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TRNSYS for Windows Packages

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ABSTRACT

TRNSYS 14.1 was released in 1994. This package represents a significant step forward in usability due to several graphical utility programs for DOS. These programs include TRNSHELL, which encapsulates TRNSYS functions, PRESIM, which allows the graphical creation of a simulation system, and TRNSED, which allows the easy sharing of simulations. The increase in usability leads to a decrease in the time necessary to prepare the simulation.

Most TRNSYS users operate on PC computers with the Windows operating system. Therefore, the next logical step in increased usability was to port the current TRNSYS package to the Windows operating system. Several organizations worked on this conversion that has resulted in two distinct Windows packages. One package closely resembles the DOS version and includes TRNSHELL for Windows and PRESIM for Windows. The other package incorporates a general front-end, called IISIBat, that is a general simulation tool front-end.

1. INTRODUCTION

TRNSYS, commercially available since 1975, is a computer program used primarily to simulate thermal energy systems. Each physical component in the system, such as a pump or solar collector, is represented by a different FORTRAN subroutine. The subroutines are combined into an executable that is then controlled with an input file which states what physical components are involved in the system and how they are connected. That all TRNSYS users have access to the FORTRAN source code and can create their own models of physical systems makes TRNSYS a very flexible tool. With the ability to link in user-written components, TRNSYS is used for everything from solar systems to dairy farms. Historically, TRNSYS has been used for simulating solar thermal systems as well as more general HVAC systems.

2. MOTIVATION

With TRNSYS Version 13.2 and earlier, the only items distributed to TRNSYS users were the FORTRAN source code and the manual containing a description of each FORTRAN component. This left the user to provide the FORTRAN compiler, an editor to work with input files and view output files, a method for keeping track all the necessary files, a plotting package for analyzing output, etc. The user also had to type in all the information contained in the input file. With TRNSYS 14.1 for DOS, several of these problems and inconveniences were addressed by including several utility programs with the TRNSYS package. TRNSHELL, a TRNSYS windowing program, encapsulates all the activities associated with TRNSYS. There is an editor for writing and viewing text files. FORTRAN compiling and linking commands can be setup to be available at the touch of a button. Plotting of output files can be done with TRNSHELL as well. Another utility program, PRESIM, allows the user to graphically create the TRNSYS input file (the file that describes the system to the executable). The user drags icons, that represent different components, to the working area and then connect them using a mouse.

These additions, and others, were welcome additions to the TRNSYS package. These programs made TRNSYS easier to learn and faster to use resulting in less time per simulation. Although these programs were only available in DOS, most users were familiar with DOS and were using or had access to that operating system. However, most PC users now operate primarily in the Windows operating

system and Windows95 promised to do away with DOS entirely. Therefore, the next logical step was to recreate these utility programs available in the TRNSYS 14.1 for DOS package and the methodology in Windows. This would prevent users from having to leave Windows to work with TRNSYS. Some users were having memory and configuration problems with the TRNSYS for DOS package that should be alleviated with the Windows package. Finally, there are many powerful new tools for creating Windows programs.

Several different groups have been working on creating Windows utility programs for TRNSYS that will recreate and expand upon the DOS-based utility programs. From these efforts, two separate TRNSYS for Windows packages have been developed.

3. TRNSHELL/PRESIM PACKAGE

The first of these two TRNSYS for Windows packages is very close in form and function to the TRNSYS for DOS package. It includes a Windows version of TRNSHELL, a Windows version of PRESIM, a Windows version of TRNSYS. and a Windows version of TRNSED, as well as the existing programs PREBID, BID, and PREP.

3.1 TRNSHELL

The TRNSHELL program captures all the activities done while using TRNSYS. To do this, TRNSHELL incorporates file handling, editing, plotting, creation of parametric tables, creation of TRNSED files, and calls the other utility programs.

When a user starts TRNSHELL, they can create and edit FORTRAN files using the TRNSHELL editor (Figure 1). They can then compile the FORTRAN source code from a

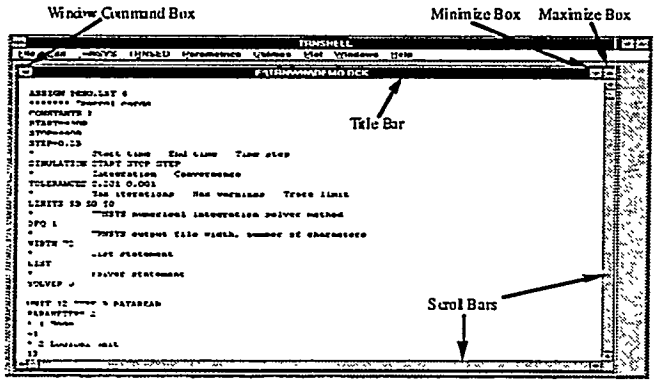

Fig. 1 TRNSHELL Window

touch of a menu button. Another menu button relinks the FORTRAN source code into an executable file for the user.

The next step in a TRNSYS simulation is to create the input file that contains the information about how the system components are connected. Creating this file can be done in the TRNSHELL editor or in the program PRESIM.

Then, returning to TRNSHELL, the user can open this file, click on the Calculate button and run TRNSYS with this newly created input file. Following the simulation, the user can view several standard output files at the touch of a menu item. One of the standard output files would be a plot file of hourly output values of system variables of the users' choice. Using TRNSHELL, the user can plot these values as desired. Figure 2 shows the plot as well as the interface for modifying the plot.

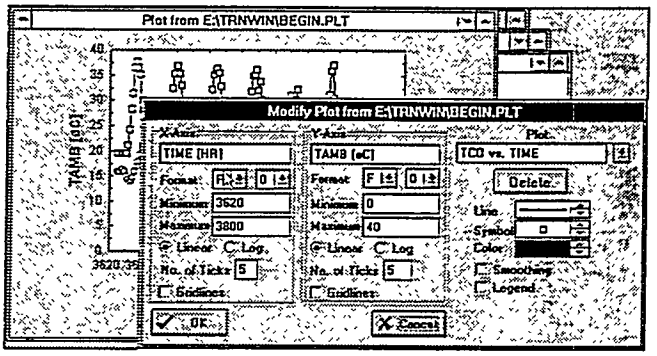

Fig. 2 TRNSHELL Plot and Modify Plot Window

TRNSYS users receive all the FORTRAN source code for TRNSYS. This allows them to compile and link TRNSYS for many different platforms. It also allows the user to write their own TRNSYS components. Being able to modify existing models and create new models gives TRNSYS great flexibility and is one of the powerful features of TRNSYS. To use this capability, the user must own and be familiar with a FORTRAN compiler. TRNSHELL allows the user to edit FORTRAN files and then compile them directly from TRNSHELL with the touch of a button. This feature saves the user from having to exit Windows to DOS to recompile and relink the components.

TRNSHELL also allows for a multi-run parametric analysis to be done. Several simulation runs can be done consecutively based on a table of variable values that are automatically changed for each run. For example. if the user would like to study how changing the area of the solar collector will affect the annual performance of the solar system, the user would set up a table of several runs with the collector area as the variable in the table (shown in Figure 3). Then, the user would ask TRNSHELL to calculate the table. TRNSHELL would conduct the simulations and change the collector area for each simulation calculation.

DISCLAIMER

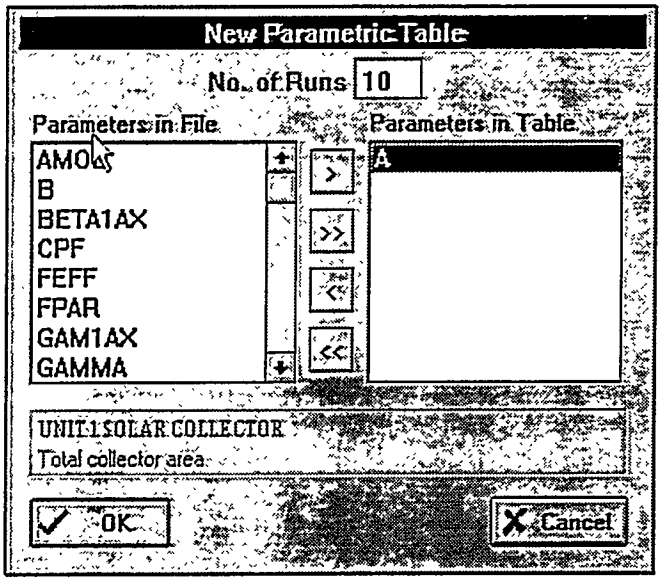

Fig. 3 Creating a Parametric Table in TRNSHELL

3.2 PRESIM

With the release of TRNSYS 14.1 for DOS, users could create TRNSYS input files using a graphical pre-processor entitled PRESIM. In PRESIM, users connect pictures of system components graphically, similar to the operation of a CAD program, and fill in component information windows called "forms". PRESIM has been upgraded from DOS to Windows for the new version of TRNSYS.

Each of the TRNSYS components has inputs and outputs which represent the pipes, ducts, and control signals of the physical counterparts. All the subroutines are linked and then controlled by an overarching main TRNSYS program. The input file tells TRNSYS what parameters and initial values to use for each system component and how the different system components are linked together. For each component, a number of parameters (variables that do not change with time), inputs (variables that change with time and may come from other components) and initial values must be entered into the input file. Below is a section of an input file that indicates to TRNSYS that one of the system components is a solar collector of 6.5 m^2 that receives its solar radiation information from a weather file. Data files of this type are obviously very difficult to interpret.

```
UNIT 1  TYPE 1  SOLAR COLLECTOR
PARAMETERS 14
1  1  6.5 4.19  1  50  .7  15  0  -1 0 1 0.1 0
INPUTS 10
3,1  3.2  0,0  5.5   6,6  6,4   6,5   0,0   6,9   6,10
20   200  0     10    0    0     0     0.2   20    45
```

PRESIM makes it easier to visualize how the components are being connected by offering the user a graphical way to create an input file. PRESIM is a utility program developed by the Solar Energy Research Center in Sweden. As Figure 4 shows, each physical component in a system is represented in PRESIM by an icon shaped like the actual component. For example, a solar collector actually looks like a solar collector.

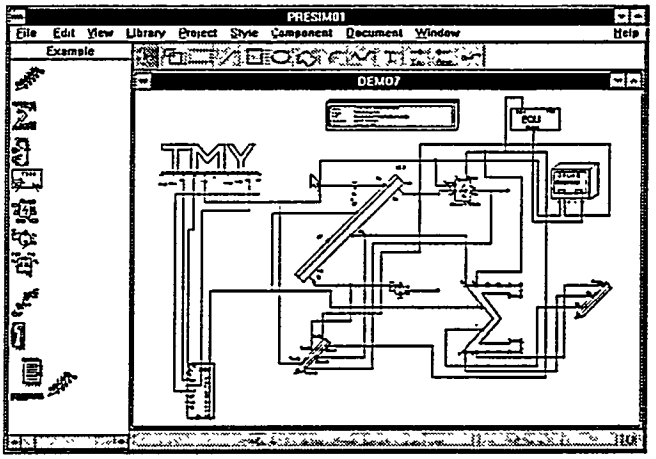

Fig. 4 PRESIM window displaying a TRNSYS solar domestic hot water application.

PRESIM divides the standard TRNSYS components into libraries of components that are displayed on the left side of the screen. The desired icon can then be grabbed with a mouse and dragged onto the working area. Two components can be easily connected by pointing and clicking with a mouse. The inputs and outputs of the components are displayed on the icon. A connection is made by drawing a line from the output of one component to the desired input of another component. By double-clicking on a component icon, the user can modify the initial values for the component inputs easily in a dialog box. Using the icons, an entire TRNSYS input file can be specified within PRESIM. PRESIM will then write the TRNSYS input file based on the connections between icons and the information entered (or default information) about the initial values of inputs. The final TRNSYS input file that PRESIM generates has many more comments than the comments a user would normally take the time to enter into a typical TRNSYS file. It is important to know that PRESIM drawings created with the DOS version of PRESIM can be used in the Windows version of PRESIM. This feature makes it easy for users of previous versions of PRESIM to convert their work to the Windows version of PRESIM.

3.3 TRNSYS

As stated before, the TRNSYS executable that is called from TRNSHELL or run independently in Windows has changed

significantly from previous versions. TRNSYS.EXE is now a separate Windows program that controls what is displayed in Windows while TRNSYS is running and then calls a Dynamic Link Library called TRNLIB.DLL that contains the actual TRNSYS FORTRAN source code. This method allows for a smooth Windows display without having to extensively modify the TRNSYS FORTRAN source code. The TRNSYS.EXE program allows the display of 10 variable values while the simulation progresses which is similar to how the Online Plotter worked in TRNSYS 14.1. Figure 5 displays the TRNSYS.EXE window that is created while the TRNSYS simulation is running. Figure 5 also shows that there are several variables being plotted. This window has the ability to pause the TRNSYS simulation while running, change the scale of the plot, hide one or more variables on the plot, and zoom into the display. These features increase the flexibility of the Online Plotter (Type 65). This display is still controlled from the TRNSYS input file. If the user does not have an Online Plotter component included in the input file, another window is created which indicates the progress of the simulation.

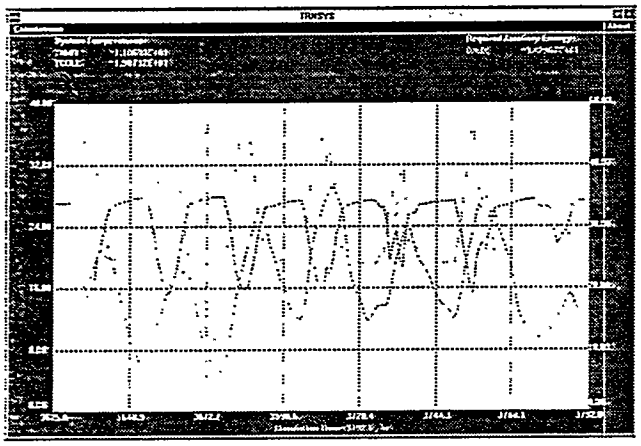

Fig. 5 TRNSYS.EXE with Online Plot Display

4. IISIBat Package

IISIBat, which can be roughly translated from French as "Intelligent Interface for the Simulation of Buildings", is a general simulation environment program that has been adapted to house the TRNSYS simulation software. Because of its flexible nature, many powerful tools and utility programs can be housed within the IISIBat shell. In this way, a complete simulation package can be incorporated into one environment program, from simulation engine and graphical connection programs to plotting and spreadsheet software. The IISIBat package is designed to handle all the necessary activities associated with TRNSYS. This is the role of TRNSHELL in the other Windows version of TRNSYS. These functions include editing FORTRAN and input files, displaying listing and output files, plotting results, offering online help, generating parametric tables, and providing shortcuts for several repetitive tasks such as FORTRAN compiling and linking. In addition, IISIBat also has an integrated pre-processing utility that allows the TRNSYS user to graphically create TRNSYS input files by connecting inputs and outputs of icons that represent TRNSYS components. This utility is similar, in theory, to the utility program PRESIM available in the concurrent version of TRNSYS for Windows.

Figure 6 shows the primary window that is used to create and work with TRNSYS systems within the IISIBat environment called the Assembly Window. The main window contains several icons with lines connecting them. Each icon represents a different component in the system (i.e., pump, solar collector, etc.). The connections between the icons represent the pipes and wires that connect the physical components. There is a series of Tools in a vertical column on the left side of the window that allow the user to place icons onto the working area, connect the icons as necessary, run the simulation, access the editor, access the spreadsheet and plotting package, and perform many other functions. The documentation for each component is extensive in IISIBat as well.

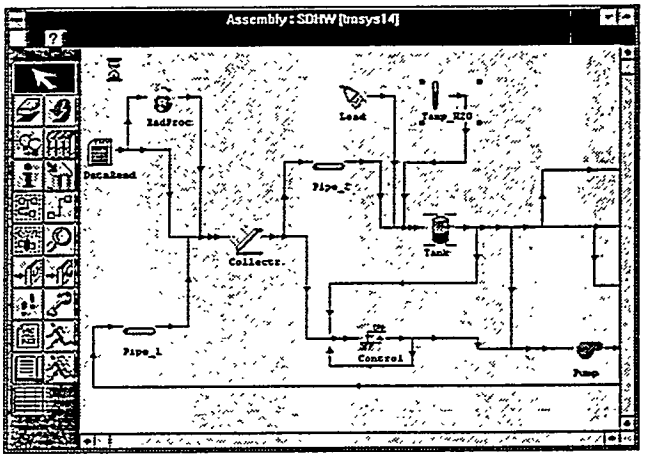

Fig. 6 IISIBat Assembly Window

Instead of having TRNSHELL control the many activities related to TRNSYS and using PRESIM to generate the input file, all the TRNSYS activities are controlled directly from the Assembly Window. For example, to plot the results of a simulation run, the user clicks the Spreadsheet Tool and then clicks on the Printer Icon. The output file generated by this TRNSYS component is automatically loaded into the Spreadsheet in which it can be manipulated and plotted. Figure 7 demonstrates the spreadsheet and plotting tool.

Another feature that will help the users to avoid referring to the manual as often is the extensive component description included with the package. Figure 8 indicates the first page

of the Proforma. The Proforma is a standard method of documenting component models into a syntactical format. The Proforma file is the model documentation standard used in IISIBat. Each TRNSYS component model has been broken down into the Proforma format and is stored in this format in the IISIBat program. The first page of the Proforma window contains information about the history and function of the component model. The second page contains a complete description of the variables required in this component model.

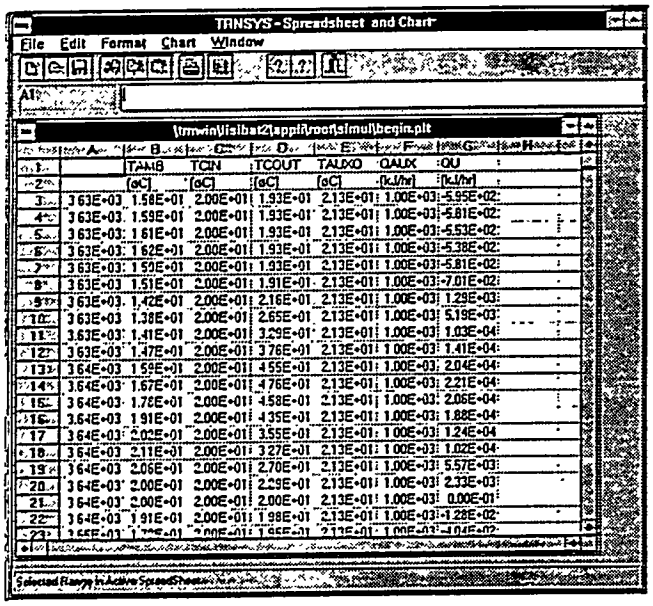

Fig. 7 IISIBat Spreadsheet and Plotting Tool

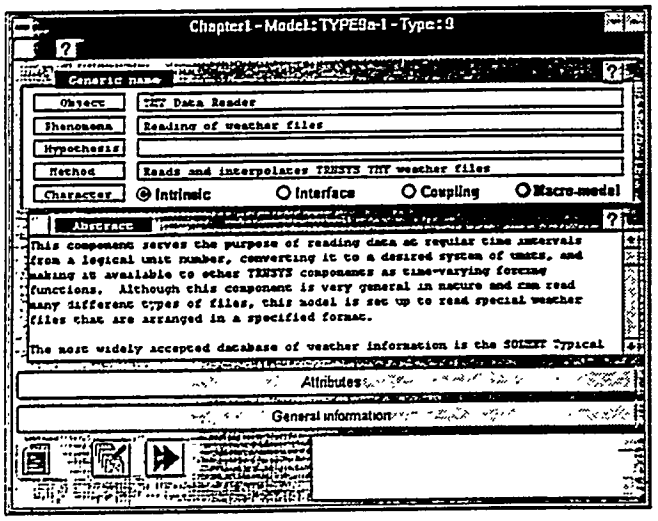

Fig. 8 First page of a TRNSYS Type Proforma

5. CONCLUSIONS

TRNSYS, a modular thermal energy system transient simulation program, has been fitted with two new front-ends to be used in the Windows operating system. Similar in function and form to the TRNSYS 14.1 for DOS package, both packages offer improvements in usability and compatibility with other Windows programs.

One of the Windows packages incorporates a general simulation front-end tool called IISIBat. Although not specifically designed to be used with TRNSYS, IISIBat is a fully integrated simulation front-end that allows the user to perform all the necessary functions for using TRNSYS as well as graphically creating TRNSYS input files. This environment allows the user to assemble a TRNSYS simulation within a window and click another tool to run the simulation.

The other Windows package offers a Windows version of many of the programs available in the last version of TRNSYS. These include TRNSHELL, which consolidates the functions associated with TRNSYS into one program; PRESIM, which allows for the graphical creation of TRNSYS input files; TRNSED, which modifies the display of the input file for use of TRNSYS by non-users. For previous owners of TRNSYS 14.1, conversion to this Windows package will be smooth as many features and functions are retained.

6. ACKNOWLEDGMENTS

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