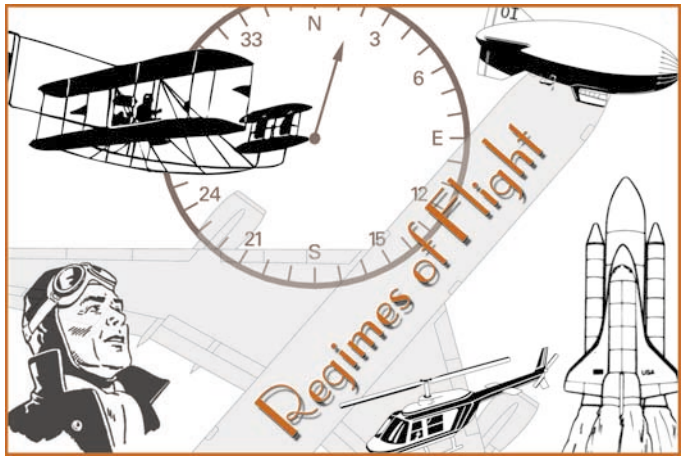
A New Regime

The Beginning of Supersonic Flight

Susanne Ashby

Susanne Ashby - Author
Amberlee Chaussee - Design, Graphics & Layout

This book is to be used with the Mini-Literature Unit as a part of the Regimes of Flight Online Curriculum series.



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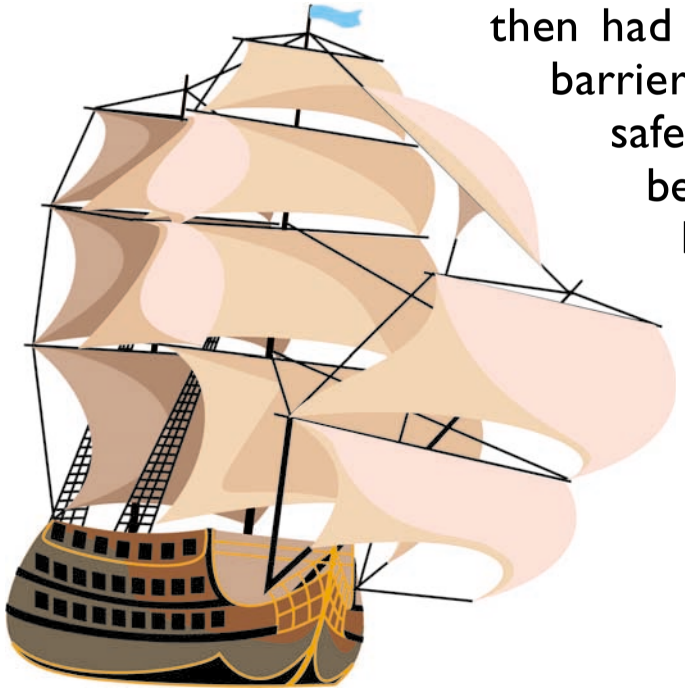
The Air Force Captain stood alone on the desert runway and watched as the sun opened its arms slowly to the earth from the eastern sky. The Captain and the experimental aircraft were both ready for another flight test. Lives had been lost before in the quest to cross the barrier from subsonic to supersonic flight. Backed by a team of engineers and aeronautical researchers, the time had come to solve the problem of supersonic flight. They knew the risks, but this time they were ready to break the sound barrier. The pink and orange hues chased away the blackness of the long night to reveal what would be the dawn of a new era.

Centuries before, New World explorers in wooden ships had stood at a similar point in time. These bold explorers had to convince the royal courts of Europe that the vast ocean between Europe and the Indies could be crossed. They had to persuade the monarchs to invest in the research needed to make the crossing: ships, maps, mapmakers, people, supplies and equipment. They then had to prove that the barrier, the ocean, could be safely overcome. A few still believed the world was flat and that such a trip would bring only death. Others believed that the mapping calculations for trips such as these were incorrect and that the distance would be too great for the ships sailing at that time. Most did believe that this obstacle, the vast ocean, was impossible to cross. They believed that lives would be lost attempting to break this barrier.



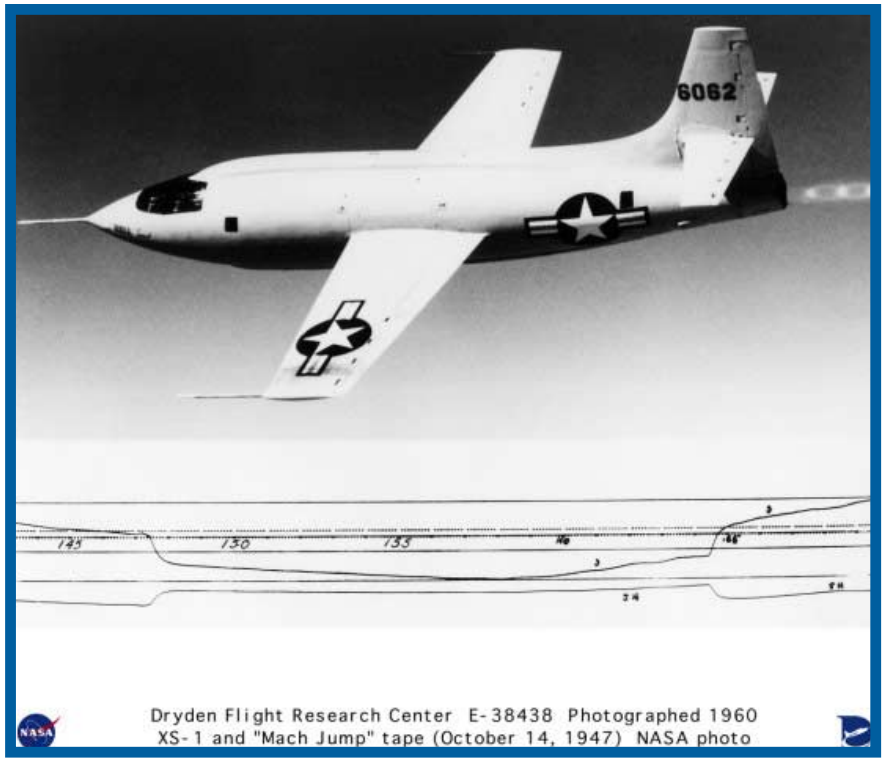
The B-29 *Super Fortress* rumbled loudly down the desert runway that crisp and clear morning of October 14, 1947. This mothership was carrying in its belly a secret cargo; the rocket powered Bell X-1 aircraft. Inside the "Glamorous Glennis" (as the X-1 was affectionately nicknamed) was Captain Charles Yeager. He was known as "Chuck" to all that worked with him on this project. He was a test pilot for NACA, the National Advisory Committee for Aeronautics.

The usually indifferent blue sky, hovered anxiously above the desert floor as the B-29 shook loose the bonds of Earth and cruised undisturbed to an altitude of 20,000 feet. This was the X-1's ninth test flight, and Captain Yeager had total confidence in its design and structure. For the flight test that day he was scheduled to reach .97 Mach, that is, just under the speed of sound.

Asked by the pilot of the B-29, Bob Cardenas, if he was ready, Captain Yeager nodded his helmeted head, "Yes, let's get it over with!"

The B-29 dropped its historic cargo from 20,000 feet. The dive speed was too slow and the X-1 was immediately thrown into a stall. Yeager wrestled with the control wheel while the rocket plummeted five hundred feet. Finally, he righted the X-1 nose down and picked up speed. He began firing each of the four rocket chambers one at a time.

The X-1 climbed at a speed of .88 Mach. As the pressure waves hammered the aircraft, the X-1 shook violently from the invisible blows. Captain Yeager expected this reaction. He quickly flipped the stabilizer switch and made a few adjustments to the X-1's controls. The aircraft's course smoothed out and Yeager could easily handle the controls once more. He was now at 36,000 feet and the B-29 had been left far behind. Yeager continued to climb to 40,000 feet at a speed of .92 Mach. He leveled off at 42,000 feet. Captain Yeager activated the switch for rocket chamber three and was immediately propelled to .96 Mach. The ride was surprisingly smooth considering that the aircraft was traveling nearly as fast as the speed of sound. He next ignited the fourth rocket.

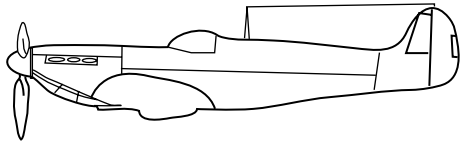


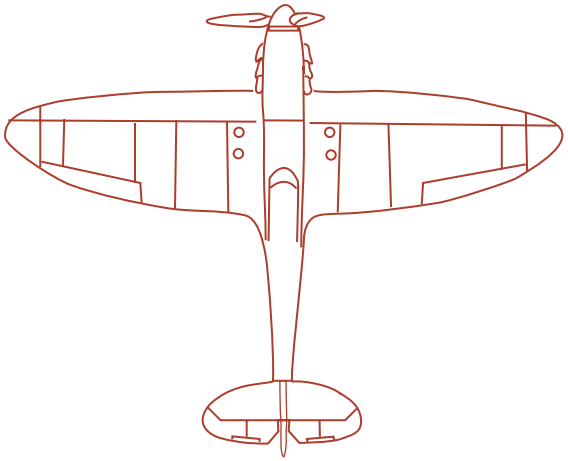
Suddenly, the Mach needle danced excitedly back and forth on the meter. It edged up to .965 Mach and then it tipped off the scale!

October 14, 1947 was officially the beginning of supersonic flight. The story, however, really began years earlier with World War II pilots. These fighter pilots flying *Spitfires* and *Mustangs* noticed that when flying at speeds around 545 miles (880 km) per hour, their aircraft suddenly became difficult to control. The airplanes would violently shake and sometimes break apart in midair. This led to the belief by experts that some kind of invisible barrier existed. They thought no aircraft could safely fly through this "sound barrier."

MUSTANG

Spitfire

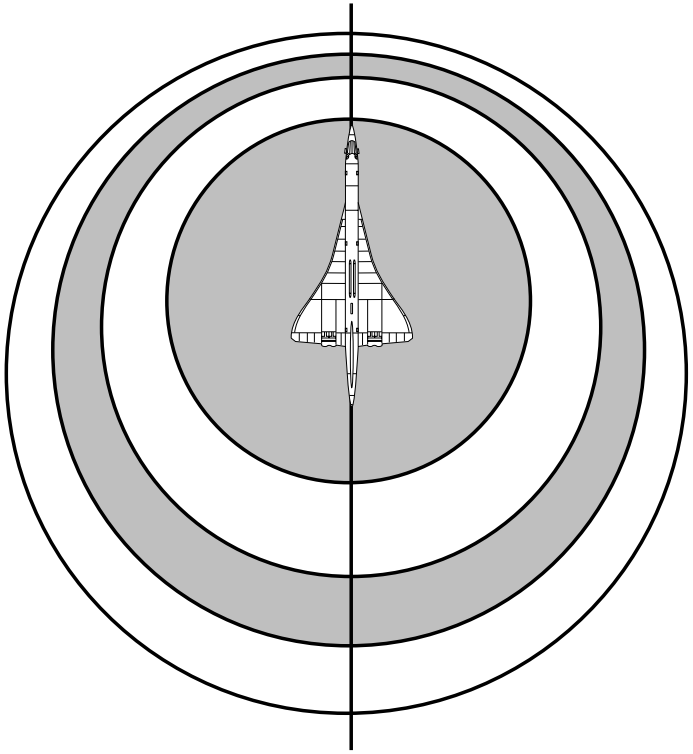




Researchers realized that with the new jet engine design being developed, humankind would be capable of flying at speeds faster than the speed of sound (Mach 1). Little was known about flying at this new regime. The wind tunnels in operation at that time could not create good quality airflow near the speed of sound. The engineers at Bell Aircraft Corporation had little research data that they could use to make the first specially designed supersonic aircraft.

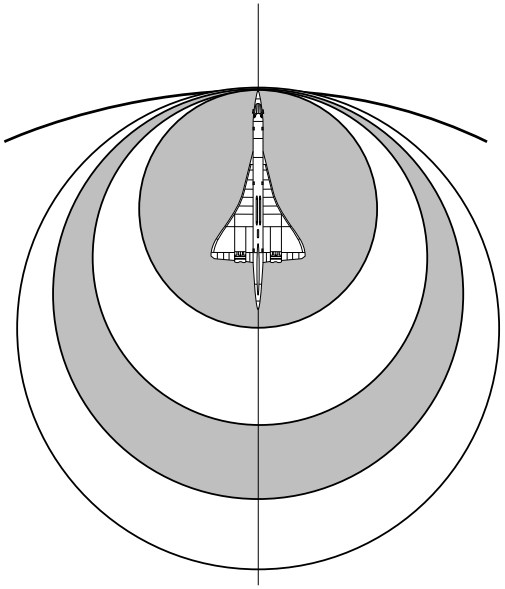
Dryden Flight Research Center E95-43116-5 Photographed 1948
Key members of the XS-1 test team (L-R): J. Vensel, G. Truszynski, Capt. C. Yeager, W. Williams, Maj. J. Ridley, and D. E. Beeler

More importantly, the aerodynamic theories in those days could not be used to describe how air flows around an airplane as it flies close to the speed of sound. The speed of sound is called Mach 1. The actual speed varies from 760 miles (1,223 km) per hour at sea level to 660 miles (1,062 km) per hour at 36,000 feet (11,000 meters). At Mach 1, the airflow around the aircraft acts differently than at slower speeds. As the aircraft moves through the air it makes pressure waves as it travels. These pressure waves stream out away from the aircraft at the speed of sound. This wave acts just like the ripples through water after a stone is dropped in the middle of a still pond.

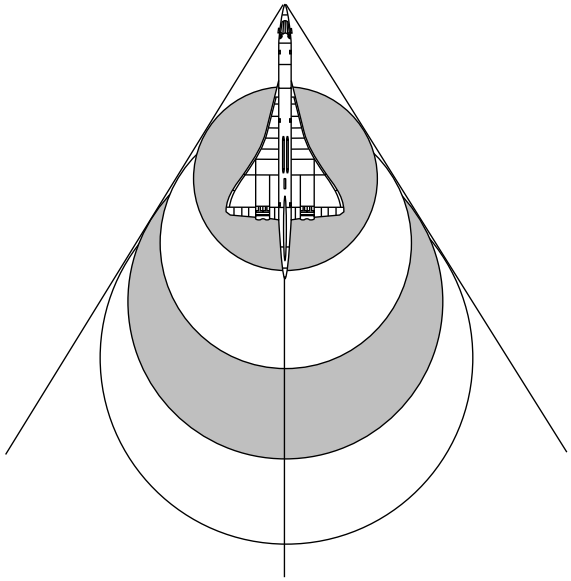


Airplane flying slower than the speed of sound with pressure waves moving out from around it.

At Mach 1 or during transonic speed the aircraft actually catches up with its own pressure waves. These pressure waves turn into one big shock wave. It is this shock wave that buffets the aircraft. The shock wave also creates high drag on the aircraft and slows the aircraft's speed. As the aircraft passes through the shock wave it is moving faster than the sound it makes. The shock wave forms an invisible cone shape. When the shock wave hits the ground it causes a sonic boom like a loud thunderclap.

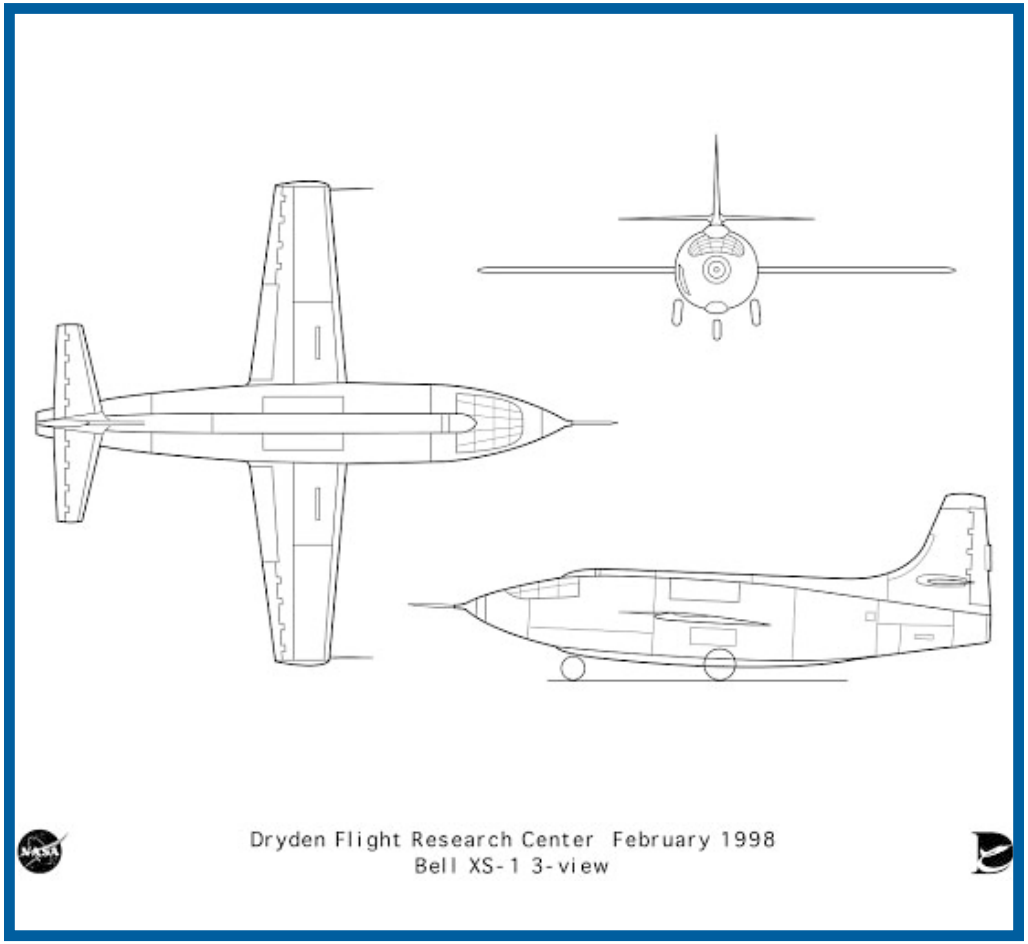


Airplane flying at the speed of sound with pressure waves building up at the airplane's nose to form a shock wave



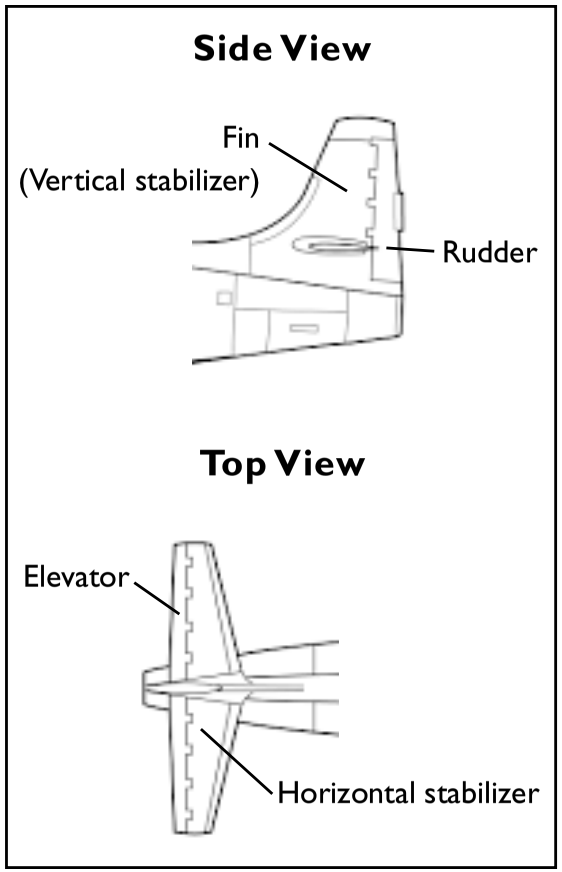
Airplane flying at supersonic speed with shock waves moving away and behind the airplane, reaching the ground with a sonic boom.

The engineers worked well with the knowledge they had. They already knew of one shape that could successfully fly at supersonic speed: a .50-caliber machine gun bullet. They used that shape and added thin, straight wings. These thin, straight wings would lower the amount of drag the aircraft would encounter at transonic speed.



After the first few test flights it became clear to the engineers that they needed to improve the ability to control the aircraft during transonic flight. They designed a new tail section, which improved the ability of the stabilizer and the elevator to control the aircraft. They called it the "flying tail."

LINE DRAWING OF X-1 TAIL SECTION



CLOSE-UP OF X-1 TAIL SECTION

The X-1 was built for supersonic speed with short, thin, straight wings attached to its bullet-shape design, a horizontal stabilizer on its "flying tail," a pressurized cockpit and a four chamber rocket engine. After eight test flights which gave researchers new information about transonic and supersonic flight conditions, the X-1 was ready to break through the imaginary sound barrier.

With each test flight in the X-1 Yeager flew closer and closer to Mach 1. He knew the aircraft was built to withstand three times as much stress as he himself could survive. He was sure that the sound barrier would not destroy the X-1. He knew he would be safe.

Yeager thought he was imagining things as the Tachometer needle remained off the scale for the next twenty seconds. The bucking bronco on which Yeager was riding had now turned into a loping Arabian. Captain Yeager raised the nose of the X-1 slightly to slow the speed. He radioed his observations to the NACA tracking van on the desert floor below. He reported the Machmeter's off-the-scale reading and that he had heard no loud sounds. He told them that after the needle went off the scale, the ride was calm and smooth.

NOTICE THE SHOCK WAVE PATTERN IN THE EXHAUST PLUME.

The NACA researchers on the ground below reported back to him that they had heard something that sounded like distant thunder rumbling across the desert. Later they determined that the X-1 had reached the speed of 1.07 Mach or 700 miles (11,200 km) per hour. The rumbling thunder sound they had heard was actually the first sonic boom made by an aircraft!

Dryden Flight Research Center EC95-43116-6 Photographed 1948
The NACA Muroc Contingent in October 1947, in front of the NACA XS-1

Like the New World explorers before him, Yeager proved that an obstacle could be overcome. He proved that the sound barrier was not a physical obstruction to break through, but an aerodynamic problem to be solved. The research program was a great success! Not only did researchers and engineers gain the knowledge of aeronautical design to make an aircraft that could fly faster than the speed of sound, but they also learned that humankind could safely fly in this new regime.

Brigadier General Charles E. "Chuck" Yeager

Dryden Flight Research Center EC-145 Photographed 1962
Early NACA aircraft in front of South Base hangar:
D-558-2, D-558-1, X-5, X-1, XF-92, X-4. NASA photo