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Hypersonic Flight: Traveling Faster than a Speeding Bullet

A speeding bullet leaves the muzzle of a gun at approximately 4,000 feet (1,200 meters) per second. If you do the math, you will determine that such a bullet travels a little less than four times the speed of sound. Mach 1, the speed of sound, equals 760 miles per hour.

Since the invention of the jet engine, the holy grail of aviation has been to build an aircraft that could fly passengers faster than a speeding bullet. On March 27, 2004, NASA proved that scramjet-powered hypersonic flight is possible with the first successful flight test of a scramjet engine. The scramjet-powered X-43A experimental airplane that NASA tested (Photo 1) accelerated to a speed that was greater than seven times the speed of sound (Mach 7). Many technologists feel that scramjet technology will eventually carry pilots and passengers at speeds approaching Mach 10.

To perform the test, NASA attached the X-43A to the nose of a Pegasus rocket, then attached the

All photos courtesy of NASA

Photo 1—Artist's concept of the X-43A hypersonic experimental vehicle

rocket to a B-52B bomber. (See Photo 2.) The three-stage flight started with the B-52B taking off from Edwards Air Force Base in California. When the bomber was in proper position, the Pegasus rocket was released and ignited to accelerate the X-43A to the speed required to operate its scramjet engine. The plane's scramjet scooped air from the atmosphere and mixed it with its hydrogen fuel for combustion. This unpiloted flight represents a major step toward the development of hypersonic aircraft that one day might take you from New York to

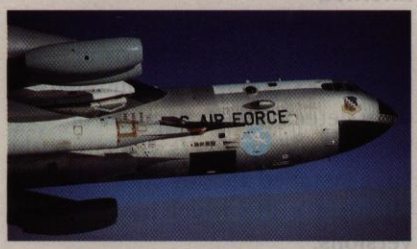

Photo 2—The black X-43A rides on the front of a Pegasus booster rocket hung from the wing of NASA's B-52B mother ship.

London in a half hour.

To get technical, a *scramjet* is a "supersonic combustion ramjet." The engine draws oxygen from the air that it flies through. It doesn't use rotating blades to compress the air it breathes because the friction of its flying speed would melt a turbofan assembly. To compress the air enough to create the needed oxygen-hydrogen mixture, the plane must be going extremely fast before the scramjet engine will operate. For that reason, NASA used the Pegasus rocket for initial acceleration. The air in a scramjet engine self-compresses as it passes through a metallic funnel that doesn't contain any moving parts.

To create an airfoil for hypersonic flight, designers needed to take into account the fact that hypersonic speeds create aerodynamic heating conditions way beyond those faced by conventional jets. The friction from the super-fast moving air not only superheats the entire craft, it also creates a sonic-boom shock wave that trails the plane along the ground.

To develop the aerodynamics for this aircraft, NASA used an arc-jet wind tunnel to test its designs. In this type of wind tunnel, a nozzle shoots super-hot gases over the model to create the environment that the plane would experience at supersonic speeds.

This giant step toward hypersonic flight won't lead to hypersonic passenger airlines until designers learn how to control the sonic booms the plane produces. But that achievement might not be as far off as most people believe. Recently, Lockheed Martin designers indicated that they now have a low-boom passenger supersonic airplane on their drawing boards. The company is ready to build the plane if the FAA will allow planes to fly at supersonic speeds over land if their pressure wave is held within certain limits.

Photo 3—This image, captured from animation video, illustrates the separation of the X-43A from the Pegasus booster.

Recalling the Facts

1. What is the speed of sound?
2. Where does a scramjet acquire the oxygen that it needs for combustion?
3. Could this NASA-designed scramjet, in its present configuration, provide powered flight from an airport runway or the deck of an aircraft carrier? Why?
4. When objects travel faster than the speed of sound they create a sonic boom. Why?

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