Multiengine Flying

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Introduction

I went through most of my life without pondering why the *Spirit of St. Louis* had only one engine. I guess I believed that multiengine airplanes had not been invented yet. But multiengine airplanes had been invented, and they were common. Lindbergh's competitors in the race to Paris were flying multiengine airplanes. Why did Lindbergh insist on an airplane with only a single engine?

Lindbergh had wrestled with a question that many pilots even today do not fully understand. In certain circumstances, a multiengine airplane is not twice as safe as a single-engine airplane; rather, it is twice as dangerous.

One of Lindbergh's financial backers in St. Louis suggested that the *Spirit of St. Louis* be designed with three engines instead of just one. One of Lindbergh's rivals was going to attempt the flight in an airplane with three powerplants. Lindbergh responded, "I'm not sure three engines would really add much to safety. There'd be three times the chance of engine failure, and if one of them stopped over the ocean, you probably could not get back to land on the other two. A multiengine plane is awfully big and heavy. A single-engine plane might even be safer, everything considered."

On another occasion Lindbergh was questioned about his single-engine decision. "Slim," the man asked, "don't you think you ought to have a plane with more than one engine for that kind of flight?" Lindbergh answered, "Suppose one of the engines cuts out halfway across the ocean. I could not get to shore with the other two. Multiengine planes are more complicated; there are more things likely to go wrong with them."

The general public and other pilots perceived that two engines were always better. It would be logical on a flight across the Atlantic that

Lindbergh have the best equipment. If you automatically thought "multi" was better, you would have also coached him into a multi-engine plane.

What did Lindbergh know that most pilots then, and even today, did not? He knew that the step to multiengine flying is a serious step. Today we are the beneficiaries of more reliable engines, better aerodynamics, and better equipment than Lindbergh ever dreamed of, yet the potential danger of a multiengine airplane remains a constant.

But the multiengine airplane does have distinct advantages over single-engine airplanes in many areas. The most important advantage is redundancy. Provided that the airplane has enough airspeed, two engines can be a lifesaver. Increases in the thrust-to-weight ratio of engines and better aerodynamics have made it possible for a twin-engine airplane to fly to safety on the remaining good engine. The safety of multiengine redundancy goes beyond the obvious fact that there are two engines. There are also two electrical systems, two vacuum systems, and two fuel systems on most twins. Two engines will often (but not always) produce faster flight speeds. Multiengine airplanes can shrink the aeronautical chart.

The disadvantages fall into two groups: economic considerations and safety considerations.

ECONOMIC CONSIDERATIONS

Multiengine airplanes cost more to buy, operate, and maintain. Having two of just about everything means that there are twice as many parts that can fail. Fuel consumption will be at least double on a twin, but groundspeed will not double.

SAFETY CONSIDERATIONS

Most of this book will deal with the significant risks that exist when one engine fails and the airspeed gets too slow. There is grave danger involved with multiengine airplanes and the minimum controllable airspeed (V_{MC}). A CD is available from the publisher and author including Power Point Presentations for each chapter, study questions, key terms, and case studies from NTSB accident reports.

Attempts have been made to enjoy the benefits of multiengine airplanes (redundancy, speed, and high-speed safety), while eliminating the dangers of V_{MC} (low-speed danger). The most visible attempt is the Cessna Skymaster.

The Skymaster beat all the odds. The marketing people inside Cessna did not believe that a twin-engine airplane with one engine in front and one engine in back would be a commercial success, but pilots in the company who knew about the conventional twin low-speed control problems persevered, and the Skymaster became a bestseller.

Cessna sold more than 1,400 Skymasters with retractable landing gear, designated the Cessna 337. There were military versions and even a pressurized Skymaster. Why was it so popular? The design offered the best of both worlds. At the time, it was faster than a single. It could stay in the air and fly to safety with either the front or the back engine dead. Best of all, no V_{MC}. When one engine fails, the airplane does not have any additional turning tendency, which is so dangerous with conventional wing-mounted multiengine airplanes.

Cessna originally thought that single-engine pilots would fly the Skymaster without any additional pilot rating, but that idea was dashed when Flight Standards Service Release No. 467 was published. The FAA required Skymaster pilots to earn a new rating, designated airplane multiengine land-center thrust.

The Skymaster stopped production in the United States in 1980. Although there are still many Skymasters around, your multiengine flying career will most likely be in conventional twins. This means that you will need to have a healthy appreciation of the pros and cons of multiengine flying.

Flying twins offers some real advantages, but also some real risk. Reducing risk requires knowledge, understanding, proficiency, and hard work. I hope this book gets you started toward those goals.

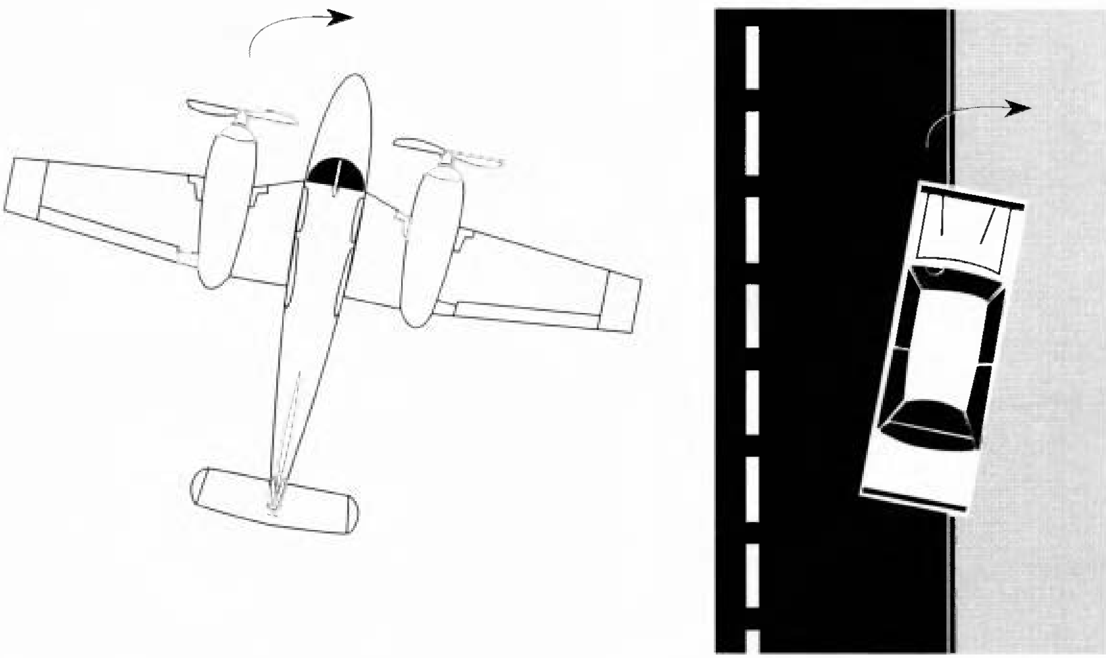

Fig. 1-2. If the right engine fails, the airplane will yaw to the right just as a car will sway to the right if the right wheels fall off pavement into sand.

all, is just a multiengine aircraft or spacecraft. Its two solid rocket boosters are attached on either side of the shuttle at liftoff. These engines also do not push through the center of gravity. It is just like a conventional light multiengine airplane (except it has a little more power!). If one of those solid rocket engines were to fail while the other continued to burn, the operating engine would continue upward. The failed engine would tend to fall back to Earth. The result would be a "yaw cartwheel" from which it would certainly be impossible to recover.

If this unwanted yaw occurs in cars, airplanes, and spacecraft, how is the yaw force counteracted? If you were the driver of the car with the left set of wheels on the pavement and the right wheels in the sand, which way should you turn the wheel? The front of the car would be pivoting to the right; to keep the car straight, you must turn the wheel to the left in hopes of counteracting the yaw. Your only hope of keeping the car straight would be if the steering wheel's left turning force were at least equal to the car's right turning force. If both forces are equal, they will in effect cancel each other, and the car will continue straight ahead. But if the forces are not equal, the car will continue to pivot, maybe to a point where control is lost.

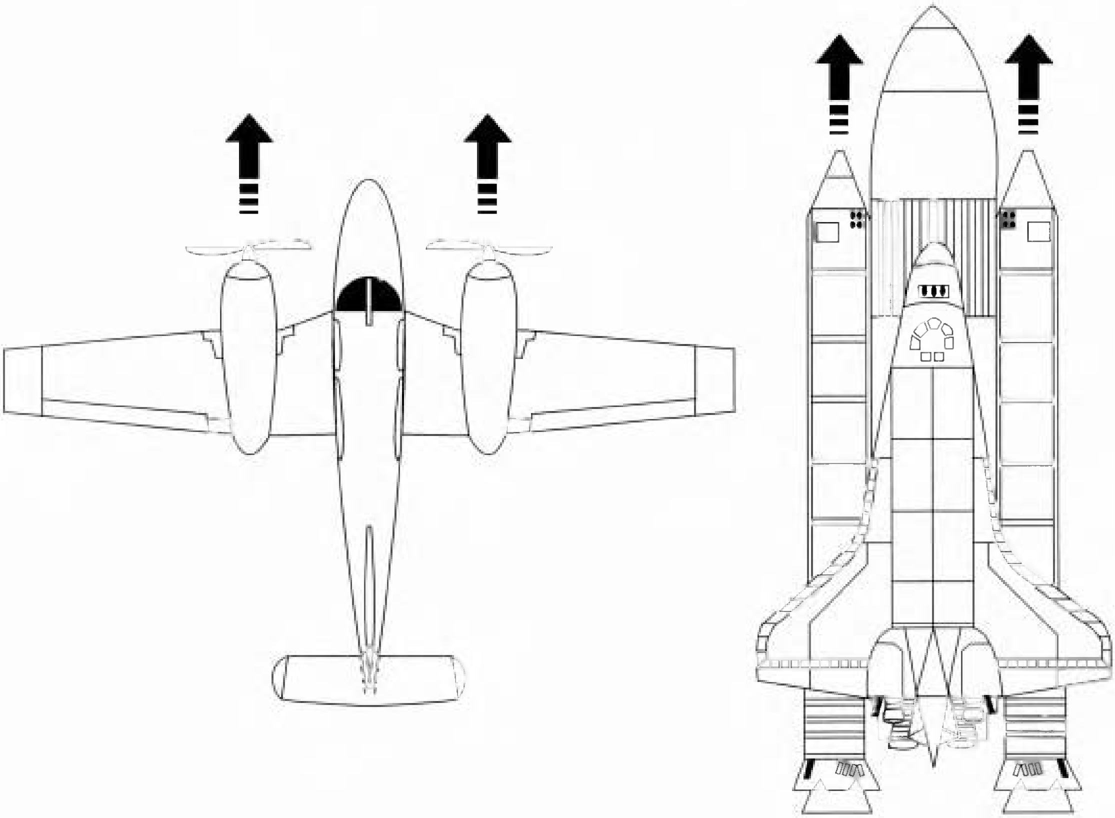

Fig. 1-3. The twin solid-rocket boosters on the space shuttle do not pull through the spacecraft's center of gravity, much as in a conventional twin-engine airplane. If one of the solid-rocket boosters were to fizzle out after liftoff, how much rudder pressure would be required to keep the vehicle on course? What is the space shuttle's V_{MC}?

In an airplane, what provides the counteracting force? Airplanes do not have steering wheels that provide any help to prevent pivot. Airplanes move in three axes: pitch, yaw, and roll. The axis in which this pivot takes place is the yaw axis (Fig. 1-4), which is controlled by the rudder. Of course the airplane control surfaces require airflow to function properly. We all test our control surfaces during a pre-takeoff check to ensure that they are moving in the proper direction. But while we are making this test, the airplane does not pitch, or roll, or yaw, because the airplane is standing still with minimal airflow. Airspeed makes the control surfaces effective.

My first instructor wanted me to feel how "sluggish" the flight controls were during slow flight and stalls. This sloppy feel of the controls was due to their lack of effectiveness, which in turn was due to the reduced airflow at slower speeds. So the pilot's ability to make the air-

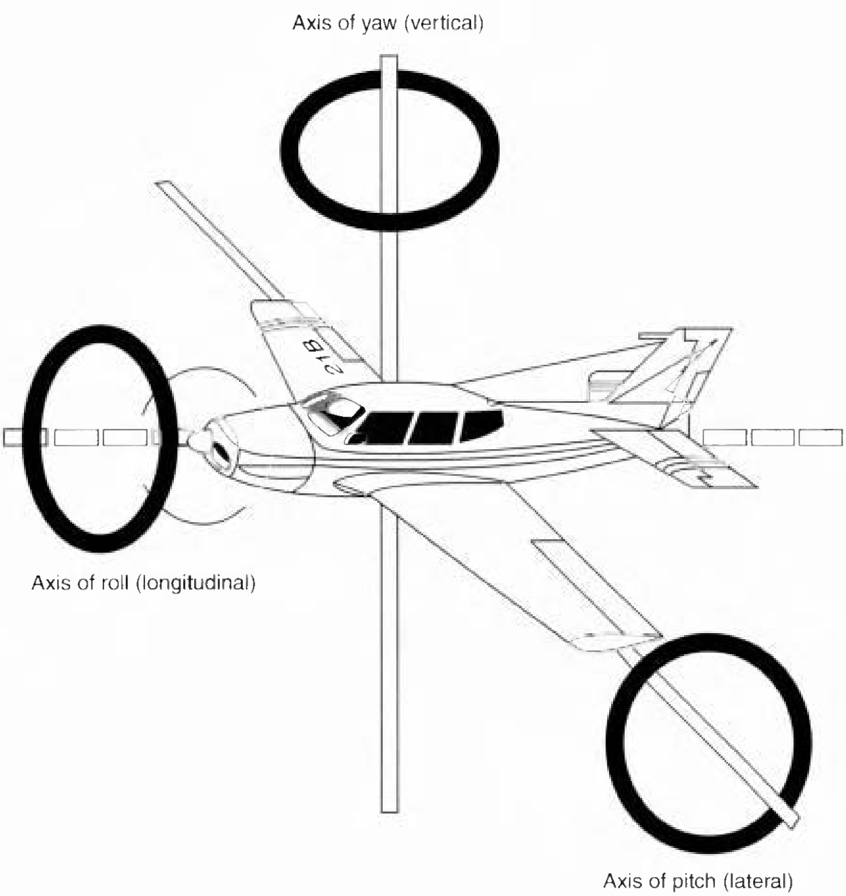

Fig. 1-4. The battle for control is fought in the yaw axis.

plane yaw by using the rudder is a function of just how fast the airplane is traveling through the air. If the pilot needs the yaw force of the rudder to counteract an uneven thrust from the engines, the pilot's ability to overcome this force therefore depends on airspeed. A car driver uses the steering wheel to overcome unwanted yaw. An airplane pilot uses rudder to overcome unwanted yaw. But the rudder does not always give the pilot what is needed.

Many forces are at work when uneven thrust exists. The "pulling ahead" force and the "lagging back" force produce the yaw in one direction. Airflow past and around the rudder can produce yaw in the opposite direction. If all these forces are equal and cancel out, then the airplane can continue straight ahead under control. But as airflow gets slower, the rudder counterbalancing yaw gets weaker, and soon the engine yaw overpowers the rudder yaw. This overpowering point is V_{MC}! V_{MC} is the airspeed that is just too slow to make the