USER-FRIENDLY INTELLIGENT TUTORING SYSTEM
SCENARIO DEVELOPMENT

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ABSTRACT

EPRI's Intelligent Tutoring System (ITS) presents the user with a user-friendly Windows™ environment to provide automated advice for operator training on plant simulators. Recent enhancements improve the development of training advice; newly developed graphical expression builder eliminates the need to programmatically enter the training advice logic. Included in the graphical tool is a direct linkage to the ITS list of variables and automatic computer coding generation from a graphical representation. In addition, the ITS is being transported to the Windows NT™ environment, which provides additional benefits, such as the Windows 95™ interface and a true 32-bit multi-tasking operating system. The new graphical expression editor and the Windows NT™ operating system make the already powerful ITS even more usable and beneficial.

BACKGROUND

During a typical simulator-based training activity, an operator engages the simulation while a human instructor stands "over the shoulder," providing advice and answering questions. The ITS replicates this "coaching" style of instructor interaction. As a tutoring application, the ITS captures both the plant operational expertise of the instructor and the tutoring expertise. In addition, deploying the ITS-enhanced simulator at the station makes training available 24-hours a day, supplementing instructor-based operator training, which requires scheduling both an instructor and the operator(s) to dedicated training shifts.

The ITS is a powerful training tool, but it is not intended to "replace" the training instructor. In fact, the most successful ITS implementation mode is where the student is only "turned over" to the independent ITS-supported exercises after the instructor feels that the student can benefit from independent exercise of some initial set of newly acquired operational skills. The ITS does not provide the initial instruction, but rather provides an environment for the student to practice and gain proficiency in using these newly acquired skills. The ITS supplements, not replaces, the human tutor.

The EPRI ITS is an add-on facility for any training simulator. It provides all the appropriate tutoring techniques. The only customization required for different implementations is the insertion of the specialized operational advice associated with the specific plant being simulated. Typically, a joint effort of an instructor from the plant and the ITS consultants typically completes the development of this advice. The advice is implemented through two mechanisms – ISSUEs and METRICs.

ISSUEs are operational concepts and procedures the operator must understand and apply properly. Therefore, if the ITS would detect an operational error and determine that

a coaching interruption would produce a positive pedagogical effect, a window with an initial terse prompt would appear. If voice synthesis were active, the computer would read the text to the operator as well. A simple acknowledgment clears the advice without further interruption, or the operator may request more advice, allowing the operator to obtain the desired level of advice for any specific situation. ISSUEs are further subdivided by priority into "Alerts" and "Hints," allowing the ITS to manage multiple errors detected simultaneously.

METRICs, the second tutoring mechanism, rely on developing a meaningful numerical representation of the operator's performance during the exercise—for example, how well the operator follows the optimal temperature and pressure profiles after a trip. By showing both the desired and actual trends for a parameter, the ITS provides a target goal for operator behavior.

The EPRI ITS is also outfitted with multi-media features, such as voice synthesis, voice recognition for command and control, and computer-based training (CBT) features. The CBT features include animation movies and static graphics to increase the effectiveness of the ITS training sessions. For additional details on the EPRI ITS see References 1 and 2 (Kraje, 1993).

UPGRADING THE ITS

The ITS has undergone modifications to allow it to run proficiently in the newer Microsoft operating systems, such as Windows 95™ or Windows NT™. The primary focus was to get the ITS to execute under the Windows NT™ operating system, which business and industry see as the operating system of the future. Windows NT™ offers many advantages from which the ITS can benefit. However, the new system operates under the Windows 95™ operating system, as well.

Included in the upgrade is an advanced graphical expression editor used to develop the logic required for operational advice within a given custom installation. This editor, dubbed GEE-Wiz (Graphical Expression Editor Wizard), assists the ITS programmer during advice generation. GEE-Wiz gives developers of advice direct access to ITS variables from selection lists and makes the assembly of logic intuitive by using graphical object-oriented methods within a typical Windows™-type interface.

REASONS FOR UPGRADE

The current version of the ITS is available only for the Microsoft Windows™ 3.x operating system. Many advances have occurred in the world of operating systems since Windows™ 3.x. Upgrading the ITS allows it to take advantage of these advances and avoid ties to a "dead" operating system. Windows NT™ is a pure 32-bit operating system developed by Microsoft Corporation. Among the advantages that Windows NT™ offers is preemptive multi-tasking, which allows simultaneous execution of multiple processes without one process stopping or interrupting another. For example the current ITS system (Windows™ 3.x) interrupts the speech synthesis of an ISSUE during data acquisition from the simulation. Use of Windows NT™ resolves this multi-tasking problem.

The graphical expression editor addresses comments that the current development of the ITS logic can be tedious and time-consuming, requiring programming skills. The advice developer must be knowledgeable in Kappa-PC syntax to enter the entire logic via the keyboard. GEE-Wiz addresses these issues by allowing the programmer to graphically build the logic, in many cases without ever using the keyboard. Development of logic within GEE-Wiz requires little or no programming knowledge. However, if the user wishes, the current method of entry is still available within the upgraded ITS.

SWITCHING TO WINDOWS NT™

The switch from Microsoft Windows™ 3.x to Windows NT™ requires changes to the ITS as it currently exists. The switch requires major changes to allow the multi-media features to operate within the Windows NT™ operating system.

The voice recognition system used for command and control of the current (Windows™ 3.x) ITS is no longer available, nor have its developers specifically upgraded it to a Windows 95™ or Windows NT™ version. Therefore, the upgraded ITS required a new Windows NT™ 4.0 compatible voice recognition package. The top candidate thus far is the Microsoft Voice product. Testing of its full functionality within the ITS is continuing at this time.

Next, the upgraded ITS uses the upgraded Win32 version of First Byte's ProVoice voice synthesis application for Windows 95™ and Windows NT™. This system is very similar to the 16-bit Windows™ 3.x version used in the current ITS, but allows for the development of 32-bit Windows 95™ and Windows NT™ applications with voice synthesis capabilities. This upgraded development platform was used to create two new voice synthesis applications: one to read text from the command line, and one to read the text contained in an ASCII file. These applications replace their 16-bit counterparts for the current ITS version. The

32-bit versions ensures the best possible multi-tasking within the Windows NT™ environment.

Also, the computer-based training (CBT) features employed within the ITS, such as animation video or movies were impacted by the move to Windows NT™. The standards for animation within the ITS CBT are AVI and MOV formatted files. The MOV files currently used within the ITS do not display properly within the Windows 95™ or Windows NT™ media players. Installation of Apple Quicktime 2.12 for Windows™ 32-bit operating systems allowed the media player to correctly detect the format of the ITS animation files. If the CBT uses AVI animation files only, Microsoft's media player requires no additional software. The installation of Apple Quicktime also provides an animation viewer alternative to the Microsoft Media Player, which ships with the operating system.

Finally, the graphical editor, GEE-Wiz, is a 32-bit Windows 95™ and Windows NT™ application. This ensures that the application multi-tasks in the most efficient way, and allows use of the latest Microsoft interface features. Note that GEE-Wiz does not run within the Windows™ 3.x operating system. To integrate the GEE-Wiz application with the ITS system, a link was provided within the instructor editor for ISSUEs and METRICs to launch GEE-Wiz. When the user subsequently saves the logic and exits GEE-Wiz, the resulting logic fills the instructor editors' edit boxes.

Note that Kappa-PC, the environment that the ITS resides in, is still a 16-bit development environment. Intellicorp, the developers of Kappa-PC, has no plans to upgrade the product to a 32-bit version. Kappa-PC runs effectively within the Windows 95™ and Windows NT™ operating systems without modification. Therefore, the Kappa-PC software remains identical to that used within the current ITS version, even after upgrading to the Windows NT™ version of the ITS.

GRAPHICAL EXPRESSION EDITOR

The majority of the time and effort spent on the ITS upgrade was on the development of the advanced graphical expression editor (GEE-Wiz). GEE-Wiz allows completion of the logic development within a graphical environment by connecting Sub-expressions, Logic Blocks, and Action Blocks. The parameters of these connected objects jointly define the logic that defines when the ITS presents the operator with ISSUEs and METRICs.

A sub-expression is basically a comparative expression; a left-hand value is compared via several available comparative operators to a right-hand value, e.g., $(x > y)$.
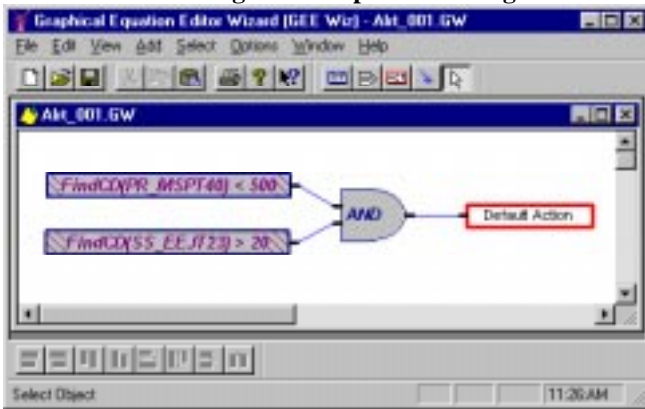
Sub-expressions allow logic flow through outlet connections that may either connect directly to action block(s), or become manipulated and combined with other sub-expressions via logic blocks before reaching the ultimate action block(s). The logical resolution of the sub-expression is passed through the outlet connections. For example, if the sub-expression resolved to True, the outlet connections pass the value of True to the downstream blocks.

The logic blocks correspond to logic operations. There are three logic operations supported within the GEE-Wiz logic blocks. These are: And, Or, and Not operations. The And and Or logic blocks allow logical checking of the two inputs and result in an output logical value (True or False). The Not block simply takes one logical input and inverts its value and outputs this inverted value through its outlet connections. The outlet connections pass the resulting logical value to the next downstream object(s), either other logic blocks or the ultimate action block(s).

The action blocks define the action to take place if the inlet to the action block logical value is True. The default GEE-Wiz action is to execute the default ITS action for the ITS logic type that is being edited within GEE-Wiz. For example, if the logic was part of the monitoring logic for an ISSUE and if the action block received a True input value, the Trigger logic for the ISSUE would be checked also. Then, if the action block for the trigger logic of an issue received a True, the ISSUE advice window would be displayed to the operator. The developer can change the action taken by an action block from the default by using Kappa programming syntax to perform other operations, such as setting internal ITS variables for future reference.

Figure 1 displays an example of a typical simple logic flow within the GEE-Wiz environment. The example logic performs the default ITS action for the trigger logic of an ISSUE, which is to display the advice in a window. The example logic checks to see if the throttle pressure is less than 500 PSI while the power is greater than 20 MW. If this condition exists in the simulation and the monitoring logic is true, the operator is presented with an ISSUE window.

Figure 1: GEE-Wiz Application Window Containing an Example of ITS Logic

may specify either the current or previous value of a variable within the variables dialog box. See Figure 4 for an example of a typical instance of the variables dialog box.

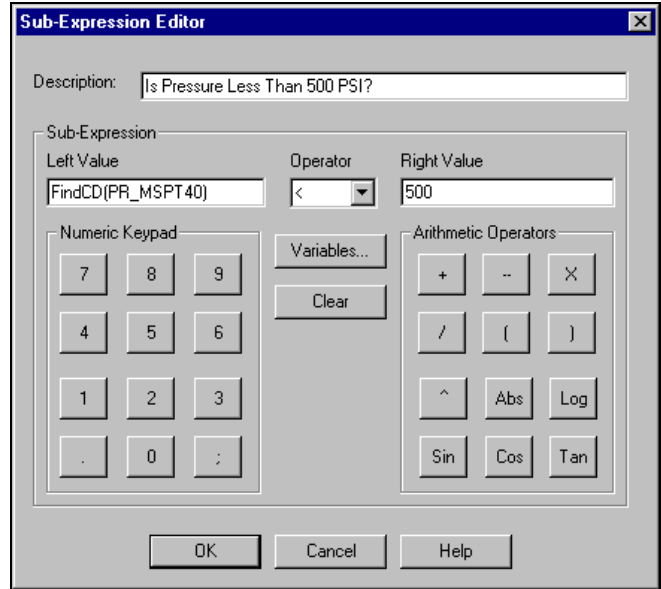**Figure 2: GEE-Wiz Sub-expression Editor**

To make the development of the graphical logic as intuitive as possible, GEE-Wiz fully utilized the normal Windows™ object manipulations. Selecting, cutting, copying, pasting, deleting, undeleting, moving, and sizing of objects are identical to those standards used by virtually every object or graphical application developed for the Windows™ environments. By using the menus (Main and Pop-Up), toolbars, hot keys, and mouse operations, all object maneuvering and manipulating tasks are easily performed. In most cases, the user may perform the same operations using several different methods.

If the user is not sure what actions a specific toolbar button or menu item performs, context-sensitive help is available at the click of a key or button. By selecting the context-sensitive help cursor and clicking on a menu item or toolbar button, the GEE-Wiz opens the help file directly to that particular topic. In addition, the user may open the GEE-Wiz help file to the table of contents, which allows the user to perform searches on keywords or peruse the logical layout of the topics. Also, GEE-Wiz includes a small but useful feature, Tip-of-the-Day. It gives quick, useful tips on methods of increasing the efficiency during the use of GEE-Wiz. Each user may set this feature to appear upon startup, or only when the Tip-of-the-Day menu item is selected.

Another powerful feature of GEE-Wiz is the ability to insert ITS internal and simulation variables directly into the sub-expression or action block text without requiring typing. Simply press the Variables button from the sub-expression or action block dialog box (See Figures 2 and 3) and select the desired ITS variable from the displayed list box. GEE-Wiz generates the list automatically by reading the current list of ITS variables when the variable dialog box initiates. In addition, the user may display and select ITS internal variables and simulation variables separately or within a main, all-inclusive list of ITS variables. Finally, the user

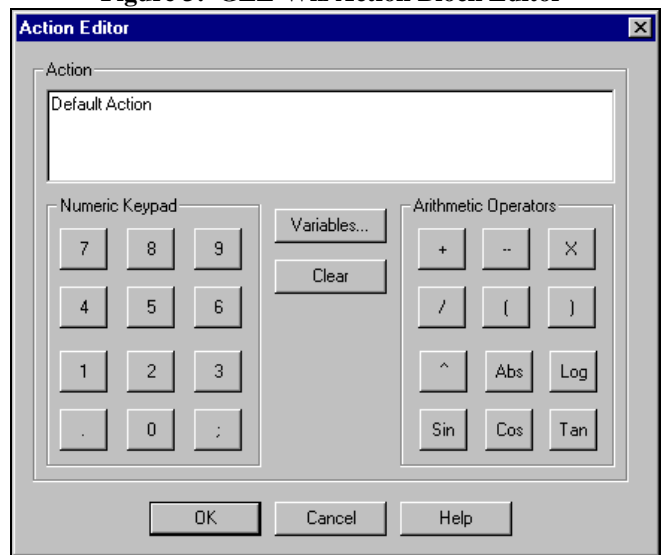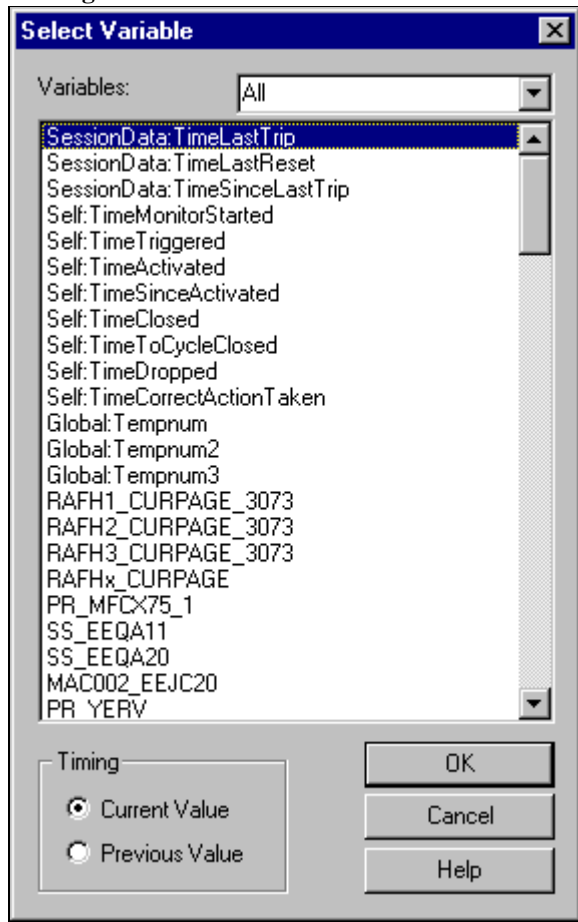**Figure 3: GEE-Wiz Action Block Editor**

Figure 4: GEE-Wiz List of ITS Variables

Additionally, GEE-Wiz implements more context-sensitive features to allow users to quickly examine the logic and GEE-Wiz functionality. By holding the mouse cursor over any object, the description text for that object is displayed on the status bar at the bottom of the main GEE-Wiz window. Also, as the mouse passes over the toolbar buttons and menu items, a brief description of the functionality of that command appears within the status bar. And in the case of the toolbar buttons, tool-tips appear at the cursor location to display even more concisely what actions that the button performs when pressed.

Another useful feature is the ability to set the display attributes of every object individually (line styles, fill styles, fonts, and colors). In addition, the user may specify the default attributes for each object type. Future objects of that particular type use these defaults.

Other features allow for quick placement of objects within the worksheet in an organized manner. The align functions allow alignment of the selected objects along their left, right, top, or bottom edges, as well as along their vertical and horizontal centerlines. The equal spacing functions allow the user to evenly space the selected objects in either the horizontal or vertical directions. Finally, the equal sizing functions allow the user to specify a uniform dimensions for all selected objects, height, width, or both. These features can quickly turn a large, complicated logic flow diagram into one that is easy to understand. They also provide an easy means of organizing the objects for printing the graphical logic for use in documentation, if required.

CONCLUSION

The EPRI ITS has undergone significant changes to make it both easier to use and more robust. A newly developed graphical expression builder eliminates the need to programmatically enter the training advice logic. Included in the graphical tool is direct linkage to the ITS list of variables and automatic computer coding generation from a graphical representation. In addition, the ITS has been transported to the Windows NT™ environment, which provides additional benefits, such as the Windows 95™ interface and a true 32-bit preemptive multi-tasking operating system. These improvements make the already powerful ITS an even more usable and beneficial addition to plant training simulators.

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