TRNSYS 17

a TRaNsient SYstem Simulation program

Updates in Version 17.1

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1. INTRODUCTION

TRNSYS, the transient systems simulation program that has been commercially available since 1975, continues to develop by the international collaboration of the United States, France, and Germany. TRNSYS remains one of the most flexible energy simulation software packages by facilitating the addition of mathematical models, the available add-on components, the capabilities of the multizone building model, and the ability to interface with other simulation programs.

The following document explains the updates for the new TRNSYS version 17.1 Updates include improvements to the TRNSYS Simulation Studio, the addition of new capabilities to the TRNSYS multizone building model, developments for the TRNSYS engine, and new components to the TRNSYS standard library.

1.1. TRNSYS Simulation Studio

1.1.1. Wizard – New 3D Multizone Building Project

The 3D Multizone Building Project has been updated to reflect the new features in the TRNSYS Multizone Building Model. Creating a new 3D Building Project with the Wizard is implemented from the “New” button or in the File menu

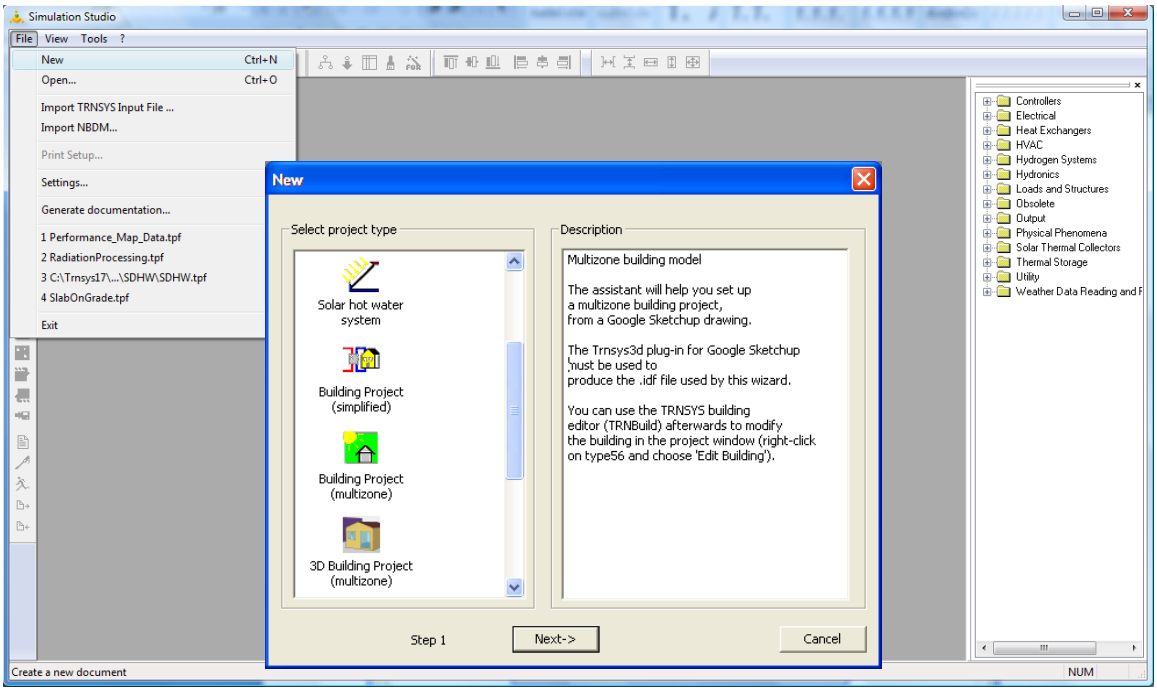
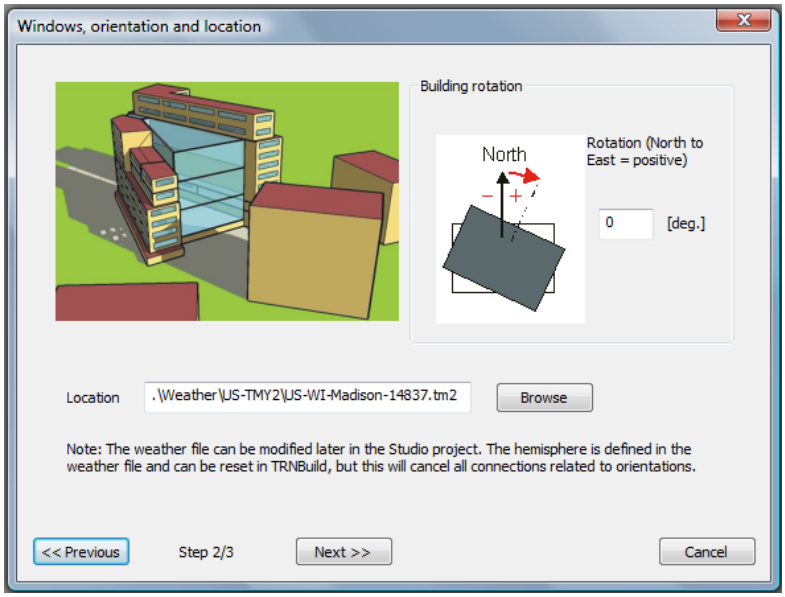
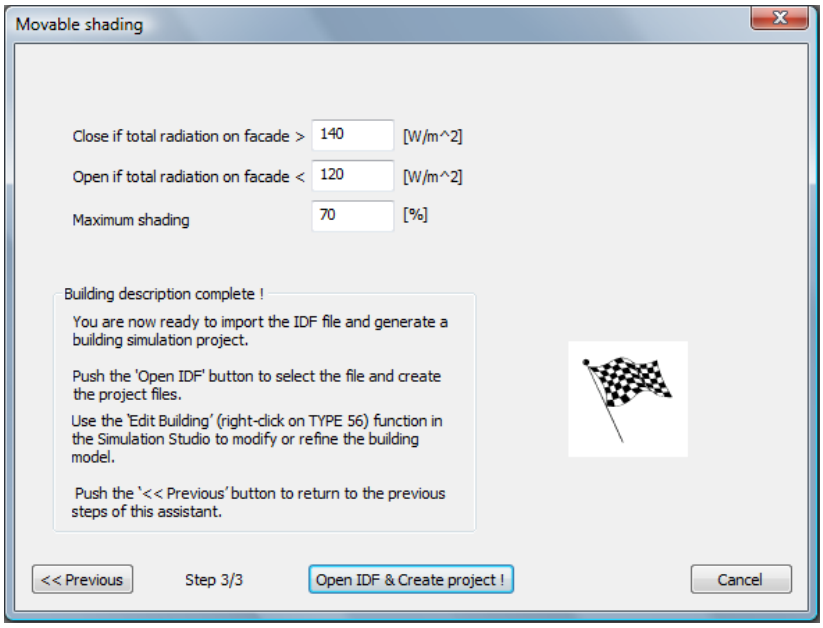


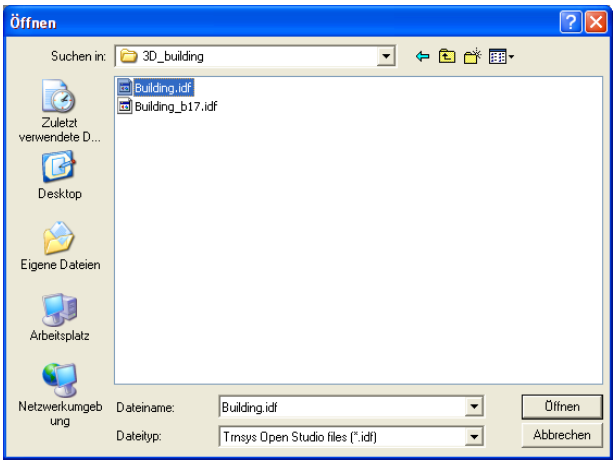
Figure 1-1: 3D Building Wizard Step 1: Launching the 3D building wizard

In the next step (2 of 3) of the Building Wizard, the user is asked for the location of the weather data file (*.tm2) and the rotation of the building. **Note:** If a different weather data format than *.tm2 shall be used, select one tm2 data set located on the same hemisphere that the desired location and replace weather data component later.

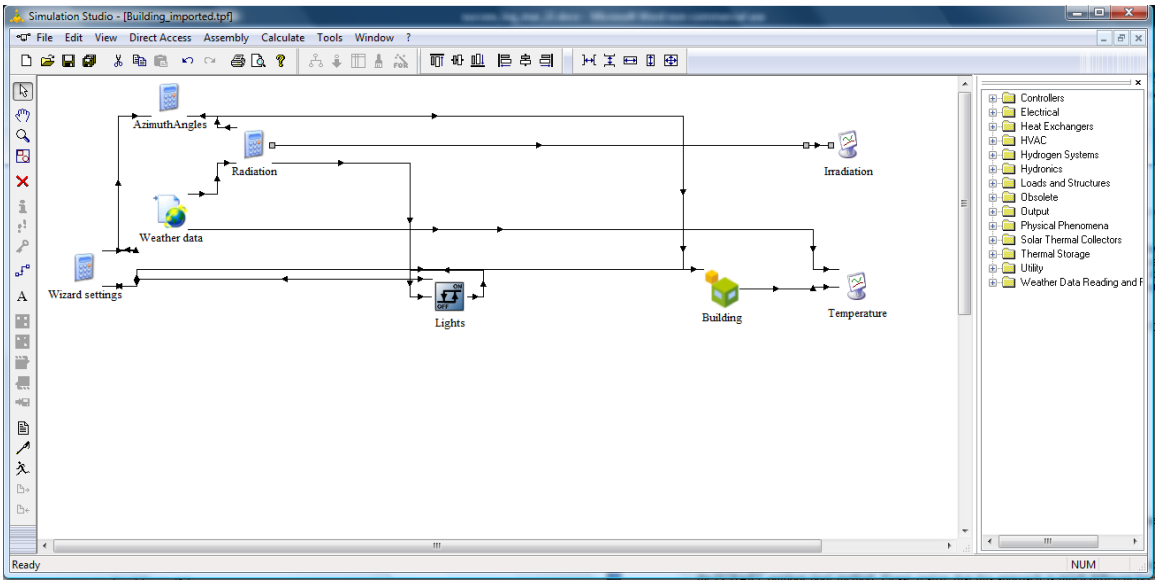


In the next step (3 of 3) the user is asked to provide any optional shading criteria for the windows of the building and then choose the TRNSYS3D drawing file (*.idf) for importing as shown below.





The wizard reads in the *.idf file that you chose and based on the information therein, generates a building description file (*.b17) and a TRNSYS Project File (*.tpf); a fully functional TRNSYS simulation is set up and the required links are generated. **Note:** The wizard uses now Type 15 as weather data component. If a different weather data format than *.tm2 shall be used, the weather data component can be replaced.



1.1.2. Wizard –Multizone Building Project

For the multi zone building without 3D, the Studio wizard now uses template deck and .b17 files to create simulation projects. The user may adapt these templates to his needs. They are located in

.\Trnsys17\Studio\Templates\MultizoneBuilding

The file MultizoneWizard.dck pilots the creation of the multizone building project, while MultizoneWizard.b17 is used to create the building description file.

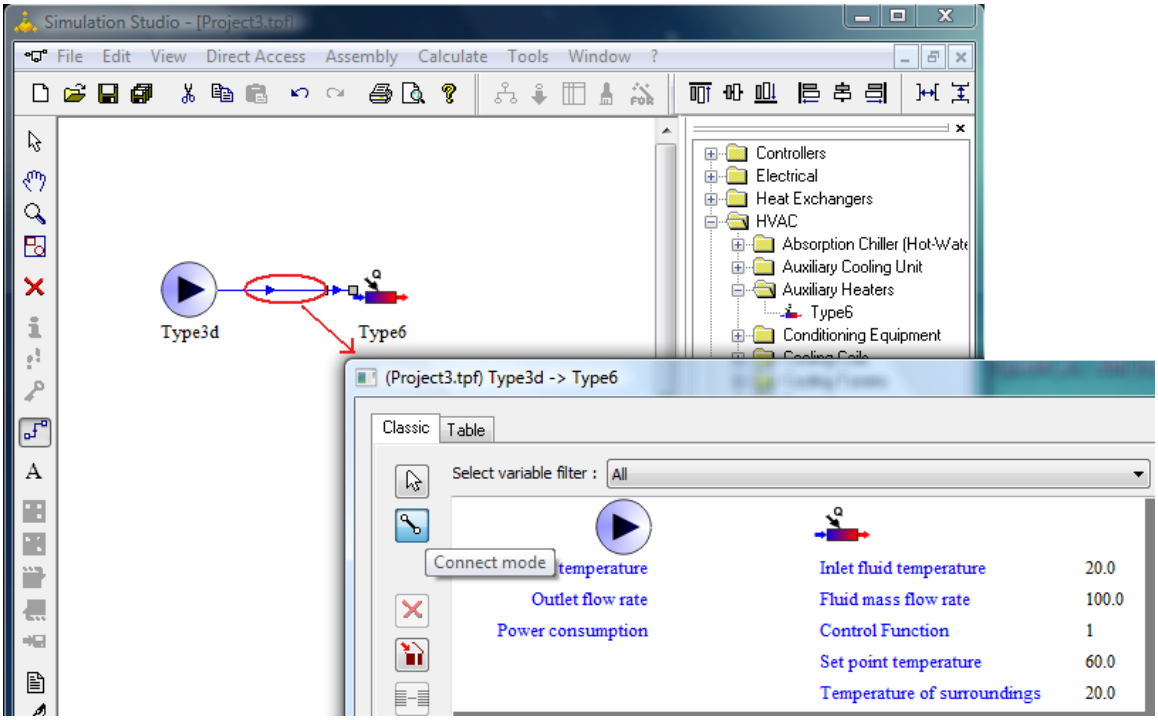
Care should be taken when these templates are modified, as such changes can provoke the generation of incorrect projects.

The template files contain variables which will be replaced by the appropriate commands by the wizard, based on user input. For example, $$VERSION will be replaced by the TRNSYS version used. Before modifying the templates, we advice users to study the existing templates and the variables they contain first, by generating some example projects and comparing them to the templates.

It is also a good idea to keep a copy of the original version of the templates.

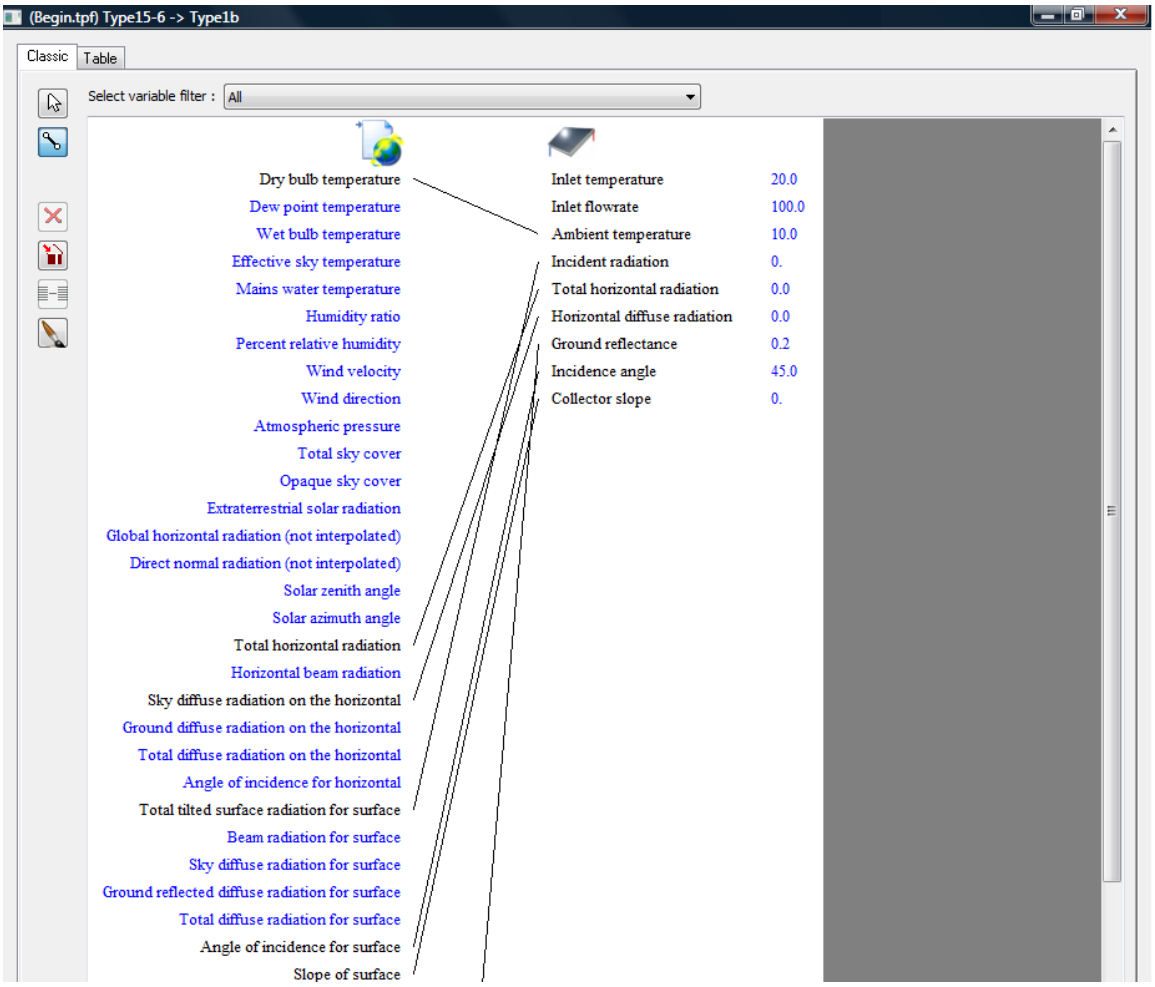
1.1.3. Automatic Connection Window Open When Creating Link

The Simulation Studio now has the option to open the connection window automatically after the user makes the connection link between two components. The user can change this setting in the menu *File* → *Settings* → *Compiler + Others*.



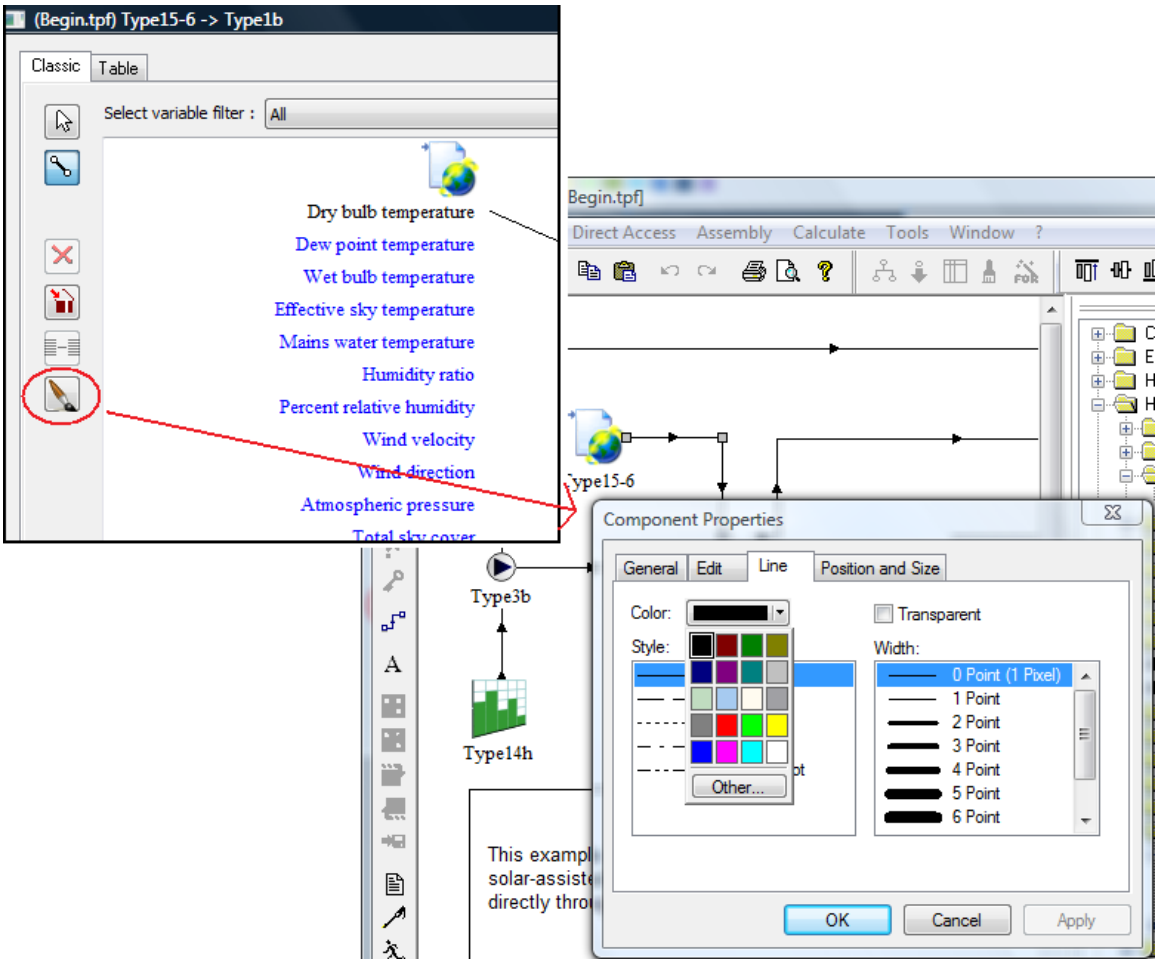
1.1.4. Automatic Connection Window to Maximize

The Simulation Studio now has the option to maximize the connection window when the connection window is opened from a link between two components. This is convenient when using components with many outputs or inputs such as the Type15 Weather Reader and Radiation Processor. The user can change this setting in the menu *File* → *Settings* → *Compiler* + *Others*.



1.1.5. Line Color/Style Button in Connection Window

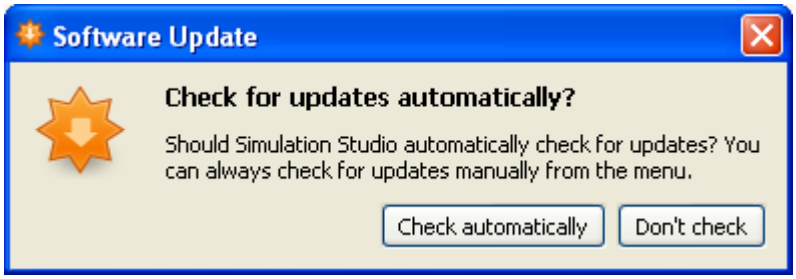
Upon opening the connection window in the TRNSYS Simulation Studio, there is a



1.1.6. Automatic check for updates

Simulation Studio contains a mechanism called 'winsparkle', which allows it to automatically check for software updates. Winsparkle is an open source software component distributed under the MIT license (see COPYING_WinSparkle.dll.txt for details).

When Simulation Studio is started for the second time, it will ask the user if he wishes the software to check for updates automatically:

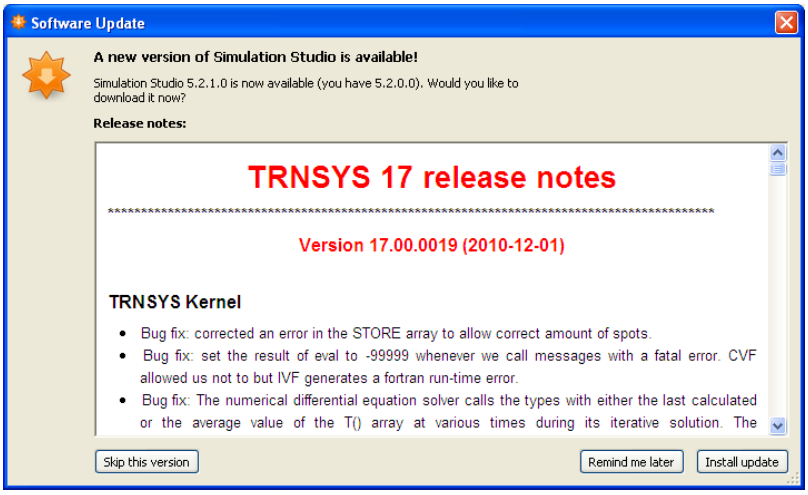


If the user clicks "Don't check" the software will not automatically check for updates. If the user clicks "Check automatically", the software will attempt to connect to the Internet to check if updates are available. This check will not be done more often than once a day.

It is also possible to check for updates manually, using the *?/Check for updates* menu in simulation Studio. This option is available even if 'Don't check' has been selected.

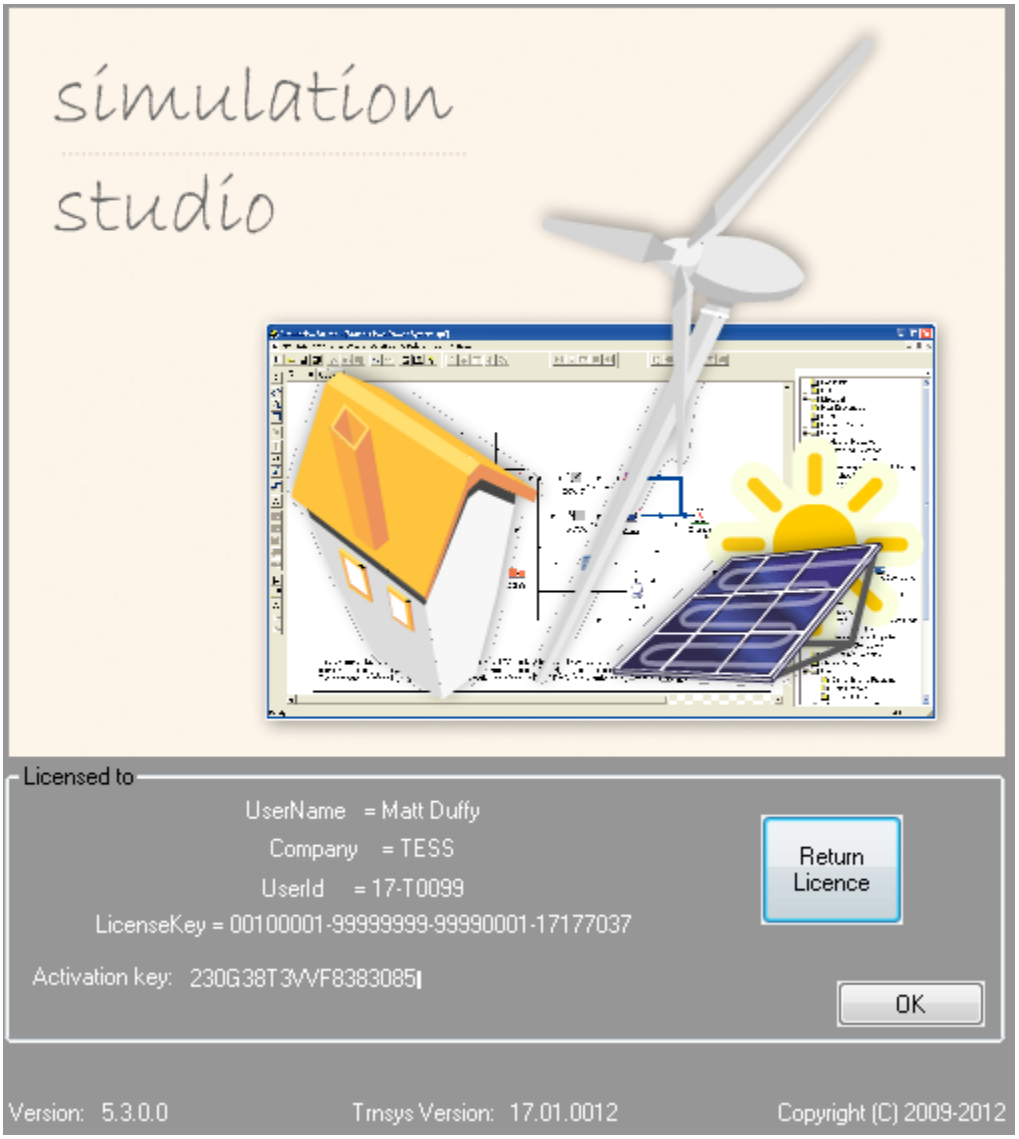
If an update is found, a summary of the update is displayed. The user can then choose between the following options:

- Skip this version: will not install the update and no longer proposes it to the user. New updates will only be proposed again if an even newer update will be available.
- Remind me later: will not install the update, but proposes it again the next day.
- Install update: redirects to the Internet site where the update can be downloaded. Simulation Studio should be closed before launching the installer after the download.



1.1.7. License Return

The Simulation Studio has a function to return its license to the online database. Users with an internet connection and administrator privileges can implement this function. It is located in the Simulation Studio's "About" section under the "?" menu. This mechanism will return the activation key to the online database to provide a license for your next computer.



1.1.8. Command line arguments

It is now possible to use Studio in command line mode, e.g. to implement batch files. When starting Studio.exe (located in Trnsys17\Studio\Exe), the following command line arguments can be given:

/d create deck file

/r run simulation

/q quit

For example, to open the 'Begin.tpf' project, create the deck file, run the simulation and then quit Studio, the following command line can be used:

\Trnsys17\Studio\Exe\Studio.exe /d /r /q \Trnsys17\Examples\Begin\begin.tpf

1.1.9. Adapting the template files

The Studio wizard now uses template deck and .b17 files to create simulation projects. The user may adapt these templates to his needs. They are located in

.\Trnsys17\Studio\Templates\MultizoneBuilding

The file MultizoneWizard.dck pilots the creation of the multizone building project, while MultizoneWizard.b17 is used to create the building description file.

Care should be taken when these templates are modified, as such changes can provoke the generation of incorrect projects.

The template files contain variables which will be replaced by the appropriate commands by the wizard, based on user input. For example, $$VERSION will be replaced by the TRNSYS version used. Before modifying the templates, we advice users to study the existing templates and the variables they contain first, by generating some example projects and comparing them to the templates.

It is also a good idea to keep a copy of the original version of the templates.

1.2. The TRNSYS Multizone Building

For the update TRNSYS 17.1, the multizone Building development focused on user convenience. For providing a better overview, the TRNBuild Navigator is now extended to airnodes, surfaces and regime data. In addition, the input and output windows are now showing a complete list of the resulting inputs / outputs.

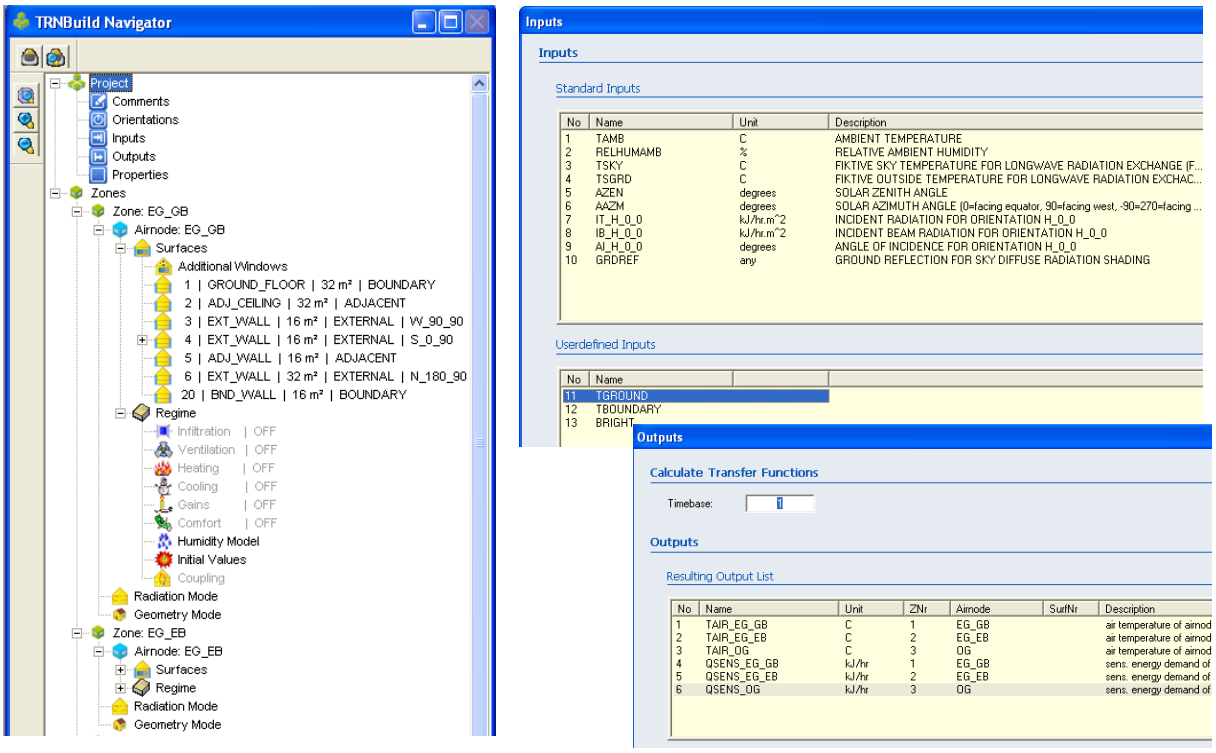


Figure 1.1.9-1: TRNBuild Navigator, Input and Output windows

1.2.1. Integration of the Hemisphere

The TRNSYS azimuth convention depends on the hemisphere of the project location:

- northern hemisphere: 0° … south; 90° … west, 180° … north, 270° … east
- southern hemisphere: 180° south; 90° … west, 0° … north, 270° … east

For user convenience the calculation of the azimuth angles depending on the hemisphere is now handled by TRNBuild. For a new project or importing a Trnsys3d file the user is asked to select the hemisphere (northern/southern) corresponding to the location of the project.

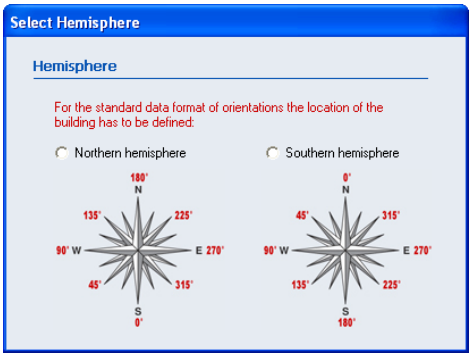


Figure 1.2.1-1: Hemisphere Selection

The hemisphere can be changed later by a switch in the TRNBuild project window. However, changing the hemisphere may result in additional manual adaption effort:

- Changing the hemisphere changes the names of the **orientations in standard format**. Inputs connections related to these orientations will be disconnected after "updating building variables" in the TRNSYS Studio. They have to be reconnected manually. If the new feature "internal radiation calculation" is used no connections for the orientations exits and no manual adaption is necessary. Therefore, users are encouraged to use the new feature "internal radiation calculation".

- Changing the hemisphere doesn't effect the names of **free formatted orientation**, but the azimuth angles as well as the rotation angle has to be adapted in the TRNSYS Studio manually.

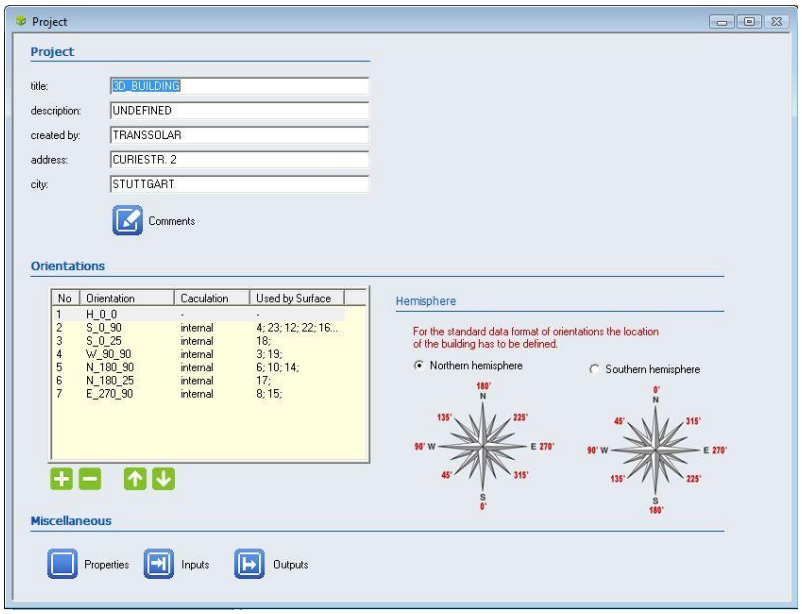


Figure 1.2.1-2: The PROJECT window

TRNSYS 17 projects using the standard format of orientations are assumed to on the northern hemisphere. If an older building project without standard orientations is opened in TRNBuild the user is asked to select the hemisphere.

1.2.2. Orientations

All possible orientations of external building walls/windows must be defined by unique names. In A standard format for orientation naming was introduced in TRNSYS 17. Because the hemisphere wasn't known version 17, the naming scheme which included the azimuth and slope of the orientation was limited to the convention azimuth for the northern hemisphere. In TRNSYS17.1, the naming scheme is adapted to acc. to TRNSYS convention:

Y_xxx_zzz

with
Y… single letter N, S, E, W or H
xxx… azimuth angle of the orientation acc. To TRNSYs convention (0…359 degree;
northern hemisphere: 0 … south; 90 … west, 180 … north, 270 … east
southern hemisphere: 180 south; 90 … west, 0 … north, 270 … east)
zzz… slope of the orientation (0…180; 0 … horizontal, 90 … vertical, 180 … facing down)

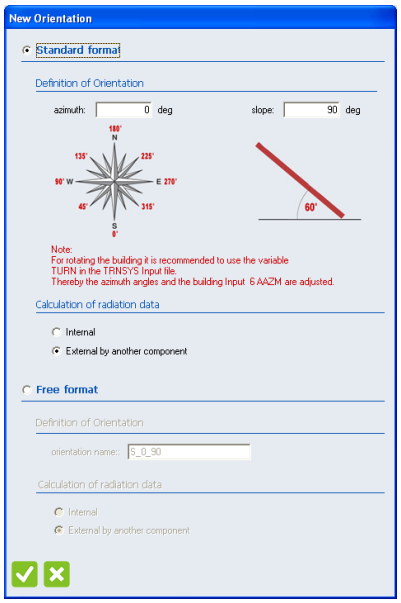
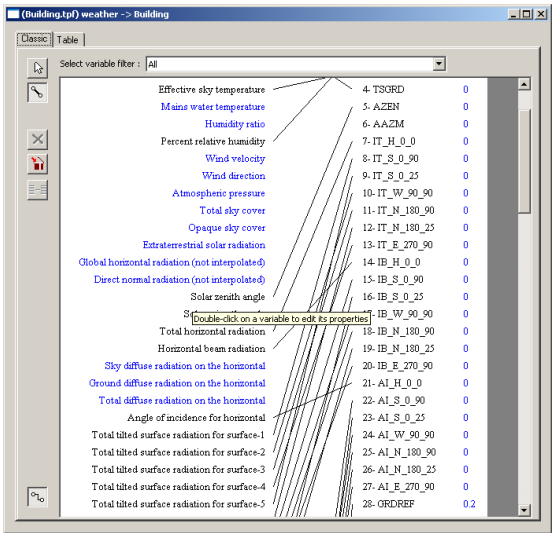
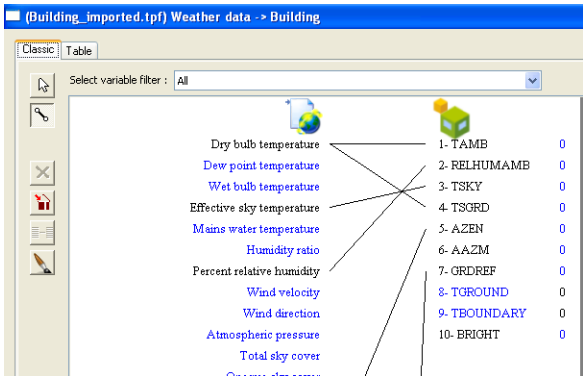


Figure 1.2.2-1: The NEW ORIENTATION window

The option "Internal calculation of radiation data" is a new feature of TRNSYS17.1 available for standard format only. This feature reduces the required input data from the weather data component significantly. For using this feature only the solar zenith (Input 5) has to be connected to the weather data component Type 15, Type16, Type99. Type 56 uses the new Trnsys functions GetConnectedUnitNumber of input 5 (solar zenith angle) and GetRadiationData as well as the new kernal routine GetIncidentRadiation for calculation the incident radiation for the oreintation.

For rotating the building using this new option it is recommended to define an equation TURN in the TRNSYS Input file (e.g. " TURN = 45 " for rotation of 45 degrees) and connect the rotated solar azimuth angle (AAZM_TYPE56 = SolarAzimuthAngle – TURN") to INPUT 6 of Type 56. If you use the studio wizards for creating a new building project the equations and connections are generated automatically.





external radiation calculation

Internal radiation connection

Figure 1.2.2-2: Connections within the Studio for different radiation calculation modes

In conjunction with the “internal calculated radiation data” the following new surface NTYPEs are available:

NTYPE 114	IB	Incident direct radiation on outside of external surfaces (without shading effects)	[kJ/hr]
NTYPE 115	ID	Incident diffuse radiation on outside of external surfaces (without shading effects)	[kJ/hr]
NTYPE 116	IT	Incident total radiation on outside of external surfaces (without shading effects)	[kJ/hr]

1.2.3. Integrated radiation control of shading devices

For user convenience, radiation depending control for shading devices of external windows has been integrated in the multizone building model. Basically, this feature replaces the external control with the ON/OFF controller (Type 2). For adjacent windows this feature isn't available and an external control by the ON/OFF controller (Type 2) can be used.

For activating this feature, the shading control has to be set to "integrated control" of the window definition in the airnode. The shading factor for the integrated control has to be specified for a completely closed shading device. The actual control (open or closed) is calculated by the given level of total incident radiation on the window plane acc. to the window type definition. Thereby, the total incident radiation is the total radiation in the plane of the window without geometrical shading effects (e.g. like a tilted radiation sensor on a roof). **Note:** The radiation level for closing has to be higher than for reopening. A difference (hysteresis) of at least 80 kJ/ h m² is recommended.

The control signal for integrated shading control is given by the new surface NTYPE 119:

NTYPE 119	SHADCNTRL	Shading control signal for integrated radiation depending shading of external windows (0..integrated shading control not active, 1.. integrated shading control active (=closed))	[-]

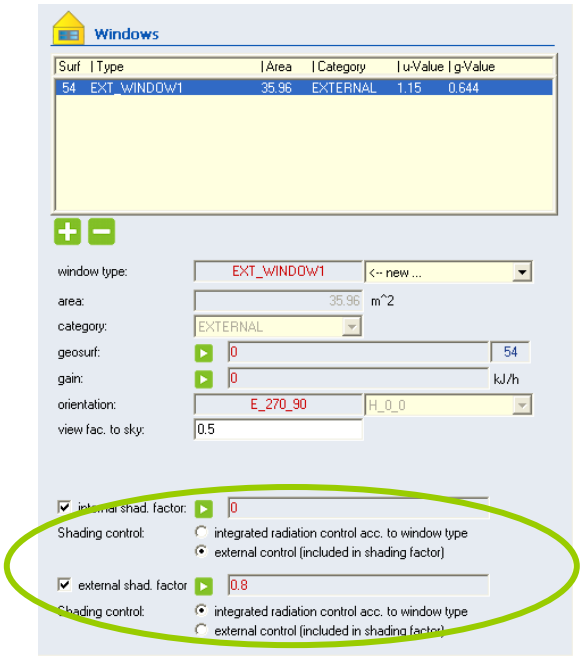


Figure 1.2.3-1: Definition of Integrated control of shading device of a window

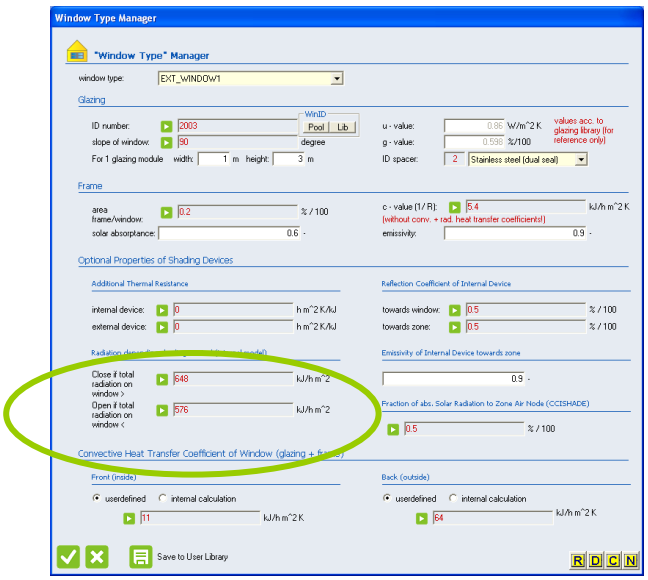


Figure 1.2.3-2: Definition of radiation level for integrated shading control

1.2.4. Radiation mode: Solar to Air Factor

In version 17.1, a so-called solar to air factor which is used in several standards is integrated. The solar to air factor (FSOLAIR) is the fraction of solar heat entering an airnode through the glazing which is immediately transferred as a convective gain to the internal air. This fraction depends on the quantity of internal items with very low thermal capacity such as furniture. Note: The solar to air factor is equal for all air nodes of a thermal zone as it is defined by the radiation mode settings!

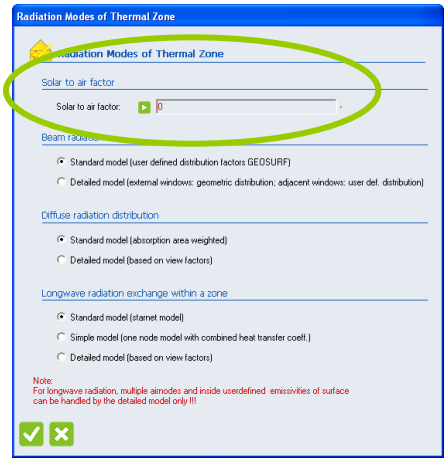


Figure 1.2.4-1: Definition of the Solar to Air Factor

The convective solar heat gain to the internal air QSOLAIR is given by a the new NTYPE 117

NTYPE 117	QSOLAIR	convective energy gain of airnode due transmitted solar radiation through external windows which is transformed immediately into a convective heat flow	[kJ/hr]

For atrium simulations, the solar to air factor can be used to take into account the effect of heat gains of the top airnode from lower airnodes due to a solar driven local convective flow near-by the vertical glazed façade. This local convective flow is introduced by absorbed solar gains of the construction behind the vertical glazed façade which isn't modeled explicitly. Therefore, the convective gain QSOLAIR of the lower airnodes have to subtracted from the lower nodes by defining negative gains and added to the top airnode as positive gain. The value of the solar to air factor strongly depends on the construction of the façade and has to be estimatied by the user (see Figure ??).

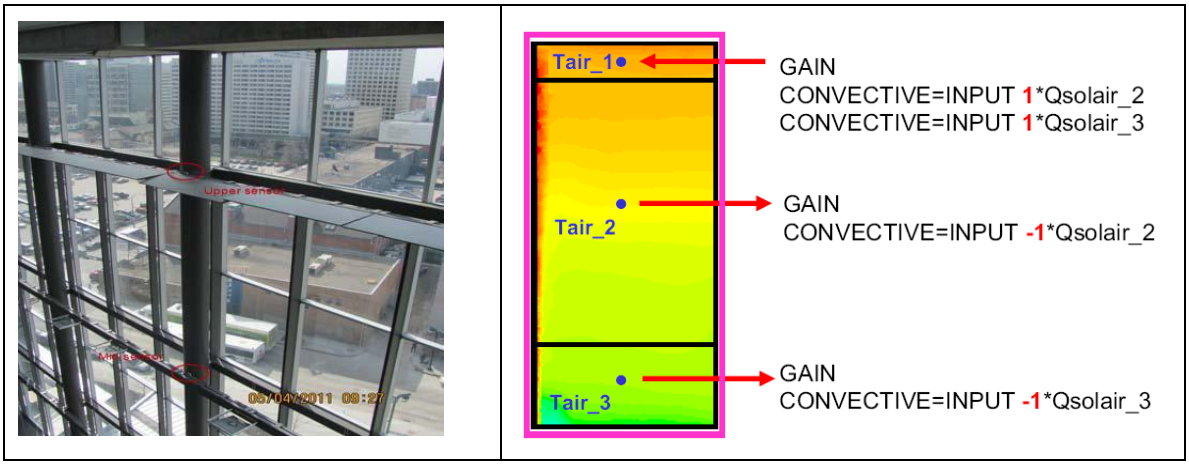


Figure 1.2.4-2: Atrium simulation - Moving solar conv. heat gains to the top airnode

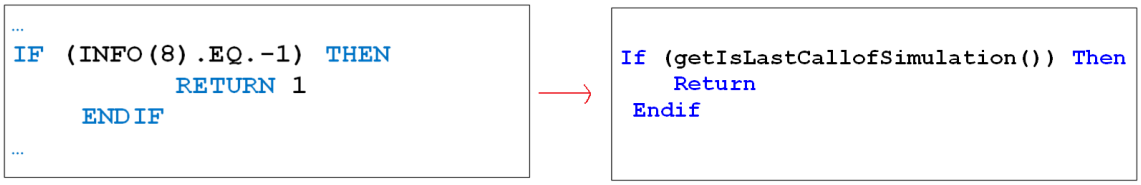
1.2.5. TYPE 56 – Improved algorithm for diffuse radiation distribution by the standard model

In Version 17.1, the primary diffuse radiation distribution of the standard mode is improved such that diffuse radiation entering a zone through an external window is distributed to all other surfaces except the window itself for the primary distribution.

Note: This improvement may change the simulation results with respect to previous versions. In general, the diffuse radiation distribution has a minor impact. However, for highly glazed zones without shading and high diffuse radiation gains this change has a large impact on the results.

1.3. TRNSYS Engine

The TRNSYS Engine has been improved to allow for the source code format and many additional access functions. In TRNSYS version 16 and before, the TRNSYS kernel automatically passed information to the TRNSYS components. Now in version 17.1, the components "**get**" the information that they need from the TRNSYS kernel using Access Functions (discussed more in the following section and in the *07-ProgrammersGuide.pdf* documentation in the TRNSYS software package). Thus, there is no need to write and decipher components with the infamous INFO array. The following figure below displays one of the new access functions from the former method with the INFO array. Nevertheless, the TRNSYS16 format of writing component with the INFO array is still compatible with the TRNSYS 17.1 Engine.



1.4. TRNSYS Components New Format

The TRNSYS Standard Library of components now has the new version 17.1 source code formulation that uses the TRNSYS Access Functions to "set" and "get" the information. The goal of the new source code format was to provide a more intuitive way for the end-user to create and interpret the source TRNSYS Standard components and add-on components as well. The following figure is an example of some of the access functions that are implemented in the source code of TRNSYS Standard Library of Components.

```
!------------------------------------------------------------------------
!Do All of the "Very First Call of the Simulation Manipulations" Here
 If (getIsFirstCallofSimulation()) Then

!  Tell the TRNSYS Engine How This Type Works
    Call SetNumberofParameters(4)
    Call SetNumberofInputs(5)
    Call SetNumberofDerivatives(0)
    Call SetNumberofOutputs(5)
    … … …

!  Set the Correct Input and Output Variable Types
    Call SetInputUnits(1,'TE1')
    Call SetInputUnits(2,'MF1')
    … … …
```

The components with new access functions also have functions to prompt a fatal error when a parameter or input is out of acceptable range, *FoundBadParameter* and *FoundBadInput*, respectively. This replaces the call to TYPECK of the previous source code formulation to provide the end-user with better and more informative error messaging.

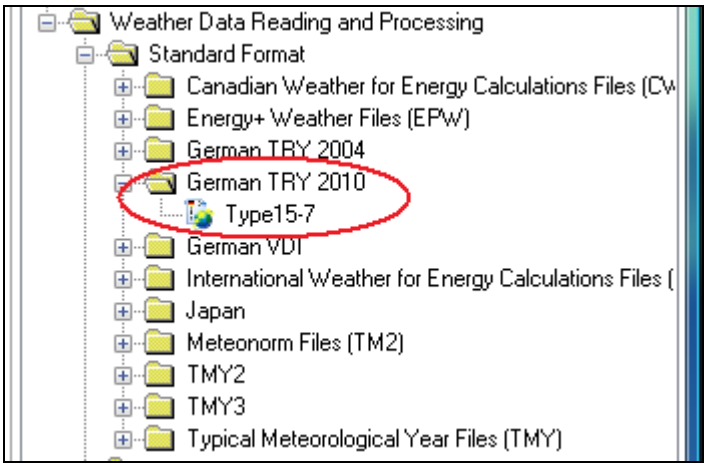
```
!  Read in the Values of the Parameters from the Input File
    qmax = getParameterValue(1)
    cp = getParameterValue(2)
    ua = getParameterValue(3)
    htreff = getParameterValue(4)

!  Check the Parameters for Problems
    If (qmax<0.) Call FoundBadParameter(1,'Fatal','The capacity must be...')
    If (cp<0.) Call FoundBadParameter(2,'Fatal','The specific heat...')

… … …

! Set outputs
    Call SetOutputValue(1,tout)
    Call SetOutputValue(2,flow)
    Call SetOutputValue(3,qaux)
    Call SetOutputValue(4,qloss)
    Call SetOutputValue(5,qfluid)
```

As discussed in section 1.8.2 of the *01-GettingStarted.pdf* manual, a user can create the shell of a new component in the interface, the TRNSYS Simulation Studio, and export that information to a fortran template to quickly and intuitively create a new component for TRNSYS.

1.5. New Components

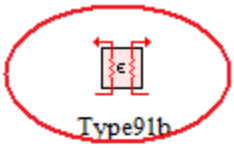
1.5.1. Type15 – TRY Mode 2010

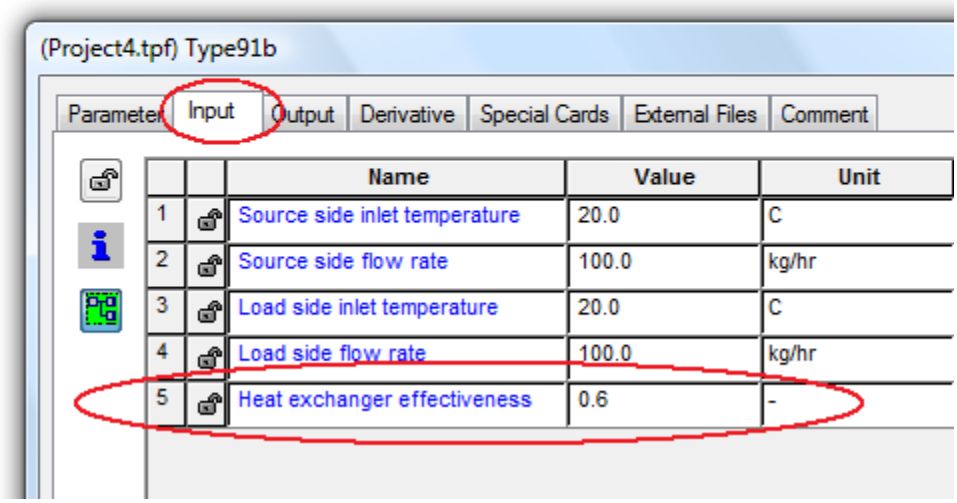
This new component for TRNSYS is compatable with the German TRY has been implemented with the TRNSYS Weather Reader and Radiation Processor component, Type15.



1.5.2. Type91 – Input Effectiveness Heat Exchanger

The Type91 TRNSYS Heat Exchanger component now has the ability to have the effectiveness of the heat exchanger as an input. Thus, the effectiveness does not necessarily have to be constant throughout the entire simulation as a time-independent parameter as with the other mode of Type91, but the effectiveness can now vary throughout the course of the simulation as an input


Type91b


(Project4.tpf) Type91b
Parameter
Input
Output
Derivative
Special Cards
External Files
Comment
Name
Value
Unit
1 Source side inlet temperature 20.0 C
2 Source side flow rate 100.0 kg/hr
3 Load side inlet temperature 20.0 C
4 Load side flow rate 100.0 kg/hr
5 Heat exchanger effectiveness 0.6 -

1.6. TRNSYS AddOns

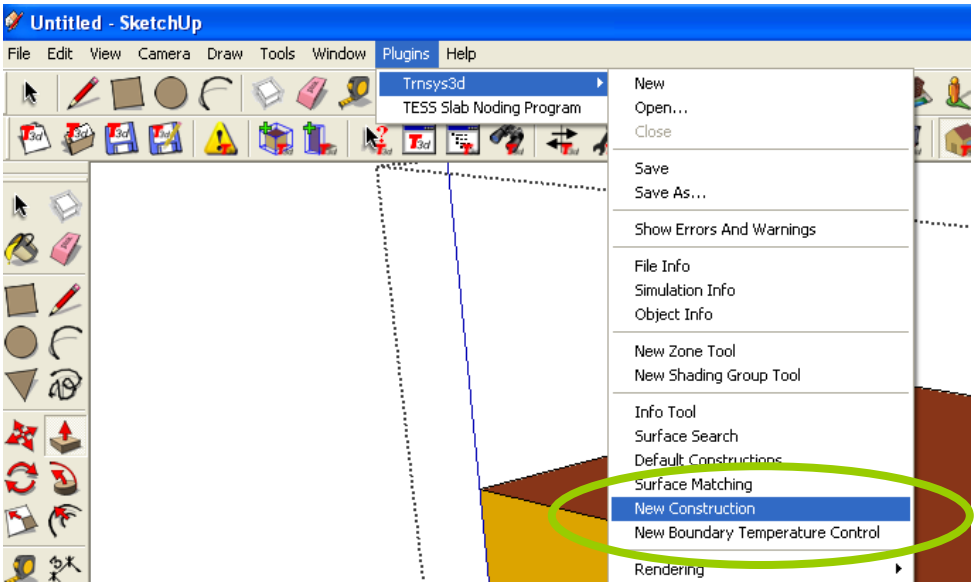
For user convenience, the install of TRNSYS 17.1 offers the option to install the two AddOns Trnsys3d and TRNviewSHMISM. The install copies the tutorials into the documentation folder of TRNSYS.

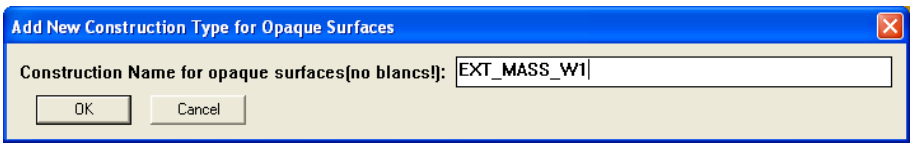
1.6.1. Trnsys3D Version 1.0.7

The updated version of Trnsys3d uses the new features of Trnsys17.1. It is recommended to use this version for TRNSYS version 17.1 only.

Definition of a new construction types for opaque surfaces

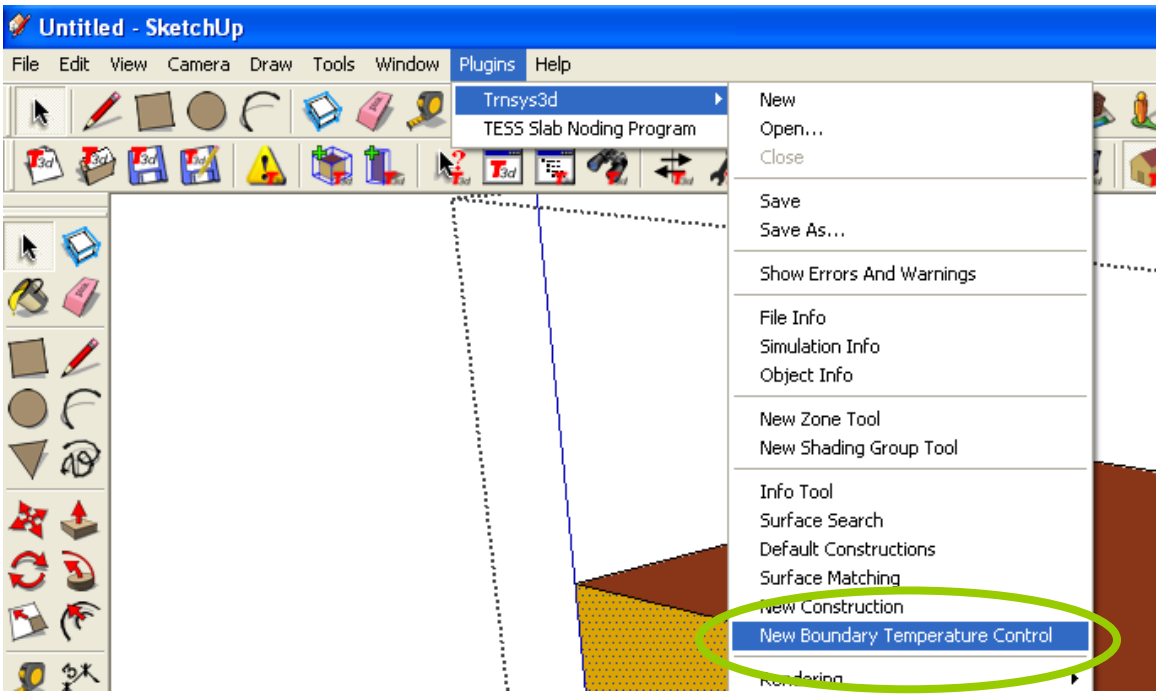
In addition to the existing construction types of opaque surfaces, new constructions can be defined by entering the name. Trnsys3d assigns a dummy layer to the new wall construction. In TRNBuild, the “real” layers are assigned by editing the construction.

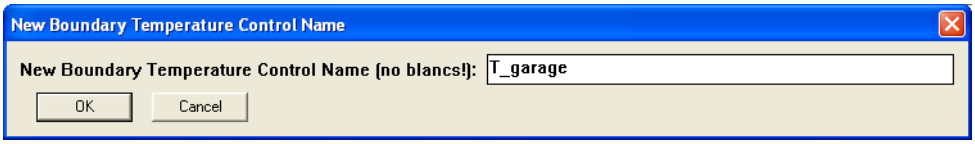


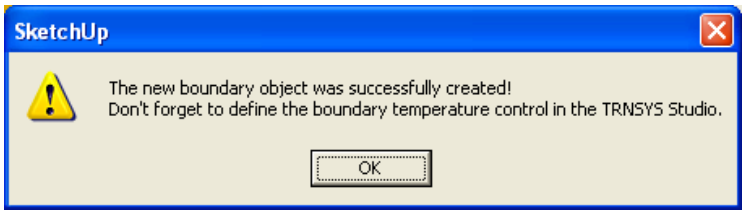


Definition of a new boundary temperature object

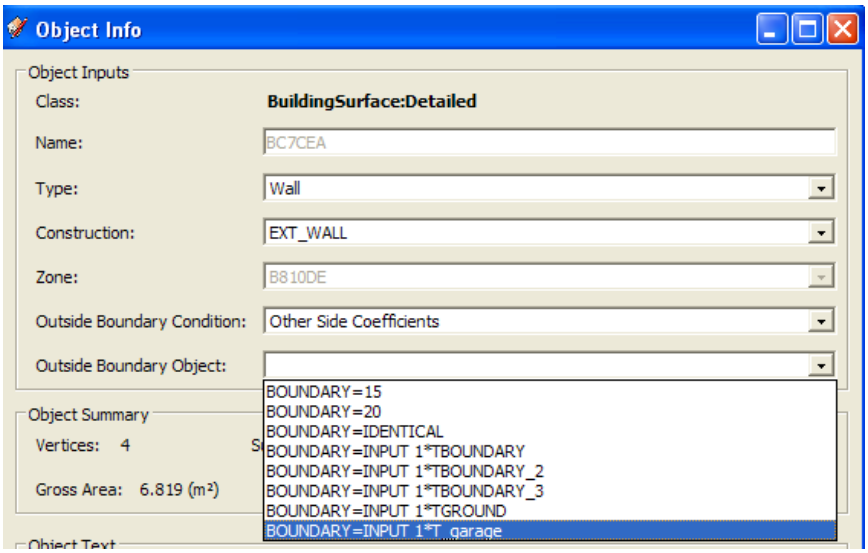
In addition to the existing outside boundary objects, new outside boundary temperatures for surfaces can be defined entering the name of the control. This name generates a new input which can be defined in the Trnsys Studio later.







The new boundary object appears in the list for “Outside Boundary Conditions = Other side Coefficients”.



Shading control for windows

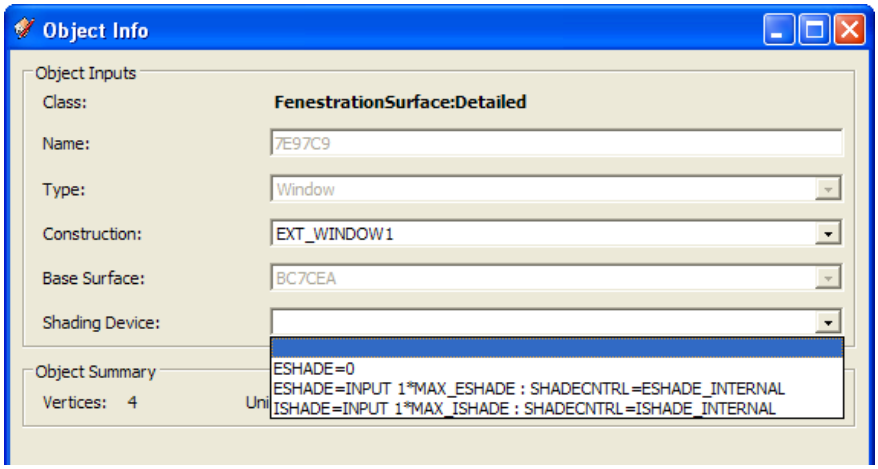
The new template file contains predefined shading controls for windows. There are three options available:

- ESHADE = 0
  -> no shading device

- ESHADE=INPUT 1*MAX_ESHADE ….
  -> external shading device

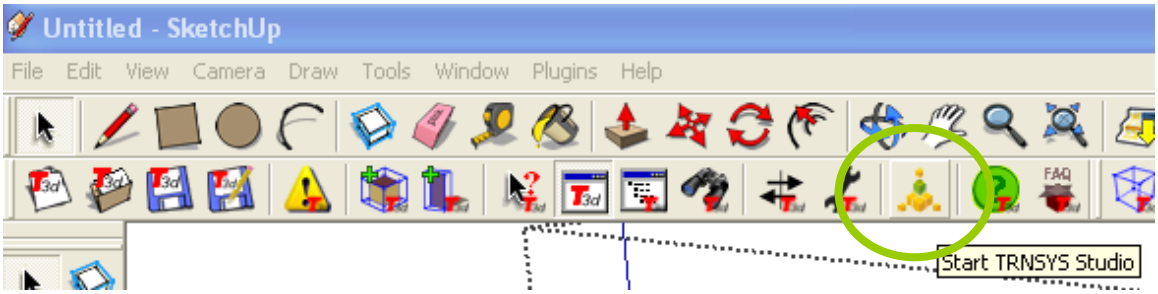
- ESHADE=INPUT 1*MAX_ISHADE ….
  -> external shading device

The maximum opaque fraction (MAX_ESHADE and MAXISHADE) as well as the radiation control are set by the building wizard of the Trnsys Studio (see section 1.1.1).

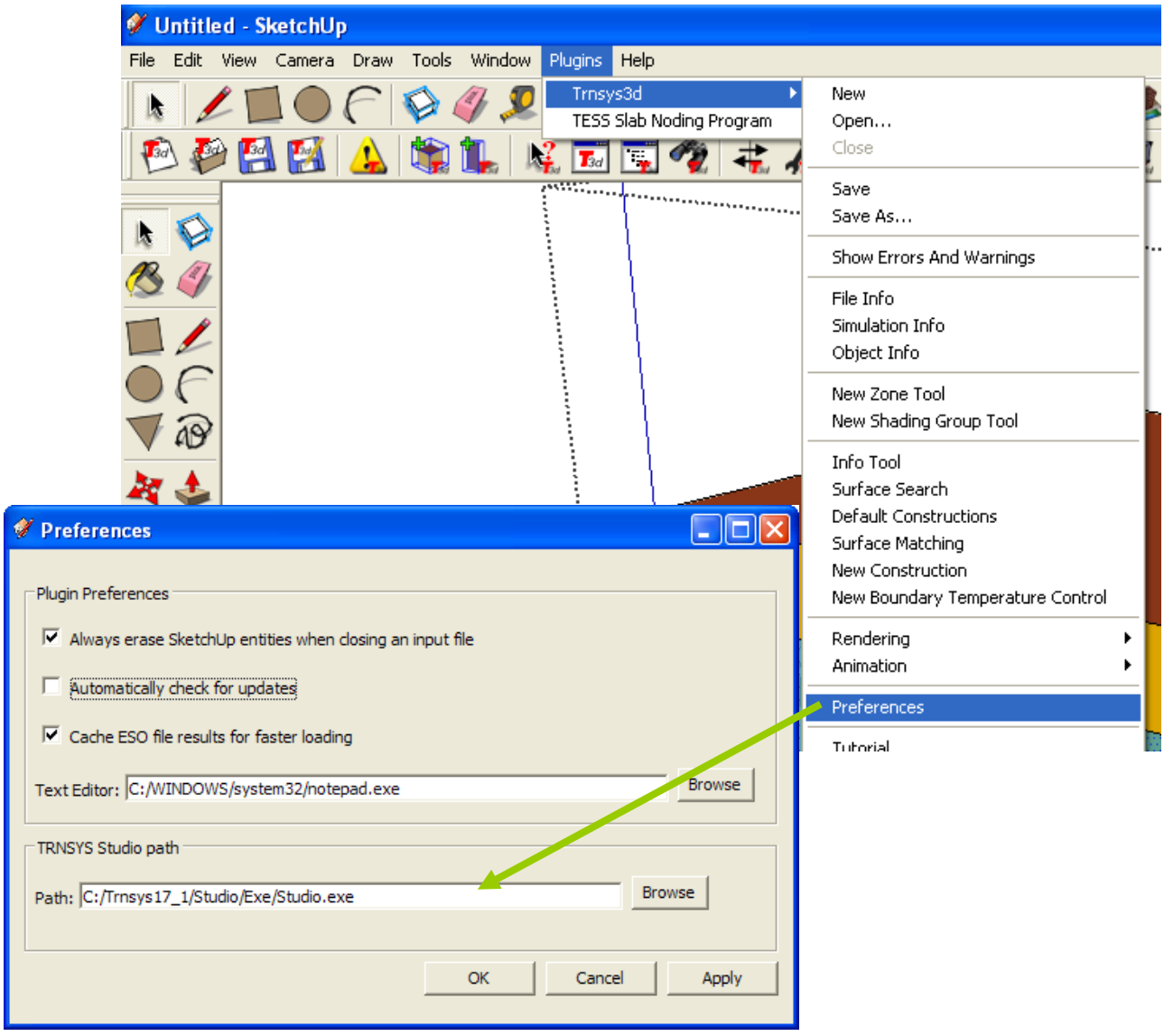


Starting the TRNSYS Studio within Trnsys3d

In the tool bar a new button Start TRNSYS Studio is integrated.



Please, double check the path for the TRNSYS Studio at Preferences first.



1.6.2. TRNviewSHMISM – Visualisation of Shading and Insolation matrices

TSNYS 17 applies shading / insolation matrices for the detailed solar radiation. These matrices are generated by TRNBuild and consist of sunlit fractions for each patch of the hemisphere. (See 05-MultizoneBuilding.pdf). For visualization of the matrices, a converter tool the TRNviewSHMISM_vxx.exe was developed. This tool converts the *.shm or *.ism file into *.obj files (linked in an *.album file) that can be automatically opened by the open source GLC Player. As a result the files are visualized like in the following figure 1.

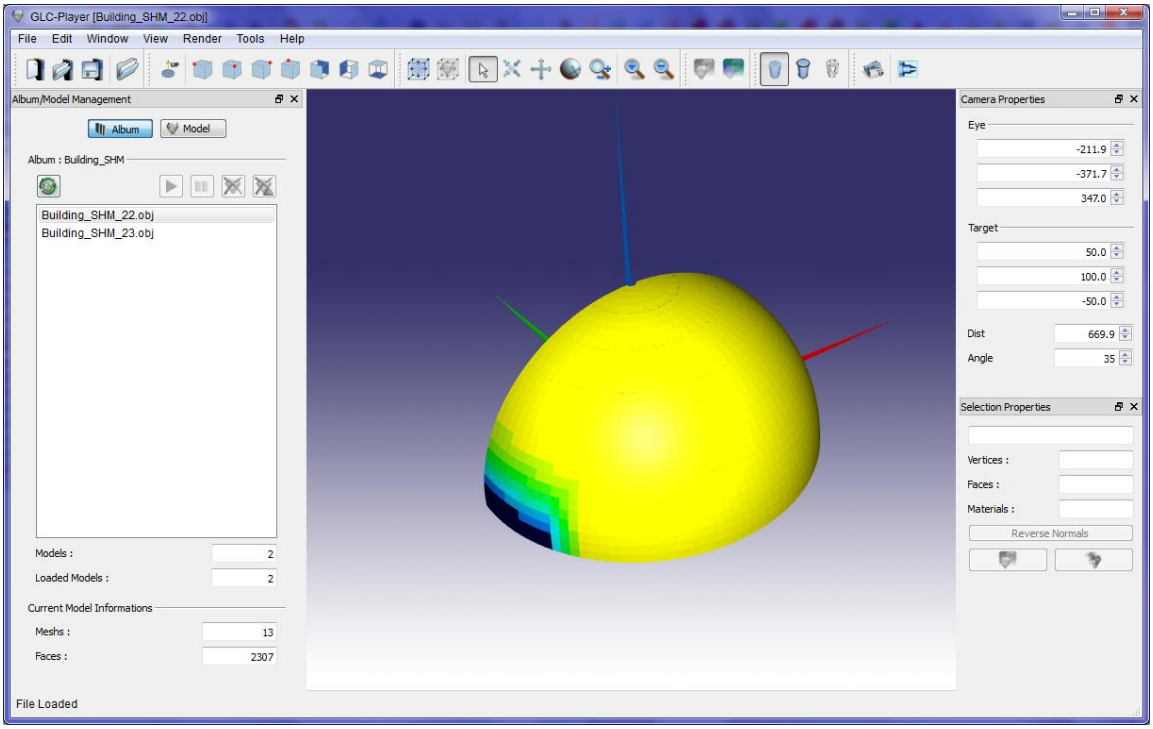


Figure 1.6.2-1: GLC player with visualized SHM information for window 22