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SimulEICon Multi-Objective Decision-Support Tool for Autodesk Revit 2012

# Aim of This Document

This document contains information on the purpose and usage of the ***SimulEICon Multi-Objective Decision-Support Tool*** add-in for Autodesk Revit. For more information, please visit <http://web.eng.fiu.edu/~zhuy/BESI/Research/tcei.html>

# Installation

## What’s Included?

You can download a zip file from <http://web.eng.fiu.edu/~zhuy/BESI/Research/tcei.html>. It contains the following files:

* Add-in manifest file
* Add-in DLL file
* NSGAII executable
* SimulEICon Access database file

## Locations

In order to use the add-in, you will need to move certain files into an appropriate location. Below, example Revit Add-in locations are given for different Windows versions.

### Windows 7

* “C:\ProgramData\Autodesk\Revit\Addins\2012\”

### Windows XP

* “C:\Documents and Settings\All Users\Application Data\Autodesk\Revit\Addins\2012\”

## Installing the Add-in

1. Extract the zip archive (downloadable at <http://web.eng.fiu.edu/~zhuy/BESI/Research/tcei.html>).
2. Place the Add-in DLL file in the desired location (e.g. “C:\Program Files\Autodesk\”)
3. Edit the Add-in manifest file to point to the DLL location. (See )
   1. Set the both **<Assembly>** tag values to the path to the DLL file chosen in the previous step.
4. Place the Add-in manifest file in the appropriate location. (See section)



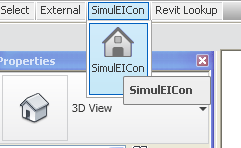
Figure

# Using the SimulEICon Add-In

Once installed, the SimulEICon add-in will be available from the Add-Ins tab of the ribbon. Figure 2 shows the tab within the ribbon. shows the SimulEICon button available within the Add-ins tab choices. **Note:** At this time, in order to select the SimulEICon button, a Revit model must be open. While viewing previous results does not require a model, using any other functionality does.

revit2012_ribbon.png

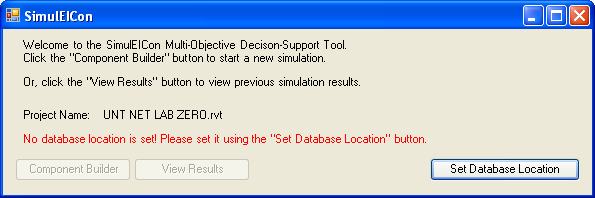
Figure



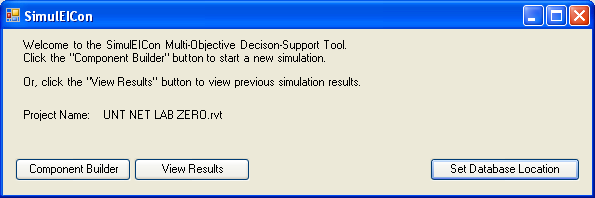
Figure

## Startup

The main window of the Add-in displays the current model name and allows users to view previous simulation results, or begin using the primary functionality. and show the main window.



Figure



Figure

## Selecting the Database File

In order to use SimulEICon, the user must specify the location of the database containing material and assembly information. This database is used in providing options and calculating the cost, environmental impact, and duration needed for different materials and assemblies.

When started, the SimulEICon add-in will search for a known database. If one is not found, the main functionality will be disabled until the user specifies a database file.

To specify a database file:

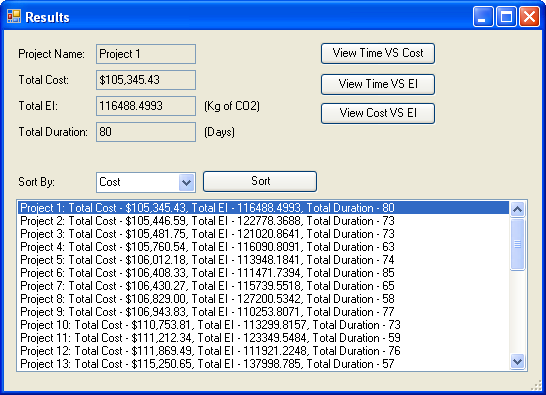
1. Open the SimulEICon add-in.
2. Select the “Set Database Location” button.
3. Choose an appropriate MS Access database file.

Once a database file has been chosen, it should persist throughout the use of the Add-in. It can be changed by using the “Set Database Location” button again.

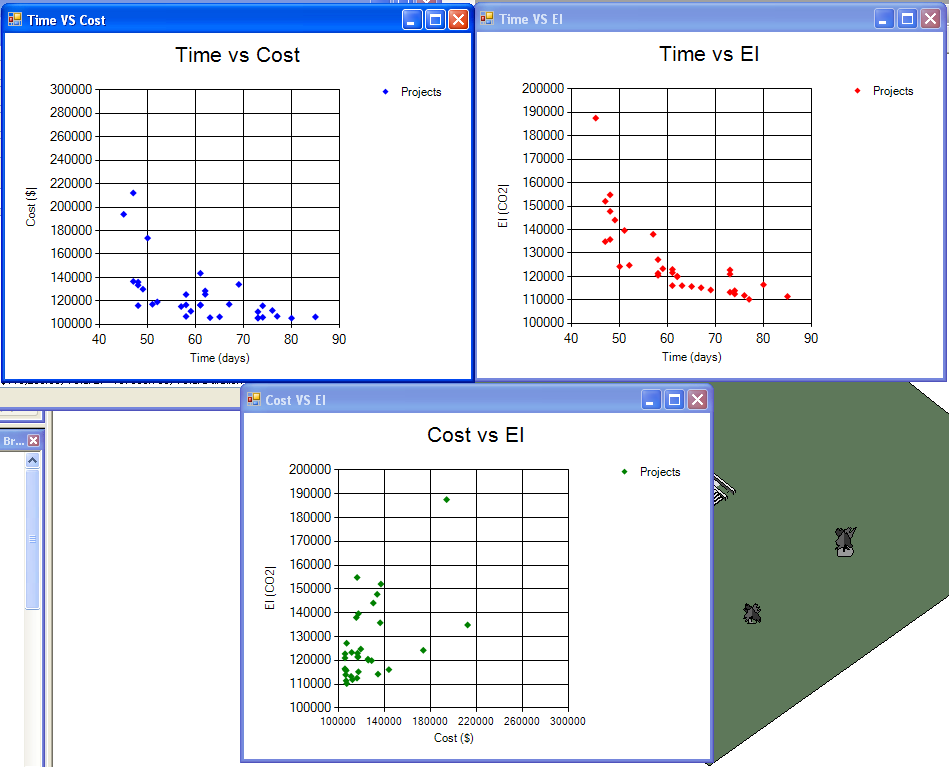
## Viewing Previous Results

To view previous simulation results, click on the “View Results” button in the main window. The user will be prompted for a results file, which is in the XML file format. Once selected, you may view the list of the resulting projects from the simulation. Figure 6 shows an example set of results.

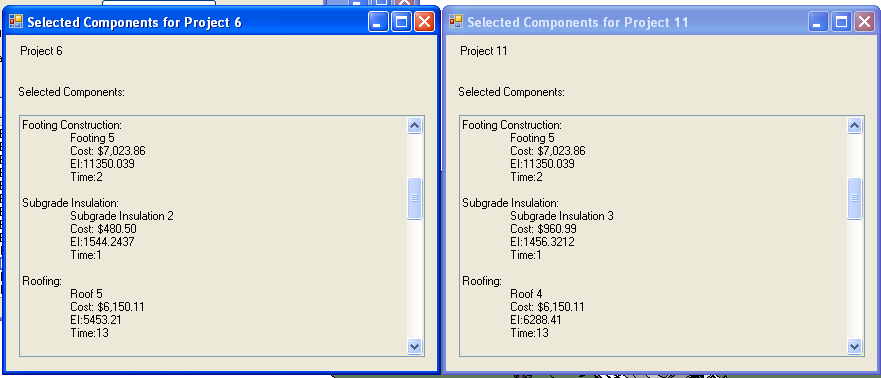
Selecting a single project will display basic information about it, including its name and estimated objective values. Listed projects can also be sorted in ascending order based on one of three objectives: time, cost, or environmental impact (EI). Users can also view scatter plot graphs comparing the different objectives. Figure 7 shows the different graphs available. Finally, users can open each project to see what components were selected for them, shown in Figure 8.



Figure



Figure



Figure

## Defining Component and Precedence Files for Optimization

SimulEICon attempts to find a set of solutions that optimize three objectives: time, cost, and EI. Valid solutions are “balanced”, meaning that no one solution completely beats out another in all three objectives. The objectives in this case aim to be minimized. The lower the time, cost, and environmental impacts are, the more optimal the solution. The NSGA-II[[1]](#footnote-2) is currently used to solve this multi-objective optimization problem.

In order to use the NSGA-II algorithm, two primary files require definition by the user. The first contains a set of components (or activities) based on the selected BIM model. For each component, one or more options may be selected. Each option contains information about itself, including estimated time, cost and EI. The second file contains the precedence order of the defined components. This is similar to a project schedule. It is used to help calculate the total duration of a project (one of the objectives) based on the time needed for each individual component.

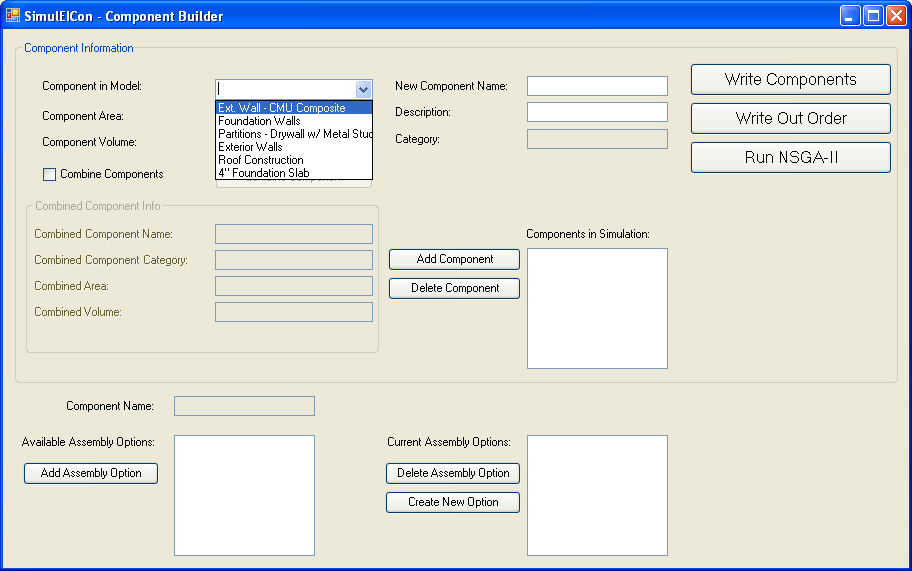
A third, optional file may also be specified by the user. This file is used to incorporate EnergyPlus[[2]](#footnote-3) energy simulation data into cost and EI calculations for projects. If this file is included, it is assumed that energy simulation data already exists and can be referenced.

The following sections give details on the functionalities available to help users define these files.

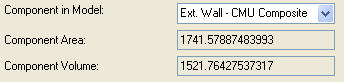
### Creating the Component File

#### Selecting Components from the BIM Model

From the main window, users can select the “Component Builder” button. This will bring up the Component Builder window. It is here that uses will be able to define component and precedence files using data retrieved from the underlying BIM model. As seen in Figure 9, wall, flooring, and roofing data are extracted from the BIM model, and made available in a list of components from the model. Once a component is selected from the model, its area and volume are displayed, as seen in Figure 10.



Figure



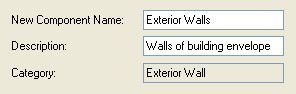
Figure

#### Adding Components from the Model into the Component File

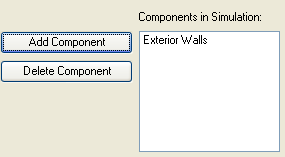
Once a user has decided a component from the model should be included in a simulation, he or she must include that component in a list of components that will be inserted into the Component File. When doing so, a name must be given to the component (see Figure 11). It does not have to be the same as the name of the component from the Model. If a component is selected from the model, a category may appear. Many components within a BIM model have categories in Revit. These categories are currently used by the add-in to retrieve available options from an external data source. When completed, the new component will be listed as seen in Figure 12.

To add a component from the model to the list of components used in the simulation:

1. Select a component from the model.
2. Enter a name that will be used for this component in the Component File.
3. Optionally enter a description.
4. Click the “Add Component” button.



Figure



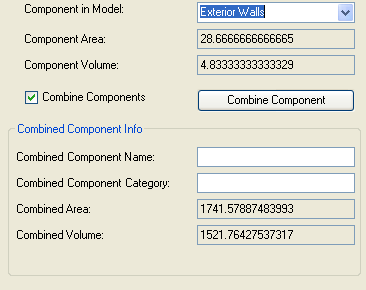
Figure

#### Combining Components from the Model

It is also possible to combine multiple components from the model into one component for use in the Component File. The combined area and volume is the sum of the individual component areas and volumes. Once combined, the new component can be named and given a category (see Figure 13), and finally added to the list of components in the Component File.

To combine components from the model and then add them to the simulation:

1. Check the “Combine Components” checkbox.
2. Select a component from the model.
3. Click the “Combine Component” button.
4. Repeat 2 – 3 until desired components are combined.
5. Enter a component name for the combined components.
6. Enter a category for the combined components.
7. Click the “Add Component” button.



Figure

#### Removing a Defined Component

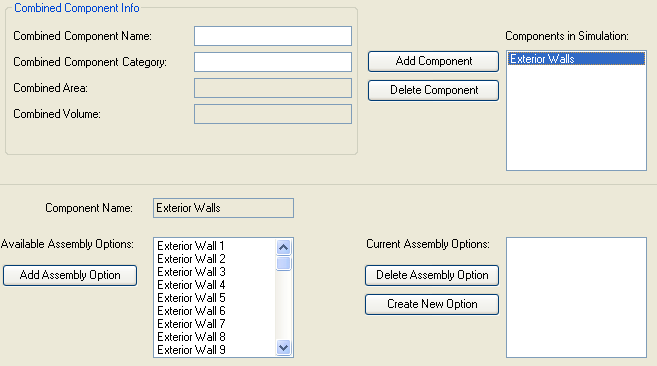
To delete a defined component (i.e. not include it in the component file creation):

1. Select the component from the “Components in Simulation” list.
2. Click the “Delete Component” button.

#### Selecting Options for the Component File

Once an item has been added to the list, “Components in Simulation”, it can have multiple options associated with it. These options are used during optimization as alternatives for the different the components. Currently, options for a selected component are retrieved based on the general category of the component. For example, in Figure 11, the new component “Exterior Walls” has the category “Exterior Wall”. This means when that component is selected, options that have the same category will be retrieved from the database.

Available options are loaded into the “Available Assembly Option” list. Once there, any option can be double clicked to view details about it, including materials, costs, and EI (see Figure 15.



Figure

1. For more information on NSGA-II, please see: <http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=996017> . [↑](#footnote-ref-2)
2. Visit [here](http://apps1.eere.energy.gov/buildings/energyplus/?utm_source=EnergyPlus&utm_medium=redirect&utm_campaign=EnergyPlus%2Bredirect%2B1) for information about EnergyPlus. [↑](#footnote-ref-3)