

Historical Perspective.



Dr. Antonio Trani and Julio Roa
Department of Civil and Environmental Engineering

Fall 2023

Early Developments

1903

Wright Brothers' first flight in North Carolina

1916

First air mail service (Army)

1918

U.S. Postal Service takes over the mail system

1925

**Kelly Act (Air Mail Act)
allows private operators into the air mail service**

1926

President Coolidge signs first Air Commerce Act

- Establishes aids to air navigation
- Provided authority for traffic rules
- Mandatory registration of aircraft providing air services
- Certification of airmen

1927

Pan American World Airways services Miami - La Habana (Cuba)

Early Airports

College Park airport



Oldest continually - operated airport in the U.S.



The Wright Brothers trained two military officers (Lt. F. Humpreys and F. Lahm) at this airport back in 1909

Bisbee - Douglas airport



First international airport

Sites of Interest

History of LaGuardia Airport (New York)

⚡ <https://portfolio.panynj.gov/2016/06/17/laguardia-airport-flashback-to-the-past/>

Roanoke Woodrum Field Airport (1971)

⚡ http://www.virginiaroom.org/digital/files/original/15/1976/RAC11_Woodrum_Field.jpg

Abandoned Airfields in the U.S.

⚡ <http://www.airfields-freeman.com>

Old Atlanta Hartsfield Airport

⚡ <https://www.atlantahistorycenter.com/exhibitions/atlanta-in-50-objects/hartsfield-jackson-atlanta-international-airport/>



Early Commercial Aircraft Development (20's - 30's)



The late twenties and early thirties introduces important advances in aircraft construction methods.

Ford (4-AT-E) Trimotor

- 175 km/hr (109 mph)
- Runway length = 350 m (1150 ft)
- 10 - 12 passengers

Early Developments

1930

**U.S., Latin America
and Europe
airlines flourish**

1935

**First air traffic
control facility
(Newark)**

1936

**The Douglas
DC-3 goes into
service**



Douglas DC-3

Cruise speed: 300 km/hr (180 mph)

21-32 passengers

11,000 built, some still fly today

Runway length = 800 meters (2,625 feet)

Early Airports



Miami Beach Seaport (Circa 1930) Blankenship, 1967

**In the 30's airports start adding concrete runways
(400-900m.)**

Large flying boats required airport terminal facilities

WWII Period

1938

President Roosevelt creates the CAA (Civil Aeronautics Authority) through the Civil Aeronautics Act of 1938



1939

CAA splits into CAA and CAB (Civil Aeronautics Board)

1939-1945

Aircraft development during WWII



1939-1945

Hundreds of low cost airports are created around the country to train pilots



1945-1947

Availability of surplus aircraft (specially many C-47 or DC-3)

End of World War II Aircraft

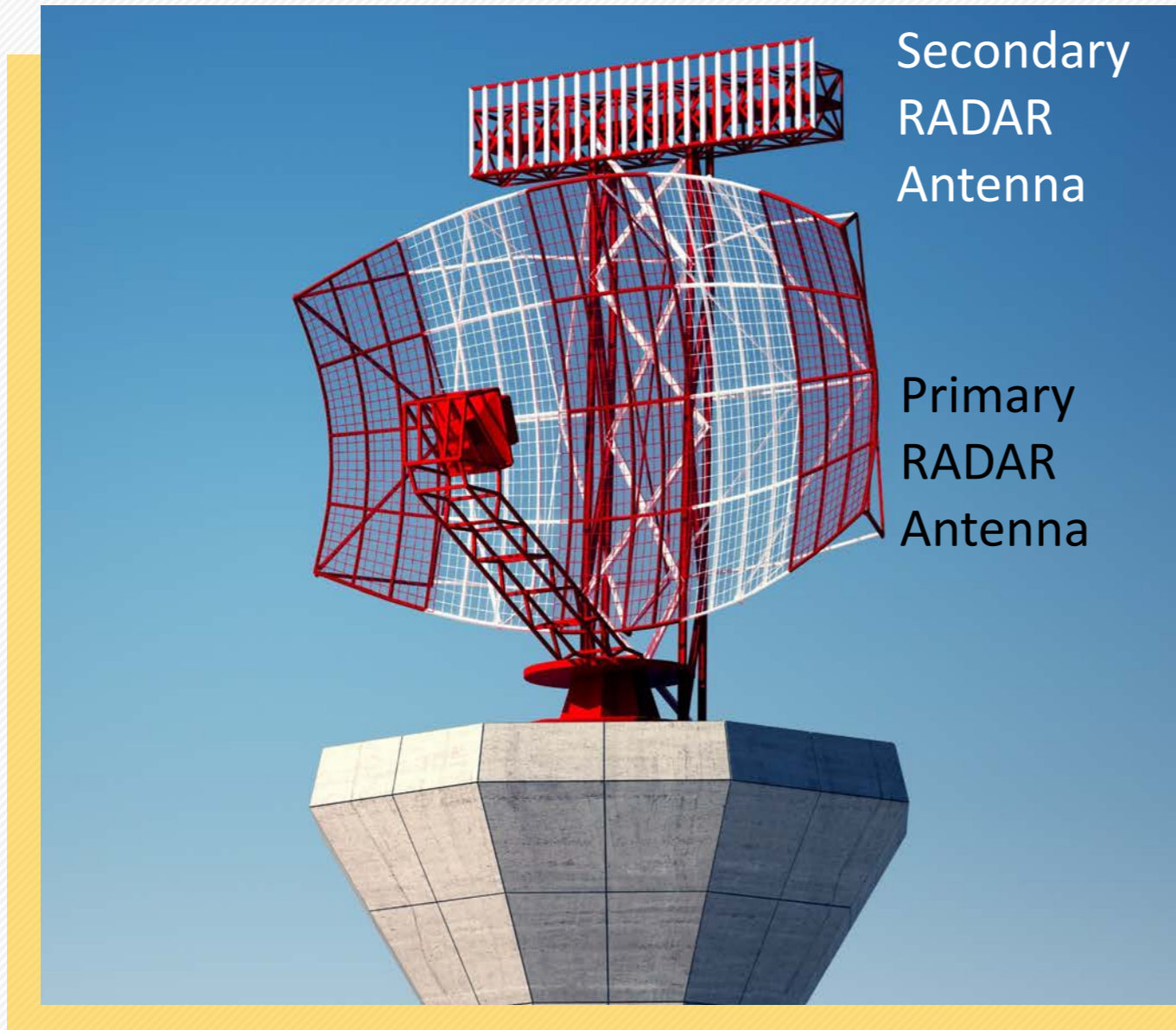


In 1947, the Douglas DC-6 is introduced by American and United. Powered by four Pratt & Whitney R-2800-CB17 "Double Wasp" radial engines

Douglas DC-6-B

- Cruise speed: 507 km/hr (315 mph)
- 45 - 65 passengers
- 300 built, some still fly today
- **Runway length = 1475 m (4830 ft)**

Development of RADAR Technology



Allows the surveillance of aircraft allowing efficient and safe aircraft operations.

Primary RADAR detects the metal sections of the aircraft.

Secondary RADAR transmits and receives information such as aircraft speed, altitude, ID, etc.

Post War Period

1945

First radar equipped control tower (Indianapolis)

1946

Federal Airport Act of 1946

1951

British launch the first commercial jet (Comet I)

- Airport runway lengths grow substantially
- More support equipment is needed

1958

Federal Aviation Act of 1958

- Creates the Federal Aviation Agency (today's FAA)
- Retains CAB for regulatory control

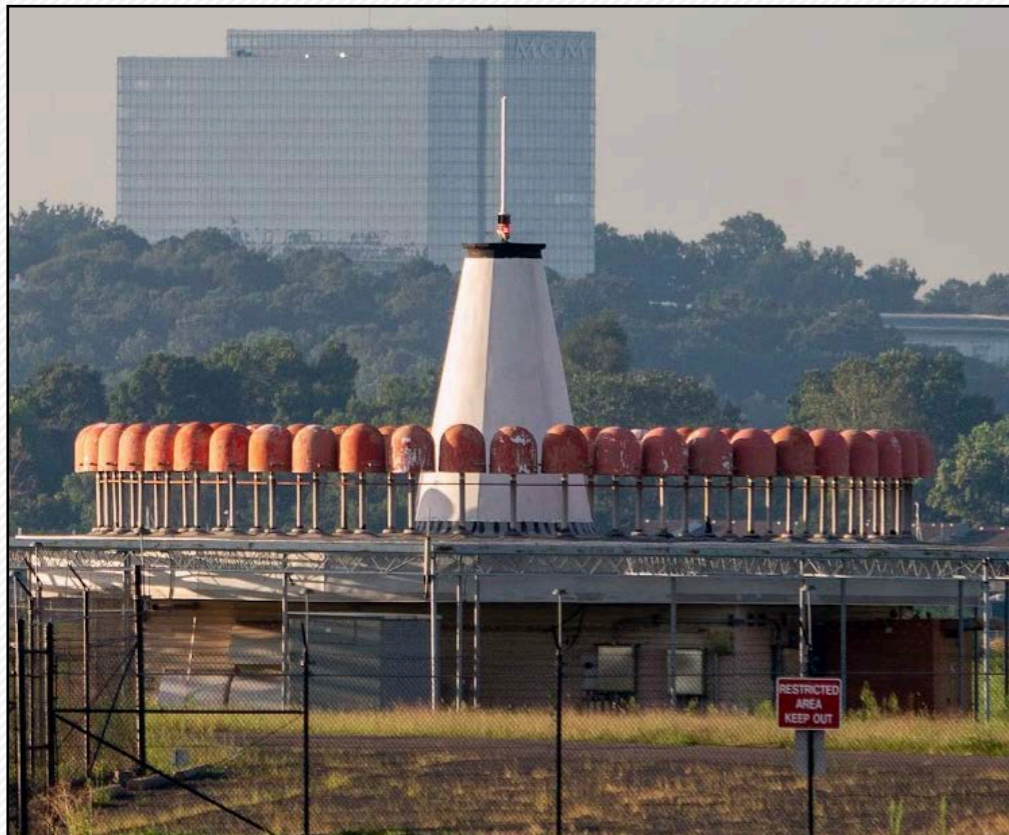
1967

Department of Transportation emerges

- FAA becomes the Federal Aviation Administration
- NTBS is created (National Transportation Safety Board)

Airport and Airway Technologies (50's)

Relevant airport/aviation technologies:



- Very High Frequency Omni-directional Range and Finding (VOR's and later VORTAC's)

- Approach lighting systems



- Instrument Landing System (ILS)



Localizer antenna

Representative Aircraft of the Post War Period

Several successful four-engine, piston and turbo propeller aircraft are developed in this period



Vickers Viscount (Turboprop)



Lockheed Constellation (Piston)

- Cruise speed: 575 km/hr (357 mph)
- 90 - 100 passengers
- **Runway length: 1,650 m (5415 feet)**

Long-Range Aircraft Development (50-60's)

The British Comet I is followed by very successful American four-engine turbojet designs from Boeing and Douglas



Douglas DC-8-50



Boeing 707-320

- Cruise speed: 950 kph
- 140 - 165 passengers
- Runway length: 3,000 m

Short-Range Aircraft Development (60's)

Several short and medium-range aircraft are introduced in the 60's



Boeing 727-200

- Cruise speed: 950 km/hr
- 134 - 165 passengers
- 78,100 kgs takeoff mass
- Runway length: 2,600 m (8,400 ft)



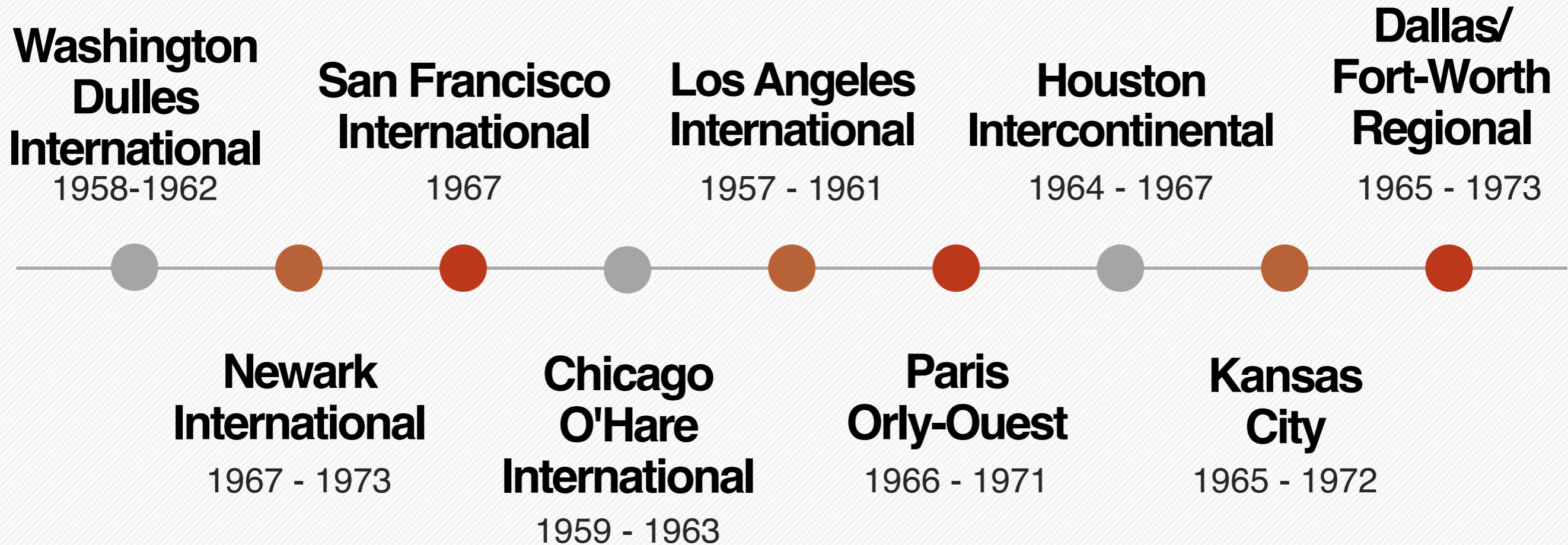
Source: NASA and Wikipedia

Boeing 737-100

- Cruise speed: 900 km/hr
- 100-110 passengers
- 50,000 kgs takeoff mass
- Runway length: 1,900 m (6,100 ft)

Airport Development in the 60's

Many of the most famous airports as we know them today were conceived in the late 50's and early 60's



Supersonic Aircraft (Late 60's)



In 1968, BAC/Aerospatiale introduced the Concorde.
Only 14 aircraft are built.

Concorde

- Cruise speed: 2,400 kph
- 90 - 110 passengers
- 7,500 km range
- Runway length: 3,200 m

Large Capacity Aircraft (60-70's)



Boeing 747-400 of KLM
Departing Chicago O'Hare Airport

In 1969, Boeing introduces the Boeing 747-100 (no picture here)

PanAm is the first airline to place it into service. Airports have to adjust gate size to this aircraft.

Boeing 747-100

- Cruise speed = 985 km/hr
- 400 passengers
- 8,000 km range
- 320,000 kg
- Runway length 3,100 m



In the early seventies new innovations appear at many airports in the U.S. (Automated People Movers -APM, centralized deicing, mobile lounges, moving sidewalks, etc.)

Airport Innovations (70's)

Important Airport Airway Development

1970

Airport and Airway development Act of 1970

- Creates the Aviation Trust Fund
- Provided assistance to airports for development

1978

Airline Deregulation Act of 1978

- Eliminates the regulation activities
- Phases out CAB in 1985
- Rise and decay of low fare airlines
- Consolidation of markets
- Growth in commuter markets

1981

PATCO strike (11,000 ATC controllers fired by President Reagan)

More Recent Issues

1982

**Airport and
Airway
Improvement
Act of 1982**

- FAA's Brown Book
(National Airspace
Systems Plan - NASP)
- Authorizes 11.1 billion
dollars for
improvements

1980's

**Few megacarriers
dominate the
domestic market**

1980-1990's

**More airline
consolidations take
place**

More Recent Issues

1990's

International megacARRIER arrangements (alliances)

1993

European liberalization starts

1990's

Commuter airlines seek alliances with majors

1990's

Low-cost carriers thrive (Jetblue, Virgin America, Southwest airlines, etc.)

Development of Twin Engine Aircraft (70-80-90's)



Development of large turbofan engines
Boeing and Airbus introduce successful
long-range, twin-engine aircraft.

Boeing 767-200

- Cruise speed = 985 km/hr
- 270 passengers
- 7,000 km range
- 200,000 kg takeoff mass
- **Runway length = 2,700 m**

Satellite Revolution

1993

- GPS (Global Positioning System) touted as the next ATC revolution
- SATNAV trails over the Pacific Ocean
- United predicts 40 million dollars in savings in the Pacific using GPS

1994

Satellite navigation trials start on Trans-Pacific routes

1996

Trails to test DGPS for low visibility landings at airports

1998

ADS-B Automated Dependence Surveillance mode B

1999

DGPS offers near precision approaches (demonstrations)

2000-2002

Capstone program demonstration in Alaska

2009

Automated Dependence Surveillance (ADS-B) in the Gulf of Mexico and selected sites in the United States

Development of Regional Aircraft (80-90's)



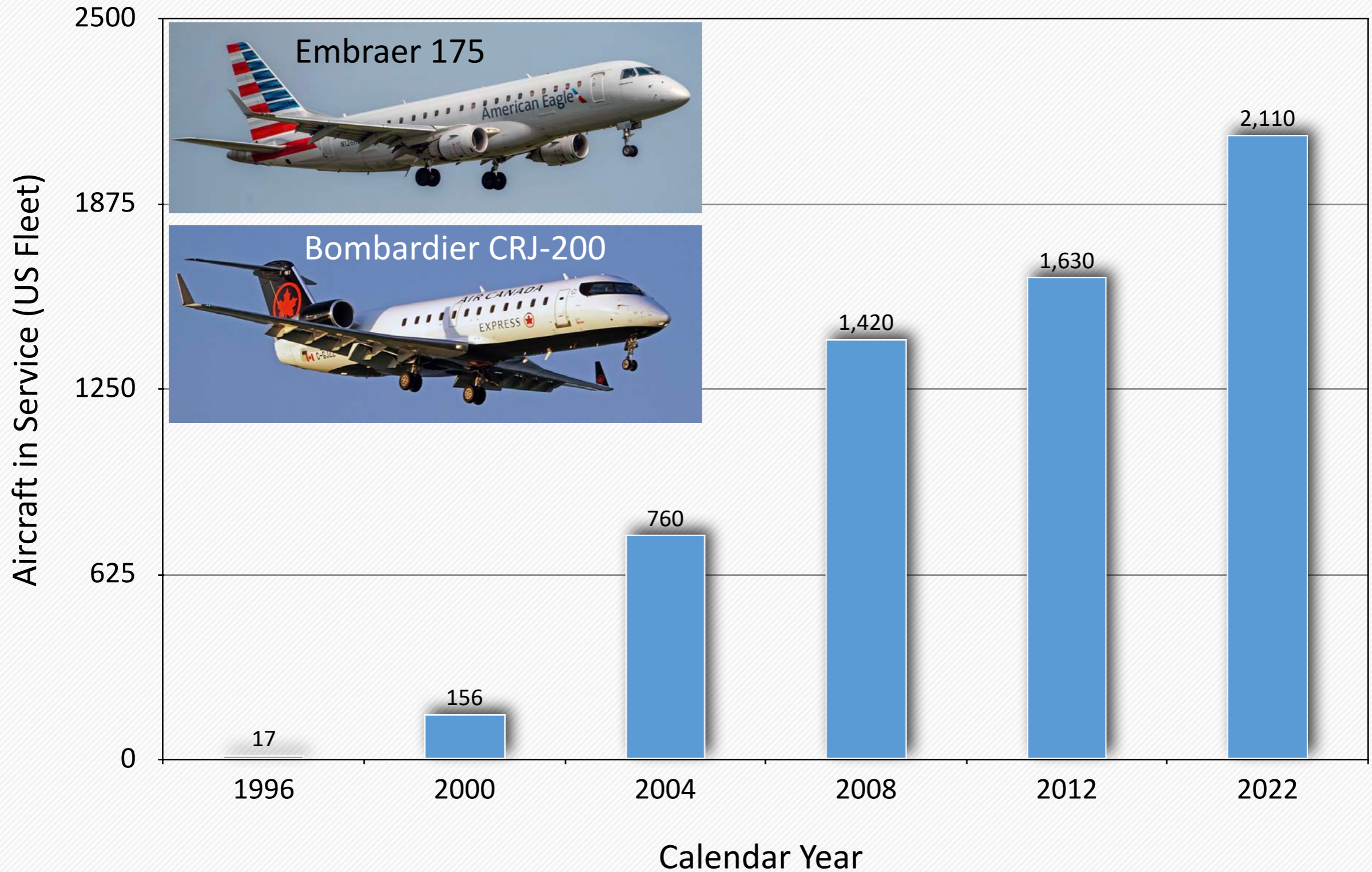
Today turbofan-powered regional aircraft are very successful at replacing older turboprop technology.

Public's perception of the turboprop as "unsafe" and noisy.

Bombardier CRJ 100/200

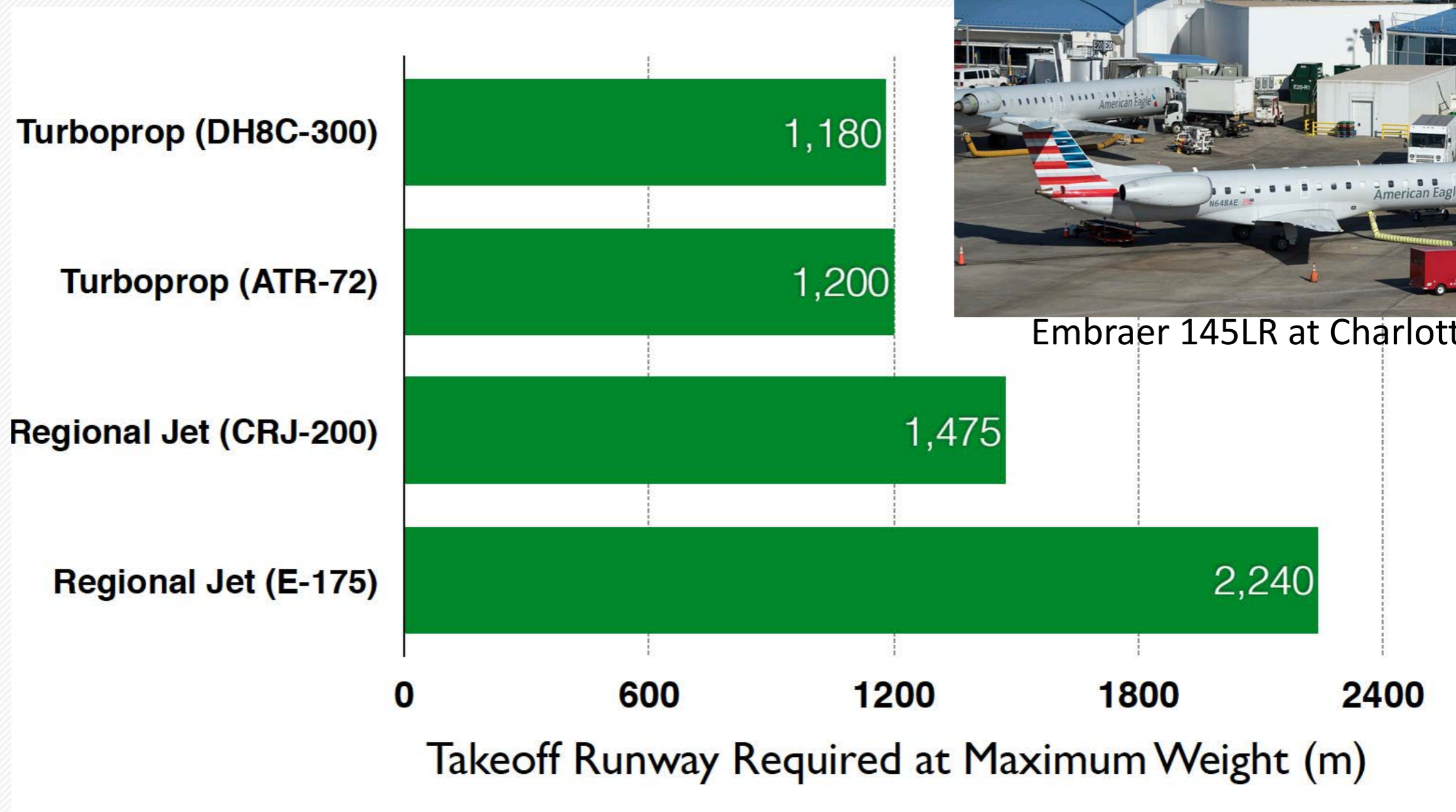
- Cruise speed = 850 km/hr
- 50 passengers
- 2,000 km range
- 32,000 kg takeoff mass
- Runway length = 1,400 m

Regional Jets in the U.S.



Regional Jet Runway Characteristics

Regional Jets require 1000 to 2000 ft more runway than typical turboprop commuter aircraft they replace



Embraer 145LR at Charlotte, NC

New Generation Regional Jets

Embraer 190



- The new generation of regional jets are closing on traditional small transport aircraft
- The new Embraer 190-195 family and the Bombardier CRJ-900 seat up to 95 and 90 passengers, respectively
- This approaches the 105-110 passengers for the smaller versions of the Airbus A318 and Boeing 737-600

Bombardier CRJ-900



Airports for General Aviation Use



The Small Air Transportation System (SATS) proposed by NASA Langley attempted to bring personal air transportation to the masses

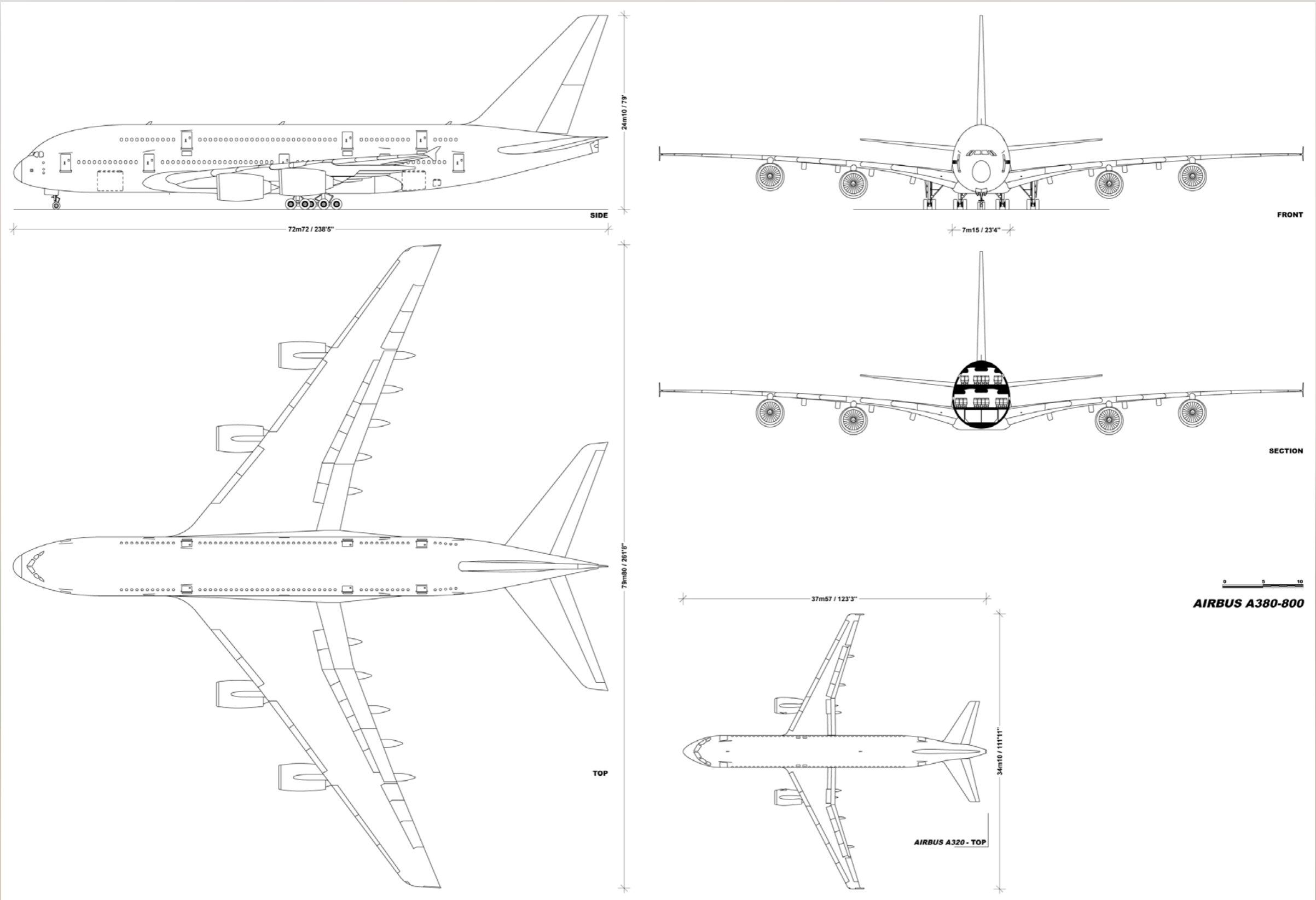


Virginia Tech/ Montgomery Executive Airport on a busy football day

September 11, 2001



- One of the darkest days in the history of aviation (four aircraft destroyed and thousands of lives lost)
- More people killed in four senseless acts of terrorism than in all aircraft accidents combined a decade before in the U.S. (this counts all civilian and military casualties in the Pentagon and in New York)
- A turning point for airport security
- A turning point for airport infrastructure in the next century
- A turning point for how public views transportation infrastructure and aviation safety/security



In 2000 Airbus launches the A380 project as the largest commercial aircraft

2003-2006: More Fuel Efficient Subsonic Aircraft (Boeing 787 and Airbus A350)

Boeing 787-8 landing
at San Diego Airport (SAN)



Boeing and Airbus designed and introduced a new generation aircraft with reductions in Direct Operating Cost (DOC) by up to 15-20% per seat compared to existing twin-engine aircraft (i.e., Boeing 767-300)

Important Agencies to Airport Engineers

FAA

Regulates and promotes aviation in US.

ICAO

- Based in Montreal, Canada
- Part of the UN charter
- Promotes and oversees aviation activities in the world.

State Department of Aviation

- Promote development in individual states
- Part of State DOTs

Airport Authorities

- Promote development of airports at the local level.
- Individual or multiple airports.

Federal Aviation Regulations



Most airport planning and design activities are carried out using Federal Aviation Regulations (FAR)

- FAR 23 and 25 (Certification of aircraft)
- FAR 121 (Operation of aircraft by air carriers)
- FAR 77 (Obstructions to navigation)

FAA provides designers and planners with Advisory Circulars (AC) to guide airport planning and design activities

- AC 150/5060-5 (Airport Capacity and Delay)
- AC 150/5300-13 (Airport Design)

The regulations are quite strict and enforced. The FAA provides guidelines to even install a light fixture on a taxiway!

What is the National Airspace System (NAS)?



A very complex system made up of airports, airways (like highways in the sky), and people (air traffic controllers and pilots).

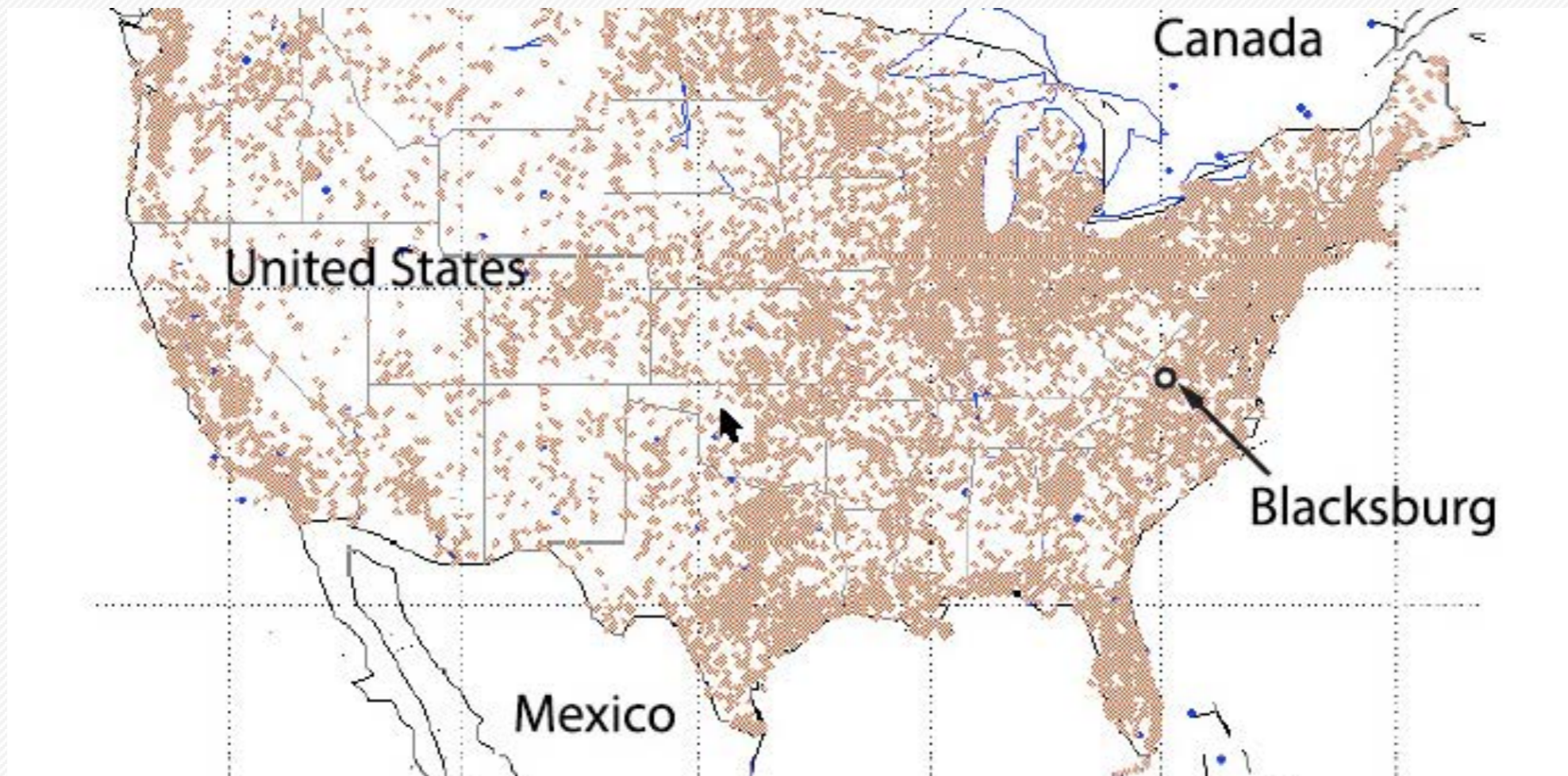
There are more than 21,000 landing facilities in the U.S. alone.

In the National Airspace System (NAS) there are 63,000 flights every day (roughly 30,000 by airlines)

Air Traffic Control in NAS handles more than 45 million flights per year
More than 100 million passengers arrive or depart Atlanta Hartsfield International airport in a year (this is equivalent to 300,000 passengers/day). ³⁶

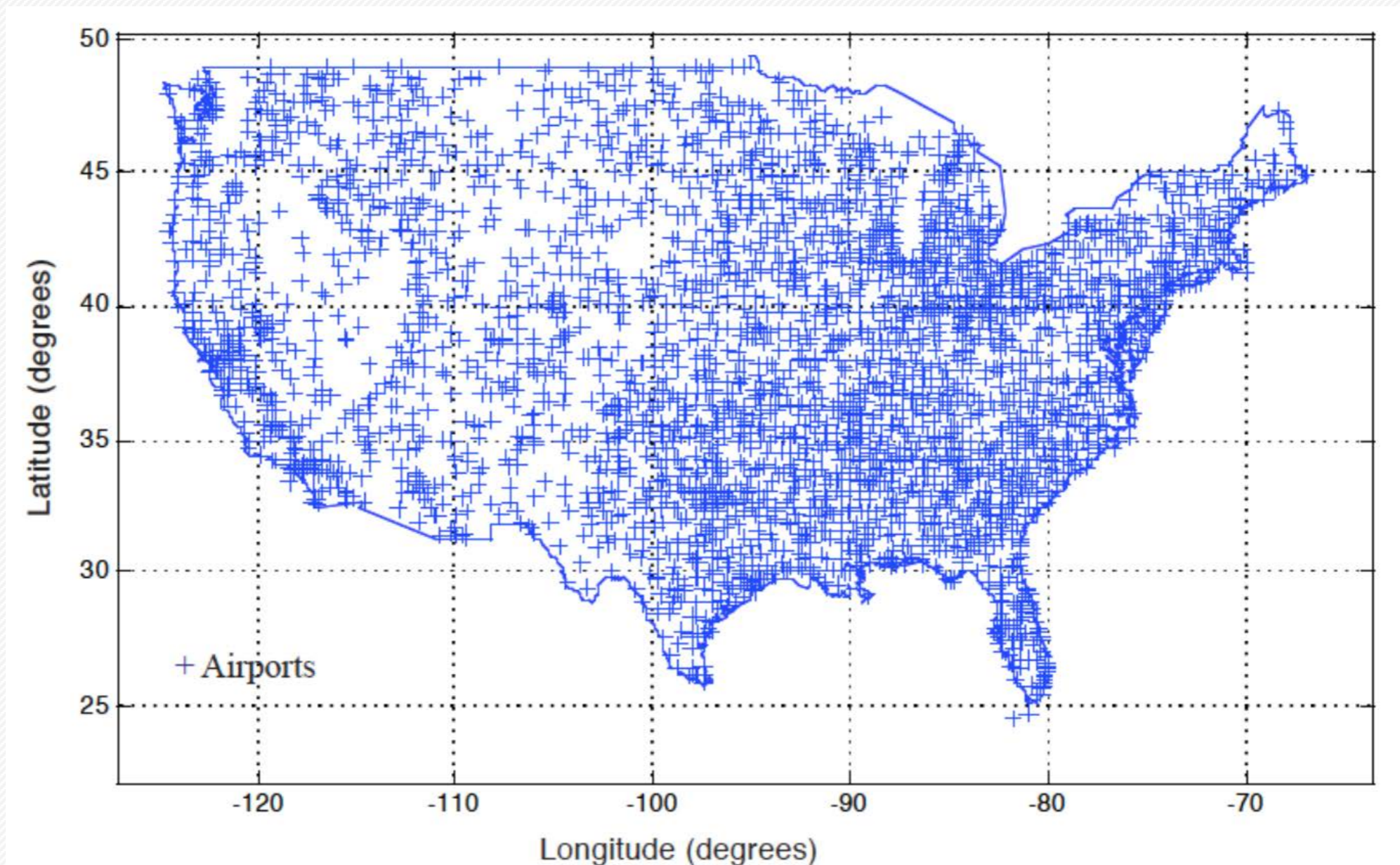
Airports in the U.S.

There are 21,000 landing facilities (public and private) in the U.S. Each brown dot is a landing facility (includes heliports).



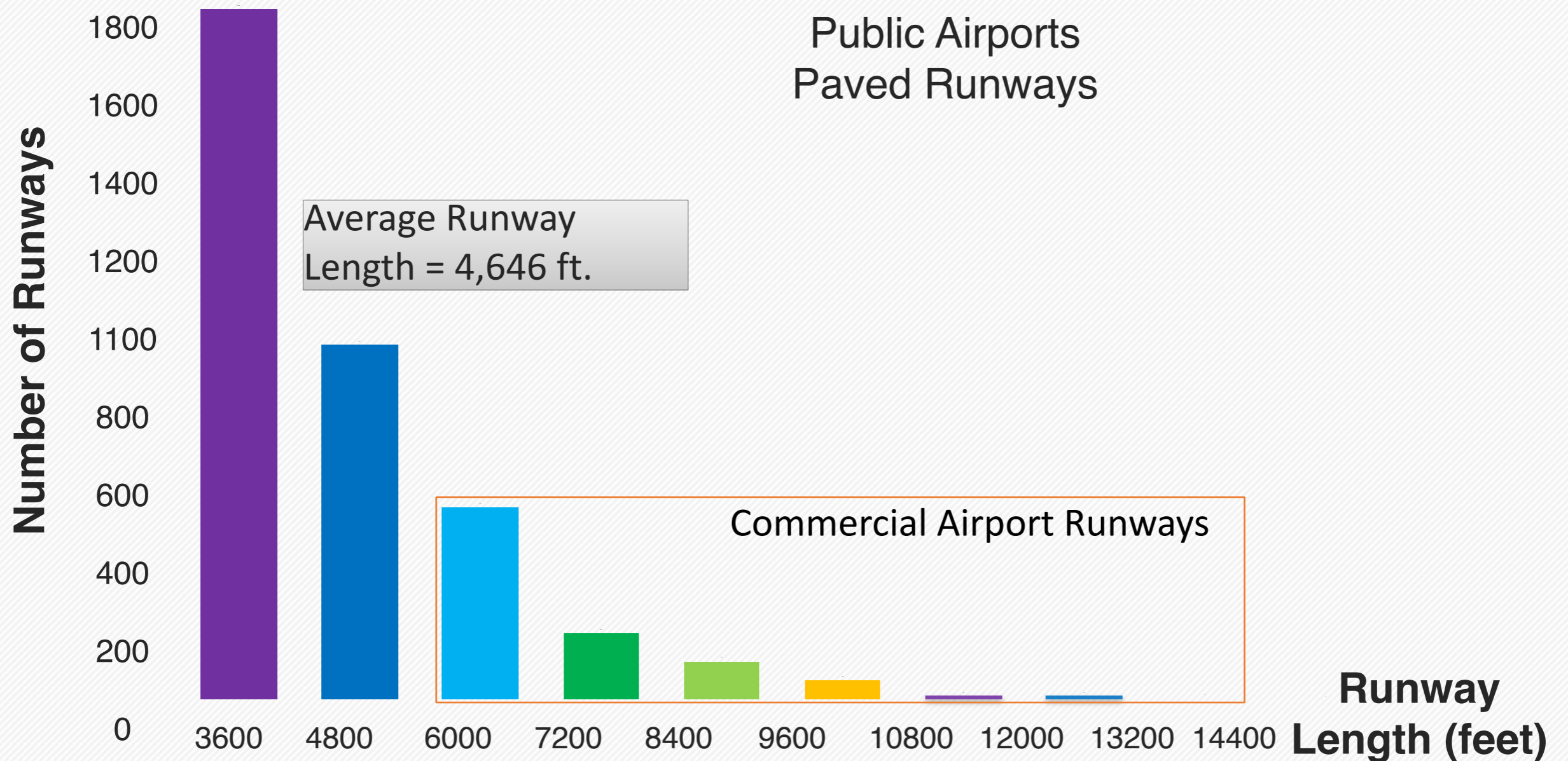
Airports in the National Plan for Integrated Airport Systems (NPIAS)

Around 3300 airports are catalogued as significant in the FAA National Plan for Integrated Airport Systems (NPIAS)



Most Airport Runways at NPIAS Airports are Short (< 4800 feet)

Not all airports are created equally. Many have short runway lengths. The distribution below shows the trend in NAS.



Uneven Demand for Air Transportation

- The top 50 airports in the country handle 87% of the total traffic in 2019 measured as the number of enplaned passengers
- The same top 50 airports handled 73% of the total NAS traffic in 1989
- NAS has experienced substantial “hubbing” phenomena in the 1990’s (large hubs became even larger)
- Minor shift to more regional jet operations and to low-cost carrier operations
- Low cost carriers fly to airports where the cost to operate is less than traditional hub airports

Airport Statistics (Sample)

- The top 100 airports in the United States, as measured by 2019 passenger enplanements (i.e., boardings), accounted for almost 94.5 percent of the 930 million passengers in the U.S. in 2019.
- More than 106 million passengers arrived or departed Atlanta International airport in 2019 (equivalent to 300,000 passengers per day!).
- The top 35 airports handle 75% of the total passengers.
- There is a need for competent airport engineers to maintain and develop plans and designs for new facilities (i.e., new airports and airport improvements).
- So you have a great future to expand existing airports and build new ones in the years to come!

Why Become an Airport Engineer?



- To plan and design challenging and large-scale airport infrastructure
 - Airports are very expensive (12 billion dollars were invested in Kansai airport Phase 1 in Japan)
 - Airport investment is a 10 billion dollar/yr industry in the U.S. alone
- To improve the safety of the system (i.e., to reduce ground collisions and accidents)
- To improve the capacity of the system (i.e., to handle more flights or operations without building more airports)
- Airport engineers have a great future and are specialized civil engineers (well paid)