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An arc toward the future

How the development of the Navaho missile led to greater tech advances

By Michael Lombardi

As World War II came to a close in Europe, Germany introduced a deadly new weapon: the V-2 ballistic missile. There was no defense against the rocket-powered supersonic missile. As a result, destroying its launch sites and capturing advanced rocket technology, as well as the German scientists who created it, became a priority as the allies advanced across Europe.

Similar research on rocketry and guided missile technology had been largely neglected in the United States during the war. But after seeing the V-2, it became a priority. The U.S. Army initiated a series of postwar guided missile and rocket development programs with a number of U.S. aviation companies.

One such program was North American Aviation's Navaho, which began with a 1946 Army Air Force contract that called for initial studies of existing rocket technology, including technology collected from Germany, to develop a surface-to-surface guided missile.

Other than captured German rocket technology, none of the other technologies that were needed to make Navaho existed. Everything from ramjet engines to computer guidance, high-temperature materials and knowledge of the aerodynamics of high-speed flight had to be developed from scratch. A company report on Navaho stated: "North American found itself in the position of a composer who is commissioned to write a symphony but must base it on a new tonal scale, a new principle of harmonics and a new set of instruments."

An X-10 is shown at Edwards Air Force Base, Calif. The X-10, used to evaluate the guidance systems and flight characteristics of the Navaho missile, was the first turbojet-powered vehicle to reach a speed of Mach 2.

For the next four years, North American and the Air Force studied various concepts. In 1950, they arrived at a phased program that was to lead to a nuclear-armed, supersonic intercontinental-range surface-to-surface missile designated the SM-64A Navaho.

The first phase was an evaluation of the guidance systems and flight characteristics of the Navaho missile. To evaluate them, North American built the turbojet-powered X-10 test vehicle. The design of the X-10—with its rear wings, long slender fuselage and canard control surfaces—later influenced the design of the XB-70 Valkyrie, as well as the Boeing Sonic Cruiser. The X-10 was the first turbojet-powered vehicle to reach Mach 2 (twice the speed of sound); it also was the first aircraft to fly a complete mission under inertial (computerized) guidance and the first to use a self-contained automatic landing system.

The next phase of the Navaho program was the development of the SM-64 ground-to-ground missile, or what North American called the G-26. The G-26 required the development of powerful rocket engines and an autonavigator unit that was small and lightweight. To develop them, North American pioneered precise lightweight electronics through the use of transistors and the development of printed circuit boards.

The 67-foot-long (20.4-meter), ramjet-powered missile rode piggyback on a 76-foot (24-meter) booster powered by a pair of 200,000-pound-thrust (890-kilonewton) engines. This powerful combination helped the G-26 become the first jet vehicle to reach Mach 3 and an altitude of 77,000 feet (23,500 meters).

In July 1957, after extensive testing at Cape Canaveral Auxiliary Air Force Base, Fla., the Air Force decided to go forward with ballistic missiles for land-based nuclear deterrence and canceled the Navaho program. While many Navaho delays and teething problems were due to its complexity, the simple reason for its cancellation was the fact that a ballistic missile traveling near Mach 20 would reach its target in a fraction of the time and was (at the time) impossible to intercept.

During its nearly 10 years of development and testing, the Navaho program made key technological breakthroughs in nearly every discipline of engineering and electronics. The pioneering work in developing the rocket engines led to the formation of North American's Rocketdyne division, still a leader in the development and production of rocket engines. The pioneering work in the development of digital computer technology and modular electronic circuitry as well as inertial guidance systems would lead to the formation of North American's Autonetics Division—now the home of the Boeing site in Anaheim, Calif.—and the development of navigation systems for airplanes, missiles and even the system used on the USS *Nautilus* to navigate under the polar icecap.

"Even though it was canceled, Navaho made important contributions to the nation's aerospace industry," said Sam F. Iacobellis, retired Rockwell executive vice president and chief operating officer, who worked on the Navaho program early in his career at North American Aviation. "In many ways, the Navaho booster was more powerful than the Atlas or Titan rockets and helped Rocketdyne in its development of the 7.5 million-pound-thrust (33,400-kilonewton) Saturn V rocket engines. The Navaho is another example of 'the patient died, but the operation was a success.' "

That success thrust North American Aviation into a position of technological leadership that led to the company being selected for the XB-70, X-15 and A3J Vigilante programs, as well as two of the most important and prestigious programs in aerospace history: the Apollo spacecraft and the space shuttle. ■

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The Navaho G-26 (SM-64) pioneered the piggyback launch configuration later used by the space shuttle. Although the U.S. Air Force eventually canceled the Navaho, the program achieved many technological breakthroughs in engineering and electronics.

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