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COMMONWEALTH OF AUSTRALIA

With the Compliments

of

The Assistant Controller

AMERICAN PROJECTS BRANCH

The Department of Supply

Copies to IG./GS/JS.

Congratulations. Your paper has come thru searching scrutiny with only minor criticisms. Ian GRANT to co-ordinate further action.

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
CANBERRA OFFICE

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January 28, 1971

Mr. Lew Wainwright,
Deputy Assistant Controller
American Projects Branch,
Department of Supply,
CANBERRA, A.C.T. 2600

Dear Lew:

I have read with considerable interest the paper, "Computers and Apollo" by Ian Grant, G.R. Seymour and J.H.K. Saxon. It is excellent and puts many things in proper context which I had only known piece-meal before. In my opinion, the paper would warrant further publication and would, no doubt, be interesting to Buzz Brockett's computer people at OTDA as well as to Ozzie Covington and Bill Wood, among others.

Some small editorial corrections would appear indicated, if further publication were to be made. Arch Morrison has already suggested the elimination of privately understood jargon and the translation of all acronyms. I agree whole-heartedly with his comment and recommend that an object always be fully named in English the first time it is used, followed immediately by the acronym in parenthesis, as in standard NASA practice. There are some minor typographical errors what would be corrected by an editor.

I believe there are several items that need correction, one rearrangement and change of emphasis that would clarify the subject matter, one diagram that would facilitate ready understanding, and some figure captions and legends that could be improved. I'll try to list these in proper sequence.

Part 1.1 a) The communications processing computers (Univac 418) had been removed from London long before I visited there in September 1970 and it is my understanding that Vern Stelter has since deactivated the London Switching Center.

b) This part introduces the first batch of untranslated acronyms.

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c) The high speed data transmission rate is given as "(40.8 Kb/s and 2.4 Kb/s)" whereas in Parts 4.2 and 4.3.2 the maximum rate is given as 50 kb/s and, from remote sites Part 3.3 gives the lower rate as 4.8 Kb/s. Perhaps 1.1 should read "(50 Kb/s for wide band links and 4.8 Kb/s total for 2 land line circuits)". This would be consistent with Figure 7.

d) I don't know how familiar the average computer minded person would be with the Apollo configuration but it would seem to me that the reader could understand this article better if he had an all-up diagram of a Saturn V at launch and/or drawings of the S-IVB, IV, CSM and LM configuration during TLI, or the docked CSM/LM configuration. Either of the first two configurations would enable the LVDC, CM Computers and LGC to be pointed out.

Part 2.1 Spacecraft Computers.

a) This is a misleading heading, since the part discusses the three computers located in both the launch vehicle and spacecraft. In NASA nomenclature, the all-up device at lift-off is called the space vehicle which comprises the launch vehicle and spacecraft. Also, while it mentions that there are three computers, this part does not mention the LGC.

b) I don't believe that the separate functions of the LFDC and CM computers are clearly enough delineated during the launch, earth orbits, or TLI.

c) The comment "these three spacecraft computers" in the last paragraph is made after only mentioning two computers.

Part 2.2 Lunar Module

a) The heading is misleading since this part discusses only the LGC and its inputs. Part 2.3 headed "LM Guidance Computer (LGC)" continues this same discussion. A rearrangement would help the article. (I will discuss this under part 2.5)

b) Para 1 calls the LGC "the heart of the guidance and navigation of the vehicle." This statement would only be true if "vehicle" was changed to read "lunar module when detached from the CSM." Otherwise, the initial statement is more true of the LVDC and the CM computer. Referenced figs. 1 and 2 relate only to the LM, not the rest of the space vehicle.

c) Para 2 says that the LGC interprets inputs from

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inertial guidance and star tracking. Unless I am mistaken, the LM has no star tracking telescope and in that case the LGC is not equipped to take star tracking inputs; this is a function of the CM computer.

d) In para 3 it mentions "star and landmark sights" in conjunction with the LGC, but here again, only the CM has a telescope which inputs such references to its own computer.

e) In para 5 the acronym "RCS" is explained as Reaction Controls when it should correctly be called "Reaction Control System". Since this part is dealing solely with the LGC, this paragraph should specifically limit the computer's control ability to the DPS, the APS and the LM/RCS since it does not control the SPS, the CM/RCS, or the SM/RCS, or would do for the latter two only in a reverse sense as demonstrated during the Apollo 13 emergency.

f) Also in para 5 I would write out "input/output the first time, even for a computer-minded reader. The discussion of DSKY applies equally well to the CM computer. LM also has a second type of DSKY called DEDA (Data Entry and Display Assembly), for putting in the ground voice updates. I believe this does not have a direct counterpart in the CM computer where navigational updates are entered directly into the computer from the sextant or telescope as well as through the DSKY.

Part 2.3 LM Guidance Computer (LGC)

a) Most of what is said about the LGC and the DSKY applies equally to the CM computer and its DSKY both of which are used possibly four or five times as much during a mission as the LGC and would seem to warrant prime place in any discussion of "Computers and Apollo".

Part 2.4 LM Abort System

a) Here again the prime discussion is devoted to the LM whereas the CM computer has several more abort modes to operate.

b) If this is truly a "second computer" in the LM, then there must be a similar second computer in the CM and the total numbers of space vehicle computers mention in Part 2.1 should be "five" instead of "three".

Part 2.5 Command Module.

a) The first paragraph would seem to relegate the

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Command Module computer mainly to controlling during earth re-entry, and accepting star and landmark inputs. This computer also has many other major roles not alluded to, such as

1) Operation of TCS during CSM/LM docking and LM retrieval;
2) CSM/LM attitude control including barbecue mode and ground photography mode;
3) SPS burns for up to seven mid-course corrections, LOI, DOI, active rendezvous with LM in an emergency, TEI, mission abort at many stages, and retrofire before re-entry;
4) orbit plane change at the moon, and
5) an interplay with the Instrument Unit (IU) during launch and TLI.

It would seem the CM computer warrants the lion's share of discussion so far as the several on-board computers are concerned.

b) In para 2, it would be well to talk about the Instrument Unit (IU) as a separate part of the space vehicle, since it is always so listed, rather than as the "SIVB instrumentation unit" which it will not be, until so used on SKYLAB.

c) Is SVDC meant to be "LVDC"?

d) If the authors should agree with what I said above they may agree with my though that the subject matter of Part 2 could better be organized as follows:

2.1 The Space vehicle and its Computers.
Mention the configuration of vehicle parts (with added figure, hopefully), show location of the several computers and explain in general terms their functions in a more chronological use, fashion, as LVDC, CM Computers, LM computers.

2.2 Launch Vehicle Computer
Talk about functions of LVDC in the IU and its interface with the ground and CM.

2.3 Command Module Computer(s)
Give this (or them) the full treatment it (they) deserve(s).

2.4 Lunar Module Computer(s)
Show how it (they) differ from CM equipment in

...5/

in sophistication, peripheral equipment and unique functions.

2.5 omit, or save this part for both the CM and LM abort control systems and delete these from 2.3 and 2.4. Reference the figures accordingly.

Parts 3,4,5 and 6 I consider to be very well written and very informative. I have only the following to say about them.

a) Part 4.3.2 In this part it is stated that the CCATS transmits 50 Kb/s to GSFC and thence to the ground stations and spacecraft. The intermediate step of slowing this stream to 2.4 Kb/s between GSFC and the ground stations and then speeding it up at the ground stations to 50 Kb/s for transmission to the spacecraft has been omitted. The reader might thus incorrectly infer that we may have one-way wide-band links between GSFC and the ground stations although probably Fig. 7 would correct this impression.

b) The conclusion, Part 6.1 might well have been extended to include the lunar landing and return. NASA's unique and utter dependence on real-time computers for every phase of an Apollo mission, is both unprecedented and more noteworthy than the authors suggest.

Figures.

a) The figures could profit from a little editorial work. I would think that each should have a title which would enable it to be understood for the most part without reference to the text. Acronyms and abbreviations like "PGNCS" in figure 1, "MSFN STN" in figure 4, and "GSFC-MCC Data Flow" in figure 7 might better be written out in full. The figure legends also introduce some acronyms not used in the text.

b) Figure 1 makes my comments above seem wrong since it clearly shows an Astronaut using a sextant in a system applicable solely to the LM. I think the figure is in error. The LM has an alignment telescope for rendezvous docking, and grid marks on the windows for ground approach guidance, but

I believe there is neither time nor occasion for the LM crew to use a sextant for star sighting.

c) In Figure 7, I think it would be proper to add IBM to the "360/75" legends and Univac to the "494" legends just as is done the first time they are mentioned in the text. At upper right "Priorities" is misspelled.

In conclusion, I wish to repeat that the paper is a good one as it stands. With a minimum of corrections, it would warrant further publication. My thesis and the major thrust of my remarks, is to suggest that a change in the emphasis in Part 2 would strengthen the paper.

Sincerely yours,

Williams

W.H. HUNTER
NASA Senior Scientific Representative
in Australia.

DEPARTMENT OF SUPPLY INTERNAL MEMORANDUM

TO : Mr. R.A. Leslie, Assistant Controller, American Projects Branch, CANBERRA. A.C.T.	REGISTRY USE ONLY
FROM : (Branch or Estab.) Tracking Station, HONEYSUCKLE CREEK. A.C.T. BCEER : EXT'N.	OUR FILE NO. 1/6/15 DATE January 7, 1971.

Your Reference :

Subject : "COMPUTERS AND APOLLO"

Please find the enclosed copy of a paper written by Messrs. G. Seymour, J. Saxon and myself. The paper was the basis of a recent lecture given to the Australian Computer Society in Melbourne and I understand it will be published by that Society.

2. I am sending this copy with the object of obtaining your opinion on whether you feel it would be worth publishing as a Department of Supply Technical Note.

I Grant

(I.F. GRANT),
Acting Station Director.

Enclosure.

Mr Wainwright I believe you had a option in mind for doing this sort of thing. (possibly as an APB technical note). The content is of interest and could be worth printing. The document may need editing to ensure that all acronyms have been explained and to eliminate the occasional piece of jargon.
Wilm 20/1.

Agree
AMM