ABSTRACT

The overall architecture of CEPS combines expert technology, conventional programming, and a large database to provide a maintenance diagnostics system for the B-1B aircraft. The CEPS concept builds on currently available resources and integrates them into a diagnostic tool which will aid the flight line technician in B-1B maintenance performance. This paper presents a brief background of CEPS and describes the major components of the system.

BACKGROUND

One of the key elements of the B-1B maintenance activities is the on-board Central Integrated Test System (CITS). CITS performs extensive monitoring of the aircraft systems and subsystems and records as many as 19,000 parameter values at various times during flight. Values such as airspeed, altitude, switch positions, hydraulic pressures, voltage and discrete performance indicators are recorded automatically at 30 minute intervals, anytime CITS detects a system fault, or when manually triggered by the flight crew.

In the CEPS program, the new technology of knowledge-based systems will be integrated with the existing capabilities of the B-1B aircraft and will serve as a replacement for the current CITS Ground Processor (CGP). The objective of CEPS is to shorten aircraft maintenance time by reducing the can-not-duplicates (CNDs) and retest okay (RTOK) rates, decreasing the amount of time required to troubleshoot and isolate malfunctions, and increasing the efficiency of the maintenance activity.

The CEPS system integrates currently available resources (such as CITS recorded data, technical maintenance documents, and maintenance procedures) into a diagnostic tool which will provide the technician with maintenance advice.

CEPS DESCRIPTION

CEPS will be programmed in "C" and hosted on the DEC MicroVax III computer. The knowledge-base will be developed using the Copernicus expert system shell.

The analysis of the CITS in-flight recorded data identifies the various shop replaceable units (SRUs) and the specific line replaceable unit (LRU) related to the functional failure. This analysis also considers the functional involvement of previously unrelated items such as aircraft wiring and connections.

The diagnostics system's power will come primarily from the knowledge-based expert system. The knowledge-based system will be built using the maintenance expertise of B-1B technicians and technical documents. The information obtained from the in-flight CITS recorded data and flight crew observations are interpreted by the inference engine to determine possible malfunction causes. By applying certainty factors about the inputs' effect on the relative strength of a diagnostics conclusion, the expert system can provide different levels of confidence regarding the malfunction cause.

Another component of the CEPS diagnostics is a series of aids for the maintenance technicians. This includes various routines which will provide trending analysis, tracking of apparent malfunctions which prove non-duplicable on the ground, and identification of false alarm reports from CITS. To provide further maintenance assistance, the system also contains on-line diagnostic information and references to printed technical documentation and specific enhancements to these materials.
CEPS PROGRAM IMPLEMENTATION

The CEPS development program consists of three major phases, of which two are complete. In Phase I the preliminary design for the CEPS system was conducted. Phase I provided a feasibility demonstration of selected CEPS capabilities and verified that the expectations of this maintenance concept were feasible. The main focus of the Phase I effort was to examine increased capabilities of on-board fault detection to include: not-duplicate, retest okay, and false alarm events. In addition, this Phase investigated system engineering and maintenance diagnostics capabilities. Products from Phase I include a detailed parameter analysis, logistics studies, management information system requirements, risk analysis, a development requirements review, a CEPS feasibility demonstration, and a detailed implementation plan for Phase II.

Phase II was the prototype demonstration of the CEPS system. This Phase consisted of the detailed design and testing of the prototyped system. It included a qualitative evaluation of the prototype system by maintenance technicians at Dyess Air Force Base, Texas, and a quantitative evaluation by the contractor and B-1B SPO engineers. Products from the Phase II effort included life cycle cost studies, management information system and logistics studies, risk analysis, prototype development and product specifications, and a preliminary Phase III system specification.

Full-scale development, production and implementation of the CEPS program were started under the Phase III effort. By combining various aspects of conventional programming with elements of artificial intelligence, the CEPS system will provide an integrated source of maintenance history and diagnostic activities. Due to funding limitations, the third phase will be implemented in two portions (Phase IIIA and Phase IIIB).

A detailed analysis and assimilation of the design, maintenance, and failure data will be conducted in Phase III. This information will be obtained through maintenance technician interviews, failure data, schematic diagrams, signal flow diagrams, and test requirement documents. The maintenance data acquired will then be represented in rules. In addition, to this effort, the data analysis routines which make up the CEPS diagnostics tools will be developed.

Phase IIIB was placed on contract Fiscal Year 1988 and is estimated to be completed in Fiscal Year 1991. Boeing Military Aircraft (BMA) is the lead contractor for the CEPS Phase IIIB development effort and will provide the maintenance advisory system. The other contractor, Rockwell International (RI) will develop the interface system between the aircraft’s CITS and the ground based CEPS.

Phase IIIB provides a minimum full-scale development and initial operation capability. CEPS will be implemented at the four B-1B SAC Main Operating Bases (MOBs): Dyess, Ellsworth, Grand Forks and McConnell. In addition, a system will be installed at OC-ALC to provide the Air Force with organic software maintenance capabilities.

Currently, the follow-on effort to phase IIIB is planned for the FY92-93 time frame. Phase IIIB will implement the diagnostics routines for the B-1B aircraft systems not covered by the previous Phase. In addition, system deficiencies, additional user requirements, and an independent study of the implemented CEPS Phase IIIB system will provide the foundation of the Phase IIIB specification.

Developing the CEPS in three phases has served to demonstrate the feasibility and capabilities of a B-1B diagnostic knowledge-based system. The prototype developed in Phase II further verified an improvement in maintenance effectiveness would be realized with the implementation of CEPS. Based on the results of the first two phases, full-scale development was recently started.