The jet engine is the technology that shrunk the world. Jets fly faster and higher than propeller planes. That cuts down travel time and brings distant places closer.

And 1958 was the year of the commercial jet. In that year US airlines introduced jet service on both overseas and domestic flights.

Jet engines developed through the 1930s and 1940s. World War II and the Korean War saw the deployment of military jets. But commercial airlines took their time in adopting the new technology.

Why hesitate? Because jet engines were very different from the engines in propeller aircraft. These differences made jets an expensive investment. Jet engines burned much hotter than the engines in propeller aircraft. So they had to be made of alloys. An alloy is a combination of different metals—or of metal and nonmetal—fused for strength, resistance to corrosion, or other desired qualities. Alloys cost more than single metals.

Jet engines also used more fuel. Planes with jet engines had higher takeoff speeds. So they needed longer runways.

In view of these differences, airlines understandably took a wait-and-see attitude toward the new technology.

But Juan Trippe, chief executive of Pan American Airways, didn’t want to wait. He’d already pioneered transoceanic air service with the “flying boats” known as Pan Am Clippers.

Trippe wanted to see Pan Am fly nonstop across the oceans. Some people thought that Comet jets would achieve this goal. A British manufacturer, De Havilland, built the Comet. But after a couple of crashes, the Comet’s promise faded.
Who would now take the lead? Trippe decided to play Douglas and Boeing off against each other. These companies were two of America’s largest airplane manufacturers. They competed for Pan Am’s business. Douglas offered the DC-8 and Boeing the 707.

In October 1955 Pan Am signed on to buy 20 of the 707 jets and 25 of the DC-8s.

Two years later, Boeing rolled out its first 707. And on 26 October 1958 Pan American introduced jet service from New York to London, with a stop in Newfoundland.

The first flight had 111 passengers. That was more people than had ever boarded a single regularly scheduled flight.

The fare was about the same as for a propeller plane: $272. It sounds like a good deal, but in 2007 dollars, that ticket would cost about $1,500.

The new service was a huge success. Several other airlines quickly adopted the 707. Pan Am continued to forge ahead. Within a year, it was able to get rid of the Newfoundland layover. It introduced nonstop service on Boeing 707-320s. Pan Am set the standard for the industry.

The era of passenger jet travel had a slow start. But once it took off, it soared. Around the world, airlines moved quickly to replace propeller planes with jets.
Juan Trippe—Pan Am’s Pioneering Chief

Juan Terry Trippe (1899–1981) was the founder and longtime chief executive of Pan American Airways.

Trippe was born in Sea Bright, New Jersey. His ancestors were English seafarers who came to Maryland in the 17th century.

While in his 20s, Trippe used some inherited money to launch Long Island Airways in New York. That venture failed. He tried again. This time he invested in Colonial Air. It flew mail routes between New York City and Boston.

But Trippe had bigger things in mind. He wanted to develop air routes in the Caribbean and South America. In 1927 he launched Pan Am. Under his leadership, it became the largest and most successful international airline in the world.

Tripp understood that success in the airline business meant knowing both economics and politics. So he reached out to aircraft builders and politicians as well as the public.

Tripp greatly improved Pan Am’s passenger service. He helped develop new aircraft, from the Boeing 707s and DC-8s to the 747. He was president of the airline until 1968.
The Significance of the Development of the Jet Engine

A Greek named Hero of Alexandria invented a type of jet engine around 100 BC.

But the history of modern jet engines begins with Frank Whittle. An engineer, he was also an officer in the British Royal Air Force.

On 16 January 1930 Whittle got a patent for his design of a jet aircraft engine. This gave the British a head start in jet aircraft. They kept the lead for a number of years.

In September 1941 the US Army Air Forces decided to build their own version of Whittle’s engine. On 1 October 1942 Robert Stanley made the first flight of the Bell XP 59-A Airacomet, at Muroc, California. It had General Electric engines based on Whittle’s design.

On 2 May 1952 the British Overseas Airways Corporation started the first regular jet airline service. It flew De Havilland Comets between London and Johannesburg, South Africa.

The Comet transformed air travel. It flew at 500 mph. It soared at altitudes of up to 30,000 feet.

But in 1954 two Comets had fatal accidents. Structural failure was the cause. Aircraft flying at high speeds and high altitudes are subject to enormous stress and pressure. This can lead to metal fatigue—a slow weakening of strength in metal caused by repeated deformation, vibration, or other stress. It’s like what happens when you bend a paper clip back and forth. Eventually it breaks.

That’s what happened to the British jets. The two Comets couldn’t take the stress and pressure. They broke up in the air. The accidents were setbacks for British aviation. But manufacturers learned a lot from them. The result was much safer aircraft.
How the Jet Engine Works

The word *turbine* means “whirl” or “spinning top.” A *turbine engine*, or jet engine, is an engine driven by a moving fluid, such as water, steam, or air, that pushes against blades or paddles attached to a central shaft.

Hot flowing gases power the turbine engines in aircraft. Some turbine engines connect to propellers.

The materials and engineering that go into a jet engine are complex. But the operation of a jet engine is simple.

A jet engine takes in air and accelerates it to extremely high speeds through an exhaust nozzle. The fast-moving air pushes the plane forward. This is the thrust force generated by the engine.

Jet engines have rotating parts. These parts can spin at tens of thousands of revolutions per minute.

A jet’s spinning motions make it different from a *reciprocating engine*—an engine that goes back and forth. Most of the aircraft you’ve read about so far had reciprocating internal-combustion engines.
**Propulsion** is a driving or propelling force. There are two basic types of jet propulsion: turboprop and pure jet. Both use a gas turbine engine. In a turboprop, the gas turbine is connected to a propeller. The jet exhaust provides some thrust, but the propeller provides most of it. In a pure jet, all the thrust comes from the jet exhaust.

All turbine engines have five basic parts: the inlet, the compressor, the burner (combustor), the turbine, and the exhaust (nozzle).

**The Significance of the Jet Engine**

Turbine engines have many advantages over reciprocating engines. Turbine engines can fly higher and faster. They vibrate less because their parts spin, rather than slide back and forth. Cooling a turbine engine is easier because it takes in so much air.

But the biggest advantage of turbine engines is that they produce more thrust per pound of engine weight than reciprocating engines do. As a result, turbine engines can carry heavier loads.

Aeronautics has a special definition of weight. That definition relates to the basic forces of flight. **Weight** is the force that directly opposes lift.

Aviators always have to think about weight. It’s possible to load an aircraft with so many passengers and so much baggage that it can’t take off. The more weight an engine can lift, the better.

**Developments in Jet Aircraft**

By the mid-1950s Boeing had been building military jets for years. That experience helped Boeing build the 707. Once again, civil aviation benefited from lessons learned building military aircraft.

The 707—Pan Am’s choice for its new transatlantic service in 1958—soon became the standard long-range jet. But airlines had other options: the DC-8 and the Convair 880 and 890.
Jets Get Smaller

Soon manufacturers started building smaller jets. These smaller jets worked well for short hauls. For example, in 1959 Air France put a new jet—the Caravelle I—into service. The French company Sud-Est Aviation built it. The Caravelle had an engine on each side of the rear fuselage. It was the first short-haul jet. It carried up to 90 passengers.

Only one US carrier, United Airlines, flew the Caravelle. But the French aircraft had a big influence on American manufacturers. Soon they, too, started building smaller jets. They wanted to offer the benefits of jet speed, altitude, and comfort on shorter routes.

In February 1963 Boeing introduced the 727. It was versatile, but noisy. Boeing produced more than 1,700 of these tri-jet aircraft. A tri-jet is an aircraft with three engines. The 727 was good for smaller airports with shorter runways and fewer passengers. It is the most successful jet ever built.

Douglas introduced its short-haul jet, the DC-9, in 1965. The company merged with McDonnell Aircraft Corp. in 1967, forming McDonnell Douglas.

Jumbo Jets

In April 1966 Boeing announced plans for the wide-body 747. It made its first flight in 1969. Airlines started flying it the next year.

The 747 carried hundreds of passengers. It dwarfed the 707. The aisle of the 747’s economy-class section alone was longer than the Wright brothers’ historic 1903 flight. The 747 was luxurious. Some models even had an upstairs cocktail lounge.

Airlines still fly 747s. Even people who don’t know much about aircraft can spot a 747. It has a distinctive bump on the top of its fuselage.
Lockheed and McDonnell Douglas were not far behind Boeing. They announced plans for jumbo jets in 1966. Both companies rolled out their new planes in 1970. The McDonnell Douglas DC-10 came out in August. The Lockheed L-1011 followed in November. Both aircraft can carry as many as 350 passengers. They can fly nonstop up to 4,000 miles.

Like the Boeing 747, the McDonnell Douglas DC-10 and the Lockheed L-1011 are still in use.

**A Global Industry**

Until 1978 American manufacturers dominated the global aircraft industry. US manufacturers had 85 percent of the world market at that time.

But other countries soon started to catch up. US manufacturers felt heat from Airbus Industrie, a European consortium working on an aircraft called the A-310 advanced technology transport. A consortium is an association of companies for some specific purpose.

American manufacturers responded to this competitive threat. They came up with new products of their own. McDonnell-Douglas brought out its DC-9 Super 80. Boeing developed its 757 and 767.

CHAPTER 5

Commercial Flight

Key Developments in the Commercial Flight Industry

As you have read, airlines didn’t switch to jet engines immediately. But once jets caught on, they caught on big.

The Transition From Propellers to Jets

Early jets had their greatest advantage for long flights. But by the early 1960s, airlines wanted to offer jet service on shorter flights, too.

At first it was difficult. But the newer jets were more reliable and efficient. They were quieter. That helped jets continue to squeeze propeller aircraft out of service. Smaller jets soon competed with prop planes for business.

Taking its cue from the Caravelle, Boeing introduced the 727. With three engines, it was well suited to short- and medium-distance runs. It was available in several configurations—setups for specific purposes. This let Boeing serve customers with many different needs.

The “big four” US airlines you read about in Lesson 1—American, Eastern, TWA, and United—introduced the 727 within four months of one another in 1964. Douglas soon followed with its DC-9.

Soon “air travel” became synonymous with “jet travel.”

The Impact of the Jet Engine on the Commercial Flight Industry

Jet travel literally brought people around the world closer together. Friends on two continents could now keep in touch much more easily. Services such as Eastern’s Air Shuttle, which required no reservations, let business people fly on the spur of the moment. They could make day trips between Boston, New York, and Washington.

Jet travel let American students spend summers in Europe. Middle class families could cross the country over a long weekend to ski or surf or visit grandma.

Jet travel even brought a new term into the language: jet lag. Jet lag is fatigue and sleep disturbance as a result of crossing time zones on a jet.

The jet era brought changes to airports as well. They built longer, thicker runways. Chicago’s O’Hare Airport introduced parallel runways. These let more than one aircraft land or take off at a time. Passengers boarded their aircraft through enclosed “jet bridges” instead of the old-fashioned passenger stairs.

When airlines switched to jets they had to improve their maintenance standards. That meant better facilities on the ground and better-trained employees.
Major Commercial Airlines Operating During This Period

The “big four” airlines—American, Eastern, TWA, and United—were still on the scene as the jet era began. They competed for passengers with several other domestic carriers.

The Civil Aeronautics Board (CAB) controlled airline routes. It decided who could enter a market; that is, which carriers could offer service between specific points.

When an airline applied to serve a new market, the CAB gave carriers already flying in that area a chance to review the application. Not surprisingly, the established carriers often found a reason to turn down the applicant. They didn’t want more competition. That made it hard for newcomers.

The purpose of federal regulation was to ensure that the airlines operated efficiently and with the greatest good for the greatest number. But regulation sometimes had the opposite effect. It controlled airfares. As a result, many people thought it cost more to fly than it should. They thought that regulation worked against free-market principles. A free market is one that operates on the basis of competition and is not controlled by government.

When Jimmy Carter became US president in 1977, pressure for deregulation began to build. Congress passed the Airline Deregulation Act of 1978. This let airlines enter or leave markets and set fares as they saw fit.

Several things happened in response. First, airlines stopped serving many smaller cities where they weren’t making money. The larger carriers shifted from “point-to-point” routing to a “hub-and-spoke” system. Passengers now flew from their local airports to a “hub” city, perhaps changed planes, and then continued on. Travelers flying from Boston to Chicago, for example, might have to stop in Philadelphia.

Second, new airlines sprang up. Donald Burr founded People Express, for instance. It was a tight, “no frills” operation. His fares were almost as low as those on intercity buses. For a few years, his business boomed.

As a result, fares dropped dramatically. Airlines made a lot of money. More people flew. The number of air passengers peaked at 317 million in 1979.

Then some problems arose. Fuel costs skyrocketed. The US economy went into recession. The airlines expanded faster than they could manage. They began to lose money. The established carriers, with expensive union contracts, couldn’t compete against newer carriers that paid their workers less. In 1981 US airlines had a net operating loss of $421 million. The number of passengers fell to 286 million.
A wave of airline bankruptcies followed over the next two decades. Two of the big four, Eastern and TWA, failed. So did Pan Am. Continental, United, and US Airways went bankrupt, too, but were able to reorganize and stay in business.

Analysts are still debating whether deregulation was a good idea. It certainly led to upheaval in the industry. Big airlines were hit worst. Passengers and small carriers benefited the most. Passenger travel more than doubled from the 1979 level, to 656 million people in 2006.

### Airline Domestic Market Share November 2005–October 2006

**Domestic Revenue Passenger Miles (billions)**

<table>
<thead>
<tr>
<th>Airlines</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>American</td>
<td>15.6%</td>
</tr>
<tr>
<td>United</td>
<td>12.1%</td>
</tr>
<tr>
<td>Southwest</td>
<td>11.6%</td>
</tr>
<tr>
<td>Delta</td>
<td>11.5%</td>
</tr>
<tr>
<td>Continental</td>
<td>7.6%</td>
</tr>
<tr>
<td>Northwest</td>
<td>7.0%</td>
</tr>
<tr>
<td>US Airways</td>
<td>4.6%</td>
</tr>
<tr>
<td>JetBlue</td>
<td>3.9%</td>
</tr>
<tr>
<td>America West</td>
<td>3.9%</td>
</tr>
<tr>
<td>Alaska</td>
<td>2.6%</td>
</tr>
<tr>
<td>Other</td>
<td>19.6%</td>
</tr>
</tbody>
</table>

Market share based on Revenue Passenger Miles November 2005–October 2006

Source: Bureau of Transportation Statistics
Discount carriers, such as Southwest Airlines, made great strides. Founded in 1971 by Herb Kelliher and Rollin King, Southwest’s formula for success was simple. It flew to less-expensive secondary airports. It used only one model of aircraft, so maintenance could be standardized. It turned flights around at the gate as fast as possible. By 2007 Southwest flew more than 80 million passengers a year to 62 cities.

**How Federal Regulation Has Evolved**

Congress enacted a new law covering air safety—the Federal Aviation Act of 1958—after a series of midair collisions. Jet airliners were coming into service around that time, too. That gave Congress another reason to pass a new law for aviation.

The act transferred the duties of the Civil Aeronautics Administration (CAA) to a new body, the Federal Aviation Agency (FAA). The FAA had broader authority on safety matters than the CAA. The FAA also took over responsibility from the Civil Aviation Board (CAB) for making rules covering air safety. The CAB continued to regulate the airlines.

Retired Air Force Lt Gen Elwood “Pete” Quesada was the first chief of the FAA. As FAA chief, he campaigned for better airline safety.

In 1966 Congress set up the Department of Transportation (DOT). The FAA was renamed the Federal Aviation Administration and became part of the DOT.

The CAB’s role in investigating accidents went to the new National Transportation Safety Board (NTSB) in 1967. The CAB lost its primary duty when Congress deregulated the airlines in 1978. It was abolished in 1984.

The FAA, on the other hand, kept getting new duties. After a rash of airplane hijackings broke out in the 1960s, Congress gave the FAA a bigger role in security.

Another new area for the FAA was aircraft-noise reduction. In 1968 Congress gave the head of the FAA power to set standards to limit aircraft noise.

A 1970 law put the FAA in charge of a new airport development program. That law also gave the FAA responsibility for certifying airport safety.
Air safety is essential to keeping the public’s trust in the air travel system. The National Transportation Safety Board (NTSB) investigates all air and other transportation accidents. It then makes recommendations to the FAA and the airlines on changes to make the system safer.

Take, for example, the crash of an Air Florida jet on a snowy day in Washington, D.C., in 1982. Safety experts and the industry learned lessons from that accident that have made flight safer for everyone.

Seconds after taking off from Washington National Airport on 13 January 1982, Air Florida Flight 90 slammed into the 14th Street Bridge over the Potomac River. The crash killed 78 passengers, crew members, and motorists.

Federal investigators from the NTSB found a big problem afterward: a copilot who couldn’t persuade the pilot it wasn’t safe to take off. They also found errors in the way the plane was de-iced.

The aircraft was covered with ice. Investigators believe that ice kept the plane’s instruments from giving a true reading. The copilot noticed something wrong. He mentioned it to the pilot. But when the pilot ignored him, he didn’t speak up again.

The silence was fatal.

One lesson: leaders need to make clear that it’s OK to ask questions or point out problems. And followers need to know they have the right to speak up.

“This accident was pivotal because it helped draw attention to the fact that pilots need to communicate better,” Robert L. Sumwalt III, vice chairman of the National Transportation Safety Board and a former airline pilot, told The Washington Post in 2007. “I don’t know of any other accident that has had this amount of impact on aviation but also in other industries,” he added.

Maritime and rail industries learned a lot from the Air Florida crash. So have hospital executives concerned about medical errors.

At the Nebraska Medical Center in Omaha, for instance, surgical teams now use checklists similar to the ones pilots use. Medical center staff adapted these lists to cover the steps necessary for a safe surgical procedure. An operating team, like the team controlling a plane, has many members. Each team member has a vital role in safety.

The last item on the Nebraska team’s checklist reflects a lesson straight from Flight 90: “If anybody sees any red flags, something they are uncomfortable with, bring it to [the surgeon’s] attention.”
Pros and Cons of Commercial Flight Travel for Passengers

During less than a century, aviation went from a circus act led by the barnstormers to a mode of transport that held the United States together. Travel by air and by private auto largely replaced travel by rail and sea. Still, some travelers weigh the pros and cons before they fly.

Pros
Jetliners offer passengers one big advantage: speed. And because flying is faster, a transcontinental flight is usually more comfortable than a cross-country bus or train ride. A flight across the ocean is far more comfortable than a week-long voyage by ship. Many parts of the world are accessible only by air. Jetliners can soar over miles of terrain that have no roads. They can fly over oceans to reach places once accessible only by ship.

Cons
Air travel has disadvantages, too. Some people still can’t afford it. Airport security has added to travel times. That sometimes defeats the speed advantage of air travel. Weather delays can play havoc with the system. Especially in the northeastern United States, a train may get travelers to their destinations more quickly than a plane.

Flying has become much safer. But some people are still nervous about being confined in an aircraft. Some find the sensations of flying uncomfortable. Also, in an age of terrorism, planes have become a major target. Some people stay away from planes because they worry about hijackings. Some are put off by the security checks passengers must go through at airports to prevent terrorism.

Finally, travelers who want to see places, rather than just fly over them, prefer trains, buses, or cars.

The Switch to Air Travel
As air travel became cheaper, safer, and more accessible, bus and train service dwindled, except in densely populated areas.

In 1940 airlines of the United States carried around about 3 million passengers.
In 1950 they carried 17 million.

In 1958, the year the first commercial jets were introduced, the number of passengers reached 30 million. In that year, for the first time, more transatlantic passengers arrived at their destinations by air than by sea.

By 1966 the scale had tipped in the direction of air travel. An estimated 5,322,000 passengers crossed the North Atlantic that year. Of these, 89 percent traveled by air.

Today, the US economy—indeed, the economy of much of the world—depends greatly on the safety and efficiency of domestic and international air travel. The Wright brothers’ short flight in 1903 has changed civilian life as much, if not more, than it did military history.
The Heroes of United 93

Modern aviation is a world of routines, procedures, and checklists.

But sometimes people have to act fast. They have to improvise. They have to find within themselves the ability to cope with situations they could never have imagined. The heroic actions of the passengers of United Flight 93 on 11 September 2001 are an example.

On that day terrorists hijacked four aircraft at almost the same time. They planned to turn the planes into guided missiles.

The terrorists used two jetliners to bring down the twin towers of the World Trade Center in New York. They slammed a third plane into the Pentagon, outside Washington, D.C. Nearly 3,000 people died in these attacks.

No one knows for sure what the hijackers intended to do with the fourth plane. That plane, United 93, was en route from Newark, New Jersey, to San Francisco. It had 37 passengers aboard, including four hijackers.

The hijackers took over the plane at 9:28 a.m. At 9:32 a.m. one of the hijackers announced there was a bomb on the plane. This was a lie. The terrorists made the announcement to explain why the aircraft had changed its course abruptly in the air over northeastern Ohio.

Passengers and crew made phone calls from the plane. They learned about the attacks on the World Trade Center. They decided to rush the terrorists and try to retake the plane.

At 9:57 a.m., 29 minutes after the hijackers took over, the passengers made their move. As they tried to break through to the cockpit, the hijacker pilot rolled the plane from side to side. He pushed its nose up and down, trying to throw the counterattacking passengers and crew off balance.

The passengers continued their brave effort. They were seconds away from breaking through when the pilot pushed the nose of the plane earthward.

At 10:03 a.m., United 93 plowed into a field in Shanksville, Pennsylvania.

It was all over in less than seven minutes.

The hijacker pilot’s objective “was to crash his airliner into symbols of the American Republic,” the 9/11 Commission report stated. “He was defeated by the unarmed, alerted passengers of United 93.”

“We are sure that the nation owes a debt to the passengers of United 93.” the report also said. “Their actions saved the lives of countless others, and may have saved either the US Capitol or the White House from destruction.”
CHECKPOINTS

Lesson 2 Review

Using complete sentences, answer the following questions on a sheet of paper.

1. Why do jet engines use alloys?
2. What caused the Comet crashes of 1954?
3. What are the advantages of turbine engines over reciprocating engines?
4. What was the particular disadvantage of the Boeing 727?
5. How did American manufacturers respond to the threat posed by the Airbus consortium?
6. How did airports have to change to handle jet aircraft?
7. What happened after Congress deregulated the airlines?
8. What prompted the US Congress to pass the Federal Aviation Act of 1958?
9. What duties has the FAA acquired since the 1960s?
10. What lessons did airlines learn from the Air Florida crash?

Applying Your Learning

11. If you’d been a member of Congress in 1978, would you have voted to deregulate the airlines? Why or why not?