[When 100 Flops/Watt was a Giant Leap: The Apollo Guidance Computer Hardware, Software and Application in Moon Missions](#)
(The slides are available under "Presentation Materials" in the above URL)
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Q. How did they validate that the code stored in the ROM was correct?

A. Once the ROM was "woven", it was a simple matter of reading every memory location and comparing the binary data (which would be the AGC assembly code) there to what they had on tape.
B. Validating the actual software for correct operation is an entirely different question and involved the use of several levels of testing starting with the all-digital simulator.

Q. What was software testing like? Unit testing, integrated testing, etc?

A. There was unit testing for those routines that operated in isolation such as the ephemeris routine which I briefly described in the talk. For major mode programs and the digital autopilots, etc., unit testing was not really useful because those programs tended to interact with each other via shared memory locations in erasable storage. It was a big enough issue that unit testing was simply not a sufficiently useful tool to indicate proper program operation.

Q. What lessons can modern HPC software developers learn from Apollo?

A. The more things change...the more they stay the same ;) One take-away I had in reading about the AGC was just how much software developers of that era faced the same challenges we face today and how often they tended to come up with similar solutions such as auto-mated documentation tools to keep astronaut checklists up to date with software interfaces. Documentation was critical to their success as was communication of key technical data among stakeholders developing different parts of the complete guidance system. Key issues that arose, arose from lack of sufficient documentation and tools for timely communication of changes.
B. Testing is absolutely critical as well as contingency planning and consumed ~50% of the whole effort's costs, and what-if thinking to ensure the guidance system was as fault tolerant and able to recover from problems as possible.

Q. Very nice talk! With a deeper understanding of the challenges encountered during Apollo 11, were you amazed that things worked?

A. Yes, very amazed. As a child, I just saw it as one big adventure. I had no appreciation for the enormity of the engineering challenges faced as well as the myriad of ways every mission could have gone wrong. Testing, combined with training and practice of ground support crews as well as flight crews, was essential to enabling each mission to get over the various "hiccups" (and there were *many* hiccups I simply didn't get a chance to discuss in this talk) they encountered.

Thank you. This was a great talk.