- Chapter One -
- The Gemini Digital Computer: First Machine in Orbit -

Crew interfaces to the Gemini digital computer

Gemini's digital computer had three sets of interfaces: the computer's controls, the Manual Data Insertion Unit (MDIU), and the Incremental Velocity Indicator (IVI). The controls consisted of a mode switch, a start button, a malfunction light, a computation light, and a reset switch. The mode switch had seven positions for selection of one of the measurement or computation programs. The start button caused the computer to run the selected program loaded in its memory. The reset switch caused the computer to execute its start-up diagnostics and prepare itself for action. The MDIU consisted of two parts: a 1 0-digit keyboard and a 7-digit register. The first two digits of the register, a simple odometerlike rotary display, were used to indicate a memory address. Up to 99 such logical addresses could be accessed. The remaining five digits displayed data. Errors caused all zeroes to appear. Negative numbers were inserted by making the first digit a nine; the other digits contained the value. The IVI displayed velocity increments required for, or as a result of, a powered maneuver. It had three-digit feet-per-second displays for each of forward-and-back, up-and-down, and left-to-right axes[39].

(MISSING FIGURE)
Figure 1-6. Manual Data Insertion Unit. (From McDonnell Corp., Gemini Familiarization Manual)

(MISSING FIGURE)
Figure 1-7. Incremental Velocity Indicator. (From McDonnell Corp., Gemini Familiarization Manual)

[24] On a typical mission the computer would be in operation during ascent as the backup to the booster. On orbit, if no powered maneuvers were imminent, it could be shut down to save electrical power. Due to the nature of core memory, programs and data stored magnetically in the cores would not disappear when the power was off, as in present day semiconductor memories. This made it possible to load the next set of modules, if necessary, from the Auxiliary Tape Memory, enter any needed parameters, and then shut down the machine until shortly before its next use. It took 20 seconds for the machine to run its start-up diagnostics upon restoration of power. After the diagnostics ran successfully, the current program load was ready for use, all parameters intact.

GT-IV was following such a procedure in preparing for re-entry on June 7, 1965. The computer was placed in the RNTY mode, and the crew received and entered updated parameters given to them when they were in contact with the ground stations. But when they tried to turn the machine off, the manual on/off switch did not function. The power had to be cut off by another means, and the re-entry handled manually [40].

Using the computer for catch-up and rendezvous was a relatively simple task. The difference between catch-up and rendezvous is that catch-up maneuvers are executed to put the spacecraft into position to make an orbit-change maneuver. After the orbit change the spacecraft is prepared to rendezvous with the target [41]. Crews began the catch-up by entering the ground-calculated rendezvous angle desired into address 83. The rendezvous angle indicated how much farther along in a 360-degree orbit the rendezvous was to take place. For example, if the crew desired rendezvous one-third orbit ahead, 12000 was entered into address 83 using the MDIU. The interval at which the pilot wanted to see updates was then entered in address 93. For example, if 04000 was entered, the computer would display on the IVI any required velocity changes at 120 degrees from the rendezvous point (the start), 80 degrees to go, and 40 degrees to go. If the IVI indicated that the computer had calculated that such a rendezvous was possible within the designated fuel limits, the astronauts pressed the START button and the IVI displayed the first set of velocity differentials. The pilot then fired the thrusters until the displays were all at zero (Astronaut John Young reported that there was a tendency to "overshoot" in trying to burn to zero [42].). After that, nothing was done unless the next update indicated a need for more velocity adjustments [43]. The astronauts also did paper-and-pencil calculations of the velocity changes as a backup by using special nomographs based on time and angles to the target [44]. These backup calculations were compared with the ground-calculated solution as well as the computer solution. However, the figures computed on-board were considered the primary solution for the terminal-phase intercept [25] maneuver [45]. In the rendezvous mode, the radar would feed information to the computer, which used it to calculate the velocity adjustments needed for final approach [46].

These examples of the use of the computer on a typical flight demonstrate that it was a relatively straightforward assistant in guidance and navigation. It permitted the Gemini astronauts to be independent of the ground in accomplishing rendezvous from the terminal-phase intercept maneuver to station keeping, a valuable rehearsal for the lunar orbit rendezvous required for the Apollo program. The astronauts participated in both the hardware and software design of the computer and its interfaces, and they were able to go to Owego and be put in the man-in-the-loop simulations. By flight time, like everything else in the cockpit, use of the computer was second nature.
