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EG8/A. R. Turley
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PA/J. A. McDivitt
PA2/M. S. Henderson
PB/A. Hobokan
PC/W. H. Gray
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PD7/W. R. Morrison
PE/D. T. Lockard
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TJ/R. L. Nance
TH3/J. E. Dornbach
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FC/E. F. Kranz
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FM4/W. R. Wollenhaupt
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FM5/R. E. Ernull (5)
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FM5/R. D. Duncan
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FM6/R. W. Becker (3)
FM7/S. P. Mann
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FM7/R. O. Nobles
FM/Branch Chiefs (8)
YA/F. Borman
IBM/Houston/G. Carlow, D70
Boeing Data Management (4), HA-04
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NR/Downey/D. W. Patterson, AC50
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KSC/CFK/P. Baker
KSC/CFK/C. Floyd
KSC/CFK/M. Walters
KSC/CFK/F. Hughes
KSC/CFK/MIT/R. Gilbert
TRW/Redondo Beach/R. Braslau
TRW/Houston/W. J. Klenk
TRW/Houston/R. J. Boudreau
TRW/Houston/C. R. Skillern
TRW/Houston/M. Fox
TRW/Houston/K. L. Baker
TRW/Houston/F. A. Evans

UNITED STATES GOVERNMENT

Memorandum

NASA Manned Spacecraft Center

TO : See list attached

DATE: October 21, 1969
69-PA-T-130A

FROM : PA/Chief, Apollo Data Priority Coordination

SUBJECT: Let's hear it for "Delta Guidance"!

As part of the Apollo software team's contribution in the search for extra LM hover time and/or payload capability, they are vigorously working on the development of a new descent guidance and throttle control technique. The pay off could be impressive compared to things like trying to decrease LM weight. Specifically, a ΔV improvement on the nominal mission of as much as 100 fps might be realized, which is equivalent to 18 seconds of hover or 300 lbs. increase in descent payload. There are also some other substantial benefits to be gained from this new program formulation. It is the purpose of this memo to make sure you know about this business as well as to give you a report on its status.

Sometime ago a couple of Guidance and Control Division (GCD) people, Tom Moore, Jay Montgomery - and others I am sure - conceived the basic idea of what they called "Delta Guidance." The unique characteristic of this guidance scheme, as I understand it, is that given a dispersion it attempts to guide the spacecraft back to the nominal trajectory as opposed to looking for a new way of achieving the targeted end conditions like most guidance techniques do. It appears that this can be done without significant penalty in terms of payload or undesirable transient trajectory characteristics. Their work has been further developed by a group of MIT people, led by Allen Klump, which has resulted in a finished set of guidance equations in our hands at this time, which only await the thorough analysis and testing required for final tuning and to develop flight confidence. In addition, a complex targeting program has been developed for use in pinning down the various guidance coefficients and targeting parameters.
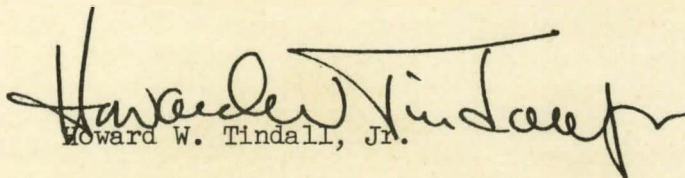
On October 16 MIT, GCD, and MPAD people got together to discuss and understand the program formulation and to layout plans for the analysis work ahead. The specific products we are aiming for are an off-line LUMINARY assembly which can be exercised in the various simulators within a month or so and an agree-to analysis plan which will yield all of the understanding and confidence required to permit addition of this program into the LM spacecraft computer for the Apollo 14 flight. Release of that program, I suppose, will not occur until March, which may seem like a long time from now. But it's clear that substantial changes to the descent guidance program - the program controlling the most critical phase of the mission - will certainly not be approved unless we have the absolute confidence of everyone involved

do that, some sort of DPS hardware change must be made. (According to Allen Klump it involves a precise shaping of some propellent valve pintle, whatever that means.) Engine requalification would no doubt be required for that too. Mr. Apollo Spacecraft Program Manager, if I still have your attention, I would like to urge you to exert whatever influence you can spare toward clearing the DPS for this kind of operation. The benefit to be gained is expected to be worth the cost and effort (converted to lbs./buck) particularly since our informal data sources indicate the DPS can hack it.

One other area requiring immediate attention, which I haven't mentioned so far, involves descent monitoring both onboard and on the ground. The LGC commanded thrust will be entirely different than now which means that some of the MCC displays and Flight Control Mission Rules will become obsolete and will require replacement. It may be desirable to change some of the onboard displays also. Nothing at all has been done so far in this area.

In summary, it appears our guidance people have conceived and are developing a technique for descent guidance which has real advantages over the existing system if it works as advertized. It is possible to get it ready and implemented by Apollo 14 provided we place high priority and continuous effort on it. In order to reap one of the greatest benefits, it is necessary that the DPS be qualified to operate in a new way and so that must be vigorously pursued. Why are you still sitting here reading this stupid thing when there is all that important work to be done?

Howard W. Tindall, Jr.

PA:HWT:js