GEMCOM becomes GEOVIA

Surpac 6.3

Solids

3DEXPERIENCE

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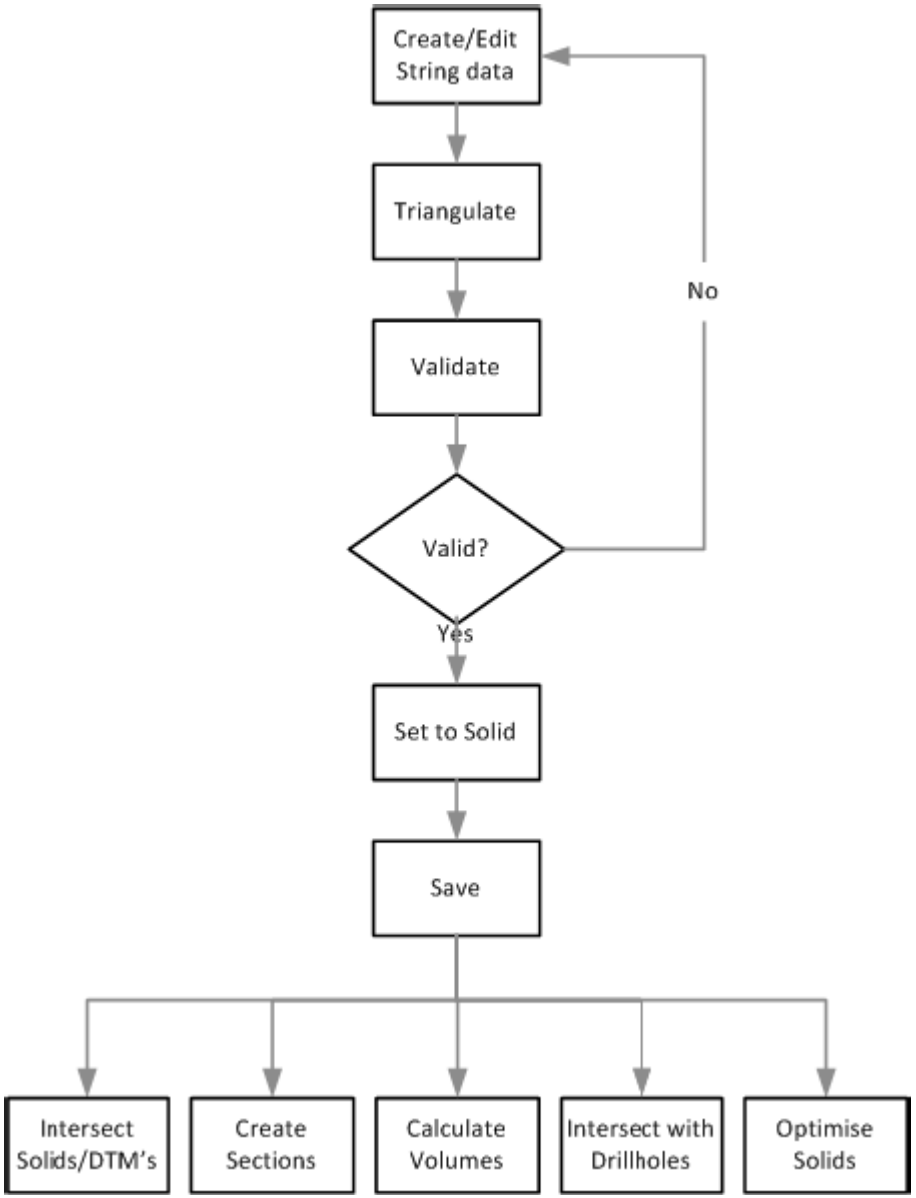
Overview



Solids Concepts

- Solid modelling allows us to use triangulation to create three-dimensional models based on Digital Terrain Models (DTMs) and String files.
- Solid models use triangles to link polygonal shapes together to define a solid object or a void.
- Solid models can be used for:
  - Visualisation
  - Volume calculations
  - Extraction of slices in any orientation
  - Intersection with data from the geological database module
- Solid model is created by forming a set of triangles from the points contained in the string.
- Triangles in a solid model may completely enclose a structure.

Solids Concepts

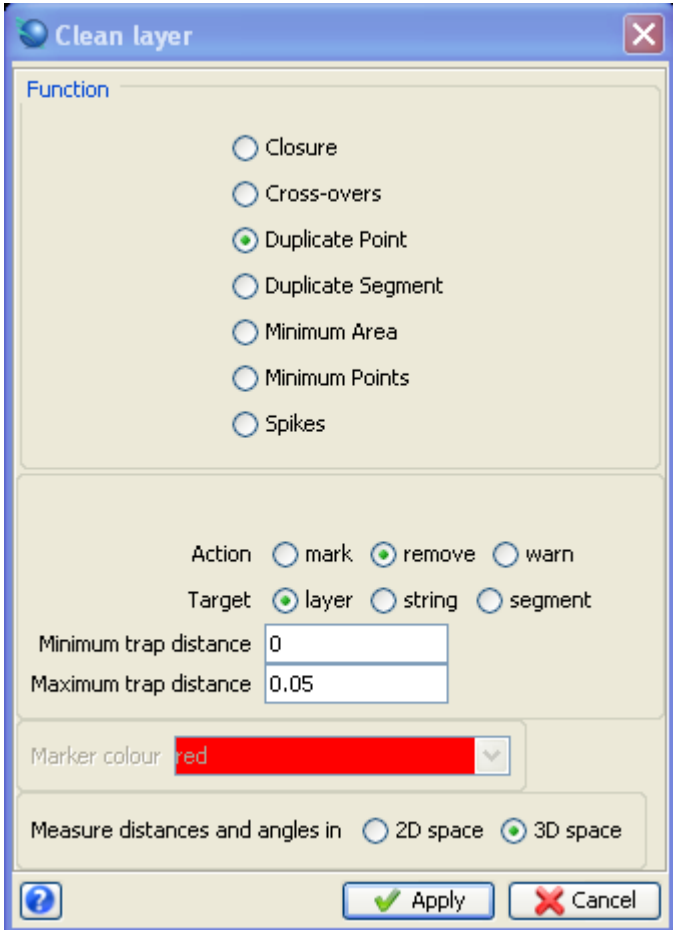
- A solid model is made up of a set of non-overlapping triangles
- Triangles form objects that may have numerical identifier between 1 and 32000
  - Objects represent discrete features in a solid model
- Object and trisolation numbers give reference to all the objects contained in solid model
- An object trisolation may be open or closed or can contain both trisolations
  - Open: if there is a gap in the set of triangles that make up the trisolation
- The reasons for treating objects as open or closed:
  - A closed object can have its volume determined directly by summing the volumes of each of the triangles to an arbitrary datum plane
  - A closed object always produces closed strings when sliced by a plane
  - A closed object could be used as a constraint in the block modelling module

Preparing a Data

- To ensure trouble free model creation, the integrity of strings should be checked prior to beginning modelling
  - String direction:
    - Strings should all be in the same direction, even if they are open strings
  - Foldbacks (spikes):
    - Foldbacks in a string will cause problems with your model as they may cause overlapping triangles to be formed
  - Excessive number of points:
    - Large number of points will slow model creation and you should filter strings as necessary
  - Duplicate points
- All data to be modelled needs to be in the same coordinate systems
- Use of normal plan projection will considerably simplify the modelling of the data

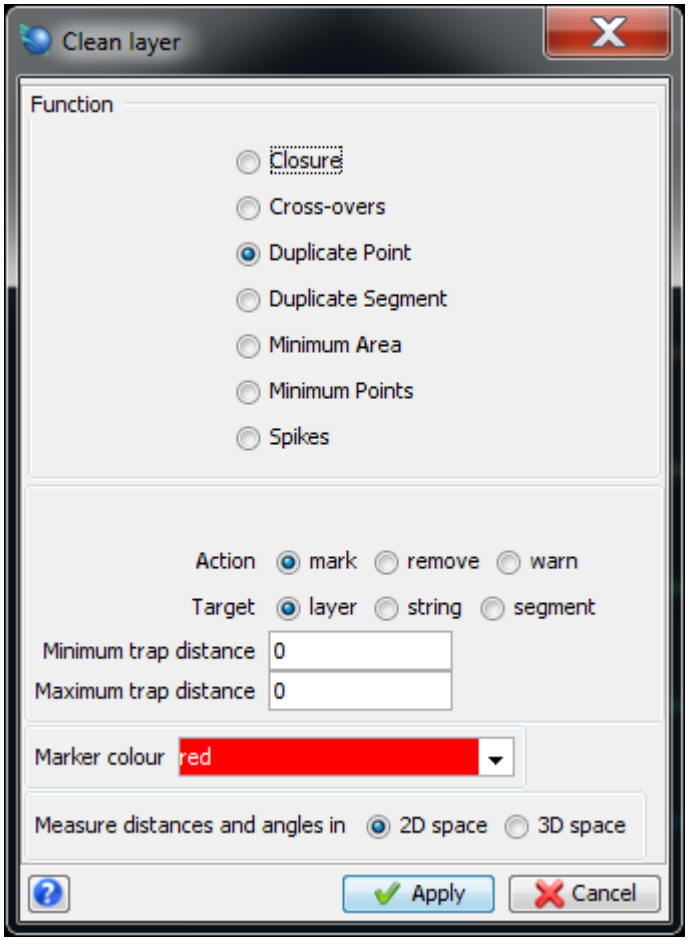
Preparing a Data

- Edit > Layer > Clean



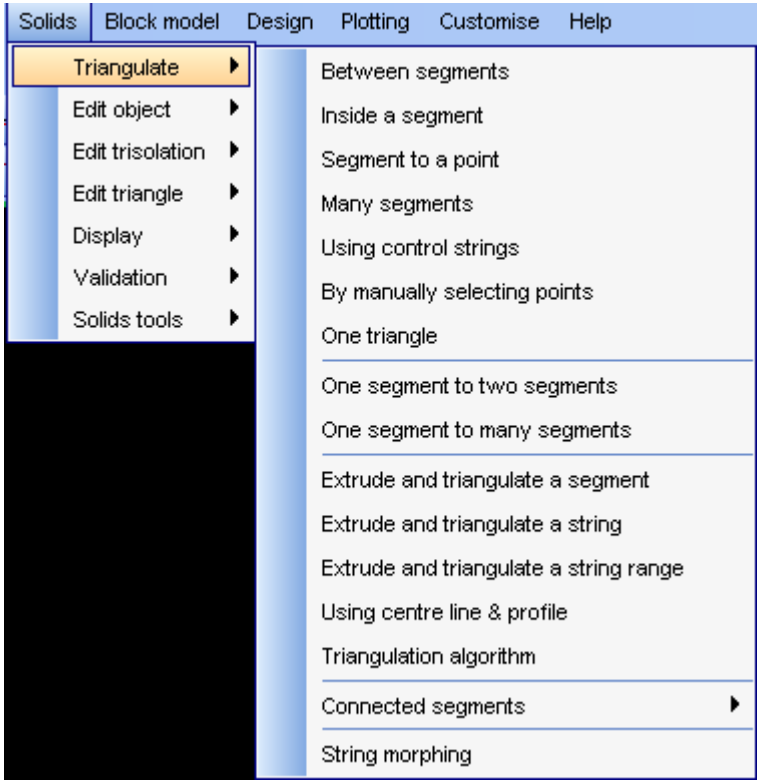
Assignment 1 – Preparing Data

- Prepare mod1.str for further processing
- Edit > Layer > Clean
  - Check if the data is in right projection
  - Check for spikes
  - Check for duplicate points
  - Save as mod1.str
  - Set to 3D space or Surpac will delete all points trying to flatten the model
    Where applicable, set minimum trap distance to 0.05, otherwise Surpac will remove too many points.



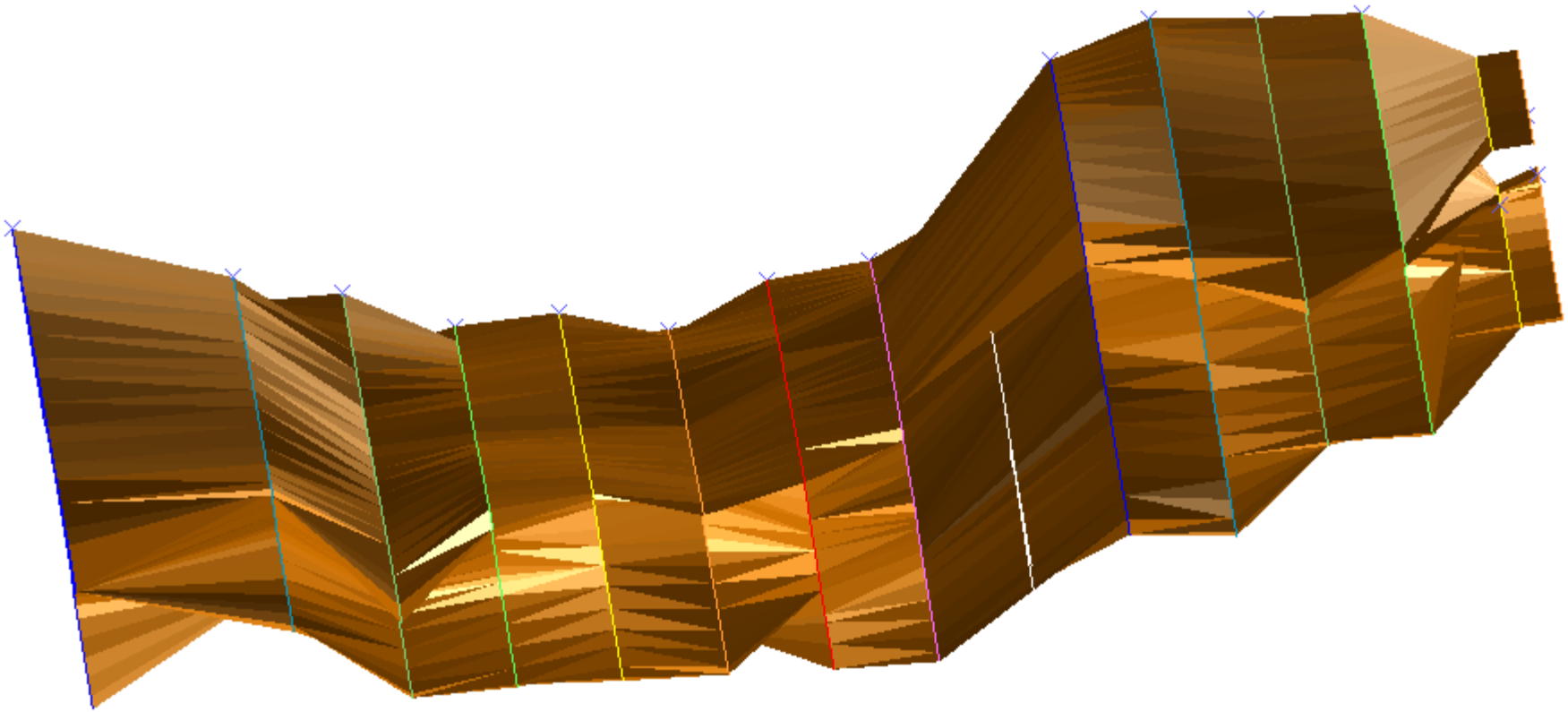
Creating a Solid

- Various triangulation methods can be used to create a solid model
  - Using between segments
  - Using control strings
  - Using bifurcation techniques
  - Using manual triangulation
  - Using many segments
  - Using segment to a point
  - Using inside segment and one triangle



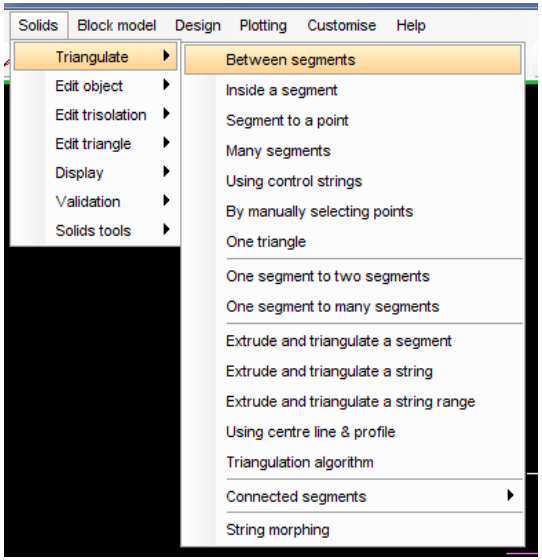
- Also available in the solids toolbar (profile)

Why we use different triangulation types...



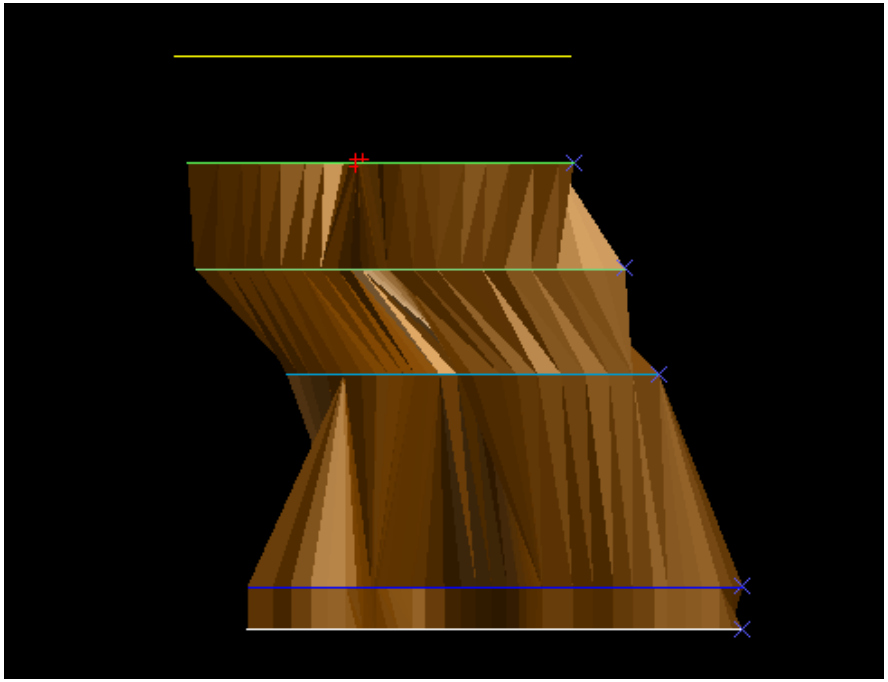
Triangulating using Between the Segments

- Triangulation between segments is the most commonly used of the solid creation techniques
- It uses algorithms that minimise the surface area of triangles formed between polygons
- It is simple to use and for many objects produces the best results



Assignment 2 – Triangulating between segments

- Open mod1.str
- Display string numbers
- Triangulate between segments 1-2-3-4-5
- Press Esc
- Save as Mod1.dtm

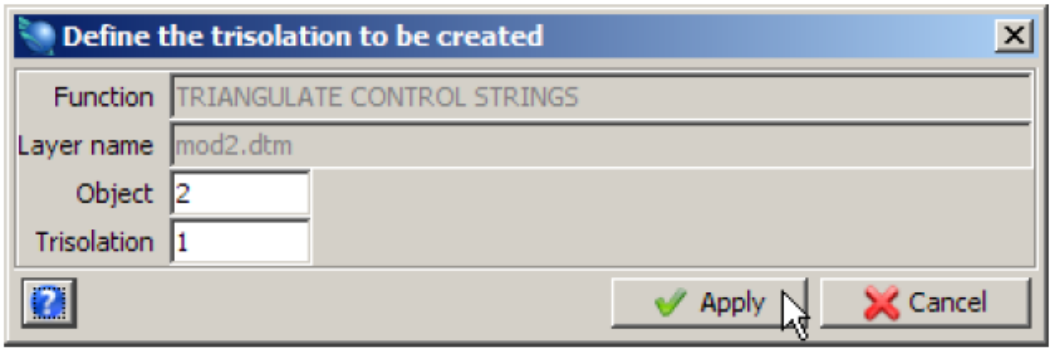


Triangulating using Control Strings

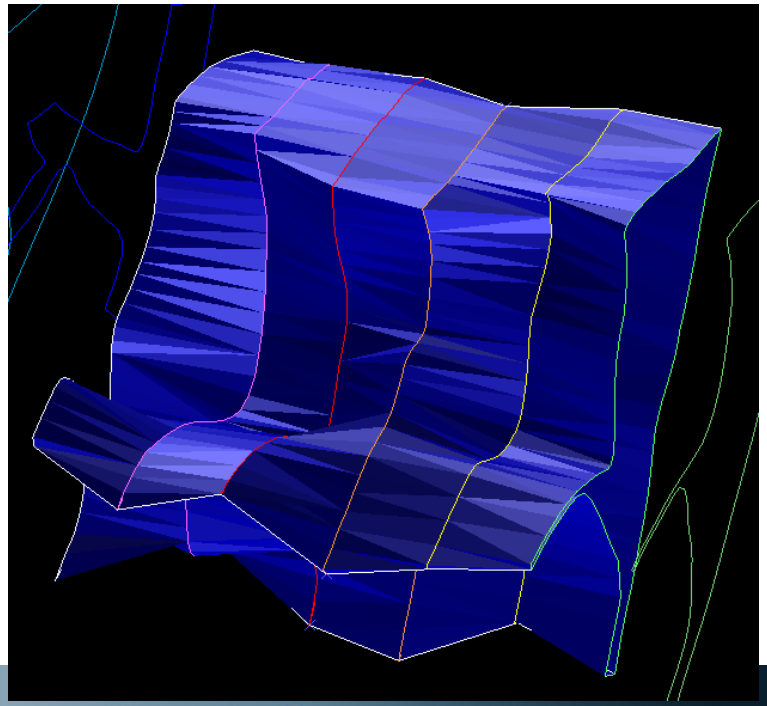
- Control strings are strings created to control the triangulation process – WHY?
- These strings link together points on your object polygons that have a strong structural relationship
- Rules:
  - 2-10 control strings
  - The first control string (master) must link all the segments to be triangulated
  - Subsequent control string may link some or all of the segments and may not have more points than master control string
  - Control strings must be all in the same direction
  - Control strings must not cross
  - Do not use same string numbers as the polygons you are modelling
  - Strings should make sense structurally

Assignment 3 – Triangulating, Control Strings

- Open mod2.str
- Solids > Triangulate > Using control strings
- Click on each control string
- Esc
- Enter the information below:



- Save as Mod1_control_string.dtm

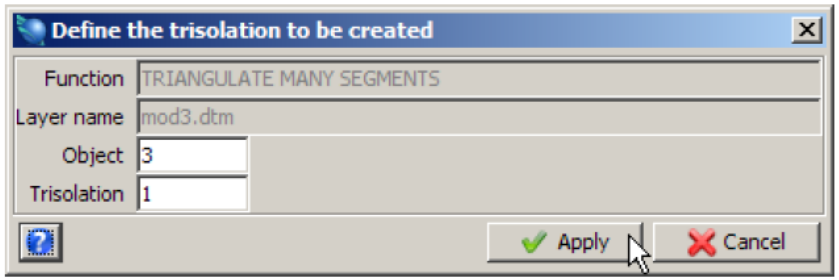


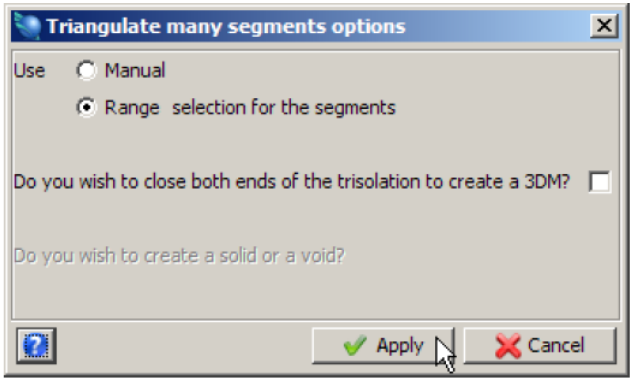
Triangulation using Many Segments

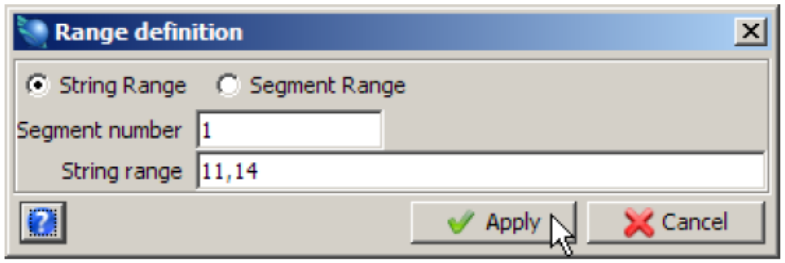
- Useful if the data is not numerically sequenced
- It is possible to select segments in the order you want triangulation to occur
- Rules:
  - Organize data in numerical sequence if selecting strings or segments by a range
  - Only display what needs to be displayed if selecting segments manually i.e. erase objects that might obscure the string data

Assignment 4 – Triangulation, Many Segments

- Open mod3.str (display strings 11 – 14)
- Select Solids > triangulate > Many segments

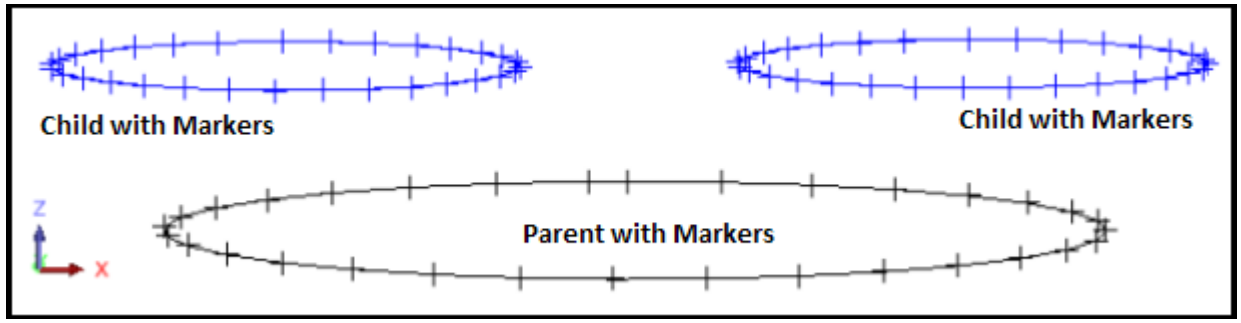






Triangulating using Bifurcation Techniques

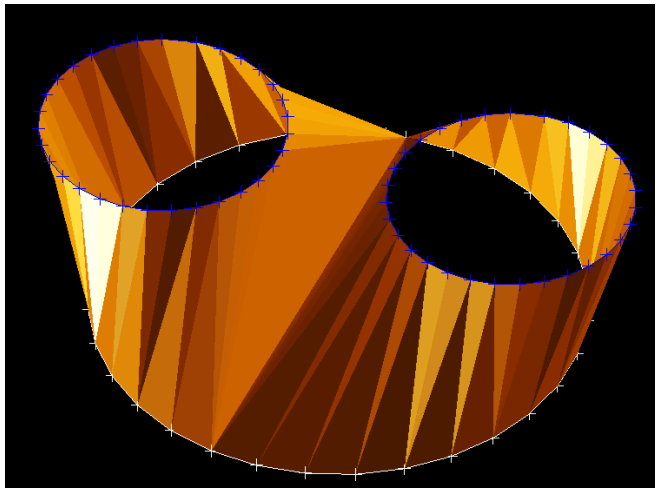
- One segment to many segments
  - For triangulation between one closed parent segment and many children



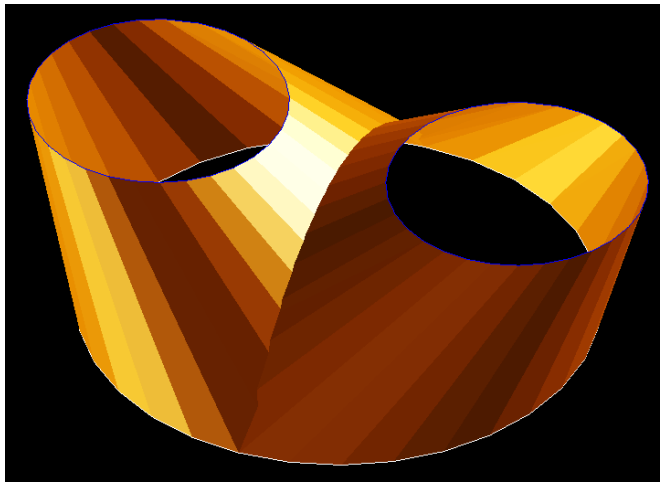
- One segment to two segments (bifurcation union)
  - Function allows you to triangulate between one closed parent and two children.
  - Can give more flexibility in where the bifurcation actually occurs
  - It has the potential to be more geologically correct
  - Option to join all of the parent segment to all of the child segments, or to split the parent segment up and join a portion of it up with each segment

Assignment 5 – Bifurcation Techniques

- A. Create bifurcation on strings:
  - Open Bifurc1.str
  - Display point markers
  - Select bifurcation one to many
  - Follow instructions
  - Save as one_to_many.dtm

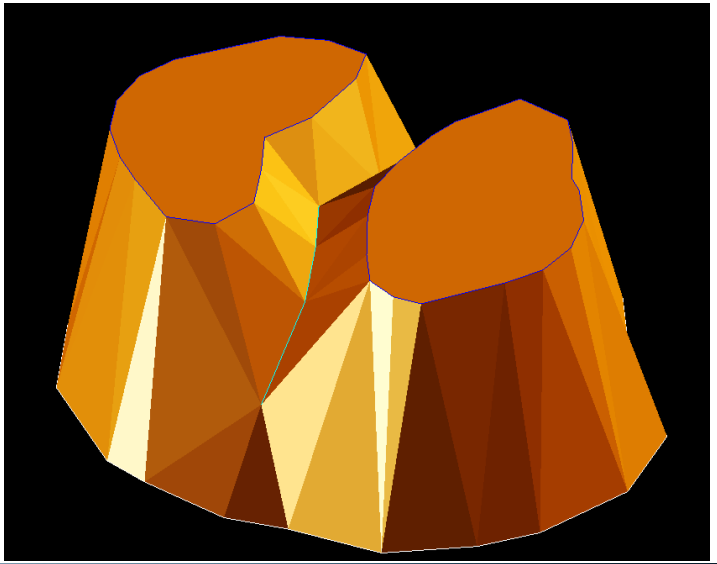


- B. Now use one to two segments
  - Open Bifurc1.str
  - Select bifurcation one to two
  - Follow instructions
  - Save as one_to_two.dtm
  - Notice the difference?



Triangulating using Manual Triangulation

- Gives high level of control, while still leaving a degree of automation to the triangulation process
- You are able to create solid of extremely complex geometry that will exactly match geometrical interpretation of the data
- You control start and end points of the triangulation on a segment-by-segment basis
- Same direction of strings rule must apply



Triangulating using Segment to a Point

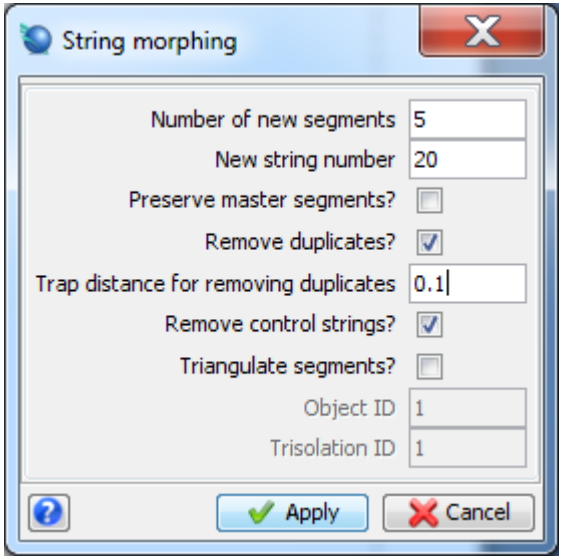
- This function allows you to automatically triangulate from a selected segment to a selected point
- Another technique which can be used to close the ends of an open DTM
  - Closed DTMs are significant because the volume report can be generated from them
- The triangulate to a point function can be used to accurately model ‘pinch outs’ in geological lenses

Triangulating using String Morphing

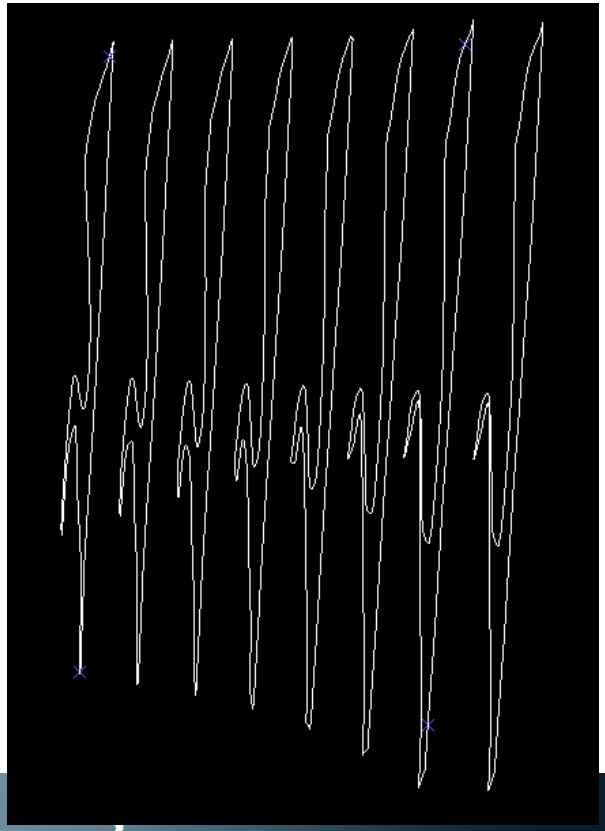
- This function creates new segments equally spaced between two existing segments which are selected in graphics.
- String morphing can greatly improve the nature of solid models by ensuring a smoother transition between structures on adjacent segments, and can greatly reduce the *staircasing* effect when solid modelling.
- Morphing additional intervening segments often enables the solid modelling of otherwise difficult segments.

Assignment 6 – String Morphing

- Open mod1.str
- Display string numbers
- Select: Solids > Triangulate > String Morphing



- Select: Solids > Triangulate > Many segments
- Select Manual in the following form
- Save as morph_mod1.dtm



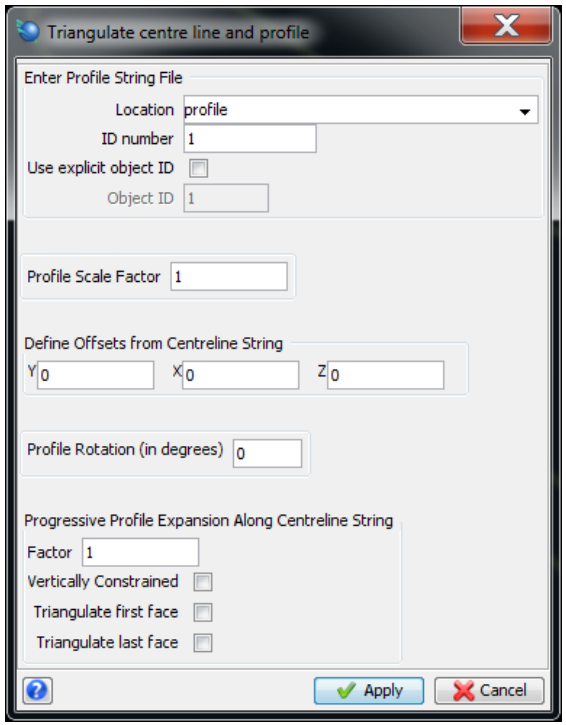
Triangulating Using Centre Line & Profile

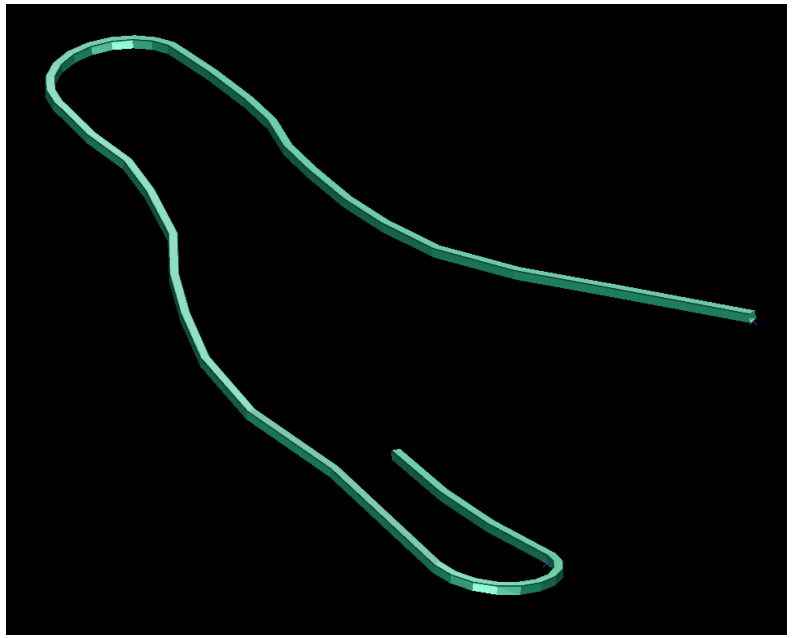
- This function allows you to create a DTM of a given profile along a specified string
- The centre line is chosen by selecting a string in the graphics window with the mouse and the profile is taken from the string file
- This profile is placed at each point on the centre line string and rotated to be perpendicular to the centre line string
- Finally the strings are stitched together to create a solid
- The ends of this DTM may be optionally closed or left open

- In order for the profile to be correctly applied to a centre line, the centre bottom point of the profile needs to have coordinates of X=0 and Y=0

Assignment – Centre Line & Profile

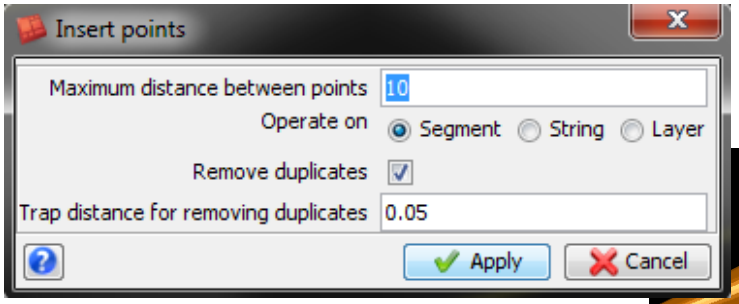
- Open Dcl100.str
- Select Solids > Triangulate > Using centre line and profile

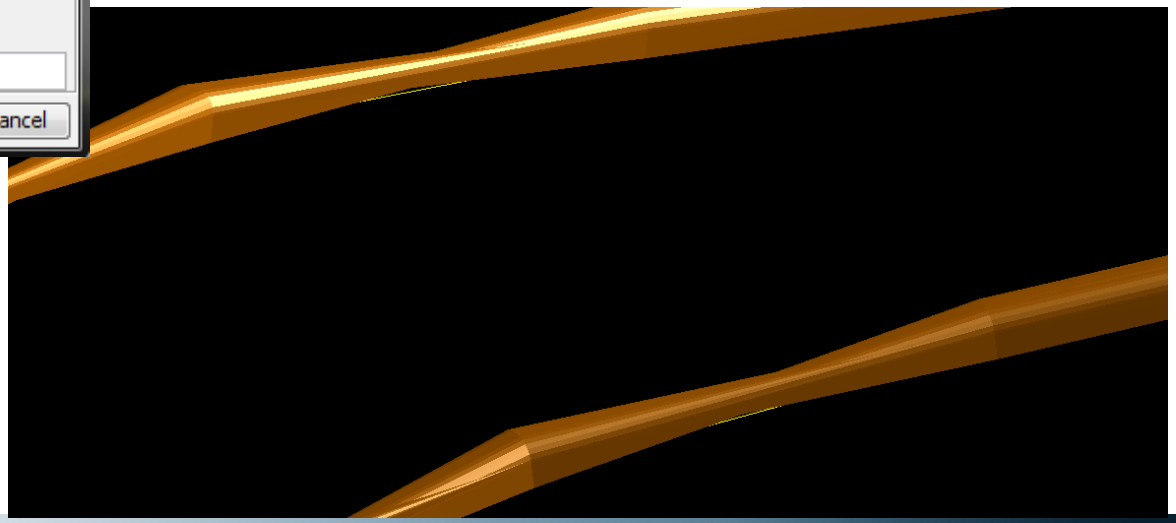




If you see twisting of the DTM...

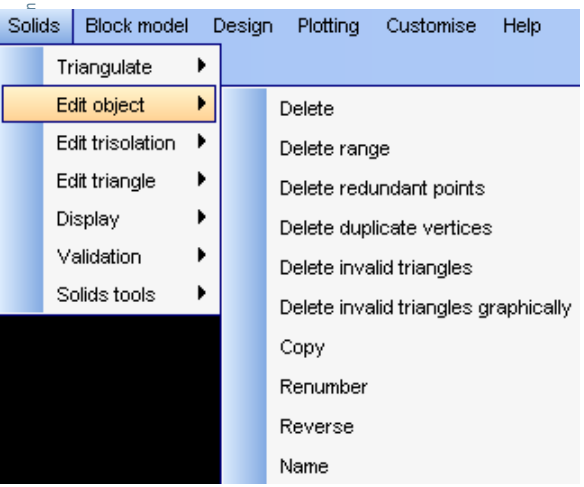
- If the model looks like this, there are not enough points along the string.
- To add more points:
  - Edit>segment>normalise segment
  - Fill in a below and apply

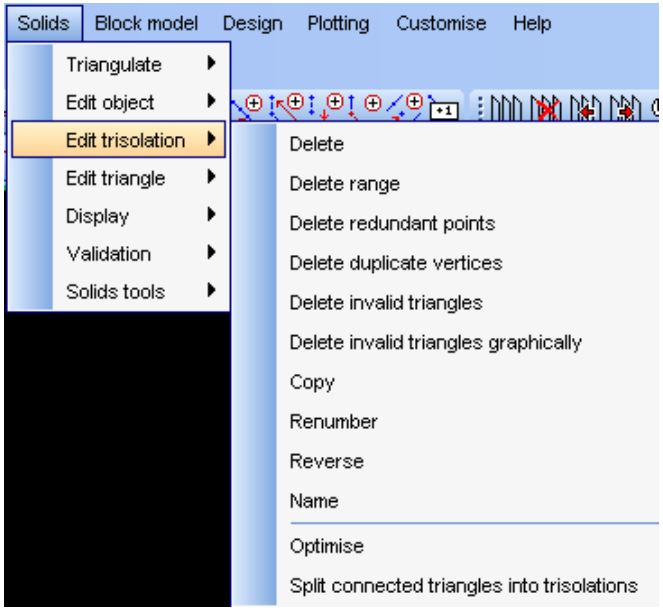


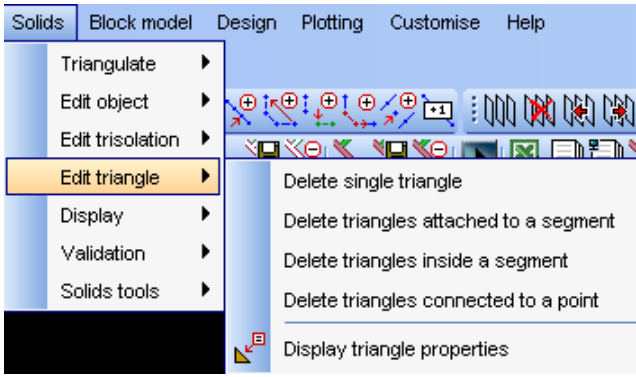


Editing Solids

- Functions for making permanent changes to the objects, trisolations and triangles
  - Edit object: applies to object and all trisolations of the selected object
  - Edit trisolation: applies to trisolations and all triangles on the selected trisolation
  - Edit triangle: applies to individual triangles

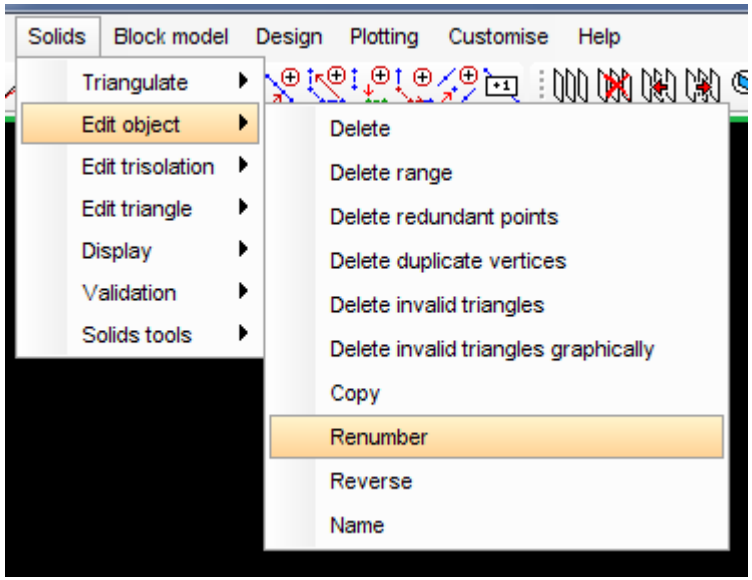


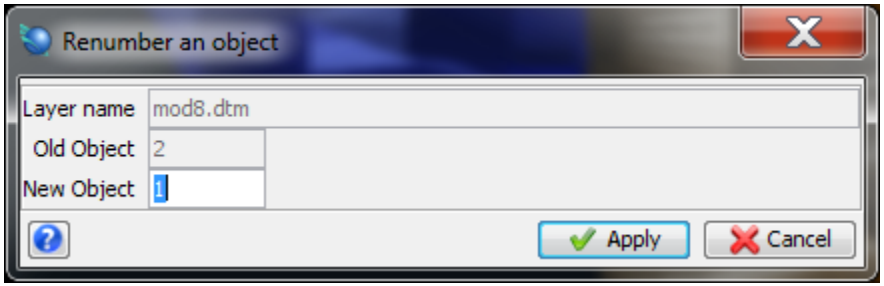




Assignment 7 – Editing Solids

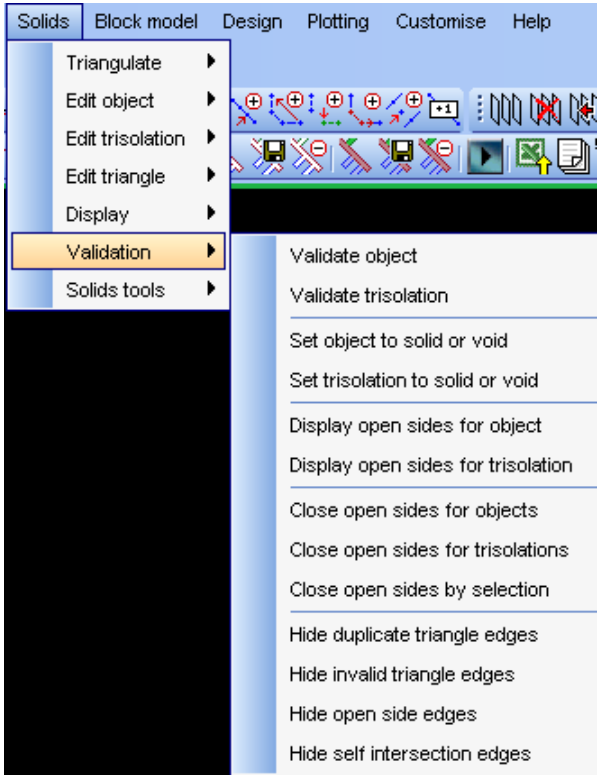
- Assignment:
  - Change the solid number 2 to solid number 1 in file mod8.dtm





Validating Solids

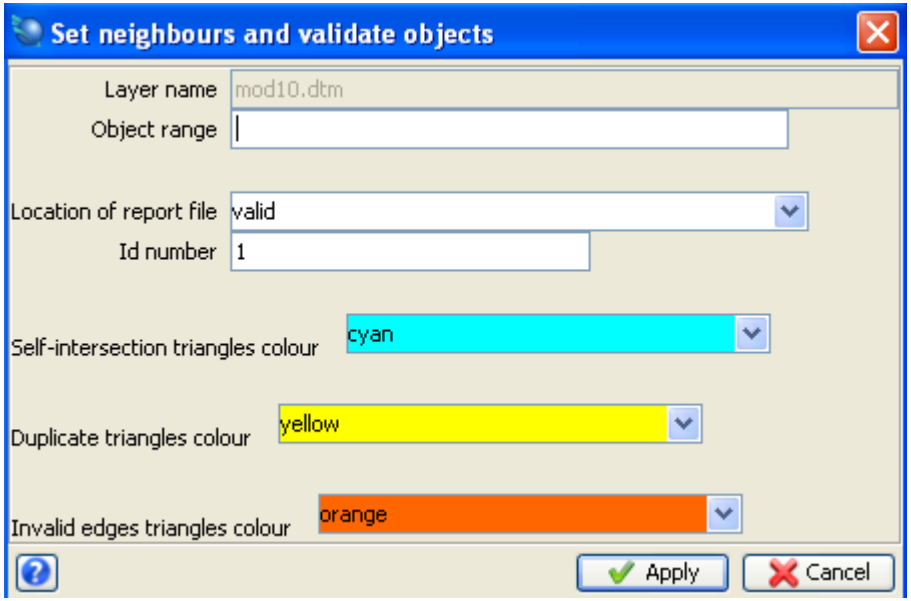
- To check that the model has been correctly formed
- Only correctly formed models are used for volume calculations, block model constraints, intersecting drillholes...
- Different validation techniques



Validating Solids

- Creates topology index for a DTM and validates it
  - Topology index = each triangle contains information about three triangles which are its neighbours
- Trisolation is evaluated as being open or closed
- Validation consists of looking for:
  - Duplicate triangles
  - Invalid trisolation edges
  - Self intersecting triangles
  - Open sides triangles
- If all above mentioned are found, these are highlighted on the screen in a user chosen colour and the trisolation is validated as false
- Set object (trisolation) to solid or void
  - To ensure that all the triangles in all trisolations of a DTM are consistent in direction

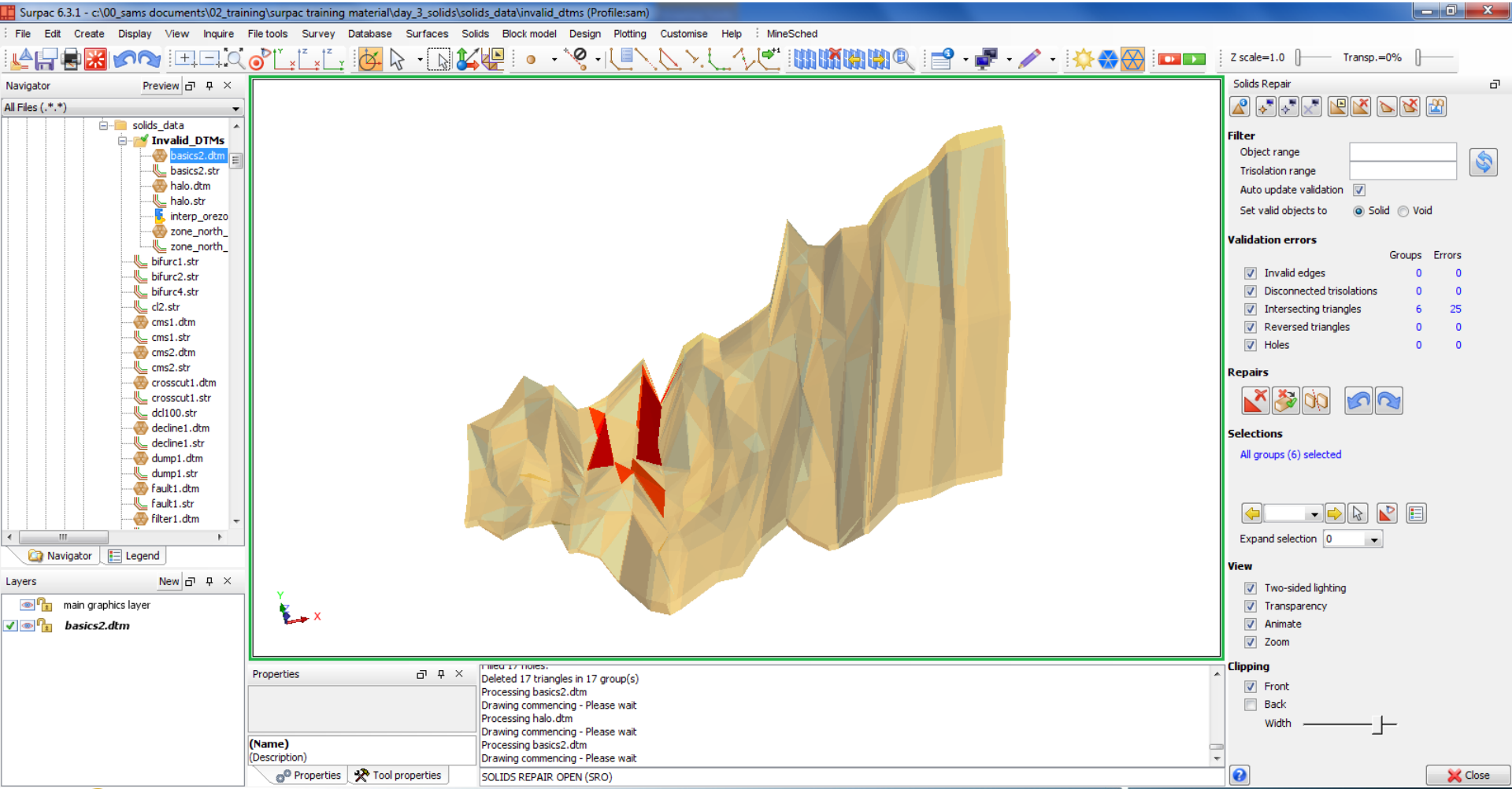
Validating Solids




```
OBJECT 1, TRISOLATION 1
=======================================

Validated = TRUE
Status = CLOSED

DUPLICATE TRIANGLES:
--------------------
NONE

TRIANGLES ATTACHED TO INVALID EDGES:
------------------------------------
NONE

SELF INTERSECTION TRIANGLES:
----------------------------
NONE

OPEN SIDES TRIANGLES:
---------------------
NONE
```

Solids Fixing

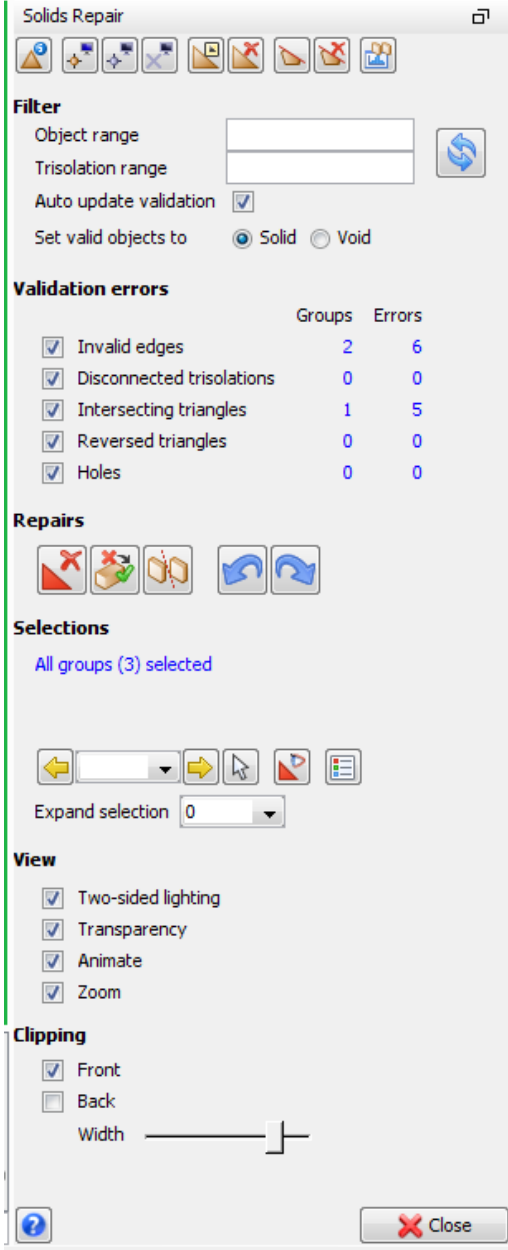
- Fixing solids in Surpac is automated.



Solids Fixing

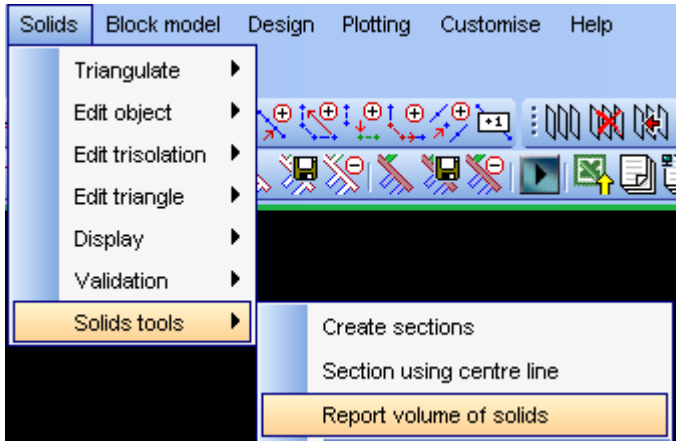
- In solids > validation > solids repair.
- A new toolbar will be displayed.
- The problem triangles are highlighted and categorised.
- These can be deleted, redrawn, split, etc.

- In the folder Invalid_DTMS there are several solids to test.
  - Can you fix all of these solids?



Reporting Volumes of Solids

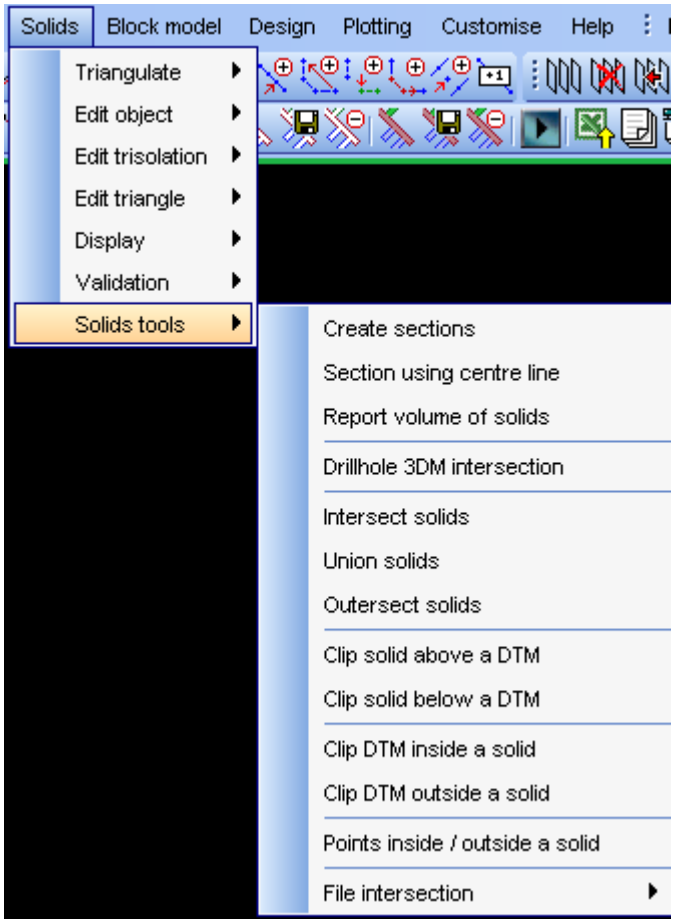
- Used to generate .not file indicating the status, surface area and volume for each trisolation of an object.
- Function calculates the volume of a closed object or trisolation
- In order to generate a volume, the solid must be validated and also have its direction set




```
SOLID MODELLING OBJECT REPORT
Layer Name: mod12.dtm

Object: 1
Trisolation: 1
Validated = true
Status = solid

Trisolation Extents
X Minimum: 5184.820 X Maximum: 5468.470
Y Minimum: 10055.129 Y Maximum: 10634.653
Z Minimum: 836.580 Z Maximum: 1078.760
Surface area: 421501
Volume : 5337158


Object: 2
Trisolation: 1
Validated = true
Status = solid

Trisolation Extents
X Minimum: 5225.070 X Maximum: 5477.490
Y Minimum: 10619.466 Y Maximum: 10920.397
Z Minimum: 904.633 Z Maximum: 1058.910
Surface area: 191274
Volume : 2293278


Totals
Surface area: 612775
Volume : 7630436
```

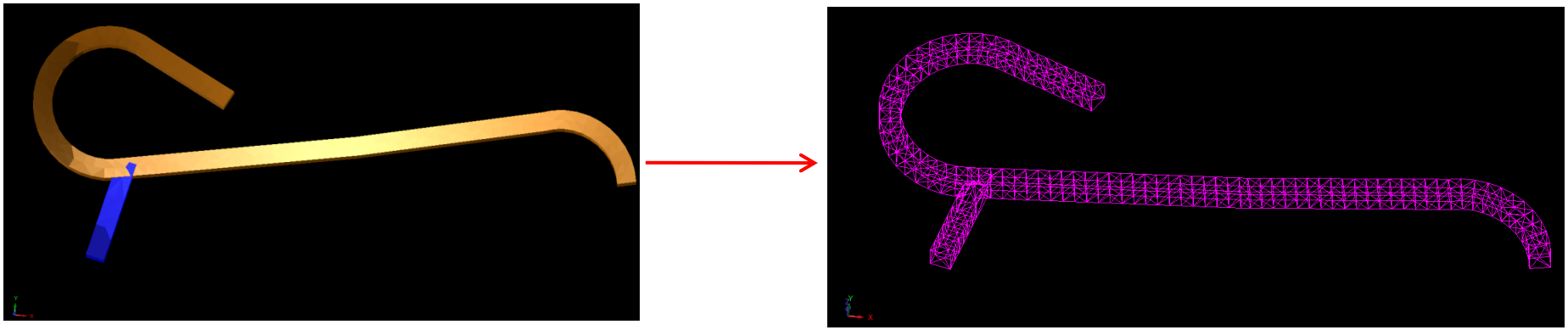
Intersecting Solids and DTM Surfaces

- With intersections of solids you can create:
  - Union solids
  - Intersect solids
  - Outersect solids
  - Clip solid above DTM
  - Clip DTM outside a solid



Intersecting Solids and DTM Surfaces

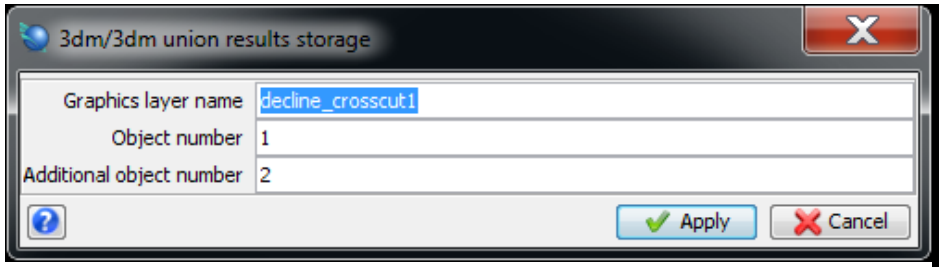
- Solids Union:
  - This function allows you to merge two solids together
  - Solid Tools > Union Solids
  - The order of selection is not important

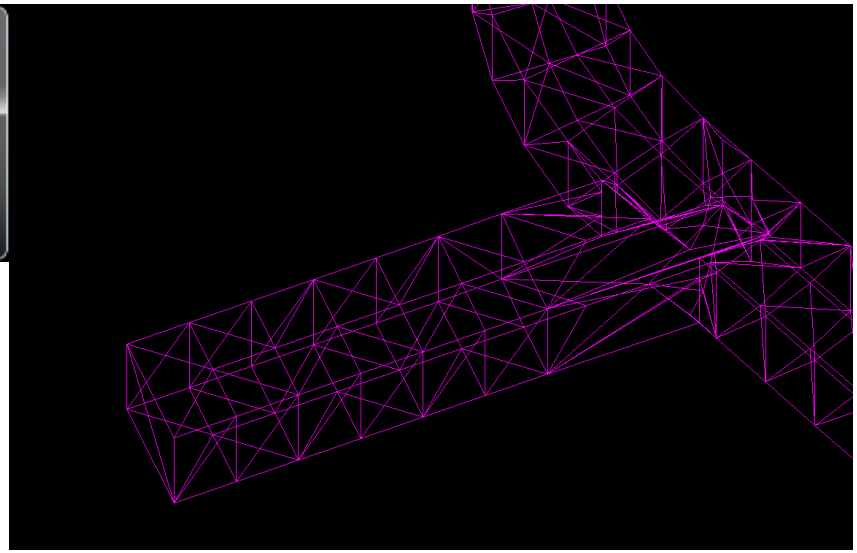


(decline1.dtm and crosscut1.dtm)

Assignment 8 – Intersecting Solids

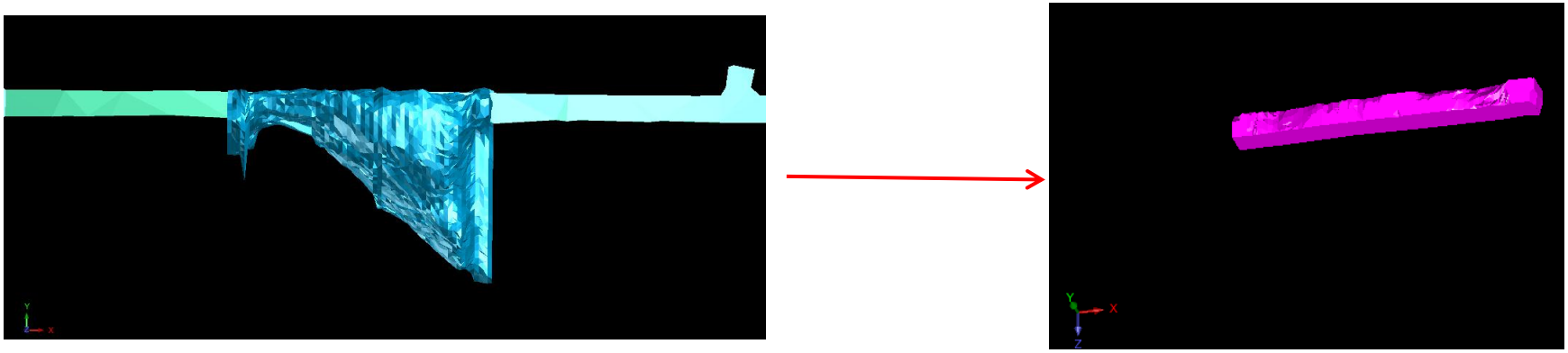
- Open decline1.dtm and crosscut1.dtm
- Type ZA
- Select: Solids > Solid Tools > Union Solids





Intersecting Solids and DTM Surfaces

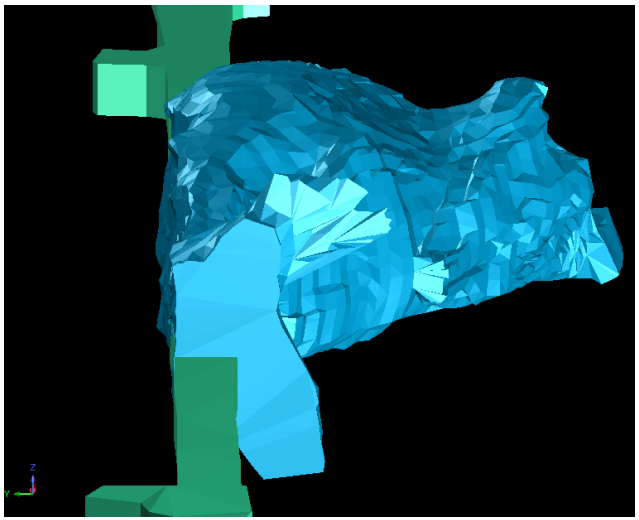
- Solids Intersection:
  - Function allows you to intersect two solids and creates a new solid, which represents the volume common to both
  - Solid Tools > Intersect Solids
  - Order of selection is not important

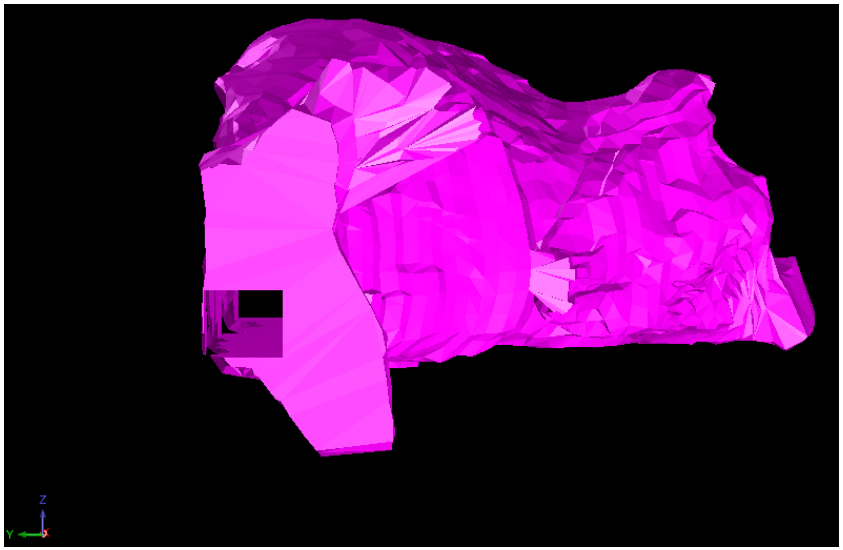


(lev1.dtm and stope1.dtm)

Intersecting Solids and DTM Surfaces

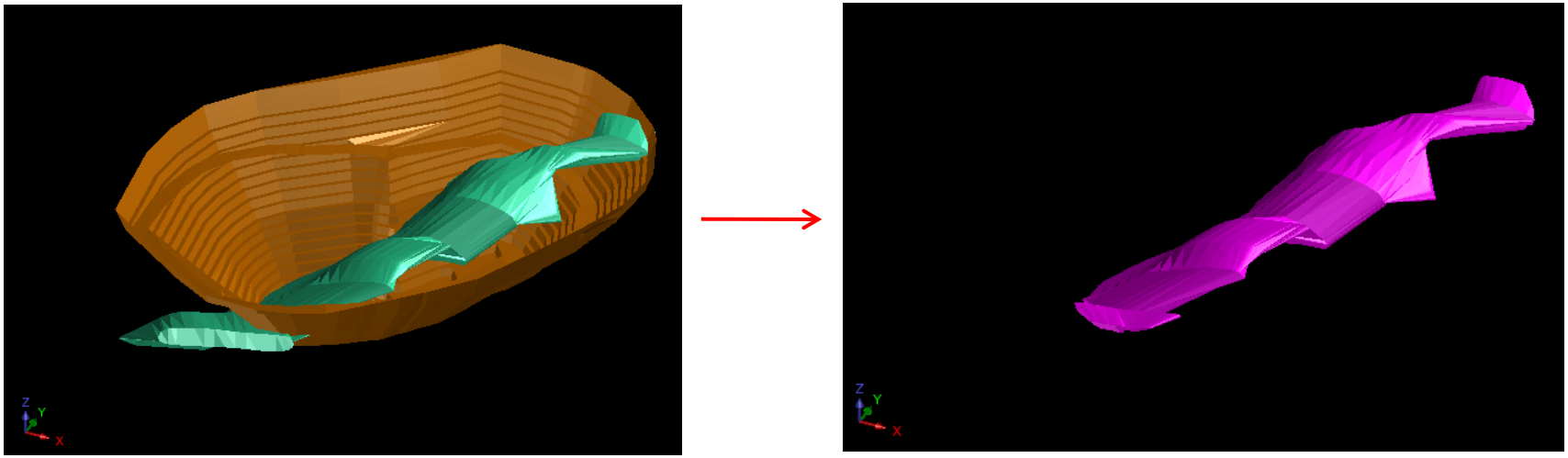
- Outersection of Solids:
  - Function allows you to find the difference between two solids
  - The order of selection is important:
    - First to select is the solid to be outersected
    - Second to select is the outersecting solid
  - Solid Tools > Outersect Solids





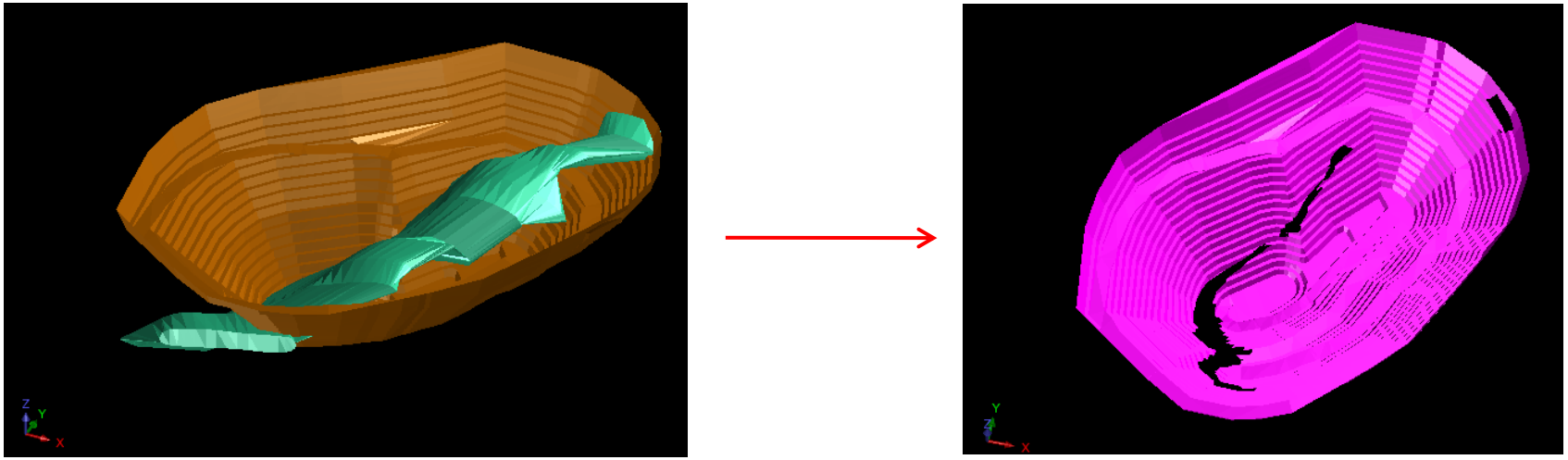
Intersecting Solids and DTM Surfaces

- Clipping a Solid Above a DTM:
  - Function allows you to find the portion of a solid that is above DTM
    - Creating a solid that represents the volume of an ore body above the DTM
  - Solid Tools > Clip Solid Above a DTM



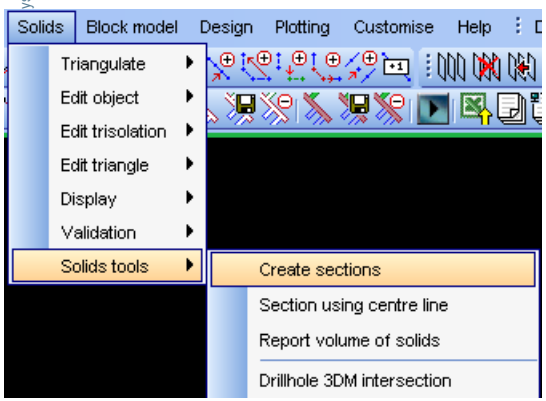
Intersecting Solids and DTM Surfaces

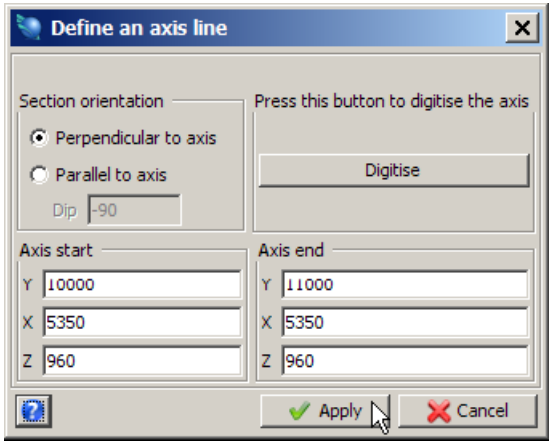
- Clipping a DTM Outside a Solid:
  - Function will retain part of the DTM that occurred outside the solid
  - Solid Tools > Clip a DTM Outside a Solid

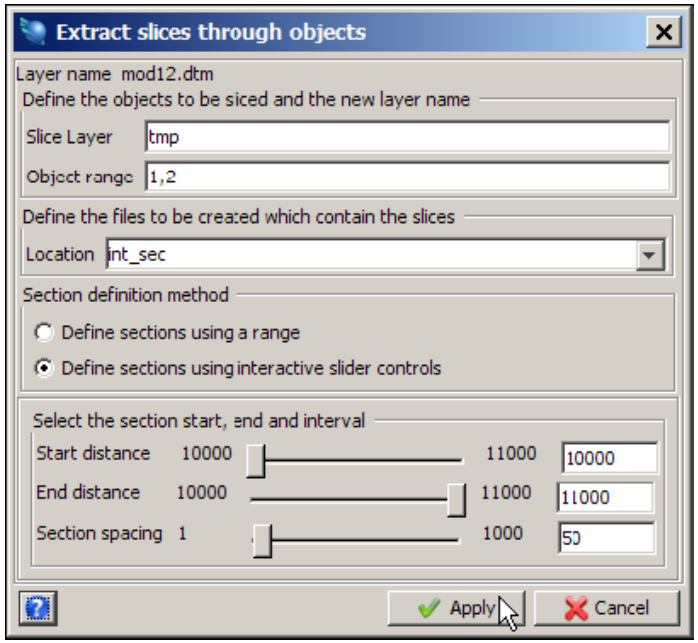


Creating Sections

- Three different methods used to create sections from solids:
  - Creating sections using the interactive method
  - Creating sections by range
  - Creating sections using a centre line
- Creating sections using the interactive method:





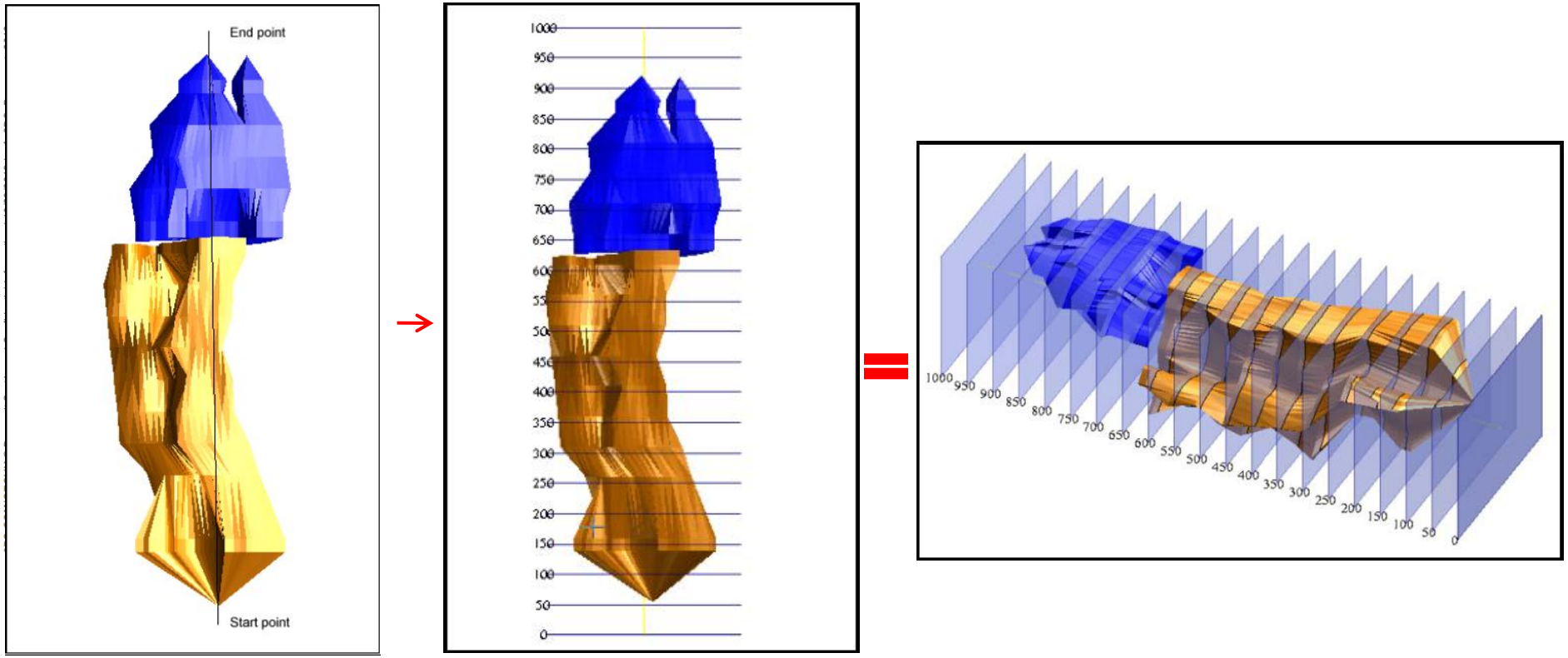


Creating Sections

- Creating sections using the interactive method:
  - Function allows you to extract horizontal, vertical or inclined slices through an object
  - The plane of intersection of the slices is defined by entering the Y,X,Z coordinates at each end of a 3D axis line and by specifying the interval along that axis at which slices are to be taken
  - Two results are produced:
    - Range of a string files which contain the extracted sections in section coordinates (saved to disk)
    - File which contains the extracted sections in real world coordinates → displayed on the screen in different layer
  - Reason to slice a DTM is to show one section at a time through a geological model along with the drill holes for that section posted to it

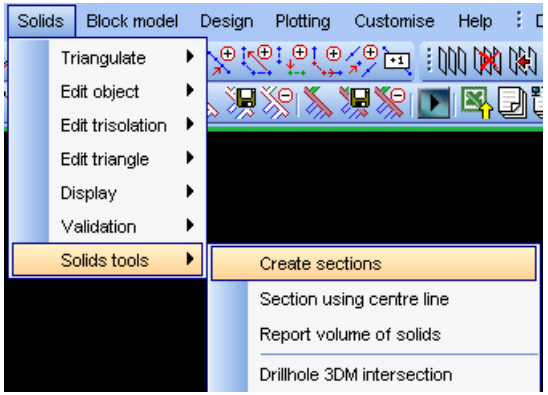
Creating Sections

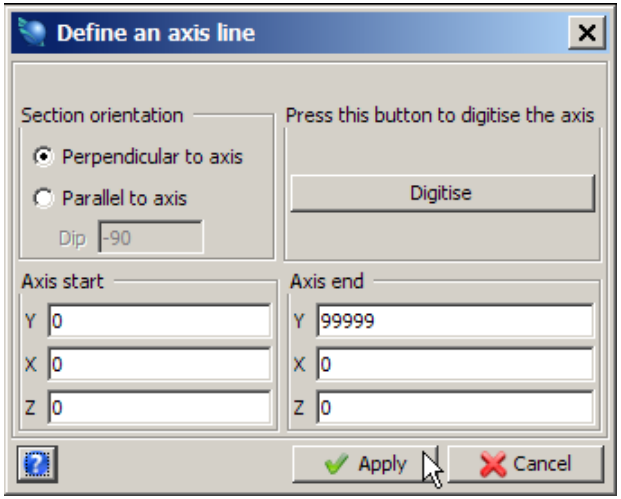
- Creating sections using the interactive method:

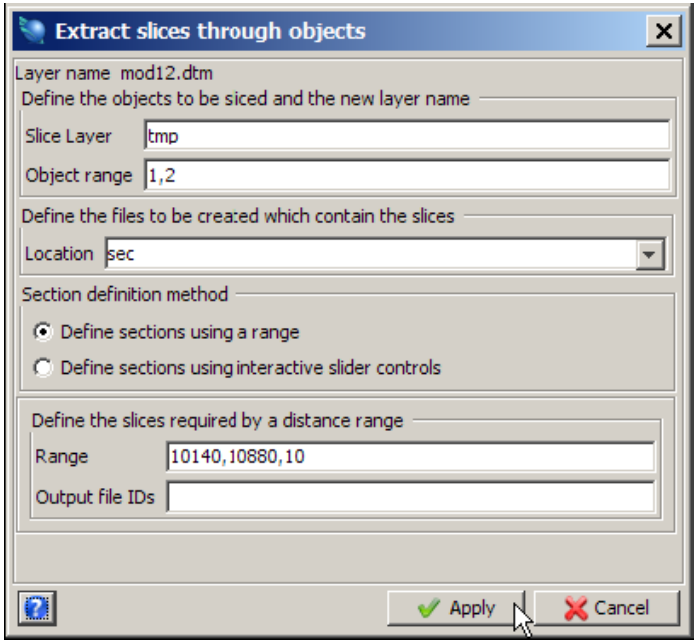


Creating Sections

- Creating sections by range:

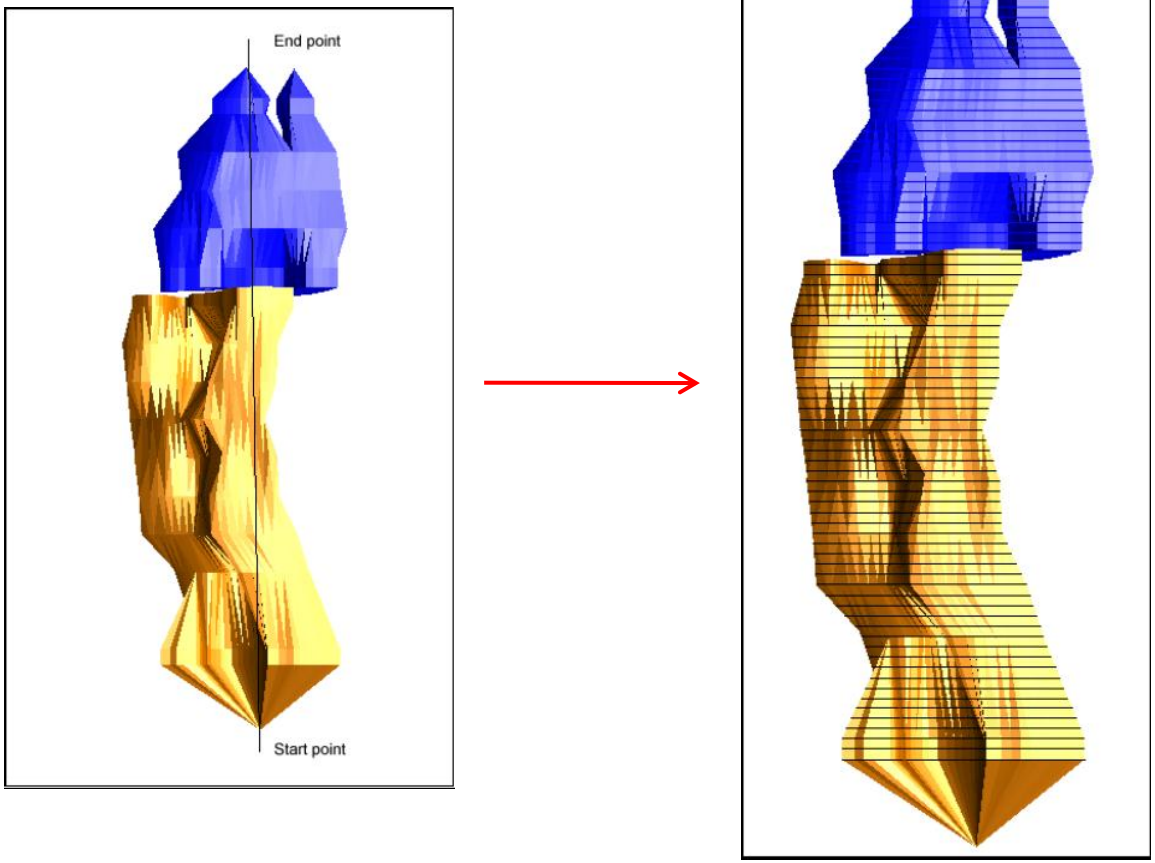






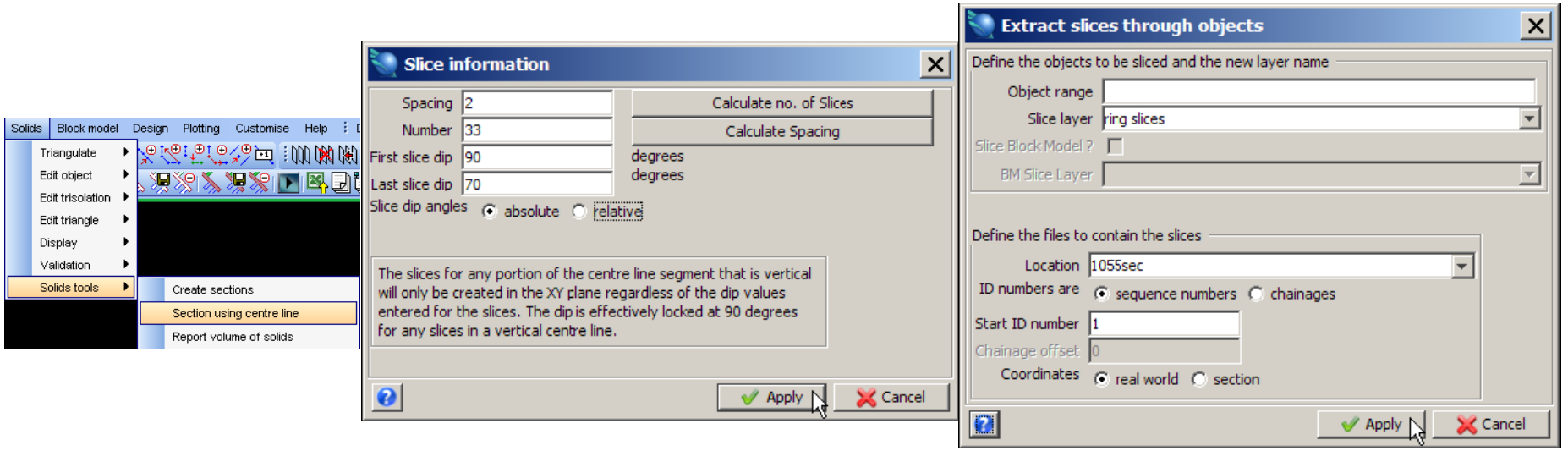
Creating Sections

- Creating sections by range:



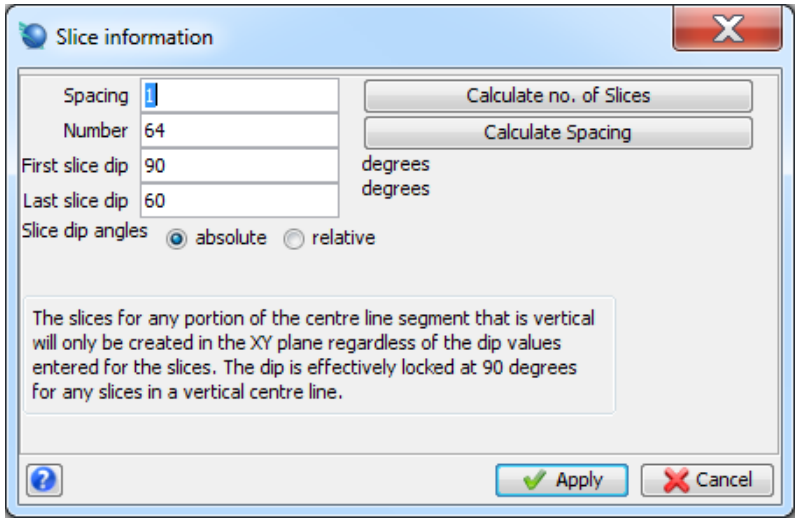
Creating Sections

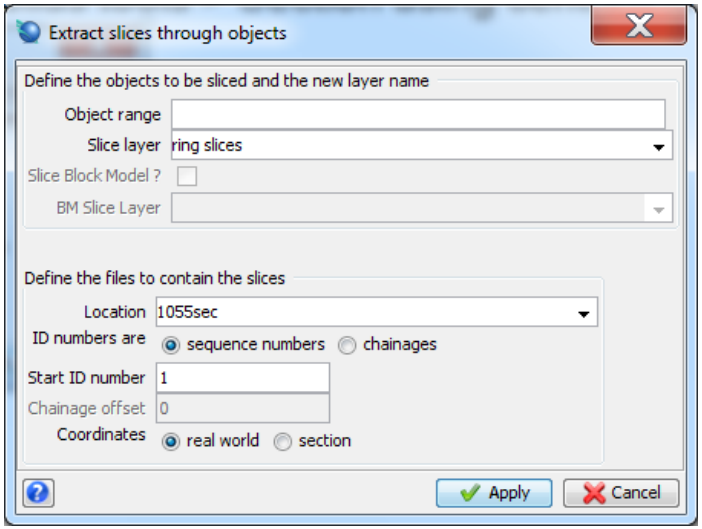
- Creating sections using a centre line:
  - This function allows you to extract slices through a DTM and/or a block model in the current graphics layer along a segment (centre line)
  - The centre line along which the slices are taken is defined by selecting two points on a segment
  - Slices are taken along the segment at a specified spacing and at a specified dip



Assignment 9 – Sections using centre line

- Open cl2.str
- Open stope2.dtm
- Select: Solids > Solids tools > Section using centreline

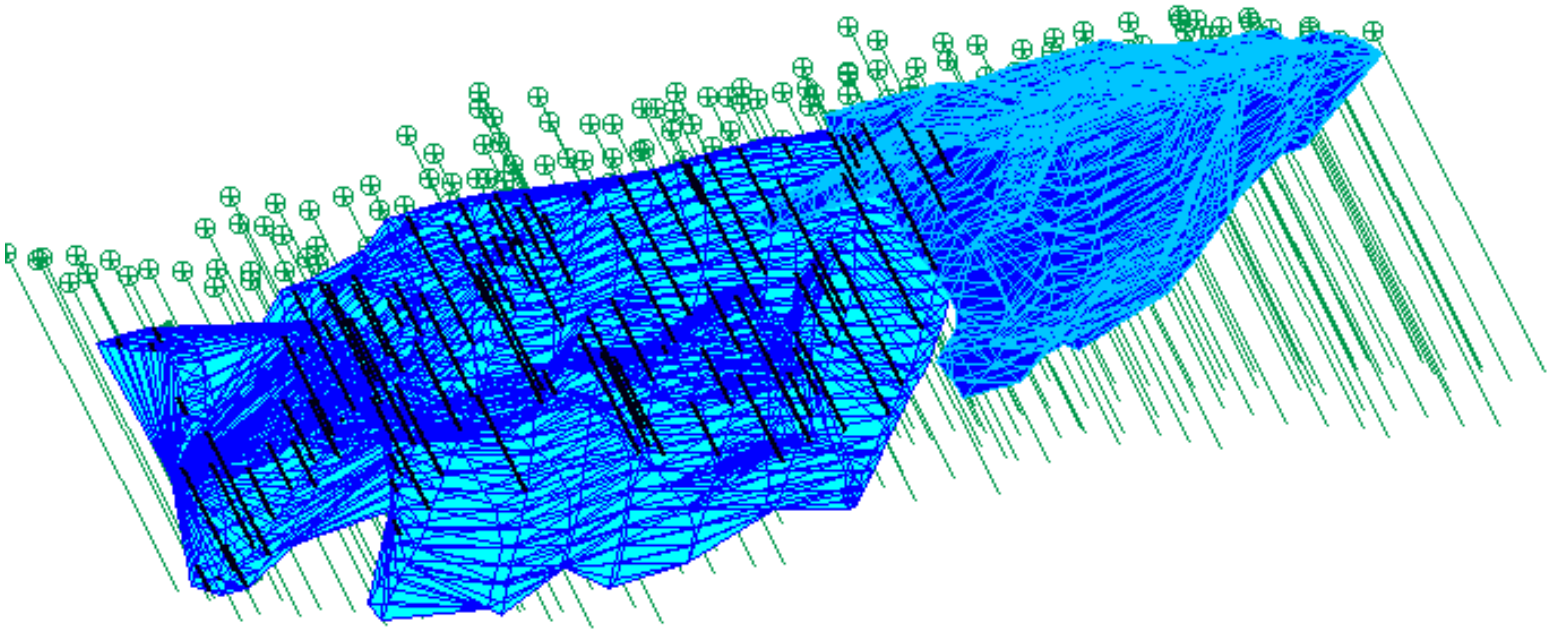




- Turn edges off to view the sections

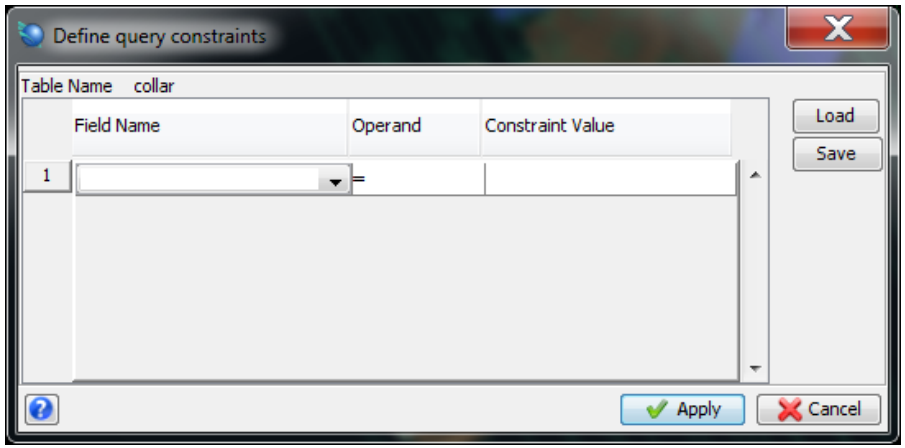
Intersecting Drill Holes with Solid Models

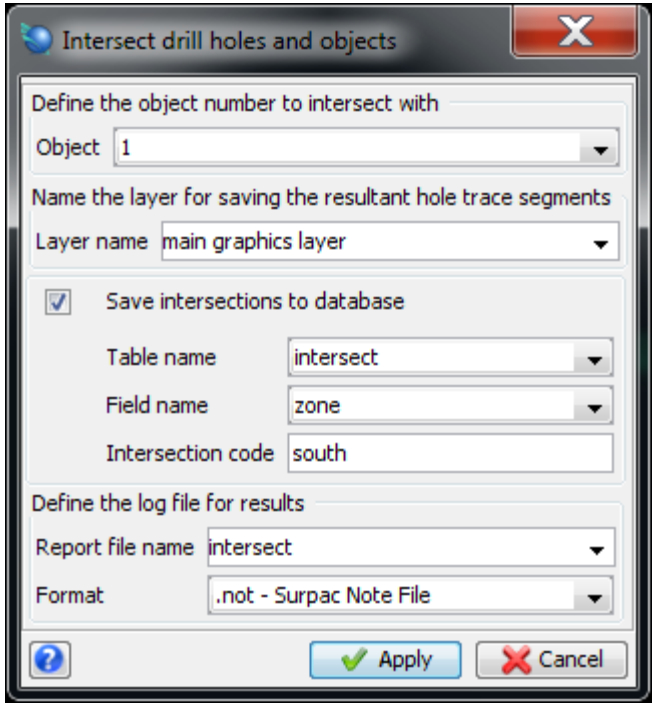
- This function allows you to perform intersection between drill holes stored in a drill hole database and 3D objects and then store the intersection data in a database



Assignment 10 - Drill Holes/Solid Intersection

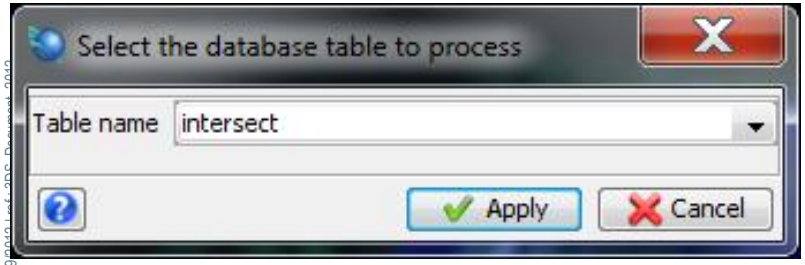
- Open mod12.dtm and connect to solids.ddb
- Display drillholes, accept defaults
- Select Database > Analysis > Drillhole 3DM intersection

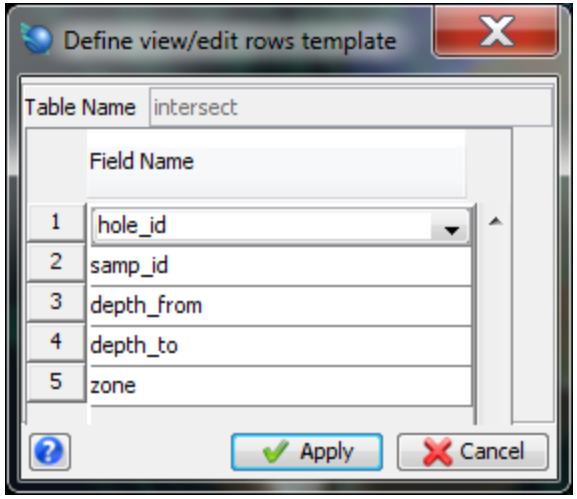


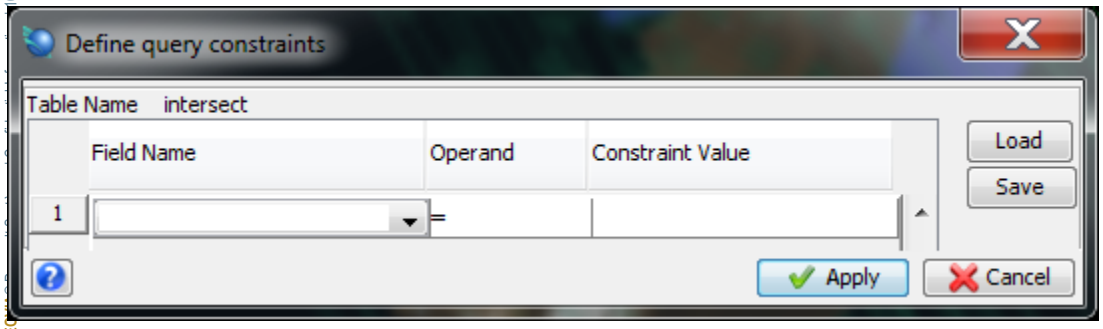


Assignment 10 - Continued

- Select: Database > Edit > View table constrained







- Close the database
- Turn transparency to 40%

End of Day 3

- Any Questions?