Updating a Surface in SKUA-GOCAD™
Paradigm® 14.1 and above

Video Notes
Updating a Surface in SKUA-GOCAD

Link to video

This video is available in Paradigm Online University under SKUA-GOCAD > Interpretation and Modeling.

Introduction

SKUA-GOCAD offers many options to update existing triangulated surfaces with new data outside the modeling workflows. In this document and associated video you will take a look at two different scenarios:

- Scenario 1: Updating an existing faulted surface with new well markers
- Scenario 2: Fitting a coarse surface to new contour lines
Important

Setting constraints before fitting a surface to new data

When you update a surface with new data, or edit it, you will need to set constraints on the surface.

Constraints enable you to:

- Preserve surface borders (including horizon to fault contacts)
- Fix points around areas previously fitted to well markers or data points
- Fit the surface to new data points

Constraints do not change the geometry of an object: interpolation does. When you set a constraint, nothing will happen until you actually run an interpolation.

In these two scenarios you will learn about the following types of constraints:

- Control nodes
- Constraints on borders
- Control points

Note For more information about constraints, please check the section ‘Constraints Concept and Terminology’ in the Online Help.
Scenario 1: Updating a Surface with New Markers

About the dataset

- One faulted horizon surface that fits to the input interpretation points and existing well markers.
- Horizon to fault contacts are perfectly sealed.

Figure 1 Initial horizon surface fitted to the interpretation points and initial set of well markers.

The aim is to fit the surface to a new set of well markers.

Figure 2 New set of wells displayed against the existing wells and initial horizon surface.
Process

Make a copy of the initial surface

- Create a copy of the initial surface for QC purposes.

Set constraints

Constraints need to be set on the surface to make sure that surface borders, or areas previously fitted to well markers remain unchanged when fitting the surface to new data.

In this specific example we want to preserve the surface borders, which include the horizon to fault contacts.

1 From the Surface commands menu select Constraints > Control Nodes > Set - On All Borders.

2 Select the surface, then click OK.
3 Use the surface’s **Style** toolbar to display the control nodes in the 3D Viewer.

![Surface borders and control nodes](image)

**Note** In this specific example, you will notice that there are control nodes around the initial set of markers. These control nodes were generated automatically when the surface was fitted to the markers. Make sure you do not unset these control nodes so that they do not move when fitting the surface to the new markers.

### Control nodes

Nodes on a surface which are set as control nodes are fixed and will not move during interpolation.

Control nodes are managed (set and unset) from the **Surface > Constraints > Control Nodes** menu.

### Method #1 Quickly fit the surface to the markers

With this method, the surface is automatically fitted to all of the markers belonging to the same feature. For more control on the parameters, check method 2.

1 In the **Objects** browser, make sure you can see the marker name(s) and the surface.
Drag and drop the surface to the well markers and select **Fit To**.

*Method #2* Set the parameters to fit the surface to the markers

1. From the **Surface** commands menu, select **Tools > Fit > To Markers**.

2. In the **Fit Surfaces to Marker** dialog box, select the surface you want to update, the corresponding markers feature, and the wells you want to fit the surface to.
3 Specify the direction for computing the mismatch and fitting the surface to the markers. It can be a constant or a property defined on the surface.

Note The direction is defined as a vector, and by default is purely vertical (X=0, Y=0, Z=1). You can pick it directly in the 3D Viewer, or toggle off Constant direction and select a vectorial property defined on the surface, such as the normal.

Depending on your dataset, there are then three different ways to proceed:

**Technique 1: Default method**

4 Leave the number of iterations by default.

5 Click OK.

The process to fit the surface to the markers is repeated three times (default number of iterations), and control nodes are inserted at the end around the markers.

![Figure 3 Control nodes are set around the markers](image)

**Process for fitting the surface to the markers**

When fitting a surface to well marker(s) the command does the following:

- First, it calculates the error between the marker(s) and the surface, along the direction you specified.
- Second, it extrapolates the error onto the surface using a Discrete Smooth interpolation (DSI).
- Third, it fits the surface to the marker(s) according to the error.

The process is reiterated, unless you have selected the option Insert points. In this case the surface fits perfectly to the markers in the first pass. When the process is finished, new control nodes are set around the markers.

**Note** Control nodes are fixed and will not move. As a result, they will prevent you from running the process again. If you want to check the fit to the markers and be able to run the process again, expand the Advanced section and toggle off Set control nodes before starting. Check “Technique 3: Reiterate the process (significant mismatch)” on page 11 for more details.
Technique 2: Insert points for a perfect fit

With this method there is no iteration. The fit to the markers is done in the first pass, and new points are inserted in the mesh at the markers’ location.

4 Select the option **Insert points**.
5 Click **OK**.

There is no residual mismatch between the markers and the surface.

Figure 4 With the option **Insert points**, the mesh of the surface is edited to insert new points at the markers location to ensure a perfect fit.
Technique 3: Reiterate the process (significant mismatch)

If you want to preserve the mesh of the surface, and there is a significant mismatch between the markers and the horizons, three iterations may not be enough to obtain a close fit.

4. After specifying the direction, expand the Advanced section:
   a. Toggle off Set control nodes.
   b. Select Keep mismatch (optional) to compute the error between the markers and the surface as a property on the surface.
      
      **Note** The error property that is computed is unitless. However it gives a good indication on how well the surface fits to the markers.

5. Click Apply.

6. Check the mismatch:
   - If the error is equal to zero, or is close to zero, select Set control nodes and click OK.
   - If there is still some mismatch repeat step 4 to step 5.
**QC the result**

To check how well the new surface fits to the markers you can:

- Use the slicer, and compare the result with the initial surface, as shown in the figure below.

![Figure 5](image)

*Figure 5* Using the slicer to check the fit to the markers and compare with the copy of the initial surface.

- Check the mismatch when fitting the surface to the markers: In the **Fit Surfaces to Marker** dialog box, expand the **Advanced** section and select the option **Keep mismatch**. The mismatch property will be stored as a property of the surface. After a few iterations, the error will be close to zero.

![Mismatch property](image)

*Figure 6* Mismatch property **ErrorFitMarkers** computed after one iteration.

- Create a cross section: Make sure you select the wells when creating the cross section, and then display the markers from the **Objects** browser. Markers displayed from the **Wells and Pillars** browser will appear as a straight line across the well tracks, which sometimes make it difficult to QC the fit to a horizon or surface.
Scenario 2: Updating a Surface with New Contour Lines

About the dataset

- One coarse horizon surface
- A new set of contour lines (Curve object in SKUA-GOCAD)

![Initial horizon surface and new set of contours.](image)

**Figure 7** Initial horizon surface and new set of contours.

The aim is to fit the surface to the contour lines. To do this, the nodes of the contour lines will be set as control points, and the surface flexed towards the points through a series of interpolations.

Note that you can apply the same process to update a surface with another type of data such as new interpretation picks, curves or fault sticks.

Process

**Make a copy of the initial surface**

- Create a copy of the initial surface for QC purposes.

**Improve the surface and coarse resolution**

This step is optional. However, the surface will be fitted to the location of the nodes on the contour curves, so it is recommended to refine the surface resolution and densify the contour lines if necessary, to get the best possible fit.

1. From the **Surface** commands menu, select **Tools > Split > All**.
2 Make sure the correct surface is select, then click **OK**, or **Apply** if you want to apply the command more than once.

![Image](image1.png)

**Figure 8** The horizon resolution is refined by applying the Split command twice.

3 From the **Curve** commands menu, select **Tools > Densify**.

![Image](image2.png)

4 Make sure the contour lines object is selected, enter a maximum distance similar to the surface resolution, then click **OK**.
Set constraints on the surface border

As in the previous scenario, constraints need to be added to the surface borders. If no constraints are set on the surface borders, the surface will retract slightly during the interpolation. This time however, a new type of constraints will be applied to the surface borders so they can move up and down vertically to fit to the nodes of the contour lines.

1. From the Surface commands menu, select **Constraints > Constraints On Borders > Set on Straight Line - All Borders**.
2. Select the surface and click **OK**.

Constraints on borders on straight lines

Constraints on borders set on straight lines force the surface to move only vertically (upwards or downwards) during the interpolation.

Set control points

Before running the interpolation, we need to add another type of constraints to the surface: control points. The geometry of the surface will be modified to fit to the location of the control points.

1. Select **Constraints > Control Points > Set Control Points**.
2. Select the contour lines and click **OK**.
3 Display the control points from the surface **Style** toolbar. The control points appear as blue dots, and their tails show which part of the surface will be pulled during the interpolation, and in which direction. Their locations correspond to the location of the nodes of the contour lines.

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Control points and interpolation

- Control points are a type of constraints set on the surface that will constrain the interpolation.
- If no control points are set to constrain the interpolation, you will end up after a few iterations with a flat surface.
- You can set PointsSet, Curve or Surface objects as control points. Concretely it means that you can apply the same method to fit the surface to any type of new interpretation data, such as horizon picks, fault sticks, and more!

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Run the interpolation

Now that all constraints are set, the surface can be fitted to the control points by running a DSI (Discrete Smooth Interpolation).

1 From the **Surface** commands menu, select **Interpolation > Geometry - On Entire Surface**.

2 Select the surface and reduce the number of iterations to better check the impact of the interpolation on the surface.
3 Click **Apply** and reiterate the process until you get the best possible fit.

![Figure 9](image)

**Figure 9** Effect of running discrete smooth interpolations on a surface with control points and constraints on borders.

<table>
<thead>
<tr>
<th>Control points</th>
<th>Constraints on borders on straight lines</th>
</tr>
</thead>
</table>

**Discrete Smooth Interpolation (DSI)**

Unique and patented interpolation method that:

- Fits the constraints set on the surface,
- Minimizes the relief of the geometry; the surface fits smoothly to the control points.

DSI takes into account all active constraints and control nodes. Therefore, we recommend you display the constraints and control nodes before a DSI.
Conclusion

Before updating an existing surface with new data, you must make sure that the constraints are set properly on the surface:

- **Control nodes** will not move during the interpolation.
- **Constraints on borders on straight lines** will allow borders to move vertically.

The surface can then be quickly fitted to well markers, or contour lines, which nodes have been set as **control points** to constrain the interpolation.