Q&A
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Computers to the Moon
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COMMENT: Eleanor - The Lunar Module was actually the Lunar Excursion Module (LEM)

A. Mark: When the design of the Apollo program started, they did indeed refer to it as the LEM. However, by the time it actually flew, its name had long since been shortened to "Lunar Module," abbreviated "LM."

Here's a link to the Apollo Operations Handbook for the Lunar Module -- it's essentially the "owner's manual" for the Lunar Module. It refers to the spacecraft as the "LM" throughout. The term "LEM" isn't even listed in the glossary as an alternate name!
https://www.hq.nasa.gov/alsj/LM10HandbookVol1.pdf

COMMENT: Eleanor - The moon is a satellite of Earth, not a planetary body.

A. You're right about the moon not being a planetary body. That's what happens when you're thinking on your feet. I regretted it as soon as I said it. "Astronomical body" was what I should have said. Oh well.

Q. Judy: Did any companies other than IBM work on the computer systems?

A. The Apollo Guidance Computer was not built by IBM -- it was designed and programmed by MIT and manufactured by Raytheon. IBM competed for the contract for the Apollo Guidance Computer and lost. However, IBM built the computer that controlled the Saturn V rocket, known as the Launch Vehicle Digital Computer (LVDC).

Q. Judy: How much did the Astronauts have to know about the computer systems, and did they need to make changes while in flight?

A. The crew had a pretty good understanding of the computer. They weren't programmers, but they understood bits and octal numbers and memory addresses and I/O ports -- things like that. They all had many hours of classroom instruction learning how the AGC worked, some of them had visited the facility where it was built, and all of them had spent hundreds of hours practicing with the computer.

The crew that really had to get their hands dirty with the computer was the Apollo 14 crew Al Shepard was the Commander, and Edgar Mitchell was the LM pilot. While they were doing the checks before descent, they discovered that the ABORT button was occasionally triggering itself, as if someone were pushing it at random times. This was a really serious problem. Once they started the descent, pressing the ABORT button

signaled to the computer that it should immediately abort the descent and begin the process of returning to orbit. An investigation after the mission determined that a ball of solder was floating around loose inside the switch and occasionally shorted out the contacts.

Programmers on the ground worked out a software hack that would cause the computer to ignore the ABORT signal -- the very first software hack in space. Mission Control radioed the procedure to the crew, and they had to enter the hack into the computer. They pulled it off, and Apollo 14 landed successfully. Scott Manley has a great YouTube video on the hack, which includes much information that should be familiar from today's presentation! Scott Manley calls it "the greatest tech support call in history." I highly recommend it -- that video is here: https://www.youtube.com/watch?v=wSSmNUl9Snw

Q. Bill: Is the DSKY software you demonstrated available online, from NASA, JPL, or whatever? Thanks! (Also, maybe mention the groundbreaking "surface-mount" computer hardware in the Instrument Unit.)

A. I've put the DSKY simulator software up on my webserver -- you can access it here: http://whatsthisthen.com/agc

I'd be delighted if you'd take a look at it. You see, the presentation that I did today was initially designed to be presented in a full hour and included a demo I built in which I've synchronized the Apollo 12 landing video with the simulated DSKY -- as you watch the video of the landing, you can see exactly what the Apollo 12 crew would have seen on the DSKY. Since I only had 45 - 50 minutes this afternoon, I had to skip the demo. If you're interested in seeing it, here's how to run it:

1. Go to http://whatsthisthen.com/agc
2. Wait for the program to finish starting up (takes about 2 seconds).
3. At the far right of the screen, click the DEMO button.
4. Press the RSET button to turn off the RESTART light (just because it's distracting).
5. On the DSKY, press: VERB, 37, ENTR, 63, ENTR. This starts Program 63, which begins the descent program.
6. However, the video doesn't start until about almost 8 minutes into the descent. You can skip ahead to that point by clicking the button labeled **P64:7:53**.
7. Click the **Lnd** button, which will cause the simulation to show you what the numbers in the DSKY mean.

If you have any questions after looking at it, feel free to ask!

I'm not the only one who built a DSKY simulator. There's a good one here: https://svtsim.com/moonjs/agc.html
Just above the DSKY is a link that says **Launch checklist**. If you click that link, it will give you instructions on how to do a simulated launch.

The granddaddy of all AGC emulators is Virtual AGC. It does a software simulation of the AGC hardware and runs the actual code that the AGC used. Running the software is not for the faint of heart, however. Nonetheless, if you're interested, it's here: https://www.ibiblio.org/apollo/download.html

The same website has probably the best collection of Apollo documentation that I've ever seen. They have a wealth of downloadable PDFs of many of the documents written during the Apollo program. A lot of it is highly technical, but press releases and other documents aren't quite so intimidating.

Q. Della: How long were they on the moon?

A. Each of the six Apollo landing missions stayed on the moon longer than the previous missions. The first landing, Apollo 11 in 1969, was on the moon for only 22 hours, and the single moonwalk was only about 2 hours. The last lunar mission, Apollo 17 in 1972, was on the moon's surface for over three days, and the crew did three moonwalks, **each** of which was almost 8 hours. They could cover far more area because they (like the previous two missions) had the lunar rover with them. If you've never seen the lunar rover, it was a small golf-cart-like vehicle. Here's a photo: https://www.nasa.gov/sites/default/files/thumbnails/image/apollo15lunarrover2.jpeg

Thanks for the nice questions and comments, everyone! If any other questions pop into your head, don't hesitate to send them along.

COMMENT: Mike: Regarding the iron core memory, the Navy's E2A Hawkeye aircraft used this memory in their radar detection computer from 1962 (development) through the 1970s. I flew in them. I kept the same little old ladies working!

COMMENT: Kevin - Nicely done! It warmed my heart to see the old IBM 729 hard drives in your opening slide(s)!

COMMENT: John (next presenter): I shot photos of launches, including Apollo 16 and Shuttle flights 1, 5, and 8. My background photo was of an Antares launch at Wallops last year.