For Official Use Only

REPORT OF THE ASAP AD HOC GROUP ON THE CHEYENNE COMPUTER

Burton P. Brown

Vincent S. Haneman, Jr.

Gilbert W. King

Lawrence H. O'Neill

For Official Use Only

Remove FOR OFFICIAL USE ONLY Markings on 31 Jan 70 (date or event))

For Official Use Only

Report of the ASAP Ad Hoc Group on the Cheyenne Computer

1. Introduction

The ad hoc group was formed at the request of the Assistant Secretary of the Army (R & D) to inquire into the technical problems and associated management problems arising in connection with the multi-purpose computer intended for navigation and fire control aboard the Cheyenne helicopter. The Cheyenne is intended to serve as an advanced aerial fire support system. Lockheed-California is the system contractor and the manufacturer of the aircraft. Teledyne is the manufacturer of the computer, under a direct contract with the Army. The computer is furnished as GFM by the Army to Lockheed.

The situation that led to the formation of the ad hoc group was the discovery that the reliability of the computer was unacceptably low when the ambient air temperature was high, but below the required upper limit of 55°C. The group was requested to:

1. Review a number of studies pertaining to various aspects of the computer.

2. Evaluate the capability of the Teledyne computer to perform the functions required of it in the Cheyenne system.

3. Recommend a course of action designed to provide highest assurance that the Cheyenne system will have an adequate computer on a schedule suited to that of the overall program.

For Official Use Only

For Official Use Only

In carrying out its assignment, the group worked for two days at Lockheed and at an Army office in Van Nuys, California. It devoted an additional day in the Pentagon to an executive session to formulate its own conclusions and recommendations and to write this report.

During its sessions in Van Nuys, the group inspected the system integration facility at Lockheed and briefly met with Lockheed engineers there employed. It was also briefed as follows:

1. By the Cheyenne project manager on the System as a whole.

2. By Stanford Research Institute on early results of a failure analysis of computer components.

3. By USAECOM on Teledyne's capability of producing computers on a schedule matched to the needs of the Cheyenne program.

4. By Lockheed on a study of the suitability of the IBM manufactured AN/AYK-6 Computer as a replacement for the Teledyne computer.

5. By USAECOM in a critique of the Lockheed study mentioned in (4) above.

On the basis of the investigation described above, the group reached the conclusions and formulated the recommendations presented in the next two sections.

For Official Use Only

For Official Use Only

II. Conclusions

1. In a basic functional sense, the Teledyne computer and associated input and output devices will process data as required in the Cheyenne system.

2. The problem of computer unreliability, although serious, is certainly correctable through the application of reasonable methods of failure analysis, corrective engineering, and quality control.

3. The Teledyne computer need not be the pacing item of the Cheyenne program. A sufficient number of reliable computers to support the Cheyenne development and test programs can be supplied by Teledyne through resort to special selection of components and computer sub-systems.

4. Teledyne can reasonably be expected to correct the problem of unreliability before the need for substantial computer production to match aircraft production is encountered. This expectation is based upon the belief that Teledyne, reacting to the Army's acceptance of recommendations herein presented and other appropriate Army action, will substantially improve its engineering and manufacturing performance over that thus far exhibited in the Cheyenne computer program.

5. No existing computer can fully replace the Teledyne computer in Cheyenne. The AN/AYK-6 suggested by Lockheed requires new development of an "interface adaptor unit" with attendant uncertainties

For Official Use Only

For Official Use Only

in technology and schedule. The basic suitability of the AN/AYK-6 itself has not been demonstrated conclusively. The analysis of the adequacy of the size of the memory unit to carry out the basic and ultimate computer functions was not precise. The simulation of AYK-6 program execution did not cover all necessary computations, nor was it done at an adequate level of detail.

6. It is possible, although not certain, that some incidents of apparent computer unreliability have resulted from the inexperience and unfamiliarity of Lockheed engineers with this type of equipment. This impression was received by members of the panel in conversations with Lockheed personnel at their Van Nuys plant during the tour of the Integration Laboratory, where programing and software problems were discussed on October 15, 1968; from the history of the TM/RM unit problem, in which failures were due to Lockheed and Lockheed subcontractor misuse; -- from the apparent small staff of fully qualified computer experts applying themselves to the tasks involved in the interface programing and software; -- and from the fact that at the time of the briefing no "in flight" failures of the equipment had occurred. While this last item can have other interpretations, it was felt to be a valid additional implication, in light of the foregoing items and the fact that failures have occurred on the bench during testing by Lockheed. If this is indeed the case, it should be corrected by the assignment of qualified experts to the Lockheed effort.

For Official Use Only

For Official Use Only

7. Teledyne has not demonstrated the careful foresight and meticulous care in seeking out potential problems that would have been appropriate in a project of the importance of Cheyenne to the Army and Teledyne. *

---

* The investigation conducted by Stanford Research Institute provides an example of the basis for this judgment. SRI's work seems to show that failures of the computer result from low signal strengths due to combinations of components with poor characteristics. Although good engineering judgment would have suggested this as a cause of failures, Teledyne has apparently failed thus far to pursue the matter.

The microelectronic assemblies (MEMAS) used in the computer include components whose characteristics (e.g., output vs. input current) are highly variable from one component to another presumably "identical" component. Moreover, the effects of temperature upon these characteristics differ from one component to another. There may therefore occur combinations of components in a MEMA that perform suitably at one temperature but fail to perform at a higher temperature.

Teledyne has apparently been responding to this situation solely by selecting MEMAS that meet requirements (specifications) at high temperature. No effort apparently is being made to diagnose physically the causes of component variability and to take corrective steps in manufacture to reduce component variability.

In a purely formal sense selection of workable assemblies from large populations is a proper way to meet specified requirements. But in the judgment of the group this procedure gives poor testimony of Teledyne's present determination to identify its problems and put forward really effective solutions for them.

For Official Use Only

III. Recommendations

1. The Army should continue to place primary reliance upon Teledyne to supply the computer needed in Cheyenne.

2. A senior civilian or military officer of the Department of the Army should directly and simultaneously present to the chief executive officers of Lockheed and Teledyne the Army's concern with the computer reliability problem and the Army's expectation that both companies will devote themselves energetically, practically, and co-operatively to overcoming that problem.

3. A cadre of highly qualified computer application and computer manufacturing engineers should be assigned by USAECOM to residence at Lockheed and Teledyne to assist the project manager. At least one engineer should be assigned to observe and advise Lockheed in its handling of the computer. At least one other should observe and advise Teledyne in its manufacturing of the computer. At least one other should assist as needed at either company and promote effective liaison between the two. It is the group's view that 3 USAECOM engineers is probably an insufficient number and that a need for additional Army engineers will be perceived.

4. USAECOM and other Army engineers and scientists assigned to the roles described in recommendation (3) above should be responsible to and report to the Cheyenne project manager. The project manager

For Official Use Only

should have an influential role in the selection of personnel to be assigned to residence at Lockheed and Teledyne in order to assure as well as possible their suitability for the work to be done.

5. Since high temperatures can always be expected to be detrimental to the performance of computers, Lockheed should be directed to study and report upon means whereby the temperature of the computer can be held to lower levels. A set of tradeoffs should be presented, giving weight, power and other requirements as a function of temperature decreases. Means of protecting the computer from excessive temperatures in parked aircraft, with no power supplied, should be proposed.

6. Teledyne should be directed to proceed at once with a comprehensive program of failure analysis, corrective engineering, and quality control for the purpose of establishing the capability to produce satisfactory Cheyenne computers in quantity at the earliest possible time .*

7. Teledyne should be directed to describe and proceed with an interim program of special selection of components and sub-systems to assure the availability of an adequate number of computers and spares to support the Cheyenne development and test phases.

---

* The group has been informed that the project manager has already taken this step. It recommends that the project manager direct Teledyne as a part of the recommended program, to seek to find the physical causes of failures and to reflect such findings in improved manufacturing methods, as far as is practical.

For Official Use Only

8. An effort to assess the qualifications of the computer engineers assigned by Lockheed to the Cheyenne program should be made by USAECOM or another qualified Army organization. Lockheed should be requested to assign personnel to correct any inadequacies found in this assessment.

9. In consultation with the project manager, Teledyne and Lockheed should develop a program of stocking computer spares to reduce to a minimum the time lost in the Cheyenne program as a result of computer failures.

IV. General Comments

It is clear that one form of response to the discovery of the Cheyenne computer reliability problem is to initiate a "back-up" computer program. The group gave consideration to the desirability of such a course of action in its deliberations.

While a back up program would be desirable in itself, and might be achievable as an "insurance" technique without risking unacceptably large sums of money, the group concludes that such a program, directly tied to the Cheyenne program is undesirable. The prospect that such a back up computer might replace the Teledyne computer would, presumably, place great pressure on Teledyne to cure

the ills of its product. But at the same time such a prospect would tend to increase Lockheed's incentive to attribute delays and difficulties in the Cheyenne program to the Teledyne computer. The possibility that a change of computer might be authorized would also be a possibility that a sizeable block of time (and possibly money) much needed for other problems might be found.

None of this should be taken as impugning the standards of the contractors. Technical problems in a complex system are seldom capable of full isolation from one another. A contractor working under heavy pressure of schedules and technical requirements has a natural, entirely sincere, tendency to attribute the most severe problems to any part of a system for which he was not directly responsible. In the judgment of the group, the strongest possible incentives should be maintained to cause Lockheed and Teledyne to work out their problems cooperatively.

If means exist to provide a back-up computer without causing this blurring of incentives, pursuing a back-up may be desirable. However, the group is not able to suggest how this might be done.

Overall, the Cheyenne computer program does not appear to be beset with problems of such severity as to suggest the need for substantial redirection.