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“Can you believe they put a man on the moon?” The Apollo Program. (3)

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DORIS CHANDLER AND THE SATURN V GUIDANCE DEBATE

Abstract

Doris Chandler was a NASA engineer who led the team of men who developed the on-board guidance algorithm used by the Saturn launch vehicles. She received a B.S. in Mathematics from Tulane University with a Phi Beta Kappa Key and joined the Aeroballistics Laboratory at the Redstone Arsenal in 1953. As a NASA employee at the Marshall Space Flight Center in the 1960s, she served in three management positions: Deputy Chief of the Guidance Theory Section, Chief of the Guidance Application Section, and Chief of the Applied Guidance and Flight Mechanics Branch.

In the early 1960s, Doris Chandler’s team developed one of two competing mathematical concepts for Saturn guidance. The advent of flyable digital computers permitted the development of software-based guidance algorithms. Reference trajectory guidance methods employing analog computing, used for ballistic missiles in the 1950s, were not suitable for new space launch vehicles like the Saturn V.

The Polynomial Guidance Mode (PGM), championed by Peenemünde veteran Rudolf Hoelker, used guidance polynomials derived from curve fits of nominal and dispersed optimal trajectories computed using the calculus of variations. PGM required extensive pre-flight computation but resulted in simple on-board software.

Doris Chandler’s team developed the Iterative Guidance Mode (IGM) based on an idea of Peenemünde veteran Helmut Horn that involved Lawden’s linear tangent steering law. IGM was controversial due to the use of multiple simplifying assumptions and the iterative nature of the algorithm. A closed form solution to the guidance problem could not be obtained.

Chandler protected her team from internal politics and the vigorous debate surrounding Saturn guidance. She encouraged them to innovate and explore new ideas, regardless of the strong opinions of engineers and management in other organizations at Marshall. Closed loop guidance using digital computing was a new idea and there were no courses, books, or papers on the topic for her team to learn from.

It had been assumed by many that PGM would fly on the lunar missions. However, by late 1963 the debate over guidance reached the point that an independent committee had to be formed to determine which algorithm should be recommended for the Saturn V. IGM had performance advantages, and it was chosen in mid-1964. Doris Chandler celebrated her team’s achievement by buying them lunch at the Redstone Arsenal Officer’s Club. She was respected as a mathematician, leader, and mentor by the men she led.