# Exchanging Information with Mathcad 2000+

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## Before you begin…

It is assumed that you are already familiar with the VisSim interface. If you have questions on how to perform basic VisSim operations, see the *VisSim User's Guide* (VISSIM_UGvV40.PDF).

It is also assumed that you have installed Mathcad 2000+ on your computer. If you need to purchase Mathcad 2000+, contact the Visual Solutions sales department.

## Exchanging information with VisSim and Mathcad 2000+

The primary purpose of embedding a Mathcad document is to run a simulation in VisSim that depends on one or more Mathcad calculations. These calculations could be performed:

- To provide initial conditions for a VisSim simulation (evaluated once at the beginning)
- As a part of the simulation (evaluated at every simulation step)
- Using the end results of a VisSim simulation as inputs (evaluated only once at the end)

### Use of the in*x* and out*x* keywords

The fundamental means of setting up the exchange of data between a VisSim simulation and an embedded Mathcad document is the use of the keywords in*x*, and out*x* in the embedded Mathcad document.

- The keywords in0, in1, in2,… refer to the corresponding input connector tabs on the an embedded Mathcad document, where in0 corresponds to the top input connector.
- The keywords out0, out1, out2,… refer to the corresponding output connector tabs on the an embedded Mathcad document, where out0 corresponds to the top output connector.

Note that all keywords must be lowercase.

## Embedding Mathcad documents

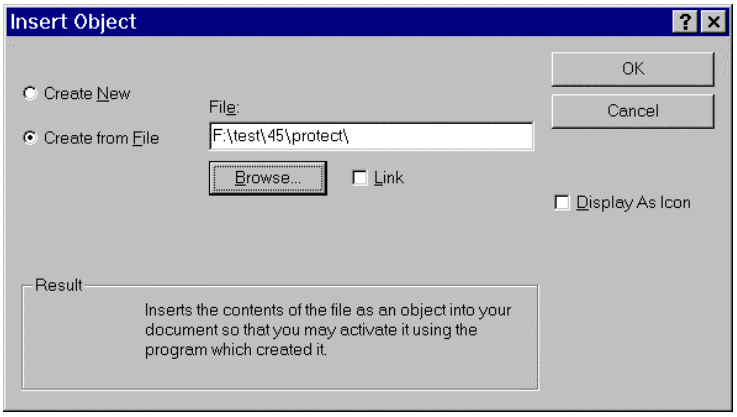
You can embed existing objects from files or insert new blank objects and create the information right in your diagram. To do so, you use the Insert Mathcad Object command in the Tools menu.

The following procedures explain how to embed objects in a VisSim diagram. For a step-by-step example on embedding a Mathcad document in a VisSim diagram, see the example under "Setting up a simple calculation in an embedded Mathcad document," later in this document.

▶ **To embed an existing Mathcad document**

1. Choose Tools > Insert Mathcad Object.

   The Insert Object dialog appears.

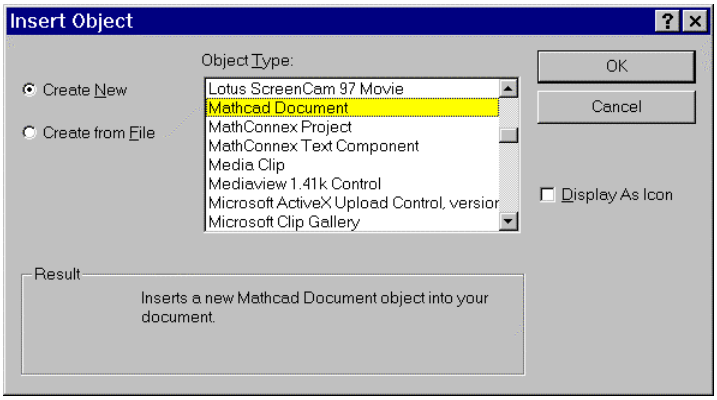



2. Activate the Create from File option.
3. Click on the Browse button to find the Mathcad document (.mcd) you want to embed in your VisSim diagram.
4. Click on the OK button, or press ENTER.

▶ **To embed a new Mathcad document**

1. Choose Tools > Insert Mathcad Object.

   The Insert Object dialog appears.




2. Activate the Create New option.
3. In the Object Type list box, select Mathcad Document.
4. Choose the OK button, or press ENTER.

## Editing and updating Mathcad documents

To edit and update an embedded Mathcad document is simple: just double-click on the embedded document. The editing environment automatically switches to Mathcad, with automatic in-place replacement of menus and options. After completing the editing, to update the embedded Mathcad document and return to the VisSim environment, simply click outside the Mathcad document.

▶ **To edit an embedded Mathcad document**

1. Double-click on the embedded Mathcad document.
2. VisSim opens a Mathcad window with the Mathcad document.
3. Make the changes you want.

4. Click outside the Mathcad document to return to VisSim.

## Scaling and cropping embedded Mathcad documents

You can resize an embedded Mathcad document by scaling or cropping it. When you scale an embedded Mathcad document, the text within the block is also scaled. When the dimensions of the embedded Mathcad document are much larger than the text, you can adjust the size of the block by cropping its sides. The size of the text within the block is not affected by this action.

▶ **To scale an embedded Mathcad document**

1. Double-click on the embedded Mathcad document.
2. Position the pointer over one of the handles on the block.
3. Hold down the mouse button and drag until the block is the size you want.
4. Click outside the Mathcad document to return to VisSim.

▶ **To crop an embedded Mathcad document**

1. Double-click on embedded Mathcad document.
2. Position the pointer over one of the handles on the block.
3. Hold down the mouse button and drag until the block is the size you want.
4. Click outside the Mathcad document to return to VisSim.

## Changing the number of connector tabs on an embedded Mathcad document

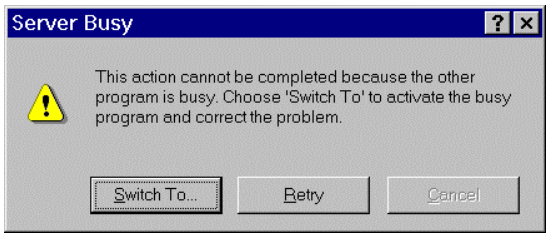
To add or delete connectors to an embedded Mathcad document, follow the standard procedures for adding or deleting connectors on VisSim blocks. Refer to the *VisSim User's Guide* for details on adding or deleting block connectors.

# Troubleshooting

This section contains information that may help you work through problems you encounter.

## Server Busy message

Occasionally, when VisSim loads the Mathcad interface OLE control for the first time, you may experience a delay and the appearance of the following message:




Just click on the Retry button a few times. Once the control is fully loaded, you will not see this message for the rest of your session.

## Incorrect results

The most common reason for getting unexpected results when using an embedded Mathcad document is due to input/output mismatch caused by incorrect numbering.

When you are entering an expression or equation in an embedded Mathcad document, it is important to remember that the input and output keywords begin with the index of 0, and not 1. In other words, the first (that is, top) input connector on the embedded Mathcad document is represented in the Mathcad expressions by the keyword in0; the second input by the keyword in1, and so on. Similarly on the output side, the first (that is, top) output of the embedded Mathcad document takes the value defined by the keyword out0; the second output takes the value of out1, and so on.

For examples of setting up the input-output relationship in an embedded Mathcad document, see the pre-configured examples in the /MATHCAD_EXAMPLES directory. Brief descriptions of these examples can be found under "Pre-configured examples."

# Setting up a simple calculation in an embedded Mathcad document

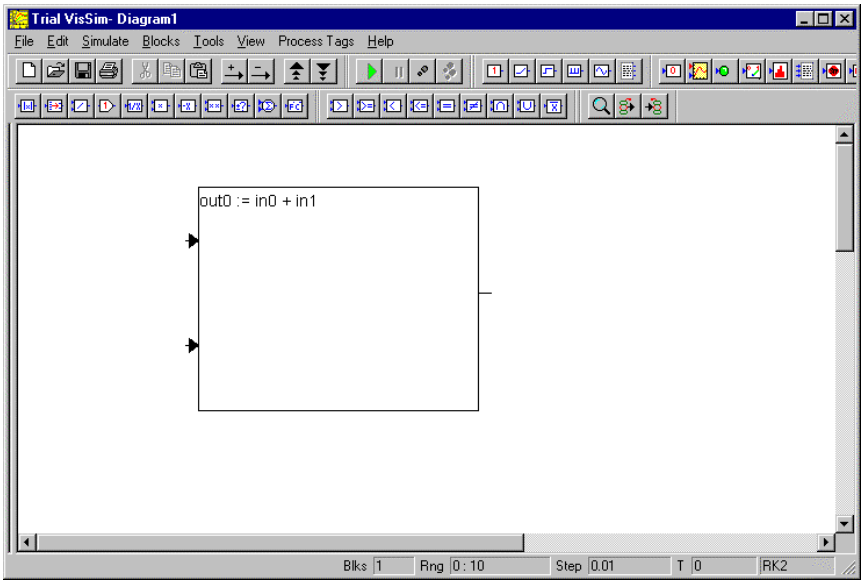
This example passes two values to Mathcad. Mathcad performs a simple arithmetic operation and returns the result to VisSim. This example is included in the …/MATHCAD_EXAMPLES directory and is named SIMPLE_EXAMPLE.VSM.

1. Start VisSim.
2. Choose Tools > Insert Mathcad Object.
3. In the Insert Object dialog box, do the following:
   - Activate the Create New option.
   - Select Mathcad Document from the Object Type list box.
   - Click on the OK button, or press ENTER.

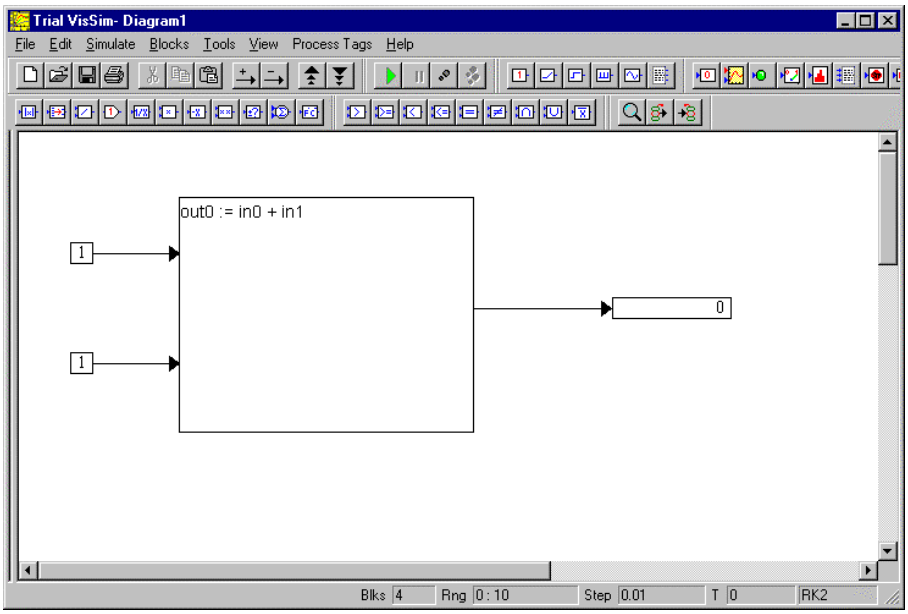
   VisSim creates a Mathcad object window. The environment automatically changes to the standard Mathcad editing work-area.
4. In the Mathcad object window, type the following expression:

   ```
   out0 := in0 + in1
   ```

   **Important**: The keywords out0, in0, and in1 must be lowercase.
5. Click outside the Mathcad object window to return to the VisSim editing environment. The menus automatically change back to VisSim menus.
6. Attach one more input connector tab to the embedded Mathcad document.



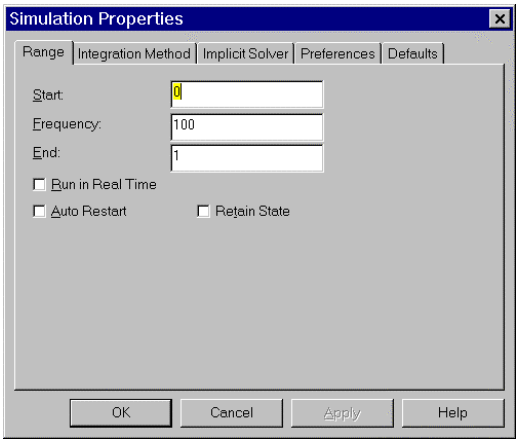

7. Wire two `const` blocks (Blocks > Signal Producer > `const`) to the inputs on the embedded Mathcad document and set their parameter values to 3 and 4; then wire a numerical `display` block (Blocks > Signal Consumer > `display`) to the output on the embedded Mathcad document to see the result.



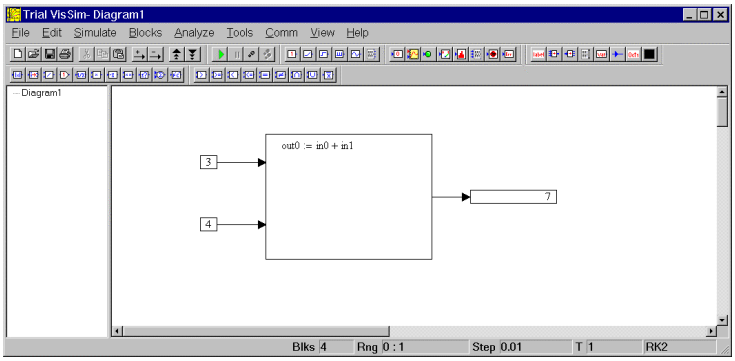

8. Choose Simulate > Simulation Properties.

   The Simulation Properties dialog box appears.

9. Set the Start and End values to 0 and 1, respectively.




10. Click on the OK button, or press ENTER.
11. Choose Simulate > Go, or click on the Run button in the toolbar. You can alternatively press the F5 key on your keyboard.
12. VisSim passes the values of the constants you have selected to Mathcad via the embedded Mathcad document, obtains the computed output value, and displays it in the `display` block.




# Pre-configured examples

Several pre-configured examples have been included to help you use and evaluate the Mathcad simulation interface. These examples are located in the .../MATHCAD_EXAMPLES directory in which VisSim/Comm 4.5 was installed, and are briefly described below.

## Communications system examples

### Fourier and wavelet transforms: FFT_WAV_MC.VSM

In this simulation, sinusoid signals are generated, buffered, and transposed using VisSim/Comm blocks. The FFT and wavelet transforms are implemented as triggered embedded Mathcad documents and the resulting transformed signals are visualized using VisSim `plot` blocks.

### 8PAM equalizer example: PAM8EQ_MC.VSM

An 8PAM equalizer system is simulated in this example. The 8PAM modulator is set to have a constellation spacing of 2 V and connected to a $6^{th}$ order 5 Hz Chebyshev low pass filter. The external taps for the five tap equalizer are read from an embedded Mathcad document. Since these taps need to be read only once at the beginning of the simulation, the Mathcad document is embedded inside a triggered compound block and the `$firstPass` system variable is used as the trigger.

### Rayleigh fading channel: RAYLEIGH_MC.VSM

The effects of Rayleigh fading on a CW signal are simulated in this model. The phase delta calculations in the form of an if-then-else structure are performed in Mathcad while the communications system blocks and the actual system simulation are performed in VisSim/Comm.

In this model, the Rayleigh channel is assumed to have an RMS Doppler spread of 1 Hz and the average power is calculated using a 2 sec sliding window. The test input complex tone has an amplitude of 1 V, power of 1 W, and a frequency of 5 Hz.

### Room temperature control: ROOMCTRL_MC.VSM

This model simulates the closed-loop temperature control of a room, with calculations being performed simultaneously in VisSim/Comm and Mathcad based on a bi-directional exchange of computational results at every simulation step.

The controller itself is a simple yet realistic ON-OFF controller with deadband. Most commercial and domestic room temperature controllers use this implementation. In this simulation, the deadband is implemented in an embedded Mathcad document, and the rest of the simulation including numerical integration and dynamic room model with randomly varying number of occupants, is implemented in VisSim.

### Trellis coding: V32TRELS_MC.VSM

This example illustrates an implementation of the V.32 trellis coding scheme. The information bit stream is encoded, distorted, and then recovered.

The trellis encoding scheme in this example is an eight-state scheme that has four input bits and five output bits. The distortion is implemented using an AWGN channel model with a signal-to-noise ratio of 20 dB. The decoder is set to a truncation length of 10. Most of the system is implemented in VisSim/Comm while the evaluation of a simple polynomial is performed simultaneously in Mathcad.

## Multi-rate and conditional execution of embedded Mathcad calculations

To run Mathcad calculations at a rate different from the simulation rate in VisSim, or to simply speed up the simulation, you can embed the Mathcad calculations inside a triggered compound block, as shown in RAYLEIGH_MC_TRIGGERED.VSM diagram. This model implements the exact same model as RAYLEIGH_MC.VSM except that the Mathcad calculations are executed at a frequency of 20 Hz (step size of 0.05) while the rest of the simulation runs at a frequency of 100 Hz (step size of 0.01.)

The difference in the speed of simulations can easily be observed by running the two models one after another and noting the total time taken to complete each simulation. Depending on the computer system being used, the triggered version takes about one third of the computational time taken by the regular un-triggered version.

For more information on running compound blocks in a VisSim diagram at different rates, see the *VisSim User's Guide*.