Using SmartSketch® with Mathcad

You will need Mathcad 8 Professional, Standard, or Professional Academic (including the latest Service Pack) to use the SmartSketch Component for Mathcad.

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With Mathcad and SmartSketch you can enjoy full interoperability without having to do any scripting or programming. You can quickly make changes from within either application and can easily turn your design ideas into precise, finished drawings. In seconds you can drive design dimensions from Mathcad and animate 2D CAD mechanisms. A few common usage scenarios represented by examples appearing in this folder are outlined below.

1. Static illustration of Mathcad computations using SmartSketch
> In this simplest usage scenario, a SmartSketch drawing can be embedded into a Mathcad worksheet as an illustration. SmartSketch does not participate in the computational flow of the Mathcad worksheet, but the drawing can be edited in-place via standard OLE in-place activation mechanism. *Creating a Static Drawing* section below explains how to create a static SmartSketch drawing in Mathcad. An example of this usage can be found in file **Belt.mcd**.

2. Dynamic illustration of Mathcad computations using SmartSketch
> In this scenario, inputs are passed from Mathcad into SmartSketch, and the SmartSketch drawing adjusts accordingly based on the passed parameters and constraints that are intrinsic to the drawing. The drawing is thus an "active," context-sensitive illustration of the calculations performed within the Mathcad worksheet. An example of this usage mode can be found in file **SimpleBeam.mcd**.

3. SmartSketch drawings as a data source for Mathcad calculations
> A SmartSketch drawing can also act as a data source for Mathcad calculations. An example of this usage is file **WindLoad.mcd**, where the geometry of a building (height, roof angle, etc.) is extracted from the drawing, letting you calculate (using Mathcad) whether the wind pressures are within limits defined by the appropriate ASCE standard. (Note: **WindLoad.mcd** will run in Mathcad 8 Professional only.) Another good example of this usage is **Ditch.mcd**, in which the amount of water that can be accommodated by a SmartSketch-drawn ditch is calculated in Mathcad.

4. Using Mathcad and SmartSketch to simulate mechanical systems (Mathcad Professional only)
> Mathcad, MathConnex, and SmartSketch together can be used to simulate mechanical systems. Probably the best example of this usage mode is the scotch yoke example (**Yoke.mxp**). Instead of solving the scotch yoke mechanism analytically, we use MathConnex and SmartSketch to simulate it dynamically, and then we use Mathcad to take the derivative of displacement to calculate angular velocity of the yoke. While the scotch yoke mechanism would be relatively easy to solve analytically, a more complex mechanism could be much harder to solve. SmartSketch+Mathconnex dynamic simulations become indispensable as the complexity of the mechanical system to be simulated increases. **BackHoe.mxp** is another good example that falls into this category.

5. Automated validation and verification of SmartSketch designs
> It is often important to determine whether the mechanical system or structure conforms to particular specifications. The structure can be drawn in SmartSketch, its parameters can then be extracted into Mathcad, where the spec verification calculation can then be performed. If the spec is not met, the design can be adjusted interactively by in-place activating the SmartSketch drawing, and the Mathcad validation portion of the worksheet will recalculate automatically for the new design parameters. The **WindLoad.mcd** file mentioned above is one example of this usage. Another good example is **Belt.mcd**, where the minimal force required for the belt not to slip is calculated in

Mathcad for a two-pulley system drawn in SmartSketch.

6. Compliance -- creating drawings from standard specifications
This scenario is reciprocal with respect to the previous one. Suppose we want to generate a drawing of a mechanical design that is subject to some specifications. We can use Mathcad to calculate the drawing parameters that will be in compliance with the specifications, and then feed these parameters to SmartSketch. SmartSketch will then dimension the drawing to precisely match the specs.

7. Displaying calculations on a SmartSketch drawing sheet
In this scenario SmartSketch is the container and the Mathcad calculations are embedded in the drawing sheet. Using the variable table and a user defined VB Script function the calculations are automatically updated each time the geometry is changed. See the **Samples\Mathcad\Ditch\ Ditch.igr** example in the SmartSketch folder.

Note: VB Script 5 or higher is required for this scenario, but is not delivered with SmartSketch. It can be downloaded from http://www.microsoft.com/vbscript.

The following sections explain how to use SmartSketch in conjunction with Mathcad to achieve the usage scenarios outlined above.

Creating a static drawing

You can insert a SmartSketch drawing into a Mathcad worksheet simply by:

1. Creating the drawing in SmartSketch (or opening an existing drawing from a file),
2. Drag-selecting the portion of the drawing that you want to use in your Mathcad worksheet,
3. Copying and pasting (or dragging and dropping) it into your Mathcad worksheet.

To create a static SmartSketch drawing from within Mathcad, insert an SmartSketch object into your worksheet. To do so:

1. Click in a blank spot in your Mathcad worksheet.
2. Choose **Object** from the **Insert** menu.
3. Choose SmartSketch Document and click "OK."
4. Use the SmartSketch menus and toolbars to create a drawing.

If you want to create a static drawing from within Mathcad from a previously created file:

1. Click "Create from File" in the Insert Object dialog box.
2. Type the path to the object file or click "Browse" to locate it.
3. Check "Link" to insert a linked object. Otherwise, the object is embedded.
4. Click "OK."

## Creating a new drawing that is computationally linked to your Mathcad worksheet

Although static drawings can add meaning to a Mathcad worksheet, you may find that you want your Mathcad equations and the drawing to be linked together. For example, you may want your Mathcad equations to drive the size or shape of a drawing. To create drawings that are linked to the variables in a Mathcad worksheet, use the SmartSketch component.

The SmartSketch component retrieves input from one or more Mathcad variables, uses them in the drawing, and may return output to one or more Mathcad variables. "Input" is data passed to the

SmartSketch drawing from an "input variable" in the Mathcad worksheet. "Output" is data passed to the Mathcad worksheet from the SmartSketch drawing and assigned to an "output variable."

To insert an SmartSketch component into your Mathcad worksheet:

1. Click in a blank spot in your worksheet. If you want to send values to the SmartSketch drawing from a Mathcad variable defined in your worksheet, click below or to the right of the variable definition.

2. Choose **Component** from the **Insert** menu. Select SmartSketch and click "Next." The first page of the SmartSketch component Wizard appears:
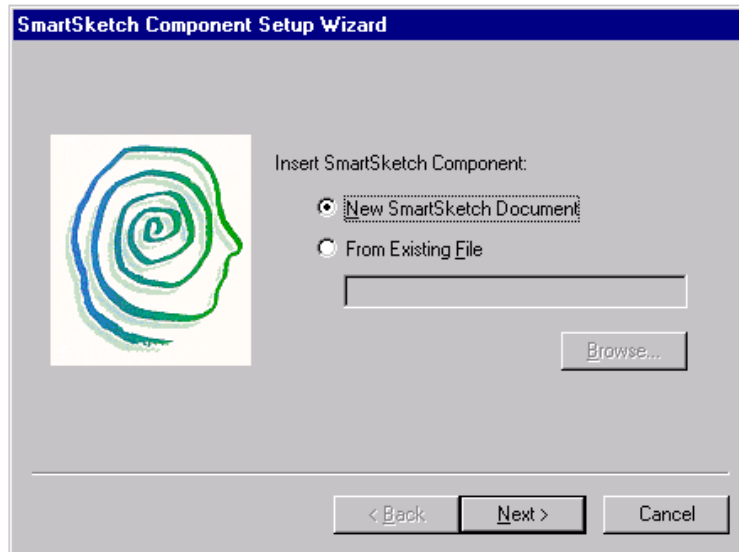
3. To insert an SmartSketch drawing you've already created, choose "From Existing File," and type the path name in the text box or use the Browse button to locate the file; then click "Open." Otherwise, choose "New SmartSketch Document." The next page of the Wizard appears:
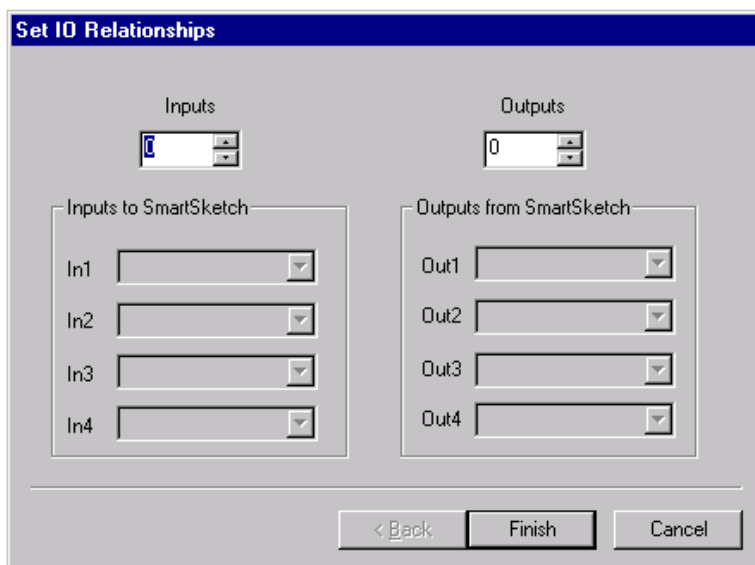
4. Specify the number of inputs and outputs. If you are using an existing file, also specify the names of the variables or dimensions in the drawing to send input to and retrieve output from. Use the drop-down menus in the text boxes next to In1, In2, etc. and Out1, Out2, etc.

5. Click "Finish." The SmartSketch component appears in your worksheet with placeholders for the input and output variables, such as those shown here:

6. Enter the names of Mathcad input variables in the bottom placeholders. Enter the output variables in the placeholders to the left of the:=.
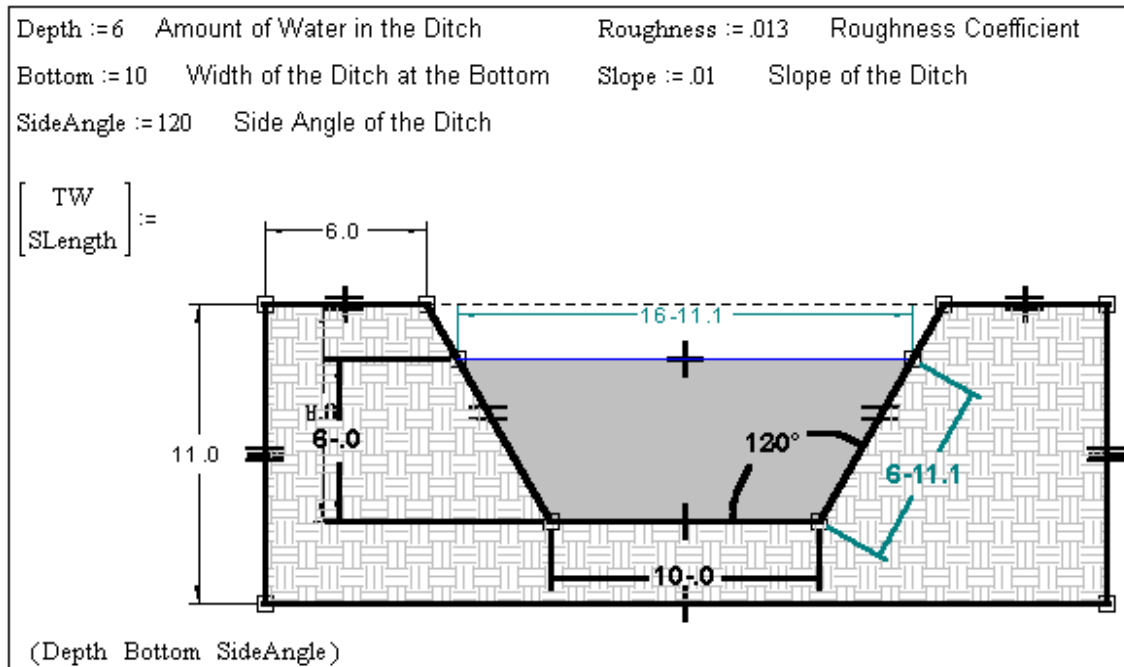
If you are creating a new SmartSketch document, double-click on the component and use SmartSketch's menus and toolbars to create a drawing. Use the Dimensions toolbar to add dimensions to your drawing. Choose **Variables** from the **Tools** menu to define variables or edit dimensions. Close the Variable Table before clicking back in the Mathcad worksheet.

NOTE: Input values that do not have units attached are passed in SI units. For example, if you send 2.0 as input for a length, it is assumed to be 2.0 meters. SmartSketch, by default, converts this to the display units (inches by default) and creates the drawing. Set your Mathcad worksheet to the SI unit system before using the SmartSketch component. To do so, choose **Options** from the **Math** menu and click on the Unit System tab.

After creating a new drawing, you need to bind variables and/or dimensions to the inputs and/or outputs. To do so, click on the component with the right mouse button and choose **Properties** from the pop-up menu. Use the Properties dialog to specify:

• **Input names.** The dimension or variable names used in the SmartSketch drawing that are controlled by the inputs to the SmartSketch component. Choose a dimension or variable name from the drop-down list.

• **Output names.** The dimension or variable names used in the SmartSketch drawing that define the output variables in Mathcad. Choose a dimension or variable name from the drop-down list.

When you click outside the component, input values are sent to the SmartSketch drawing from Mathcad and values are returned to Mathcad as output. The figure below shows an example of a SmartSketch drawing connected to variables in a Mathcad worksheet.

```
Depth := 6    Amount of Water in the Ditch        Roughness := .013    Roughness Coefficient

Bottom := 10    Width of the Ditch at the Bottom      Slope := .01     Slope of the Ditch

SideAngle := 120    Side Angle of the Ditch
```

$$\begin{bmatrix} TW \\ SLength \end{bmatrix} :=$$

(Depth Bottom SideAngle)

NOTE: In order for the dimensions in a drawing to resize parametrically, there should be a check next to the **Maintain Relationships** option under the **Tools** menu in SmartSketch. To verify this, double-click on the component and choose **Tools** from the menu bar.

Computationally linking a existing SmartSketch drawing to your Mathcad worksheet

The sample file TRIANGLE.IGR (located in **\Samples\CAD\SmartSketch** under the Mathcad folder) is a sample SmartSketch drawing you can use to practice with the SmartSketch component. This example is a drawing of a right triangle whose dimensions are two legs, a hypotenuse, and the angle between the hypotenuse and the horizontal leg.

Follow the steps below to use TRIANGLE.IGR to:
• Send one input from a Mathcad input variable **S** to the drawing.
• Retrieve an output value from the drawing and send it to a Mathcad output variable called **A**.

To begin:

1. Define an input variable in the Mathcad worksheet. Type **S:=1.063*in**

2. Click in a blank spot in your worksheet.

3. Choose **Component** from the **Insert** menu and select SmartSketch. Click "Next."

4. Click "From Existing File."

5. Click the Browse button and navigate to the file TRIANGLE.IGR located in **\Samples\CAD\ SmartSketch** under the Mathcad folder. Then click "Open." The Properties page of the Wizard appears.

6. Specify the number of inputs and outputs. For this example, specify 1 input and 1 output.

Next, specify the names of the input and output variables. In TRIANGLE.IGR, the horizontal leg of the triangle is called "Length." SmartSketch calculates "Angle" which is the size of the angle between the horizontal leg and the hypotenuse. To send input to "Length" and send the value of "Angle" as output:

1. For In1, choose "Length" from the drop-down list. For Out1, choose "Angle" from the drop-down list. The dialog should look like this:
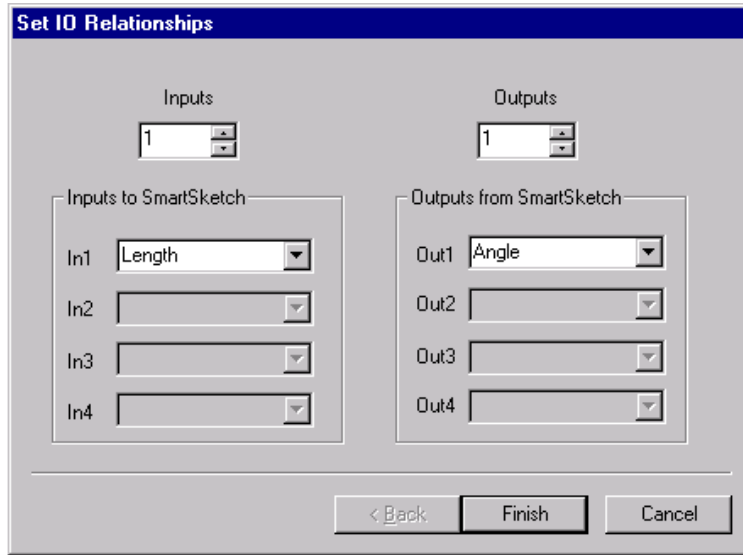
2. Click "Finish." The SmartSketch component appears in your worksheet with one placeholder for the input variable and one placeholder for the output variable.

3. Type **S** in the bottom placeholder. Type **A** into the placeholder to the left of the :=.

When you click outside the component, 1.063 inches is sent as input to the SmartSketch drawing and used to calculate the value of the angle; that value is sent as output to the Mathcad variable **A**.

$S := 1.063 \cdot in$

$A :=$

S

$A = 62.009 \cdot deg$
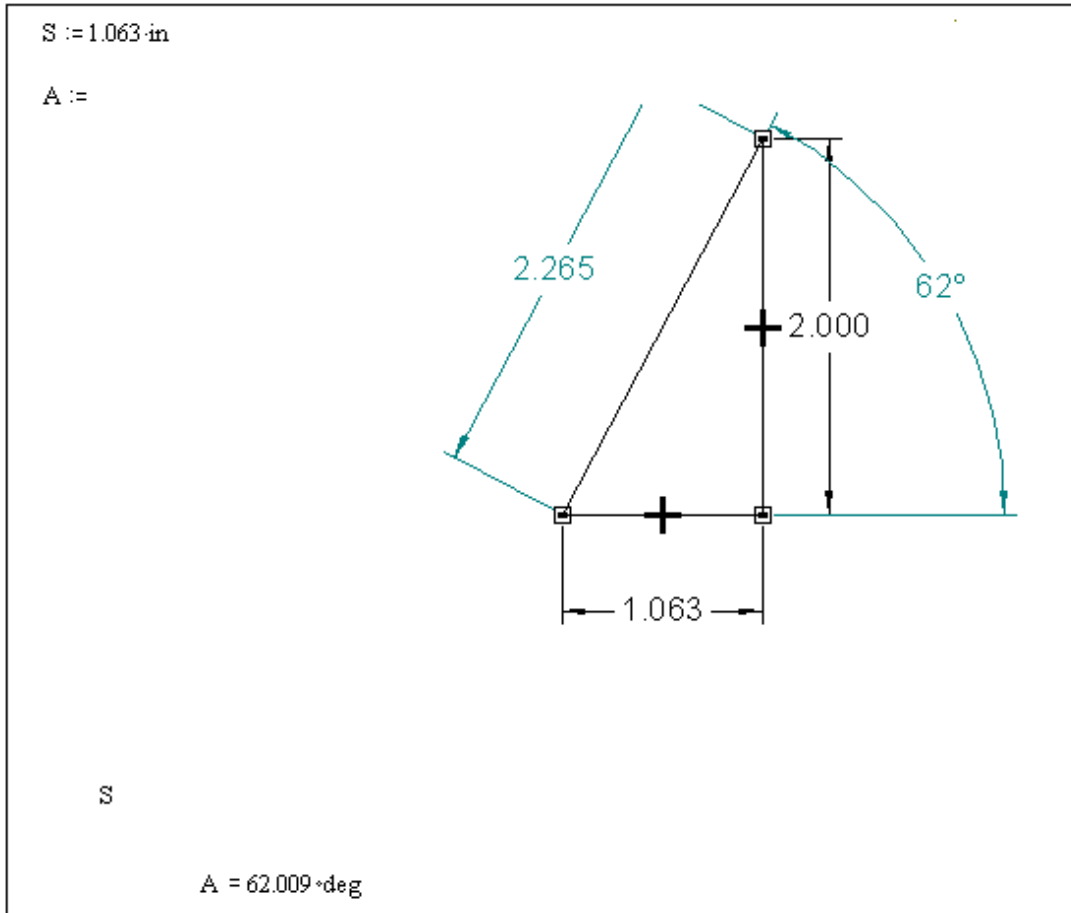
To understand how the variables in a SmartSketch drawing are defined, examine SmartSketch's Variable Table. To do so:

1. Double-click the SmartSketch component in the Mathcad worksheet. Menus and toolbars change to SmartSketch's menus and toolbars.

2. Choose **Variables** from the **Tools** menu. For TRIANGLE.IGR, the Variable Table looks like:

3. Close the Variable Table.

Accessing SmartSketch

After inserting the SmartSketch component into a Mathcad worksheet, you can use the component to edit and create drawings in SmartSketch, provided you have SmartSketch installed on your system. To do so:

1. Double-click the SmartSketch component in the Mathcad worksheet. Menus and toolbars change to SmartSketch's menus and toolbars.

2. Edit the SmartSketch drawing however you'd like.

3. Click back in the Mathcad worksheet to have the component recalculate and to resume working in Mathcad.

NOTE: Changes you make to an existing SmartSketch document using the SmartSketch component do not affect the actual SmartSketch document from which it was created.

Changing the inputs and outputs

To add or remove inputs and outputs:

- Click on the component with the right mouse button and choose **Add Input Variable** or **Add Output Variable**. To eliminate an input or output choose **Remove Input Variable** or **Remove Output Variable**.

To change the input variables and output variables used from the SmartSketch drawing:

- Click on the component with the right mouse button and choose **Properties** from the pop-up menu. Use the drop-down choices in the text boxes next to In1, In2, etc. and Out1, Out2, etc.

More information and technical support

For more information on the Mathcad components, refer to "Exchanging data with other applications" in Chapter 16 of the *Mathcad User's Guide*.

For more information on SmartSketch, refer to the tutorials and documentation available by choosing from the **Help** menu in SmartSketch.

Sample Mathcad files containing SmartSketch components are located in the **\Samples\Mathcad** folder under SmartSketch. For more details on Mathcad and additional specific examples, please visit MathSoft's web site at http://www.mathsoft.com or http://www.SmartSketch.com.

For technical support or additional information on other MathSoft products, please visit http://www.mathsoft.com, or visit MathSoft's Webstore at http://www.mathsoft.com/webstore. You can also contact MathSoft directly by emailing support@mathsoft.com or calling them at 617-577-1778.