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23S Memo 72-6

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FROM: R.A. Sheridan

DATE: 25 January 1972

SUBJECT: Impact of 'CCS Q' Simulator Error on Flight Programs.

REFERENCE: Simulator Error, DCG Memo #403, January 3, 1972.

A Simulator bug was discovered while testing the DIGFLY SELF-CHECK routines. Apollo flight programs contain only the erasable and fixed memory checks. The other self test routines were deleted from SUNDANCE and COLOSSUS Programs. DIGFLY contains the original self test routines which include instruction checks, special and central register checks, arithmetic multiply and divide checks, as well as erasable and fixed memory checks. SELF-CHECK was verified as to proper functioning on the AGC computer in the System Test Laboratory.

A digital simulation of DIGFLY SELF-CHECK was attempted to cross-check the results with an old simulation from the Honeywell 1800. ICOUNT, CLOCK and TRACE special requests were used to verify performance. An ABORT occurred in the 0-UFLOW subroutine. 0-UFLOW checks that all overflow and underflow bit combinations are generated by the adder and are written into and out of A, B, C and Q registers. The subroutine does a CCS Q which will set the overflow bit in A if Q contains overflow. The simulator error was that the overflow check switch was not turned on to indicate that overflow had occurred. A subsequent TS instruction would not skip an instruction, as required. The test loop was exited prematurely and the abort was generated based on ICOUNT results. SELF-CHECK also indicated a malfunction and generated an 1102 program alarm.

The impact of the simulator error on flight rope simulations was investigated. ROPECHK option of self test was utilized since it reads all fixed memory locations. A comparison stop was made with the CORONER when fixed memory contained 10002. The addresses were verified for a CCS Q instruction and the use of Q investigated. Table 1 lists the occurrences of the CCS Q for the latest rope assemblies.

DIGFLY 73 has one occurrence of CCS Q - the one that uncovered the bug. LUMINARY 210 has six uses of CCS Q - none of which can have overflow. ARTEMIS 72 and SKYLARK 48 have one use of CCS Q - which cannot have overflow. A CCS Q can also be obtained by an INDEX E followed by a CCS A or L. This instruction sequence was also striped out by ROPECHK. The Interpreter and RTB OP code sections are the only programs to use this instruction set. A CCS Q instruction would not occur for these cases.

It can be concluded that the digital simulations for ARTEMIS, LUMINARY and SKYLARK programs were not affected by the CCS Q simulator error. The simulator error fix of 1/3/72 was verified with DIGFLY 73.

Self Test simulation of DIGFLY was completed on the corrected version of the Instruction Interpreter. It can now be said that the Simulator can pass the AGC SELF-CHECK routines. The real world of digital simulation is again phase locked with the pseudomorphic world of the hardware.

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TABLE I

OCCURRENCE OF CCS Q IN FLIGHT ROPES

| ROPE | LOCATION | PAGE | SUBROUTINE | LOG SECTION | Q CONTAINS |
|--------------|----------|------|------------|----------------------------------|------------|
| DIGFLY 73 | 22, 3102 | 521 | OFLOOP | AGC BLOCK TWO SELF-CHECK | OVERFLOW |
| LUMINARY 210 | 05, 3434 | 833 | ABRTJASK | P70 - P71 | -0 or 2 |
| | 25, 3334 | 574 | RADIN | P20 - P25 | 0 or 1 |
| | 31, 2042 | 614 | N99LOOP | P20 - P25 | 5 0 |
| | 31, 3364 | 810 | UNWCLOOP | LUNAR LANDING GUIDANCE EQUATIONS | 4, 2, or 0 |
| | 35, 3473 | 681 | NTARGCHK | P34 - P35, P74 - P75 | 5 0 |
| | 42, 2045 | 294 | ATTCK2 | EXTENDED VERBS | 2 0 |
| ARTEMIS 72 | 15, 3060 | 1085 | OVRLINE | CM ENTRY DIGITAL AUTOPILOT | ADRES or 0 |
| SKYLARK 48 | 15, 3060 | 1086 | OVRLINE | CM ENTRY DIGITAL AUTOPILOT | ADRES or 0 |