MULTIPLE MIRROR TELESCOPE OBSERVATORY

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Subject: MMTO Servo Drive System

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Editor's note: This information on the MMT telescope servo drive system has been condensed and edited from a presentation made by Dr. Bobby Ulich to engineering staff members of the MMT on July 22, 1985, by C. Janes. The tone has been intentionally left conversational.

DRIVE SYSTEM HISTORY

The prime contractor for building the Multiple Mirror Telescope was Aeronutronic Ford, actually the Western Development Labs of Aeronutronic Ford, in Palo Alto, California. They used to be known as Philco Ford. Most of the work on the controls was supervised through the Smithsonian Astrophysical Observatory. Several people there were instrumental in making decisions about the control system. Foremost among them was Nat Carleton, who is still with the Smithsonian, and Tom Hoffman, who was an engineer at the Smithsonian at the time. He now works for A.D. Little in Cambridge. However, he's still interested in this sort of thing and he's available for questions. These people decided they would depart from the traditional control concepts for optical telescopes and copy what was basically a radio telescope design.

The MMT is different from most optical telescopes in that it has shaft angle encoders that couple directly to the axes. They're not gear driven or friction-wheel driven, so the axis of the encoder turns one-to-one with the telescope. The designers wanted to try to get enough resolution so that they could track the telescope smoothly to a fraction of the image diameter of a star without having to have a second incremental encoder system. However, they weren't so sure they could do this. So, on the drive gears for each axis there is a machined smooth surface. If it became necessary to put incremental encoders on the telescope, they could be added and driven with a friction wheel. That was never fully designed or implemented; although, there are a few drawings in the old file that show a couple of ideas.

Another thing they did was to use ball bearings rather than hydrostatic bearings. Many people wondered if the friction variations would be so large that the mount would be very jerky in tracking. This question was settled when they first assembled the yoke. They put a dummy weight on it to simulate the telescope and then turned the yoke on the azimuth bearing. The azimuth bearing was supplied by Kayden, U.S. The designers measured the friction and found it was low and had rather small ripple. They knew they could track the telescope smoothly enough if they had a control system with angular resolution and high enough resonant frequency when driving the telescope to give the necessary bandwidth.

The Smithsonian had a laser interferometer measuring the position of the yoke. They attached a cable, wrapped it around the azimuth yoke, ran it over a pulley, and hung a weight on it so they could apply a known torque to the