The History of a Wind Tunnel

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You are looking at the Lewis Research Center, the principle propulsion research center for the National Aeronautics and Space Administration. Lewis was established in 1941 as part of the National Advisory Committee for Aeronautics. In the critical twenty years since, Lewis scientists and engineers have made many significant contributions to America's aircraft and spacecraft. During and immediately following the war, efforts were concentrated on the piston type or reciprocating engine. Then in the mid-1940s and early 1950s came the urgent quest for sustained supersonic speeds through research on turbojet, ramjet, and rocket engines. Then over the past several years there has been intense research on advanced rocket, nuclear, and electric propulsion for space travel.

With the establishment of the NASA in 1958, the center's research emphasis moved from aviation to space technology. Consequently the entire staff faced the task of adopting older aircraft facilities so they could be made useful for the new science of space technology. The present soon became the past, and the urgent need to bring the future into the present became a constant challenge.

The Lewis Altitude Wind Tunnel is a typical example of an aircraft facility that has been altered to accept more current research programs. The Altitude Wind Tunnel, or AWT for brevity, has been the scene of important research accomplishments during the last two decades.

It is designed not only to provide simulation of aircraft speeds, but also by use of its enormous vacuum equipment, it can create its own atmosphere which parallels environmental conditions found at 90,000 feet—a space atmosphere. The AWT was initially built to simulate conditions normally encountered by aircraft at 50,000 feet. A giant fan simulates speeds of up to 400 miles per hour, while simultaneous vacuum pumps raise the tunnel's altitude from ground level to 50,000 feet. Also since high-altitude is much colder this refrigeration equipment cools the circulating air to provide a more realistic simulation.

This was the AWT in 1943, and almost immediately it was put to work to improve the performance of World War II combat aircraft. The tunnel made its first vital contribution by solving a cooling problem that was affecting to performance of B-29 engines. Bomber pilots had reported that at higher altitudes their engines were overheating and losing power. B-29 engines were mounted in the AWT's test chamber and taken up to high altitude. Following intensive study, Lewis engineers determined accurately that following redesign of engine baffles the cooling problem would be solved. They were right and history records the mighty accomplishments of the B-29 aircraft in the Pacific war.

And then after a short year of use for piston engines, for which it was designed, came the first change. Turbojet engines had entered the field of aircraft propulsion and with a great list of problems. These engines, gulping great quantities of air need larger inlet ducts in which achieving an even distribution of flow was a serious problem. Our country's first jet airplane, the Bell YP-59A as well as the P-80 turbojet fighter took their turns respectively in the test chamber of the tunnel. Aviation experts were concerned that these early jet aircraft suffered uneven distribution of airflow. Following tunnel checkout at more than 400 miles per hour engineers redesigned engine inlets for a more even distribution of airflow. Result, a powerplant with about 25% greater efficiency.

During the course of these studies it was discovered that the early jet engines had serious flameout difficulties wherein combustion would cease above altitudes of 30,000 feet. Altitude Wind Tunnel tests established the flameout limits of these engines and subsequent modification of their combustion systems raised operational altitudes 10 to 20,000 feet.

In the late 1940s came the demand for supersonic speeds. And here resourceful engineers and scientists received another big challenge, which was to be met by a redesign of the tunnel's capabilities. And so the metamorphosis of Lewis' Altitude Wind Tunnel began. The sound barrier has been broken again and again and now the speed capability of the tunnel has to be increased to more than 700 miles per hour. Engineers and scientists, after much study, have discovered that by taking advantage of the pressure differences between the outside air environment and those created by altitude simulation, they could provide enough pressure to simulate speeds to on and two times the speed of sound. The only sacrifice involved was the reduction of the effective test section from an area large enough to accommodate nearly an entire airplane configuration to one test a typical propulsion engine.

The redesign was accomplished in nick of time because by now the Korean War was well under way and jet pilots from that conflict reported difficulty in their efforts to out-climb the enemy. Lewis engineers had already developed the afterburner or tailpipe burner, originally proposed by the Germans. This know-how plus added successful research efforts so improved the Sabre afterburner that shortly our jet pilots had no difficulty in outperforming the Red Migs at high altitudes.

Jet engines improvement continued but by 1957 with the refinement of ramjet propulsion systems, the AWT had virtually completed its role in the field of jet propulsion systems. In October of 1958 the National Aeronautics and Space Administration was created by an Act of Congress and the former National Advisory Committee for Aeronautics became the framework for this new research organization.

The Lewis staff quickly transferred their research to space propulsion problems. Among other facilities they designed and built a Multiple Access Spin Rig for research on spacecraft controls. The potentiality of this rig for acquainting Project Mercury astronauts with orientation and control problems in space was quickly recognized. And here it is being gyrated by an astronaut. The location? Once again the now venerable Altitude Wind Tunnel.

Before this scene became a reality further modifications of the giant facility were required to provide a realistic space altitude simulation to equal environmental conditions found at 100,000 feet. The modification was accomplished completed successfully by increasing the AWT's vacuum potential by use of more elaborate and powerful pumps. Of course, the upstream section of the tunnel was ideal for placement of the giant gimble rig.

During the early part of 1960 all seven astronauts received lengthy indoctrination aboard the flying device. Each astronaut was deliberately spun out of equilibrium and was then required to sense and control the motion of his craft in a given period of time. And this is precisely what Alan Shepherd did during his flight into space on May 5, 1961.

The Altitude Wind Tunnel received further modification so that the job for Project Mercury could be accomplished more efficiently and on time. These are scenes of actual capsule separation precisely as it will happen during a space flight. For this investigation the tunnel's full altitude potential was used. The cameras record the scene remotely at a simulation altitude of nearly 100,000 feet. This will be the scene at Cape Canaveral shortly. One of the astronauts rides the Mercury capsule on its first orbital flight atop of the Atlas launching vehicle. This is the payoff of some of the research accomplishments done at the AWT.

But this metamorphosis of the AWT continues so that the Lewis staff of engineers, scientists, and physicists can solve the problems related to programs that come after Project Mercury. In 1961 the first Centaur featuring upper-stages powered by Lewis developed high-energy fuels will be launched from Cape Canaveral. This leads to the great Saturn also equipped with high-energy Lewis fuels for upper-stages. Then will come the launching of instrumented electric propulsion rockets, a noticeable Lewis achievement. These include miniature nuclear reactors for power sources. And it is the AWT will continue its role as an earthbound space laboratory where propulsion systems may be tested at space altitudes.