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MEMO

TO: R. Larson
FROM: P. Kachmar
DATE: January 28, 1971
SUBJECT: Excessive N49's During Short Rendezvous Simulations on the Grumman Hybrid Simulator.

The purpose of this memo is to report the contents of a phone call with Butch Cockrell of NASA. It concerned the excessive N49's seen by Grumman while they were simulating the "short" rendezvous which is to be used on Apollo 14.

The simulation in question was supposedly a zero error run, i.e., zero state errors and zero sensor errors. The Grumman data from this simulation was sent to NASA and MIT with subsequent reduction of this data by Butch Cockrell.

The data shows that excessive state updates occurred on marks 4, 5, 6, 8, 11, 12 prior to TPI on either the shaft or trunnion angle incorporation. The data also indicated that the bias estimates were jumping around on the order of several mills. This fluctuating bias estimate indicates the possiblity of a random error in their radar model on the order of several mills, not zero error as they had supposed.

Butch has been able to reproduce, on a digital simulation and using the Grumman mark data, the state vector updates obtained by Grumman at each mark in the pre-TPI tracking sequence..

This mark sequence was then repeated (using the same mark data) twice: In the first case, no bias estimation was done (0's loaded in the W-matrix bias estimation slots) and in the second, the filter angle variance was increased. (One of the above runs was done on the Grumman simulator. I don't recall which one.)

When no bias estimation was done, there were N49's for the first several marks and none thereafter. This is what would happen if there was a random error in the radar model whieh was larger than the filter expeeted. Without bias estimation, the random errors are not thrown into the estimated bias slots to effect the delq at a subsequent mark whieh has a different random error. As the W-matrix is reduced at eaeh mark, the sensor random error is not weighted as heavily and the state updates get smaller, hence no more N49's.

In the simulation in whieh the filter varianee for angle measurement incorporation was inereased, the N49 problem disappeared. This also points to a random error in their radar model (for angle measurements). A larger varianee down-weights the angle measurement, and does not allow the random angle error to feed back into the state estimate or into a bias estimate.

From the data he has seen and the additional simulations he had done Buteh is sure that the Grumman radar model was not the zero error sensor they had assumed. I would agree on this. He also didn't think it was necessary that MIT get the mark data from him and repeat his runs.

Pete Hoffman of Grumman is delving into the Grumman radar model and will get in touch with Butch who will also eontaet us and let us known the additional info he gets.

All the "short" rendezvous simulations done at the Cape, Houston and MIT use essentially the same error model (i.e., environment parameters to generate the mark data) and all simulations yield the same test results. So we are sure the programs work like they are supposed to. Grummans radar model is different from the above and, as mentioned above, is presently being looked at. Some additional simulations might be made at Grumman using the CFP sequence (CDH-TPI region) and W-matrix values of 10000, 10 to see if the problem existed at Grumman in their past rendezvous simulations (i.e., in the CFP profile).