Retractable Landing Gear

Aircraft designers of the 1920s knew that reducing drag on an airplane in flight was important to improving speed and fuel efficiency, as well as maneuverability and controllability. But they still had relatively little understanding of what actually caused drag on airplanes. Various structures obviously caused drag, but they had first to identify the most important sources before they could address them.

In 1927, the National Advisory Committee for Aeronautics (NACA) opened its new Propeller Research Tunnel (PRT) at Langley Memorial Aeronautical Laboratory in Virginia. The PRT was a very large wind tunnel for the time, with a diameter of 20 feet (6.1 meters). It was designed to allow the testing of an entire airplane fuselage with engine and propeller, as opposed to simply a part of an airplane or a scale model. NACA aeronautical engineers suspected that the aircraft landing gear contributed to much of the drag of an airplane, and the PRT was the first wind tunnel that would allow them to test this.

Landing gear consists of the wheels that stick out below the fuselage so that an airplane can roll down the runway during landing and takeoff. In early aircraft, they were fixed in an open position so that they protruded at all times, even while the plane was flying and nowhere near the ground. Tests in the PRT immediately demonstrated that landing gear contributed up to 40 percent of fuselage drag, which shocked the researchers. They realized that reducing the drag produced by the landing gear would significantly improve the performance of the airplane in flight.

There were several ways to reduce the drag of the landing gear. The two most obvious methods were to either retract the landing gear inside the aircraft or redesign a fixed landing gear so that it produced less drag while still protruding below an aircraft.

Retracting landing gear were not a completely new idea in the 1920s. J.W. Wartin's Kitten, built in 1917, had retractable gear (but could not actually fly). The Dayton Wright RB-1 of 1920 and the Verville Sperry R-3 of 1922 also had retractable gear. But these aircraft were rarities and most airplanes had fixed landing gear at the end of metal struts because they were easy to design, strong, and relatively lightweight.

When designing an aircraft, engineers have always had to address five conflicting requirements. These are: performance, weight, cost, reliability, and maintenance. The best solution to the performance requirement was to pull the landing gear completely inside the fuselage and cover them over, presenting a smooth surface that produced no drag. But while ideal from a performance standpoint, this approach affected all of the other requirements—it weighed more, cost more, was less reliable, and required more maintenance. The wind tunnel data from the PRT caused aircraft designers to look immediately for ways of developing landing gear that provided better performance and hopefully did not have too many other costs associated with them.

The Boeing Monomail, which first appeared in 1930, and the Lockheed Orion are generally considered pioneers in the development of retractable landing gear, proving that it was practical. But airplane designer Jack Northrop, who was very interested in streamlining aircraft to improve performance, produced the Northrop Alpha, Beta, and Gamma with fixed landing gear during the 1930s. These aircraft had streamlined coverings that extended down from the fuselage, with the wheels sticking out at the bottom. These were generally referred to as "trouser" gear. The Lockheed Sirius, which was built for Charles Lindbergh, had streamlined coverings over the wheels themselves that were referred to as "pants"-type landing gear. Although trouser and pants gear produced more drag than fully retracted gear, they were still a substantial improvement over uncovered landing gear. More importantly, they were still lighter, cheaper, more reliable, and easier to maintain than the retractable gear. But during the 1930s, numerous designers embraced retractable gear—they were willing to accept the other drawbacks of retractable landing gear simply to achieve the better performance.

Airplane designers explored numerous ways to retract aircraft landing gear into the fuselage. In some aircraft they were pulled straight up, usually into cowlings behind the engines (as in the DC-1, 2 and 3), sometimes with part of the wheels protruding outside the airplane. In other cases, particularly with smaller aircraft, the struts folded inward so that the wheels fit into the bottom of the fuselage horizontally, sometimes covered with a door to further reduce drag. Some of the drive mechanisms were electric, whereas others were hydraulic. The designers had to ensure that the gear deployed and locked in place. Landing gear that collapsed when a plane landed could cause the plane to tumble out of
control and kill the pilot, or at least seriously damage the airplane.

For early retractable landing gear not even the performance improvements were clearly achievable, since a retractable landing gear with its motors and associated machinery weighed more than a fixed gear, thereby requiring greater lift from the aircraft and negating some of the benefits of the reduced drag of the retracted gear. While retracting the gear could improve the performance of the plane, it might require a bigger engine and more fuel—not to mention more money.

In fact, it was this delicate tug-of-war between the extra weight of the gear and the reduced drag that was most important for the overall acceptance of retractable landing gear. Drag increases with speed and therefore reducing drag becomes more important as an aircraft's speed increases. As aircraft speeds continued to increase during the 1930s, particularly as aircraft began to reach speeds of 200 miles per hour (322 kilometers per hour), the increased weight of retractable gear became less important than reducing drag, and retractable landing gear became commonplace to most aircraft.

Today, many low-speed private aircraft still have fixed landing gear because of cost and maintenance concerns. Some even have the streamlined “pants” coverings over their wheels. But virtually all larger and faster aircraft have completely retractable landing gear. Designing such gear presents engineers with a number of problems, particularly how to mount them on the airplane without affecting other parts of the aircraft design. Large commercial airliners like the 747 and Airbus A340 have enough internal volume so that the landing gear can fit inside the fuselage diameter. But some smaller commercial aircraft have to compromise. Their fuselages are so small that fitting the landing gear inside the primary fuselage would result in a large bump inside the cabin that passengers would have to walk over. So their landing gear are often fitted inside bulges that stick outside of the fuselage. This is also common to large military transport aircraft like the C-5 and C-17, which use up every inch of interior space and need long flat floors inside so that tanks and other equipment can be rolled inside.

--Dwayne A. Day

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