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# ARTIFICIAL INTELLIGENCE ISSUES RELATED TO AUTOMATED COMPUTING OPERATIONS


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# ARTIFICIAL INTELLIGENCE ISSUES RELATED TO AUTOMATED DATA PROCESSING OPERATIONS

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## ABSTRACT

Large data processing installations represent target systems for effective applications of artificial intelligence (AI) constructs. The system organization of a large data processing facility at the NASA Marshall Space Flight Center is presented. This paper describes the methodology and the issues which are related to AI application to automated operations within a large-scale computing facility. Problems to be addressed and initial goals are outlined.

## ACKNOWLEDGEMENTS

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## OBJECTIVES

The objectives of the research reported herein are to investigate the notion of applying artificial intelligence (AI) techniques for the automated operation of a very large computer system; to focus on the conceptual aspects of this automated system; and to report on the more important issues surrounding such an effort.

The objectives of the research were achieved by first observing the nature of the computing system involved, reviewing the more important references which set the stage for eventual applications of AI, reviewing the more relevant applications articles, and reporting on the topics which are germane to the study.

## INTRODUCTION

It has recently become very obvious that Artificial Intelligence (AI) techniques can be useful in a broad spectrum of programming domains. AI research was once regarded as somewhat "borderline". There was serious doubt concerning the usefulness of AI techniques for the solution of real production problems. Many areas of Computer Science currently exploit AI concepts: areas such as database management, computer-aided instruction, and human-machine interaction. These are certainly areas which are of great importance to computer operations conducted by NASA at MSFC. Further research and development would invite applications of existing AI algorithms as well as extensions which promote the maximum level of automation for the computing/data processing function.

A consideration of operational aspects of the data processing function and their automation would require the modeling of expertise and the construction of programs called expert systems. The core elements of the AI discipline which would be exploited in arriving at an expert system goal are: knowledge representation, knowledge utilization, and knowledge acquisition.

## THE EXISTING ENVIRONMENT

The Engineering Analysis and Data System (EADS) provides Cray computer users at Marshall Space Flight Center with a front-end processor to the super computer mainframe. Jobs submitted to the Cray are submitted through EADS. Figure 1 shows the system configuration for EADS.

An inspection of Figure 1 reveals the computer communication links between principle elements of the system and the control consoles which are used to monitor and control major elements in the system. These include:

Front-End Processor (FEP-1);
Front-End Processor (FEP-2);
Support Processor (SP-1);
Support Processor (SP-2);
Cray X-MP/4 Processor; and
Bus Service Center

These are pointed out to gain some perspective on the magnitude of the automation problem, as it regards an artificial intelligence application.

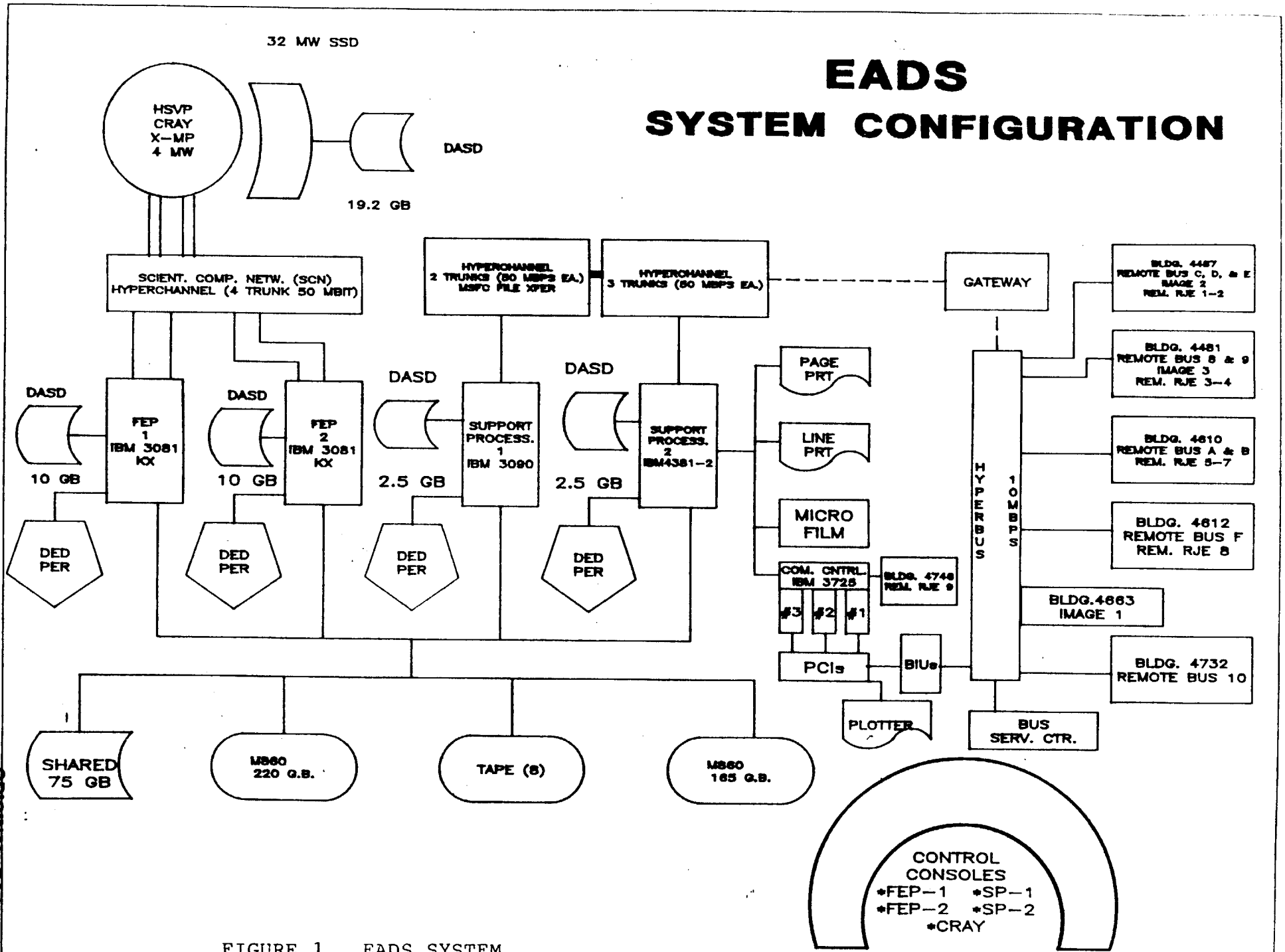


FIGURE 1. EADS SYSTEM

## BACKGROUND

There is currently a tremendous optimism concerning artificial intelligence, expert systems, and knowledge-based programming and the potential applications of these technologies. There is very little agreement, however, regarding when AI systems should be applied, how AI systems should be developed, and the fundamental limitations of AI system capabilities.

Artificial Intelligence uses computing machines to process facts by using complex reasoning based on rules in order to produce "intelligent conclusions." It is generally agreed upon by experts in the field of AI that the discipline does not allow its practitioners to capture common sense abilities or the sense to distinguish relevant from irrelevant information.

An Expert System can be defined as a system that draws conclusions from facts, beliefs, and rules, some of which are heuristic, using complex reasoning based on inference rules. This definition of an expert system and the definition of Artificial Intelligence from the preceding paragraph should be contrasted with a definition of intuition. That is, S. Dreyfus in [18] defines intuition as the ability, effortlessly and rapidly, to associate with one's own present situation an action or decision which experience has shown to be appropriate.

Intuition is what people have and complex reasoning systems do not have and, probably, will never have. The development of any AI or Expert System should be mindful of the limitations of these definitions.

## FUNDAMENTAL STRATEGIES

There are two important aspects to any AI program or algorithm:

1. A knowledge-representation framework

2. Problem-solving and inference methods.

Once an AI application is identified, these two aspects interact closely with each other. The choice of the knowledge-representation framework determines the kind of problem-solving strategies which are appropriate.

Computer systems at MSFC represent two areas where AI applications exist:

1. Equipment

    a. Design
    b. Diagnosis
    c. Instruction
    d. Maintenance
    e. Configuration
    f. Monitoring
    g. Sales

2. Data Processing

    a. Instructions
    b. Natural-language Interface
    c. Intelligent Data Access
    d. Intelligent Data Analysis
    e. Planning and Scheduling

Each of these categories presents an array of possibilities where AI solutions could be investigated. AI systems should be developed which provide their economic leverage by performing the types of tasks that occupy a high percentage of highly-paid people's time, rather than "far-out" or science-fiction notions.

The selection of an AI application area and the evolution toward automated computing systems should be done with considerable forethought. It is also important to think differently from the classical programming approach. That

is, the usual software engineering cycle -- define problem, specify requirements, design software, code program, test program, and deliver software system -- is no longer appropriate. Instead, incremental development of the expert system is possible where program structures and mechanisms that contain knowledge, infer information, and control program inferences are independent and separate. Figure 2 below shows the component parts of an "exploratory" programming system.

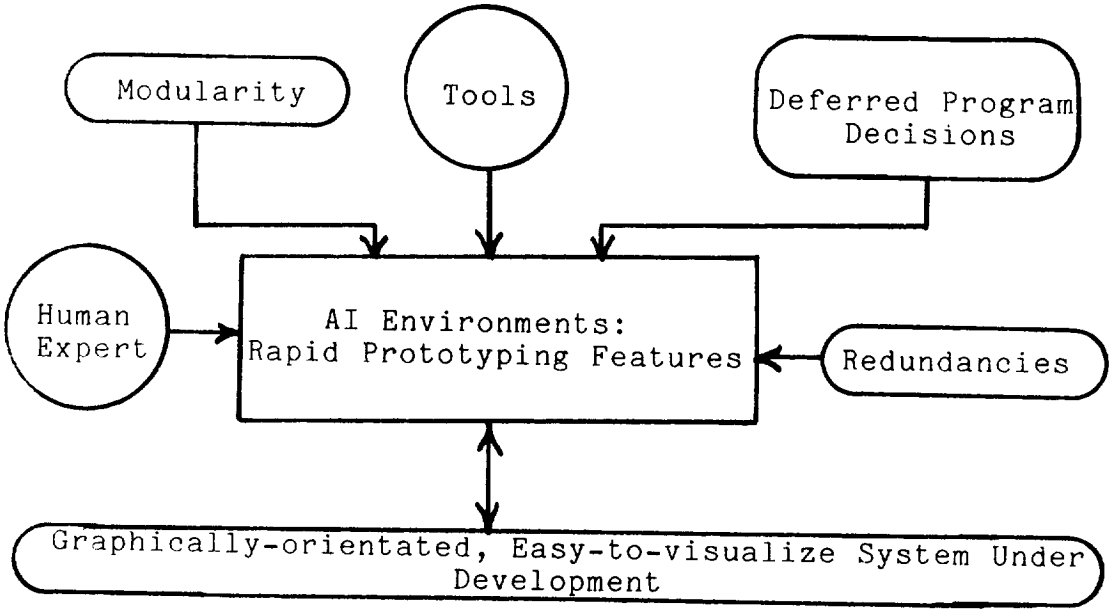


Figure 2. Exploratory Programming Features

## EXPERT SYSTEM BUILDING CYCLE

There are four major steps to follow in building a knowledge system using standard AI tools. [8] The itemized list shown below provides an outline of the usual methodology:

1. ANALYZE THE PROBLEM;

## SOME POINTS OF CAUTION

Most of this brief report deals optimistically with the current state of AI technology and the possibility of AI applications in the MSFC computing and data processing environment. A number of issues surrounding such an endeavor give rise to some degree of caution and are listed here.

- One of the most critical problems with today's means for building expert systems is that virtually each new system must be custom crafted.
- Significant changes will likely arise in expert systems as AI research uncovers newer aspects of areas such as parallel processing, non-Von-Neumann machines, connectionism, neural networks, and so on.
- As the amount of knowledge in an expert system grows larger and more comprehensive, the problem of control of reasoning becomes ever-greater.
- The central problem in AI research is "common-sense reasoning", and is not about to be solved.
- An expert system project fails unless experts cooperate. There is not other source of expertise, and without knowledge the program will not work.

## CONCLUSIONS AND RECOMMENDATIONS

A computer program which has the ability of making intelligent decisions in the world must have a general representation of "world", which it is able to use in interpreting inputs. The development of such a program requires that knowledge be defined and its acquisition be accomplished. [19] In general, a computer program is needed which decides what to do by inference using a formal language. The outcome being that a certain strategy will achieve its assigned goal. The notion of an intelligent machine being devised which is programmed to make intelligent decisions regarding its own operation is reasonable. The idea presents an interesting and recursive relation; however, the solution methodology should be no different than any other AI application.

AI is solving more and more real-world problems, but application to government systems and administration has been minimal. [2] The effective development of AI software for automated computer operations presents some difficult problems. These include:

(i) the machine-compatible knowledge must be synthesized which reflects expertise about a large number of facts, rules, or decision factors;

(ii) software must account for the probability of outcomes as opposed to procedural certainty, based on changing conditions;

(iii) heuristic solutions must emerge based on expert experience and knowledge gained over long periods of time in an often unstructured manner.

Not only does AI Technology have the potential to enhance the automation process, but is is quite reasonable to expect that traditional automation applications could be easier and less costly using an expert system approach. The most likely projects which would begin an AI-based automation effort in a computer system installation are the following:

- Document and Archival Retrieval;
- Computer-Aided Engineering Techniques;
- Computer-Aided Instructions;
- Procurement Management Processes;

- On-line Operations Manuals;
- Natural-language Querying of Database;
- Network and Computer Communication Management.

We will likely see AI techniques embedded within commercial mainframe applications on a routine basis in the not-too-distant future. Expert system tools are also likely to be available as modular packages so that application-specific architectures can be derived using standard modules.

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