FROM CLEAR SKIES TO ALL - WEATHER: THE EVOLUTION OF THE U.S. ARMY'S OPERATIONAL CAPABILITIES

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DOI: 10.19062/1842-9238.2024.22.1.7

Abstract: *Nowadays, within the Air Force, pilots train for instrumental flying in adverse weather conditions. The instrument flight program developed by the US military over 30 years ago, from the end of World War I to the late 1940s, is still in use today in many pilot training programs around the world. During the development of this program, the military was at the forefront of technological development.*

Keywords: *instrumental flying, training programs, simulator, military aviation*

1. INTRODUCTION

Military organizations do not generally adopt technology and doctrine hastily. Innovation in the military is an evolutionary process, but it is inconsistent. The attitude of military personnel, availability of funds, technological advancement, operational requirements, and other factors control the speed at which an idea is accepted. This is also valid for contemporary fundamental ideas, such as that an airplane should be operational regardless of the prevailing weather conditions.

In this manner, the instrument flight program developed chaotically due to the factors listed above. The evolution process lasted almost 30 years, with the first phase being non-existent and the terminal phase becoming necessary. It began as an experiment in the 1920s, trying to evolve into operational based on a training program in the 1930s. Finally, in the late 1940s, it succeeded in becoming mandatory in the pilot training program for large-scale operations and flying in unfavorable weather conditions.

Instrument flying fully evolved in the late 1940s because the instrument management and training program of that period was very similar to that used today. Specifically the main characteristics of instrument flight in military aviation are:

• All pilots must fulfill a minimum number of hours per year and periodic examinations, both written and practical, to maintain their rating;

• Out of 190 flight hours for a pilot in training, approximately 40 hours are dedicated to instrument flight, to which the theoretical courses are added;

• The use of simulators is frequent, requiring 30 hours of practice.

This study aims to show the impact of this program, the evolution of the main elements, the instrumented aircraft, the pilots who tested the program and built the training plan, the evolution of the training programs, and the military operations that showed how effective it is. The program lasted three decades, during which the military gradually adopted instrument flight. The military was quite reluctant to adopt large-scale and rapid changes, so they partially implemented specific techniques until forced by a special event.

The army implemented this method for several times until the program became mature and reliable. This plan had three significant parts divided for each decade. Hence, after World War I, the army became permanently included in aviation. In the early 1920s, with the advent of permanent military aviation, it quickly began to develop navigational instruments and techniques. Pilots and engineers worked closely together on radio navigation, flight instruments, and airways. At the same time, the Air Force did not adopt instrument flight, even if it accomplished massive developments in the field, so aviation remained operational during daytime only, flying just in relatively good weather conditions.

This changed in the 1930s when it was recognized that the technology was perfected enough to be implemented; this was also supported by Jimmy Doolittle and William Ocker. Thus, the introduction of the limited instrument flight program for pilots took place. In 1934, the Air Corps took over airmail; this was a setback for aviation, demonstrating the poor training of pilots for instrument flying. After a number of 66 plane crashes and forced landings, military aviation began to take instrument flight much more seriously, increased the number of training hours, and introduced flight instrument management. It was also during this period that strategic bombing was introduced into the doctrine of war; this struggle made pilots obliged to be able to fly instruments. These changes were complicated to implement due to logistics. In the late 1930s, aircrew were trained to fly in all weather conditions, but this was seen as redundant and not a combat requirement by the crew. The pilots were not well trained and the program did not prepare them to be operational pilots in all weather conditions.

The Second World War showed the problems of the instrument training system with the advent of large-scale operations such as the bombing of the European Campaign. The US Air Force had to reorganize the entire program in the shortest possible time, implementing it for students and all Navigant personnel to meet operational requirements. The effort was successful, so the Army Air Corps was reborn after the war as the United States Air Force with all-weather personnel and training system, and the necessary infrastructure to continue operations. The training system remained in continuous development and refinement. In 1948, during the Berlin crisis, when it was blocked, and the only access point was by air, the importance of instrument flight became undeniable, not only for bombing campaigns. There was no incident, and this express the excellent training of the aircrew and the fact that the instrument training program has become viable and well-rounded. This training system is still applied today with minor differences.

2. THE TWENTIES

Throughout the twenties, the air services conducted more research into flight instruments but did not equip them in aircraft or aviator training in all flying conditions. There were several reasons why not much progress was made. Flight instrument technology was valid but not highly developed, especially navigation equipment. Many aviators were not enthusiastic about flying through the clouds. They learned to fly in World War I without the aid of instruments. They either did not trust instruments and flying through clouds or were pilots who believed they could fly in weather without artificial aids.

This problematic state changed by the decade's end when the Air Corps inaugurated the first pilot training tool. A combination of engineering achievements and the efforts of military instrument enthusiasts brought about this change. Improved technology made the all-weather flying routine possible and pro-instrument pilots convinced the hierarchy that

it was time for the Air Force to have the all-weather capability. The first requirement was the presence of advanced technology.

In the 1920s, the Army established an Instrument Section at McCook Field, Dayton, Ohio. The Instrument Section worked with instrument manufacturers and government agencies to develop flight instruments and determine Army requirements. Pilots and their engineers perfected an innovative flight instrument, the pitch and turn indicator. This device, first produced by the Sperry Company in 1918, consisted of an operational gyro needle that indicated the direction of turn and a steel ball in a glass tube (like a pendulum) that stated the inclination. After testing and improvement at Dayton, the pitch and yaw indicator became the primary control instrument for the first time in two decades of flight instruments. It allows pilots, for the first time, to control precisely their aircraft when they cannot see the horizon.

The development of radio navigation during this decade made the first all-weather airway and large-scale air operations possible. At these agencies' request, Air Services cooperated with the U.S. Post Office and the Department of Commerce in developing commercial application equipment. Early in the decade, the Air Service opened the first airmail routes before civilian entrepreneurs took over and publicized the first airways in the United States. In the late 1920s, these government projects produced radios, aircraft receivers, and cockpit visual and audio indicators. This equipment made weather navigation reliable for the first time and was quickly put on the market. These advances resulted from the work of many people, military and civilian. Many military engineer pilots who became known for their work were early proponents of instrument training. Lieutenant, later General Alfred F. Hegenberger, and Lieutenant, later General James H. Doolittle, were two supporting trainers from the aviation engineers.

Hegenberger worked in the Instrumental Section at McCook from 1919 to 1933, except for three years in Hawaii. During this period, he played an essential role in all the projects in this section. He designed the first standard displaying instrument for the military and built the first instrument with a landing system. The first attempts at radio-navigation flight in the U.S. were in June 1927 (the radios failed, but the crew survived) and the first instrument flight in May 1932. In 1934, Hegenberger was awarded the Coller Trophy, an international aviation award for his achievements and experimental work. He was also the first to recommend instruments and navigation training for military pilots in 1923. He later designed and taught the first Air Corps instrument-training course, but these were for specialists, not all pilots.

James H. Doolittle is one of aviation's most famous pioneers. His instrumental flight experiments are only a tiny part of his glittering career. In 1928, the Air Corps loaned Doolittle, who was already a public figure participating in aerial and endurance events such as air racing, to the Guggenheim Fund for the Advancement of Aeronautics. Doolittle's job at the lab was to find a way to land a plane through the fog. He and his associates spent a year building and testing instruments and radio-landing equipment. Their work was completed on September 24, 1929, when Doolittle made the first fully instrument-based flight. He took off, steered his aircraft through a predetermined route, and landed using only instruments. Doolittle's cockpit was covered with canvas, but in the other seat was a safety pilot, who was there in case of an emergency. This was hailed worldwide as a step forward in aviation safety and a demonstration that flight instrument technology had developed since the beginning of the decade.

In his summary of his work at Guggenheim, Doolittle confidently recommended that the Air Corps equip aircraft and train aviators for instrument flight. The new devices and techniques were not left in the laboratory; they were immediately exposed to the market.

Entrepreneurs quickly took advantage of the possibilities offered by the civilian development of flight technology. In 1926, the Bureau of Air Commerce intended to increase the development of the aviation trade and succeeded. He placed the commerce department in charge of creating airlines, airports, navigation facilities, and weather instruments for operational airlines. In the early 1930s, there was an extensive system of publication of flight lines consisting of radio-navigation signals, light beacons, emergency landing fields, and weather stations.

Later, the instruments acquired procedures according to the radio signals. They were developed to accept normal flight traffic in the cloud-covered airport. Commercial passengers and airmail operators at night and in inclement weather were routine in the late 1920s.

Despite the rapid development in which it participated, the Air Force remained in the experimental stage during the 1920s. It did not provide instrument flight training or require pilots to practice flying in weather conditions. It was a rise of operational pilots, not experimental engineers, who believed that instruments were crucial for poorly prepared pilots who could not master the true art of flying. The most critical instrumental lawyer was Captain, later Colonel William C. Ocker.

Ocker became a believer in instruments from World War I when, after several near-disasters caused by flying in clouds without instruments, he discovered that he could easily control an aircraft using a turn and slide indicator. Since then, he has not flown without one. He obtained his version, which he attached to the wing of any plane he flew. Ocker came to believe that the Air Corps lost many aircraft and aviators due to incompetence in flying in various weather conditions. The military stations of those times were suggestive but not conclusive. Since the Air Force did not train or operate in instrument conditions, instrument flight was not one of the customary categories that Air Service accident investigators recognized. It was considered that accidents were caused by lack of experience during flying and bad weather conditions; therefore, weather was a cause category. For example, during 1921-1922, 18% of all accidents occurred when the weather was unclear, and weather was determined to cause 5 % of accidents. At the same time, 55 % of accidents were not investigated, or the cause was determined for unknown reasons. Based on his experience, Ocker knew that pilots losing control of their aircraft during their attempt to fly through the clouds without instruments was the cause of this large number of unknown reasons.

In 1926, Ocker discovered a way to demonstrate that flight instruments were a necessity, not just a support for instrument flight. From that moment, he became an essential man in the field of military instruments. His discovery happened by accident during his annual physical flight. One of the flight tests consisted of rotating the pilots in a chair called the Barany chair and then stopping it almost instantly to determine how quickly their eyes recovered and focused. Dr. David A. Myers added a demonstration to the Barany chair test. He observed the pilots spinning while blindfolded. The intention was to show that, with sight, the sense of balance could be easily understood. Blindfolded, the pilots quickly lost track of the direction of rotation and could not feel the difference in acceleration or tell when the seat had stopped rotating. Ocker took the balance test, became disoriented like other pilots, and decided to try his experiment. He placed his yaw and pitch indicator in an opened box and tried the test again, this time watching the needle turn. He found that the flight instrument kept him oriented the whole time. This solidifies that pilots relying on their senses and experience was a myth. The human body cannot sense where it is going without sight. Pilots need help through instruments to fly when they cannot see out of the cockpit.

Armed with his ideas and his toolbox to prove them, Ocker became a crusader. He and Dr. Myerz reported their findings to the War Department, and Ocker began offering tours of the Barany chair to all interested pilots, both civilian and military. He also published articles, gave speeches, and developed additional records. In testing pilots between 1929 and 1932, Ocker found that 3% could maintain control of an aircraft for more than 20 minutes during flight in bad weather conditions. One aircraft, after reviewing Ocker's records, adopted instrument training and reduced its weather cancellation rate to less than 1% on specific routes.

Ocker's intention was not entirely to demonstrate that the instruments were necessary for flight operations in weather conditions. He wanted the Air Corps to add flight instrument training programs. While stationed at March Field, California, and Brooks Field, Texas, Ocker designed a program and trained a cadre of instruments. In 1932, Ocker and one of his assistants, named Carl Crane, published one of the first books on flight instruments. To supplement his flight training, Ocker designed and built devices to aid his training. Among them was an improved version of his demonstration needle return, which won a $1000 award from the National Aeronautical Certification Committee and was the first non-visibility flight instrument. The hood was a fabric device that enclosed the aircraft's cockpit to allow the pilot to simulate flying through clouds. Ocker also tried to build a machine that could simulate instrument flight without leaving the ground; he was unaware that a genius mechanic named Edwin Link was making the final changes on a working simulator that would later revolutionize training tools. In the late twenties, Ocker petitioned the Air Corps several times to adopt his training program and the equipment with it, but his proposal was not accepted.

Interest in flight instruments increased in 1930, when Ocker won several conventions in the Air Corps and the aviation community, gaining much publicity. The head of the Air Corps, General Lahm, was aware of Ocker's work but also of the fact that foreign airlines and companies were training their pilots with flight instruments. The program was for advanced students, being short and limited, but it was a start.

3. THE THIRTIES

The 1930 instrument program was more like an introduction to flight instruments than a course of Instruction. This program consisted of approximately 10 hours of flying (5% of the total hours a pilot must complete) and two hours of ground training. All students started with straight level flights and easy turns, progressing to more manoeuvres such as climbing, descending, and steep turns. Later in the course, they mastered solo instrument flight and compass orientation. In addition to all this, the students also practiced acrobatic maneuvers. This implementation was complex as there were not enough training aircraft to be equipped with flight instruments and no user manuals. Since instrument flying was new to the Air Force, the need of more qualified personnel was prioritized.

The Air Corps implemented an instrument technique based on the turn and pitch indicator. This was called "1, 2, 3", "A, B, C" or "x, y, z" depending on their variation. These procedures taught students that each aircraft's control surface (aileron, elevator, and rudder) corresponded to a single instrument indicator. For example, the rudder controlled the yaw with the A, B, and C methods. Each one was corrected or changed, thus creating a vicious circle. Student pilots were warned to avoid attempting to visualize the aircraft's position as this imposed step would slow down the process; the glide and airspeed indicators were understood after more practice. These were the best options until the advent of artificial horizons (now called altitude indicators), which were on the market but not widely available in the early 1930s.

In addition to being able to introduce an instrument course into the advanced training program in 1930, the Air Corps mandated that all pilots complete a minimum of instrument flight hours per year. However, instrument-equipped aircraft and instructors were rare in operational units as well as in training units. In addition, the pilots' lack of motivation to master the instrument flight was caused by the absence of flight controls or procedures that assured them the preparations were complete. The Air Corps did not take instrument flying seriously then, remaining only a daytime service. The Air Corps concentrated on traditional flying methods.

In 1934, President Roosevelt fired the airmail operators and gave the jobs to the Air Corps. General Benjamin Foulois accepted the mission immediately. Although he was aware of the limits of instrumental capacity, he worried about restoring the budget that had been consumed countless times. The Air Corps chief saw the mission as an operational test for the Airmen and a chance to show their capabilities. The requirements became challenging despite the General's reasons for accepting this assignment. The Air Force must operate for the first time in history under all environmental conditions and time pressure.

The Presidential Directive gave the Air Corps 10 days to prepare. The demands were so great that aircraft, pilots, and technicians had to relocate and prepare. This preparation included enormous efforts to install the instruments in the aircraft and prepare the training routine in adverse weather conditions for the mail flight line crews. A major drawback was that all this happened in the middle of the deadliest winter.

After a week of flying, numerous crashes were announced, their total number being eight destroyed aircraft, including five dead pilots and six in critical condition. The Roosevelt administration criticized the Air Corps. Thus, the military imposed much greater security measures for the operation, which reduced airmail services to a fraction of what the airlines delivered, therefore having to suspend operations so that the pilots of the instrument-training airline could be called in to assist the flight airmail. Fifty-two pilots flew missions in military aircraft. In June, at the project's final, there were 66 accidents, 12 fatal and 15 serious injuries.

A War Department investigated the project along with the entire Army program. The fact that many accidents were caused by weather and darkness played an essential role in the committee's findings. The investigators recommended that Air Corps pilots receive more flight time and training, which includes more darkness and bad weather. The Air Corps was also ordered to equip the aircraft with all the instruments used by the flight lines.

The Air Corps did not wait for the committee to find everything. In May, while the airmail operation was still in progress, instrument training was doubled for students, adding a 10-hour course in addition to the normal one. The curriculum ended up being remarkably similar to the advanced program. Students practiced basic and advanced maneuvers, navigation, and radio navigation if the facilities were in order. Instrument flying at that time covered 10% of the Air Corps' training pilot schedule.

Another consequence of the airmail episode was the significantly increased funding of the Air Force. From the budget allocated to them, the Army could buy many more high-quality instruments, equipment, and radios for aircraft. In April 1935, the Army ordered all joint training and attack aircraft to be equipped for instrument flight. In 1936, radio equipment was installed in all tactical aircraft, and in 1937, all Air Corps aircraft, except single-seat fighters, were equipped with flight instruments. The purchase of these instruments reflected the changing attitude toward flying instruments, and all of this resulted from the airmail mission.

The Air Corps decided in 1934 to monitor the instrument flight efficiency of all pilots, not just students. At the beginning of 1935, the minimum number of hours in instrument flight for all aviators was set at 10 hours annually. In addition, that same year, the Air Corps initiated a check to test all pilots' knowledge of the instruments. Every pilot should take an evaluation exam once every six months. Furthermore, commanders supervised the pilots to ensure that all practice hours were done according to schedule. These procedures constituted the first instrument flight management system. They illustrated the dramatic change in attitude that took place in 1934. Instrument flying was in this way seen as an essential skill. All pilots had to be competent for this type of flight. The Air Corps was on its way to becoming an all-weather service.

The need for all-weather service did not just grow out of the airmail mission, as there were other factors at work and observable changes in air doctrine. Strategic bombing became an essential part of the Air Corps' plans for the war. Along with its requirements for protective, long-range missions, strategic bombing involved the possibility of flying through clouds because weather conditions were rarely favourable over a large area. By 1935, the Air Corps tactical school emphasized instrument flying, close navigation, and formations, all necessary for bombing to reach the intended target. A tactical school study of the period showed that while storms immobilized ground and naval forces, aircraft, if well equipped, could operate in precipitation, high winds, and no vision. The required equipment included flight instruments, radio navigation, communications equipment, and an autopilot to maintain a proper course. This method of attack was of great help and, at the same time, showed that instrument flying had taken a permanent place in the Air Corps' thinking. Limited daytime and clear-sky operations have become outdated, at least on paper.

By the decade's end, the Air Corps had become the Army Air Forces (AAF), and instrument flying was well established. Annual instrument flying requirements rose to twenty hours a year, but when World War II began, the requirements dropped, and this type of flying became routine for new cadets. The pilot training curriculum has expanded to three phases: primary, standard, and advanced. Each stage includes instrument flight.

There was also an extension of instrumental training. The primary and advanced students flew the Link Trainer for fifteen hours, which had just become available. In Link, they could practice instrument manoeuvres and improve their flying technique without leaving the ground. From then on, all pilots will become familiar with Link and its following versions. Although the simulator had just arrived, it quickly became essential in pilot training. It enabled the expansion of instrument work that was much cheaper and safer than aircraft training.

4. LINK TRAINER

The Link Trainer was named after its inventor, Edwin Link. Mr. Link was the only one qualified to build the first working flight simulator. He was an expert engineer and mechanic who worked in his father's piano and organ factory. He was an aviator who learned to fly in the storm era in his spare time with whatever money he could scrape together. The high cost of flight training led Link to build a device that could replace some of the expensive flight hours required to learn the basics.

Link built the first simulator in 1929. It was constructed from a miniature replica of an aircraft (consisting of bushy wings and a tail section) mounted on a gimbals. The stick and rudder pedals in the cockpit activated a set of air cushions (no doubt inspired by Link's old career as an organ builder), which caused it to roll and pitch like an aircraft in flight.

During this time, Link piloted his flight school in Binghampton, New York, and used the simulator to teach students essential control of an aircraft without leaving the ground. This reduced the flight time required to acquire the license and lowered costs. In 1930, using the simulator, Link could allow a student to fly solo with 2 hours of flight compared to 15 hours for his competitors.

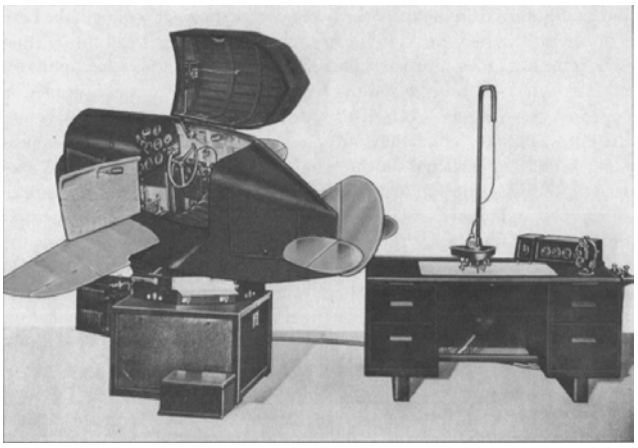

FIG.1 A Link Trainer device with the instructor's desk [3]

In addition to teaching, Link's business includes air service, such as air deliveries. To expand his capabilities, he obtained an instrument rating. Once Link was an instrument pilot, it was not long before he added a dashboard and flight instruments to the simulator and brought the first instrument simulator to market. That happened in 1931 when the aviation industry was unprepared for such a revolutionary concept. As a result, the Link Trainer was used in amusement parks for many years until it was taken seriously.

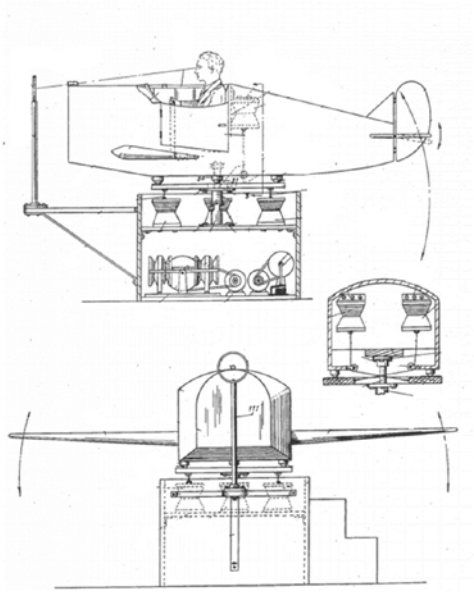

FIG.2 The sketches of a link trainer device [3]

Eventually, the word spread, and in 1934, the Air Corps, very interested in instrument training after the airmail flight, ordered six Link Trainers, initially Link. They were training a single group of pilots. At first, Air Corps orders were slow due to a lack of funds. However, other agents and government officials, realizing that the device offered a real-world experience at a fraction of the cost and without flight risks, steadily ordered

trainers in the 1930s. The US Navy, Civil Aeronautics Administration, airlines, and Air Forces of Germany, Japan, England, Russia, France, and Canada bought Link Trainers before World War II. The savings were numerous; Link used about 5 cents an hour of electricity compared to $10 for aerial training fuel. The Air Corps, which took over instrument training for good in the mid-1930s, made the Link the standard for pilot training in 1936 and continued to purchase them as funds permitted. By 1939, the army owned 40 Links (by comparison, the British Air Force had 200 simulators in 1939).

The US Air Force has found that simulator training can be economical in several ways. In 1939, he opened his first enlisted Link instructor course. Using enlisted instructors to teach instrument procedures (Link was primarily used for procedural and hands-on training) was cheaper than delegating pilots for coaching. During the war, hundreds of Link Trainer instructors were used to teach the prominent classes of pilots.

At the start of World War II, all Link production was reserved for the military only. Between them, the Naval and Air Forces bought 7,316 Links by 1945. The investment was worth it. The Air Force estimated that after the war, it saved 243 lives, $78,839,441, and 15,142,953 hours per year using the Link to train war aviators.

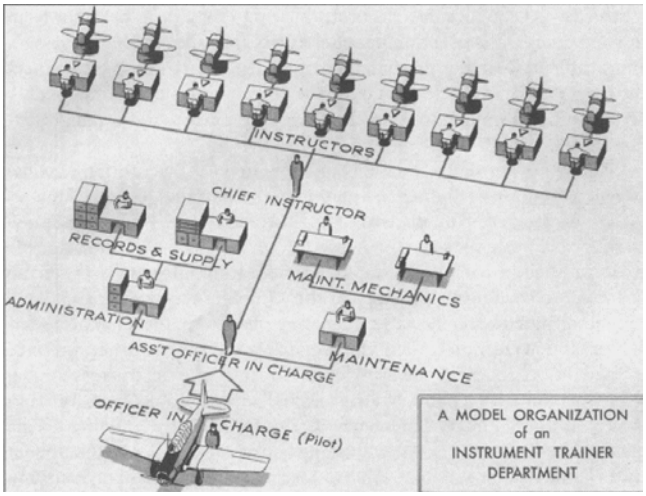

FIG.3 A model for organizing a pilot training department [3]

The trainers used in the war were quite different from the crude device of 1934. Edwin Link constantly updated the simulator, adding more capabilities and accuracy to an actual flight. The 1934 "A" model presented students with only the base. It had a compass, an airspeed indicator, a vertical speed indicator, a turn and pitch gauge, and a headset for receiving radio aural signals for navigation. Neither the Model A's instrument panel nor its flight characteristics resembled a real aircraft. It was just procedural training for memorization and practice; actual flying was learned in real airplanes.

During the war, Link Trainer's sections were organized as separate units into small groups with their administration, maintenance, and instructor divisions. The students were going through an entire course of instrumental training. They would start with the basics of controlling the aircraft, as they would in the flight program, and then learn complex manoeuvres and navigation using the aural radio range and other navigation equipment. The course also contained instruments for holding the landing slope and extensive instruction on radio communications. The course was comprehensive, covering every phase of instrument flight. The simulator has evolved from a simple introductory training aid to a complete and complex training system. Naturally, the possibilities of this simulator technology were not limited to instrumental training for students.

Edwin Link built various training devices for the military during the war. There were gunnery instructors, bombing instructors, navigation instructors, and even a bomber crew where the pilot, co-pilot, navigator, and bombardier could simulate an entire mission. Simulators were becoming specific to the weather.

By the 1950s, simulators were a staple feature of flight training. The Link Company produced combat simulators where crews could practice engaging and destroying enemy aircraft. There were also bombing simulators and transport simulators. All new aircraft had a proper simulator.

5. THE FORTIES

World War II began for the Air Force Training Command in 1939 when the War Department purchased several flight simulators. The first production run started with less than 300 examples in the 1930s. This rose to 4,500 a year, and with war approaching, the rate rose rapidly from 7,000 to 12,000 and finally to 30,000. This increase continued until 1943, when it reached 102,000, and the new training plans were detailed even without approval.

Pilot training has changed drastically. The duration of the three phases of the program has been compressed to increase effectiveness, and thus, the AFF has reduced the duration of drop training from one to seven months. Civilian contractors handled primary training, while the military focused on basic and advanced training.

Over the three phases, the student pilots flew 205 hours in the 1942 training program, including 30 hours of instrument flying. In addition to the 30 hours of instrument training that covered 15% of the flight, another 30 hours spent in the Link Trainer were added. Instrument flight hours were increasing for cadets training to fly in combat aircraft. For example, bomber pilots trained an extra 20 hours. Wartime weather predictions proved accurate, so pilots had to prepare for all weather conditions.

Disquiet over the instrument flying of AAF pilots had existed since the beginning of the war. A military investigation in late 1949 found that trainers were unqualified, training was irregular, and pilots completing the course lacked confidence in their abilities, thus disliking instrument flying. The AAF was also criticized for the fact that their program focused on trivial elements instead of focusing on gyroscopic instruments. A specialist training command blamed unqualified instructors and neglect of cadets for all the problems at a conference. During the meeting, Joe Duckworth emphasized that the AAF treats instrument flight training as an insignificant phase. Cadet training from 1943 reflected the problems and attitudes the AAF wanted to overcome, so all squadron commanders ensured that instructors were fully aware of the importance of instrument flying. The results that superiors wanted required changes in training systems.

To improve the instrument flying situation, the AAF took several actions in 1943, including schools for instrument instructors, a new program for instrument flying, and a standard method for flying by altitude indicator.

Unfortunately, adjusting the flight methods to the altitude of the gyro indicator remained a problem, as it had been part of the ship's standard equipment since the early 1940s. General Yount complained about the pilots' inability to use the gyroscopic instruments and the negligence of the equipment because the cadets were not familiar with the procedures. The general ordered aircrew and mechanics to familiarize themselves with the new instruments. All this made up a start but not a training program.

A much easier system to master was the whole panel system. The pilots could visualize the aircraft's altitude much more easily with the help of all the instruments, but mainly the artificial horizon.

Students learned to associate altitude with instrument indications. The Air Lines and the Navy were teaching aircraft control panels before the AAF. The director of training at the AAF engineering school, Col Joe Duckworth, knew the techniques well enough to apply the training syllabus to his students at Mississippi in 1942. In June 1943, the AAF standardized the control panel syllabus due to its success.

In 1943, the AAF took further steps to integrate full-panel flight and improve instrument training. Therefore, the AAF ordered a set of professional tools to cover every stage of the program, from basic maneuvers to landing the aircraft. In addition, in 1943, the AAF built schools for training instructors. Later, there was a school of instruction for each secondary training command.

In addition to revising pilot training, the AAF also changed procedures for operational pilots, and from 1943, all necessary instruments had to be on board ship. Each pilot must receive a certificate each year to maintain its instrument rating. To obtain the certificate, the pilot must pass a written test and a flight test through which he must do all the basic maneuvers. The certificate was of two types: white to green for the experienced. Pilots holding a green certificate could fly in worse weather conditions with fewer restrictions. The two categories of pilots were necessary because of the diversity of flight instruments.

In addition to being challenging to get used to, the new 1944 program revealed the problems of the mid-war era. For the pilots to be able to participate in the war in big numbers, they had to have the certificate as soon as possible from the moment they arrived at the unit. The condition for using flight instruments only with a green certificate has been revoked. Another change was the replacement of the written exam with an oral one, and commanders were primarily responsible for issuing certificates in their units. Students continued their wartime training with an emphasis on flight instruments.

The 1945 instrument-training syllabus contained 37 hours of flying and 25 hours spent in the Link Trainer, which was very similar to that of 1942 but improved to make the training more effective. Each instructor was required to complete 15 flying hours, 10 with the Link Trainer, and 25 classroom hours. Ground instrument training schools became routine, and in 1945, 30 hours of this training were introduced. The training also became more intense, so the cadets had an hour of instrument flying daily.

The training increased significantly in 1947, reaching 270 hours, but it was much better organized than during the war. Although the training has improved, only two stages remain beginners and advanced. Fifty-five hours were devoted to instrument flight, more precisely 20% of the total, and 40 hours were dedicated to the Link Trainer. Ninety-five was the maximum number of hours awarded until then for instrument flight.

Four differences made the 1947 curriculum effective: instrument flight was considered a basic concept to be taught, simulators were important elements for cadet training, and the altitude indicator was the basis of flight instruments.

CONCLUSIONS

The historical evolution of instrument flying within the Army offers insightful lessons on integrating technological advancements into military operations. This journey demonstrates that creating a crucial military capability involves more than just getting and using technology, it's a complex process that goes beyond simple acquisition and deployment. A multitude of factors, including operational demands, organizational culture, financial constraints, and the indispensable contribution of skilled personnel, shape it.

In the past, the Army dedicated extensive periods, sometimes up to three decades, to refine and perfect essential combat skills like instrument flying.

This process was not merely about embracing a new technology but involved a comprehensive and iterative process of adaptation, training, and continuous improvement to meet the evolving demands of warfare. Such a deliberate and prolonged development period underscored the complexity of achieving operational proficiency and technical mastery in the military.

However, the contemporary military landscape is marked by rapid technological change, pressing the armed forces to identify and integrate indispensable technologies swiftly. This shift has made the long timelines from the past impractical. Yet, the fundamental influences that dictate the success of technological integration, operational requirements, the mindset within the organization, budgetary allocations, remain as relevant today as they were during the development of instrument flying capabilities.

The Army's journey with instrument flying serves as a powerful reminder of the challenges and factors involved in improving military capabilities. It shows that achieving real expertise and readiness in using new technologies goes beyond just having innovative tools; it calls for a strategic approach to dealing with these ongoing factors. This strategic approach involves recognizing the potential of a new technology and investing in the training, adaptation, and continuous learning necessary to fully realize its benefits.

As the military navigates the persistent challenge of identifying and deploying critical technologies in a rapidly evolving landscape of innovation, the insights gained from the evolution of instrument flying provide invaluable guidance. They underscore the importance of a well-rounded and nuanced strategy beyond simply acquiring technology, emphasizing the necessity for patience, creativity, and concerted effort to establish sustainable and effective military capabilities.

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