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PLANNERS WORKBENCH: AN EXPERT SYSTEM FOR CABLE ASSEMBLY
PLANNING(U) MICROEXPERT SYSTEMS INC CALABASAS CA
M BECKER ET AL. 22 APR 89 TR-11 N00164-88-C-0074

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<p>PRESENTED PLANNER'S WORKBENCH (PW) AT A SOFTWARE REVIEW IN WHICH IT PERFORMED AS EXPECTED. SOME CHANGES WERE NOTED BY LMSC. DEMONSTRATED PW TO UPPER MANAGEMENT AT LMSC AS EXPOSURE FOR PHASE 3 FUNDING OPPORTUNITIES. A LOT OF EXCITEMENT WAS GENERATED AND POSSIBILITIES ARE BEING PURSUE. WE TOURED A CABLE ASSEMBLY SHOP IN MEXICALI, MEXICO AND SAW A WHOLE NEW APPROACH TO CABLE ASSEMBLY.</p>			
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23 MARCH 1989 - 22 APRIL 1989

PLANNER'S WORKBENCH

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AN EXPERT SYSTEM FOR CABLE ASSEMBLY PLANNING

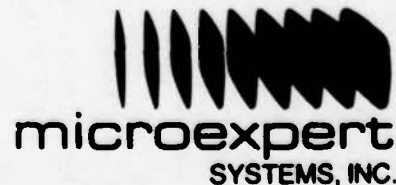


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PREPARED BY:

MICROEXPERT SYSTEMS, Inc.
24007 Ventura Blvd.
Calabasas, CA 91302
(818) 712-9934



24007 Ventura Blvd., Suite 210, Calabasas, CA 91302 • (818) 712-9934

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Technical Report #11
23 March 1989 - 22 April 1989

I. Administration

Phase II and Phase III Planning

MICROEXPERT has initiated the process of firming up the final design of Planner's Workbench and considering how to extend it to solve other cabling problems. Meetings with LMSC to present the progress of Planner's Workbench to date and to discuss Phase III alternatives are reported separately and in detail. In addition, MICROEXPERT met with IBM to discuss follow-up programs, and with Hughes Aircraft company to consider problems inherent in extending the Planner's Workbench design. The IBM meeting also is reported separately.

The meeting with Hughes Aircraft consisted of a tour of a cable assembly shop and a discussion of the findings. Hughes' methods of cable assembly differ from Lockheed's in concept. Moreover, the cable assembly operation in question was less complex and involved greater changes and more restricted runs.

MICROEXPERT toured a Hughes Aircraft cable assembly shop in Mexicali, Mexico on 7 April 1989 to investigate ways of extending Planner's Workbench. It would be difficult for Planner's Workbench to be used in a shop of this type.

Keywords: Critical Technology. (KR)

Our software review and presentation with LMSC was given on 14 April 1989 at LMSC. The design review with J. Rogers and F. Schalk in the morning was very informative for them and also for MICROEXPERT. Jim and Frank were both able to quickly understand the user interface of Planner's Workbench. This understanding then fostered a number of important comments and new pieces of data to be offered. The afternoon presentation with J. Buckel, Manufacturing Director, and J. Creagan, Jr, Group Engineer established strong contacts for further Phase III discussions. A highly interactive presentation and demonstration generated many exciting ideas for the future for Planner's Workbench. A more detailed report on these two meetings is provided in the Trip Report dated 14 April 1989 attached to this report.

II. Summary of Phase II Work Accomplished

Planning Modules

Form Board Planner

The pre-planning cable analysis was completed and implemented prior to the software review and presentation April 14. This analysis considers the cable as a whole and positions it optimally on the form board or lay-up board (Wirematic Planner). This approach eliminates needless bending and allows the rule bases to operate more efficiently. Other factors considered during analysis include keeping the connectors close to the edge of the boards to make operator interaction easier, and bending segments with the fewest wires when bends can not be avoided.

Color Coding Planner

MICROEXPERT redesigned the interface with the UIM in the Graphics and Dialog Windows. Messages sent to the Dialog Window now clearly describe and explain the decisions made by the rule base. The Graphics Window now includes an icon that indicates when a connector requires color coding.

Wirematic Planner

MICROEXPERT performed extensive development on this planning module. The pre-planning cable placement analysis detailed above was applied successfully to the Wirematic Module. The number of posts required by each connector for use in wire routing was determined after analyzing existing Wirematic programs. Nomograph wire bundle size data and color coding requirements were derived from the Color-Coding Planner.

The total length of the wires in each segment was computed following the rules obtained during Knowledge Engineering. Additional wire length was added due to twisting requirements and connector types. The designers also analyzed how many cable layouts can fit on one lay-up board. Since bending considerations are more lax in this module than the Form Board Planner, multiple designs are usually possible.

Hardware Assembly Planner

The prototype rule base developed at the end of the previous period proved to be extremely accurate in handling the assembly steps. Minor changes were made to the output message sent to the Dialog Window. The major addition to this module was constructing a graphic interface with the UIM to display the hardware assembly. This proceeded smoothly by a process of making minor changes or customizing generic routines already developed by MICROEXPERT for specific applications.

User Interface Module

The designers developed a prototype database accessor for the cable segments and solved a scrolling problem in the Dialog Window. The system now also can accept user input from the keyboard and the basic Color Table values provided in the standard GRAPHICS utilities have been extended.

The user can now select file names from the Graphics Window using the graphics tablet and cursor in interfacing in the database and DCM. The prototype developed this period writes the three (3) cable segments that Planner's Workbench is tasked with solving onto the window and then accepts mouse input to determine which is selected. Eventually this interface will read the segment numbers from the database and display them onto the window, storing their position for comparison with the mouse input.

The Dialog Window must be able to scroll. After a review of the design, it was decided to shift the GRAPHICS data structure within the window, rather than shifting the viewing parameters of the window. This single line at a time shift increases the accuracy and presentation quality of the Dialog Window.

A keyboard input routine that enables Planner's Workbench to accept input from the keyboard as well as the graphics tablet was added to the UIM functions. This routine has been used to select the operating mode for each planning session.

The Color Table entries provided in the basic GRAPHICS utilities included 8 colors, not enough colors to keep the interface easy to understand. The current table now has 18 colors.

III. Summary of Future Plans

- Further retire a Phase III Plan to enhance and extend Planner's Workbench.
- Continue to meet with IBM and others regarding involvement in our Phase III effort.
- Follow up on our article abstract sent to The CADAM Users' Group Fall meeting.
- Implement modifications to the expert systems suggested during the software review on 14 April 1989.
- Design Wire and Part data file interface for the DCM for inclusion with the 2D data.
- Continue developing the DCM object recognition and data extraction routines of the CADAM files.
- Finalize software code for the expert system planning modules.
- Extend development of the UIM to include database access, menu selections and final interface needs of the expert systems.

IV. Appendices

The following documents are appended hereto:

- Updated Master Phasing Schedule.
- IBM meeting review dated 11 April 1989.
- Trip Report dated 14 April 1989.

April 11, 1989

REVIEW OF MEETING WITH IBM ON APRIL 10, 1989

Mike Becker, Paul Griffith and Herm Siegel, of MICROEXPERT Systems, were joined by Joy Marchone and Claude Pelletier, of IBM. Herm reported on the history of the purpose of the SBIR Program and on the level of participation of the government through the different phases of the project. He then briefly described where Planner's Workbench fits into the cable assembly planning process. Mike described the structural components of Planner's Workbench and summarized the progress to date and plans for the future.

Joy indicated that Planner's Workbench must be made more generic and must adhere to the Software Application Architecture (SAA) before IBM can fully embrace the product. Joy then described IBM programs for assisting business partners. They include:

- **Industry Remarketer Program** - IBM will reduce the price of its hardware by 40% to software developers in order to stimulate buyers to purchase hardware/software systems without loss of profit for software developers.
- **Application Specialist Program** - Software developers receive a fee for each IBM computer sold to support the purchase of the software. 12-month renewal.
- **Industry Specialist Program** - Similar to the Application Specialist Program, except that the developer must have two installed versions of the software before you can enter this program.
- **Cooperative Software Program** - The software product acquires an IBM logo. Both the the software developer and IBM can sell the software.

Joy is checking on other business partnerships that IBM may have established in this area and will get back to us on this.

A meeting has been set for 10:00am, May 2, 1989 at the MICROEXPERT facility to continue discussions.

TR0410C9

TRIP REPORT
TO LOCKHEED MISSILE AND SPACE COMPANY
April 14, 1989

Purpose of trip: Demonstrate Planner's Workbench expert systems to Jim Rogers and Frank Schalk to verify the accuracy of its solutions. Anita Neuman also arranged an additional presentation and demonstration to John Buckel, Manufacturing Director, Missile Systems Division. John Creagan Jr, Group Engineer - Advance Technology, Anita Neuman, and other manufacturing and artificial intelligence personnel at LMSC also attended the meetings.

Trip Highlights:

Demonstration to J. Rogers and F. Schalk

The expert systems of Planner's Workbench successfully completed the planning of each of the three cables for which LMSC had provided data to MICROEXPERT. During the execution of each cable's planning session both Jim and Frank gave advice as to better ways of solving each given problem. The graphic interface showing the form board and lay-up board was easily understood by both Jim and Frank and served as an excellent device for eliciting suggestions about changes.

Jim and Frank concluded that in most cases the results of the Planner's Workbench expert system would work. Most of their suggestions were limited to human engineering considerations. They both were impressed with the amount we had accomplished and were pleasantly surprised to learn that the final product will include a program to automate the functions of the Wirematic - a task they felt was beyond the scope of Phase II.

Presentation and Demonstration to John Buckel, et al

Herm Siegel and Mike Becker reviewed the history of Planner's Workbench and the SBIR program and described the purpose and status of each expert system planning module. Brian Ringer demonstrated Planner's Workbench, showing two of the three cables.

John Buckel was very interested in how Planner's Workbench could be used in other planning systems and how adaptable it might be. The discussion of adaptability focused especially on assessing changes in the Data Converter Module (DCM) to handle 3D modelling. The modular design of Planner's Workbench provides the necessary entry points for whatever modules need to be changed or added to the system so that the 3-D modeling problem is solvable.

John challenged Planner's Workbench to run a particularly difficult cable that is produced in the shop. We will undertake this challenge when Anita Neuman provides us with the CADAM drawings and the parts and wires listings for the cable.

A discussion of the Phase III direction of Planner's Workbench and potential roles for LMSC ended the meeting. John Buckel will have Anita check into the ultimate funding source of Planner's Workbench to see if it is the same as one of their programs.

Summary of trip: The knowledge engineering/review meeting generated helpful data that will increase the overall effectiveness of Planner's Workbench. The experts, Jim and Frank, emerged with a belief that Planner's Workbench will be a tool that they will be able to use on a daily basis. The afternoon presentation may establish Lockheed as a Phase III partner. John Buckel expressed considerable enthusiasm about Planner's Workbench becoming a more generic product that could be applied to manufacturing planning needs other than cable assembly. John is scheduled to be in Calabasas at the end of April and has been invited to stop by for a tour of MICROEXPERT's facilities.

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Schedule Name: Master Phasing Schedule
 Project Manager: Michael Becker
 As of date: 21-Apr-89 11:43am Schedule File: C:\TL\ILDATA\CRANE

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Task	Status	Month																	
		Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Receive Preliminary Contract	D M																		
PDR Software Design	R	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
MSI/LMSC Meeting #1	D M																		
MSI/LMSC Meeting #2	D M																		
Monthly Report #1	D M																		
MSI/LMSC Meeting #3	D M																		
Receive Final Contract	D M																		
Receive IBM-RT	D M																		
Preliminary Demo Software	R	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
CDR Software Design	R	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
MSI/LMSC Meeting #4	D M																		
Document Software	RD																		
Prelim. Phase III Plan	ALL																		
MSI/USN Meeting #1	D																		
MSI/LMSC Meeting #5	D																		
Attend CUE Meeting	D																		
Present paper/demo CUE/DC	R	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
MSI/LMSC Meeting #6	D																		
MSI/LMSC Meeting #7	D																		
MSI/LMSC Meeting #8	D																		
MSI/USN Meeting #2	ALL																		
MSI/LMSC Meeting #9	MB, HS																		
MSI/USN Meeting #3	ALL																		
Training Demo	MB, PG, HS																		
MSI/LMSC Meeting #10	MB, HS																		
Final Demo	MB, PB, PG, HS																		
MSI/LMSC Meeting #11	MB																		
Final Phase III Plan	ALL																		
MSI/LMSC Meeting #12	MB, HS																		
MSI/USN Meeting #4	ALL																		
Final Monthly Report	ALL																		
Close contract	MB, KN, HS																		

==== Task - Slack time (====), or
 C Critical +== Started task Resource delay (----==)
 R Resource conflict M Milestone > Conflict

END

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