CONF-9003157--2

PNL-SA--18027

DE90 010990

# ARTIFICIAL INTELLIGENCE/EXPERT SYSTEMS WITHIN THE U. S. ARMY DEPOT SYSTEM COMMAND

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March 1990

Presented at the
Artificial Intelligence Applications
for Military Logistics
Williamsburg, Virginia
March 27-30, 1990

Work supported by
the U. S. Department of Energy
under Contract DE-AC06-76RLO 1830

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# Artificial Intelligence/Expert Systems within the U.S. Army Depot System Command

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The Depot System Command (DESCOM) is the industrial arm of the U.S. Army. It employs over 37,000 individuals (97% civilian), has an operating budget of over $2 billion, and holds over $33 billion of material in storage. As a result, DESCOM is a prime candidate for extensive use of traditional industrially oriented expert systems (ES).

DESCOM supports three primary mission areas: maintenance, supply, and ammunition. In addition, DESCOM performs a number of other support activities. Each of these mission areas has unique requirements and potential for ES applications.

In 1987, DESCOM entered into a modernization effort called READY 2000. The driving force behind this modernization was a desire to reduce DESCOM's logistics operations and a need to modernize facilities and operations. A number of technologies were identified that would greatly benefit the future development of the organization.

Artificial intelligence (AI) was identified as a desirable technology, and a specific AI component of the READY 2000 program was established. The purpose of this AI component was to rapidly infuse AI technology into DESCOM's organization. The objectives of this effort included integrating AI technology into the performance of current organizational responsibilities, establishing internal capabilities in this technical area, and rapidly demonstrating the immediate utility of the technology.

To accomplish these objectives, DESCOM has initiated a number of activities. First, an AI Program Management Plan was developed. This plan outlines the responsibilities, goals, and objectives of the ES initiative and describes resources available to DESCOM staff for meeting these responsibilities. DESCOM has initiated extensive staff training. Each depot, as well as DESCOM headquarters, is encouraged to train existing staff in AI techniques. To compensate for the ever-present learning curve, DESCOM retained the services of the Department of Energy's Pacific Northwest Laboratory (PNL). PNL is providing interim ES capabilities such as assisting in developing proposals, evaluating candidate applications, and selecting software/hardware resource options.

DESCOM has also established an internal steering committee and working group. The steering committee directs and approves the short-term allocation of DESCOM resources, while the

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[a] Pacific Northwest Laboratory is operated for the U.S. Department of Energy by Battelle Memorial Institute under Contract DE-AC06-76RLO 1830.

working group develops internal ES capabilities and near-term ES technical development. Both of these groups have been involved in the initial rounds of identifying and evaluating candidate applications. Furthermore, the working group has conducted workshops in the area of speech recognition and has been extensively involved in transferring related ES applications from other Department of Defense (DOD) organizations to DESCOM.

A final step in the initial establishment of AI technology in DESCOM was the creation of a validation/verification process. While this process will undoubtedly undergo a number of refinements in the future, it has been initially created to accommodate the anticipated rapid influx of transferred DOD applications.

Currently, the DESCOM ES program is well under way and existing AI applications are being converted over to DESCOM use. Furthermore, the working group, steering committee, and individual depot points of contact have begun identifying and promoting specific application development opportunities. At present, DESCOM has three operational AI systems:

- Expert System Evaluator - This system was developed by DESCOM's AI Core Group. The ES evaluator helps command personnel assess potential applications of ES technology. It is also useful as a training device for introductory AI concepts. The basic approach of this system is to focus on the fundamental elements of the ES technology and fully explain the reasoning behind various decision points. Knowledge engineers/programmers are still required for development if the ES evaluator recommends a particular application. This system is currently operational at all 13 U.S. Army depots.

- Speech Recognition Weapon Tracker - This AI application was developed by the U.S. Navy and adopted by Anniston Army Depot. Anniston has been using speech recognition to verify the serial numbers of small arms weapons for 4 years. As a result, the annual work-year requirement of this function has been reduced from 11 to 3. In addition, 100% weapons accountability is ensured during the maintenance process. This application is ideally suited for the speech recognition technology because of the "hands-busy, eyes-busy" nature of the task. This system was written in FORTRAN 77 on a General Dynamics microcomputer and uses a VOTAN voice terminal to interface with the computer.

- Hughes Artificial Intelligence Diagnostic System (HAIDEX). This system performs maintenance diagnostics on the FIREFINDER system. The HAIDEX is in operation at the Sacramento Army Depot where the FIREFINDER system undergoes depot maintenance. The system runs on a Symbolics LISP machine. HAIDEX was developed by Hughes Aircraft through funds provided by the Program Manager for Test Measurement and Diagnostics Equipment. This system can detect memory faults in the FIREFINDER System in 1 hour, a drastic reduction of the 36 to 90 hours previously required; detection of input/output control faults, which previously required from 4 to 14 days has been reduced to 2 hours.

In addition, three other systems are nearing completion:

- Justification and Authorization (J&A) Advisor - This system is being developed for use by DESCOM personnel at all Army depots. It assists in preparing more complete, accurate and properly documented J&A documents and Authorization documents for other than full and open competition. This application is being reprogrammed in-house from a similar program provided by the U.S. Air Force Logistics Command. Potential use of this ES throughout the Army Material Command is being pursued by the U.S. Army, System Integration and Management Activity (SIMA) in St. Louis.

- Help Desk Expert System - This system is being written as a rule-based system in M.1 by Anniston Army Depot. It will provide a tool for the depot Directorate of Information Management Problem Control Centers to produce solutions for ADP system users who are experiencing hardware/software problems.

- EEO Advisor - This system will walk operating officials or EEO counselors through details of potential EEO complaints. It screens data to assist in deciding whether laws have been violated or whether complaints are frivolous and need little or no corrective action. It also provides rights notices to both management officials and complainants.

Several other applications are currently in the development phase:

- Intelligent Fault Locator - This is a maintenance diagnostic system for the AH-64 Apache helicopter. The system has been developed to this point by McDonnell Douglas Helicopter Co. and has been funded by the U.S. Army Aviation Systems Command. The system may be placed into use at Corpus Christi Army Depot in Fiscal Year 1991.

- CH-47D Flight Control Advisor - The system performs diagnostics for flight control on the CH-47D helicopter. This system is being developed by Boeing Vertol and is also funded through the Aviation Systems Command. This is being written in C using the shell S-1 and runs on an IBM-compatible PC.

- FERRET -TOW (AH-1S) - This system will perform diagnostics for the TOW missile system on an AH-1S Cobra helicopter. The system is being developed by Hughes Aircraft Co. The project is being funded by the U.S. Army Aviation Command and will be potentially used at Corpus Christi Army Depot. The system is currently written in Inter-Lisp-D and runs on a Xerox 1109 LISP machine.

- Cost Estimating Expert System - This system is intended to aid engineers in developing cost estimates for the fabrication of communication-electronics shelters. The system will produce a bill of materials along with material and labor costs. It is being developed by East Stroudsburg University for the Tobyhanna Army Depot. It is being programmed in RuleMaster and is funded under the Ben Franklin Partnership program in Pennsylvania.

- Robotic Repair of Printed Circuit Boards - This system is being developed to automate the process of repairing printed circuit boards. The capability to remove and replace components has been demonstrated. The system uses AI technology to assist in planning the removal replacement process and may include heuristics to assist in deciding which component is the target of the removal process.

- Automated Statistical Process Control (SPC) - This system is conceived as a generic system to monitor data collected from some arbitrary industrial process and to identify impending or emerging quality-related problems. It is being based on the current manual methods of SPC and is intended to be highly transportable from process to process. The system is being developed by Pacific Northwest Laboratory and will use a combination of AI technologies, including neural networks, rule-based reasoning, and binary trees. The effort is funded under the READY 2000 program.

- Mission Essential Function Model (MEFM) - This system is being built as an object-oriented model of the DESCOM organization. The system's intended uses include depot configuration planning and management and resource planning; it will also serve as an organizational reference. The system is being developed by Pacific Northwest Laboratory in Goldworks II.

The effort is funded under the READY 2000 program.

Near term conceptual future projects include

- a storage planning advisor

- an inventory adjustment advisor

- a speech recognition project to prepare ammunition surveillance records

- an ammunition distribution decision support system

- an Abrams Tank electronics maintenance diagnostics analyzer.

In addition to these applications, DESCOM has nearly 100 other potential applications documented that range from a pay-setting advisor to a computer-aided sign language interpreter for the profoundly deaf.

As a result of these steps forward, DESCOM is wrestling with the issues of standardization, delivery versus development environments, and specific technology development tradeoffs. DESCOM intends to promote the development of specific new ES technology in areas that will be of significant use to DESCOM. Furthermore, the use of this technology will continue to be promoted throughout the depot system.