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THE HISTORY OF APOLLO ON-BOARD GUIDANCE, NAVIGATION, AND CONTROL

David G. Hoag*

When Apollo astronauts finally walked on the moon, thousands of engineers, scientists, managers, and technicians of many disciplines and specialties shared in the glorious accomplishment of an extraordinary national goal. This is the story of an essential part of that endeavor—that of the development and execution of the guidance, navigation, and control systems which, on-board Apollo along with the astronauts, made essential measurements of the motions of the spacecrafts and directed necessary maneuvers for the mission.

The Beginnings

The forerunner of the Apollo guidance, navigation, and control system, is found in an unmanned spacecraft and mission study started in 1957 by the Instrumentation Laboratory at MIT under a contract with the Air Force Ballistic Missile Division. The small Instrumentation Lab team for this study, led by Milton Trageser and supported by AVCO Corporation, the MIT Lincoln Laboratory, and Thiokol Chemical Corporation, produced a complete design of a 150 kg autonomous spacecraft which would take a close-up high resolution photo of Mars. This Mars probe had several novel features, later incorporated in the Apollo system, including a space sextant to make periodic navigation angle measurements between pairs of celestial objects: the sun, the near planets, and selected stars. The guidance technique utilized original formulations designed by Dr. J. Halcombe Laning and Dr. Richard Battin to operate a small rocket at appropriate times to put the spacecraft on a corrected trajectory which would utilize the Martian gravity during the close passage and thereby send the spacecraft with its Mars picture on a path back to earth for physical recovery. Spacecraft attitude control was to be accomplished by torquing small momentum wheels with the use of

* Charles Stark Draper Laboratory, Inc.