

Mach's supersonic research was a half-century ahead of its time.

That Four-Letter Word

BY C. V. GLINES

WE use the word "Mach" often these days. Chuck Yeager "went through the Mach" in 1947 to make his place in history. Aircraft speeds are displayed in jet cockpits on the "Machmeter." A number of related terms such as "Mach angle," "Mach effect," and "Mach line" have been derived from this four-letter word.

What does it mean? Where did it come from?

Simply explained, the Mach number deals with the measure of airflow. It assigns a numerical value to the ratio between the speed of a solid object through space (or gas) and the speed of sound through that same medium. When the speeds are equal, the object has reached Mach 1.

The word comes to us as a result of work done by Dr. Ernst Mach, a renowned Austrian scientist who specialized in ballistics and sonics (the study of sound) in 1870-90. Born in 1838 in the village of Turas, Austria, he graduated in 1860 from the University of Vienna at the age of twenty-two with a doctorate in physics.

After teaching physical sciences for three years, he became a professor of mathematics at the University of Graz in 1864. Three years later, he was named head of the physics department at the University of Prague and later the University of Vienna. He became fascinated with sonics during this period. The first results of his work were published in 1873.

In the 1890s, Mach intensified his study of sound and the effects of shock waves and turbulence on projectiles and ballistic objects hurtling through the air. He enunciated a theory that embodied what is known today as the Mach number. His work took him into high-speed photography, where he was the first to photograph a jet of air issuing from a vent at supersonic speed. This pioneer activity led to widespread use of this technique today in wind tunnel studies of the effects of airflow on aircraft, automobiles, and other types of vehicles.

While conducting his work in the laboratory, Mach stirred up controversy among his scientific peers. His writings gave rise to a new theory of philosophical thought rooted in the physical sciences. He was labeled a "positivist"—one who believes that all knowledge of phenomena in the natural sciences must be verifiable by observation and experience.

His ideas about verification were unique for the times. He developed very definite criteria that required rejection of such metaphysical concepts as absolute space and time and of certain theories concerning the atomic and

Dr. Ernst Mach (1838-1916)



molecular makeup of matter. His severe criticisms and his insistence on verification were taken to heart by later scientists. One was Albert Einstein, who developed his theories of relativity with Mach's views in mind.

Mach also became controversial for his political views. He rejected Karl Marx's dogma of dialectical materialism. Mach published his thoughts in a book, *Analysis of Sensations*, that incurred the wrath of Lenin, who blasted Mach and his theories in *Materialism and Empirio-Criticism*.

Mach eventually became such a "nonperson" in the Communist world that it was not until the 1950s that the Soviet Air Force began to use aerodynamic terms bearing Mach's name. In the 1930s, the term "Baird number" was used to designate supersonic speeds, after Sir Leonard Baird, a British aerodynamicist. Baird's work was based on Mach's, and his name is rarely used today. The first use of the term "Mach number" is found in a German scientific text published in 1929.

Mach published his final report on sonic research in 1898 and shortly thereafter suffered a stroke that left him partially paralyzed. Despite his handicap, he was named to the Austrian House of Peers in 1901. He moved to Munich before World War I and died there in 1916.

The Mach number is now an accepted measure of airspeed. The sonic boom heard every time an aircraft passes through Mach 1 is an indirect tribute to Dr. Ernst Mach, a man who dared to think differently. ■

C. V. Glines is a regular contributor to this magazine. A retired Air Force colonel, he is a free-lance writer, a magazine editor, and the author of numerous books. His most recent article for AIR FORCE Magazine was "Flying Blind" in the September '89 issue.