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AUTHOR Callaway, R. O.; Elmer, James D.
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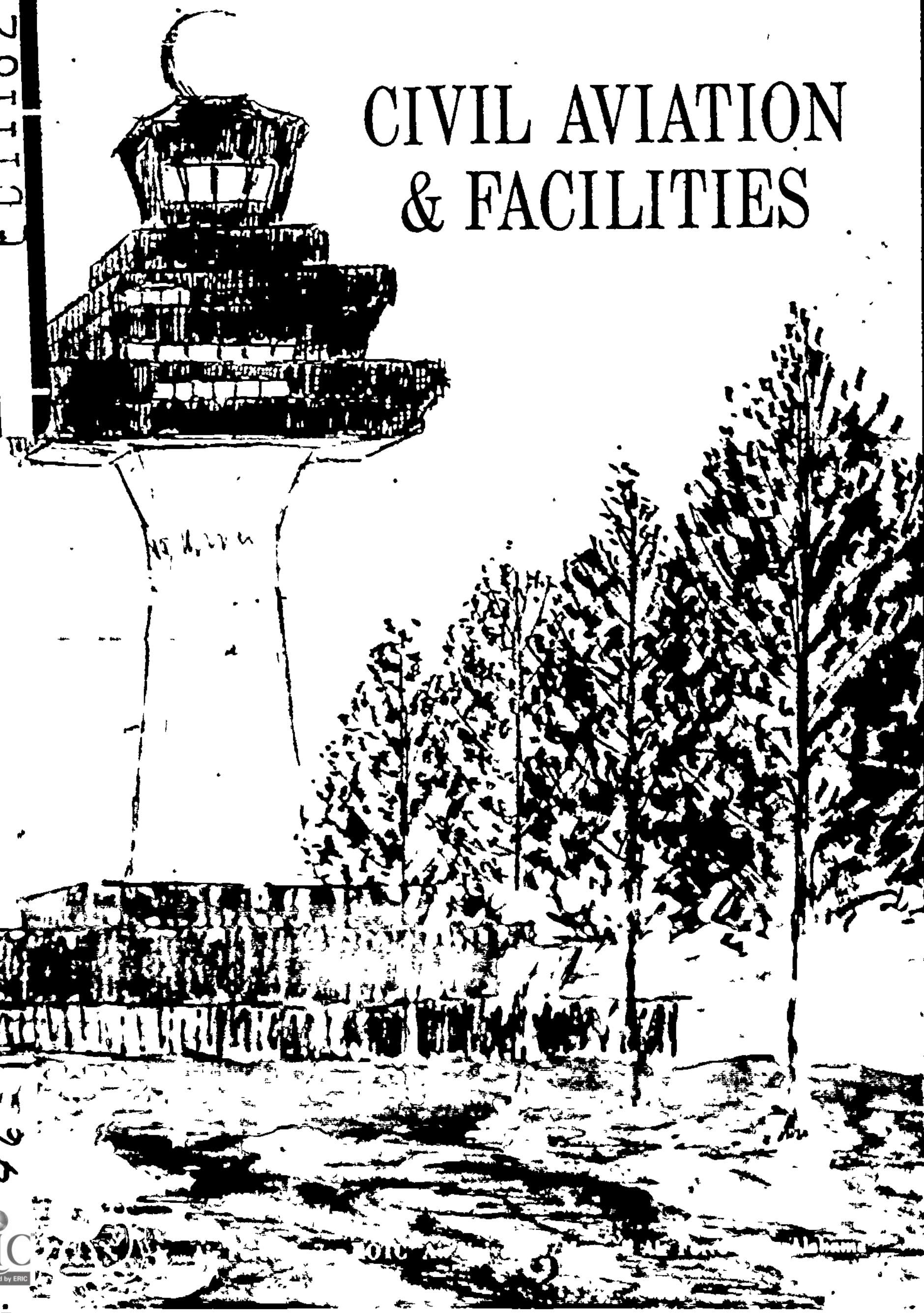
ABSTRACT

This is a revised textbook for use in the Air Force ROTC training program. The main theme of the book is concerned with the kinds of civil aviation facilities and many intricacies involved in their use. The first chapter traces the development of civil aviation and the formation of organizations to control aviation systems. The second chapter describes varieties of aviation for which the term "general aviation" is used. This includes brief descriptions of agricultural, business, instructional, recreational, air taxi service, and civil air patrol aviation systems. The third chapter delves into the problems related to the management of aviation facilities. The fourth chapter presents a discussion of the construction and operation of airports. Finally, the last chapter deals with the development and role of air traffic control. (PS)

CIVIL AVIATION & FACILITIES



AEROSPACE EDUCATION II

Civil Aviation and Facilities

R O CALLAWAY
Academic Publications Division
3825th Academic Services Group

and

Lt Col James D Elmer
Air Force ROTC (AU)

AIR FORCE JUNIOR ROTC
Air University
Maxwell Air Force Base, Alabama

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This publication has been reviewed and approved by competent personnel of the preparing command in accordance with current directives on doctrine, policy, essentiality, propriety, and quality.

Preface

EVERY DAY thousands of aircraft of various types are in the air. Most of these aircraft are a part of civil aviation. You will remember from other booklets in your AFJROTC course that civil aviation includes all types of flying except military flying. When we think of aviation other than military, we usually think of the flying done by commercial airlines. If we limit our thinking to commercial flights, however, we will be only partly right, for civil aviation includes not only the commercial airlines but also general aviation. You undoubtedly are familiar with military flying and commercial airline flying, but the term "general aviation" may be new to you. This category of flying consists of nonscheduled flying activities in business and agriculture, contract cargo transportation, industrial aviation, flight instruction, air taxi service, and recreation flying.

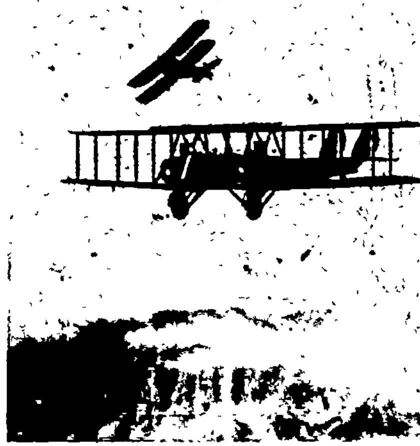
The growth of flying activity has increased the necessity for regulation of flying by the Federal Government. At the same time, it has, of course, greatly increased the necessity for improved facilities of every type. It has also made imperative an effective air traffic control system. This booklet, then, is concerned primarily with these broad subject areas—the relationship between civil aviation and the Federal Government, the types, growth, development, and status of both general aviation and commercial airlines, the major facilities provided for civil aviation, and air traffic control.

Some people argue that, despite the fact that aviation is now more than 70 years old, air transportation is still in its infancy or at least that the full potential of air transportation has not been realized. Certainly civil aviation has grown by leaps and bounds since the close of World

War II. Just how far it will go and the extent to which we will depend in the future on air transportation remains to be seen. But to anticipate the future and appreciate the developments under way, we should try to understand the background of civil aviation and its present status.

Contents

Chapter 1



The Government and Private Aviation

THIS CHAPTER explains the need for Federal control over civil aviation. A brief history of civil aviation is followed by a section stressing the close cooperation between military and civilian air resources during World Wars I and II. Governmental cooperation with civilian authorities is further demonstrated by Project Beacon, the role of the civil reserve air fleet, and the etsablishment of an international civil aviation organization. After you have studied this chapter, you should be able to do the following: (1) tell how civil aviation in this country worked together with the Government, especially during wartime; (2) explain the role of the civil reserve air fleet in the defense of our Nation; and (3) outline the main areas of responsibility of the Federal Aviation Administration.

Civil aviation includes all flying other than military, but our attention usually focuses on the commercial airlines with their cargo and passenger services. Most people are aware of airline flying. Relatively few people, however, are conscious of general aviation which includes private flying for business or pleasure as well as such diverse activities as agricultural crop dusting, geological prospecting, mapping, and highway traffic regulation. Yet general aviation traffic is quite heavy and has compounded problems at some of the busier airports.

During the years since the Wright brothers' first flight, civil aviation has grown to maturity under the stimulus of war and the paternal guidance of the Federal Government. Virtually every contribution of research to military aviation is ultimately reflected in the progress of civil aviation. At the same time, the Government has directly and persistently fostered the growth of civil aviation, particularly in the lean early years. Today the airlines—the most important component of civil aviation—are on the point of financial independence.

Civil aviation is a major element of aerospace power. A nation's ability to use its airspace is measured by the density of its civil air traffic. Civil aviation occupies an integral position in the larger complex of national aerospace power and contributes in important ways to the security of the nation.

Throughout the spectrum of aerospace power, technological development and efficiency of the civil and military establishments go hand in hand. Without the stabilizing influence of uniform air navigational and communications facilities worldwide, without the steady advance in flight safety, and without the progressive evolution of international air agreements, regulations, rules of flight conduct, and regulatory agencies that establish a worldwide opertaing code, today's crowded airspace would be completely chaotic.

BEGINNINGS OF AIR TRANSPORTATION

The flight of the Wright brothers in 1903 marked the dawn of a new era in transportation. After the historic flight, the Wrights continued to develop their invention. Practice brought rapid progress. In Europe, Santos-Dumont, Henri Farman, Louis Bleriot, (BLE HR-ee-oh) and others continued to experiment and improve aircraft. European enthusiasm was highlighted by the establishment of international speed races at Rheims, where leading European governments offered prizes for improved aircraft engines. Rapid acceptance of the airplane in Europe is indicated by the number of licensed pilots in 1911. In that year, there were 353 pilots in France, 57 in Great Britain, 46 in Germany, 32 in Italy, and 27 in Belgium In that same year, there were only 26 licensed pilots in the United States.

Despite the small number of pilots in 1911, the United States' interest in aviation was not completely lacking In 1908 the Army Signal Corps contracted with the Wright brothers for its first plane Orville Wright was teaching Lt Thomas Selfridge to fly the aircraft on 17 September 1908 when the ship went out of control. Wright regained control too late for a smooth landing. When the plane hit, Selfridge suffered a fractured skull. When he died a few hours later, the Army lost its first military pilot.

The Wrights built another plane, "Aeroplane #1, Heavier-than-Air Division, US Aerial Fleet," and trained Lts Frank P. Lahm and Frederic E. Humphries to fly. However, a crash on 5 November 1909 destroyed the plane and the men were transferred back to Artillery. The Army was left with neither a usable plane nor a qualified pilot.

Flying activities were transferred to Ft. Sam Houston, Texas, and on 2 March 1910, Lt Benjamin S. Foulois (FOO loy) began taking flying lessons—by mail! His first flight was a solo flight, of course, and until 1911, he was the Army's **only** pilot flying its **only** plane.

By 1914 the United States was still behind most other major nations in the field of aeronautics. Safely surrounded by oceans, the United States felt no need to compete with Europe in building up the military aeronautical establishment. Because of the lack of public interest, money and planes were hard to get. Pilots were hard to get and harder to keep because flying was dangerous. Army aviation finally received recognition in 1914. It was put on a firm and permanent basis. The Army Aviation Act of 1914 created the Aviation Section of the Signal Corps and authorized 60 officers and 260 enlisted men.

The Aviation Section expanded its organization, but it still lacked funds. By 1916 things had become so intolerable that, when the 1st Aero Squadron pushed across the Mexican border to capture Pancho Villa, the aircraft lasted only six weeks. The planes and their replacements were unfit for field service. Thus, the strength of the Aviation Section was reduced to 35 pilots and no aircraft suitable for combat.

Civil interest in aviation was not completely lacking during the lean, early years. American Glenn Curtiss, famed "fastest man on earth," turned his interests from motorcycles to airplanes. He went into business making flying machines. In 1910, Curtiss flew an aircraft from New York City to Albany, New York, a remarkable feat for the time.

In 1911 Calbraith Perry Rodgers completed the first continental flight across the United States. His trip consisted of a series of short hops Rodgers' actual flying distance was 4,251 miles. His average flying speed was 52 miles per hour. The total time taken from Long Island to Pasadena was 49 days. Aircraft repairs had slowed him down, or he might have made the trip in 30 days and won the Hearst $10,000 prize. Even though he did not win the prize, he had made the flight without the aid of prepared landing fields, advance weather information, special instruments, or adequate supplies or facilities. He had shown the potential of the airplane as a means of transportation in this country.

In 1914 the St. Petersburg-Tampa Airboat Line made the first attempt to operate a regular passenger service. The company flew passengers across Tampa Bay in a Benoist (BEHN-oh-ist) flying boat. There was a $5 charge for the 20 minute journey. The line stayed in business 4 months and carried 1,200 passengers. (See Figure 1.)

By this time the airplane itself had taken on the basic features of the modern aircraft. The fuselage was enclosed, landing wheels were added, and more efficient engines were installed. Improved power plants enabled the pilots to climb higher, reaching altitudes of 26,000 feet.

Yet both civil and military aviation growth in the United States lagged behind the rest of the world. The lack of public support and the lack of a clearly defined status for aviation caused this lag. Until the outbreak of World War I the airplane was regarded as of potential use only for sporting or military purposes. The far reaching effects of air travel had not yet been felt by civil or military authorities much less by the general public.

From the advent of the airplane until after World War I, the Federal Government did little toward establishing rules and regula-

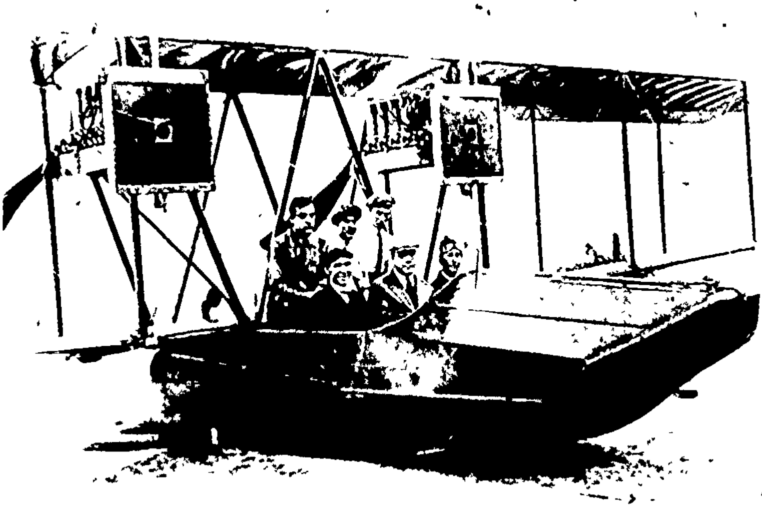


Figure 1 Benoist Flying Boat

tions to govern aviation. As early as 3 March 1915, Congress created the **National Advisory Committee for Aeronautics.** This body, however, was not a regulatory agency. Its chief function was to supervise and direct scientific study of the problems of flight and to direct and conduct research and experiments in aeronautics. Whatever interest the Government had in aviation was limited to military aviation until after World War I.

WORLD WAR I AND AFTER

The achievements of Army aviation and the American aircraft industry in World War I were not as great as they should have been. The task accepted by the Army air arm at the urging of the Allies was beyond this country's capabilities. It was not possible to overcome in a brief 19 months the effects of almost a decade of neglect

America's air resources in April 1917 were indeed meager. We had fewer than 150 pilots and fewer than 250 planes. By European standards none of these planes could be classified as more than trainers The United States lacked plans and programs for building an air force that could fight in Europe Moreover, the country even lacked the basic knowledge on which to base such a program.

The idea of planning for a war before it began was still new to the Army, and it was also alien and repugnant to much of the public. The United States had always begun its buildup after hostilities started, and we followed this philosophy in World War I and again in World War II

We entered World War I on 6 April 1917. Our allies asked us to build a great armada of planes and send them to the front The French asked us to provide 16,500 planes during the first six months of 1918. From 1913 through 1916, the American aircraft industry produced fewer than 1,000 military and civilian planes, now Army planners were asking for 22,000 military planes in one year!

Americans envisioned great fleets of American planes turning the tide of battle in Europe. Ample money was appropriated, but time had been lost and technology was inadequate. The 11,000 planes we produced were designed by the British However, America did produce the 420 HP Liberty engine The Liberty engine greatly improved aircraft performance and was even used by European manufacturers

When World War I ended, nearly 9,500 men were in the Air Service. During the frantic demobilization of 1918-1919, almost

95 percent of these men were released to return to civilian life. Many of these young fliers were happy to be home again, but before long they became restless. Flying had been their life, and they didn't want to give it up.

There were a few small commercial airlines being formed, but these needed few pilots because most people were afraid to fly. These former pilots had to buy their own planes if they wanted to fly. A few eked out a living by taking up thrill seeking passengers and by giving flying lessons. A few others started small airlines.

Many became **barnstormers.** By putting on flying exhibitions at county fairs, carnivals, or anywhere crowds gathered, they publicized aviation. When World War I ended, few people had ever seen a plane, and most people feared or disapproved of aviation. Then came the barnstormers who may not dave dispelled the fears of the general public, but they certainly did create interest in fliers and flying.

Still the United States hesitated to recognize the "aeroplane" as a potential passenger vehicle. Speed was not much greater by plane than by train. Furthermore, public interest had not yet been sufficiently aroused.

Up to 1917 neither private American enterprise nor the Government was ready to adopt any system of subsidized air transportation. But in March 1917, Congress, newly aware of the defense value of the plane, granted the Post Office Department $100,000 for airmail transportation. Post Office officials had requested such funds as early as 1911.

The Post Office Department, with the help of Army pilots, opened an airmail route between Washington and New York. The first flight took place on 15 May 1918. In Washington, the first plane was loaded with four bags of mail, but it failed to start. Its fuel tanks were empty. It was finally fueled with gas siphoned from another plane at the airfield and took off But it got off course and landed on a Maryland farm, 25 miles from Washington. The plane from New York to Washington made the trip in 3 hours and 20 minutes. Airmail service was on its way.

This initial airmail service was uneconomical and caused considerable doubt concerning the potential of air transport. It was, therefore, in the face of much doubt and opposition that the Post Office Department continued its pioneering efforts in air transportation. Service was begun in 1919 between New York and Chicago and extended to San Francisco the following year. (See Figure 2) In 1922 the Post Office Department took the unprecedented step of airplanes and airports for night travel This step was necessary for airmail to compete with first class mail on trains.

By establishing beacon lights along the transcontinental run at 10-mile intervals and constructing emergency landing fields every 30 miles, the Post Office established the world's first lighted airway. On the lighted airway between Chicago, Illinois and Cheyenne, Wyoming, the world's first regular night service was started on 1 July 1924. Transcontinental airmail service was soon established with schedule times of 34 hours and 20 minutes westbound, and 29 hours and 15 minutes eastbound. This day-and-night airway from coast to coast became the central trunk of a growing and spreading system of regional branch lines. The airway was later named the transcontinental route or Columbia Line. We will see this airway again later in the section on air traffic control.

Though this day-and-night airway system had molded regional lines into a national airway system, many problems remained to be solved. No substantial progress had yet been made in aircraft radio communications, adequate weather reporting, development of an efficient aircraft, or methods of coping with bad weather conditions.

The new lighting system brought a new scale of airmail rates—10¢ per ounce up to 1,000 miles, 15¢ up to 2,000, and 20¢ over 3,000 miles. Still, all-weather flying was deemed necessary to meet competition. Stubborn insistence on all-weather flying led to mounting pilot fatalities. After a pilots' strike, a compromise enabled the

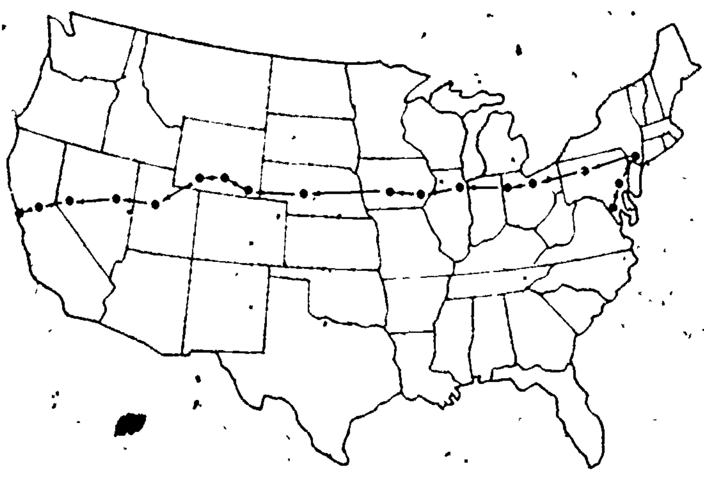


Figure 2 First Transcontinental Air Mail Service

local station manager, rather than an official in Washington, to order or cancel a flight. After that, pilot fatalities dropped sharply.

By 1925 the Government considered opening airmail contracts to commercial carriers. The Kelly Air Mail Act of 1925 provided an economic basis for the air transport industry. It provided for the transfer of air mail service to private operators, under competitive bidding, for four years. The rate was fixed at not less than 10¢ an ounce.

This act readily attracted private capital, and a number of airlines opened up during the latter 1920s. In effect, the Government's awarding of contracts according to the need of the companies amounted to indirect subsidy. (Webster defines a subsidy as "a grant by a government to a private person or company to assist an enterprise deemed advantageous to the government.") A subsidy may be an outright gift, such as early railroad rights-of-way, or it may be the amount paid in excess of the usual charge or costs. The airline subsidy was indirect in that contracts were awarded to keep companies in business, but those companies were paid at the regular rates.

Congress went a step further. In the Air Commerce Act of 1926, Congress said it was a responsibility of the Federal Government to build, maintain, and regulate the airways without which the air carriers could not have continued systematic operations. Responsibility for the airways was given to the Department of Commerce.

The transatlantic solo flight of Charles A. Lindbergh in 1927 probably produced greater mass enthusiasm—both here and abroad—than any other event in the history of aviation. This feat suddenly made Americans aware that perhaps the airplane was a safe, speedy, and useful vehicle. As a result, more people now wanted to discover the thrill of flying. More important, businessmen began to consider aircraft building and flying as a profitable investment. This led to a boom which brought 44 scheduled airlines into existence in 1929.

In May 1928, a number of prominent industrialists formed the **Transcontinental Air Transport (TAT).** Wright and Curtiss Aircraft Companies and Pennsylvania Railroad held large interests. Colonel Lindbergh headed the Technical Committee which mapped out and organized the coast-to-coast route. This was the turning point in the development of civil air routes. Suddenly, emphasis shifted to transcontinental routes and nation-wide systems. Furthermore, financial participation shifted to Wall Street. Airlines became big business with manufacturers such as Boeing and Curtiss forming airline combines. These combines fought for supremacy on the Columbia Line or transcontinental air route. The early airlines have changed, but they still survive today as the big four (American, Eastern, TWA, and United). Moreover, their route patterns mapped out between 1927 and 1930 remain the backbone of the country's air route structure.

In the years immediately prior to the stock market crash of 1929, the airlines were well on their way to becoming big business. When the national economy suffered during the depression following the crash, the airlines suffered too, and the Government had to help the airlines through the lean years. The Wall Street collapse brought disaster to many airlines and led to the passage of the McNary-Watres Act of 1930. Under this act, the Government encouraged the development of passenger traffic. Largely as a result of this legislation, airline passenger accommodations improved materially, and passenger traffic on domestic air routes increased substantially. Of course, technological improvements of the airplane and airways also helped increase the efficiency and safety of air travel.

The airlines up to this time had depended on airmail payments for financial stability. But President Franklin D. Roosevelt forced the airlines to turn to passenger and express revenue for their main source of income when he drastically lowered airmail payments. On 9 February 1934, he went a step further, he cancelled all airmail contracts and had the Army fly the mails. The Army pilots were inexperienced in flying over vast stretches of unknown territory and in bad weather. This was a period of especially bad weather for which they were unprepared. Their casualty rate grew and so did the hopes of the airlines for airmail contracts. On 10 March 1935, all mail flights were cancelled. Soon after, airmail contracts were again awarded to civil carriers who have carried the mail ever since.

Many technological advances had taken place since 1925. The industry was trying to create a plane that could fly cheaply. Some of the major technical advances made between 1925 and 1936 included the increase of wing loading and the development of multiengined planes, engine nacelles, cantilevered wings, and high octane gasoline. The first planes to incorporate all these features were the Boeing 247 and the Douglas DC–2 and DC–3 (Figs 3 & 4) which made their appearance as air transports in the period from 1933 to 1936.

Equally important, the development and expansion of safe airways during the 1930s made air travel more efficient. The Government provided more revolving beacon lights, radio range and broadcast stations, weather teletype service, and emergency fields. Airway facilities were, in fact, about adequate for the flight requirements of the period.

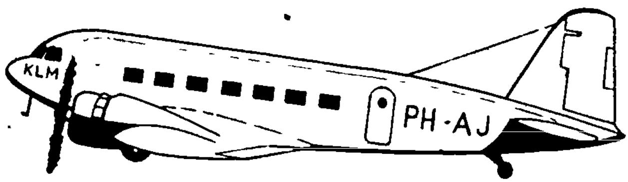


Figure 3. DC–2.

Still, an adequate volume of travel, essential to successful air transportation, eluded the airlines. Too many people were afraid to fly. News of spectacular air crashes instilled even greater fear into the hearts of many potential passengers.

The introduction of better equipment and improved air facilities, which made flying safer, lessened people's fear of flying. The airlines had become safety conscious. This new consciousness led them to accident research and investigation which disclosed mechanical and personal errors. They have continued to improve their equipment and facilities, until today, air crashes are big news because they occur so seldom.

The Black-McKellar Bill of 1934 assigned the **Interstate Commerce Commission** the responsibility of establishing the rate of mail payments made to air carriers and recommended that a study be made of commercial aviation. This bill forced the airlines to compete for passenger business. They used up-to-date advertising methods and promotional techiques to make airline service more attractive. They added many little extras to make the trip more pleasant—meals, stationery, maps, picture postcards, newspapers, magazines, blankets, first-aid medicines, and help in the care of children. Many of these extras attract passengers today.

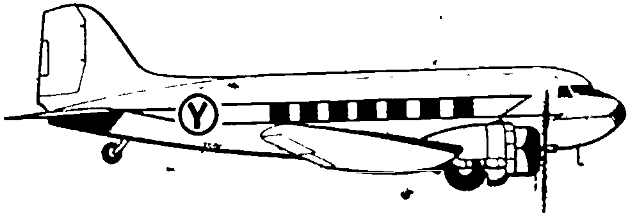


Figure 4 DC–3

Reduction in fares made air transportation competitive with first-class Pullman rail travel. The price per passenger mile in domestic air transport dropped from 12 cents a mile in 1929 to an average of 5.4 cents in 1935 and 5.2 cents in 1938—a level maintained, with some fluctuations, well into the 1950s. This reduction in fares was partly due to increased efficiency of operation and competition among air carriers, mail contracts also played a role, they permitted the airlines to distribute the costs of operation over mail service and passenger transport.

Growth was not limited to passenger transport. Many businesses had discovered the value of air cargo transport. Those technical improvements that made passenger service more economical and safer also improved cargo transportation.

In Europe, air transport had been recognized early as an important instrument of national policy and defense. In the United States, the defense concept of civil aviation, while recognized early and accepted in principle had never been as heavily stressed. This concept was reviewed in the study conducted under the Air Mail Act of 1934.

The study of commercial aviation led to the Civil Aeronautics Act of 1938. With its passage, one Federal statute and agency were substituted for the several which had been regulating the industry. The Civil Aeronautics Authority (CAA) consisted of three practically autonomous groups. a five-man Authority, which dealt with economic and safety regulations, a three-man Air Safety Board, for the investigation of accidents, and an Administrator, who was in charge of the development and operation of air navigation facilities as well as general development and promotional work. Organizational difficulties, duplication of activity, and dissension, within the ranks of the Safety Board brought about a reorganization of the regulatory agency in 1940.

The Civil Aeronautics Authority was, in effect, split and provided the nucleus for two new organizations. The five-man Authority became the Civil Aeronautics Board (CAB), to which was assigned the safety rulemaking function, the Administrator was transferred to the Department of Commerce, where he exercised his functions as head of Civil Aeronautics Administration (CAA). Hence the abbreviation CAA continued to be used.

After 1940, the CAA, under the Department of Commerce, was to encourage aviation's development to fill the commercial and defense needs of the United States. The 1940 reorganization did not solve all the difficulties the CAA experienced. Rather, the CAA underwent a series of small changes which eventually led up to the passage of the Federal Aviation Act in 1958

On the eve of the Second World War, the Federal Government, on the premise of national interest, continued to provide an element of direct aid for the transportation of mail. This aid helped put the air industry on a financially sound basis. The subsidy element in airmail payments was on the whole less than the subsidy paid in most countries. The value of this investment became immediately apparent with the outbreak of World War II on 7 December 1941.

CIVIL AVIATION AND WORLD WAR II

The airlines and general aviation made significant contributions to the war effort. While contributions of general aviation were of a largely aeronautical nature (except for the civilian pilot training program and the Civil Air Patrol), contributions of the airlines were on the whole more direct and immediate. The assistance of both were particularly notable in the critical early days of the war when our military air power existed largely on paper. Among the tasks performed by the airlines during World War II, the most important are described below:

1. *Provided the Armed Forces with transport aircraft.* At the outbreak of war, the airlines turned over 324 aircraft, or half their domestic fleet, to the military forces. These commercial airliners formed the nucleus around which the Army Air Forces and Navy were able to build their huge transport commands. In addition, the airlines also delivered to the Armed Forces airplanes previously ordered for commercial use. Some of these planes were transferred even before Pearl Harbor.

Perhaps just as important to the successful prosecution of the war was the healthy condition of the airline business at the outbreak of the war. Had the United States lacked sound, thriving, and expanding commercial airlines, the aircraft industry would not have been so technologically advanced or economically important Even with this commercial stimulus, aircraft production was inadequate for the immense military needs, and it was not until several years later (March 1944) that the required top production level was reached.

2. *Supplied key personnel* In addition to supplying the Armed Forces with aircraft and crews, the airlines furnished the services with many experienced executive personnel to set up and operate the transport commands. These executives became the transport command organization commanders, chiefs of staff, etc. Without these top men, the gigantic wartime airlift operations described above would not have been achieved at so early a date.

3. *Supplied many technical services.* When the war broke out, the airlines were the principal source of maintenance and repair personnel. The military services turned to these technicians for servicing, maintaining, converting, and modifying their aircraft. They worked in both airline-operated and Government-controlled repair shops.

4. *Furnished contract flying service.* The Armed Forces were not able to perform all the flying functions demanded by the war effort. The airlines filled the gap by supplying contract flying service to the Air Transport Command (ATC) and Naval Air Transport Service (NATS). These contract flying operations grew remarkably between 1942 and 1945.

5. *Trained flying personnel.* The airlines also helped the war effort by training navigators, pilots, mechanics, and meteorologists for ATC and NATS. In addition, private operators expanded their facilities and trained thousands of fliers under the Civil Aeronautics Administration's Civilian Pilot Training Program. Together, these students became the backbone of the Army, Navy, and Marine air arms.

6. *Provided airbase facilities.* Civil authorities, in conjunction with CAA, established airbase facilities for the use of both scheduled and non-scheduled airlines in cities throughout the United States. These formed the nucleus for many military installations when expansion of such aviation facilities became vital for national defense.

7. *Met demands of accelerated war business.* Despite the tremendous inroads made into the civil air transport fleet, the airlines greatly speeded up the conduct of war business through commercial airline travel. Notwithstanding a forced cut of nearly half in daily scheduled plane miles, the airlines in 1942 were able to carry 82 percent of the last prewar year's number of passengers. In 1944, the airlines carried 15 percent more passengers. This was made possible by pushing up the hours aircraft were in use from 6.5 hours to 11.5 hours a day in 1944.

One of the most significant developments in domestic air cargo transportation was the vastly increased use of air express. Air express pound-miles (a pound mile is carrying one pound one mile) increased fivefold and previewed the postwar potentialities of cargo service.

POST-WORLD WAR II EFFECTS

The wartime advances made in the development of aircraft and engines during World War I had a direct and beneficial effect on civil aviation. Later, it was developments in civil aircraft that benefited military aviation. During World War II, scientific and technological progress profoundly affected civil aviation. Most significant was large-scale production and opertional use of jet-propelled and rocket-propelled fighters and of guided missiles by the Germans. This fore-shadowed the coming of a revolutionary new era in air transportation within a matter of years.

Jet propulsion, radar, and other scientific and technological developments brought about improvements in equipment and airways. These improvements aided the postwar expansion of civil aviation.

During wartime, there had been a great demand for air transportation and airline travel. This demand continued during the rapid demobilization following the war.

Both Government officials and airline executives were misled by the heavy demand for air travel. They ordered more planes, hired more personnel, and filed for new routes. When the demand dropped, they found themselves in financial trouble.

To counteract the crisis, the airlines cancelled their equipment orders. This threw the production industry into chaos. Highly skilled engineers and other technologists were forced to leave the aircraft industry because their jobs were eliminated. Ultimately, both the aircraft industry and the airlines were threatened with collapse, a condition which would have had disastrous effects on military aviation.

The period 1946-1947 was a rough one for the airline industry. It was only through the creation of the CAA that the airline industry survived. As early as 1938, Congress had foreseen the difficulties an airline crisis would bring.

The CAA Act empowered the Civil Aeronautics Board to set reasonable rates for airmail carriers. In addition to granting higher temporary mail pay rates, the CAB also approved some loans made to the airline industry by banks, insurance companies, and the Reconstruction Finance Corporation.

By employing newer and more thoroughly tested equipment and by taking advantage of the improved airways, the airlines were able to increase the safety and regularity of their service. The year 1950 saw the airline industry achieve an unprecedented safety record when the passenger fatality rate was only 1.1 per 100 million passenger miles flown. (Flying one passenger one mile equals a passenger mile).

The Airline passenger business showed a marked upturn in 1949, and by the latter part of the year, the industry was out of the red. In 1950, the industry experienced its most successful year, with all categories of traffic at record-breaking levels for two years in a row, the industry's profits were the greatest since the end of World War II. Domestic air carrier operating revenues exceeded the half-billion dollar mark for the first time, giving the airlines a net profit of $63 million. About half of this profit would not have been possible without the $30 million mail subsidy.

The years since 1950 have seen a shift in the Nation's travel habits caused by the increase in speed and in services. Planes are now more comfortable and convenient, and public response to these improvements has been remarkable. The airlines now account for more than 70 percent of all public domestic intercity traffic. In the late 1950s, the airlines carried only about 35 percent of this traffic. As passenger traffic has increased, the cost of flying has gone down. Air travel and aerospace industries have become "big business," accounting for a large portion of our gross national product.

Because of the combination of improved equipment and enlarged route systems, revenue ton miles have increased at the rate of 13.1 percent each year since 1960. (A **revenue ton mile** is hauling one ton of cargo one mile for which pay or revenue is received). Not all of this growth has been reflected in profits. Much of the airlines' money is invested in capital outlays for replacing equipment.

In the years since 1950 airline traffic has more than doubled, and general aviation traffic has doubled several times. This has led to a condition known as the "crowded air." Until 1958, the CAA controlled civil aviation, and a number of other agencies controlled military aviation. Often there was little coordination between these agencies. This lack of coordination caused confusion in the use of air lanes and culminated in a series of air crashes in 1957-1958. In response to an aroused public, Congress enacted the Federal Aviation Act which created the **Federal Aviation Agency (FAA)** and gave it the responsibility for regulating all airspace over the United States and establishing a unified system of air traffic control.

The establishment of the Federal Aviation Agency in 1958 brought together in one organization the Civil Aeronautics Authority (CAA), the Airways Modernization Board and the safety-rule-making function of the Civil Aeronautics Board. The CAB continued as an independent agency overseeing the economic aspects of the industry. Certain military personnel were assigned to FAA to insure civil-military cooperation.

The FAA is headed by an Administrator appointed by the President with the advice and consent of the Senate. He must be a civilian with aviation experience.

For the first time in the history of aviation the act assured coordination and cooperation between civil aviation and the military services. It also provided for the assignment of military personnel to posts within the Agency thus insuring military participation.

The FAA continued as an independent Governmental agency from 1958 through early 1967. Then the Federal Aviation Agency became the **Federal Aviation Administration** and it became part of the Department of transportation. The current organizational structure is the result of all the previous efforts to organize this complex and rapidly expanding area but by no means is it the final and ultimate organizational solution. New developments in the industry create new organizational needs and the Government will adapt to these needs as they emerge. In Chapter 3 we will discuss the roles of FAA and CAB in regulating commercial air traffic.

Throughout the history of aviation the Federal Government has played a role. The pioneering efforts of the Post Office Department proved that air travel could be both safe and efficient. During wartime the Government saw how vital air power was to our national defense. The Government helped the struggling air industry in times of need and gave the boosts that the industry needed to stay alive. In turn as the air industry expanded it brought growth to the national economy and promoted national defense. Thus, the relationship has been one of mutual cooperation. As higher performance aircraft come into use and as air travel grows in popularity, Government regulation becomes more and more vital to public safety and the orderly movement of thousands of aircraft.

AVIATION SAFETY

The primary business of the FAA is aviation safety. The FAA's vigorous program for the prevention and investigation of aircraft accidents identifies human and physical hazards to flying and sets standards for aircraft manufacturers, maintenance practices, aircrew training, and the management of air traffic. Accident investigation findings contribute to the storehouse of knowledge used in preventing future accidents. The FAA has found that the greatest problems in safety are people problems. Even highly skilled pilots, mechanics, and controllers sometimes become complacent in their attitudes toward safety. Many times job performance gets to be such a routine task that the experienced airman exhibits a lack of sound judgement. In such a case people become overconfident in their ability and attempt feats for which they lack the skill and training, much like the overconfident automobile driver who tailgates and weaves in and out of traffic. Many accidents are caused by ignorance regarding a particular aircraft and changes in weather or by failure to keep current on flight rules and regulations.

People problems are much harder to cope with than physical problems. When runways become damaged or a faulty mechanism is discovered in an aircraft, the fault can be corrected quickly. People, on the other hand, must be motivated to perform in a safe manner. The FAA constantly solicits the support of aviation personnel in maintaining safety standards and practices. The FAA promotes, coordinates, and assists in conducting local and national safety programs, but it is the efforts of private citizens that cause the programs to succeed. Individuals, companies, and organizations are urged to adopt safety standards for themselves. These standards can be maintained by participating in safety meetings and special training sessions to update skills. FAA inspector specialists are available to explain the principal causes of accidents and to discuss measures that can be taken to avoid them.

The law requires that all aviation accidents be reported to the FAA. The formal report of an accident is submitted by the pilot or other responsible person involved. Non-fatal light plane accidents are routinely investigated by inspectors appointed by the FAA. The inspector assigned to investigate a particular accident is normally the FAA field representative located nearest the accident site. The inspector's actions include an on-site investigation to examine the physical evidence and to take statements from the persons involved. The evidence obtained is forwarded to the National Transportation Safety Board for evaluation. Information pertaining to the accident is analyzed and placed in computer storage where it is compared with data from other accident reports to determine trends in accident causes. This information is issued to aviation personnel interested in the case and to others who may be affected by similar hazards. An example of the uses made of accident report information is indicated in the following hypothetical example:

Elmer Jones, 32 years old, is vice president of Central Banking Company in Kansas City, Missouri. He handles large loan accounts throughout the states of Kansas and Missouri and flies his own twin-engine aircraft on frequent out-of-town trips. On 31 July 1973, he was landing at Kansas City International Airport when his left brake failed. The right landing wheel went off the side of the runway causing the aircraft to turn sharply to the right. The aircraft left the runway and the left wing tip struck a runway marker causing an estimated $650 damage to the aircraft and $30 damage to airport property.

Mr. Jones filed an accident report immediately, and the local FAA inspector, Mr. Rogers, investigated. His findings confirmed Mr. Jones' statements, however, he also found the cause for the brake failure. The left brake cable had become frayed, and when pressure was applied to the pedal, the cable came apart. A check of the right brake cable showed that it too was badly frayed. Further investigation revealed that Harry Black, the aircraft mechanic of Aviation Maintenance Contractors Inc., had been the last person to inspect the aircraft. Mr. Black stated that he had not looked at the brake cables but that the brakes had worked perfectly.

Mr. Rogers, the inspector, found no other physical evidence that would have contributed to the accident. He did find that the aircraft had traveled more than 60 feet after the pilot, Mr. Jones, discovered that the left brake was not functioning properly. Mr. Jones stated that he was in a hurry to clear the runway and believed that he could maintain directional control by use of the rudder, however, he misjudged the nearness of the runway edge.

The causes of this accident are quite clear and there were no injuries. Mr. Jones' attitude toward safety was changed considerably by this event. He had always viewed safety as did the old time pilots of open cockpit, fixed gear, fabric-covered planes who said, "Any landing you can walk away from is a good one." Mr. Black, the mechanic, had also learned a valuable lesson. Yet, the case was not closed at this point. When the Safety Board checked the computer printout data, it was found that two other aircraft of the same make and model had experienced recent brake failures. The manufacturer was contacted immediately, and a check was made to determine how many aircraft had been sold with this type of brake cable. The buyers of every one of these airplanes were traced, and the cables were replaced at the manufacturer's expense.

Many minor accidents are much more serious and complex than our example. However, it illustrates the importance of aviation safety and how the FAA is instrumental in using accident investigation results to make air travel safer for all.

All commercial air carrier accidents and fatal light plane accidents receive the special attention of the Safety Board. The Board maintains a team called a **Go-Team** that is made up of safety investigators (usually 10 members or less) who stay ready to proceed to the site of major accidents. These men are experts in accident investigation and at the accident site, they may work from 5 to 10 days to gather facts which they present to the Safety Board for evaluation.

In addition to accident investigation, the Safety Board makes recommendations to Congress and agencies of the Government concerning safety matters. Board employees make special studies, conduct public hearings, and provide useful information to the public through the press.

It should be remembered that the goal of accident investigation is to discover the cause of the accident, and to use these findings to help prevent future accidents. After all, the main purpose of an accident investigation is prevention of a similar accident.

RELATIONS BETWEEN CIVIL AND MILITARY AVIATION

Because of the nature of aviation, the roles of civil aviation, military aviation, and the Federal Government are necessarily tied together. The Federal Aviation Administration (FAA) itself is a combination of these three—whose interests may conflict. Today, there are fewer conflicts because each activity has representatives in the FAA.

The FAA provides the authority necessary for effective management. It stimulates intergroup cooperation, and this cooperation was behind many of the advances made since the establishment of the FAA. One of these advances, a radar advisory service for jet aircraft, provides safe inflight separation of aircraft operating within controlled airspace on an instrument flight rule (IFR) flight plan. This service was made possible by joint use of military air defense and FAA long range radar systems.

Other improvements were made in safety and more efficient use of airspace by consolidating some military refueling areas and eliminating others. Climb corridors were established for high speed jet aircraft to provide greater safety when the pilot's forward visibility was restricted during climbs.

Other studies on proximity (nearness) warning devices were initiated, and plans for greater use of military radar for enroute traffic control were formulated. Restricted areas used by the military were changed, some were eliminated, and others were made available on a part time basis. This provided extra airspace which had not been available previously.

Cooperation between the military and the FAA was further increased when the military were required to consult the FAA before constructing new airports and runways. On several occasions this cooperative planning prevented conflicts in the use of airspace by integrating present needs with future plans.

Clearly, the FAA has increased safety and efficient use of airspace. Management of the nation's resources through joint efforts has also saved millions of dollars.

PROJECT BEACON

At the request of President John F. Kennedy, a task force known as **Project Beacon** was established in early 1961. The purpose of this task force was twofold. (1) to conduct a scientific review of aviation facilities and related research and development, and (2) to prepare a practical long-range plan to insure efficient and safe control of all air traffic within the United States. Sound planning was to provide an orderly and economic evolution of the present system of air traffic control in pace with continuing advances in technology and national needs. Both civil and military representatives participated in the study. The study was completed, and a report on the results was sent to the President on 1 November 1961.

The study groups estimated a 44 percent increase in total flying by 1975. However, controlled traffic was estimated to increase by 300 percent. Although there had been sufficient improvements in air traffic control measures to handle the prevailing air traffic, it was obvious that many improvements had to be made to cope with future problems. Separation standards dependent on calculated position and pilots' reports were insufficient; radar control would be necessary to handle growing air traffic. The simultaneous use of both instrument flight rules (IFR) and visual flight rules (VFR) along the same airways was a problem. There were also problems of radio frequency congestion and pilot and aircraft controller overload due to the requirement for frequent position reports. In the terminal area, improvements in approach and departure clearance delivery were necessary to prevent inefficiency through excessive delays.

Project Beacon study groups recommended several future improvements in the area of controlling air traffic. First, the study groups recommended the development of a system for immediate and continuous aircraft position and altitude information to the air traffic controller. Other areas singled out for future improvement included the segregating of controlled and uncontrolled air traffic, the establishing of positive control areas above certain altitudes, and the establishing of speed limits in certain areas. Still other recommendations involved the employment of general purpose computers in air traffic control and the integration of air defense radar with FAA radar in order to provide continuous radar service enroute The plan was to provide safety, economy, and efficiency of operation for both civil and military operations

By the beginning of 1965, many of the recommendations of Project Beacon had been completed, and others were nearing completion. In the area of safety, many scientific studies have been made concerning hazards of lightning strikes, problems of turbulence, and airframe fatigue. Radars used by traffic controllers have been modified to give suitable weather displays on radarscopes. Aeromedical research has provided information both on human factors in aircraft accidents and also on impact and acceleration considerations for future aircraft design.

Project Beacon recommends achieving greater air safety through better aircraft maintenance practices and procedures. An experimental Maintenance Management Audit System was developed to evaluate systems and practices used by air carriers in directing and controlling aircraft maintenance.

Tremendous advances have been made in air traffic control. The airways structure has been streamlined to provide complete direction and guidance above 18,000 feet at all times. Instrument flight rules (IFR) are required above this altitude, and radar service is available in practically all areas of the United States. Joint use of the Air Force's SAGE direction centers has provided extra safety. SAGE is an acronym for "semiautomatic ground environment." SAGE operates a type of electronic digital computer that reports and acts on a developing situation. The widespread use of radar, in addition to providing greater safety, has been a tremendous asset in expediting departures and arrivals in congested areas.

A traffic control radar beacon system, which displays a constant altitude and identification signal on the controller's radarscope, is being implemented for both military and civil aviation. Present radar systems do not provide adequate altitude information although they do help the radar controller determine distance. This new system displays both altitude and distance information. The last chapter of this book will discuss this new system. It will also explain present air traffic control procedures and lists other new aids to air traffic control.

The FAA, then, plays a significant part in maintaining our national defense posture. The military services and the commercial airlines can now use common systems of air traffic control, and they can work together to solve common problems

CIVIL RESERVE AIR FLEET (CRAF)

The scheduled United States airlines have a double mission The first mission is to stimulate commerce by carrying passengers and cargo safely, dependably, and economically throughout the free world. The second mission is to provide airlift assistance to the Department of Defense and civilian disaster relief agencies in the time of national emergency or natural calamity This double mission is defined in the Civil Aeronautics Act of 1938 which states that the airlines are to serve domestic and foreign commerce, the postal service, and the national defense effort.

The airline industry responds to the needs of the military. It provides contract activity, commercial air movements, and individual ticketing. This service has satisfied some very large requirements without the declaration of a national emergency.

In the event of a national emergency, there must be an established organization to insure quick response. In 1952, the airlines and the Government together developed the **Civil Reserve Air Fleet (CRAF)** to meet this need. Certain airplanes in the airline fleet are designated and specially equipped as CRAF planes and are available for emergency on Government call. The airplanes are an important part of CRAF, but there is more to CRAF than airplanes. Also included in this organization are the trained crews and mechanics This fleet therefore is self-sufficient and ready for use in emergency.

In time of emergency, efficient operation of transport for the domestic economy is also essential, hence, the Department of Commerce has a major responsibility for commercial aircraft allocations in the CRAF program. The Commerce Department is advised by the Defense Department for the military requirements and by the CAB for civil requirements.

The CRAF program, as it applies to international operations, is activated in three stages. The first stage does not require a declaration of emergency. Cargo and passenger aircraft with their crews and appropriate support are immediately available to the military. The number of aircraft used in the first stage may be very small or there may be as many as 50 to 100 to meet a specific need. Natural disasters such as earthquakes, floods, and droughts often require the speedy movement of people from one area to another, or require cargo aircraft to fly in needed supplies and materials. These operations are usually of short duration and can be accomplished with a limited amount of airlift.

Stage two is an "airlift emergency" as determined by the Secretary of Defense. At that time, a large number of aircraft would be made available from the airlines until the emergency ended. The 1948 Berlin Airlift is an example of a stage two operation. Although CRAF had not been officially established at that time, hundreds of civilian aircraft were used to assist the Department of Defense in delivering food, fuel, and needed medical and other supplies to the German people who had been isolated in Berlin by the Communists.

A third stage would activate the full CRAF, more than 400 aircraft. This would occur in time of war, during an unlimited national emergency, or during a civil defense emergency declared by the President or Congress. The concept of CRAF is a good one because it provides a force in being ready to respond to a national emergency.

While CRAF has never been activated in accordance with emergency plans, a large amount of contract airlift is purchased each year from airlines participating in CRAF In 1972, $419 million were spent on international airlift contracts and more than $50 million on domestic airlift contracts. Over 90 percent of all military passengers are airlifted on commercial airlines.

The scheduled airlines were used to lift a large percentage of the Military Airlift Command's transient passenger traffic into and out of Southeast Asia. At the height of activities in Vietnam, the airlines lifted more than 2,500 passengers and over 180 tons of cargo per day to Vietnam.

A high percentage of the troops transported during the Korean conflict were airlifted, however, that percentage was less than half the airlift rate of the Vietnam war. The speed and carrying capacity of airline aircraft were far less then than they are today.

THE INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO)

Global transportation systems faced the same problems of air traffic control that the United States did. The unprecedented air traffic following World War II made it mandatory to control and regulate the use of the air. As a result, national leaders sought to establish standard operating and legal arrangements for air travel on a worldwide basis. The delegates from 52 countries met in Chicago on 1 November 1944. There they established an organization which they called the **International Civil Aviation Organization (ICAO)**. The purpose of this organization is to promote civil aviation on a global scale as a means of creating international friendship and understanding.

The ICAO has its headquarters in Montreal, Canada. It has been an effective organization, making major contributions to world cooperation in air transportation. It sets technical standards and air operating rules, and it carries out accident investigations. In this, it resembles the FAA. However, the ICAO has a distinctly international nature.

WORDS AND PHRASES TO REMEMBER

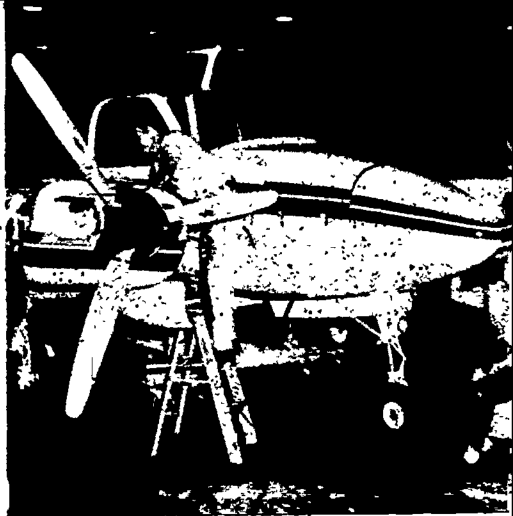
Civil Aviation
National Advisory Committee for Aeronautics
barnstormers
TAT
Interstate Commerce Commission
Civil Aeronautics Authority (CAA)
passenger miles
revenue ton mile
Federal Aviation Agency (FAA)
Federal Aviation Administration (FAA)
Go-Team
Project Beacon
SAGE
Civil Reserve Air Fleet (CRAF)

REVIEW QUESTIONS

1. How did military aviation aid civil aviation? How did civil aviation aid military aviation?
2. Explain the Federal Government's role in aviation.
3. Describe the Civil Reserve Air Fleet (CRAF).

THINGS TO DO

1. We note in this chapter that the Federal Government exercises control over virtually all phases of commercial aviation. Much of this control is applied through FAA. You might, therefore, obtain from your local FAA representative (usually found at the local airport) copies of some FAA regulations. You might ask your AEI for permission for a committee to call on the local FAA office and invite a representative to speak to the class on the relationship between the Government and commercial aviation.
2. In relation to the above, you might also investigate the relationship between commercial and military aviation and determine the extent to which FAA exercises control over military aviation.



Chapter 2

General Aviation

IN THIS CHAPTER, we are concerned with the fastest growing segment of the aviation industry—general aviation. You will read about what it is, what it includes, and why it is growing so rapidly. You will learn about agricultural aviation, business aviation, instructional flying, recreational flying, and the newest aspect of air transportation, air taxi service. The Civil Air Patrol is also an important part of general aviation, and so you will read about its mission and how the organization functions. Just what the impact of such a rapidly growing industry will be on our country is explained at the end of the chapter. When you have studied this chapter, you should be able to do the following: (1) tell why aviation is so important to the business executive, the farmer, and the average citizen; (2) discuss why "air taxis" are such a popular part of general aviation; (3) outline the mission of the Civil Air Patrol; and (4) explain how the producers of private aircraft contribute to the growth of general aviation.

General aviation is a term used to designate that part of aviation which is neither military nor airline. Included in general aviation are agricultural aviation, business aviation, instructional flying, recreational aviation, and air taxi service. General aviation also covers such conservation activities as forest, power, and pipeline patrol, such public service activities as ambulance, rescue, and emergency service; and such law enforcement activities as automobile traffic surveillance.

General aviation is the most rapidly expanding segment of the total aviation picture. Its growth has a significant effect on both the national economy and on individual well-being. General aviation has brought airmindedness to many diverse businesses and industries, and today it carries a much greater volume of traffic than is carried by the commercial airlines.

Not only is general aviation the fastest growing segment of aviation, but all major criteria for measuring its growth point to a continuation of the trend which has existed for two decades. To cite a few figures: in 1957, there were 66,520 aircraft in the general aviation fleet and 1,829 aircraft in the air carrier fleet (fig. 5). To put it another way, there were about 40 general aviation aircraft in service for every air carrier aircraft in service. In 1972, there were approximately 135,000 aircraft in the general aviation fleet and approximately 2,600 aircraft in the air carrier fleet. This means that there were more than 50 general aviation aircraft in service for every air carrier aircraft in service. Estimates for 1980 indicate a ratio of greater than 60 to 1.

The growth in numbers of general and air carrier aircraft is shown in Figures 6 and 7. This information, furnished by the

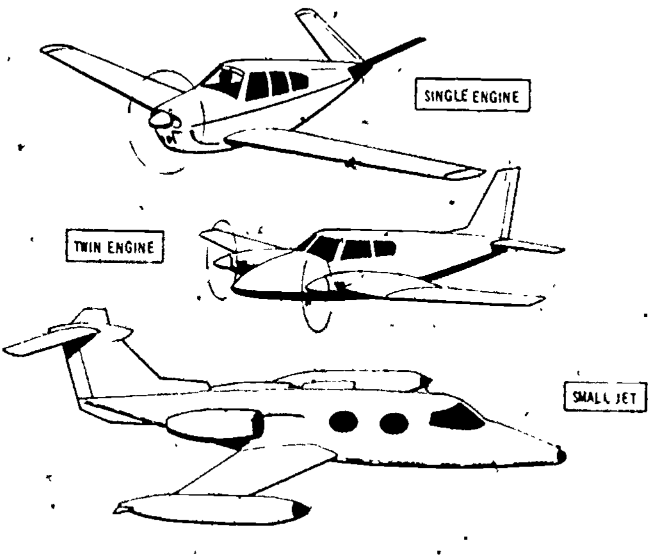


Figure 5. General Aviation Aircraft

Federal Aviation Administration, provides an interesting study of trends in the use of various types of aircraft as well as the total number of aircraft in use and the number estimated for the future. In general aviation, the greatest rate of increase is in turbine powered aircraft and rotocraft, while in air carrier aviation, the piston engines have almost been entirely replaced by jets.

AGRICULTURAL AVIATION

The airplane has been used in agriculture since 1919, when the United States Department of Agriculture (USDA) aerially dusted fruit trees infested with caterpillars. From this pioneering experiment stemmed the aerial application business in agriculture. Many different types of crops are now treated from the air. Airplanes can be successfully used for spraying, dusting, seeding, and fertilizing crops. In a recent year, for example, airplanes were used to treat 1 out of 6 tillable acres in the United States with some 140 million gallons of spray chemicals and more than 700 million pounds of dry chemicals.

Aerial spreading of fertilizer is not uncommon in the South and Southwest. It is particularly useful in rice production. Aerial seeding is profitable with some crops, such as grasses, grains (especially rice), cover crops, and oil seed crops other than cotton. It is predominantly used in the South and Southwest where rice is an important crop. The airplane has been used for reforestation and pasture reseeding. The airplane is also used to distribute defoliation chemicals which cause plants to lose their leaves and mature more rapidly. Defoliation aids mechanical cotton picking.

Aerial application is not the only segment of **agricultural aviation.** Farmers and ranchers often own their own planes to check on their crops and animals and to keep up their many other business interests. The **Flying Farmers** has become a nationally recognized flying organization.

Aircraft Type	1967	1972	1977	1982
Piston	101,292	128,300	149,600	187,500
Turbine	915	2,500	4,400	7,300
Rotocraft	1,622	2,600	3,750	5,200
Other (balloons, derigibles & glider)	877	1,600	2,250	3,100
Total	104,706	135,000	160,000	203,100

Figure 6. General Aviation Growth

(in millions)

Fiscal Year	Total	Fixed Wing Aircraft by Type			Rotocraft	Balloons Derigibles Gliders
		Piston				
		Single-engine	Multiengine	Turbine		
1967	21.6	16.9	3.7	0.5	0.5	0.1
1972**	27.5	20.8	4.5	1.2	0.9	0.1
1973*	28.8	21.8	4.6	1.3	1.0	0.1
1974*	30.2	22.8	4.8	1.4	1.0	0.2
1975*	31.8	23.9	5.0	1.6	1.1	0.2
1976*	33.2	24.8	5.2	1.8	1.2	0.2
1977*	34.8	25.7	5.5	2.1	1.3	0.2
1978*	36.4	26.8	5.7	2.3	1.4	0.2
1982*	44.4	31.9	7.1	3.4	1.8	0.2
1983*	46.2	33.0	7.4	3.7	1.9	0.2

*Forecast
**Preliminary

Figure 7. Hours Flown in General Aviation

BUSINESS AVIATION

Modern big business has turned increasingly to air transportation for a variety of reasons. Today there are fewer key executives to oversee large business and industrial complexes. Plants and offices have been scattered throughout the country for economic reasons. Many of these plants are located far away from a large airport. Demands on executives' time are ever increasing. Directives handed down via teletype are not as effective as face-to-face contacts. But how does the executive get from New York City to Savannah, Georgia, for a two o'clock meeting, to Birmingham that night to speak at a company banquet, and to Knoxville for a conference the next morning? He flies the company plane. Thus, he saves his valuable time. He has a flexible schedule, and he can land at any one of the more than 12,000 general aviation airports.

This is not to say that every major company has its own plane. Many use the airline services. Others charter airplanes. Still others use air taxi service. But business has definitely taken to the air. Executives, salespeople, buyers, factory managers, and many others use this time-saving method of getting their jobs done quickly.

FAA forecasts predict that for at least the next 10 years business flying will increase. By the mid 1970s, business flying will account for 10.4 million hours of flying time. This figure represents almost a third of the total number of hours of flying in general aviation. Yet, only a small percentage of the 400,000 or so businesses which need and can afford their own aircraft use them at the present time.

INSTRUCTIONAL FLYING

Every year many people learn to fly. Many more want to learn. Some of you are probably interested in learning to fly. Why? There are probably as many different reasons as there are people who learn. The reasons range from a desire to boost company earnings to thoughts of dining in Memphis, shopping in New York, fishing in Alaska, or surfing at Malibu. Whatever the reason, a student pilot needs to learn well.

The Federal Aviation Administration realizes this and has set up certain requirements and tests which the student pilot must pass to qualify for a **Private Pilot's Certificate**. The FAA has also certified flight schools which meet FAA curriculum requirements.

A prospective student pilot must be 17 years of age and able to pass an FAA administered medical examination to gain acceptance in an FAA certified flight school. On the first day of school, he is given a handout which describes the curriculum. He discovers that he will be given individual ground instruction before and after each flight. The ground instruction subjects are.

(a) Theory of flight including airframe and engine operation.

(b) Federal air regulations and air traffic procedures.

(c) Meteorology.

(d) Dead-reckoning navigation, including the use of the flight computer.

(e) Radio navigation and communication.

(f) Use of pilot information manuals such as the Airmans' Information Manual.

He is informed that, before he can solo, he must pass a written examination on general operation of the aircraft, theory of flight, and **Federal Air Regulations** (FARs). This test has been designed to assure that the student has acquired the knowledge needed to be competent in solo flight.

A student pilot soon realizes that there is a lot to know about an airplane. He discovers that it will take a lot of time and practice to learn to fly safely. After many takeoffs and landings, stalls, banked turns, practices in emergency procedures, talks with the tower, and hours of cross-country flying, the student is ready to solo. He is not allowed to take passengers up until he receives his certificate. He works for his required 20 hours solo time. He can fly as frequently as he wants, whenever and wherever he wants to go, provided his instructor considers him competent. The instructor always considers the weather before permitting a trip. Soon, the student has accumulated his 20 hours solo time and is ready to be tested by the FAA. When he passes both the written exam and a flight check, he is awarded a Private Pilot's Certificate.

RECREATIONAL FLYING

A trip to other countries used to be possible only for persons who could spend several months in travel. This left out average persons with only a two- or three-week vacation. Now many people fly to other countries for vacation travel. The travel time to and from other countries by air may be only one or two days, or less. This leaves most of the vacation time free for sightseeing and other pleasures.

Many persons own their own aircraft to fly for pleasure. Quick trips to the beach, to resorts, or to vacation spots in the mountains can now be made over week-ends. For many persons, flying itself is a form of recreation. The thrill of being able to look down at the earth from the sky is an enjoyable sensation to flying enthusiasts. Air shows and "flying" have also become very popular.

AIR TAXI SERVICE

Small planes are becoming faster, more comfortable, and safer because of modern equipment. These improvements make a major contribution to the boom in personal and business flying, but the boom does not stop there. It opens up a new field of operation commonly called **Air Taxi Service.**

The signs are good for this young industry.

First, the whole air transport industry is growing faster than was thought possible a few years ago. The airline fleet is getting larger, its airplanes are larger, and they are flying more trips and carrying more passengers.

Second, this growth is going on in the face of a decline in other kinds of public short-haul transportation such as trains and buses. The local service airlines are rapidly becoming small trunk lines. Because of the availability of the private automobile, other forms of short-haul transportation are losing ground.

Third, the US Postal Service is faced with short-haul problems. The number of mail trains has decreased by 90 percent since 1925, and traffic congestion interferes with mail trucks. The Postal Service is looking at air taxi service as a possible way to improve its operation.

There are two types of "air taxis": those which provide demand service, like ground taxis or airplane charter operations, and those which fly their routes according to schedules.

The people providing demand service have small equipment needs, and they can work as little or as much as they like. Most demand companies start with small planes with one pilot per plane to keep operating costs down. These companies are not likely to get rich, because their passenger volume is not high. Because costs are based on a minimum break-even fare, one person traveling alone seldom finds the cost-benefit ratio acceptable.

The scheduled air taxis are not really taxis. They refer to themselves as **commuter airlines,** but this is not quite accurate either.

Some commuter airlines connect with the major airlines, and some fly between heavily traveled points such as New York and Washington. These feeders using single- and twin-engine planes provide other lines with convenient connections. Though they call themselves airlines, they are not curtailed or regulated as such.

As air taxis and commuter airlines fill short-haul needs, they increase in importance, and they also face more problems. Two big problems confront them at the present. economics and regulation.

The economic problem was faced by the **trunk airlines*** years ago, and the answer then was subsidy. Now these same airlines disapprove of subsidies for air taxis. United Air Lines has realized that what is good for general aviation is also good for United, so the company has become partners with the local carriers. Today, profitable interline cooperation between this trunk and local carriers is a reality.

One of the possibilities under consideration is subsidy by local governments. The amount of subsidy would depend upon the amount of use the community made of the airline. The more they used the line, the less subsidy the community would have to pay. This would give the community pride of ownership and also promote greater usage of the line.

The second major problem of the airlines is regulation. There is considerable controversy about present standards. The air taxi people think they are too strict, and others think that single-pilot operation on any basis is not safe enough. As the operation of air taxis and commuter airlines increases, there are bound to be greater demands placed upon them by both the Government and the traveling public.

CIVIL AIR PATROL (CAP)

Discussion of the **Civil Air Patrol (CAP)** is included in this section because the aircraft used by the CAP are of the general aviation type.

Civil Air Patrol was formed by a group of civilians just prior to the US entry into World War II. Throughout the war, Civil Air Patrol volunteers used their airplanes to fly numerous submarine and border patrol missions, airlift missions, and mercy missions. Their wartime record was exemplary and no doubt helped influence the congressional action which first established Civil Air Patrol as a private, benevolent, nonprofit corporation and later made CAP a United States Air Force auxiliary.

Today CAP continues its services to the nation through three major efforts. emergency services, aerospace education, and the CAP cadet program. Its members wear the USAF uniform with special insignia to identify the wearer as a member of CAP.

*A *trunk line* is the main line or route of an airline company, a railroad, or the like

There are two types of active CAP members. cadets and senior members. To join CAP, the prospective cadet must be at least 13 years old but not older than 17. The senior member must be at least 18 years old. Upon being accepted, the CAP member attends meetings, completes education and training requirements, performs duty assignments, and participates in unit activities on a regular basis. Satisfactory progress in the program is rewarded by promotions and by eligibility for special courses and activities.

Membership in CAP does not exempt the member from service in the Armed Forces. Furthermore, membership does not obligate one to active service with the Armed Forces or with CAP during a wartime emergency. It does, however, provide the member with an opportunity for accomplishing a worthwhile service for his country and it provides an opportunity for developing self-confidence, self-discipline, and knowledge.

The nature of CAP and its relationship to the Air Force make it necessary that each CAP member understand military practices. For this reason, drill and ceremonies are integral parts of cadet training in CAP and physical fitness and moral leadership are also important in the cadet program. The subjects taught in CAP aerospace education are similar to those taught in AFJROTC. Because of this, AFJROTC cadets may receive CAP credit for their aerospace education courses. CAP cadets learn about aerospace achievements, the effect of these achievements on society as a whole, and how such achievements contribute to aerospace power. In some instances, cadets may even learn to fly at reduced rates through the local chapter of the CAP

CAP also provides aerospace education to its senior members and promotes aerospace education for the general public. This is accomplished by making curriculum materials and teacher training programs available to the educational community and by providing aerospace information to local civic clubs, fraternal organizations, and other interested groups.

CAP flies many kinds of missions. Primary among these is search and rescue. Under the supervision of the Air Rescue and Recovery Service (ARRS), the CAP, National Guard, Navy, Coast Guard, and local law enforcement units provide inland search and rescue in the United States ARRS provides its services to the Air Force and also to other military and civilian activities upon request. The Civil Air Patrol flies most of its search and rescue missions inside the US Annually, CAP members fly 69 percent of all ARRS missions In addition to this invaluable service, the CAP flies blood-life missions, provides emergency airlift for the sick and injured, and helps in emergency work following natural disasters. The CAP also plays a role in civil defense readiness. The seniors in the CAP program function as leaders in CAP flights, squadrons, groups, and wings. They provide much of the guidance for the cadet program.

GROWTH AND IMPACT OF GENERAL AVIATION

General aviation is the most rapidly expanding segment of US aviation. Think about that statement for a minute. What does it mean? It means that there are more general aviation planes, more general aviation pilots, more hours flown in general aviation aircraft, more people employed in the manufacture of general aviation aircraft, more general aviation airports, and more takeoffs and landings made by general aviation planes than all other types combined.

About 100,000 new pilot permits are issued yearly despite the expense of instruction, which for most students runs between $750 and $2,000. In 1972, more than 745,000 persons, including students, held active pilot certificates. This figure is expected to reach at least 1,250,000 by 1982. Nearly 75 percent of the takeoffs and landings at airports with control towers were made by general aviation airplanes. This is more than one aircraft movement every second for every day of the year.

Aircraft producers are paying more attention to general aviation's needs and desires. A wide variety of aircraft to meet the increasing number of missions for private air travel is being produced. Dozens of new models from trainers to pure jet business transports have been introduced. The passenger and cargo carriage capacity of many existing models have been increased. While production of new aircraft is high, utilization of the entire fleet of more than 135,000 planes increases.

Increased emphasis on pilot training, improved maketing techniques, and equipment with greater capability have been some of industry's efforts contributing to growth in general aviation. Economic and social factors also played a part.

There are many small general aviation airports scattered throughout the United States, but many general aviation airports are not much more than dirt landing strips. With today's rapid growth and improving technology, general aviation airports need to be improved. Many communities are considering improving or adding a general aviation airport as a way to attract new industries.

WORDS AND PHRASES TO REMEMBER

Federal Air Regulations (FARs)
Air Taxi Service
commuter airlines
trunk airlines
Civil Air Patrol (CAP)
general aviation
agricultural aviation
Flying Farmers
Private Pilot's Certificate

REVIEW QUESTIONS

1. **Define general aviation. Why is it growing so rapidly?**
2. **Business aviation is growing more rapidly than any other type of aviation. Why?**
3. **Define air taxi.**
4. **Discuss the Civil Air Patrol.**

THINGS TO DO

1. If there is a flying school in your community, you might contact officials at the school to determine how many pilots the school trains per year and report to the class on all that is involved in learning to fly, including cost.
2. You as an individual or as a member of a committee from the class might contact your local chamber of commerce or industrial development board to investigate the impact of aviation on your community.
3. If there is no local airport in your community, you might work up a report to indicate the economic advantage that would accrue to the community if an airport were added. Or you might justify the lack of an airport.

SUGGESTIONS FOR FURTHER READING

Perhaps the best source of recent information in this fast-growing field is periodical literature. Keep up with current developments in this area by reading such magazines as Aviation Week and Space Technology, and Air Force Magazine.

Chapter 3

Commercial Airlines

IN THIS CHAPTER, we are primarily concerned with the Government rules and regulations affecting commercial airlines. The restrictions placed on commercial airlines are for the good of all citizens. The Civil Aeronautics Board imposes required restrictions on airlines. Also included in this chapter is a discussion of the responsibility of the Federal Aviation Administration to provide safety regulations. You will discover reasons for the growth in the airlines industry. Modern equipment and technological improvements are reasons for people to use airlines more frequently. Rapid growth in any industry tends to create problems. With all the planes now in use, we can anticipate problems in the design of new planes and airports, the scheduling of these planes, and the efficient management of modern airports. A very important part of commercial airlines is air freight. The impact which air freight has had on our economy is discussed toward the end of this chapter. After you have studied this chapter, you should be able to do the following: (1) outline the responsibilities of the Federal Aviation Administration and establish proof that their concern for safety has paid off; (2) discuss some of the problems facing a growing commercial airlines industry; and (3) explain why air freight makes our lives more pleasant.

Commercial airlines is a term loosely used to include scheduled and nonscheduled airlines. When we think of the airlines, we usually think of the trunk lines operated by such companies as

American, Eastern, Trans-World, and United, but the term includes much more. Air cargo lines, such as Airlift International and Flying Tiger, are airlines; local service lines such as Delta, Western, and Braniff are airlines, even the commuter airlines, discussed in the chapter on general aviation, are airlines. All of these activities are lumped together and called **scheduled airlines.**

Yet, scheduled airlines do not present the entire picture. There are still some **nonscheduled airlines** which operate on the basis of passenger demand. Most of the traffic carried by the nonscheduled airlines consists of charter flights and overflow traffic from the scheduled airlines.

ROLE OF THE GOVERNMENT IN AIRLINE MANAGEMENT

The **Civil Aeronautics Board (CAB)** has broad authority to promote and regulate the civil air transport industry within the United States and between the United States and foreign countries. It has the responsibility of regulating airline competition, that is, authorizing enough competition to assure ever-improving service, but not to the extent that it would destroy an airline's prospects for economic health necessary for progress.

CAB Responsibilities

The CAB authorizes US carriers to engage in interstate and foreign commerce, and also authorizes foreign air carriers to fly in the United States.

Granting a carrier permission to engage in interstate and foreign commerce can only be allowed when certain requirements are met. These requirements are necessary to assure the continuing ability of the carrier industry to meet the needs of the public. For example, a scheduled airline must demonstrate that it is fit, willing, able, and financially responsible to perform such transportation properly; that its management is honest, efficient, and economical; and that its operation will serve the public convenience and necessity. The CAB awards a certificate of public convenience and necessity only after exhaustive investigation, including a full public hearing. The following is a brief list of some of the stringent qualifications an airline must meet.

1. A scheduled airline must serve all points designated on its certificate, even those that do not by themselves generate enough traffic for economical service. It cannot suspend service at any city without CAB approval, which is based upon a review of the public interest.

2. A scheduled airline must provide regular service, according to a complete system flight schedule that must be published and filed with the CAB. These schedules must receive CAB approval as international schedules receive International Civil Aviation Organization (ICAO) approval.

3. A scheduled airline must publish and file proposed fares and tariffs with the CAB, which can reject them if it deems them not in the public interest.

4. A scheduled airline must carry the mail and support national defense efforts in accordance with the rates and provisions set down by the CAB. The CAB determines minimum rates to be paid for these public services and the US Postal Service and the Department of Defense negotiate contracts with specific carriers who provide the services.

5 A scheduled airline must file full service, traffic, and financial reports with the CAB at specified time intervals. It must also keep its records and facilities open for CAB inspection at all times. It must keep the CAB informed as to ownership. It cannot merge, consolidate. or acquire another airline without CAB approval.

As you can tell by the scope of the problems it handles, the CAB is constantly considering new proposals and suggested changes that will result in better management and increased service. Often an airline finds that it would be advantageous to change a schedule or alter an existing route plan. In this case, the airline would submit a proposed new schedule or route plan to the CAB for consideration. The proposed change may affect other airlines serving the same area and they may object to the plan. When all objections are received, the proposal goes before the Board for a hearing. The Board can dismiss the proposal, accept it, accept it on a temporary basis, or expand it. In reaching a decision, the Board does not necessarily decide according to precedent. Each case must be judged on its own merit and the Board may reverse its decisions made on past cases.

The CAB is also concerned with insuring that airlines are compensated for providing essential services at a loss to their companies. For example, the Board may grant subsidies to carriers to finance the costs of providing necessary air service to communities when the volume of traffic is not sufficient to meet the costs of such service. Thus, the public interest is served by providing air transportation to the small communities which would otherwise be without air service.

Another area of interest and responsibility for the CAB is that of relationships between carriers. The Board approves or disapproves all proposed mergers, acquisitions of control, interlocking relationships, and agreements between air carriers considering the interests of travelers, shippers, and other air carriers which may be adversely affected. It is concerned with whether air carriers and travel agents engage in unfair methods of competition and deceptive competitive practices in the sale or conduct of air transportation services.

As stated earlier, the CAB is the Government agency concerned with the broad aspects of promotion and regulation of the airline industry. The Government is also concerned with the actual operation of the nation's aircraft. Regulation and control responsibilities in this area are assigned primarily to the Federal Aviation Administration (FAA).

FAA Responsibilities

The Federal Aviation Administration (FAA) has the responsibility for publishing and enforcing safety regulations. The special Federal Aviation Regulations it has established for scheduled airline operations are more detailed and strict than those of any other class of aviation.

A scheduled airline is required to have a complete dispatch system encompassing communications for the dispatch and operational control of all its aircraft. No scheduled flight can take off without specific authority from a system dispatch office. Dispatchers, who must hold FAA dispatcher certificates, must be thoroughly familiar with the route, weather conditions, navigational facilities, and airport conditions under which they dispatch aircraft.

A scheduled airline can fly on instruments over a particular route only if the route is equipped with navigational aids approved by the FAA. It can schedule flights only into airports inspected and approved for the operation by the FAA.

A scheduled airline must show that competent personnel and adequate facilities and equipment are available along its routes to properly service, repair, and inspect its airplanes.

Each scheduled airline flight captain must be pre-qualified on the routes he is to serve, demonstrating adequate knowledge of weather characteristics, navigational facilities, communications procedures, and the airports he may have to use.

A scheduled airline must maintain two-way ground-to-aircraft radio equipment over all routes served in order to maintain system-wide contact. This is in addition to radio facilities operated by FAA.

A scheduled airline must fly "proving runs" under the supervision of the FAA before inaugurating a new route or aircraft.

A scheduled airline must have available weather information of a type prescribed in detail by the FAA. For example, a trip may not be cleared unless a complete enroute and destination weather forecast is attached to the dispatch release form.

The FAA's concern for safety has paid off for the air traveler. In fact there are from seven to 10 times as many fatalities per million miles traveled by automobile as there are for a like number of air passenger miles traveled.

FAA is not complacent about the airline's safety record, and officials realize that the air is growing more crowded daily and congestion breeds accidents.

The US scheduled airlines, in addition to observing the highest safety standards required of any segment of aviation, observe service and operational policies and practices above and beyond that required by the Government. They have exercised leadership in the development and use of many safety devices and procedures including (1) creation of the Nation's first air traffic control service; (2) pilot-operated airborne weather radar, (3) anti-collision lights on aircraft; (4) reversible-pitch propellers, and thrust-reversing mechanisms for jet engines, (5) **preventive maintenance**—through aircraft inspections at frequent intervals, and replacement of parts at prescribed intervals whether or not they need it; (6) swift notice to all airlines of a problem encountered with an aircraft of any one airline; and (7) a policy of flying under instrument rules and procedures even in good weather when operating above specified altitudes, as an added measure to assure safe separation of aircraft in flight.

The airlines and the FAA cooperate in this overall safety program for they believe it is their responsibility to protect the traveler from accidents which can be prevented.

AIRLINE MANAGEMENT

Management of commercial airlines has become exceedingly complex. There are, of course, numerous reasons to account for the growing complexity, but one of the most obvious reasons is the phenomenal growth of commercial aviation.

Growth

Commercial aviation is far and away the fastest growing major industry in the country. Taking 1950 as a starting point, the airline performance is unique. The electric utilities have more th[illegible] tripled in size; the chemical industry is about four times as [illegible] as in 1950; the trucking industry has almost tripled; and [illegible] and automobile industries continue to increase production each year. Total industrial production in the country has doubled since 1950. But by 1970 the airline industry had grown to more than seven times its size in 1950.

In 1971, the airlines experienced a period of slow growth. Although scheduled passenger miles flown were slightly higher than previous years, they fell below the number expected. Many personal and business decisions to fly were affected by higher fares and a sluggish national economy. To a small degree the fear of air piracy kept people on the ground.

The actual number of air transport aircraft produced in 1971 and 1972 was lower than it had been in the late 1960s. In terms of available seats, however, production far exceeded the levels of previous years. This is explained by the changeover in the airline industry to the large-capacity, wide-bodied jets. Total revenue passenger miles flown as shown in Figure 8 are expected to increase from 140 billion in 1972 to about 404 billion in 1982. In other words, revenue passenger miles will almost triple in ten years, but the number of carrier aircraft (See Fig. 9) will increase by only one-third.

In 1950, only 0.2 percent of the gross national product (GNP) was spent on air transportation. The GNP in 1971 exceeded a trillion dollars and air transportation represented 0.7 percent of it. By 1982, it is anticipated that more than 1 percent of the GNP will be spent on air transportation. This increasing trend can be attributed to many factors such as greater aircraft speed, range, comfort, and safety, higher personal income levels, lower fares, more leisure time, and greater interest in travel.

The rapid growth of air traffic is made possible by a great outpouring of capital funds. This investment in new equipment and facilities stimulates company growth by preparing for it.

What is the reason for this growth?

Throughout history transportation and communication have gone hand in hand with each acting as a stimulus for the other. Although there have been great advances in the technology of communications (with telecommunications satellites, color television, and direct distance dial telephone service, for example), the basic efficiency of the face-to-face confrontation has never been equalled. Today, there is even greater demand for fast transportation to get one to a meeting and back again. This demand is growing greater as our society becomes more complex. The reason for the meetings vary from passenger to passenger. Some are rushing to business conferences, others are going home, and perhaps still others are off for vacations. Whatever the reason for the trip, rapid transportation is appreciated, because it allows time for valuable face-to-face communication.

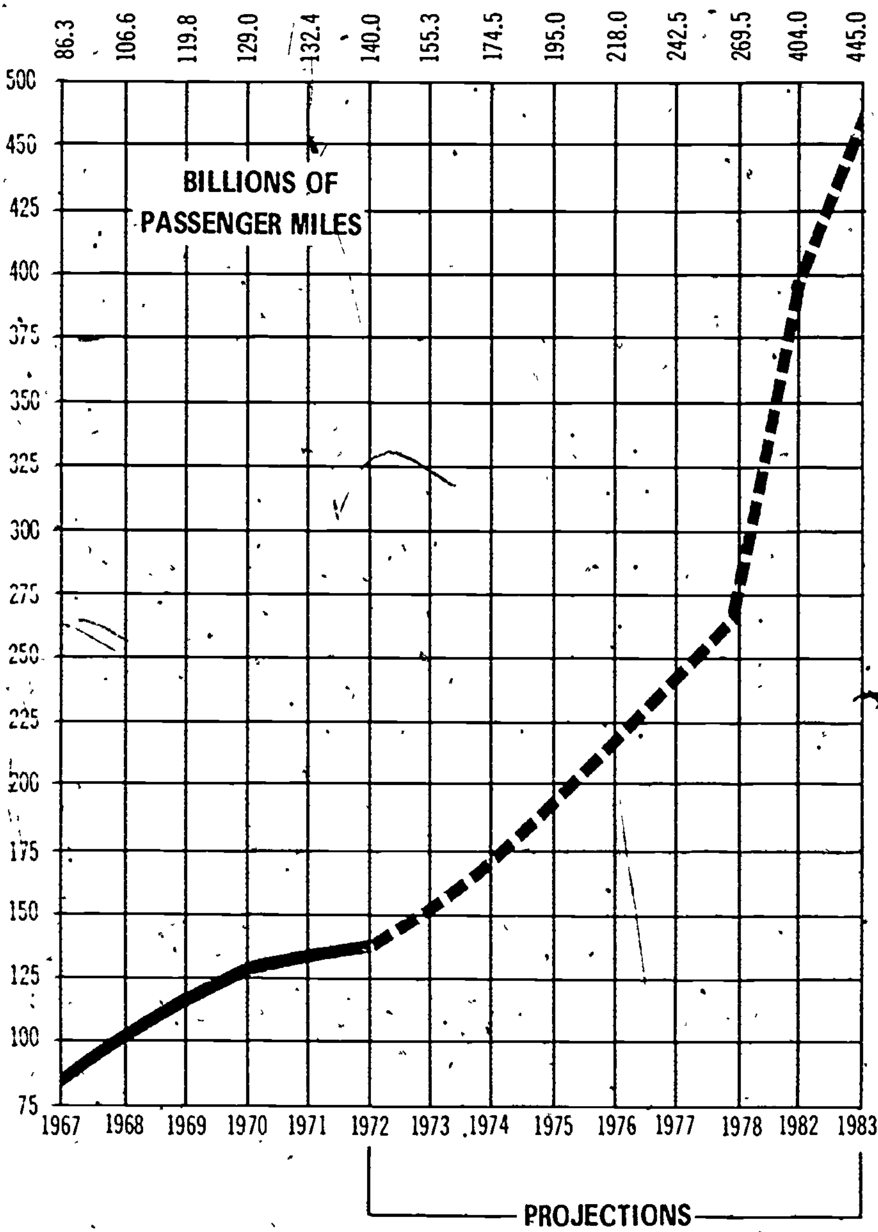


Figure 8. Projections of Passenger Traffic

The airlines have worked at serving the Nation's communication need in two major ways. They have first applied radical technological improvement. Public response to this improvement—in speed, comfort, convenience, and reliability—has always been dramatic. Hence, there is a constant pressure on the engineers to advance the state of the aviation art. Perhaps the greatest untold story of this industry is the long partnership between airline engineers and manufacturers, each stimulating the other to develop technological breakthroughs. A major part of this effort has been the adaptation of military technology to civil use. However, as the industry has grown in purchasing power, it has generated its own research and development support. Major US and foreign industries are finding that it pays to develop innovations tailored especially to the airlines. Combining this with military research results in continued technological improvement.

In addition to the stimulant of an improved technology, competition has also played a central role in the airline growth story. The ambitions of competitors are reflected in the size of their orders for airplanes. Where there are plenty of empty seats, there is no restraint on demand. Therefore, passengers are seldom turned away, a very desirable feature for the traveling public. In turn, the competitive pressure to fill those empty seats leads to efforts to get more people to fly. Given many additional seats, airlines mount massive efforts to sell them. This process has been a major contributing factor accounting for the remarkable development of the air travel market. In 1972, the airlines sold 48.1 million more seats than in 1967. In 1983, they expect to sell more than 475 million seats, nearly 3 times as many as in 1972. (See Figure 8.)

Aircraft Type	1965	1972	1977	1982
Piston	1,221	131	68	45
Jet	564	2,107	2,427	3,110
Turboprop	276	345	233	130
Total Fixed-wing	2,061	2,583	2,728	3,285
Helicopters	20	17	22	25
Total All Types	2,081	2,600	2,750	3,310

Note: Included are all passenger and cargo aircraft owned or leased by commercial air carriers. Aircraft used for training and air taxi operations are not shown here.

Figure 9. Air Carrier Aircraft.

Critics complain that the industry is operating with too many empty seats. Good service at peak times of day, of the week, and of the year inevitably means empty seats at other times. Running an airline is a little like running an elevator system in an office building. If the object is to keep the elevator full **(high load factor)**, then obviously it might be possible to install only one elevator in a building and rent all the space normally given to large elevator capacity. Average load factors on the one elevator would be high, but some of the tenants might not get home until after midnight. Those who worked on the top floor, where relatively few people need to go, would have to wait forever. If, however, good service is the objective, the building operator has to increase the number of elevators at the sacrifice of **average load factors.**

The airline industry could buy fewer airplanes and plan for a scarcity of seats, but the public would soon become aroused at the lack of seats and the inconvenience. This would lead to a decrease in flying.

Coinciding with this growth of air travel has been a major change in the habits of work and play of the entire nation. A new mobility, unlike anything experienced by any nation before, is developing.

The usefulness of the airplane to the business world has long been appreciated. Mobility of the productive people in business stimulates the pace of economic development. Decisions are made faster, work gets started sooner, problems are resolved more readily, and the whole process of selling and buying is aided by fast transport. Telephone and teletype have not replaced personal confrontation. The personal touch still sells the product best. Mobility is valuable to the business world, but is equally valuable to the arts, sciences, religion, education, the law, government, and other branches of human activity.

Promotional Fares

Perhaps one of the most significant social changes that is taking place in the last half of the twentieth century is the change in the leisure activities of Americans. Demands for vacation and personal travel by air occupy priority attention of airline management.

There are dozens of ways of approaching the market, and the airlines are prepared to try them. The airlines expect to reap substantial benefits from the combination of an air trip and a rental car. As roads become increasingly crowded and super highways more and more monotonous, the airlines are strongly advocating the fly-and-drive combination.

But by far the most productive experiments are in the field of promotional price reductions. Numerous excursion, off-season, off-peak, and other **promotional fares** are available both for domestic and international travel. The airlines have combined many of these low fares with hotel, car-rental and sight-seeing bargains and have developed highly attractive all-expense packages. The all-expense package is a well-tested method of getting "first time" travelers away from home.

For the individual traveler, the **excursion rate** is the most economical. To take advantage of this reduced rate, the traveler must purchase a tourist class round trip ticket. The excursion rate applies from midnight Sunday to 2.00 p.m. Friday and from midnight Friday to 2:00 p.m. Sunday.

Space-available reductions for military men on leave have also been highly successful. If the seat has not been sold by departure time, a military man in uniform may use it at one-half price. Millions of military men have taken advantage of this 50 percent savings since it was introduced. Military personnel may also reserve tourist class seats at two-thirds the normal fare.

The airlines are now offering space-available discounts for other groups. Even with the fare reductions, the airlines realize a profit, a partial fare is more than no fare on an empty seat.

These and other promotions including the rapid spread of economy and coach services, have resulted in a marked reduction in the average revenue the airlines earn per passenger mile. However, this is partially offset because more and more people are using the airlines, and air travel is becoming increasingly accepted as a common mode of travel.

These reductions will continue, but there are practical limits to fare reductions in a period of generally rising costs. The airlines, traditionally, have operated on a thin margin of profit. In their most profitable period, the early 1950s, the margin was 5 cents on the dollar. The profit margin is now considerably less. Profits are necessary to underwrite vast expansion and improvement programs.

Promotional fares have allowed airlines to sell more seats during off-peak periods, but they have been unable to meet all the demand for seats during peak periods. Congress has authorized other interested and qualified air carriers to supplement the regularly scheduled airlines by providing limited charter service to certain groups of travelers.

Air Charter Service

Suppose a high school graduating class wanted to fly to the Bahamas as a class trip. The first question the planning group would probably ask is, "Can't we get a group rate?" Everybody loves a bargain, and nonscheduled air charter service aircraft have provided such service.

Air charter service was officially started in 1962 when Congress authorized air carriers to supplement scheduled airline service. However, Congress recognized the necessity for protecting the scheduled airline companies and placed restrictions on supplemental carriers. These carriers cannot sell individual passenger tickets nor can they solicit business from the general public.

Air charters then are limited to three types of group service. The first type is **single-entity charters** where a single entity, such as a company, charters an entire aircraft. A second type is the **affinity group charter.** This type is for groups such as a high school graduating class, who have some common and continuing interest other than just the desire to take a trip. For those persons who are not members of a group, the **tour group charter** can be used. Tour charges must include charges for ground transportation, hotels, or other items in addition to the cost of the flight.

Charter flights, like other airline services, are affected by changes in policy as well as the public demand for services. Recent growth indicates there is a definite demand. Supplemental carriers have adjusted to CAB regulations and are now available for most groups. Air charter service is here to stay and may well be the best way to go.

IMPACT OF THE JET AGE

Today most of the larger airlines have converted their fleets from a mixture of several types of aircraft to an all jet inventory. The turboprop is more economical for shorter hauls, but it is being replaced. What has brought about this demand for jets?

First, let's look back to 1952. This was the year the British airlines placed the Comet I (Fig. 10) in service and thereby

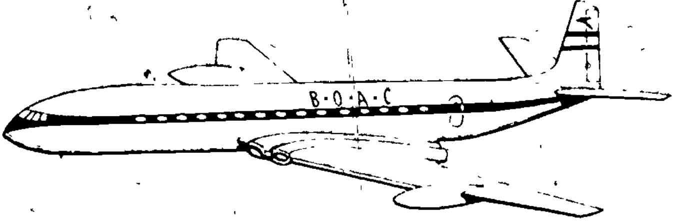


Figure 10 Comet I

became the first to use jet aircraft in commercial operations. Technology was advancing rapidly and manufacturers were designing and developing improved aircraft faster than the airlines had previously paid for them. This was indeed unfortunate for some airlines because the rate of aircraft replacement is one of the most vital features of an airline's whole economic structure.

Boeing and Douglas were applying their technological knowledge in designing improved aircraft as well as in designing jets. Here again the military influenced civil airline progress and design. Without the B-47 bomber there probably would have been no Boeing 707; and the theoretical advantages of turbo-props on the cost side would have been given more emphasis.

American Airlines, using the Boeing 707, was the first to begin domestic US jet service with its own aircraft. It inaugurated the transcontinental route from New York to Los Angeles on 25 January 1959. Jet service was underway. Another significant date in the progress of jets was Pan American's inauguration of its round-the-world jet service on 10 October 1959.

Once the appetites of the airlines had been whetted by the speed, reliability, and passenger appeal of the new aircraft, ways and means were found to extend the scope of the jet aircraft beyond original plans. In the early days, the jets were believed to be best on longer range flights on which speed could be exploited; but on short-haul routes the turbo-prop was thought to be more suitable. But even on short-haul routes the jet had great passenger appeal. Competition has brought the day of all-jet liners into being. Trans-World Airlines, first claimed the distinction of having an all jet fleet, and many others rapidly followed suit.

Competition demands continuous updating of aircraft, and this is complicated and costly. Manufacturers must be sure of a market for new planes before actual production can be started, otherwise millions of dollars may be wasted in design and development. For example, McDonnell Douglas felt they could turn their tri-jet DC-10 into a twin jet shorthaul, widebody transport. The DC-10 Twin, could be produced for delivery late in 1974 if sales could be assured. To get some idea of user acceptance of the DC-10 Twin, McDonnell Douglas invited representatives of the air carrier companies to a two-day symposium in April 1972. Fourteen US and foreign carriers sent representatives.

The DC-10 Twin would be 17 feet shorter than the DC-10, but it would have larger engines to permit heavier loads for short-haul operation. The new aircraft would cost the buyer about $16.2 million. (See Figures 11 & 12).

Figure 11 DC-10

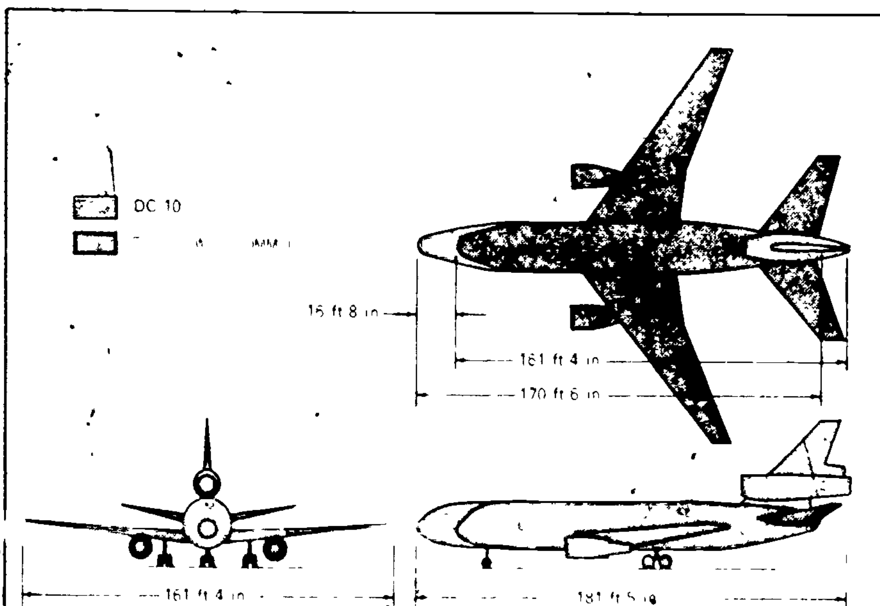


Figure 12 Comparison of DC 10 and DC 10 Twin

The symposium provided the carriers an opportunity to evaluate the DC-10 Twin's capabilities in meeting anticipated needs and gave them a basis for comparing prices with other manufacturers At the same time, McDonnell Douglas officials were afforded a chance to estimate the carriers' acceptance of the aircraft before spending some $120 million for its development. The decision was made to go ahead.

The DC-10 Twin represents only a part of the effort by the aircraft industry to develop a subsonic aircraft that is more efficient than those already in operation. Designs such as the Air Force's powerful C-5 engine resulted in the development of the DC-10 and the Boeing 747.

Boeing used a design similar to the C-5, Figure 13, to produce the 747, Figure 14. The Boeing 747 is basically a passenger plane with 490 seats, 10 abreast. The variations of design for the 747 include such things as five passenger classes, with a luxury class at the nose, first class next, then standard, economy and coach sections, entertainment section, and a section for nonsmokers. One popular version, Figure 15, has 38 first class and 313 economy seats.

The Boeing 747 is doing much to alleviate some of the traffic pressures in the air while creating some knotty problems on the ground. The strain one of these planes places on airport runway and taxi surfaces is tremendous. Also, where do you put 490 passengers when the aircraft is grounded by weather? As a result of this problem, many of the accommodations offered by

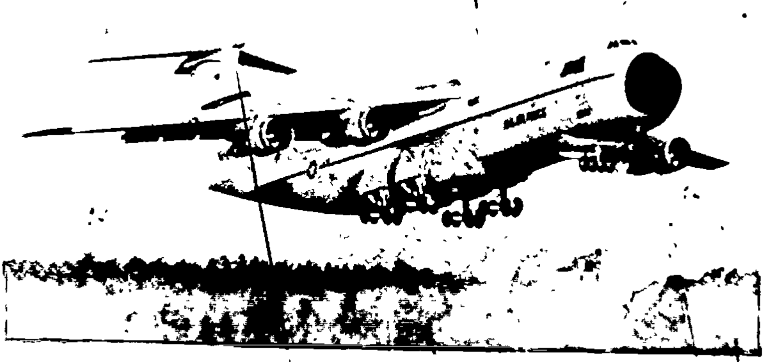


Figure 13 C-5 Galaxy

Figure 14. Boeing 747

major airports have been altered to serve the 747 and other large jets.

A great amount of effort and money has also gone into the development of a large jet that would travel over long distances at a much higher rate of speed than the 747. This plane is the **supersonic transport (SST).**

THE SUPERSONIC TRANSPORT (SST)

The development of a high-speed, long-range, transport was underway a decade ago in Europe and the United States. Such an aircraft traveling at 1,800 miles per hour at 60,000 feet could deliver 280 passengers across the Pacific Ocean nonstop. A joint effort of the French and British aircraft industries, with Government support, produced the first operational SST, the Concorde. The Soviet Union also has an SST, the TU-144. The US prototype was developed by the Boeing Company and was scheduled for initial flight in 1972, with deliveries to be made to the airlines beginning in 1976, but the Boeing SST project was dropped in 1971.

The Boeing SST prototype has an overall length of 280 feet and a wingspan of 142 feet, its tail section is 50 feet high, the aircraft's weight is approximately 635,000 pounds, and each of its four General Electric GE4 engines can produce 60,000 pounds of thrust (See Fig 16)

In addition to the tremendous developmental and production costs of the SST, a major environmental consideration went into the decision to abandon the project The noise and shock waves

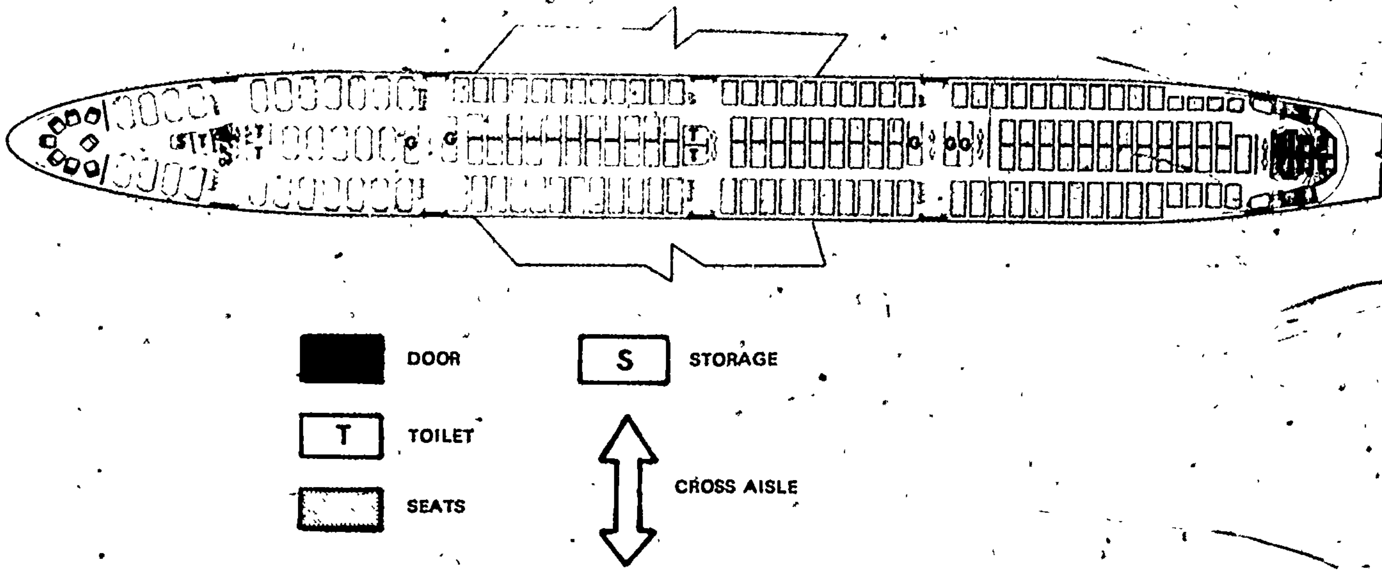


Figure 15 747 Interior

anticipated were considered to be intolerable. Flight would necessarily have to be almost exclusively over water to protect the population. Other assumptions by FAA regarding the SST included:

1. Maintenance of the aircraft would involve the development of new methods, because of the size and complexity of the SST, the type of propulsion systems, and the evolution of airborne integrated data systems in support of maintenance.

2. Ground support equipment, passenger terminal facilities, and turn-around servicing have already been expanded to serve jumbo jets. Therefore, only slight additional considerations would be required to serve the SST.

3. No significant changes would be required for taxiing the SST. Systems development is already underway to provide television aid to pilots of the wide-body jets which allows them to see the position of nose and main gears while taxiing. Television aid would certainly be required for the SST because its flight deck is about 60 feet from the nose gear and 175 feet from the main gear.

4. Flight dispatch procedures for the SST would probably require computer-aided planning and flight following capabilities for precise operational control. Because of the heavy traffic at terminals in most cities and because of the critical nature of fuel consumption in SST operations, flights could not be released for takeoff unless the plane could land immediately upon arrival at the destination. Landing delays are never economical, and it would be impractical to hold the SST over an airport to await its turn to

Figure 16 Boeing Supersonic Transport (SST) Prototype.

land. Air traffic control procedures would have to take into account the flight profile, cruise altitude, and maneuvering restrictions of the SST. The radius of a turn at supersonic speed is very large. Collision avoidance by the "see and be seen" principle would be almost impossible except, when overtaking another aircraft.

5. New materials testing methods would be required to assure an adequate safety margin in the life of the aircraft structure.

6. New concepts of failure analysis would be needed for airworthiness certification.

7. Test flight standards would have to be developed for the SST to insure an adequate level of safety.

As illustrated by the SST, the implications of airline investment are far-reaching. The improved efficiency and economy of operations made possible by modern equipment has been the most important single means of absorbing the steady advances in wage rates and in material and equipment prices. By this means, airline investment has enabled the carriers to keep average fares per passenger mile down and thus contribute to an easing of inflationary pressures.

SOURCES OF FUNDS

An overwhelming proportion of airline earnings have been retained to help finance required investment in expansion and improvement. In a recent year, for instance, more than 85 percent of the profits earned were reinvested in the industry's expansion and improvement program. Yet retained earnings were sufficient to finance only about 30 percent of these expansion outlays. The balance was derived from other internal sources.

It is this investment program that enables the American airlines to give the most modern and efficient airline service in the world.

ROUTE STRUCTURE

Routing is important to an airline, because traffic flow determines the financial health of an airline. So each airline jealously guards its routes and strenuously objects to more competition on its established routes, but it welcomes an additional route segment.

More than 770 cities are served by the scheduled airlines. Of the total, more than 400 are served exclusively by local service airlines.

The routes shown on the map in Figure 17 are designated and regulated by the CAB. Service to Alaska and Hawaii and many new stateside routes have been omitted for lack of space. Although the map looks like a busy hodgepodge of lines, it illustrates to some extent the volume of scheduled air service in the United States. These routes are not permanent, but are subject to change by the CAB. Most changes which occur are additions to, rather than deletions from, the present system.

Each airline has certain cities it must serve according to a published schedule. The CAB approves the route and regulates competition so that one segment is not overworked and another ignored. To add a segment to an established route, an airline must file projected plans with the CAB, which will conduct a feasibility study. If the Board decides the route segment could be profitable and no airlines strenuously object, it will grant a trial run authorization.

On some of the routes, local service airlines and trunk lines are in direct competition, while on others, the local service airlines act as **feeders** to the trunk line long distance hauls. Yet even this elaborate route system fails to serve the public adequately. There are many areas left that receive little of no airline service. It is in these areas that the commuter airlines and air taxis are useful. They use smaller planes and place smaller demands on the airports they use. Commuter airlines and air taxis are proving that they can provide good service.

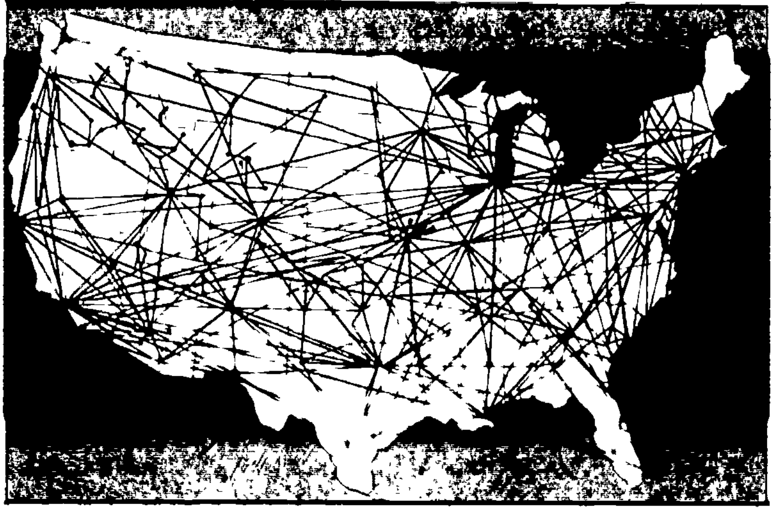


Figure 17 Airline Routes

Thus far we have stressed interline competition as a stimulus to airline growth and improvement. But interline cooperation also plays its part in improving passenger service. It is often difficult to fly directly from one point to another without changing airlines and the airlines cooperate to meet the passenger's needs.

Richard, for example, wanted to fly home for Christmas vacation. He was living in Montgomery, Alabama, and his home was in Salt Lake City, Utah. He called Delta Airlines in Montgomery to schedule his flight. Delta did not have a flight to Salt Lake, but they arranged his flight by checking reservations with other airlines.

Richard flew with Delta from Montgomery to Dallas. At Dallas, he changed to Braniff Airlines. Braniff flew as far as Denver, Colorado. At Denver, he changed to Western Airlines which flew to Salt Lake City. On the trip back to Montgomery, he was routed another way because of heavy traffic. He left Salt Lake City on Western, changed to Braniff at Denver, changed to Eastern at Dallas, changed planes (still Eastern) at New Orleans, and landed at Montgomery.

The entire trip was prearranged and booked by Delta Airlines in Montgomery. It is this type of cooperation that insures today's traveler the speedy and convenient trip he has come to expect.

AIR FREIGHT

In 1971, domestic and internationl **air freight** (express and mail) was 5.3 billion ton miles. Air freight tonnage is expected to reach 25 billion ton miles per year by 1982.

Air freight is big business, and its future is bright. The massive investment by the airlines in cargo aircraft has a favorable effect on the cost of producing and distributing goods. Airline investment has enabled the carriers to bring about the marked downward trend in air freight rates. Future improvements made possible by larger airplanes will have a further favorable impact on freight rates.

The development of air freight so far has shown some remarkable parallels with the history of the trucking industry. The trucks made possible a great speed-up in the processes of production and distribution for industry. In the radius of their most economic operations, they provided overnight door-to-door delivery.

Today, more attention than ever is being given in industry to shortening the time required to produce goods and reducing the time between production and sale of goods. Anything that helps reduce the time between order and delivery is very significant, particularly in highly competitive industries.

The key elements in air freight growth can be divided into two major categories. The first includes a list of things airlines have been doing on their own to stimulate air freight. The second includes a number of basic production and distribution trends which are highly favorable to air freight growth.

The most significant decision made by the airlines has been to provide capacity in advance of demand. Hundreds of millions of dollars have been committed to flight equipment in anticipation of the growth of the business. The consequences are two-fold. First, top priority is given by airline management to expanding the market. With enormous capacity to sell, the airlines gear up their sales efforts to sell it. Second, plenty of capacity means that a convenient and readily available service is provided which can be relied on day in and day out. Surges in demand can be handled and new markets won for air freight. The existence of plenty of capacity has thus been a major factor in creating freight traffic.

An important part of the capacity story, of course, is the growth of the passenger service. The jet airplane—a few hours to anywhere—has caught the imagination of the American people. Such an upsurge in jet travel has its impact on the freight business because the jets have very large freight compartments. As the switch to jets accelerates, enormous new capacity will open up on the local service airlines and on short-haul flights all over the country. The Boeing 727 "Quick Change" airplanes have significantly increased freight capacity. Finally, the very large Boeing 747, the Lockheed C-5A, and the Douglas DC-10, have also increased air freight capacity significantly.

Improvement in quality of service includes the use of advanced electronic systems for keeping track of lists of goods **(waybills).** Airlines sometimes even suggest markets for shipper's products. Particularly in the foreign field, they maintain special services and publications describing market opportunities for air freight shippers. As a result, many a domestic producer has found himself deeply involved in the export trade. The airlines have become experts on the distribution patterns of major industries and are constantly working with shippers to improve the production and distribution process. They give advice on improvements in packaging and are currently working on a container program which has increased efficiency of handling and lowered the packaging cost on a wide variety of commodities.

Much progress is being made in closing the gap between air and ground rates. Air freight revenues dropped 20 percent per ton mile in the past ten years. What this means is that you can ship more goods by air for your money now than in past years. By way of comparison, railroad average revenue per ton mile has dropped only about 12 percent, and truck revenue has actually risen 8 percent in this 10 year period. This decline in shipping cost is continuing. Major impact is expected from the reductions in shipping rates which have been filed with the CAB for the airlines' new family of containers.

The airline industry has been energetically stimulating traffic growth by improving rates, capacity, and quality of service.

Airline initiative has been paralleled in industry by a number of important trends highly favorable to air freight. The most important trend is the increasing pressure on industry to speed up the production and delivery cycle. Modern management methods are increasingly being applied to eliminate lags in the production and distribution process. As management techinques become more effective, profits increase. Air Freight is particularly valuable where components have to be gathered from all over the country. Significant savings can be made by speeding up the gathering process. Many complex industries are beginning to rely on air freight as a way to keep production lines running in different parts of the country.

In marketing, the computer has had a significant effect. For industries using tens of thousands of spare parts, or large varieties of sizes and colors, the money saved by maintaining a single national warehouse with a short reorder cycle via air freight is considerable. The trend in recent years to computerized inventory control has increased the use of air freight.

As the modern production process grows more complex, airlines recognize the importance of the emergency shipment. While the mainstay of the air freight business has become the regular shipper, emergency shipments are also very important. Whether the item is a new propeller shaft for a steamship or a miracle drug for a small boy, air freight provides an essential service.

Air freight has made great strides, but the lines are still confronted with some major problems. Air freight is changing so rapidly that many air freight employees need annual refresher courses. Second the airlines need to develop more air freight specialists. Third, they need to move faster in developing and installing electronic systems to simplify documentation. Fourth, they need to make further improvements in air-ground coordination and build more and bigger freight terminals in more cities.

The quality of air freight service is being improved, and efficiency and economy of operations result in rate reductions.

MANAGEMENT PROBLEMS

Occasional problems are to be expected, but what aviation observers see in the future is increased demand, increased crowding on runways, and increased delays for airliners.

Such delays mean irritated passengers and heavy costs to the airlines. Loss in wasted fuel, crew costs, and other outlays have cost the airlines a minor fortune already and the situation is getting worse. Who knows for sure what delays will cost when the big planes holding 500 to 1,000 passengers arrive?

Delays occur daily across the country. They are considered when scheduling is done, but still problems come up to throw off the entire system. Little things like mechanical difficulties and weather can mar an otherwise perfect schedule.

Connection Problems

In many ways connection problems are tied in with scheduling problems. The routes authorized by the CAB necessitate connecting flights. No one airline serves all areas.

Since connecting flights are vitally important to air travelers, airlines cooperate in setting them up. One point in favor of rate regulation is that it facilitates connections. A passenger who misses his flight because of delay in flight can turn in his ticket with another airline and catch the next plane with a minimum of delay. In this way the passenger is satisfied and the right company gets paid for the actual flight. This is how it works most of the time, however, problems arise during peak periods with peak traffic. Christmas is one of these times. If a traveler were delayed enroute and missed his connection, he would have to wait until the next flight with an empty seat. At Christmas he could have quite a wait on his hands.

Since in the near future larger planes will bring ever increasing numbers of passengers to ticket counters, the airlines and airports must cooperate in planning how to handle the crowds. Already waiting lines at ticket counters are long and slow, this is even worse for the passenger who only has 20 minutes to make a flight and the line is 30 people long. Airline companies are turning to computers to help cut down the time that counter personnel spend looking up schedules and cross checking connections.

Air Piracy

A very real problem for commercial airlines today is air piracy. Although not well know, this is not a new problem. Before we discuss how this affects today's air traveler, let's briefly review the history of air piracy.

The modern era of aircraft hijacking **(skyjacking)** is dated from 1 May 1961, when a National Airlines Convair 440 with six passengers on board, enroute from Marathon, Florida to Key West, was hijacked and taken to Cuba. This was the first successful attempt to hijack an air carrier aircraft of United States registry. However, there is evidence that aerial piracy has been a serious problem since the beginning of air commerce.

Among the earliest reports of aircraft hijackings were those in the period from 1923 to 1926, involving a French air carrier which flew across the Spanish Sahara. The desert tribesmen, called Pilliards, would lay in wait for aircraft which made forced landings in the desert. The crew members would be captured and either murdered or held for ransom. This problem became so serious that the airlines were forced to fly the aircraft in pairs. If one was forced down, the other would land and rescue the crew and passengers. The service was finally discontinued in 1926 because of the Pilliards.

In 1930 and 1931, a number of revolutions swept through South America and the revolutionaries seized a number of aircraft in Peru, Brazil, and Chile. In 1931, the threat of hijackings became so serious in Brazil that Pan American Airlines' operations were completely halted and they discharged most of their personnel in that part of the world. Pan American also encountered aerial piracy with its introduction of flying boat service into China during the 1930s. They found that in order to protect their aircraft when they landed in Chinese ports it was necessary to equip them with machine guns.

Between the end of World War II and the beginning of 1961, there were 33 successful skyjackings reported, all involved aircraft of foreign registry, and most occurred in Central Europe.

The history of aerial piracy clearly shows that attempts to take over aircraft is not something new. However, it is only very recently that skyjacking has become highly publicized. During a 12-year period ending in 1973, there were 160 attempts at air piracy, and 72 of these were successful skyjackings. The greatest number of skyjackings occurred in 1969 when 40 attempts were made and 33 succeeded. Since that time the success rate has dropped significantly because of security measures employed by government and the aviation industry.

On 5 September 1961, Public Law 87-197 was enacted as an amendment to the 1958 Federal Aviation Act. This law defined aircraft piracy as any seizure or exercise of control, by force or violence, or threat of force or violence, and with wrongful intent, of an aircraft in flight in air commerce. The penalty for conviction of air piracy was set at a minimum of 20 years imprisonment, to a maximum of death. The law also established a penalty of up to 20 years and/or fine of $10,000 for conviction of assaulting, intimidating, or threatening a commercial crew member or flight attendant (stewardess), to the point of affecting the ability of crew members to perform his or her duty. The penalty is increased to a maximum of life in prison if a deadly weapon is used. A $1,000 fine and/or one year confinement was established for anyone convicted of carrying a concealed weapon aboard an air carrier aircraft.

In 1969, the Justice Department authorized the FAA to place armed guards (sky marshals) aboard flights in an attempt to reduce the skyjacking threat. This action was only partially effective. Many persons felt an in-flight shootout was not the best solution. The philosophy that evolved during the 1970s calls for preventing the hijacker from boarding the aircraft. Psychologists have been employed to assist in identifying potential skyjackers with little success. Electronic detection devices have been installed at all commercial carrier airports and armed guards are present at loading gates. At the time of this writing, Federal Regulations require that all carry-on baggage must be searched before boarding.

On the international scene, organizations such as the United Nations, the International Civil Aviation Organization (ICAO), the Air Line Pilots Association (ALPA), and the Air Transport Association of America (ATA) are actively promoting both international agreements and domestic legislation to eliminate the skyjacking threat to aircraft passengers and crews. Today, there are 40 contracting states (countries) to an international agreement started at the Hague, Netherlands in 1971. This agreement obligates the contracting country to establish severe penalties for air piracy, and to either prosecute hijackers or extradite them to the country to which the aircraft belongs.

What does all this mean to the average air traveler? First there are additional delays and harassment due to the requirement that all hand baggage must be searched. Most passengers, however, accept this inconvenience.

Money is another significant problem. The enforcement of the new anti-hijacking regulations means special equipment must be purchased. Additional security personnel are needed to search passengers, and they must be paid. Once a passenger has been searched, he cannot be allowed back into the terminal area, or he must be searched again. This means more waiting rooms, telephones, concessions, and restrooms are required between the security check area and the loading ramp. Generally, these additional requirements affect the cost of flying.

OUTLOOK FOR THE FUTURE

There are many aviation problems, but with the cooperation of the airlines, airport planners, air traffic control people, and aircraft producers, these problems will be solved.

Airport designers are working to ease the congestion in ticket lines, waiting rooms, and the multitude of other terminal activities. Rapid transit people are working on designs that will ease the traffic parking problem by providing downtown to airport service quickly and efficiently. Heliports are being built as another alternative to the long drive to the more remote airport. Mobile lounges are being provided. Most airlines have downtown ticket counters. These are just a few things that are being done for the air traveler.

Small jets are now on the market. Boeing calls its 737 the "baby bird" because it is smaller than either the 707 or 727, but it is longer and heavier than the largest bomber flown in World War II—the B-29 Superfortress. This plane does well on the shorter routes run by local service airlines. It provides economical jet service to many communities.

The 300 passenger Concorde and TU-144 SSTs are now in production. The SST is capable of providing fast jet service to any place on the globe. However, there are still many problems generated by the SST that must be solved before it is accepted for operation in many parts of the world. Noise control is one of these problems and was one of the major reasons the US decided to abandon the development of the Boeing SST project.

The next generation of aircraft may be the V/STOL (Vertical or Short Takeoff and Landing) type. The V/STOL concept envisions aircraft that will operate acceptably from runways or platforms that are shorter than 2,000 feet. FAA is focusing much attention on the need for V/STOL aircraft because of increasing problems in short-haul service. Today, about half of all air travel consists of trips under 500 miles, and the typical short-haul passenger spends about two-thirds of his door-to-door travel time to reach the airport or to get home. Concern for the environment, the advent of large jets, and the rising costs of desirable real estate have pushed airports farther from the centers of population.

The V/STOL can bring aviation closer to where people live and work by means of a short-haul service. These aircraft have far steeper arrival and departure flight paths than conventional aircraft and yet they are speedy enough to cut down significantly the overall travel time of the passenger. (See Figure 18)

Helicopters have been in existence for many years but their use for general aviation purposes has been limited for several reasons. Maintenance costs are very high, current models are limited in capacity for both passengers and freight, they are slow and noisy, and they are needed most in densely populated areas.

Perhaps the nearest thing to a transport STOL (Short Takeoff and Landing) aircraft is the McDonnell-Douglas modification of the French-built Breguet (Bray ZHAY), originally a military troop transport with a maximum capacity of 67 persons. Both Eastern and American Airlines have experimented with the Breguet, which is capable of taking off and clearing a 50-foot obstacle within 1,600 feet Cruise speed is about 250 nautical miles per hour. The aircraft is a four-engined turboprop designed with a deflected slipstream to distribute the propeller blast effectively over the wing. It has a propeller shaft synchronization system that allows one engine to transmit power to all four shafts.

Hopefully, V/STOL craft will be able to operate out of close-in locations away from the main "jetport." The smaller, close-in airports that are no longer suitable for jet aircraft operation could become "metroports" for short takeoff and landing craft.

A further development of the V/STOL system would be the construction of port facilities on the tops of large buildings, on elevated platforms over railroad yards, major highways and shipping piers, and on floating platforms in rivers and harbors.

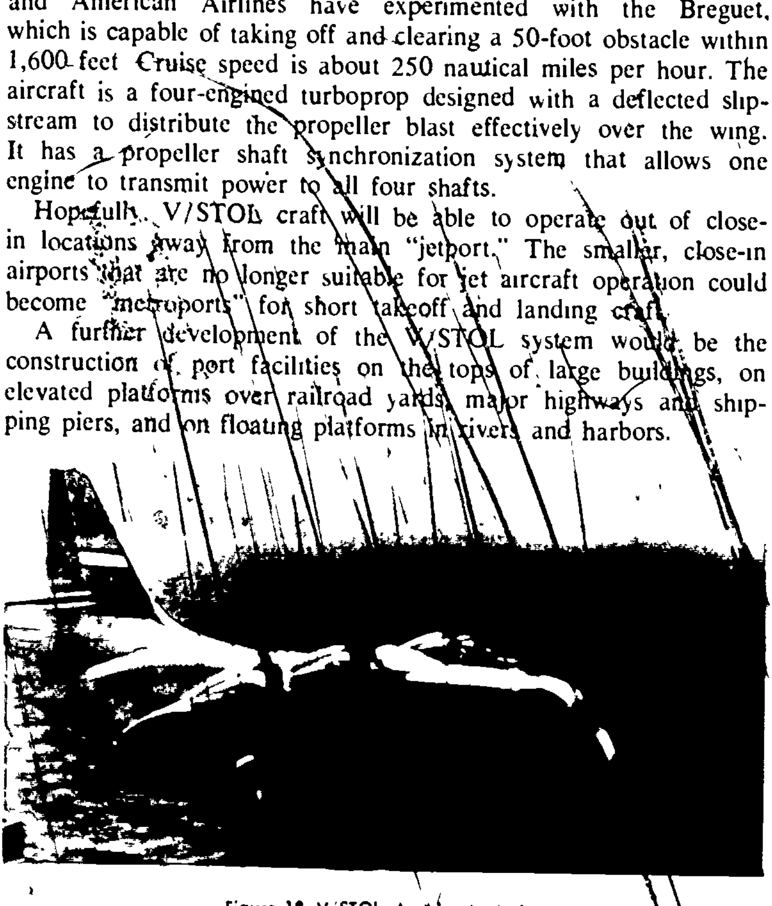


Figure 18 V/STOL An Idea in Action

Advancements in V/STOL development will greatly improve air travel and eliminate many of the present irritants. Modern air travelers are not willing to drive two hours to make a one hour jet flight.

WORDS AND PHRASES TO REMEMBER

Commercial airlines	air charter service
scheduled airlines	single-entity charters
nonscheduled airlines	affinity group charter
Civil Aeronautics Board	tour group charter
preventive maintenance	supersonic transport (SST)
average load factor	feeders
high load factor	air freight
promotional fares	waybills
excursion rate	skyjacking
space available reductions	sky marshals

REVIEW QUESTIONS

1. Define commercial airlines. Distinguish between scheduled and non scheduled airlines.
2. What is the role of CAB in the operation of airlines?
3. What, in your own words, is the significance of the statement, "Throughout history, transportation and communication have gone hand in hand with each acting as a stimulus for the other?"
4. What impact has the jet age had on the airline industry?
5. Why is interline cooperation necessary?
6. How have the giant jets affected air freight?
7. What effect does giant aircraft have on current management problems such as scheduling flights and making connections?

THINGS TO DO

1. Find out more about V/STOL aircraft and make an oral report.
2. Describe how some of the newer jet planes are designed and why.
3. Visit the FAA office nearest you, or local airport and airline officials and obtain a sample copy of a CAB or FAA regulation and describe its use in regulating air traffic or other airline activities.

SUGGESTIONS FOR FURTHER READING

Your school library should have several good books on air transportation and the history of aviation. Current periodicals and even your daily newspaper can tell you much about developments in commercial airlines

Chapter 4

Airports

AIRPORT development has roughly paralleled aircraft development. Present-day airport terminals are highly complex places of business. In the last chapter, you learned how the Federal Government helps and regulates the commercial airlines. In this chapter, you will read about the role of the Federal Government in building and regulating modern airports. You will also read about the basic facilities essential to all airports. You will find out the relationship between an airport's functions and its design. After you have studied this chapter, you should be able to do the following: (1) list the essential facilities common to all airports, (2) tell how mobile lounges and other improvements help the large airports, and (3) list some problems facing most airports today, and make some suggestions as to how these problems may be solved.

THOUGHOUT the brief history of flight, growth in airport size and capabilities has accompanied growth in aircraft size, weight, and speed. When the Wright brothers flew their gliders, they needed a place with treeless slopes and a steady wind. The Weather Bureau suggested they try the beach at Kitty Hawk, North Carolina. Later, when they were ready to attempt powered flight, they returned to Kitty Hawk. The flat beach was the perfect landing field.

The Wright brothers returned home and for a while continued experimenting. They built other planes and tested them over a 68 acre pasture near Dayton. The demands of the aircraft were small. Any level pasture could be used as a runway for takeoff or landing.

In 1911 when Calbraith Perry Rodgers made his coast-to-coast flight, he made 68 hops. There were no airports to land on, and Rodgers crashed 15 times. By the time he reached California, the plane had been almost completely rebuilt.

After World War I, many pilots turned to barnstorming. They would fly over a town, circle it to attract attention, land in a farmer's field, and take people up for a few dollars. A farmer's field made a fine landing strip for the Jennies and DH-4s.

In October 1919, the Army Air Service held a mass round trip race across the continent. The DH-4s, they planned to use had a range of only 300 miles, so the Army, with the help of cities along the 3,000 mile route, set up airports every 200 miles. These same airports were later used by the commercial airlines.

In 1927 planes were flying mail by night along an airway marked by gas and electric beacons, with emergency landing fields every 25 or 30 miles.

As time went on, aircraft became larger and more efficient. They placed greater demands on runways and other airport facilities. A grass pasture was no longer an adequate landing strip. It could not support the weight of the larger, improved aircraft. Even the dirt strips were inadequate. Asphalt runways came into use to be replaced later by concrete. Asphalt and concrete could support more weight and also had greater all weather capability. (See Fig. 19)

The Federal Government helped speed up airport growth by furnishing aid for the construction or improvement of airports. Such aid was first made available in the early 1930s. However, it was not until passage of the **Federal Airport Act** of 1946 that a substantial aid program was set up. This act authorized a maximum expenditure of $100 million per year for airport improvement and construction. By 1960 the Federal aid program had contributed more than $500 million for the construction and improvement of 1,528 airports.

By 1972, Federal assistance to airports had reached $220 million per year and there were 11,989 airports in the United States. Of this total, 10,598 were classified as airports, 931 as heliports, and 460 as seaplane bases. The current **National Airport System,** which includes only those airports considered necessary to meet the national need for civil airports, contains 3,240 airports. All Na-

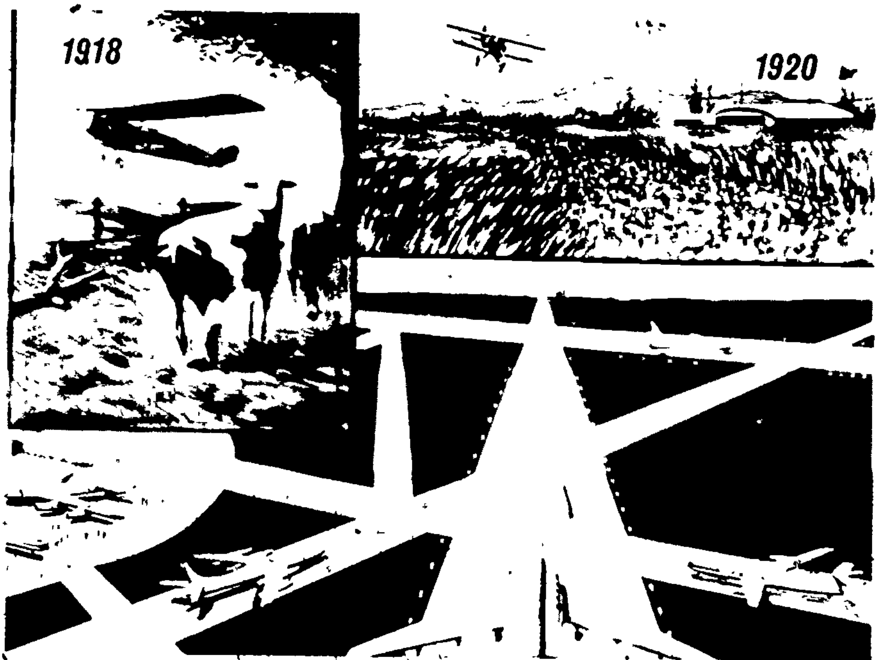


Figure 19 Airports, Yesterday and Today

tional Airport System airports are eligible for federal development aid.

The Government aid program applies to construction of runways, taxiways, control towers, and air traffic control aids. It is not available for terminal construction or parking lot development

The **National Aviation System Plan** for fiscal years 1971 through 1980 shows an estimate of the total cost of airport development during the period to be more than $6 3 billion Of this total, the plan shows an estimate of $2 3 billion needed for the 1973-77 period These amounts are only estimates, for the amount of money needed increases with the constant upgrading of requirements Since no one knows for sure exactly what the new aircraft will need in the way of airports, these plans have to be flexible To insure this flexibility and to incorporate changed criteria, the National Aviation System Plan is reviewed and revised annually

The Federal Government is not the local airport's only source of help Some states have instituted grant-in-aid programs for their cities and towns To qualify for such aid, the town must show need and justification for aid. The airports receiving state aid must meet special requirements, however, these state requirements are usually consistent with FAA requirements. State aid is in addition to Federal Government aid, not in place of it.

Air transportation is as dependent upon an adequate system of public airports as it is upon the aircraft themselves. Aircraft are refueled, serviced, and repaired at airports. Pilots receive current weather information from weather stations located at airports. Passengers enplane and deplane at airports. Cargo and baggage is loaded and unloaded at airports. Many other facilities are located there for the information, comfort, and convenience of passengers and crew members.

STANDARDS FOR CONSTRUCTION AND OPERATION

To insure that logical construction criteria apply generally to airports, individual governments establish airport construction standards. In the United States the Federal Aviation Administration establishes and continually updates construction standards.

To determine the number and types of airports required to serve a community, the planners must consider possible volume of traffic as well as the character and capacity of available airports or airport sites. They must first plan for probable future needs so that the site selected will be large enough to satisfy future as well as current requirements. In this way, they can determine whether one or more additional airports will be required.

The critical factor in airport capacity is usually the number of **aircraft movements** which runways can handle in an hour. An aircraft movement is a landing or takeoff. An airport with only one runway can accommodate about 50 aircraft movements an hour in clear weather and about 30 under instrument operation. With two runways which can be used simultaneously, an airport can accommodate about 100 to 120 aircraft movements per hour in clear weather and about 70 under instrument operation.

The designation of airport type and construction should be a matter of public concern. Today, in the United States, most airports are publicly owned because this (1) makes them eligible for Federal airport aid, (2) permits the use of the power of eminent domain*, to acquire land needed to assure their continued utility, (3) in some states it permits the use of zoning power to

*The power of eminent domain gives the Government the right to condemn property if it is necessary for public benefit The owners are paid a fair market value and have the right to appeal prevent the obstruction of approach and circling airways, and (4) assures their continued availability as public airports.

The FAA has classified airports in the United States into three broad functional categories or systems. These are the primary system, secondary system, and feeder system. Each system is further graded in accordance to air traffic density, of the annual number of passengers enplaned and aircraft operations—movements. This classification system is illustrated in Figure 20.

While the construction standards establish various categories of airports, airline operators actually determine the purpose for which any one airport is used. A given airport may have been classified as being for short domestic flights, but later it may also be used for long-range flights to accomodate a change in traffic. When this happens, runway length and surrounding obstructions may restrict aircraft operations to the extent that some aircraft cannot takeoff or land with a full load of cargo or passengers.

Scheduled airlines may be forced to limit operations at such airports. To operate safely and efficiently under these conditions, an airline must carefully observe specifications for takeoff weights and landing weights at each airport in its system. These specifications consider temperature and wind at time of takeoff for each runway at each airport.

Aeronautical Activity Levels for Functional Role Airport Classification System

AIRPORT CATEGORY	OPERATIONAL DENSITY
Primary System (More than 1,000,000 passengers enplaned annually)	
High density	More than 350,000.
Medium density	250,000 to 350,000.
Low density	Less than 250,000.
Secondary System (50,000 to 1,000,000 passengers enplaned annually)	
High density	More than 250,000.
Medium density	100,000 to 250,000.
Low density	Less than 100,000.
Feeder System (Less than 50,000 passengers enplaned annually)	
High density	More than 100,000.
Medium density	20,000 to 100,000.
Low density	Less than 2,000

Note. The system is determined by the number of passengers enplaned annually while the density of operations is determined by the number of aircraft take offs and landings per year.

Figure 20 Airport Classification System

LOCATION OF AIRPORTS

How well an airport serves a community is partially determined by its location in relation to the businesses and residents it serves. Whereas bus and train depots are generally located in the city, the airports are usually located outside the city. This is necessary because airports cover large areas of land and there must be a minimum of surrounding obstructions.

Most airport locations for the major cities were selected and activated in the 1920s and 1930s. They generally represented a compromise between convenience of location and space requirements. As aircraft have become larger and larger, they have required larger airports, and a number of cities have built more remotely located airports. Further expansion will mean that more remotely located airports will be built to handle the burgeoning traffic.

The National Aviation System Plan reflects the airport requirements for the individual community and for the Nation as a whole. (See Fig. 21). It also gives guidelines which are used to determine the proper location for airport construction or improvement.

An important factor is community need. The airport must not only be large enough so that it won't limit growth, but it also must not be so large that resources are wasted by overdevelopment.

One of the most important considerations governing the location and selection of an airport site is the nature and composition of the soil and subsoil upon which the airport is to be built. Adequate drainage is essential to the proper maintenance of paved runways because more runway failures occur with unstable subsoil conditions than with any other condition.

An increase in airline service or general aviation activity may create a need for further development at an existing airport or the construction of a new airport.

When small single engine general aviation aircraft use the same airport used by jumbo jets, location and control problems usually arise. These must be considered in selecting an airport location and configuration.

For airports used by both the scheduled airlines and general aviation, the airline aircraft is usually the more critical. The most demanding aircraft requirements are imposed at the airports used by the trunk lines. Equipment employed by the trunks include large wide-body jets and turbojets. These aircraft require runway lengths in the 10,000-foot range with pavement of runways, taxiways, and aprons strong enough to accommodate their tremendous weight. Additionally, apron dimensions, fueling and terminal facilities, and necessary land requirements are quite extensive.

The requirements of the aircraft used by the local service airlines at non-trunk airports are less demanding. During the next few years, it is expected that most local service carriers will convert present piston equipment to turboprop or light turbojet aircraft. The runway lengths required by the newer equipment will be shorter than that required by the trunk lines. Pavement strength and load carrying capacity are much less than trunkline airports.

The capacity of an airport configuration is expressed as the number of operations that can be accommodated within a given time period and within acceptable limits of delay. Basic airport requirements include sufficient runway length to safely provide for the types of aircraft, along with an additional runway for crosswind coverage, if necessary. Beyond this, capacity must be great

NATIONAL AIRPORT SYSTEM COMPOSITION AND REQUIREMENTS 1973–82

SYSTEM CLASSIFICATION	IN BEING 1973	PROJECTED SYSTEM ADJUSTMENTS: SYSTEM ADDITIONS[1]	PROJECTED SYSTEM ADJUSTMENTS: INTRA-SYSTEM CHANGES	PROJECTED 1982 NATIONAL SYSTEMS
Primary system:				
High density	12	8	+30	50
Medium density	14	3	+13	30
Low density	28	1	−4	25
Total	54	12	+39	105
Secondary system:				
High density	31	15	+207	253
Medium density	185	80	−15	250
Low density	174	80	+88	342
Total	390	175	+280	845
Feeder system:				
High density	61	127	+5	193
Medium density	795	463	+448	1,706
Low density	1940	633	−773	1,800
Total	2396	1,223	−320	3,699
National system total	3240	1,410	−1	4,649

[1] Includes new airport construction requirements and additional privately and publicly owned airports to be included within the national system over the 10-year period

Figure 21 National Aviation System Plan Airports 1973-1982.

enough to prevent unacceptable delays to aircraft movements. For example, delays to aircraft movements may indicate the need for an additional runway. Its required length may be substantially shorter than the primary runway, if the aircraft mix is such that separation of aircraft types by runway is feasible. This plan enhances capacity of airports at minimum expense.

BASIC FACILITIES

Once a location is chosen, the basic facilities must be outlined. For most airports, the runways, the lighting, the control tower, and the terminal complex are basic.

Runways

Only a few years ago airport runways were virtually unknown. The first early frail aircraft used sod fields for take-offs and landings. These sod fields were ideal for these early aircraft, because, on them, the aircraft could take off and land in any direction These aircraft were so light and so sensitive to the direction of surface winds that it was imperative that they takeoff and land directly into the wind. Because these aircraft were so light, the sod fields could easily support their weight.

As heavier aircraft began to be built in the late 1930s, it became necessary for airport builders to reach a compromise between takeoff and landing direction and a load bearing surface that would support the added weight of these heavier aircraft. This compromise required the construction of runways of sufficient strength to support the aircraft weight that were aligned with the most common wind direction. Although the new runways frequently required crosswind takeoffs and landings, this was not too serious because the greater weight of the new aircraft made them less sensitive to the direction of surface winds.

These early runways were usually constructed of concrete or asphalt with asphalt being the most common construction material. The new airports would commonly have more than one runway so the pilot could choose the one with the least amount of crosswind. As aircraft became even heavier and less sensitive to crosswinds, multiple runways were reduced until today, many modern airports have only one runway which is generally aligned with the prevailing winds.

With modern aircraft, the problem is not so much the direction of the runway as it is one of runway length and load bearing strength. In general, the heavier an aircraft is, the more runway length is required for the aircraft to reach flying speed on takeoff. The heavier it is, the stronger the runway must be to support its weight. This is particularly true in the case of landings when an aircraft of many thousand gross pounds impacts with the runway at speeds near 100 knots. The pounding a modern runway takes under such conditions is hard to imagine. For this reason, most runways today are constructed of concrete with an extremely high tensile strength.

In addition to sufficient length and tensile strength, a modern runway must be built to support high density traffic, it must provide for takeoffs and landings under emergency conditions, and it must have a surface with a sufficiently high coefficient of friction to enable fast-moving aircraft to stop in a minimum distance. Modern highway building is child's play by comparison.

Each runway should have a number of high-speed turnoff lanes. These lanes permit the plane to turn off the runway at speeds of 60 to 70 miles per hour with the minimum use of brakes and reverse thrust. In doing so, they speed up aircraft movements by clearing the runways for takeoffs or landings.

Taxiway patterns from the entrance to the apron area to the takeoff position should permit a smooth flow of traffic with no opposite direction paths and as few crossings as possible.

The size of the apron area is determined by the number of airport loading positions required. This number will vary a great deal from airport to airport. Whatever the number required, it is essential that adequate space be provided for the safe movement of aircraft to and from their loading positions with a minimum of sharp turns, stops, and opposing traffic. (See Fig. 22)

Airport Lighting

Airports use various types and colors of lights to aid pilots. The familiar airport beacon is one of these. Green on the reverse side of the white beacon has long been the mark of an active civil airport. A split white beacon denotes a military airport.

When an airport **rotating beacon** is operating during daylight, it means that ground visibility in the control zone is less than 3 miles and/or the ceiling is less than 1000 feet and that a traffic clearance is required for landings, takeoffs, and flight in the traffic pattern.

Approach lighting systems are visual aids used during instrument conditions to supplement the guidance information of modern electronic aids Lighting systems are intended to improve operational safety during the final approach and landing phase of flight.

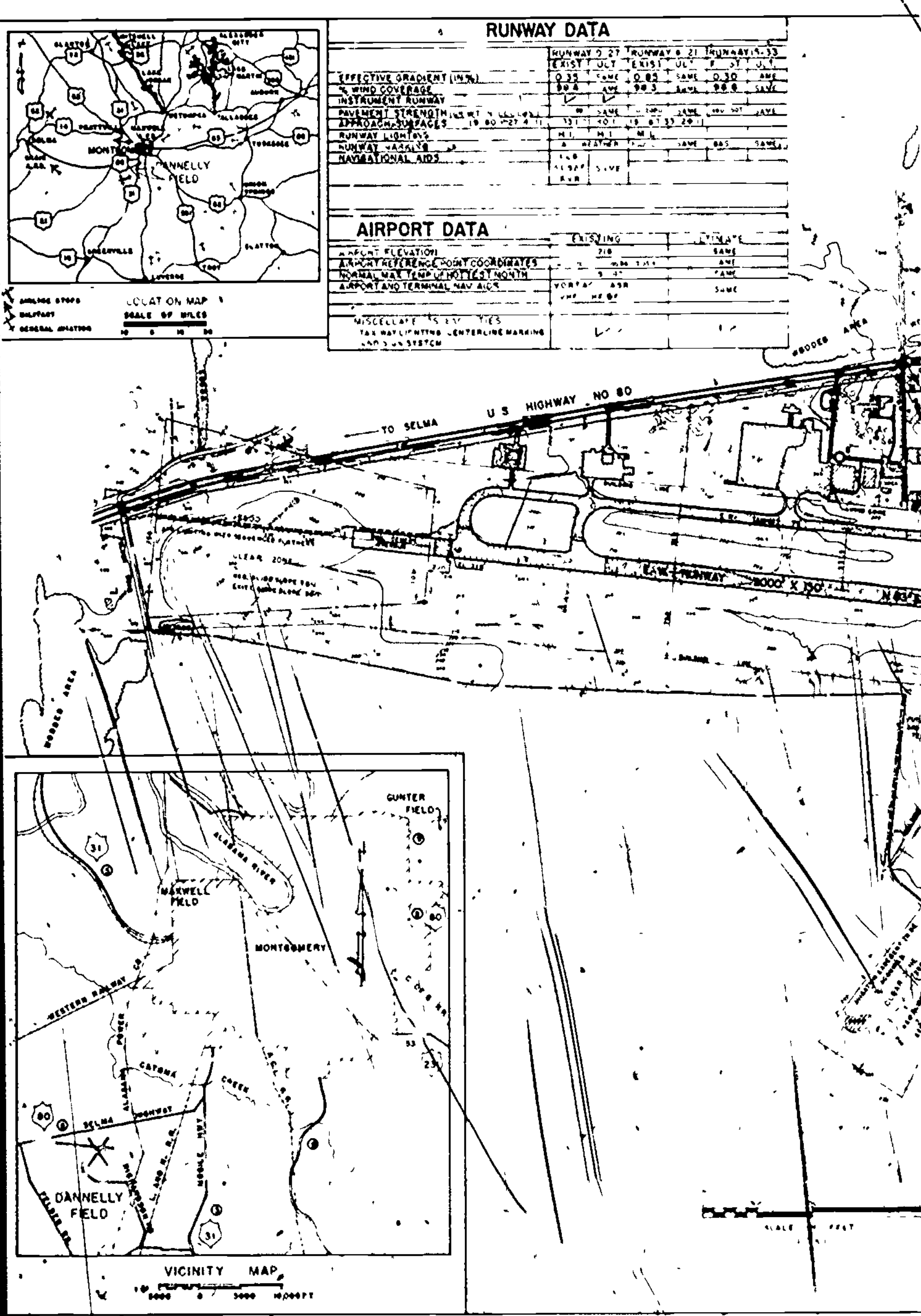
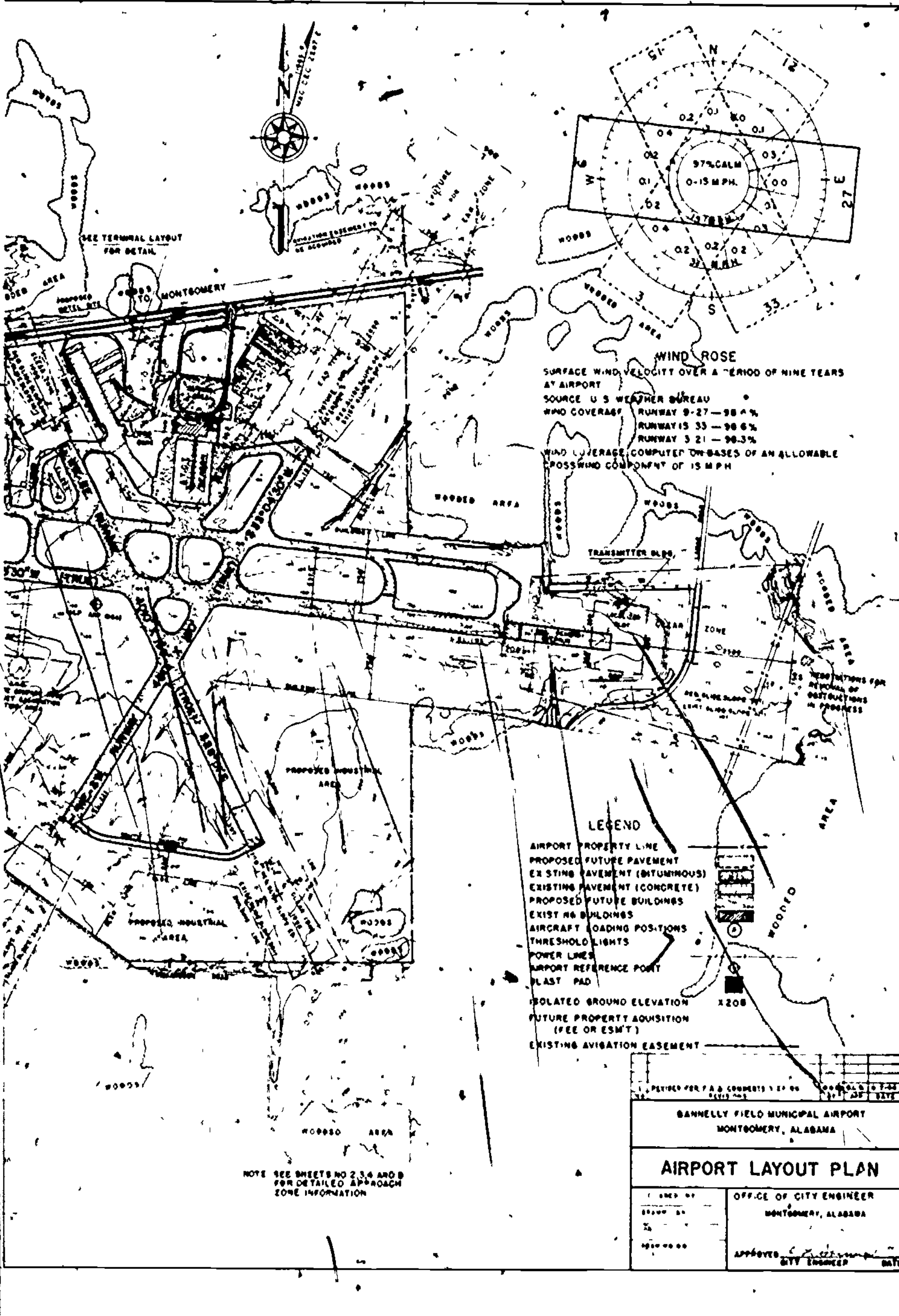


Figure 22. Montgomery's Dannelly Field


WIND ROSE
SURFACE WIND VELOCITY OVER A PERIOD OF NINE YEARS AT AIRPORT
SOURCE U S WEATHER BUREAU
WIND COVERAGE RUNWAY 9-27 — 98.6%
RUNWAY 15 33 — 98.6%
RUNWAY 3 21 — 96.3%
WIND COVERAGE COMPUTED ON BASES OF AN ALLOWABLE CROSSWIND COMPONENT OF 15 M P H
97% CALM
0-15 M.P.H.
SEE TERMINAL LAYOUT FOR DETAIL
TO MONTGOMERY
WOODED AREA
TRANSMITTER BLDG.
CLEAR ZONE
PROPOSED INDUSTRIAL AREA
LEGEND
AIRPORT PROPERTY LINE
PROPOSED FUTURE PAVEMENT
EXISTING PAVEMENT (BITUMINOUS)
EXISTING PAVEMENT (CONCRETE)
PROPOSED FUTURE BUILDINGS
EXISTING BUILDINGS
AIRCRAFT LOADING POSITIONS
THRESHOLD LIGHTS
POWER LINES
AIRPORT REFERENCE POINT
BLAST PAD
ISOLATED GROUND ELEVATION X208
FUTURE PROPERTY AQUISITION (FEE OR ESM'T)
EXISTING AVIGATION EASEMENT
NOTE SEE SHEETS NO 2,3,4 AND 8 FOR DETAILED APPROACH ZONE INFORMATION
DANNELLY FIELD MUNICIPAL AIRPORT
MONTGOMERY, ALABAMA
AIRPORT LAYOUT PLAN
OFFICE OF CITY ENGINEER
MONTGOMERY, ALABAMA
APPROVED
CITY ENGINEER
DATE

Most runway and approach lighting systems allow the controller to adjust the lamp brightness for different visibility conditions, or at a pilot's request. The extreme brilliance of high intensity lights penetrates fog, smoke, and precipitation, but may cause excessive glare under some conditions.

Approach lighting has evolved from a simple line of lights that was aligned with the center line of the runway to variations such as the following:

- Lines of light that extend beyond the approach end of the runway and are the same width as the runway. This enables the pilot to align his aircraft with the runway even though the runway is obscured by weather or darkness.
- These same lines of light, in one variation, are made to flash sequentially. This not only accomplishes the above, but it points the direction of landing.
- Approach lights that are tiered or elevated. The more distant lights from the approach end of the runway are mounted on a higher level than the nearer lights. This accomplishes all of the above, and, in addition, it indicates to the pilot the glide slope that is required in order to contact the approach end of the runway at the proper place.

The *US Standard* approach lighting has been adopted as the national standard for both military and civil airfields. It consists of 3,000 feet of high intensity, white centerline lighting leading to the runway threshold. Sequenced flashing (strobe) lights may be installed in the outer 2,000 feet. This lighting system will ultimately replace other systems now in use. (See Fig. 23)

Runway lights are white, slightly elevated from the ground and spaced 200 feet apart along each side of the runway. They can be turned on and off by individual controls operated from the control tower. Green threshold lights are placed across the end of runways. Blue lights guide pilots along taxiways at night.

Red **obstruction lights** mark all obstructions surrounding an airport. High obstructions, such as radio towers, which extend more than 70 feet above their surroundings, are marked at the top and at the one-third and two-third levels

Control Towers

The airport **control tower** is easily spotted at a busy airport. It looks like the glass dome atop a tower, but why is it there? The glass tower gives control tower operators a clear view of the airport. The control tower operators are the only air traffic control (ATC) personnel with visual contact with the planes. It is their job to direct the traffic flow in the air as well as on the ground. Control operators work in sets, doing one job at a time.

But the glass tower is not the only part of the tower. In windowless rooms at the base of the structure are radar operators who direct traffic under instrument conditions by use of radar The radar rooms are extremely important and should not be overlooked.

For years, the control tower and ATC offices were built onto terminals. In 1961, Congress directed the FAA to finance and build its own control towers. The FAA desired a prototype that could be duplicated anywhere, one that would be beautiful as well as useful. Since only a few men actually have to see the field and

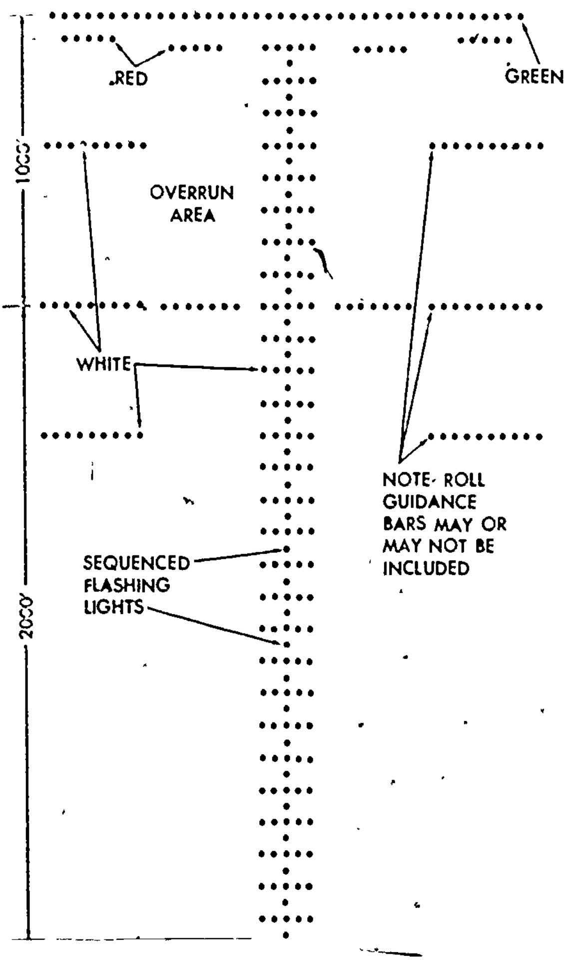


Figure 23 Approach Lighting

the planes, their designer put the cab on top of the shaft. The rest of the men—mostly radar and radio operators—only need to see their instruments. The new design placed these men and their equipment in a building at the base of the tower that would be partially covered with earth. This would insulate against noise while rooting the tower into the landscape. These towers would be placed in a position away from the terminal that would allow them to see the runways more clearly making their job easier. The control tower at Dulles International Airport in Washington, D.C., as shown in Figure 24, is an example of a modern tower.

Terminals

The **airport terminal building** is essentially the service center for the transfer of passengers and their property between surface vehicles and aircraft. It may also contain the necessary Government facilities for the safe handling of air traffic, including flight service station, air traffic control tower, and Weather Bureau station. Other Government activities sometimes included are post office, airport mail facility, and, where there is international traffic, customs, immigration, public health, and Department of Agriculture stations.

The traveler expects to find, in the airport terminal building, comfortable seating, restrooms, and various concessions. At the same time, the terminal designer must consider safety, efficiency and convenience in his design.

Since its inauguration in this country in 1958 jet flying for the public has greatly increased the popularity of air travel. The larger volume of traffic has imposed unexpected demands upon recently built airports and has necessitated expansion of those facilities directly serving the public, such as waiting rooms, newsstands, eating concessions, and parking areas.

The designer of an airport terminal building is faced with integrating the needs and requirements of the public, tenants, and owner into a scheme that operates efficiently and with a maximum degree of safety. Each must be considered from the standpoint of functional relationship to the others, with special emphasis being placed on planning for future demands.

Terminal buildings, particularly large ones, are civic business enterprises sponsored by local governments in response to air transportation needs. The problem confronting developers is one of providing suitable space for masses of travelers and adequate working space for airline and concessionaire tenants based on reasonable forecasts of passengers and customers. The past decade and a half has seen communities build terminal buildings that were considered, at the time of construction, to be larger than needed. Some were even criticized as being "white elephants." Many of these as well as surrounding building space and aircraft parking aprons have become so overloaded that entirely new areas must be developed. The problem of expansion could become sufficiently critical to require consideration of a new airport site This emphasizes the need for well thought out planning for the future.

Planning of terminals should allow for direct and easy movement of passengers and baggage. The line of movement for the boarding passenger is from the ticket counter, to the waiting room, past concessions, and then to the aircraft loading gate. Deplaning passengers should follow a direct route to the baggage counter, which should be near the platform where baggage is unloaded from the baggage trucks. In the same way, baggage should follow a direct route from the passenger ticket counter to the planes, and at destination back again from the planes to the baggage claim counter. (See Fig. 25)

There are basically two concepts of terminal building operations at an airport—the centralized concept and the unit concept. A consolidation of these two concepts is sometimes pos-

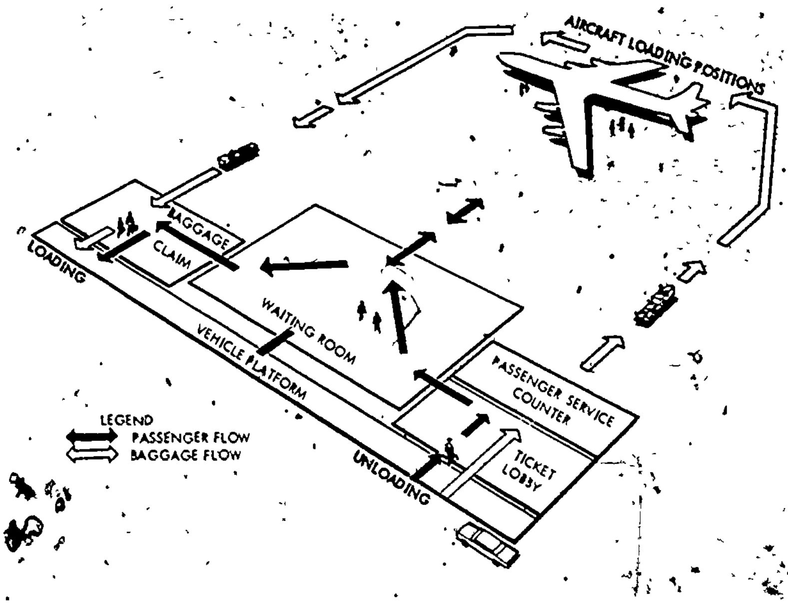


Figure 25. Passenger Baggage Flow.

sible. (The type of terminal used is determined by the amount of traffic it must carry.)

CENTRALIZED CONCEPT.—The centralized concept of building design refers to an operating arrangement wherein passenger, ticketing, and baggage facilities of all airlines are based in the same building. The passenger service and ticketing functions are usually in a unified area. Likewise, the centralized concept almost always employs a consolidated arrangement for baggage handling facilities. The central waiting area and its surrounding concessions and other facilities serve passengers from all airlines, as well as visitors, using the terminal building. The layout of a building using this concept should be made flexible to allow for conversion to future needs.

UNIT OPERATION CONCEPT.—The unit (or decentralized) concept of terminal building operation is employed at several airports. Under this plan, each airline is housed in a separate building or in an area of an elongated or winged building with its own facilities for the handling of passengers, visitors, baggage, and cargo. This permits each airline to choose its equipment and furnishings, and to follow its pattern of operations and customer services without the compromise and cooperation necessary in centralized operations. Each airline can determine the degree of luxury it will use to attract customers. The traveler goes directly to the airline facilities he plans to use. In using the unit type of operation, duplication of public and concessionaire facilities results in higher capital investment for the airport owner and in less profit for concession operators because of the dispersal of customers.

The unit terminal building operation generally means long walking distances for transferring passengers. It may also cause excessive rolling distances for vehicles handling interchange baggage, mail, express, and cargo. Further, airline servicing is not easily consolidated. The unit operation tends to cause confusion for travelers and airport visitors. Locating airline facilities in scattered buildings or units causes inconvenience and hardship on passengers trying to arrange for flights.

CONSOLIDATION OF OPERATIONS.—Consolidation of the ticketing and baggage operations within a building can result in a savings of space. Using the centralized concept, one service organization would be responsible for transfering passengers, baggage, mail, or cargo to and from aircraft. By modifying the concept any one or all of the above activities could be consolidated, depending on the needs of the individual terminals.

AIRCRAFT LOADING POSITIONS.—Configuration of the terminal building depends upon the number and arrangement of aircraft loading positions. Airports with relatively low passenger volume, employing a one-level system, can usually operate most efficiently with a frontal scheme in which aircraft loading positions are parallel with the face of the building. Airports with high passenger volume and a full flying schedule may effectively use a finger scheme for placement of the aircraft loading positions. Figures 26 and 27 illustrate the basic finger and frontal configurations of airport design.

A finger system is a large number of loading positions in an area close to the center of activities in the terminal building. This reduces walking distances for passengers and rolling distances for service vehicles.

In a one-level system using either covered or fenced fingers, the passengers enplane and deplane on the apron level. Service trucks move along either side of the finger to aircraft loading positions. In a two-level system, trucks operate on the apron level, and passengers move on the upper level. In either scheme, passenger and truck routes to the aircraft should not cross unnecessarily.

The number of aircraft loading positions can be held to a minimum by carefully controlling their use. Using the loading positions as much as possible produces three important results. (1) saves

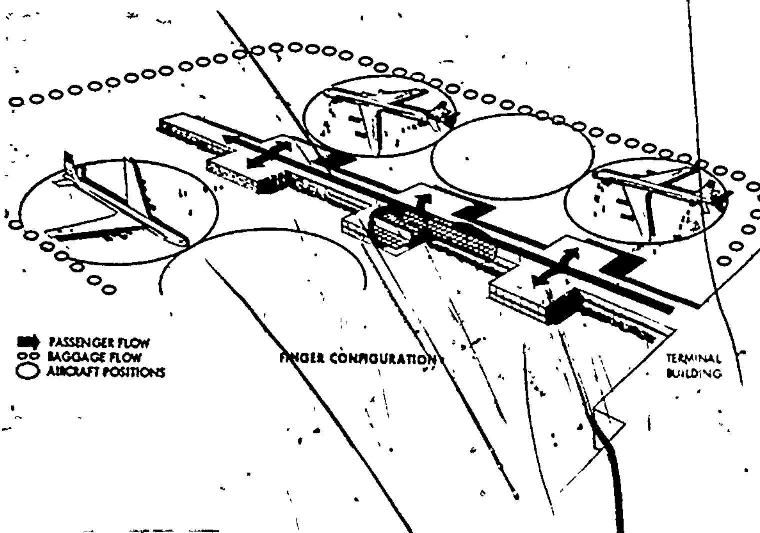


Figure 26. Aircraft Loading Positions—Finger Configuration.

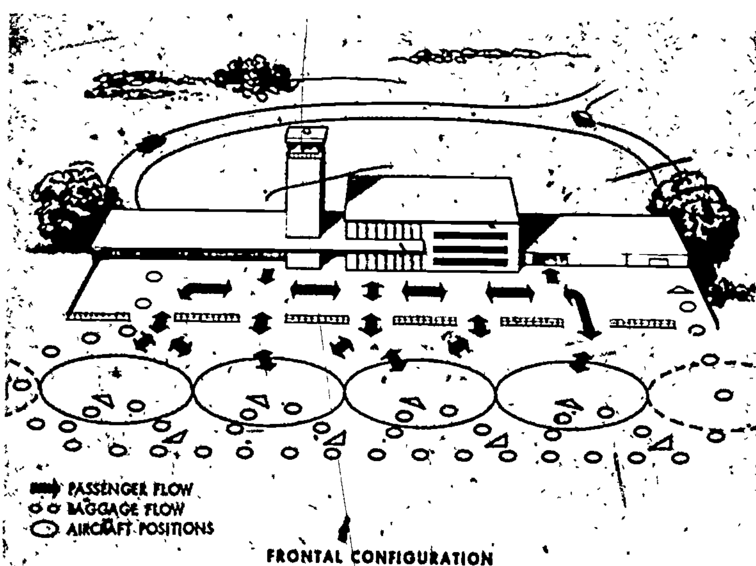


Figure 27. Aircraft Loading Positions—Frontal Configuration.

construction costs of unneeded aircraft loading positions, (2) reduces the length of fingers needed to reach the outermost positions; and (3) reduces the time and distance required for passengers or service vehicles to reach the far positions.

Remote loading positions are in use at some airports that require more positions than can be supported by fingers. This helps to reduce walking distance for passengers. The aircraft are parked at servicing points out on the apron, and passengers are transported to the aircraft from the terminal by mobile lounge. The passengers board the lounge from the main concourse of the terminal without walking up or down stairs. In the mobile lounge they are taken to the remote loading position where they enter the aircraft directly from the lounge. Mobile lounges have been in use at Dulles International Airport outside Washington, D.C., for several years. Dulles is one of the rare airports with capacity for expansion to meet future needs. It was designed specifically to handle jet transports and is used for long range flights.

The mobile lounges originally purchased for use at Dulles were built to service aircraft of the period. These older lounges had a capacity of 90 to 100 passengers. Later models carry 150 or more people in complete comfort. The mobile lounge fits tightly against the building so that passengers can enter without going up or down any stairs or ramps. (See Fig. 28) To facilitiate loading, each lounge has two entrances. Passengers are protected from airport noise and weather while aboard the lounge. On arrival at the aircraft, the lounge is connected to the plane by a telescoping ramp whereby passengers can pass from one vehicle to the other. FAA is now studying the feasibility of the Sky-lounge shown in Figure 29 for transporting passengers between nearby airports.

NOISE CONTROL AND SAFETY FACTORS.

Problems of noise control and safety are important to airport planners. Both of these are vitally important. Airport noise control and safety consciousness are mandatory if the airport is to fit into the community. Planes produce a great deal of noise especially when landing or taking off. Jet planes emit higher frequency sound which are far more annoying than the lower frequency sound produced by propeller-driven aircraft. This noise is an irritation not only to airport neighbors but also to people in the immediate vicinity of terminal buildings and maintenance facilities. Therefore, terminal planners provide noise deflecting barriers at some terminals, movable covered ramps connect the aircraft and terminal. These allow passengers to remain indoors.

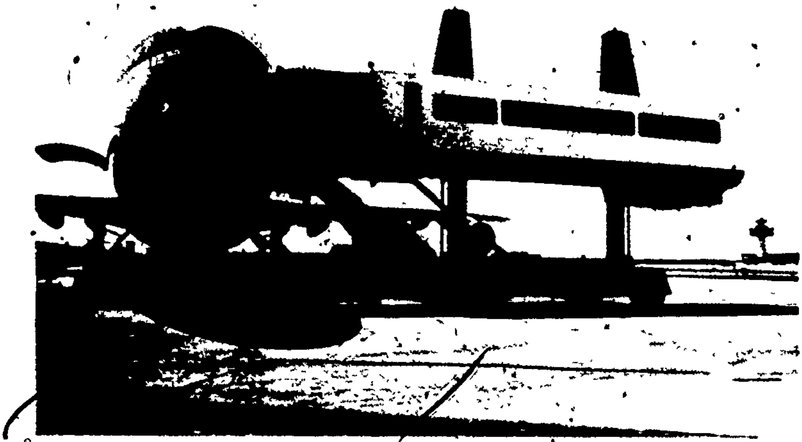


Figure 28. Mobile Lounge Used at Dulles International Airport.

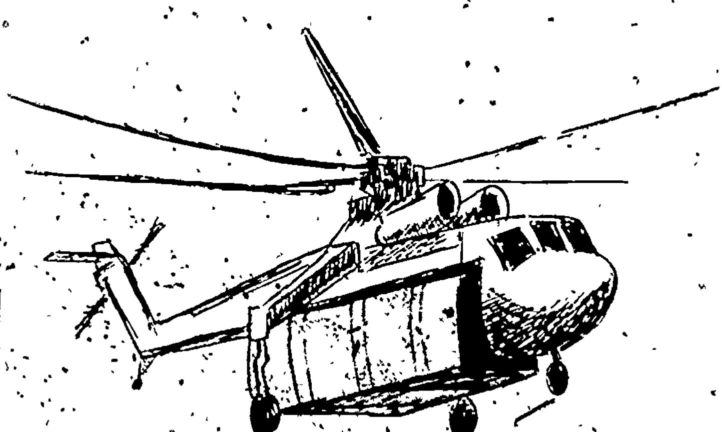


Figure 29. "Skylounge" Concept.

No fully satisfactory answers have been found for complaints of disturbing noise lodged by residents of communities near airports. A partial solution is found in changing airport flight patterns and aircraft takeoff procedures. An initial rapid climb at full thrust to about 1200 feet followed by a reduced rate of climb at reduced thrust to cruising altitude cuts the number of complaints, but this represents a compromise in safety and aircraft efficiency speed.

It is also possible to reduce complaints by directing low-flying aircraft over less densely inhabited areas. A more satisfactory solution involves the development of devices to suppress jet engine noise at the source without too seriously affecting weight, drag, or power output.

Airport planners today also recognize the need to restrict or "zone" areas around the airport in order to reduce noise complaints. Unless such action is taken, homes or businesses are often constructed in high noise areas around the airport.

Another serious noise problem is the so-called **sonic boom** produced by airplanes traveling at speeds greater than mach 1, the speed of sound. The sonic boom is caused by the shock waves generated by the aircraft. It is a sudden pressure change which can be heard on the ground but not in the plane that produces it. This shock wave follows the aircraft throughout the flight so that sonic boom is a continuing phenomenon. When supersonic aircraft fly at low altitudes the boom may be strong enough to cause damage. The shock of the sonic boom varies with the size of the aircraft.

The 10 areas shown in Figure 30 are considered the most important areas for further activity in aviation safety research and practice. The ultimate aim of safety consciousness is to help make flying safe.

CARGO TERMINALS

The cargo terminal is constructed for handling freight and is often an interline effort. It may or may not be built adjacent to the passenger terminal, although such a location facilitates the loading and unloading of freight carried on passenger flights.

The air terminal designers consider the entire shipment and distribution cycle when they plan to construct a new terminal or enlarge one already in use. They must consider the market and the volume of trade. They must also consider the speed and efficiency required to process freight for shipping, and they must provide for quick and efficient loading. Provision must be made to unload, outprocess, and load the freight to be delivered onto trucks.

Improved container packaging has led to large savings in time and money. Figure 31 shows the basic family of air freight containers.

The computer has had a very definite impact on the air cargo industry. It can analyze cost distribution and discover weaknesses in the present system.

Automation is a possible solution to the problem generated by increased air cargo traffic. Automation in the handling of air freight is already easing congestion at the larger airports. For example, the Boeing 747 has a very large hold of 214,000 pound cargo capcity. Shippers, therefore, must develop a system of loading and unloading that can match this capacity. Can you imagine how long it would take to load or unload a 747 by hand? Automation seems to be an answer. The following illustrations show some of the newest terminals and some approaches to the problem of increased traffic.

1. **Airport & Navigational Aids.** Improve navigational and landing aids at inadequately equipped airports including maintenance, testing, and trained personnel.
2. **Loss of Control/Turbulence.** Continue studies on turbulence, including training, instrumentation, meteorological factors, especially methods for detection.
3. **Emergency Evacuation.** Review evacuation procedures to accommodate larger passenger loads and for new types of structures. Reappraise current techniques.
4. **Economics of Safety.** Develop parameters for cost effectiveness of safety equipment vs. losses from accidents.
5. **Crash Fire Protection.** Provide "on-board" fire protection thru suppression of ignition sources, containment of fuel, and rapid evacuation facilities.
6. **Weather Information.** Improve adequacy and dissemination of information, particularly on weather hazards, including thunderstorms, fog, icing, turbulence.
7. **V/STOL Development.** Conduct operational suitability testing, with emphasis on safety factors.
8. **General Aviation.** Improve training programs, expand methods for disseminating forecasts and weather data in "plain language" form, provide inherent stability and crashworthiness in private aircraft.
9. **Collision Avoidance.** Accelerate development of proximity warning devices in light of new technology, to anticipate increased congestion.
10. **Component Reliability.** Use quality control, system monitoring, and reliability analysis, as an important part of engineering design and operational planning to reduce malfunctions.

Figure 30. Safety Research Areas.

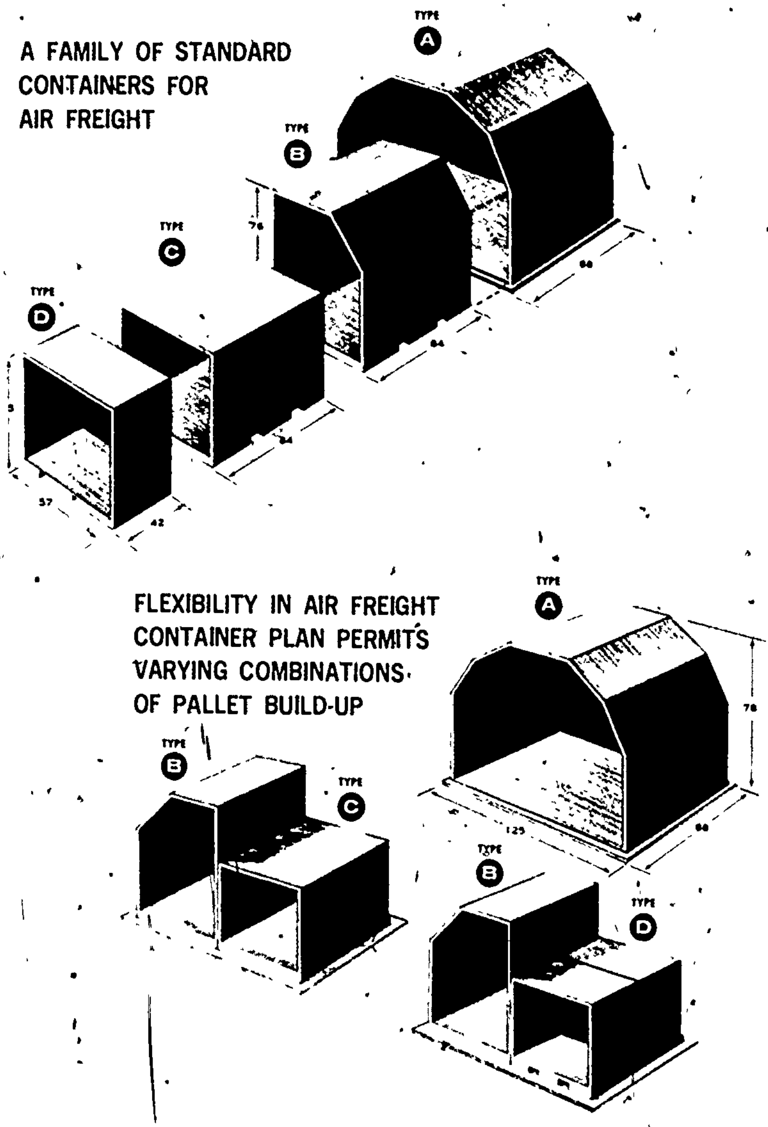


Figure 31. Air Freight Containers.

AIRPORT IMPROVEMENTS

Under the 1970 Airport and Airway Development Act, $2.5 billion is now available from Federal funds over a 10-year period ending 30 June 1980. At the present time, local agencies must provide half of the funds needed for airport improvement or new development. The FAA provides the remaining half. It is expected that future legislation will increase the Federal share of matching funds to 75 percent and to continue the program beyond the 30 June 1980 expiration date.

Distribution of airport development funds over the period 1973-82 would be controlled in accordance with the current FAA Aviation System Plan with primary systems getting 52 percent, secondary systems 28 percent, and feeder airports 20 percent. New airports would get more of the money than that spent for improv-

DISTRIBUTION OF AIRPORT DEVELOPMENT ASSISTANCE (ADAP)

PURPOSE	5-YEAR PERIOD, 1973-77	5-YEAR PERIOD, 1978-82	10-YEAR PERIOD, 1973-82
	Percent	Percent	Percent
A. Development of existing airports in—			
Primary system	28.1	4.4	18.3
Secondary system	22.8	10.6	17.8
Feeder system	17.6	4.5	12.1
Subtotal	68.5	19.5	48.2
B. Establishment of new airports in—			
Primary system	15.9	60.5	34.2
Secondary system	8.8	12.9	10.5
Feeder system	6.8	7.6	7.1
Subtotal	31.5	80.5	51.8
Total	100.0	100.0	100.0
C. Estimated levels of assistance (billions)	$1.40	$1.15	$2.55

Summary of Federal Funding for Airport Development Program, 1973-82

PROGRAM	1972	1974	1975	1976	1977	1978-82	1973-82
ADAP	$280	$280	$280	$280	$280	$1,150	$2,550
Planning grants	15	15	15	15	15	75	150
Total grants	295	295	295	295	295	1,225	2,700

Figure 32. Plan for Airport Funding.

ing existing airports. Of the airport construction funds, a major portion would go for the building of 12 new primary airports. (See Fig. 32)

The FAA recognizes many potential problem areas in the Aviation System Plan. The environmental effects of airport upgrading and building cause a great deal of public resentment and unfavorable reaction. Noise, pollutants, land use, and airport access facilities constitute the major source of public reaction. Unless solutions to these problems are found, many needed airport development and building projects may be stopped. Especially constraining are the environmental blocks to V/STOL—ports and heliports because of their closer proximity to densely populated areas.

The Aviation System Plan does much to overcome many problems by promoting area cooperation, standardizing design, providing assistance and guidance, and making studies.

The next 10 years should bring improved airport lighting, fire protection, offshore airports and heliports, fog dispersal systems, snow and ice removal, and traffic sensing devices to aid ground controllers. Passengers will benefit from improved traffic flow to and from airports, high-speed exits and entrances, aircraft transporters, and new and better programs for accident prevention.

WORDS AND PHRASES TO REMEMBER

Federal Airport Act
National Airport System
National Aviation System Plan
aircraft movements
prevailing winds
rotating beacon
runway lights
obstruction lights
control tower
airport terminal building
sonic boom

REVIEW QUESTIONS

1. The Federal Airport Act set up a substantial aid program. What can the money be used for?
2. Why are airports necessary?
3. Why are most airports located at a distance from the cities they serve?
4. Review the basic facilities at an airport.
5. Describe a mobile lounge.
6. Suggest solutions for three problems facing airports today.
7. What factors should be considered in an airport terminal design?

THINGS TO DO

1. This chapter can lead to several interesting projects. The most obvious project of course, is to visit an airport. However, simply going to an airport and looking around is not going to show you what you read about in this chapter. The part of the airport which you see as a traveler is the part designed for the public. Your trip to an airport should be arranged in advance with either one of the commercial airlines at the airport or with the airport management. See if you can arrange to see the "backstage" operations: scheduling, air freight movement, etc. You can also follow up on the problem areas discussed in this chapter, the airport noise problem, the cargo loading problem, the passenger movement problem, etc.
2. Design an airport terminal that meets modern needs.
3. St. Louis, Missouri has had difficulty in selecting a new site for a major airport. See if you can find out some of the reasons for their situation.

SUGGESTIONS FOR FURTHER READING

Bernardo, James V. *Aviation in the Modern World.* New York. E. P. Dutton & Co., Inc., 1960.

Federal Aviation Administration. *The National Aviation System Plan 1971-1980.* US Government Printing Office, Washington, D.C., 1970.

Horonjeff, Robert. *Planning and Design of Airports.* New York. McGraw-Hill, 1962.

Chapter 5

THIS CHAPTER deals with controlling aircraft in the air. You will read about the early history and gradual development of air traffic control. You will then take a simulated flight which will demonstrate how today's air traffic control devices and procedures work. During this "flight," you will see how modern navigational aids are a part of the air traffic control operation. Finally, you will read about some problem areas and some future developments in air traffic control. After you have studied this chapter, you should be able to do the following: (1) outline the development of air traffic control and show how this development parallels that of the airlines; (2) discuss how today's air traffic control guides planes from one airport to another; and (3) list some problems and potential solutions involving air traffic control.

JUST AS it is important to regulate and control train, bus, and auto traffic operating on this Nation's highways, it is also important to regulate and control traffic operating in the skies. Although airways provide paths for planes to follow through the air, these airways are three-dimensional. they have height, as well as length and width. This three-dimensional aspect of airplane flight makes the problem of air traffic control far more difficult than that of surface traffic control. Even when airplanes slow down, their pilots have to keep them above a certain minimum speed (the stalling speed). Air traffic, then, is traffic continually in motion.

Control of air traffic is a service of the Federal Government. The Federal Aviation Administration (FAA) is charged with controlling air traffic in the United States. To insure that air traffic moves safely and efficiently from point to point, the FAA maintains several different kinds of air traffic control (ATC)* facilities. Some of these facilities "just grew", others are relatively recent additions to ATC.

DEVELOPMENT OF ATC

The present intricate air traffic control system had its beginning with the airmail service. It can be traced back to the post World War I barnstorming era. Between 1918 and 1926, the US Post Office Department secured, maintained, and operated a number of aircraft to provide airmail service.

A pilot flew "by the seat of his pants" from point to point, and the mail got through. Navigating the early mail planes depended on the pilots being able to see the ground and figure out where he was by means of visual landmarks. Navigational aids, however, came to the assistance of the airmail service pilots and provided the beginning of today's highly sophisticated air traffic control system.

A chain of radio stations, built between 1920 and 1921, was the first major aid to the early airmail pilots. Used primarily for weather information, these ground-based radio-telegraph stations provided pilots with advance weather information for subsequent legs of their flights. These early radio aids were really the first step in the complicated communications network which forms a substantial portion of today's air traffic control.

These early mail flights took place during the day. The Post Office Department, however, naturally sought ways to enable pilots to fly the mails during the hours of darkness, as well. As we discussed in Chapter 1, by 1926 a system of light beacons had been built, extending from the Atlantic to the Pacific. These lights enabled pilots to fly, theoretically, around the clock, from New York to San Francisco. This light line was the second long step forward, elementary as it seems to us today, in the development of a country-wide air traffic control system.

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*ATC, unfortunately, stands for two things Air Training Command and Air Traffic Control In this chapter, ATC will mean Air Traffic Control

A major problem in these early attempts to assist pilots was that pilots could not always see the lights! The Post Office Department, the Army, the Navy, and the National Bureau of Standards had been at work, devising new and better ways of using radio equipment to guide the pilots and their planes. Up to this point, the use of radio had been confined to radio-telegraph (Morse code) sending and receiving equipment installed in only a small number of airplanes on an experimental basis.

The new system involved the use of low and medium frequency **radio ranges** and the establishment of four electronically derived courses which enabled the pilot to determine his directions and to navigate across the country by listening to the radio signals. This was another major step in the evolution of the concept of air traffic control.

One extremely significant result of the establishment of the low frequency radio ranges was the establishment of **airways.** Airways are designated paths through the airspace, actually, airways are **air highways.** It is important to understand that the airways are defined by radio aids to navigation. Airways grew as air traffic grew, just as railroad lines grew connecting population centers. These early airways were designed by color and number. Red, green, blue, and amber airways crisscrossed the country.

The first semblance of an airways system was established with these color designated airways. It served as a valuable transitional device from visual navigation to electronic navigation. However, the pilot still had to listen to the radio signals which defined the airways, and he had only four defined airways to follow.

The demand for other than just fair weather flying raised a complex problem. Its answer, accurate and safe instrument flight, brought with it the need for specific air traffic control. The devices which airports had used to help airplanes land, including flags, flares, lights, and ground signals, were no longer sufficient. Expediting the movement of aircraft and preventing collisions between aircraft flying under limited visibility conditions were becoming increasingly important. This was especially true around the major airline terminals when aircraft on the same or converging airways were flying "on instruments."

As a result, the airlines requested and obtained the approval of the Bureau of Air Commerce to establish their own traffic control officers at the important airports. Each of these air traffic control offices was organized as an independent operation controlled by the airline manager at the airport chosen. Newark, Chicago, and Cleveland were the sites of the first traffic control offices.

This traffic service was designed for airline use in the interest of increasing the safety of their own operation. The service was made available without charge to all private, military, and other Government aircraft using the airways. In this way, the airlines were able to keep track of the proximity (closeness) and movement of other aircraft in the area.

As longer non-stop flights began and air traffic in general increased, congestion began to occur along the airways farther from the airports. Traffic to and from other airports along the airways had to be fitted in with that leaving from and arriving at the main terminals. It became apparent that there was a need for control farther out along the airways than the airline officers were prepared to handle. A unified nationwide control of air traffic could provide an answer to this growing problem.

In 1936, the Bureau of Air Commerce took over control of air traffic along the airways. The Bureau arranged to take over the three airline traffic control offices then in operation. This was the nucleus of our present system of air traffic control and aids to navigation under the direction of the Federal Government.

The passage in 1938 of the Civil Aeronautics Act marked the start of a new era in civil aviation. This piece of legislation consolidated the various Government agencies which dealt with the expanding aviation industry, among them the Bureau of Air Commerce. Under the new Government structure, the fast-growing air traffic control operation was handled by the Civil Aeronautics Authority. This Government body expanded the jurisdiction of the three original airline traffic control offices outward to control larger areas. Additional offices were created as the need dictated and funds became available.

A reorganization plan of 1940 transferred the air traffic control function to the newly created Civil Aeronautics Administration under the Department of Commerce. The entry of the United States into World War II slowed down the application of new technology to air traffic control in civilian aviation, but the war accelerated military applications of new ideas such as the use of radar. After the war, radar became the chief tool of the air traffic controller, especially at heavily used airports and on heavily congested airways.

Many new navigational aids have taken the place of the early, simple "clock-and-compass" used by pre-World War II pilots. At the same time, the Federal Government has kept pace with the growing complexities involved in controlling the ever-increasing volume of air traffic. Passage in 1958 of the Federal Aviation Act incorporated the functions of the Civil Aeronautics Administration into the Federal Aviation Agency, including air traffic control.

The Federal Aviation Agency maintains centers for research and development in traffic control. Several high-level government task forces have closely examined the present state of air traffic control and have made recommendations for the future development of aids to aircraft movement.

Airport traffic control, an increasingly important part of air traffic control, was left to the owners and operators of the various airports until World War II. The need gradually emerged for centralized control and regulation of airport traffic, and the Federal Government took over control of airport traffic to centralize its regulation in a single agency which would follow a single set of procedures. Today's Federally controlled airport traffic control forms a highly important segment of overall air traffic control.

ATC IN ACTION

A hypothetical flight from Oklahoma City's Wiley Post Airport to Love Field in Dallas will serve as an illustration of how ATC works. For this trip, we will use an airplane with a complete set of navigational equipment, and we will use almost every facility the Federal Aviation Administration (FAA) provides. (See Fig. 33)

In this booklet, we have used only a few of the common abbreviations which form a large part of the air traffic controller's vocabulary. You may encounter many of these abbreviations in your own reading on air traffic control The following list of air traffic control terms includes their usual abbreviations, and the terms themselves are explained in the text of this booklet.

Airport Surveillance Radar (ASR)
Air Route Surveillance Radar (ARSR)
Air Route Traffic Control Center (ARTCC)
Automatic Data Interchange System (ADIS)
Flight Service Station (FSS)
Instrument Flight Rules (IFR); Visual Flight Rules (VFR)
Instrument Landing System (ILS)
Pilot Weather Reports (PIREPS)
Precision Approach Radar (PAR)
Radar Approach Control (RAPCON)
Radar Bright Display Equipment (RBDE)
Radar Microwave Link (RML)
Remote Center Air Ground (RCAG)
Remote Transmitter and/or Receiver Site (RTR)
Tactical Air Navigation (TACAN)
Ultra High Frequency (UHF)
Very High Frequency (VHF)
Very High Frequency Direction Finder (VHF/DF)
Very High Frequency Omni Directional Range (VOR)

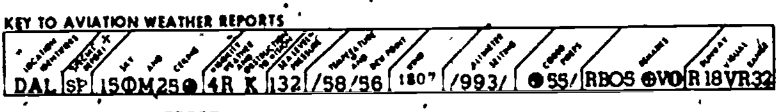
Figure 33. Air Traffic Control Terms.

Planning Our Flight

We first obtain a weather briefing, and we have to file a **flight plan.** Weather conditions along our path of flight are extremely important and will determine whether or not we fly at all. Hundreds of FAA and **National Weather Service** facilities make weather observations periodically and provide observations and forecasts to all interested points. Collection and distribution of this data requires an extensive and complex network of Teletype systems.

The basic teletypewriter operates at 100 words per minute, which is fast enough for local or area operations but which becomes too slow to handle national weather traffic. A faster system called the **Automatic Data Interchange System** collects data from the basic teletype circuit and transmits it throughout the Nation. This system may be programmed to print out weather information at the basic Teletype speed as the information comes in on the high speed line.

Since we are interested in weather at Dallas, the operator would have programmed the system to print out the Dallas weather conditions in the following format:



DECODED REPORT

DALLAS. SPECIAL OBSERVATION. 1500 FEET SCATTERED CLOUDS. MEASURED CEILING 2500 FEET OVERCAST. VISIBILITY 4 MILES. LIGHT RAIN. SMOKE. SEA LEVEL PRESSURE 1013.2 MILLIBARS. TEMPERATURE 58° F. DEWPOINT 56° F. WIND 180° 7 KNOTS. ALTIMETER SETTING 29.93 INCHES. PILOT REPORTS TOP OF OVERCAST 5500 MSL. RAIN BEGAN 5 MINUTES PAST THE HOUR. OVERCAST OCCASIONALLY BROKEN. RUNWAY 18 VISUAL RANGE 3200 FEET.

+ S INDICATES THAT REPORT CONTAINS IMPORTANT CHANGE

Typical Teletypewriter Message Showing Weather Conditions. The Bottom Part Shows The Key to Interpreting the Message.

Figure 34. Teletype Weather Message

Although weather conditions, as shown in Figure 34, do not look very favorable, there does not appear to be any turbulence which would endanger the aircraft. It may be necessary to fly a part of the route on instruments due to low ceilings and limited visibility. Following good flight procedures, we will get a complete weather briefing.

Filing our Flight Plan.—The next step is filing the flight plan. A flight plan alerts **Flight Service Stations (FSS)** along our route of flight that we are coming their way. Each FSS will also provide us with additional weather information, barometric pressure settings for our altimeter, and notify other stations of our progress. It is important to call each FSS, since this facility may initiate search and rescue activities if we are more than one hour overdue. We contact the local FSS and file this flight plan. (See Fig. 35)

Next, a Flight Specialist enters information from our flight plan into a teletype network (Fig. 36) very similar to the one which handled weather data. From here it will proceed to flight service stations all along our route and be printed out at 100 words per minute. They know we are coming and approximately what time to expect us.

DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION
FLIGHT PLAN

Form Approved
OMB No. 04-R0072

1 TYPE	2 AIRCRAFT IDENTIFICATION	3 AIRCRAFT TYPE/ SPECIAL EQUIPMENT	4 TRUE AIRSPEED	5 DEPARTURE POINT	6 DEPARTURE TIME PROPOSED (Z)	6 DEPARTURE TIME ACTUAL (Z)	7 CRUISING ALTITUDE
✓ VFR / IFR / DVFR	N1594B	C172/U	120 KTS	PWA	1400	1405	3500

8 ROUTE OF FLIGHT

PWA OKC ADM V15 DAL - LOVE FLD

9 DESTINATION (Name of airport and city)	10 EST TIME ENROUTE HOURS	10 EST TIME ENROUTE MINUTES	11 REMARKS
LOVE DALLAS	1	45	

12 FUEL ON BOARD HOURS	12 FUEL ON BOARD MINUTES	13 ALTERNATE AIRPORT(S)	14 PILOT'S NAME, ADDRESS & TELEPHONE NUMBER & AIRCRAFT HOME BASE	15 NUMBER ABOARD
5	00		JOHN DOE WILEY POST HANGARS OKLAHOMA CITY, OKLAHOMA	2

16 COLOR OF AIRCRAFT	
RED/SILVER	CLOSE VFR FLIGHT PLAN WITH ________ FSS ON ARRIVAL

Figure 35. Flight Plan.

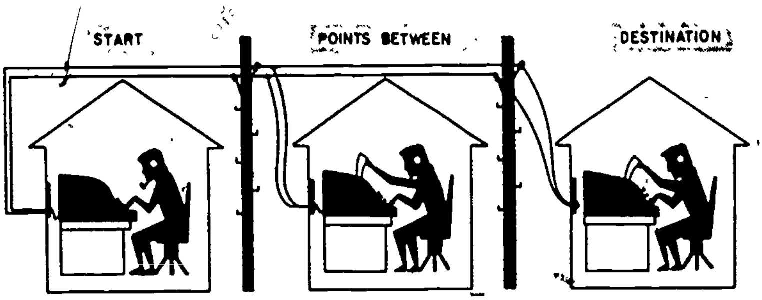


Figure 36. Teletype Network.

PREPARING FOR THE FLIGHT.—First we perform the **preflight inspection;** and after engines are started and the preflight inspection is complete, we are ready to taxi for takeoff. We tune our radio to 121.7 MHz (Ground Control frequency) and ask for taxi instructions.

Aircraft: WILEY POST GROUND CONTROL THIS IS CESSNA ONE FIVE NINER FOUR BRAVO AT HANGAR 4 READY TO TAXI. VFR FLIGHT PLAN TO DALLAS LOVE FIELD. OVER.

FAA Ground Control: NINER FOUR BRAVO, WILEY POST GROUND CONTROL, RUNWAY ONE SEVEN. WIND ONE EIGHT ZERO AT ONE ZERO. ALTIMETER TWO NINER EIGHT. TAXI NORTH ON RAMP. HOLD SHORT RUNWAR ONE SEVEN.

Aircraft: NINER FOUR BRAVO. ROGER.

Ground control has advised us that we will be taking off to the south (runway heading 170°) with a wind from 180° at 10 knots. We have our instructions and taxi to the run-up area adjacent to the runway. At this point, a check is made of the engine and controls for proper operation. After this checkout the transmitter-receiver frequency is changed to 119.7 MHz (Tower frequency) to request takeoff instructions.

Aircraft. WILEY POST TOWER, CESSNA ONE FIVE NINER FOUR BRAVO READY FOR TAKEOFF.

FAA Control Tower: NINER FOUR BRAVO CLEARED FOR IMMEDIATE TAKEOFF.

Aircraft: WILEY POST TOWER, NINER FOUR BRAVO. ROGER.

The controller and aircraft are communicating through a transmitting and receiving site (Fig. 37):

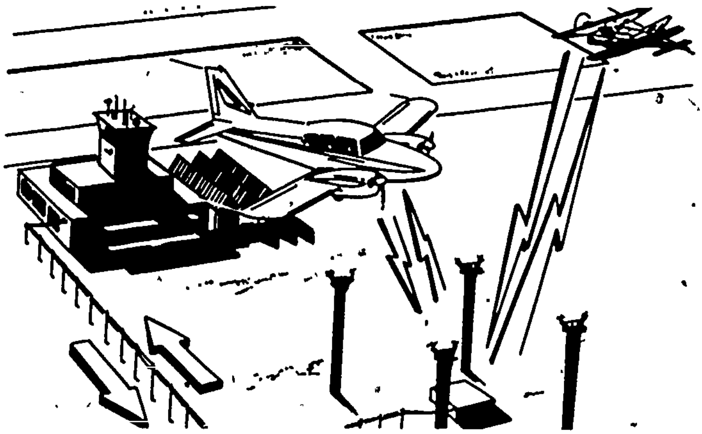


Figure 37. Communications Transmitting and Receiving Site.

From the tower, the voice goes over phone lines to the transmitter and from the antenna to the airplane receiver, the pilot replies, and his reply is picked up by the receiver antenna, then the voice goes back to the control tower over the phone line. Several frequencies are usually available to permit more than one controller and pilot to converse simultaneously. This site is called the Remote Transmitter and/or Receiver Site. In addition to the Very High Frequencies (VHF) we are using, Ultra High Frequencies (UHF) are also available.

We should make a list of the frequencies we may be using during our trip for communications and navigation. The exact frequency to use at each place is shown on the Sectional Chart or, the Airman's Informational Manual (AIM).

The Flight

During the course of our flight, we will be using almost all the navigational and ATC facilities in general use today. While this is a bit unusual, we think it will give you a better idea of the many aids that are available to guide and direct an aircraft in the air today.

VOR NAVIGATION.—We are now in the air, and we climb to the altitude at which we intend to fly. We are leaving the airport traffic area, and must tune in the Oklahoma City VHF Omnidirectional Range (VOR) to get onto the course we intend to fly. By using VOR, a pilot can select courses at 1 intervals providing 360 flyable VOR radials (courses).

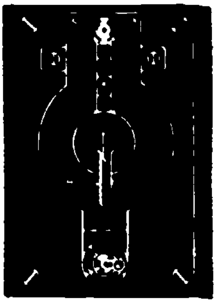


Figure 38. VOR Setting.

The first step is to tune the VOR frequency, see Figure 38, in this case to 115.0 MHz. We listen to the identification to be sure we have selected the proper station. Some VORs have a recorded voice giving the station identification, but all VORs send out the identification in code each six seconds. The identification for Oklahoma City is OKC; or as we would hear it: — — —, — . —, — . — . in code (See Fig. 39).

A ALFA . —	N NOVEMBER — .
B BRAVO — . . .	O OSCAR — — —
C CHARLIE — . — .	P PAPA . — — .
D DELTA — . .	Q QUEBEC — — . —
E ECHO .	R ROMEO . — .
F FOXTROT . . — .	S SIERRA . . .
G GOLF — — .	T TANGO —
H HOTEL	U UNIFORM . . —
I INDIA . .	V VICTOR . . . —
J JULIET . — — —	W WHISKEY . — —
K KILO — . —	X X RAY — . . —
L LIMA . — . .	Y YANKEE — . — —
M MIKE — —	Z ZULU — — . .

At this time, we tune the VHF transmitter to 122.1 MHz and call the Oklahoma City FSS to report the actual time of takeoff.

Aircraft: OKLAHOMA CITY RADIO. THIS IS CESSNA ONE FIVE NINER FOUR BRAVO OFF AT ZERO FIVE, VFR FLIGHT PLAN FROM OKLAHOMA CITY TO DALLAS. PLEASE ACTIVATE MY FLIGHT PLAN. OVER.

FSS: CESSNA ONE FIVE NINER FOUR BRAVO, ROGER, ACTIVATING YOUR FLIGHT PLAN AT ZERO FIVE.

The next step is to tune the course selector, Figure 40, to the desired course, to take us over the VOR facility. To visualize the proper course, look at the layout of magnetic directions around the VOR as shown on the Sectional Chart (Figures 41 & 42).

To get to the VOR, we must fly a magnetic course of 218° to the facility. The bearing selector should now be tuned to a course of 218°.

Notice that we now have an indication on the deviation indicator. The needle is deflected to the right, and since we fly the needle, we correct our heading to the right to intercept the 218° radial. When the needle is centered, we are on course. If we overcorrect, the needle will point left, indicating **fly left.**

At the same time that the deviation indicator began working, the TO-FROM indicator showed an indication of TO. This means that our course is taking us nearer the station.

As we follow this course, the needle begins to move back and forth and finally moves to FROM, an indication that we have just passed over or by the station and are moving FROM it.

Now we turn the Bearing Selector to 145° and make a left turn to intercept this radial. The deflection indicator needle points

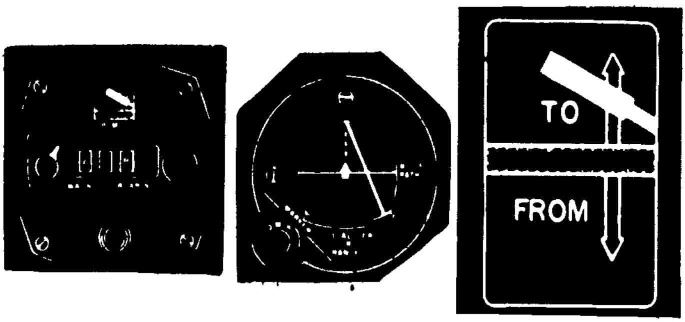


Figure 40. Course Setting.

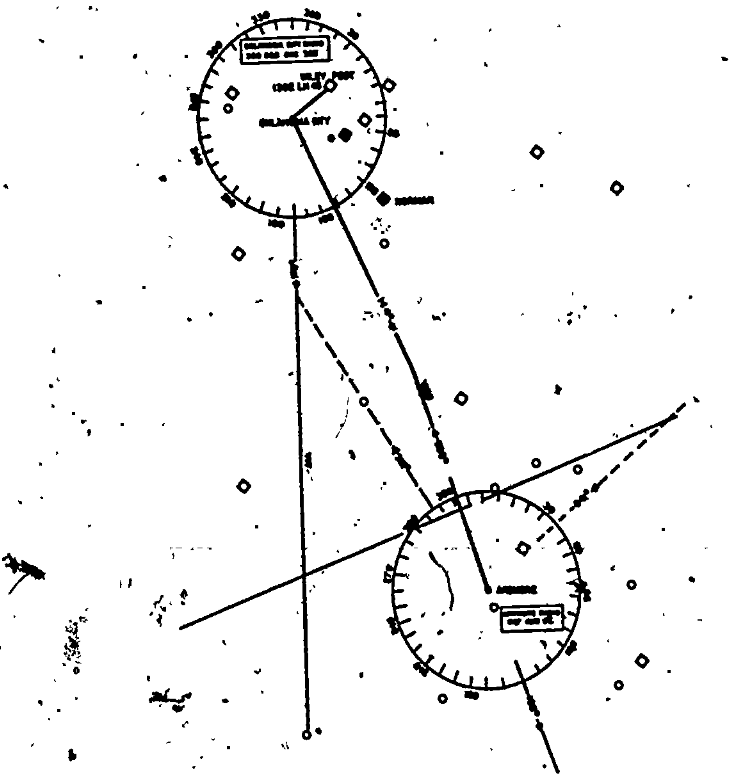


Figure 41. VORS on Sectional Chart.

in the direction to fly: left deflection means fly left, right deflection indicates fly right, and in the center means on course. Notice that 145° is a Victor Airway labeled with the designation V163

Although there are many ways of using VOR indications, this simple explanation is adequate as long as the compass heading of the aircraft agrees within several degrees of the desired VOR radial to be flown.

Let's compare VOR flying to flying a compass heading. No wind drift calculation is required, magnetic deviation and variation computations are unnecessary and the accuracy of each radial of the VOR is within 1°. In general the VOR makes for more effortless, more accurate, and safer flying. It allows us to precisely navigate over ground we may not even see.

The VOR operates in the frequency range of 108-118 MHz. Dual sets of equipment are installed at each location and are electronically monitored. If a transmitter fails, the monitor switches to the standby transmitter and places it in operation. If the standby equipment fails, the monitor will shut the entire facility down and sound an alarm at a control point. A technician must then repair the equipment and certify it as a usable facility.

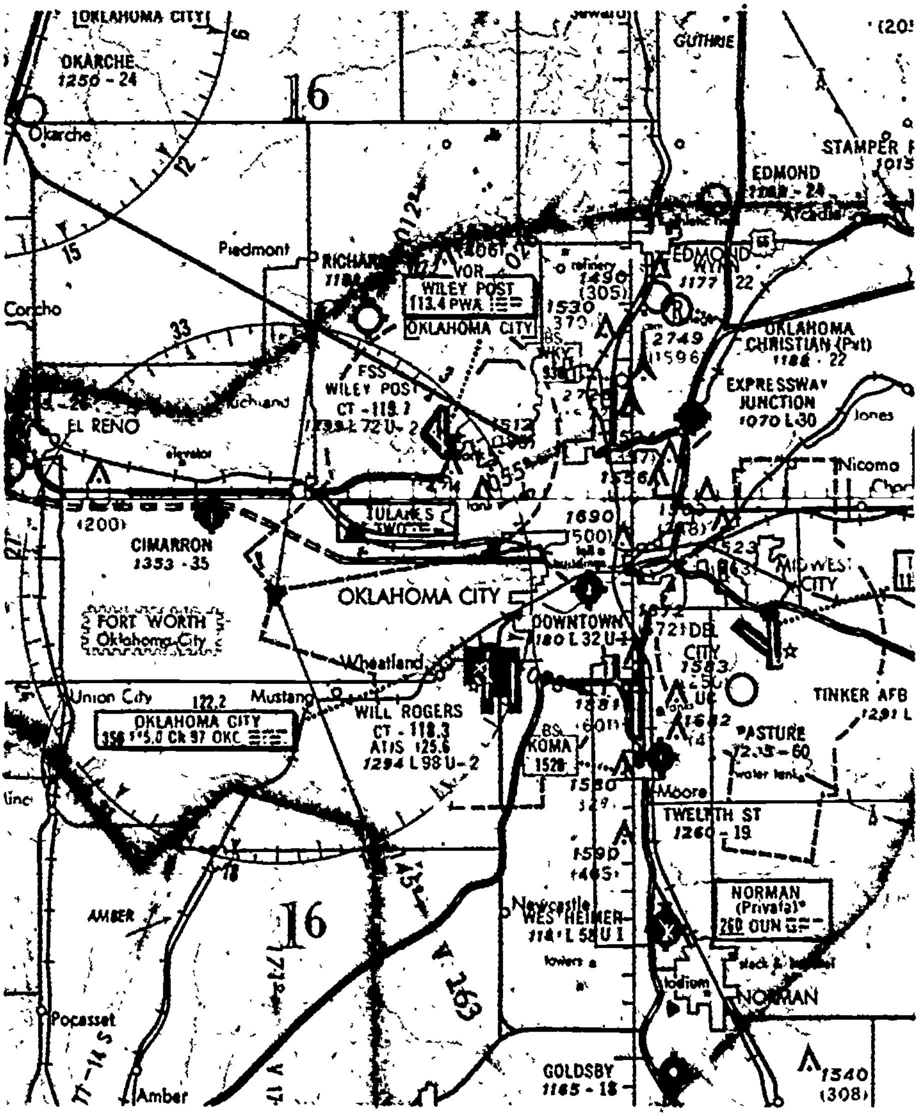


Figure 42. Aeronautical Section Chart, Oklahoma City Area

TACAN.—Now that we are outbound from the first VOR, a check on our position may be made using Tactical Air Navigation (TACAN). Our airborne equipment, called an interrogator, will ask the ground station what our distance is from it and will also indicate the direction of the ground station from us. VOR and TACAN are usually installed in the same building and called VORTAC. The VOR station we are using also has TACAN, Figure 43, so we now select channel 97.

The interrogator dials rotate as they search for the reply from the ground station. When the reply is received, the dials show the distance from our plane to the TACAN.

The other instrument is indicating 325°, which is the azimuth of the ground station from us.

These readings confirm that we are on a course of 145° FROM the VORTAC or, in other words, that it is at 325°, 20 miles behind us.

Our next VOR, Ardmore, VOR is ahead of us and it is time to retune our VOR receiver to 116.7 MHz. The Bearing Selector should be changed to 153° which will take us to the VOR. When we cross over the VOR station, the TO-FROM indicator will switch to FROM and we will change our course to 135°. VORs are spaced about 50 to 100 miles apart and provide a reception distance up to approximately 180 miles, depending upon the altitude of the aircraft. The altitude we are flying would provide us with a range of from 50 to 100 miles.

At 15 minutes past the hour weather reports are broadcast over the voice channel of the VOR.

This is Ardmore area radio, time one-five, aviation weather, Ardmore: ceiling—5,000, broken. visibility, 4, light drizzle, fog: temperature 58, Dew point 57, wind 170 degrees, 6

Figure 43. TACAN Instruments.

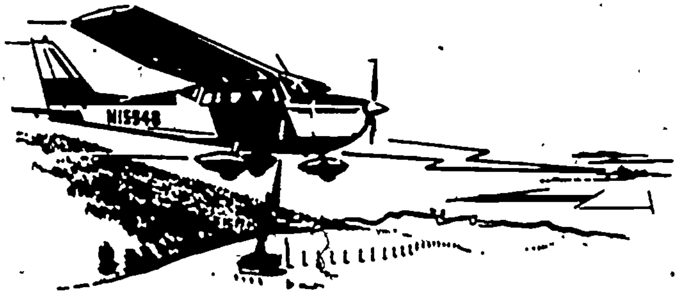


Figure 44. Aircraft Over VOR and Reporting to FSS.

knots, altimeter two niner niner two. this is Ardmore area radio.

The ceiling is lowering, and the visibility is decreasing. Instrument flying will probably be necessary before long.

The VOR is below us now, and it is time to report to the local Flight Service Station (See Fig. 44). Tune the transmitter to 122.1 MHz and call the FSS.

Aircraft: ARDMORE RADIO THIS IS CESSNA ONE FIVE NINER FOUR BRAVO, OVER.

FSS: CESSNA ONE FIVE NINER FOUR BRAVO THIS IS ARDMORE RADIO, GO AHEAD.

Aircraft: NINER FOUR BRAVO OVER ARDMORE VOR, 3,500, VFR FLIGHT PLAN FROM OKLAHOMA CITY TO DALLAS, OVER.

FSS: CESSNA NINER FOUR BRAVO, OVER ARDMORE RADIO, 3,500, ARDMORE ALTIMETER TWO NINER NINER TWO, ARDMORE, OUT.

Communications has again played an important role in the safety of our flight. The Flight Specialist can send our position report over the **Teletype Net** to our next reporting point in a matter of seconds. (See Fig. 45)

IFR.—Ardmore has been broadcasting Special Aviation Weather Reports and Pilot Weather Reports (PIREPS) which indicate mild turbulence and near zero visibility. The weather is definitely closing in. To continue flying VFR, we must stay clear of low visibility areas. Our choice is between turning back or to continue the flight under Instrument Flight Rules (IFR). If we did not have an FAA approved instrument rating, we would be forced to turn back, but in this case, we will go on.

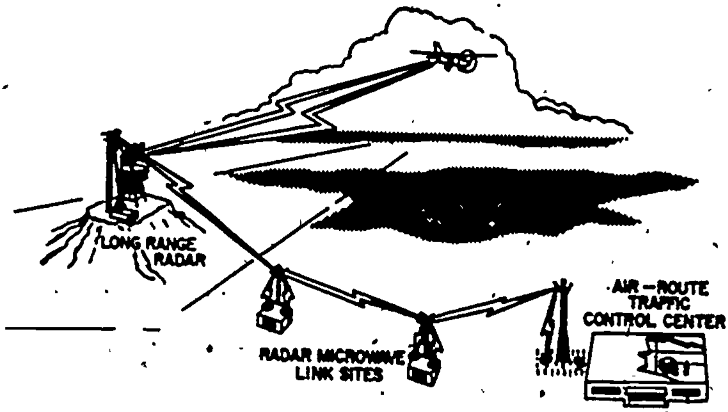


Figure 45. Enroute ATC Radar.

Again we call Ardmore Radio, this time to request a change in flight plan from VFR to IFR.

Aircraft: ARDMORE RADIO THIS IS CESSNA ONE FIVE NINER FOUR BRAVO, OVER.

FSS: CESSNA NINER FOUR BRAVO, ARDMORE RADIO, GO AHEAD.

Aircraft. ARDMORE RADIO, CESSNA NINER FOUR BRAVO, ANTICIPATE INSTRUMENT FLYING CONDITIONS IN APPROXIMATELY THREE ZERO MINUTES. REQUEST YOU CANCEL MY VFR FLIGHT PLAN FROM WILEY POST AIRPORT TO LOVE FIELD AND REQUEST IFR CLEARANCE TO DESTINATION, OVER.

FSS. CESSNA NINER FOUR BRAVO, ARDMORE RADIO, GO AHEAD WITH YOUR IFR FLIGHT PLAN, OVER.

Aircraft: ARDMORE RADIO. CESSNA NINER FOUR BRAVO, REQUEST VICTOR ONE FIVE BLUE RIDGE DIRECT LOVE FIELD, REQUESTING 4000 FEET. OVER.

Ardmore Radio now contacts the **Air Route Traffic Control Center (ARTCC)** and advises the operator of our requested route and altitude. Notice that we have requested a change in altitude from 3500 to 4000 feet. Altitudes are different for VFR and IFR flights. This is another safety feature to make sure that aircraft have proper separation. ARTCC approves our IFR flight plan and issues a clearance to Ardmore Radio for relay to the aircraft. Ardmore Radio issues the clearance, radar beacon codes, and the radio frequency changes needed to contact Fort Worth ARTCC.

FSS: CESSNA NINER FOUR BRAVO, THIS IS ARDMORE RADIO, CLEARANCE, OVER.

Aircraft: ARDMORE RADIO, CESSNA NINER FOUR BRAVO READY TO COPY, OVER.

FSS: ATC CLEARS CESSNA NINER FOUR BRAVO TO LOVE FIELD AIRPORT VIA VICTOR ONE FIVE BLUE RIDGE DIRECT. CLIMB AND MAINTAIN 4000 ON VICTOR ONE FIVE, SQUAWK ONE ONE ZERO ZERO AND CONTACT FORT WORTH CENTER ON ONE TWO EIGHT POINT ONE. OVER.

Aircraft: ARDMORE RADIO, ROGER, CESSNA NINER FOUR BRAVO, OUT.

Ardmore Radio has introduced a new term—**squawk.** This refers to special radar beacon equipment which allows the radar operator to positively identify a specific aircraft on a radar scope. When the pilot sets the requested settings in the aircraft transponder, the radar operator can read this special code or squawk on his scope. This is another safety feature in aircraft control. We will discuss it more later. Even though the Fort Worth ARTCC is out of our radio range, we are now being monitored by radar (Fig. 46) and may still communicate with them over the **Remote**

Figure 46. Electronic Aircraft Identification and RADAR Scope.

Center Air Ground (RCAG) communication sites which act as extended voices and ears for the Center. The voice from the controller is carried over telephone lines to RCAG sites where it is transmitted to us, our transmission is received by the RCAG and relayed to the controller over telephone lines.

The ARTCC is connected to many of these remote sites providing full coverage of the control area. This means that for the duration of our flight we can maintain effective communications although we may be many miles from the center itself. The site we are using now is located on a mountain near Ardmore and is kept in operation by electronic technicians from Ardmore.

The frequencies in use at each of these sites may be paired; for example, each communications channel includes one VHF transmitter and receiver and one UHF transmitter and receiver, both of these having automatic standby equipment to assume operation in case of failure or malfunction of the main equipment, or in case of commercial power failure.

Standby Engine Generators are also installed with many other navigational aids. This is especially important since usually the same elements which wreck utility power lines occur during the time when the aircraft needs assistance most. These units are capable of sensing power failure, starting the engine, and assuming the full load in about seven seconds. The larger units of the type used at the ARTCC produce 550,000 watts each. enough to supply a medium size town with all its power requirements.

We now climb to 4000 feet, make the necessary frequency changes, and contact the Fort Worth Center.

Aircraft: FORT WORTH CENTER, THIS IS CESSNA ONE FIVE NINER FOUR BRAVO, OVER.

Center: CESSNA NINER FOUR BRAVO, FORT WORTH CENTER, GO AHEAD. OVER.

Aircraft: CESSNA NINER FOUR BRAVO OUT OF 3500 FOR 4000, SQUAWKING ONE ONE ZERO ZERO, OVER.

Center: CESSNA NINER FOUR BRAVO, IDENT, OVER.

Aircraft: ROGER.

Center. CESSNA NINER FOUR BRAVO RADAR CONTACT FIVE MILES SOUTHEAST ARDMORE VOR; REPORT REACHING 4000. OVER.

Aircraft: ROGER

IDENT refers to the radar beacon equipment. When the pilot pushes a switch on his transponder, it causes a larger return on the radar operator's scope.

Upon completion of our climb, we call the Forth Worth Center and report.

Aircraft: FORT WORTH CENTER, CESSNA NINER FOUR BRAVO LEVEL AT 4000, OVER.

Center: CESSNA NINER FOUR BRAVO, ROGER.

RADAR.—The controller in the center will observe our progress on his radar indicator. During the flight it is his responsibility to advise us of other aircraft which may be in our area and to reroute any aircraft which may be in danger of collision. The long range radar the controller is using is called **Air Route Surveillance Radar** and has a range of up to 200 miles. This means that either the radar at Oklahoma City or the one just north of Fort Worth could be watching us.

Even though we are in rain clouds, this radar can see us because of a feature called **circular polarization.** This feature eliminates the radar echoes of most of the heavy rain so the controller can watch the aircraft. Another nice feature of this radar is the ability to show only targets which are moving. This prevents the radar display from being cluttered and simplifies the controller's duties.

The chance of radar failure is very slight, since each site has two complete radar systems, in case of malfunction the other radar takes over.

Here is a little problem. If we are being scanned by radar in Oklahoma City, how does the controller in the Fort Worth ARTCC see us? This calls for a system to move the radar information from Oklahoma City to Fort Worth, a **Radar Microwave Link** is used. Actually this system is a number of receiver-transmitter sites, located about 25 miles apart, which receive, amplify, and transmit the signal to the next site.

When the radar signal arrives at the ARTCC, it is converted to a television type display which allows the controller to view the presentation with a fairly high level of surrounding light. The equipment which performs this conversion is called **Radar Bright Display Equipment.**

The displayed presentation shows to the controller the present location of the aircraft as well as a trail indicating several minutes of previous position.

ELECTRONIC AIRCRAFT IDENTIFICATION.—Increasing air traffic has made it difficult for the controller to identify or distinguish various aircraft being monitored. To help solve this problem, a secondary radar system called **Air Traffic Control Radar Beacon System** has been developed. Remember our earlier discussion of squawk. The controller can assign our aircraft a code number. Then, when the ground equipment interrogates our airborne transponder, it will reply or squawk our assigned code.

The code which is assigned to the aircraft will be immediately displayed for the controller's use. This is especially important in congested areas where many aircraft are in the air and identification is difficult. Aircraft beacon transponders are in use that can also report the aircraft altitude. A new video mapper has been developed which will not only permit the controller to tell the pilot where other aircraft are, but he can also tell him his position in relation to ground obstructions such as towers and "granite clouds" (mountains).

Secure in our knowledge that we are in safe hands, we continue our flight to a point approximately 40 miles from the Dallas VOR (refer to Fig. 47). There, the Fort Worth ARTCC changes

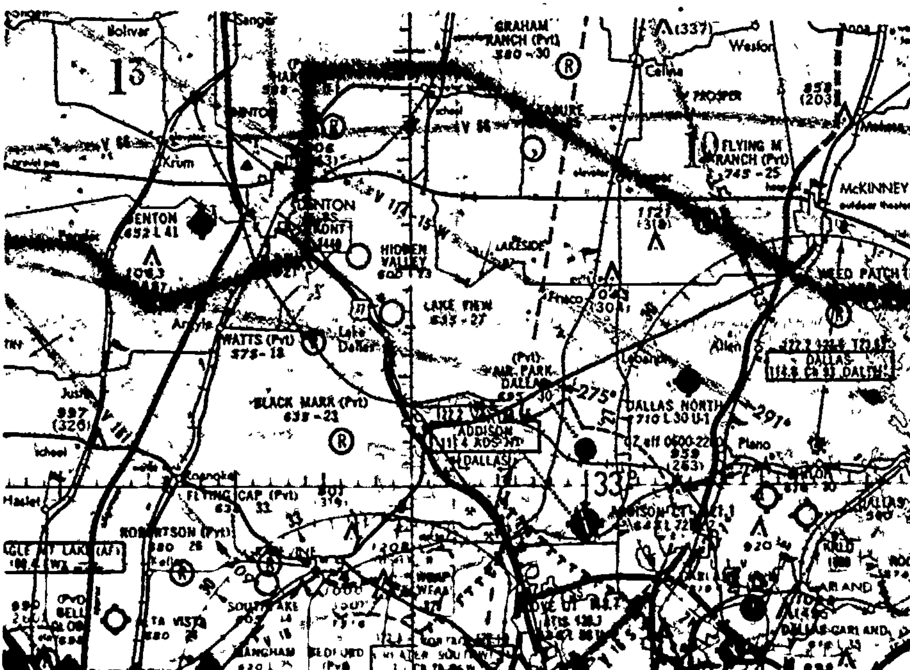


Figure 47. Aeronautical Section Chart, Dallas-Fort Worth Area.

our radar beacon code and gives us a **hand-off** to the Dallas-Fort Worth **Radar Approach Control (RAPCON).**

Center: CESSNA NINER FOUR BRAVO, FORT WORTH CENTER, OVER.

Aircraft: FORT WORTH CENTER, THIS IS CESSNA NINER FOUR BRAVO, GO AHEAD. OVER.

Center: CESSNA NINER FOUR BRAVO YOU ARE NOW IN RANGE OF APPROACH CONTROL RADAR PREPARE FOR HANDOFF, OVER.

Aircraft: FORT WORTH CENTER, CESSNA NINER FOUR BRAVO READY TO COPY, OVER.

Center: CESSNA NINER FOUR BRAVO CHANGE BEACON CODE TO ZERO FOUR ZERO ZERO AND CONTACT DALLAS-FORT WORTH APPROACH CONTROL ON ONE TWO FIVE POINT EIGHT, OVER.

Aircraft: FORT WORTH CENTER, CESSNA NINER FOUR BRAVO, ROGER, OUT.

We are now being monitored by **Airport Surveillance Radar** which has a range of about 60 miles. This radar will be used to guide us to the airport traffic pattern. Airport Surveillance Radar also has the ability to display only those targets which move. This feature eliminates displaying buildings around the airport which could obscure the aircraft targets. (See Fig. 48)

Superimposed directly on the radar presentation is a map which shows the controller our exact location with respect to the desired course and allows him to follow our progress throughout each phase of the approach.

Visibility is near zero, and we are entirely dependent on radar to advise us of our proximity to other aircraft and to provide a safe course to avoid collision. We are still safer here than we would be in the family automobile on the freeway.

To complete the handoff from the Fort Worth ARTCC, we now change our radar beacon code, adjust our radio frequency, and contact Dallas-Fort Worth Approach Control Radar.

Aircraft: DALLAS-FORT WORTH APPROACH, THIS IS CESSNA ONE FIVE NINER FOUR BRAVO, OVER.

Approach: CESSNA ONE FIVE NINER FOUR BRAVO, DALLAS-FORT WORTH APPROACH, IDENT, OVER.

Aircraft: ROGER DALLAS-FORT WORTH APPROACH, CESSNA NINER FOUR BRAVO AT 4000 AND SQUAWKING ZERO FOUR ZERO ZERO, OVER.

Approach: CESSNA NINER FOUR BRAVO FLY HEADING ONE EIGHT ZERO FOR VECTOR TO RUNWAY ONE THREE LEFT TRAFFIC PATTERN, DESCEND AND MAINTAIN 2000, OVER.

Figure 48. Airport Surveillance Radar Scope.

Aircraft: CESSNA NINER FOUR BRAVO OUT OF 4000 FOR 2000, HEADING ONE EIGHT ZERO, OVER.

Visibility improves as we descend to 2000 feet where clouds are scattered and broken. Now we can see quite clearly below us, so it will not be necessary to make an instrument approach to the runway. When we reach a point 5 to 10 miles from Love Field Airport, Radar Approach Control again contacts us to give us a report of our position in relation to the airport and instructions for contacting the control tower.

Approach: CESSNA NINER FOUR BRAVO THE AIRPORT IS TWELVE O'CLOCK NINER MILES, REPORT AIRPORT IN SIGHT, OVER.

Aircraft: CESSNA NINER FOUR BRAVO, AIRPORT IN SIGHT, REQUEST VFR LANDING, OVER.

Approach: CESSNA NINER FOUR BRAVO, VFR LANDING APPROVED, CONTACT LOVE TOWER ONE ONE EIGHT POINT SEVEN, OVER.

Aircraft: CESSNA NINER FOUR BRAVO, ROGER, OUT.

We now change our radio frequency to 118.7 MHz and contact the control tower.

Aircraft: LOVE TOWER THIS IS CESSNA ONE FIVE NINER BRAVO NINER MILES NORTH, LANDING, OVER.

Love Tower: CESSNA NINER FOUR BRAVO, LOVE TOWER, CLEARED TO LAND RUNWAY ONE THREE LEFT, OVER.

Aircraft: CESSNA NINER FOUR BRAVO, ROGER.

When the tower operator sees that we have landed, he gives us instructions on leaving the runway.

Love Tower: CESSNA NINER FOUR BRAVO TURN RIGHT NEXT TAXIWAY. . .CONTACT GROUND CONTROL ONE TWO ONE POINT NINER WHEN CLEAR, OVER.

Aircraft: CESSNA NINER FOUR BRAVO, ROGER.

We have cleared the runway in use (the active runway), so we now change frequencies and contact Ground Control.

Aircraft: LOVE GROUND, CESSNA ONE FIVE NINER FOUR BRAVO OFF THE ACTIVE, OVER.

Love Ground: CESSNA NINER FOUR BRAVO, LOVE GROUND, TAXI TO THE RAMP, OVER.

Aircraft: CESSNA NINER FOUR BRAVO, ROGER, OUT.

Our flight is now over and we make the final entries on our flight log. Our flight plan was automatically closed out because we were flying IFR although we made a visual landing. If we had landed on a VFR flight plan, we could have contacted the Dallas Flight Service Station by radio to close the flight plan. However, all IFR flight plans are closed automatically when landing at an airport with a control tower. (See Fig. 49)

ATC Facilities Used in Flight

Our flight from Oklahoma City to Dallas involved complex navigational aids on our airplane and at ATC facilities on the ground. Here is a review of the ATC functions.

After we filed our flight plan and got our weather briefing, the information on the flight plan was sent out over the Teletype circuits to the several air traffic controllers who would monitor and guide us. This information was put in the form of **Flight Strips** which were then displayed on a **Flight Progress Board** near each controller. The information on these strips and boards was used by the controllers to guide our airplane. Radar information, too, aided the controllers in "seeing" just where our airplane was at any given time along the route.

Our flight went along smoothly, until we ran into some bad weather. We called the Fort Worth ARTCC, and it picked us up on its radar. The remote communications site enabled us to talk directly with the controllers in the Fort Worth ARTCC.

FLIGHT LOG

DEPARTURE POINT	VOR IDENT. / FREQ.	RADIAL TO / FROM	DISTANCE LEG / REMAINING	TIME POINT—POINT / CUMULATIVE	TIME TAKEOFF	GROUND SPEED
CHECK POINT OKC	OKC	218	9	'05	ETA 1410	
	115.0	145	170	'05	ATA 1410	
ADM	ADM	153	80	:50	1457	
	116.7	150	90	:55	1500	
DAL	DAL	151	78	:46	1543	
	114.6	221	12	1:41	1546	
DESTINATION LOVE		221	12	:05	1550	
FIELD			TOTAL	1'46	1551	

PREFLIGHT CHECK LIST	DATE
EN ROUTE WEATHER/WEATHER ADVISORIES	
DESTINATION WEATHER	WINDS ALOFT
ALTERNATE WEATHER	
FORECASTS	
NOTAMS/AIRSPACE RESTRICTIONS	

Figure 49. Flight Log.

SCALE 1:1 000 000 — Nautical Miles / Statute Miles — WORLD AERONAUTICAL CHARTS

SECTIONAL AERONAUTICAL CHARTS — SCALE 1:500,000 — Nautical Miles / Statute Miles

When our airplane got close enough to Dallas Love Field, the ARTCC controller told our pilot that we were being "handed off" to Dallas RAPCON. This simply meant that we were now being monitored and directed by radar at Love Field, rather than the Fort Worth ARTCC. The ARTCC controllers are concerned with airplanes flying on the airways between major points, rather than with airplanes which are flying close to major airports.

We were able to make a "straight in" landing. Suppose, though, that Love Field had a great deal of air traffic. The RAPCON would have advised us to enter a **holding pattern.** This would enable the traffic around the airport to land or take off and keep us out of their way. When we were cleared to land, the approach radar would follow us all the way in. The controller would tell us whether we were above, below, or on the glide path.

All of these techniques help to make today's flying extremely safe. The electronic facilities are usually duplicated at most ATC facilities in case one system fails, another system can be activated. The FAA checks the efficiency and accuracy of air traffic control operations, procedures, and facilities by flying its own aircraft into and out of selected airports and along selected air routes. FAA air traffic control specialists are highly trained in such subjects as weather, navigational aids, FAA regulations, flight assistance, and radio communications. These specialists serve an apprenticeship period to acquaint them with the various tasks involved in air traffic control before attending formal training. The formal training period is a minimum of two years long and may last up to three years. Before a graduate is considered to be fully trained, he must complete "on-the-job" training (OJT) where he is observed and supervised by experienced personnel. In addition, advanced training in the latest techniques and equipment insures that each air traffic control specialist keeps up with changes in his field.

THE FUTURE

What does the future hold for the air traffic controller? The future of air traffic control naturally depends upon advances in other areas. Air traffic control must follow developments in aerospace technology.

The FAA is very much concerned about air traffic congestion. A part of the solution lies in the acquisition of more and better airports and facilities to speed takeoffs and arrivals, but control and efficient use of air space is also a problem.

Air traffic control is concerned primarily with enroute control, terminal control, and flight service stations. The FAA's National Aviation System Plan provides for the expansion and improvement in all three of these areas.

Enroute air traffic control improvements are constantly being made and during the time span covered by the plan, it is expected that:

1. Air-ground communications will be improved through satellite communications application in the oceanic areas by a frequency system reserved for aircraft use only, and the linking of communication to computers (data link).

2. Traffic handling capabilities will be improved through the use of computers that provide controllers with traffic separation information and automatic flight directors.

3. Collision avoidance systems will be improved through the establishment of a network of updated ground station facilities.

Terminal control services are provided to facilitate control of air traffic on and in the vicinity of an airport. In terminal areas with high traffic density, it is impossible for every pilot to make radio contact with tower personnel at the same time. FAA now provides terminal information to pilots through the use of **Automatic Terminal Information Service (ATIS)** equipment without actually contacting tower personnel. The use of electronic voice switching systems and voice recorders cuts the amount of time each aircraft must be in voice contact with the terminal.

Air surveillance radar and improved beacon systems provide immediate information on aircraft entering a terminal area. This capability coupled with new airport surface guidance equipment reduces the time aircraft must remain in the area before landing. Other improvements include digital weather displays in current use and automatic weather sensing and transmission equipment that is expected to be perfected in the near future.

FSS services are necessary to insure that inflight aircraft reach their destinations safely. Flight service stations of the future will provide automatic enroute course corrections, weather information, and pre-flight briefings.

From its beginnings in the early 1920s, air traffic control has developed significantly. We know that in the future there will be more airplanes in the air and more people flying in these planes. Airports will be designed to accommodate these new airplanes, and air traffic control will have to keep pace with all of these changes.

WORDS AND PHRASES TO REMEMBER

air traffic control (ATC)
radio ranges
airways
National Weather Service
Automatic Data Interchange System
flight plan
Flight Service Stations (FSS)
preflight inspection
Teletype Net
Air Route Traffic Control Center (ARTCC)
squawk
Remote Center Air Ground (RCAG) site
IDENT
Air Route Surveillance Radar
circular polarization
Radar Microwave Link
Radar Bright Display Equipment
Air Traffic Control Radar Beacon System
hand-off
Radar Approach Control (RAPCON)
Airport Surveillance Radar
Flight Strips
Flight Progress Board
holding pattern
Automatic Terminal Information Service (ATIS)

REVIEW QUESTIONS

1. Trace the development of air traffic control. How has the Federal Government helped develop today's sophisticated air traffic control system?
2. Discuss the functions of flight service stations, air route traffic control centers, and approach control. How does each of these air traffic control functions help today's pilot?
3. How does radar help the air traffic controller?
4. What devices will aid the air traffic controller of the future? How will these devices also aid the pilot?

THINGS TO DO

1. You might arrange a visit to your local airport and get permission to observe the air traffic controller at work. If this is not possible, you might investigate the possibility of inviting an air traffic controller to speak to the class on the duties, responsibilities, and problems of his job.

2. From the relatively brief account given in the text, combined with information gathered from additional reading, work up a script for a simulated ATC handling of takeoffs and landings at a busy airport. Assign various roles to members of the class and present the simulated exercise to the class.

3. An excellent portrayal of the problems involved in running a modern large airport can be found in the novel *Airport* by Arthur Hailey. Mr. Hailey says of this book that "before beginning any new novel, I spend at least a year investigating the background. It worked that way with *Airport*. I traveled from airport to airport, talking . . . with airport and airline officials, pilots, stewardesses, maintenance men, air traffic controllers." You might read this novel with a "factual background" and give a book review of it to the class.

4. Get a copy of the Airman's Information Manual and find out what kinds of information are available in it.

INDEX

A

V

W

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