betterment. Historian Joseph Corn calls the belief people like T. E. Lawrence held the “winged gospel”: the airplane would improve the human condition when intercontinental flight permitted the free admixture of peoples and ideas. This, these true believers fervently hoped, would eliminate the misunderstandings they perceived as the causes of war. Corn writes that Americans “viewed mechanical flight as portending a wondrous era of peace and harmony, of culture and prosperity.” The airplane’s ability to evoke such utopian imagery, he argues, descended in part from Christianity. Christian religious symbols, from the Star of David through the angelic hosts to the ascension of Christ, linked Heaven directly to flight. The flying machine, by its very nature, drew on these ancient symbols to stimulate a utopian vision of the future. That utopian aerial future would come about simply through the operation of unimpeded progress.

The religious symbolism of flight also reinforced another traditional thread in American culture, technological utopianism. Corn traces this thread partly to the rise of evangelical Christianity and partly to the sheer pace of technological change in the nineteenth century. In a single lifetime, the development of large-scale production techniques and the deployment of mass transportation tech-
nologies of steamboat, steamship, and railroad had transformed American life. One could not live through such an age without developing an implicit recognition of the power of these new technologies to alter old patterns of life. Those transformations, in turn, fed upon the Enlightenment notion of progress and its seeming promise to deliver social improvement concomitant with the advance of technology.

Corn shows that this vision of “aerial progress” had strong democratic overtones. Belief that the airplane was a force for the spread of democracy ran deep enough that, before 1940, the federal government attempted to develop an airplane for the “everyman.” There was wide public support for the goal of an “airplane in every garage.” In part, this was a reaction to the hated railroad trusts, since personal airplanes could allow the public to simply bypass them. It was also an extension of the public’s response to Henry Ford’s notion of personal mobility. Ford’s own 1925 entry into airplane manufacturing was greeted with enormous enthusiasm by a public that believed he could make airplanes available to the masses the same way he had with the car. He failed, but others kept trying through the late 1940s, when the public’s enthusiasm for the winged gospel finally faded. The dream was kept alive, however, by private fliers’ clubs and lobby organizations, which will be important later in this book.

Yet there was more than one possible “aerial future” implicit in the winged gospel’s vision. While Corn focuses on the mainstream version, he briefly acknowledges a minority thread within the vision: the airplane as mass transit. This was the vision held by Otto Praeger, the assistant postmaster general who built the initial airmail service; by Herbert Hoover, who as secretary of commerce helped produce the initial air carriers; by entrepreneurs like Great War ace Eddie Rickenbacker, who headed Eastern Airlines; by the near-legendary William Boeing, whose two air-related startups, Boeing Air Transport and Boeing Aircraft Company, eventually became the two largest businesses of their type in the world (United Airlines and The Boeing Company, respectively); and by investors like Henry Ford, William A. Rockefeller, and Cornelius Vanderbilt Whitney. The airplane-in-every-garage was not at all what they perceived in the airplane. Instead, they imagined a ticket counter in every drugstore. This commercial vision of the airplane-as-mass-transit was much more important to the development of blind landing systems than was the more populist democratic vision. The drive to maintain reliable, scheduled service provided the direct impetus for many of the innovations this book documents. It was the commercial version of aerial progress that motivated government support and regulation of aviation in the
early years, too, most clearly reflected in the Post Office’s involvement, in the placement of aviation regulation in the Department of Commerce, and in the foundational legislation’s very title: the Air Commerce Act.

Missing from Corn’s book entirely is a third thread that was an inherent part of the aerial future: the airplane-as-ultimate-weapon. This was the dark side of aviation, recognized much more strongly in Europe than in America. Frenchman Jules Verne recognized the potential well before the Wrights actually flew, and British and Italian strategic theorists generated the doctrine known as “strategic bombing” during and after World War I. Yet plenty of Americans recognized, and approved of, this version of “aerial progress.” Most famous among them was Brigadier General William Mitchell, whom the U.S. Army eventually court-martialed for publicly criticizing army aviation policy. Many historians of military aviation have documented Mitchell’s public promotion of the airplane-as-weapon and his quest for a military air arm equal in stature (if not superior) to the army and navy. Seldom explicitly acknowledged was that Mitchell’s proposed Department of Aviation would have placed all aviation under military control, a very different vision of aviation’s future and one that General Henry “Hap” Arnold tried again to achieve in 1942 by working to militarize the Civil Aeronautics Authority. Civil pilots and the airlines were vehemently opposed to military rule, although it was the navy’s refusal to release the many naval reservists within Civil Aeronautics Authority to the army that directly blocked Arnold’s attempt at domination. Mitchell’s and Arnold’s military vision of the aerial future was thus diametrically opposed to the ideal of democratic aviation because it envisioned centralized control over all aviation activities in the United States.

These three visions of aviation’s future mostly manifested themselves in conflict over infrastructure. While one could design individual aircraft for specific purposes, the enthusiasts of the air all agreed that only one infrastructure to support aviation should be built. The selection of technologies for that infrastructure became the most hotly contested part of aviation development because advocates promoted technologies that “fit” their vision of the future. The plethora of blind landing system designs created during the interwar period provided wide latitude for this politicized process of selection to operate. On some occasions, the process of resolving disputes over blind landing system selection took the form of negotiations. In others, disputants resorted to congressional politics to get their way. Differing visions of aerial progress thus directly affected the development and deployment of blind landing systems.

In a recent book, historian Eric Schatzberg has investigated the role played by belief in what he called “the progress ideology of metal.” He argues that belief in
this ideology, which promoted metal as the “modern material” in contrast to old-fashioned wood, caused aircraft manufacturers, regulators, and purchasers to demand all-metal aircraft after the Great War. They did this despite what he calls the technological indeterminacy of the situation: researchers were never able to demonstrate convincingly that either material was superior in terms of strength, maintainability, or ease of manufacture. Schatzberg contends that this inability to prove objective superiority left a “social space” in which ideology could operate to influence the research agenda. A similar analysis can be applied to the case of blind landing systems: several systems worked about equally well. None could be proven superior, and that lack of objectively demonstrated superiority allowed the three competing visions of aviation’s future to influence the selection of blind landing systems.

Besides ideological motivations, there were several other major influences on the development of blind landing systems. “Nature” gave inventors, engineers, scientists, and entrepreneurs no end of trouble, and early hopes for a quick solution to the blind landing problem collapsed as the magnitude of nature’s impact on the operation of these systems became clear. Both what William Cronon has called “first nature,” the natural environment, and “second nature,” the human-built environment, caused problems in roughly equal measure. It would be too much to claim that these inventors negotiated with nature to achieve success, but they gradually learned that a rather intimate understanding of the effects of both regional and local operating environments, and a close tailoring of both the equipment design and specific, local installations to those conditions were necessary to achieve even a possibility of success. Systems that could not be tailored to local conditions were early casualties of the selection process. Even the mature, more flexible landing system adopted worldwide after World War II could not be tailored to all existing localities, and a great many airfields worldwide therefore cannot use it. While progress ideology was important as a motivator for technological change, “nature” influenced the technologies at a very detailed level.

So too did that amorphous, hotly debated thing called “human nature.” I argue that the blind landing quest’s failure was not an engineering failure but a human one. Scientists and engineers achieved technological systems capable of blind landings, a reality evident to anyone familiar with “smart weapons” and robot aircraft, both of which were in use by the waning days of World War II. If one can make a bomb find its own way to a target the size of a ship, one can certainly make an airplane find its way to a much larger runway. The first transatlantic flight of a fully robotized aircraft duly occurred in 1948. Yet by this time the very idea of blind landings had vanished from the literature, replaced on the orders of
the armed services and the Civil Aeronautics Authority by a new term, “instrument approach.” Flying and landing an aircraft “blind,” using only the instruments provided in the aircraft, was ultimately an act of technological faith. The evangelists of blind landing discovered to their dismay that average pilots and regulators had come to believe that no machine was trustworthy enough to actually land an airplane without visual verification by the human crew. Hence the final thread in this history is a social one. Pilots were the arbiters of technological progress in aviation: technologies that did not earn their faith vanished; those technologies that succeeded are still with us. Faith was neither automatic nor absolute. Pilots had to be convinced to trust their equipment enough to fly blind. Most never achieved that level of trust, however. Faith had its limits, and we must therefore examine how pilots, not just the famous great pilots but ordinary fliers as well, responded to these technologies to get at those limits. This also means we must examine the development of procedures for the use of blind flying and landing technologies, because building reliable procedures and training pilots to use them were key elements in the production of pilot faith.

By the end of World War II, the majority of the technologies of the modern air traffic system had been developed in the course of efforts to produce all-weather operations. Yet individual technologies were insufficient to solve the weather problem. What no one foresaw before the war was the need for integration. Wartime operations made that clear to aviation leaders, who began to make progress toward integrated airport approach and landing control in the late 1940s. The effort stalled out as the nation returned to prewar levels of budget stringency, but the immediate postwar effort included all of the prewar developments, radar derived from wartime programs, and, in a complete rejection of blind landing, runway lighting. With the exception of digital computers, this suite of technologies was the basis of the modern air traffic system, deployed nationwide after a series of catastrophic accidents created renewed political pressure for reform.17 While the construction of modern air traffic control is beyond the scope of this work, its roots are in this immediate postwar drive for integration.

The book begins with an examination the development of blind, later called “instrument,” flying, to argue that the development of technique was as important as the development of technologies for flying blind. In Chapter 2, I explore the relationship between airfield design and blind landing systems, to argue that the conversion of paved runways in the United States during the late 1920s rendered one possible blind landing system unusable. The early history of the current “instrument landing system” is the subject of Chapter 3, which argues that the instability of early versions helped delay the system’s adoption while forcing
engineers to innovate to stabilize them. Chapter 4 examines one potential solution to the instability problem, microwaves, pursued jointly by Stanford, MIT, the Army Signal Corps, the Civil Aeronautics Authority, and the Sperry Gyroscope Company, in the context of disputes and negotiations between government agencies and airlines over whether to adopt improved versions of the original National Bureau of Standards system as the U.S. standard or the microwave system.

World War II serves as a major division in the book. The European air war marked the first attempt to use air power in all weather conditions, and the Allied forces quickly found that they needed a blind landing system—or several. Chapters 5 and 6 each examine the development and deployment of one such system, one using ultra-high frequencies (UHF), which eliminated the microwave system that had appeared so promising in 1939, and a radar based system that became famous as “ground controlled approach.” Chapter 7 traces the postwar fight between supporters of these two systems over which to adopt as the national standard, to argue that the struggle represented a conflict between two very different visions of aviation’s future. Chapter 8 examines the transformation of the two systems into an almost-all-weather system of landing aids, marking the final acceptance that routine blind landings were simply not humanly feasible.