TRNSYS 14 GOES WINDOWS AND WINDOW 4.1
Tool for energetic and visual building simulation

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Abstract
New developments of both user-friendly interfaces and mathematical models have been added to the very known software package TRNSYS /2/, a transient system simulation program, during the last year. They respond to the growing application of this building and system simulation software for low energy building design by over 200 consulting companies in Germany.

Introduction
For evaluating energy concepts of buildings during the first design stage, simulation tools are widely used by consulting engineers. In order to simplify the input of the building description a connection between CAD systems and thermal simulation tools is desired.

In Germany, TRNSYS is the most used simulation package for buildings and systems with over 250 licenses on the market. The new developed interface TRNSCAD links AutoCAD with TRNSYS by transferring the required geometric data from the CAD to the thermal simulation program. In connection with libraries of materials, wall constructions and windows, the time consumption for describing the building is reduced significantly. In addition to the output of geometric data, a visualization of the building including shading effects is available by clicking on a special button within TRNSCAD. For the graphical impression of the proposed design TRNSCAD applies a standard AutoCAD render program.

This paper will discuss the further developments of the simulation tool TRNSYS, for example the new window model, based on a window library done by WINDOW 4.1 from LBL.

The Solar Energy Laboratory of the University of Wisconsin, USA, in collaboration with TRANSSOLAR, Germany, SERC, Sweden and CSTB, France, is proud to announce the arrival of two TRNSYS 14.2 for Windows packages. The existing TRNSYS package has been upgraded to Windows from DOS and another powerful new environment program called IISiBat has been introduced.

Responding to the desires of TRNSYS users who worked primarily in Windows and responding to the possible demise of DOS with the introduction of Windows 95, the TRNSYS contributors have worked hard to recreate and improve the TRNSYS utility programs in Windows. This includes TRNSYS itself (with Online now in Windows), TRNSHELL, TRNSED, PREBID, PRESIM, and the all new IISiBat program /3/.

There are now TWO packages available to the TRNSYS buyer. One package is very similar to the DOS version and features PRESIM as a connection program and TRNSHELL as an environment program. Under separate development, the Centre Scientifique et Technique du Batiment (CSTB) in France has been developing a generalized simulation environment program that is designed to be a front-end program for any simulation program. This environment program is called IISiBat and is the cornerstone of the second version of TRNSYS 14.2. A FREE demonstration version of TRNSYS 14.2 for Windows is available from the Solar Lab World Wide Web site. Simply open the information side at http://sel.me.wisc.edu and click on TRNSYS. In addition, TRANSSOLAR provides a German Web site (http://www.transsolar.com) including a demo version.

Why Move TRNSYS to Windows ?
With TRNSYS Version 13.1 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 of 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. With the utility program PREBID, the TRNSYS package contains a convenient tool for creating the building description.

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 Windows 95 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 all eliminated with the Windows package. There are many powerful new tools for creating Windows programs.

The most important benefit of moving TRNSYS to the Windows environment is that the same simulation runs **THREE TIMES AS FAST** on the Windows version as it did on the DOS version. In Windows, TRNSYS.EXE is a Windows program that controls the windows that the user sees including the Windows-version of Online. The FORTRAN code that actually runs the simulation is compiled to a Dynamic Link Library (.DLL) that is called by the Windows program. Because it is a DLL and not standalone program, TRNSYS can operate much faster than in DOS.

How TRNSYS works under Windows

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

20 variable values while the simulation progresses which is similar to how the Online Plotter worked in TRNSYS 14.1. Figure 1 displays the TRNSYS.EXE window that is created while the TRNSYS simulation is running. Figure 1 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.

Can TRNSYS Only Be Run Under Windows Now ?

The answer is a definite NO. There is a very simple way to compile TRNSYS for Windows for a different operating system or as a stand-alone DOS program.

General Methodology For Using the TRNSYS for Windows with IISiBat Version

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 2 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.

The user will enter the Assembly Panel of IISiBat and begin by dragging icons which represent system components onto the working area. The user then must create links between the components that share information.

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 3 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 4 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.

TRNSCAD - A CAD Interface For The Multi-zone Building Model

TRNSCAD is an AutoCAD application (available for release 12 and 13) for creating the geometric building data required by TYPE 56, the multi-zone building model of TRNSYS. The goal of the development was to reduce the effort of the geometric building description significantly.

In TRNSCAD, a 3D-drawing of the building can be generated from scratch, from blue prints with a digitizer board or by importing an existing CAD drawing in a file format readable by AutoCAD (i.e. DXF). The complete TRNSCAD drawing includes all geometric data of the building and information about wall names and types. As output, TRNSCAD creates a special input file for PREBID containing all geometric information about zone volumes, surface areas and orientations. In addition, the building data created during a TRNSCAD session could be used for other simulations (e.g. daylight ..) and for visualization.

In general, a building created with TRNSCAD is composed of modules, the smallest unit within TRNSCAD. Each module is described by a closed polyline within the horizontal z-plane and then extruded with a fixed wall height. For modules with sloped surfaces, wedge modules can be defined as well. Several modules can be assign to one thermal zone. The assignment of a module to a thermal zone can be changed at anytime if necessary. Also, a module can be copied, deleted, moved or edited. However, it is not possible to change the shape of a module. Windows can be defined on „EXTERNAL" vertical walls and can be copied/deleted afterwards. TRNSCAD detects automatically if two modules have a wall in common and marks them as „ADJACENT" and „INTERNAL" walls, respectively.

PREBID under Windows

With the utility program PREBID, a convenient tool for create the building description is included in the TRNSYS package. By moving to the Windows environment, the interface has been improved significantly. First, the basic information about the project can be entered in an initialization window. Then, the building description is entered for each thermal zone in turn. All the information describing a thermal zone is contained in a single window as shown in Figure 6. Due to its clear structure, this zone window provides a good overview of the walls and windows within the zone as well as the regime data. Program libraries are provided in order to simplify the specification of wall constructions, layer materials and

windows. In addition, the user can compose his own user libraries. For the user convenience, default values are available for many parameters as well as a brief information on common values.

Beside PREBID, the BID program for calculating the wall transfer functions itself has been moved to the Windows environment. Thereby, the error tracing has been improved. Also, the new BID version is now integrated within PREBID.

New Window Model of the Multi-zone Building

The new window model included in the multi-zone building model (TYPE 56) is based on the stand-alone TYPE 97 by Robert Weber from EMPA.

This new model enables to perform detailed calculation of windows with up to 6 panes and different gas fillings between panes. The angular dependency of the transmission, absorption and reflection of solar radiation for the different panes of the window is pre-calculated once by the known Window 4.1 program from the LBL /1/. The window model requires the same input format as DOE 2.1. The resulting window properties are then used by the new window model within the TYPE 56 to calculate pane temperatures and radiation heat exchange through the window in detail at each time step. Also, it can be distinguished between an internal and external shading device to obtain more accurate surface temperatures of the window. Figure 7 shows the basics of the new window model.

For incorporating the new window model, the user has to specify a third parameter as the logical unit number of the window library file containing the properties of the window. Within the new package a window library is available for common glazing types of different manufacturers.

New Humidity Model of the Multi-zone Building

Up to now, there were two options to model the humidity effects within building zones. The first option was to increasing the capacity parameter WCAPR within the zone description. For many cases, this option is too inaccurate for describing the dynamics of the humidity. Another option was offered by TYPE 78 which simulates the humidity transfer through different wall layers in detail. However, these calculations were more time consuming.

As a new option, the multi-zone building model (TYPE 56) now contains an improved humidity model. This model incorporates a separate humidity buffer divided into a surface storage and deep storage. The interaction of the surface and the buffer storage is shown in Fig. 8 The surface buffer is additionally connected with the zone node. Every buffer is defined by three parameters.

Nomenclature

/1/ Lawrence Berkeley Laboratory CA 94720 USA; WINDOW 4.1 for Analyzing Window Thermal Performance in Accordance with Standard NFRC Procedures

/2/ S. Klein, W.A. Beckmann, Trnsys, Version 14.2, SEL, University fo Wisconsin, Madison, July 1996

/3/ R. Pelletret, W. Keilholz , S. Soubra; Iisibat, a new interface for TRNSYS, CSTB Sophia Antipolis, July 1996
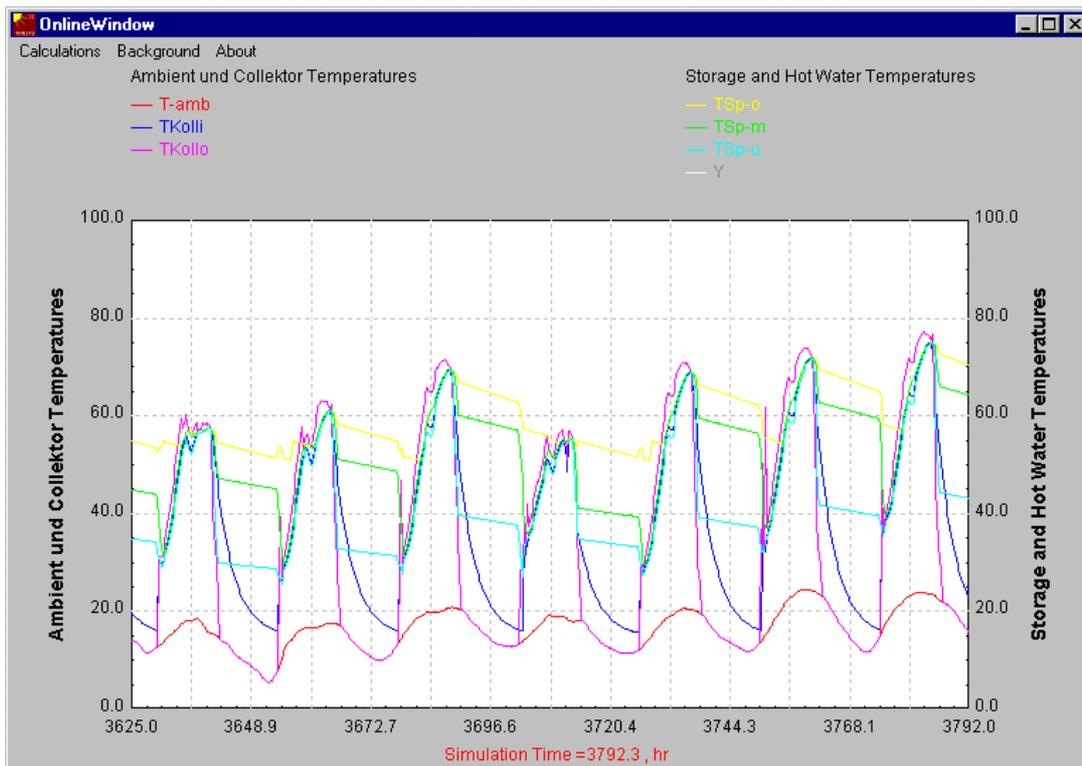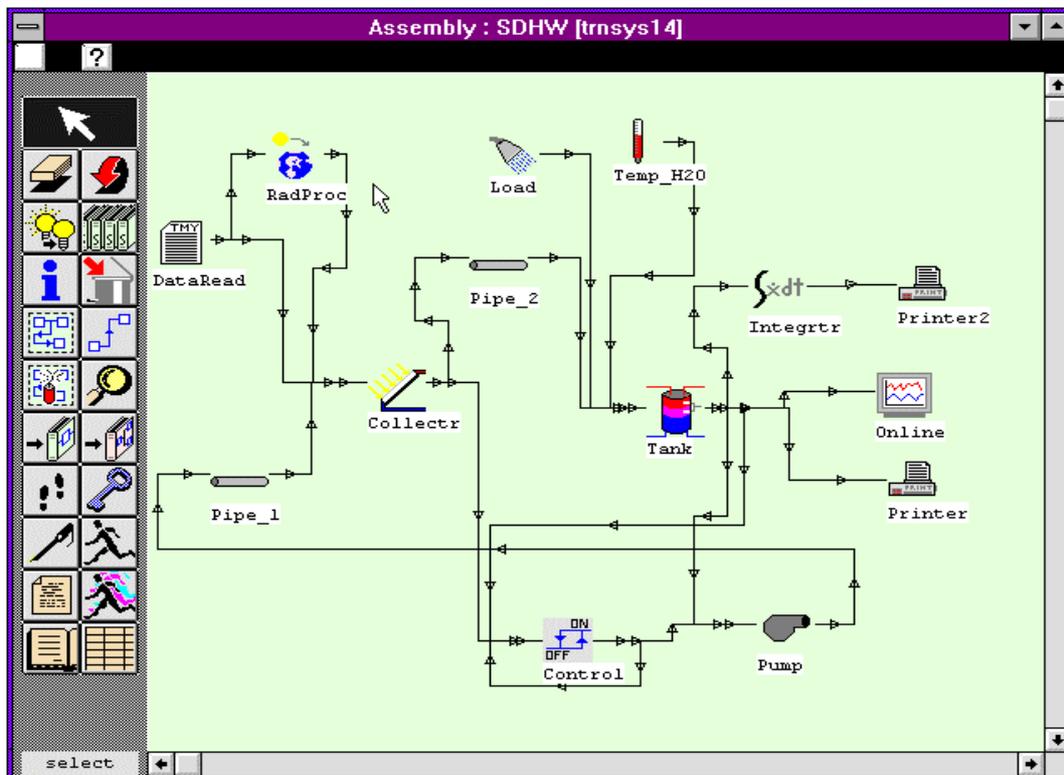
Figure 1: TRNSYS.EXE with Online Plot Display

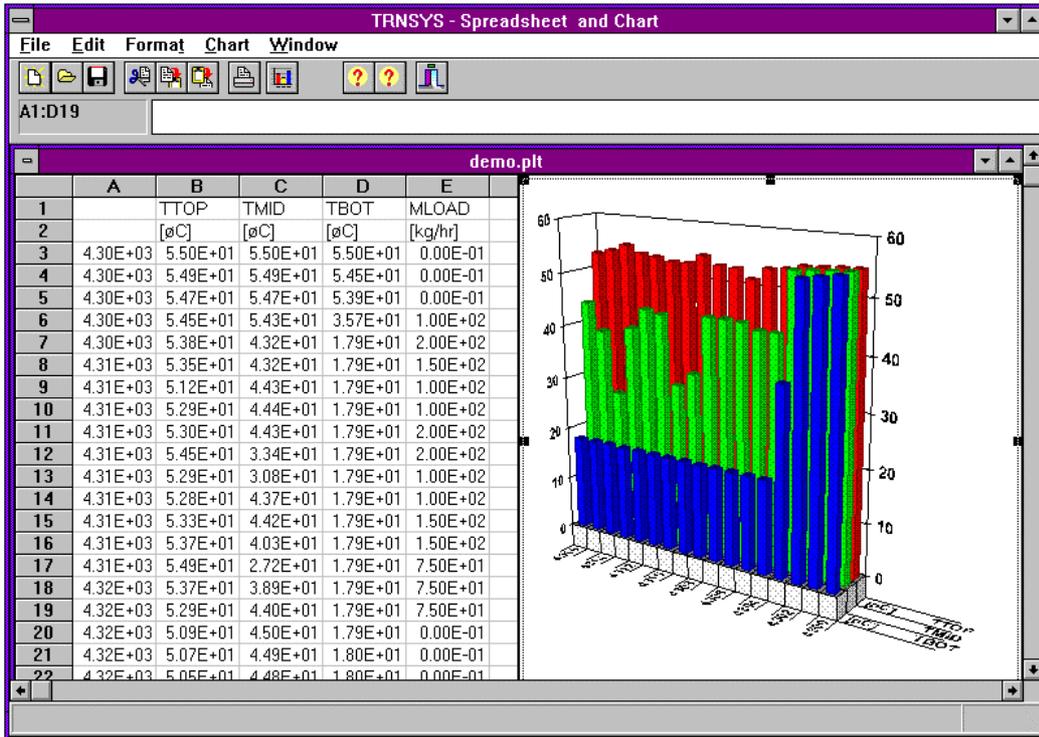**Figure 2: IISiBat Assembly Window**

TRNSYS - Spreadsheet and Chart

File Edit Format Chart Window

A1:D19

demo.plt

	A	B (TTOP) [øC]	C (TMID) [øC]	D (TBOT) [øC]	E (MLOAD) [kg/hr]
1		TTOP	TMID	TBOT	MLOAD
2		[øC]	[øC]	[øC]	[kg/hr]
3	4.30E+03	5.50E+01	5.50E+01	5.50E+01	0.00E-01
4	4.30E+03	5.49E+01	5.49E+01	5.45E+01	0.00E-01
5	4.30E+03	5.47E+01	5.47E+01	5.39E+01	0.00E-01
6	4.30E+03	5.45E+01	5.43E+01	3.57E+01	1.00E+02
7	4.30E+03	5.38E+01	4.32E+01	1.79E+01	2.00E+02
8	4.31E+03	5.35E+01	4.32E+01	1.79E+01	1.50E+02
9	4.31E+03	5.12E+01	4.43E+01	1.79E+01	1.00E+02
10	4.31E+03	5.29E+01	4.44E+01	1.79E+01	1.00E+02
11	4.31E+03	5.30E+01	4.43E+01	1.79E+01	2.00E+02
12	4.31E+03	5.45E+01	3.34E+01	1.79E+01	2.00E+02
13	4.31E+03	5.29E+01	3.08E+01	1.79E+01	1.00E+02
14	4.31E+03	5.28E+01	4.37E+01	1.79E+01	1.00E+02
15	4.31E+03	5.33E+01	4.42E+01	1.79E+01	1.50E+02
16	4.31E+03	5.37E+01	4.03E+01	1.79E+01	1.50E+02
17	4.31E+03	5.49E+01	2.72E+01	1.79E+01	7.50E+01
18	4.32E+03	5.37E+01	3.89E+01	1.79E+01	7.50E+01
19	4.32E+03	5.29E+01	4.40E+01	1.79E+01	7.50E+01
20	4.32E+03	5.09E+01	4.50E+01	1.79E+01	0.00E-01
21	4.32E+03	5.07E+01	4.49E+01	1.80E+01	0.00E-01
22	4.32E+03	5.05E+01	4.48E+01	1.80E+01	0.00E-01

Figure 3: New Spreadsheet and Plotting Tool

Chapter1 - Model : TYPE9a-1 - Type : 9

Generic name

| Object | TMY Data Reader |
Phenomena	Reading of weather files
Hypothesis	
Method	Reads and interpolates TRNSYS TMY weather files
Character	⦿ Intrinsic ◯ Interface ◯ Coupling ◯ Macro-model

Abstract

This component serves the purpose of reading data at regular time intervals from a logical unit number, converting it to a desired system of units, and making it available to other TRNSYS components as time-varying forcing functions. Although this component is very general in nature and can read many different types of files, this model is set up to read special weather files that are arranged in a specified format.

The most widely accepted database of weather information is the SOLMET Typical

Attributes

General information

Figure 4: First page of a TRNSYS Type Proforma
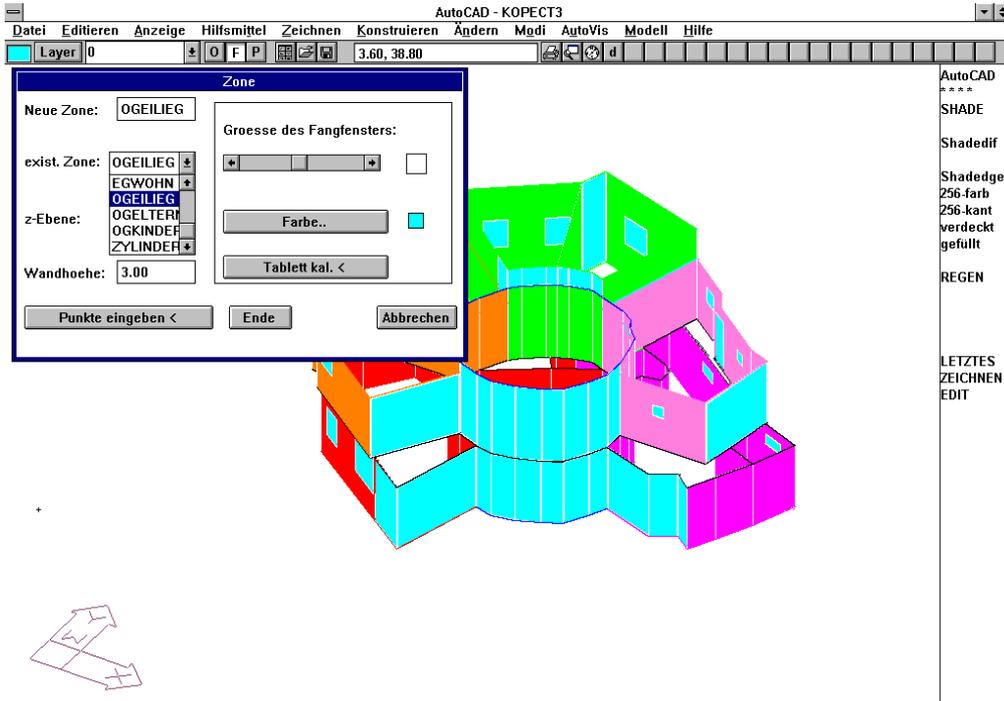
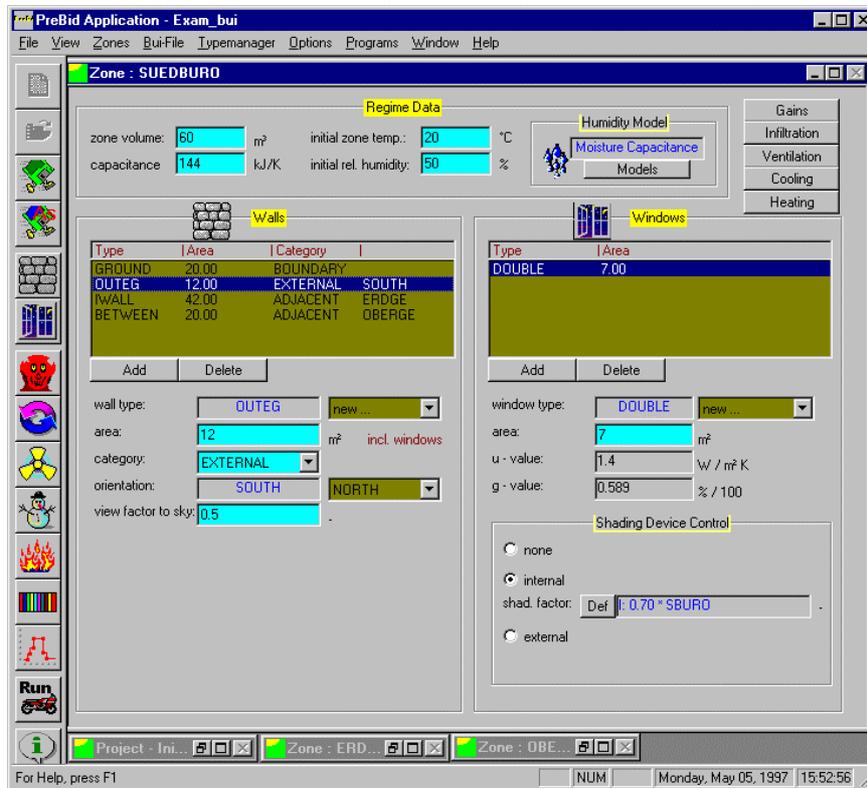**Figure 5:The definition of a new model within TRNSCAD.**
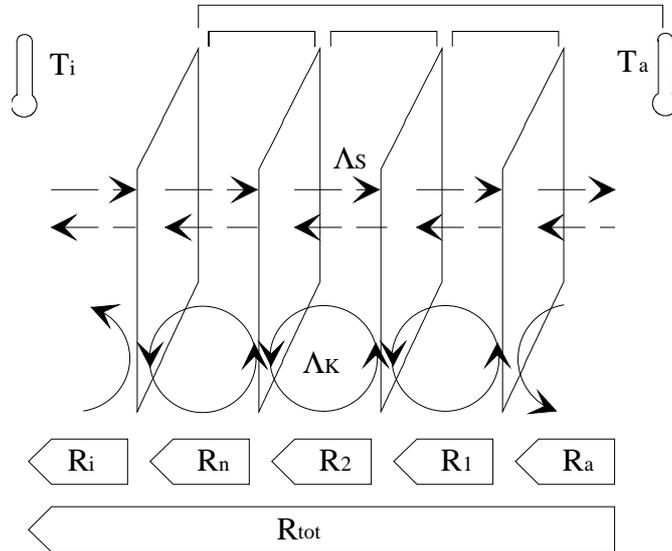

Fig. 6: The zone description within PREBID
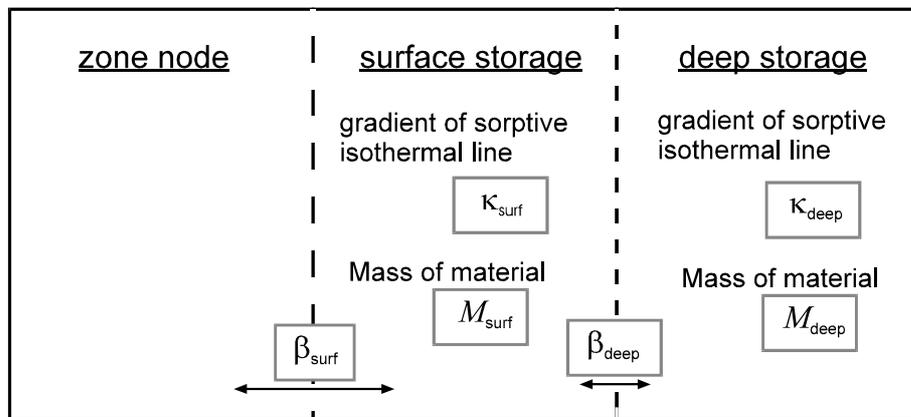
Fig. 7: Detailled window model, thermal side

Fig.8: Sheme of the new humidity model; the parameters of the model are highlighted