

Surface creation in Move

Move™ is a powerful tool, especially when it comes to surface creation, which is a fundamental part of 3D model building. Several methods for the generation of realistic geological surfaces from points, vertices and lines exist in Move as part of the model building toolkit. Surfaces can also be extracted from an existing surface or volume and can consist of rectangular grids or triangular meshes. The different methods for creating surfaces are summarised in Table 1, and this monthly feature focusses on two techniques: **Delaunay Triangulation**, which is one of the most useful methods for building surfaces from surface and subsurface data, and **Create Top/Mid/Base Surface**, which can be used to create a new, resampled surface from existing objects in Move.

Table 1: Comparison of methods

Name of method	Honours point data	Suitable for overturned surface with multiple z	Methodology	Recommended for
<i>Create surface from points or vertices including well markers</i>				
Delaunay Triangulation	yes	no	Geometric	Curvilinear faults or horizons
Multilevel B-Spline Approximation	no	no	Deterministic	Curvilinear faults or horizons
Inverse Distance Weight (IDW)	no	no	Deterministic	Curvilinear faults or horizons
Ordinary Kriging	no	no	Geostatistical	Curvilinear faults or horizons
Advancing Front	yes	yes	Geometric	Curvilinear faults or horizons, salt bodies, ore bodies, igneous intrusions, surfaces with heave polygons
Alpha Contour	no	yes	Geometric	Curvilinear faults or horizons, salt bodies, ore bodies, igneous intrusions
<i>Create surface from lines</i>				
Linear	yes	yes	Geometric	Curvilinear faults or horizons, salt bodies, ore bodies, igneous intrusions
Spline Curves	no	yes	Deterministic	Curvilinear faults or horizons, salt bodies, ore bodies, igneous intrusions
Delaunay Triangulation	yes	no	Geometric	Curvilinear faults or horizons
Extrusion	yes	yes	Geometric	Curvilinear faults or horizons
<i>Create surfaces from volumes</i>				
Extract Surfaces from GeoCellular Volume	no	no	Deterministic	Curvilinear faults or horizons
<i>Create planar or resampled surfaces</i>				
Create New Planar Surface/Grid	no	no	Geometric	Planar surfaces, growth strata
Create Top/Mid/Base Surface	no	no	Deterministic	Curvilinear faults or horizons, converting from triangular mesh to rectangular grid

Methods other than using the **Create Surface** tool (see Figure 1) also exist, such as extruding a line using the **Extend** tool, using the **Shape** tool and multiple horizon surfaces with faults can be created using the **Layer Cake** tool. **Horizons from Template** also allows the user to create a new surface from an existing surface or from surface intersection lines. All of these are found on the **Model Building** panel.

With the exception of seismic data and images, all model objects in Move are constructed from points or vertices. The objective of surface creation is to fit a smooth surface through points or vertices that usually have a scattered or non-uniform distribution, primarily using scattered data interpolation (e.g. Franke & Nielson 1991; Lee *et al.* 1997). For points or well markers, **Delaunay Triangulation**, **Advancing Front** and **Alpha Contour** (Table 1) use a geometric approach to honour all existing vertices, whereas the other algorithms highlighted in Table 1 interpolate between points deterministically or geo-statistically to produce an optimum surface.

Delaunay Triangulation method

The **Delaunay Triangulation** methodology in the Create Surface tool (Figure 1) (Delaunay 1934), fulfils what is called the “empty circle property”. This means for a circle with circumference that intersects the vertices of triangular faces, a “circumscribing circle”, it should contain no other vertex in its interior (Figure 2).

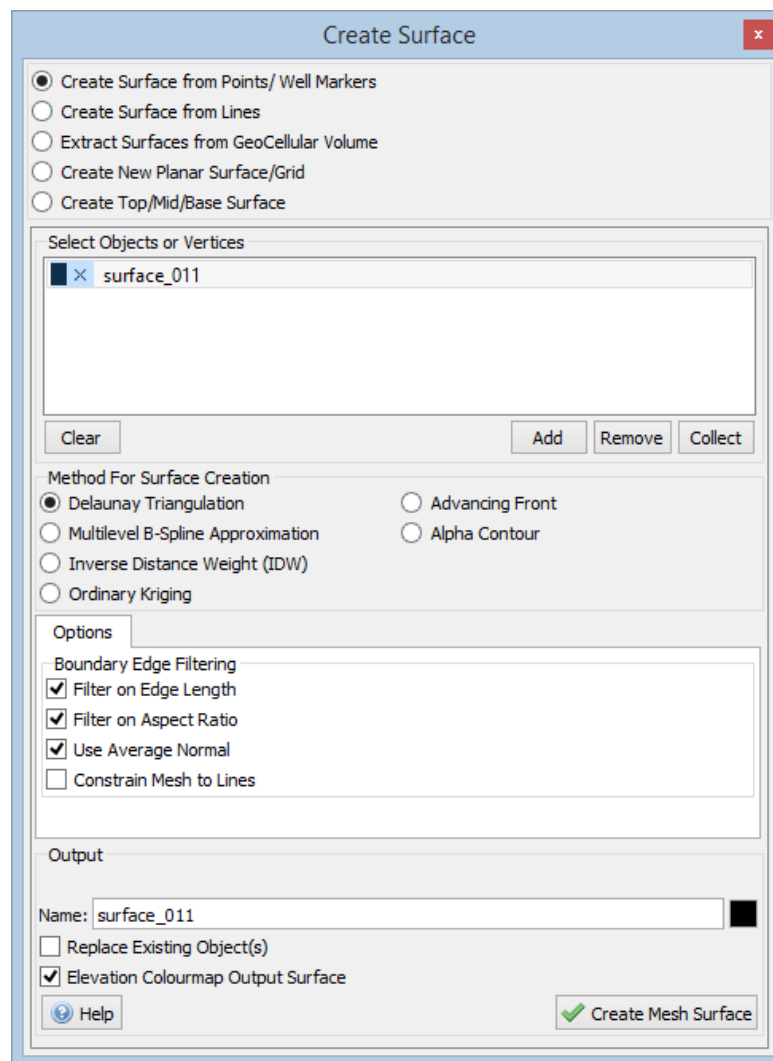


Figure 1 Create Surface toolbox in Move showing options for Delaunay Triangulation

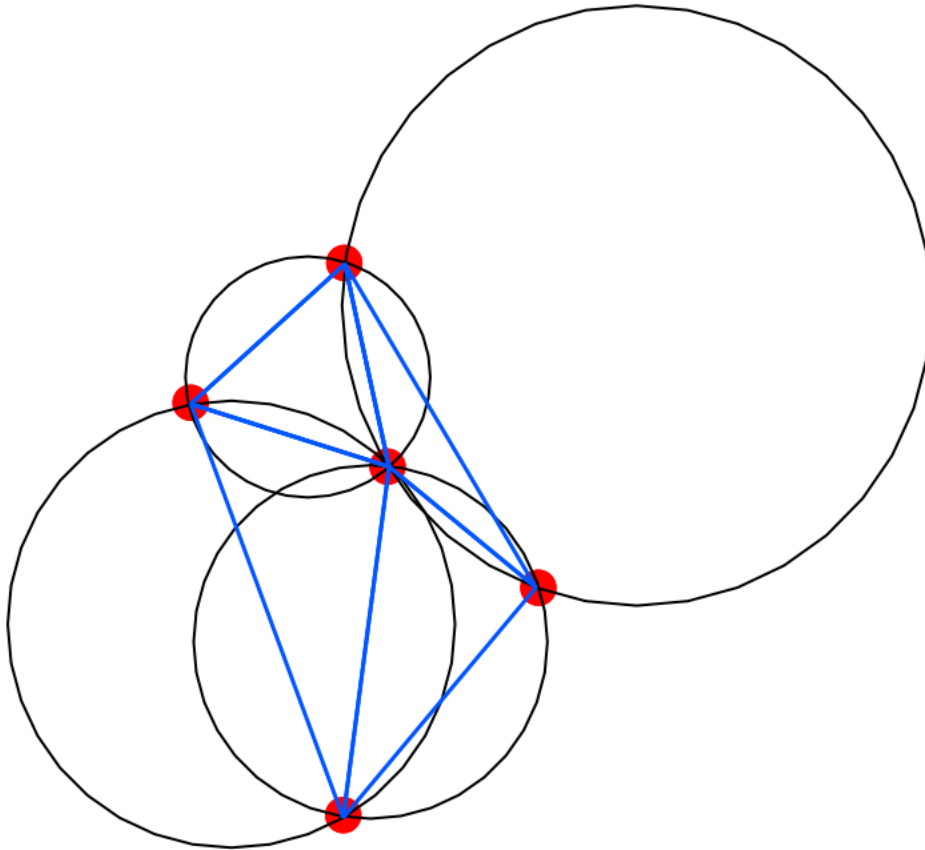


Figure 2 Delaunay Triangles in blue with circumscribing circles in black. Note that no circle contains a point/vertex (highlighted in red)

Delaunay Triangulation creates an irregular triangular mesh surface and has the advantage of honouring every control point (Figure 3). Successful surface creation will result in the enclosing surface or convex hull of the vertices used. Filtering options in the tool, such as **Filter on Edge Length** or **Filter on Aspect Ratio**, can be used to reduce the likelihood of creating thin triangles. This method is recommended for simple curvilinear faults or upright folded horizons without major fault displacement and should not be used with vertices that have multiple z elevations. It works most effectively when there is a uniform distribution of data. Where this is not the case, resampling of control lines or interpolation of additional interpreted sections in 2D may be required to get the best results. It cannot be used to create rectangular grids.

Figure 3 shows an upright doubly-terminated fold closure from the Zagros Mountains. XYZ point data of the top surface of the target reservoir horizon were extracted from an existing 3D seismic volume. The objective was to identify the highest point of the culmination of the structure for drilling and it was important to honour all data points. In Move, the recommended method for surface generation with these constraints is **Create Surfaces from Points/Well Markers** using **Delaunay Triangulation**.

Using **Delaunay Triangulation**, a surface was created that honours all existing data points, shown in black on Figure 3. The created surface has been colour mapped for elevation, clearly identifying the location of maximum z elevation (in purple). The **Reshape** tool (found on the **Model Building** panel) could subsequently be used to modify this surface as new data becomes available.

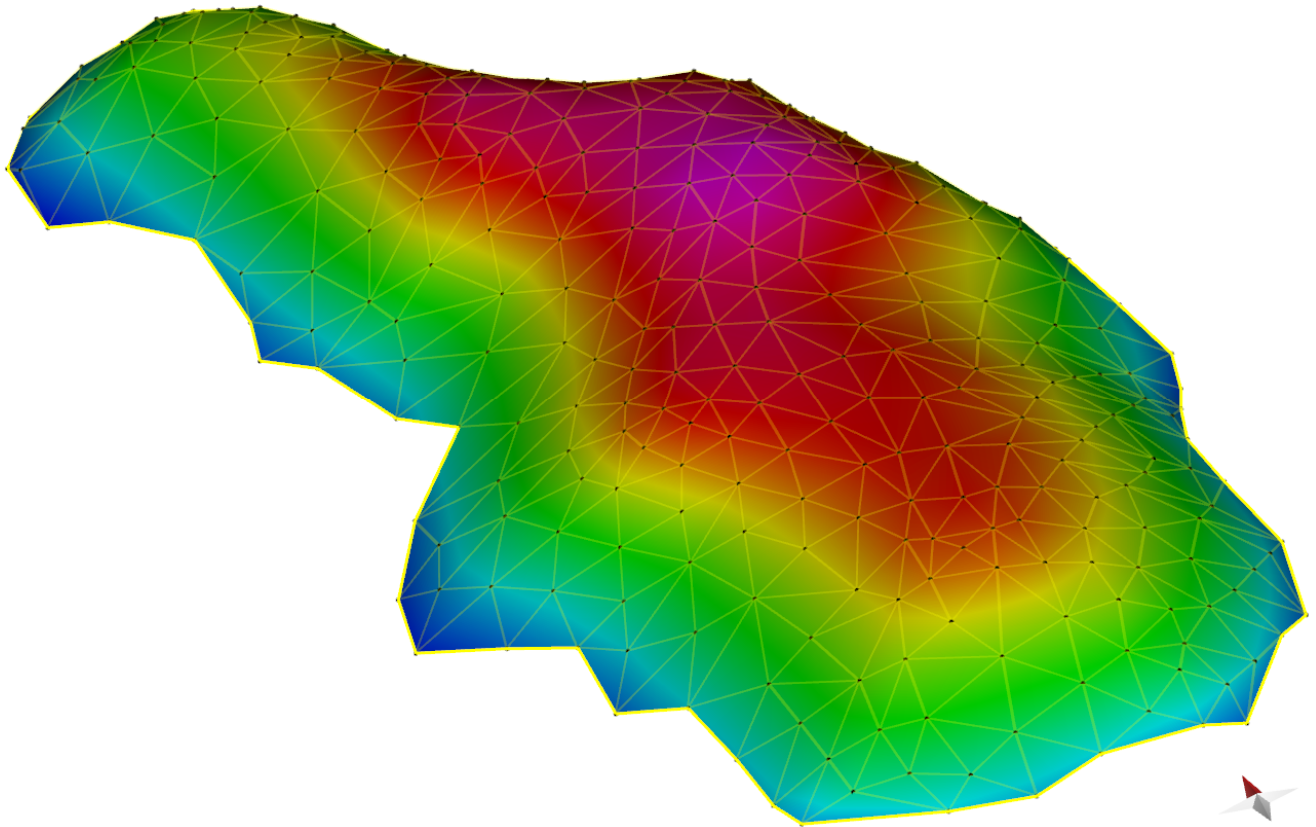


Figure 3 Doubly-terminated complex upright fold surface created using **Delaunay Triangulation**. Note irregular placement of mesh nodes in black. All existing control points are honoured.

Create Top/Mid/Base Surface method

The **Create Top/Mid/Base Surface** method (Figure 4) can be used to construct a new, resampled, triangular mesh or rectangular grid surface from existing objects in Move. The elevation of the new surface is calculated by projecting points perpendicular to the surface creation grid (shown in green on Figure 5) and carrying out a weighted average. Move calculates the surface from the upper vertices of the selected object for **Top** surface, then mid-way between uppermost and lowermost vertices for **Mid** surface, and from the lowermost vertices for **Base**. This method can be used for vertices that have multiple z elevations however, the tool will select the appropriate points/vertices for surface creation. **Create Top/Mid/Base Surface** is most useful and therefore the recommended workflow in Move for converting a triangular mesh to a rectangular grid.

For frequent creation of gridded surfaces, it is possible to save a settings file that can be loaded into the **Create Surface** tool at a later date. For surfaces consisting of uniform triangles or rectangles, the **Grid Options** (Figure 4) can be used to define the cell size, 3D grid orientation and select how the new surface will fit to the model boundary or selected objects prior to surface creation.

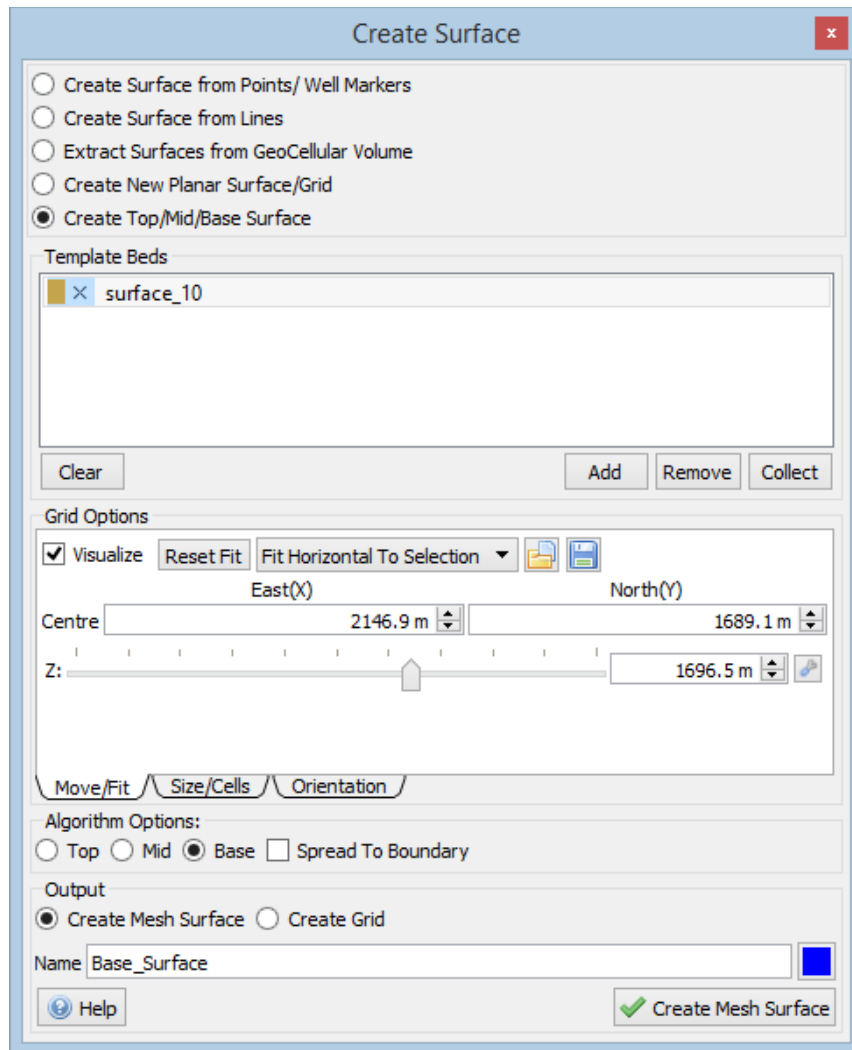


Figure 4 *Create Surface* toolbox showing options for *Create Top/Mid/Base Surface*

Figure 5 shows an XYZ point cloud derived from 3D seismic data over a salt body in the Gulf of Mexico. The objective was to derive a rectangular grid surface of the shape and location of the lower surface of the body to export to Petrel* E&P software platform for drill planning. Using the **Create Top/Mid/Base Surface** method in Move, a construction grid was created (in green on Figure 5) with the **Fit Horizontal to Selection** option selected in **Grid Options**. This surface (shown in blue on Figure 5) was then exported using the Move Link for Petrel module (on the **Modules** panel) for further analysis.

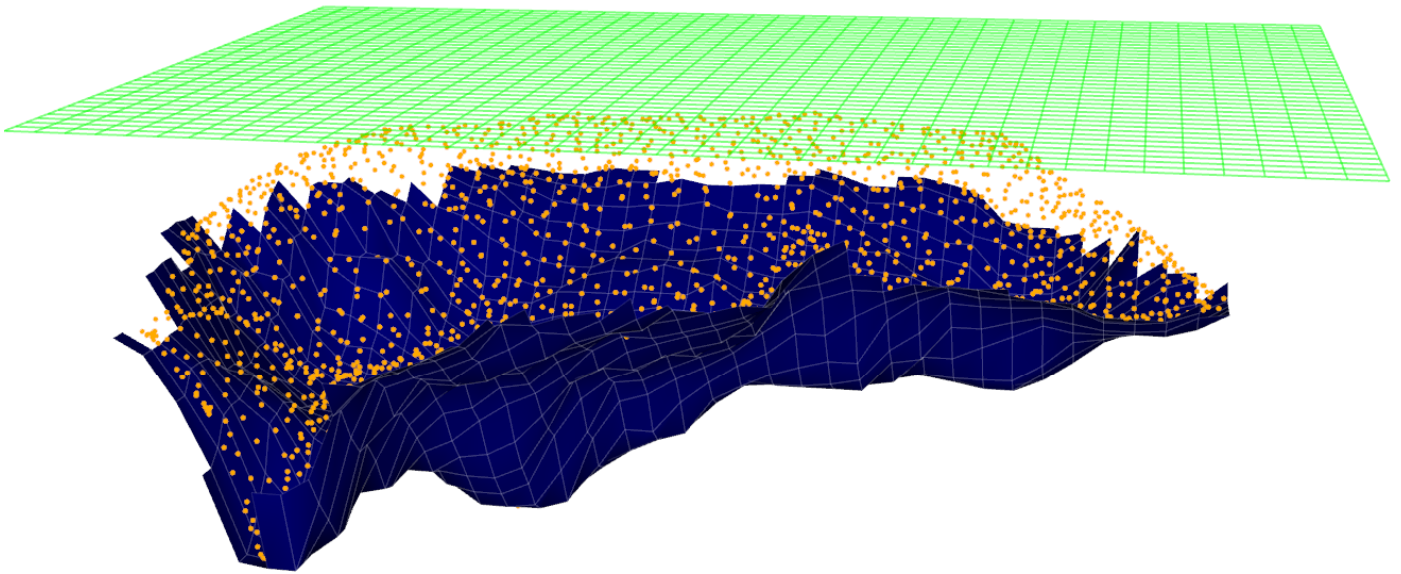


Figure 5 **Base** surface rectangular grid in blue created from xyz point cloud data (in yellow) using the **Create Top/Mid/Base Surface** method. The **Fit Horizontal to Selection** option has been chosen.

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If you require any more information about surface creation, then please contact us by email: enquiries@mve.com or call: +44 (0)141 332 2681.

References

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