PROBLEMS WITH IBM APPROACH AS IT IS DEFINED IN THE IBM APOLLO STUDY REPORT NO. 63-928-129

I. Mechanical Problems

1. Questionable whether the numbers of sub-assemblies stated in the IBM report can fit into the allocated volume. A layout of their computer at MIT indicates it probably will if there is room for the connector and cabling required in the junction box. A weight estimate that resulted from this layout is 88 lbs. with magnisium casting and 100 lbs. with aluminum. The weight estimate in the IBM report was 88 lbs. for 1.9 cubic feet which means it would float. This is very unlikely.

2. Mounting in the S/C seems very difficult. The junction box would have to go in first and mate with the PSA connectors. The computer would have to plug into the connectors on the junction box (several 244 pin Hughes connectors would have to mate all at once) and be secured to the top of the cavity. The PSA would have to be removed in order to mount. Finally the coolant lines would be attached at the front.

   Mounting the cold plate version was not considered in the study since a quick look indicated there isn't room in the vertical dimension to get this version into the S/C.

3. The integral cooling approach requires flexable coolant lines at the front of the racks with quick disconnect coolant lines. The coolant circulates through the Magnesium-Lithium billet which make up the basic structure. They didn't seem to realize there is a corrosion problem with water circulating in Magnesium. The structure will develop leaks and will contaminate the cooling system.

4. The memory must be loaded by ground test equipment before installation into the S/C. If there is any loss of data after installation the computer must be removed and returned to ground test equipment for reloading. Verification of the memory before launch would have to be done through PACE.

II. Reliability Problems

1. There is very little (10^7 operating hours on the uncased transistors) or no reliability history on many of the components and assembly techniques they use. Therefore, the failure rate data they quote and use in their computation seems very optimistic.

2. The probability of a memory loss induced by a transient is fairly high. With a loss of memory they have no way of restarting in flight. Note I-4.

3. There is a problem during prelaunch countdown in detecting failures in the redundant element and repairing these or flying with the failure. Again to repair, the computer must be removed requiring the PSA to be removed and the cooling system to be broken. The IBM report quotes a 650 hour MTBF which means there will be a high probability of a failure during prelaunch countdown.

4. The ULD connector looks very marginal in design. The female side uses a single sided spring contact. Our experience with this type of connector has indicated extreme difficulty in vibration environment.

III. Thermal Problems

1. The thermal design is marginal in the vacuum environment. They used lower inlet temperatures for the coolant than probably should be assumed under the restriction that they were to be put at the end of the cooling system.

2. The cold plate version was not studied in detail since mechanically it looks impossible, however the junction temperatures quoted in the report is 109°C with cold plate temperatures of 90°F. The ICD limit is 105°F.

IV. Input - Output Problems

1. It is not clear from the report whether all interface requirements have been included.

2. It is not clear how the Central Processor reads into the discrete outputs. There must be a serial to parallel conversion before the Data Adapter sets the discrete output latches at the display interface. The display will not work otherwise.

3. The IBM report admits the servicing of the interfaces will require more computer time than the MIT Computer. It is hard to estimate how bad this is without writing some programs for the machine. MIT estimates the IBM computer to be 5 times slower in C/M and still slower in the LEM system.

V. Programming Problems (Should be covered more by R. Battin)

1. IBM word length too short, therefore they must do double precision operations. The present design is not capable of doing double precision except with extreme difficulty. They can add more hardware and help the situation but more memory will also be required in order to solve the equation fast enough, say at re-entry.

2. The machine instruction codes are not designed to solve the type of guidance equation we have in Apollo. They are well suited for the path adaptive equation of Saturn guidance. To solve Apollo equation will require more memory than we require.

3. The machine instruction codes although more in number are less powerful. Again to perform equivalent operation will require more memory.

In summary: What they presented is probably to big as it is. It is very likely they will need more memory than already estimated. They will probably have to change their design (machine instruction codes) in order to be able to do the job at all. It is very likely the weight, volume, and power that they have quoted is lower than required for the machine that they proposed in the report.

Eldon Hall
10/8/63