Task 8.6 - Advanced Man Machine Interface (MMI)

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CONTENTS

<u>Paragraph</u>		<u>Page</u>
1.0	INTRODUCTION	1
2.0	BACKGROUND	2
3.0	DESIGN	5
	3.1 Initial Design	5
	3.2 Ergonomics Study	5
	3.3 Windows NT Design Effort	5
	3.4 Additional Design Research	6
	3.4.1 Data Analysis	6
	3.4.2 Improved Long Range Communication Abilities	6
	3.4.3 Modular Features	7
	3.4.4 Extensibility	7
4.0	CONCLUSIONS	8
5.0	SUMMARY	9

1.0 INTRODUCTION

The Solar/DOE ATS engine program seeks to improve the utilization of turbomachinery resources through the development of an Advanced Man Machine Interface (MMI). The program goals include timely and succinct feedback to the operations personnel to enhance their decision making process. As part of the Solar ATS Phase II technology development program, enabling technologies, including graphics environments, communications technology, and operating systems were explored to determine their viability to support the overall MMI requirements.

This report discusses the research and prototyping effort, as well as the conclusions reached.

2.0 BACKGROUND

A Man Machine Interface in turbomachinery applications provides operations personnel a view in to the operating condition of the turbine and its driven equipment. Often, the turbomachinery application is part of a much larger station or plant environment. Effective operation of the turbomachinery equipment necessitates operations personnel to have an in depth understanding of the equipment. To resolve equipment or process issues, an operator will often need to refer to operator manuals, drawings, previous experience and sometimes the expertise of others (Figure 1).

Utilization and access of these resources is not only time consuming, but highly dependent on the skills, experience and knowledge of the operator.

The Advanced Man Machine Interface will provide an integrated view into the operations as well as support information. Advanced communications will enable the equipment control and monitoring to be performed locally or remotely (Figure 2). Expert knowledge, drawings and electronic documentation will be embedded in the operator interface. The system will be built around industry standards with an open architecture design. This will provide both the scalability needed for complex applications as well the flexibility to incorporate new features in the future.

Access to information from a variety of sources will enable the operator to more effectively operate and maintain turbomachinery. Remote monitoring should allow more efficient utilization of skilled personnel as well as faster troubleshooting. Information is moved to the appropriate persons rather than moving the persons to the site.

OMI

Drawings

Experience

Contacts

Figure 1.

Figure 2.

3.0 DESIGN

3.1 INITIAL DESIGN

Several aspects of the overall system were prototyped utilizing UNIX. UNIX is a preemptive multitasking operating system. Two graphical user interface (GUI) development tools, SL-GMS™ and Sammi™, were used in the initial prototypes. The early prototype encompassed the acquisition of data from a programmable logic controller (PLC) and the display of the data in the form of meters, strip charts and numeric values. The following design considerations were demonstrated:

1. Communications using TCP/IP, an industry standard network protocol. TCP/IP is a suite of protocols that specify how computers communicate.
2. ASCII configuration files for project and view files. ASCII files can be created from other applications and are easily modified using many popular text editors.
3. Multiple window applications using X Windows. X Windows is a commonly used standard for graphical interfaces in networked UNIX environments.

3.2 ERGONOMICS STUDY

In parallel with the initial prototype, an ergonomic study was performed to identify issues in Solar's current Man Machine Interface as well as design considerations for a new MMI. The results of the study concluded that Solar's current operator interface substantially conforms to basic ergonomics recommendations. The report identified various ergonomics factors that need to be considered in a MMI. The following list summarizes the recommendations:

- Order of indicators should reflect their typical sequence
- Presentation style should be consistent
- Standard symbols and colors should be utilized
- Menu navigation should be simple and straightforward

3.3 WINDOWS NT DESIGN EFFORT

During the initial prototyping effort, a search for commercially available software components was made. Functionality, cost and support for the UNIX operating system were some of the primary criteria for these components.

During the research and investigation for software tools, it became apparent that the number of tools for the UNIX environment was much less than that for Microsoft Windows™. In addition, market research indicated a growing acceptance of Windows NT™ as an operating system for mission critical applications. Based upon these factors, a decision was made to develop a similar prototype in the Windows NT environment.

The tools used to develop the prototype were Allen-Bradley WinLinx™, Microsoft Excel™, and Borland Delphi™. WinLinx is a Windows software program that interfaces with a PLC. Excel is a spreadsheet application, and Delphi is a graphical programming environment for developing applications that run in Windows.

The prototype demonstrated:

1. Communication over industry standard networks (TCP/IP). Data collected on the computer connected to the PLC was displayed on several other computers over the network.
2. Flexible field configuration. Screens were dynamically modified without shutting down the data collection process.
3. ASCII configuration files for project and view files. ASCII files can be created from other applications and are easily modified.
4. Multiple window interface with Windows GUI. Also demonstrated multiple language and multiple engineering units capability.
5. Possible integration with the electronic version of Solar's Operation, Maintenance and Instructions (OMI) manual. The electronic manual can be searched for a set of keywords parsed from an alarm message.
6. Viewing of project drawings.

Based on the results of the prototype, the decision was made to target the MMI for the Windows NT operating system.

3.4 ADDITIONAL DESIGN RESEARCH

Additional aspects of the advance MMI were researched and investigated. Data analysis and communications were identified as two key areas for advancement.

3.4.1 Data Analysis

A major goal of the MMI is to automate the analysis of control system data, providing the operator with information, not just data. This will include, but not be limited to the identification of certain conditions (or the possibility thereof) and the recommended course of action.

Several commercially available expert/diagnostics software applications were reviewed. A major factor in considering these systems is the methods and mechanisms for configuring and maintaining the logic.

In the investigation, a simple prototype rule based system was designed. The rules are defined in an ASCII file, making input and maintenance fairly straightforward. This prototype system will be tested for effectiveness and supportability in providing a software verification check for Solar's existing operator interface.

3.4.2 Improved Long Range Communication Abilities

Various communication options were investigated and it was determined to utilize the Remote Access Services (RAS) of Windows NT. This will provide connectivity via standard modem, ISDN card and X.25. Integrated Services Digital Network (ISDN) is a technology for simultaneously transferring voice and data over normal digital telephone lines. X.25 refers to public networks often used by companies doing business internationally.

The application will be designed to minimize the information passed over the network. A configuration check will be done at startup to verify if the remote software is out of sync with the local software. If appropriate, the latest version of the software will be downloaded.

3.4.3 Modular Features

Object oriented technologies and tools were investigated. An object oriented design approach will be used to reduce the software development through the use of commercial and custom software components.

3.4.4 Extendibility

The system will be designed to support Object, Linking and Embedding (OLE). OLE is a standard established by Microsoft that enables custom software applications to be developed using commercial and custom components. The MMI views will be OLE container files that will contain graphics, text, data values as well as OLE objects. Typical OLE objects would be drawings, video segments and sound clips which will provide instructions or advice to the operator.

The design of the historical data logger will support a Structured Query Language (SQL) compliant data base. This will provide the mechanisms for user configurable reporting and data analysis with applications developed in Visual Basic™, PowerBuilder™, and other common programming environments.

4.0 CONCLUSIONS

As a result of the research and prototyping effort, the following conclusions were reached.

1. Providing information as opposed to data is critical to improving an operator's utilization of equipment.
2. A consistent user interface can greatly reduce the learning curve and improve user acceptance.
3. Identification of current and emerging industry standards is important to leveraging enabling technologies.
4. Object Oriented system design enables code reuse through the use of commercial and custom components, thereby reducing development effort.

The conclusions reached will provide guidance in the development phase of the Advanced MMI.

5.0 SUMMARY

A working prototype of an Advanced MMI demonstrated many of the features of Solar's current MMI as well as several aspects identified as key areas for advancement. Phase III will involve the productionization of the MMI with the electronic OMI, pre-engineered expert systems, user configurable reports, and various communications options.

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