

Solids Modelling in Surpac v6.1

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Introduction

Overview

Solids Modelling allows us to use triangulation to create three-dimensional models based on Digital Terrain Models (DTMs) and String files. This tutorial introduces the theory behind the solids modelling process and provides detailed examples using the solids modelling functions in Surpac. By working through this tutorial, you will gain skills in the construction, use of and modification of solids models.

Requirements

This tutorial assumes that you have a basic knowledge of Surpac. We recommend that you understand the procedures and concepts in the Introduction to Surpac manual. The DTM Surfaces tutorial may also be helpful in understanding some of the concepts in this tutorial.

You will also need to have:

- Surpac installed on your computer, and
- The data set accompanying this tutorial.

Workflow



Note: This workflow demonstrates the steps in this tutorial. There are other ways to achieve a result.

Solids Concepts

What is a Solid model?

A Solid model is a three-dimensional triangulation of data. For example, a solid object may be formed by wrapping a DTM around strings representing sections through the solids.

Solid models are based on the same principles as Digital Terrain Models (DTMs). Solid models use triangles to link polygonal shapes together to define a solid object or a void.

The resulting shapes may be used for:

- visualisation.
- volume calculations.
- extraction of slices in any orientation.
- intersection with data from the geological database module.

A DTM is used to define a surface. Creating a DTM is automatic. Triangles are formed by connecting groups of three data points together by taking their spatial location in the X - Y plane into account.

The drawback of this type of model is that it cannot model a structure that may have foldbacks or overhangs, for example:

- geological structure.
- stopes.
- underground mine workings, for example: declines, development drives and draw points.

A Solid model is created by forming a set of triangles from the points contained in the string. These triangles may overlap when viewed in plan, but do not overlap or intersect when the third dimension is considered. The triangles in a solid model may completely enclose a structure.

Creation of Solid models can be more interactive than the creation of DTMs, although there are many tools in Surpac that can automate the process.

The following diagram shows an example of a Solid model (design decline and ore body).

Terminology

A Solid model is made up of a set of non-overlapping triangles. These triangles form objects that may have a numeric identifier between 1 and 32000. Objects represent discrete features in a solid model. For example, in the above diagram, the decline and the ore bodies have different object numbers since they represent different features.

However, features such as ore bodies can consist of discrete pods, and you may want to give these pods the same object number to indicate that they are from the same structure. In this case, each discrete pod must have a different trisolation number. A trisolation is a discrete part of an object and may be any positive integer.

Object and Trisolation numbers give reference to all the objects contained in a Solid model.

An object trisolation may be open or closed. A trisolation is open if there is a gap in the set of triangles that make up the trisolation. An object may contain both open and closed trisolations. The reason for treating objects as open or closed are:

- 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.
- an open object cannot provide the same capabilities; when sliced by a plane the strings it produces may be open or closed or both.

Solids Files

Solid models are stored in the same way that DTMs are stored, in two ASCII text files, with .str and .dtm extensions.

Set Up For This Tutorial

Task: Set the Work Directory (Windows XP)

- 1. In the **Navigator**, right-click the **solids** folder.
- 2. From the popup menu, select Set as work directory.



The name of the work directory is displayed in the title bar of the Surpac window.

Surpac 6.1 - c:\documents and settings\all users\gemcom\surpac\61\demo_data\tutorials\solids

Task: Set the Work Directory (Windows Vista)

- 1. In the Navigator, right-click the solids folder.
- 2. From the popup menu, select Set as work directory.



The name of the work directory is displayed in the title bar of the Surpac window.

Surpac 6.1 - c:\users\public\gemcom\surpac\61\demo_data\tutorials\solids

Preparing Data

Task: Combine String Files into one File

- 1. Choose File tools > Combine/Split file options > Combine string files.
- 2. Enter the information as shown, and then click **Apply**.

🐚 Combi	ne String	js Into a Single File	×
Define the	files to be	e combined	7
Location	xs	*]
ID range	10140;10	160;10260,10860,50;10880	
Define met	hod to cre	eate new file	7
Location		ore	
ID number	,	0	
		Retain descriptions	
		Combine crest and toe files	
Start strin	g number	1	
2		🖌 🖌 Apply	

This will combine all sixteen files into one string file called **ore1.str**.

- 3. Choose File tools > Change string directions.
- 4. Enter the information as shown, and then click **Apply**.

💘 Change the dire	ection of strings	×
Define the strings to be t	urned	
Location	ore 💌	
ID range	1	
Str range	1;16	
Start at Segment 1 or 2	1	
Retain descriptions		
Define the direction requir Select direction option — C Make strings anti-clo	red ockwise ④ Make strings clockwise ① Reverse existing direction ✔ Apply 📐 🔀 Car	ncel

This will ensure that all digitised segments are set to clockwise. This string file is a series of sectional interpretations, representing a copper ore body.

Task: Check String File Directions Using String File Summary

- 1. Choose File tools > String summary.
- 2. Enter the information as shown, and then click Apply.

≷ String file su	ımmary X
Location	ore 💌
ID range	1
Field width	12
Number of decimals	1
2	🖌 Apply 🙀 🛛 🗙 Cancel

3. Enter the information as shown, and then click **Apply**.

🔍 Define result file			×
Define the f	ile to be created		
Location	summary		•
ID number	1		
Format	.not - Surpac Note File		•
2		Apply	💢 Cancel

File summary1.not is displayed.

```
String Summary Report
                                                                                                              Jul 07, 2008
File: ore1.str
Date: 07-Jul-08
                                              Purpose: Reversed strings
String Segment Direction # Points 2d Len 3d Len Area X Min X Max Y Min
                 _____
                                      _____
                                                                                       _____

      1
      Clockwise
      98
      782.3
      782.3
      10521.4
      5234.6
      5468.5
      900.2

      1
      Clockwise
      80
      781.8
      781.8
      10510.2
      5234.6
      5468.5
      900.2

      1
      Clockwise
      66
      619.9
      619.9
      7753.7
      5253.3
      5428.9
      921.4

      1
      Clockwise
      26
      178.8
      178.8
      417.3
      5301.7
      5372.3
      1016.3

      2
      Clockwise
      18
      174.8
      174.8
      928.1
      5385.3
      5434.1
      990.0

      44
      353.5
      353.5
      1345.4
      5301.7
      5377.4
      1015.9

      2
      Clockwise
      29
      209.9
      209.9
      646.0
      5301.7
      5377.4
      1015.9

      2
      Clockwise
      20
      176.3
      176.3
      995.8
      5385.3
      5434.1
      990.0

      49
      386.2
      386.2
      1641.8
      5301.7
      5434.1
      990.0

1
2
з
4
4
4
5
5
5
                                                              337 2923.7 2923.7 31772.5 5234.6 5468.5 900.2
File Summary :-
Location = ore
ID range = 1
2d Len 3d Len Area X Min X Max Y Min Y Max Z Min Z Max
                                     _____
                  _____
                                                                          _____
                                                                                             _____
                                                                                                                                _____
2923.7 2923.7 31772.5 5234.6 5468.5 900.2 1078.8 10140.0 10880.0
String Summary Report
                                                                                                                                                                                  1/1
```

- 4. Close summary1.not.
- 5. Click the **Reset graphics** icon 👪.
- 6. Open ore1.str.
- 7. Choose **Display > Strings > With string numbers**.

8. Enter the information as shown, and then click **Apply**.

💐 Drawing	X
Draw Strings	
Layer name	ore1.str 💌
String range	
Seg range	
Seg pnt range	
Desc field number	d1 💌
Text Alignment	< 💌
Position of text in segment	○ All points ④ First point ○ Centroid
	🗸 🖌 Apply

Ore 1 string is displayed.



Note: The same results could be achieved by opening all the files into one layer and then saving the layer as **ore1.str**.

Use this file to do a final check that all strings are closed and clockwise in direction.

Task: Transform Data from Section View to Plan View

- 1. Click the **Reset graphics** icon 🗱.
- 2. Choose File tools > String maths.
- 3. Enter the information as shown, and then click **Apply**.

🌏 s	String math	5				×
Defin	e the files to be	processed -				
Loca	tion ore					-
ID ra	nge 1					
Defin Locat	e the files to be tion mod	created —				_
	String range	Constraint	Field	=	Expression	
1	all		У	=	z	
2			z	=	У	
0					🕜 Appl	🔀 Cancel

4. Open mod1.str.

The plan view of the segments is displayed.



Task: Check and Remove Foldbacks

- ^{1.} Click the **Reset graphics** icon \bigotimes .
- 2. Open mod1.str.
- Choose Edit > Layer > Clean.
 ✓ Note: By using the Layer option, all strings are checked.

4. Enter the information as shown, and then click **Apply**.

🍋 Clean layer	×
Function	
C Clos	ure
C Cros	s-overs
C Dupl	icate Point
C Dupl	icate Segment
C Minir	num Area
C Minir	num Points
Spike	es
Action ⓒ mark ⓒ re Trap angle 5 Target segment	move C warn degrees
Marker colour red	
Measure distances and angle	s in 🔿 2D space 💿 3D space
2	🗸 Apply 🙀 🔀 Cancel

A temporary marker (a red circle) appears on one of the segments.

5. Zoom in on the highlighted area to view the foldback.



6. Re-run the **Clean** function with **Action** set to **remove**. This will automatically remove the foldback.

Note: Any errors highlighted by the **Clean Layer** function can also be manually edited if preferred.

Task: Highlight and Remove Duplicate Points

- 1. Click the **Reset graphics** icon 🔀.
- 2. Open mod1.str.
- 3. Choose Edit > Layer > Clean.
- 4. Enter the information as shown, and then click **Apply**.

🤍 Clean layer	×
Function	
0	Closure
0	Cross-overs
۰	Duplicate Point
0	Duplicate Segment
0	Minimum Area
0	Minimum Points
0	Spikes
Action	⊙ mark ⊙ remove ⊙ warn
Target	
Minimum trap distance	0
Maximum trap distance	0.2
Marker colour red	
Measure distances and a	angles in C 2D space 💿 3D space
	🗸 Apply 🚶 💥 Cancel

Note: Duplicate points are highlighted by a temporary marker (red hash symbol) as shown. Surpac will not triangulate points less than 0.05 units apart.



5. Re-run the **Clean** function with **Action** set to **remove** to delete any duplicate points.

Vote: To see all of the steps performed in this section, run **_01_data_preparation.tcl.** You will need to click **Apply** on any forms presented.

Creating a Solid

The following sections describe the various triangulation methods that can be used to create a Solid model.

Triangulating Using Between Segments

Task: Create a Solid Model

- 1. Click the **Reset graphics** icon 🔀.
- 2. Open mod1.str.
- 3. Choose **Display > Strings > With string numbers**.
- 4. Enter the information as shown, and then click **Apply**.

🐚 Drawing		×
Draw Strings		
Layer name	mod1.str	•
String range		
Seg range		
Seg pnt range		
Desc field number	d1 💌	
Text Alignment	< 💌	
Position of text in segment	C All points C First point C Centroid	
2	🛛 🖌 Apply	1

- 5. Choose Solids > Triangulate > Between segments.
- 6. Enter the information as shown, and then click **Apply**.

💐 Define t	he trisolation to be created
Function	TRIANGULATE AUTOMATIC
Layer name	mod1.str
Object	1
Trisolation	1
	🛛 🗸 📈 Cancel

You are prompted to Select a point on the first segment to be triangulated.

7. Click string 1.

You are prompted to Select a point on the next segment to be triangulated.

8. Click string 2.

Continue using the Between segments function up to and including string 5.

9. Press ESC.

The part of the solid created using triangulate between segments is displayed.



10. Save mod1.dtm.

💐 Save File		×
Layer Nam	e mod1.str	
Filenam	e mod1	•
Output Format Typ	e Surpac DTM Files	
Extensio	n .dtm 💌	
Options Purpose String Range File format	text	DTM/3DM Options Force solid validation on save 🔽 Force rigid backwards compatibility 🔽
	Diridi y	
2		🛛 🗸 Apply 🕌 🔀 Cancel

Note: You can use the **Between segments** function indefinitely as long as the selected strings are still in the same active layer as the first string selected.

Vote: To see all of the steps performed in this section, run **_02a_create_solid_automatic_triangulation.tcl.** You will need to click **Apply** on any forms presented.

Triangulating Using Control Strings

Task: Create Control Strings Using the Digitiser

- 1. Click the **Reset graphics** icon 🔀.
- 2. Open mod2.dtm.
- 3. Choose **Display > Hide everything** to erase all strings and objects.
- 4. Choose **Display > Strings > With string numbers**.
- 5. Enter the information as shown, and then click **Apply**.

🤍 Drawing		×
Draw Strings		
Layer name	mod2.dtm	-
String range	5,10	
Seg range		
Seg pnt range		
Desc field number	d1 💌	
Text Alignment	< 🔽	
Position of text in segment	O All points 💿 First point O Centroid	
2	🛛 💞 Apply 🕌 🔀 Canc	el

Strings 5 to 10 are displayed.



6. Choose Create > Digitise > Start new string.

7. Enter the information as shown, and then click **Apply**.

🐚 Digitiser string attributes	×
String # 100 Z 940	
Desc	
Define the Point attribute values © Use Z and Desc of selected point O User entered Z and Desc of selected point O Z of selected point and user entered Desc O User entered Z and Desc values	
Apply 📐 🔀 Canc	el

- 8. Choose Create > Digitise > New point by selection.Each point digitised will snap to an existing point in each polygon.
- 9. Digitise string 100 as shown between strings 5 and 10.



- 10. Choose Create > Digitise > Start next string.
- 11. Choose **Create > Digitise > New point by selection** and digitise string101.
- 12. Choose Create > Digitise > Start next string.
- 13. Choose **Create > Digitise > New point by selection** and digitise string102.
- 14. Press **ESC.**
- 15. Choose Solids > Triangulate > Using control strings.
- 16. Click on String 100.

Tip: When selecting each control string graphically, click on the string midway between the polygons. This will ensure that the control string is correctly selected.

17. Next, click String 101 and then click String 102.

18. Press ESC.

19. Enter the information as shown, and then click Apply.

Define the trisolation to be created		
Function	TRIANGULATE CONTROL STRINGS	
Layer name	mod2.dtm	
Object	2	
Trisolation	1	
	🗸 Apply 👷 🔀 Cancel	

The part of the solid which uses control strings is displayed.



20. Choose File > Save as > string/DTM to save this part of the model as mod2.dtm.



21. Click Yes.

Vote: To see all of the steps performed in this section, run **_02b_create_solid_control_ strings.tcl.** You will need to click **Apply** on any forms presented.

Triangulating Using Many Segments

Task: Create a Solid by Specifying a Range of Strings

- 1. Click the **Reset graphics** icon 🔀.
- 2. Open mod3.dtm.
- 3. Choose **Display > Hide everything** to erase all strings and objects.
- 4. Choose **Display > Strings > With string numbers**.
- 5. Enter the information as shown, and then click **Apply**.

🔍 Drawing	
Draw Strings	
Layer name	mod3.dtm
String range	11,14
Seg range	
Seg pnt range	
Desc field number	d1 💌
Text Alignment	< 🔽
Position of text in segment	○ All points
	🛛 🖌 Apply 🙀 🛛 💥 Cancel

Note: The range definition form could be applied with a blank string range to triangulate all strings in the current graphic layer.

- 6. Choose Solids >Triangulate > Many segments.
- 7. Enter the information as shown, and then click **Apply**.

Define the trisolation to be created		
Function	TRIANGULATE MANY SEGMENTS	
Layer name	mod3.dtm	
Object	3	
Trisolation	1	
2	🖌 🖌 🕹 🖌 🖌 Apply	

8. Enter the information as shown, and then click **Apply**.

🥘 Ti	riangulate many segments options	×
Use	C Manual	
	Range selection for the segments	
Do yo	u wish to close both ends of the trisolation to create a 3DM?	
Do yo	u wish to create a solid or a void?	
2	🗸 🖌 📈 🖌 🖌 🖌 🖌	

9. Enter the information as shown, and then click **Apply**.

Range definition	
String Range	C Segment Range
Segment number	1
String range	11,14
2	🗸 🗸 Apply 🙀 💦 Cancel

Selected segment image is displayed.



10. Save as mod3.dtm.

Verify creation of multiple files		
🔥 Warning		
You are about to overwrite the following files:		
mod3.dtm, mod3.str		
This operation could result in a possible loss of data.		
Do you wish to continue?		
For more information see the online documentation.		
Yes X No		

11. Click Yes.

If you want to run manually through the material again, you will need to copy **original_mod3.dtm** to **mod3.dtm**.

Note: To see all of the steps performed in this section, run **_02c_create_solid_triangulate_ many_segments.tcl.** You will need to click **Apply** on any forms presented.

Triangulating Using Bifurcation Techniques

Task: Perform Bifurcation - One Segment to Many Segments

- 1. Click the **Reset graphics** icon 🗱.
- Open bifurc1.str.
 Put it in a suitable view so that you can see all three shapes.
- 3. Choose **Display > Point > Markers** to display all points as markers.

The Parent and Child segments with Markers are displayed:



- 4. Choose Solids > Triangulate > One segment to many segments.
- 5. Enter the information as shown, and then click Apply

🐚 Define t	he trisolation to be created 🔀
Function	TRIANGULATE TO A POINT
Layer name	mod5.dtm
Object	7
Trisolation	1
2	🗸 🖌 🖌 🖌 🖌 🖌 🖌

6. Enter the information as shown, and then click **Apply**.



You are prompted to select the first break point on the parent segment for the first child.

Click the parent segment.
 Here you are being asked to select where you are going to perform the bifurcation,

You are prompted to select the second break point on the parent segment for the first child.

8. Click the opposite side of the parent segment. The bifurcation example is displayed.



You are asked to select the portion of the parent segment to join to the first child. This means which side of the parent will you join up with which child.

- 9. Click the left side of the parent segment.
- 10. Enter the information as shown, and then click **Apply**.



11. Click the left child.

You are asked whether the next child is a segment or a point



12. Click **Apply** on this form and then click the right child. The bifurcation example is displayed.



Note: This is just one way of performing a bifurcation. The benefits are the relative simplicity and the ability to split the parent string to more than two components.

Task: Perform One Segment to Two Segments (Bifurcation Union)

- 1. Click the **Reset graphics** icon 👪.
- 2. Open **bifurc1.str**.
- 3. Choose View > Data view options > View by bearing & dip.
- 4. Enter the information as shown, and then click **Apply**.

🥘 Spe	cify view by bearing and dip	×
Bearing	0	
Dip	-15	
2	🗸 🖌 🖌 🖌 🖌 🖌 🗸 Cancel	

5. Choose Solids > Triangulate > One segment to two segments.

6. Enter the information as shown, and then click **Apply**.

Define the trisolation to be created	
Function	BIFURCATION UNION
Layer name	bifurc1.str
Object	1
Trisolation	1
0	🛛 🗸 🕺 Cancel

7. Enter the information as shown, and then click **Apply**.

Bifurcation option:	s	×		
Do you wish to split the parent segment?				
String number to store bi	32000			
2	🖌 🗸 🗸	🔀 Cancel		

You are prompted to select the parent segment.

- Click the parent segment.
 You are then prompted to choose whether the first child is a (S)egment or a (P)oint.
- 9. Click **Apply**, and then click the left child.

🍓 First chik	d segment or point	? X
Is the first chil	d a Segment or a Poin	^{t?} ⊙ s ⊖ p
2	V Apply	💢 Cancel

You are then prompted to choose whether the second child is a (S)egment or (P)oint.

10. Click **Apply**, and then click the right child.

Second 🧐	child segment or point?	? X
Is the second	d child a Segment or a Point	? • S • P
0	V Apply	🔀 Cancel

The bifurcation example is displayed.



Task: Perform Bifurcation Union – Split Parent

- ^{1.} Click the **Reset graphics** icon ⁸⁸.
- 2. Open bifurc1.str.
- 3. Put it in a suitable view so that you can see all three shapes.

 Choose Display > Point > Markers to display all points as markers. The bifurcation example is displayed.



- 5. Choose Solids > Triangulate > One segment to two segments.
- 6. Enter the information as shown, and then click **Apply**.

🥘 Define t	the trisolation to be created
Function	BIFURCATION UNION
Layer name	bifurc1.str
Object	1
Trisolation	1
2	🖌 🖌 🖌 🖌 🖌 🖌 🖌 Apply

7. Enter the information as shown, and then click **Apply**.

Bifurcation option	s	X
Do you wish to split the p	arent segment?	
String number to store b	furcation points	32000
	🖌 🗸 🗸	🔀 Cancel

The position of the line of bifurcation is controlled by splitting the parent segment in different ways.





Note: The first series of prompts will define a portion of the parent segment to be assigned to the first child.

- 8. Click the first break point on the parent segment for the first child (ie. point 1 as shown)
- 9. Click the second break point on the parent segment for the first child (ie. point 2 as shown)
- 10. Click the parent segment on the left side of the defined breakline.
- 11. Click **Apply** and then click child 1.

💐 First child	segment or point	? X
Is the first child	a Segment or a Poin	t? ⊙s⊙p
2	Apply	🔀 Cancel

Note: The next series of prompts will define a portion of the parent segment to be assigned to the second child.

- 12. Click the first break point on the parent segment for the second child(point 3 as shown).
- 13. Click the second break point on the parent segment for the second child(point 4 as shown).
- 14. Click the parent segment on the right side of the defined breakline.
- 15. Click **Apply** and then click child 2.



The bifurcation example is displayed.



Note: To see all of the steps performed in this section, run **_03a_bifurcation.tcl.** You will need to click **Apply** on any forms presented.

Task: Use One Segment to Two Segments to Model a Bifurcation.

- 1. Click the **Reset graphics** icon 🗱.
- 2. Open mod4.dtm.
- 3. Choose **Display > Hide everything**.
- 4. Choose **Display > Strings > With string numbers**.
- 5. Enter the information as shown, and then click **Apply**.

🐚 Drawing		×
Draw Strings		
Layer name	mod4.dtm	-
String range	14,15	
Seg range		
Seg pnt range		
Desc field number	d1 💌	
Text Alignment	< 🔽	
Position of text in segment	○ All points ⓒ First point ○ Centroid	
	🛛 🖌 Apply 🙀 💦 Cance	el

Note: String 14 will be the parent segment and the two segments of string 15 will be the child segments.



6. Choose Solids > Triangulate > One segment to two segments.

7. Enter the information as shown, and then click **Apply**.

🥘 Define t	the trisolation to be created 🔀
Function	BIFURCATION UNION
Layer name	mod4.dtm
Object	4
Trisolation	1
2	Apply 🔀 Cancel

8. Enter the information as shown, and then click **Apply**.

Bifurcation options				
Do you wish to split the parent segment?				
String number to store bifurcation points 32000				
2	🕜 Apply 📐	🔀 Cancel		

You are prompted to select the parent segment.

- Click string 14.
 You are then prompted to state whether the first child is a (S)egment or a (P)oint.
- 10. Enter the information as shown, and then click **Apply**.

🥘 First child	segment or poin	t? X
Is the first child	l a Segment or a Poi	nt? OSCP
2	V Apply	💢 Cancel

- Click the left child segment of string 15.
 A prompt will appear asking whether the second child is a (S)egment or (P)oint.
- 12. Enter the information as shown, and then click **Apply**.



- 13. Click the right child segment of string 15.
- 14. Choose **Display > All layers**.
- 15. Click the **Zoom all** icon $\stackrel{ extsf{Q}}{ extsf{Q}}$.

The following image is displayed.



16. Save as **mod4.dtm**.

Note: To see all of the steps performed in this section, run **_03b_bifurcation_on_model.tcl.** You will need to click **Apply** on any forms presented.

Task: Perform Bifurcation Using the Triangulate Shape Tool

- 1. Start the triangulation.
- 2. Open bifurc4.str.
- 3. Zoom out.
- 4. Choose the Triangulate Shape tool by clicking the Karlin icon.
- 5. Click the start point as shown.



Notice that the point is highlighted as you hover over it, or if you click the point.

6. Select the line of bifurcation as shown, clicking the points indicated with green arrows.



Hint: When selecting the points in a segment, Surpac chooses the shortest path between two points. This sometimes gives unwanted results by either skipping intermediate points or flipping to the opposite side of the segment. This is easily fixed by clicking on the intermediate points, which anchors the point by forcing Surpac to select it.

7. Continue selecting the shape by following the left child node as shown and returning to the start point.



8. Notice that once the shape is joined up by clicking at the start point, that part of the model is triangulated as shown.



You have now triangulated the right side of the left child and next you will triangulate the left side of the left child.

9. Select the points as shown, finishing at the point where you started.



You have now finished the triangulation for the left child

10. Select the points as shown, finishing at the point where you started.



You have now triangulated the left side of the right child.

11. Select the points as shown, finishing at the point where you started.



12. You have now finished triangulating the bifurcation using the Triangulate Shape tool. The bifurcation example is displayed.



Next you will use data-centric mode to triangulate inside the parent and child segments to close the solid.

13. Click the Select Mode tool and select Segment/Trisolation mode as shown.

File Edit Create Dis	play View	Inquire	File tools	Survey	Da
🎯 🎽 🗗 🗖 🖉 🦉	🔶 🔓 🔹	0 🎸	🔼 🛛	₹•+	-
Navigator		Select			
All Files (.*.*)	₽	Select Poin	t/Triangle		
		Select Seg	ment/Trisola	ation	
	13% <mark>50</mark>	elect mediu	m sized obj	ects like se	gm

14. Click the parent segment to select it, and then right click to display a popup menu.

15. Choose **Triangulate**.

Select points	
Select strings	
Toggle a segment open/closed	
Clean	
Triangulate	
Reverse	
Delete	
Show all	
Hide selected	
Zoom to fit the current selection	
Viewport	→
Save	•
Recent commands	•
¢ 📘 🖂 🎸	

Notice that the parent segment has become closed.

- 16. Click the left child segment to select it, and then right click to display a popup menu.
- 17. Choose Triangulate.
- 18. Click the right child segment to select it, and then right click to display a popup menu.
- 19. Choose Triangulate.

The closed solid is displayed.



- 20. Save the solid model as **bifurc4finished.dtm**.
- 21. Choose Solids > Validation > Validate object.

22. Enter the information as shown, and then click **Apply**.

Set neighbours and validate objects						
Layer name	bifurc4.str					
Object range						
Location of report file	valid 🗾 🔽					
Id number	1					
Self-intersection triangles colour						
Duplicate triangles colour						
0	🛛 🗸 Apply 🕌 🔀 Cancel					

- 23. Open the file **valid1.not** in a text editor.
 - The Solids Modelling Validation report is displayed.

SOLIDS MODELLING VALIDATION REPORT. DATE: 08-Jul-08
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 OBJECT 2, TRISOLATION 1
Validated = TRUE Status = CLOSED DUPLICATE TRIANGLES:

You can see that from the report that the solid is closed and validated.

Triangulating Using Segment to a Point

Segment to a point is a useful function for creating the ends of your ore body. In the following tasks you will learn about:

- Creating points to triangulate using the digitiser.
- Creating a solid using Segment to a point.

Task: Create Points to Triangulate Using the Digitiser

- ^{1.} Click the **Reset graphics** icon ^{1.}
- 2. Open mod5.dtm.
- 3. Choose **Display > Hide everything** to erase all strings and objects.
- 4. Choose **Display > Strings > With string numbers**.
- 5. Enter the information as shown, and then click Apply.

Solution Drawing				×		
Draw Strings						
Layer name	mod5.dtm			*		
String range	1;16					
Seg range						
Seg pnt range						
Desc field number	d1	*				
Text Alignment	<	*				
Position of text in segment	🔘 All points	۲	First point 🔘 Centroid			
2			🗸 🖌 Apply	:el		

- 6. Click the 4×10^{-1} icon to put the data in section view. The strings are displayed.
- 7. Move the cursor to the centre of string 1 as shown.



Notice that the elevation (z) of the centre point of string 1 is at approximately 990m.

8. Move the cursor to the centre of string 16 as shown.



Notice that the elevation (z) of the centre point for string 16 is at approximately 1035m. You will now digitise string 1001 as shown to use as end points for the model.



- 9. Click the conto zoom to the extents of the data and return the data to plan view.
- 10. Zoom out to create space for the end points.
11. Choose **Create> Digitise > Properties**.

12. Enter the information as shown, and then click **Apply**.

🧐 Digiti	🔄 Digitiser String Attributes 🛛 🔀			
String #	1001			
- 50 mg # - 7	990			
Desc	220			
Desc				
Define the	e Point attrib	ute values		
0	Use Z and	Desc of selected point		
(User entered Z and Desc of selected point			
	C of select	ted point and user entered Desc		
	🔵 User ente	red Z and Desc values		
L				
2		🗸 🖌 Apply	cel	

You will now use the digitiser to create the end points for triangulation.

- 13. Choose Create > Digitise options > Enter attributes for each point.
- 14. Choose Create > Digitise > New point at mouse location.
- 15. Click the southern most point.
- 16. Enter the information as shown, and then click **Apply**.

ligitiser String Attributes			
String #	1001		
z	990		
Desc			
0			Apply 🔀 Cancel

- 17. Click the northern most point.
- 18. Enter the information as shown, and then click **Apply**.

ligitiser String Attributes		g Attributes	
String #	1001		
z	1035		
Desc			
0			🗸 Apply 🛛 🔀 Cancel

19. Click the final point on string 1001.

ligitiser String Attributes		g Attributes	
String #	1001		
z	1035		
Desc			
0			🖌 🖌 Apply

- 21. Press **ESC** to finish digitising.
- 22. Click the try icon to view the data in long section view.
 23. Choose Display > Point > Attributes.
- 24. Enter the information as shown, and then click **Apply**.

le Drawing		×		
Draw Point attributes				
Layer name	mod5.dtm	*		
String range	1001			
Seg range				
Seg pnt range				
Desc field number	z			
Text Alignment	< 💌			
Position of text in segment	⊙ All points ○ First point ○ Centroid			
0	🛛 🖌 Apply 🛛 🔀 Cance	el		

The data is displayed as shown.



25. Choose **Display > Strings > With string numbers**. Enter the information as shown, and then click **Apply**.

S Drawing		×
Draw Strings		
Layer name	mod5.dtm	~
String range		
Seg range		
Seg pnt range		
Desc field number	d1 💌	
Text Alignment	< 💌	
Position of text in segment	O All points 💿 First point 🔘 Centroid	
0	🛛 🖌 Apply	el

26. Click the 🤍 icon from the toolbar to zoom to the extents of the data and return the data to plan view.

The strings are displayed as shown.



27. Save mod5.dtm.

Task: Create a Solid Using Segment to a Point

- 1. Click the **Reset graphics** icon
- 2. Open mod5.dtm.
- 3. Choose **Display > Hide everything** to erase all strings and objects.

525

4. Choose **Display > Strings > With string numbers**.

🥘 Drawing				×
Draw Strings				
Layer name	mod5.dtm			*
String range				
Seg range				
Seg pnt range				
Desc field number	d1	*		
Text Alignment	<	*		
Position of text in segment	O All points	۲	First point 🚫 Centroid	
0			🛛 🖌 Apply	cel

- 6. Display the northern end of the model as shown.
 - **I** Note:You need to see the points on string 1001 and also both segments of string 16.



7. Choose Solids > Triangulate > Segment to a point.

Note: The Trisolation to Be Created 🛛 🔀				
Function	TRIANGULATE TO A POINT			
Layer name	mod5.dtm			
Object	6			
Trisolation	1			
2		🗸 Apply 🛛 🔀 Cancel		

- 9. Click a point of string 1001 (ie. the one you just digitised).
- 10. Click the matching segment of string 16.
- 11. Press ESC. You have now finished the first triangulation.
- 12. Choose Solids > Triangulate > Segment to a point.
- 13. Enter the information as shown, and then click **Apply**.

📎 Define the Trisolation to Be Created 👘 🔀				
Function	TRIANGULA	TRIANGULATE TO A POINT		
Layer name	mod5.dtm			
Object	7			
Trisolation	1			
0		🗸 Apply 🛛 🔀 Cancel		

- 14. Click the second Northern point of string 1001.
- 15. Click the second matching segment of string 16.
- 16. Press **ESC**.

The northern end will look like the image shown.



You will now repeat this process on the other end of the data.

17. Change to the view as shown.



- 18. Choose Solids > Triangulate > Segment to a point.
- 19. Enter the information as shown, and then click **Apply**.

lefine the Trisolation to Be Created 🛛 🔀				
Function	TRIANGULA	TE TO A POINT		
Layer name	mod5.dtm			
Object	8			
Trisolation	1			
2		🗸 Apply 🛛 🔀 Cancel		

- 20. Click the southern point of string 1001, and then click string 1.
- 21. Press ESC to finish the triangulation.
- 22. ick the **Q** icon to zoom to the data extents.
- 23. Choose Display > All layers. Notice that there is still a gap between strings 15 and 16. You will now create objects 9 and 10 to fill these gaps.
- 24. Choose Solids > Triangulate > Between segments.

🗟 Define the Trisolation to Be Created 🛛 🔀				
Function	TRIANGULA	TE AUTOMATIC		
Layer name	mod5.dtm	mod5.dtm		
Object	9			
Trisolation	1			
0	(🕜 Apply 🛛 🔀 Can	cel	

- 26. Click a segment on string 15.
- 27. Click the corresponding segment on string 16.
- 28. Press ESC.
- 29. Choose Solids > Triangulate > Between segments.
- 30. Enter the information as shown, and then click **Apply**.

📎 Define the Trisolation to Be Created 🛛 🔀				
Function	TRIANGULATE AUTOMATIC			
Layer name	mod5.dtm			
Object	10			
Trisolation	1			
2		🗸 Apply 🛛 🔀 Cancel		

- 31. Click the other segment on string 15.
- 32. Click the corresponding segment on string 16.
- 33. Press **ESC**.



34. Save mod5.dtm.

🛇 Save File				×
Layer N Filer Output Format 1 Exter	lame name Type nsion	mod5.dtm mod5 Surpac DTM Files .dtm		< >
Options Purpose String Range File format	⊙ te	ext	DTM/3DM Options Force solid validation on save Force rigid backwards compatibility	2
2			🗸 🖌 Apply	ancel
		Verify Creation of N Warning You are about to overwrite th mod5.dtm, mod5.str This operation could result in Do you wish to continue? For more information see the	ne following files: a possible loss of data. online documentation.	

35. Click Yes.

Note: If you want to see all of the steps performed in this chapter, run **_04a_segment_to_a_ point.tcl.** You will need to click **Apply** on any forms presented.

If you want to run manually through the material again, you will need to copy **original_mod5.dtm** to **mod5.dtm**.

Triangulating a Fault

Task: Triangulate a Fault – Data Preparation

- 1. Click the **Reset graphics** icon 🔀.
- 2. Open fault1.str.
- 3. Open mod6.dtm.
- 4. Choose **Display > Hide surface/solid**.
- 5. Choose **Display > Strings > With string numbers**.
- 6. Enter the information as shown, and then click **Apply**.

💐 Drawing		×
Draw Strings		
Layer name	mod6.dtm	•
String range	1,16	
Seg range		
Seg pnt range		
Desc field number	d1 💌	
Text Alignment	< 💌	
Position of text in segment	○ All points ④ First point ○ Centroid	
	🗸 🖌 🖌 🖌 🖌 🖌 🗸 Apply	

 Rotate the data as shown to view the fault plane. Section Strings plus fault are displayed.



The string **fault1.str** represents the fault through this area. Ideally, you need two shapes that coincide with the fault on either side of the fault. The following steps illustrate one way of doing this.

8. Choose File > Save > string/DTM.

💐 Save File		×
Layer I	Name	
File	name s1	_
Output Format	Type Surpac String Files	
Exte	nsion .str 💌	
Options		
Purpose		DTM/3DM Options
String Range	10	Force solid validation on save 🔽
File format	text	Force rigid backwards compatibility 🔽
	C binary	
		🗸 Apply 🕌 🔀 Cancel

- 10. Choose File > Save > string/DTM.
- 11. Enter the information as shown, and then click **Apply**.

🥘 Save File		×
Layer N	Name	
Filer	name n1	•
Output Format	Type Surpac String Files	•
Exte	nsion str 💌	
Options — Purpose		DTM/3DM Options
String Range	11	Force solid validation on save 🔽
File format	🖲 text	Force rigid backwards compatibility 🔽
	O binary	
0		🖌 Apply 📐 🔀 Cancel

- 12. Click the **Reset graphics** icon \bigotimes .
- 13. Open **south1.str**, **north1.str** and **fault1.str**. The plan view of the fault is displayed.

String 10 Fault String		String 11
String 10	7	Eault String
	String 10	T due of hig
Plan view of Fault and ore polygons immediately north (String 11)		

You now need to press these strings onto the surface of the fault.

This function works only on Z or Description fields, therefore you will need to swap your Y and Z coordinates to make this function work correctly (ie. go to section view).

1. Choose File tools > String maths.

2. Enter the information as shown, and then click **Apply**.

<u> </u>	ring	maths					×
Defin	e the	files to be process	sed				
Loca	tion	fault					-
ID ra	nge	1					
Defin	e the	files to be created	I				
Derin	e ene	Thes to be created					
Locat	tion	f_section_view					-
Locat	tion	f_section_view	Constraint	Field	=	Expression	_
Locat	tion	f_section_view	Constraint	Field y	=	Expression z	•
Locat	tion	f_section_view	Constraint	Field y z	=	Expression z y	

- 3. Choose File tools > String maths.
- 4. Enter the information as shown, and then click **Apply**.

🐚 St	ring maths						×
Defin	e the files to be	processed -					
Loca	tion north						•
ID ra	nge 1						
Defin	e the files to be	created					
Locat	tion n_section	_view					T
	String range	Constraint	Field	=	Expression		
1	all		У	=	z		
2			z	=	У	1	
3				=			
0					🗸 🗸	ply 👌	🔀 Cancel

5. Choose File tools > String maths.

🐚 String	maths					×
Define the	files to be pr	ocessed				
Location	south					•
ID range	1					
Define the	files to be cr	eated				
Location	s_section_vie	ew				–
St	ring range	Constraint	Field	=	Expression	
1 all			У	=	z 🔺	
2			z	=	У	
0					🗸 Apply	🔀 Cancel

- 7. Click the **Reset graphics** icon 🔀.
- Open n_section_view1.str, s_section_view1.str and f_section_view1.str in that order. The fault with Ore Polygons is displayed.



9. Choose Surfaces > Create DTM from Layer.

Create a DTM From a Layer
Object ID 1
Object name
Creating a DTM using breakline test
Perform break line test
Interpolate additional points
Point interpolation distance 50
Apply 🙀 💥 Cancel

11. Save as **f_section_view.dtm**.

Note: To see all of the steps performed in this section, run **_04b_triangulate_fault_data_preparation.tcl.** You will need to click **Apply** on any forms presented.

Task: Triangulate a Fault - Draping Strings and Triangulating

- 1. Choose Surfaces > DTM file functions > Drape strings over a DTM.
- 2. Enter the information as shown, and then click **Apply**.

🐚 Overlay strings on a DTM	X
Define the DTM Location f_section_view ID number 1 Object ID 1 Trisolation ID 1 Use descriptions Handle descriptions as Opefault Text Math	Define the input strings Location n_section_view ID number 1 String range Define the output strings Interpolate new points Location n ID number 1 Define the boundary string Location ID number 1 ID n
	🖌 Apply 📐 🔀 Cancel

The operation to be performed is Z = Z and this is the default operation displayed.

۱	Define req	uired operat	tions	×
	Str field	Operator		DTM field
1	Z	=	-	Z
2		=	•	
3		=	-	
4		=	-	
5		=	-	
6		=	-	
7		=	-	
8		=	-	
9		=	-	
10		=	-	
?		V Apply		K Cancel

Strings can also be pressed onto a DTM by opening the DTM into one layer and the string file to be pressed into another. You will now press string 10 in file **s1.str** against the fault plane.

- ^{4.} Click the **Reset graphics** icon ³³.
- 5. Open f_section_view1.dtm.
- 6. Open **s_section_view1.str**, which contains string 10.
- 7. Rotate the view so you can clearly see the string.



- 8. Choose Surfaces > Drape string over DTM.You are prompted to select the string to be draped over the DTM.
- Click string 10.
 You will be prompted to select the layer that contains the DTM file.
- 10. Enter the information as shown, and then click **Apply**.

🐚 String over	DTM	×
DTM layer name	F1.dtm	1
Object ID	1	
Trisolation ID	1	
	✓ Interpolate new points	
2	🗸 Apply 🕌 🔀 Cancel	

Note: You will see that the string is pressed onto the DTM surface. New points will be interpolated into the pressed string so that the strings are pressed perfectly against the DTM surface.

- 11. Save as **s1.str**.
- 12. Choose File tools > String maths, and swap n1.str (string 11) back to plan view as shown.

🥘 St	ring maths				X
Define	e the files to be	processed —			
Local	tion n				-
ID ra	nge 1				
Define Locat	e the files to be ion n	created			-
	String range	Constraint	Field	= Expression	
1	all		У	= z	
2			z	= y	
0				Apply 🔀 Cance	1

13. Choose File tools > String maths, and swap s1.str (string 10) back to plan view as shown.

🐚 St	ring maths				×
Defin	e the files to be pro	ocessed			
Loca	tion s				-
ID ra	nge 1				
Defin Locat	e the files to be cre tion s	eated			-
	String range	Constraint	Field	= Expression	
1	all		У	= z 🔺	
2			z	= y	
0				Apply 🔀 Canc	el

Now you are ready to incorporate the newly created strings into your solid model.

- 14. Click the **Reset graphics** icon \bigotimes .
- 15. Open **s1.str**.
- 16. Open n1.str, appending it to the same layer.
 ✓ Note: Hold down the CTRL key while dragging and dropping n1.str into graphics.

You should see that the two string segments are coincident along the plane of the fault.

17. Open and append **mod6.dtm**.

Two string segments are displayed.



- 18. Choose **Display > Hide everything**.
- 19. Choose **Display > Strings > With string numbers**.
- 20. Enter the information as shown, and then click **Apply**.

🧐 Drawing				×
Draw Strings				
Layer name	n1.str			*
String range	10,11			
Seg range				
Seg pnt range				
Desc field number	d1	4		
Text Alignment	<	*		
Position of text in segment	O All points	۲	First point 🚫 Centroid	
0			🗸 🖌 🖌 🖌 🖌 🖌 🗸 Cano	cel

21. Zoom in and adjust the view as necessary to see the data clearly.



- 22. Choose Solids > Triangulate > Between segments.
- 23. Enter the information as shown, and then click **Apply**.

🧐 Define	Sefine the Trisolation to Be Created				
Function	TRIANGULATE AUTOMATIC				
Layer name	main graphics layer				
Object	11				
Trisolation	1				
2		🗸 🗸 Apply			

- 24. Click string 10, segment 1 and then string 10, segment 2.
- 25. Press ESC.
- 26. Choose Solids > Triangulate> Between segments.
- 27. Enter the information as shown, and then click **Apply**.

Solution to Be Created				
Function	TRIANGULATE AUTOMATIC			
Layer name	main graphics layer			
Object	12			
Trisolation	n 1			
2	Apply X Cancel			

- 28. Click string 11, segment 1 and string 11, segment 2.
- 29. Press **ESC**.

The following image is displayed.



30. Save as mod6.dtm.

If you want to run manually through the material again, you will need to copy **original_mod6.dtm** to **mod6.dtm**.

Note: To see all of the steps performed in this section, run **_04c_draping_strings_and_triangulating_fault.tcl.** You will need to click **Apply** on any forms presented.

Triangulating Using Inside Segment and One Triangle

Task: Triangulate Inside a Segment

- 1. Click the **Reset graphics** icon 🔀.
- 2. Open mod7.dtm.
- 3. Choose **Display > Hide surface/solid**.

- 4. Choose **Display > Strings > With string numbers**.
- 5. Enter the information as shown, and then click Apply.

≷ Drawing		X
Erase Objects		
Layer name	mod7.dtm	-
Object range	10,11	
Trisol range		
Triangle range		
Desc field number	d1 🔽	
Text Alignment	< 💌	
Position of text in segment		
	🗸 🖌 Apply	el

- 6. Choose Solids > Triangulate > Inside a segment.
- 7. Enter the information as shown, and then click **Apply**.

Define the trisolation to be created				
Function	TRIANGULATE INSIDE SEGMENT			
Layer name	mod7.dtm			
Object	11			
Trisolation	1			
2	🖌 🖌 Apply 🔪 🔀 Cancel			

- 8. Click String 10, Segment 2. (ie. the segment located on the fault)
- 9. Choose Solids > Triangulate > Inside a segment.
- 10. Enter the information as shown, and then click **Apply**.

Note: The trisolation to be created X				
Function	TRIANGULATE INSIDE SEGMENT			
Layer name	mod7.dtm			
Object	12			
Trisolation	1			
2	🖌 🖌 📈 Apply			

- 11. Click string 11, segment 2. (ie. the segment located on the fault)
- 12. Press ESC.
- 13. Save the result as **mod7.dtm**.

If you want to run manually through the material again, you will need to copy **original_mod7.dtm** to **mod7.dtm**.

Note: To see all of the steps performed in this section, run **_04d_triangulate_inside_segment.tcl.** You will need to click **Apply** on any forms presented.

Task: Triangulate Using the One Triangle Function

- 1. Click the **Reset graphics** icon 👪.
- 2. Open mod1.str.
- 3. Zoom in on any part of the file.
- 4. Choose **Display > Point > Markers** to display all the points in the segments.
- 5. Choose View > Data view options > View by bearing & dip.



- 7. Choose Solids > Triangulate > One Triangle.
- 8. Enter the information as shown, and then click **Apply**.

Define the trisolation to be created 🛛 🗙					
Function	n TRIANGULATE ONE TRIANGLE				
Layer name	mod1.str				
Object	1				
Trisolation	1				
2	🗸 🖌 Apply 🙀 🕺 Cancel				

- 9. As prompted, click a point on a string.
- 10. As prompted, click a point on a following string.
- 11. As prompted, click a point on the first string, adjacent to the first point you selected.

Note: A closed triangle is displayed. The software prompts you to select another point. If you select a point on the second string, a second triangle will appear. Using this process you can manually build up the triangulation.



12. Press ESC.

Vote: To see all of the steps performed in this section, run **_04e_triangulate_one_triangle.tcl**. You will need to click **Apply** on any forms presented.

Triangulating Using Manual Triangulation

Task: Triangulate Using Manual Triangulation

- 1. Choose File > Open > String/DTM file.
- 2. Enter the information as shown, and then click **Apply**

≷ Open File		×
Layer main graphics layer Location mod1.str Load file as Surpac String File	er ?S	¥ ¥
Options		
ID Range		
Data loading options Drawing styles file Replace current data 🔽 Rescale display 🔽		T
0	🖌 🖌 🗸	🔀 Cancel

- Choose View > Data view options > View by bearing & dip to change the view to Bearing = 70, Dip = -20.
- 4. Zoom in on strings 1 and 2.
- 5. Choose **Display > Point > Numbers** to display the numbering sequence of strings 1 and 2.
- 6. Choose Solids > Triangulate > By manually selecting points.
- 7. Enter the information as shown, and then click Apply.

Define the trisolation to be created 🗙				
Function	TRIANGULATE MANUAL			
Layer name	main graphics layer			
Object	1			
Trisolation	1			
2	🗸 Apply 📐 🔀 Cancel			

Note: Follow the prompts at the bottom of the screen with care as the segments must be selected in a strict order.

- 8. Click point 34 on string 1 and then the corresponding point 118 on string 2.
- 9. Click point 57 on string 1 and then the corresponding point 137 on string 2.
- 10. Press **ESC**.

The triangulated image is displayed.



Note: To see all of the steps performed in this section, run **_04f_triangulate_manual.tcl.** You will need to click **Apply** on any forms presented.

Editing Solids

Task: Edit a Solid

- 1. Click the **Reset graphics** icon 🔀.
- 2. Open mod8.dtm.
- Choose Solids > Edit trisolation > Renumber.
 Note: This function allows you to renumber a trisolation by pointing to and clicking on triangles.
- 4. Click each trisolation in the lower part of the solid and enter the following information to renumber all the trisolations south of the fault to Object = 1, Trisolation = 1.

Renumber an object trisolation 🗙					
Layer name	mod8.dtm				
Old Object	1				
Old Trisol	1				
New Object	1				
New Trisol	1				
2	🗸 Apply 🙀 💥 Cancel				

5. Click each trisolation in the upper part of the solid and enter the following information to renumber all the trisolations north of the fault to Object = 2, Trisolation = 1.

🥘 Renu	mber an object trisolation 🗙
Layer name	mod8.dtm
Old Object	2
Old Trisol	1
New Object	2
New Trisol	1
2	🗸 Apply 📐 🔀 Cancel

6. Press ESC.

You will see two objects displayed on the screen.

7. Save the file as **mod8.dtm**

If you want to run manually through the material again, you will need to copy **original_mod8.dtm** to **mod8.dtm**.

Note: To see all of the steps performed in this section, run **_06_edit_solid.tcl.** You will need to click **Apply** on any forms presented.

Validating Solids

Task: Validate Solids

- 1. Click the **Reset graphics** icon 🔀.
- 2. Open **mod10.dtm**. This is the Solid model with objects 1 and 2.
- 3. Choose Solids > Validation > Validate object.
- 4. Enter the information as shown, and then click **Apply**.

🖹 Set Neighbour	s and Validate Objects	×
Layer name	mod10.dtm	
Object range		
Location of report file	valid 🔹 🗸	
Id number	1	
Self-intersection triang	gles colour	
Duplicate triangles colo	our <mark>yellow ···································</mark>	
Invalid edges triangles	colour	
	🛛 🖌 Apply 🔤 💥 Canc	:el

Note: Leaving the object number blank will allow both object 1 and object 2 to be validated.

5. Open valid1.not.

The Solids Modelling Validation report is displayed.

SOLIDS MODELLING VALIDATION REPORT. DATE:	08-Jul-08
OBJECT 1, TRISOLATION 1	
Validated = TRUE Status = CLOSED DUPLICATE TRIANGLES:	
NONE TRIANGLES ATTACHED TO INVALID EDGES: NONE TRIANGLES ATTACHED TO INVALID EDGES:	
NONE SELF INTERSECTION TRIANGLES:	
NONE OPEN SIDES TRIANGLES:	
NONE	

6. Close valid1.not.

Setting an Object to Solid or Void

Task: Set an Object (Trisolation) to Solid or Void

- 1. Click the **Reset graphics** icon 🔀.
- 2. Open mod11.dtm.
- 3. Choose Solids > Validation > Set object to solid or void.
- 4. Enter the information as shown, and then click **Apply**. This will make both objects into solids.

😫 Set Triangle Directions for Objects 💦 🔀		
Layer name	mod11.dtm	
Object range		
Solid		
2	Apply X Cancel	

5. Choose File > Save > string/DTM to save your model as mod11.dtm

Note: The solid can now be used to calculate a volume, or as a constraint in block model filling. Later you will use the model you have created to demonstrate viewing solid models, intersecting drill holes and performing volume calculations.

If you want to run manually through the material again, you will need to copy **original_mod11.dtm** to **mod11.dtm**.

Note: To see all of the steps performed in this section, run **_07_solids_validation.tcl.** You will need to click **Apply** on any forms presented.

Triangulating Using Centre Line and Profile

Task: Create a Solid Using Centre Line and Profile.

- 1. Click the **Reset graphics** icon 🔀.
- 2. Open pfl1.str.

These are a series of profile strings representing the outlines of various underground features.

- 3. Choose **Display > Strings > With string numbers**.
- 4. Enter the information as shown, and then click **Apply**.

💘 Drawing		×
Draw Strings		
Layer name	pfl1.str	-
String range		
Seg range		
Seg pnt range		
Desc field number	d1 💌	
Text Alignment	< 💌	
Position of text in segment	O All points O First point O Centroid	
	🕜 Apply 📐 🔀 Cancel	

The profiles examples are displayed.



5. Choose File > Save > string/DTM.

6. Enter the information as shown, and then click **Apply** to save string 4 only into **prof1.str**.

🛬 Save Fi	e	×
Layer I	Name pfl1.str	
Filer	name prof1	-
Output Format	Type Surpac String Files	~
Exte	nsion .str 💌	
Options		
Purpose	Created using STR MATHS from pf	DTM/3DM Options
String Range	4	Force solid validation on save 🔽
File format	• text	Force rigid backwards compatibility
	C binary	
2		🛛 🗸 Apply 🔤 🔀 Cancel

- 7. Click the **Reset graphics** icon 🔀.
- 8. Open prof1.str.
- 9. Choose **View > Zoom > Out**.
- 10. Choose **Display > 2D grid**.
- 11. Enter the information as shown, and then click **Apply**.

🥘 Draw a Gr	id		×
Grid Parameters - Grid I Y Direction: 1 X Direction: 1 Z Direction:	Line Interval	Label Frequency	
Grid Extents Y Direction: X Direction:	Minimum: -1 Minimum: -16	Maximum: 7 Maximum: -6	View 💌
Grid Position In Front C Enter the value:	Midpoint C Behind C Po	sition	
Appearance Replace current g Append to	rid: 🔽 file: 🔽	Line colour:	▼ ▼
2			🗸 Apply 🚶 💢 Cancel

Note: 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, Y = 0.

The profile example is displayed.



Solution Note: The profile needs to move 10.75 in the x direction and -1 in the y direction to have its bottom centre at (0,0)

12. Choose File tools > String Maths.

13. Enter the information as shown, and then click **Apply**.

ء 🚫	String maths	5				×
Defin	e the files to be	processed -				
Loca	tion prof					-
ID ra	nge 1					
Defin Locat	Define the files to be created					
	String range	Constraint	Field	=	Expression	
1	4		x	=	x+10.75	
2	4		У	=	y-1	
0					V Apply	🔀 Cancel

- ^{14.} Click the **Reset graphics** icon \bigotimes .
- 15. Open prof1.str.
- 16. Choose View > Zoom > Out.
- 17. Choose **Display > 2D grid**.

≷ Draw a Gr	id		×
Grid Parameters - Grid I Y Direction: 2 X Direction: 2 Z Direction:	ine Interval	Label Frequency	
Grid Extents Y Direction: X Direction:	Minimum: -1 Minimum: -16	Maximum: 7 Maximum: -6	View 💌 View 💌
Grid Position	Midpoint C Behind C Po	osition	
Appearance Replace current g Append to l	rid: 🔽 iile:	Line colour:	V V
2			🗸 Apply 📐 🔀 Cancel

The profile is displayed.



Notice that the centre, bottom point of the profile is now at (0,0)

19. Click the **Reset graphics** icon 🔀.

20. Open **dcl100.str**, which represents the centre line of a decline.



- 21. Choose Solids > Triangulate > Using centre line & profile.
- 22. Enter the information as shown, and then click **Apply**.

🐚 Triangulate centre line ar	nd profile 🔀
Enter Profile String File	
Location prof	•
ID number 1	
Use explicit object ID 「	
Object ID 1	
Profile Scale Factor 1	
Define Offsets from Centreline String	
Yo Xo	Z ₀
Profile Rotation (in degrees)	-
Progressive Profile Expansion	
Factor 1	
Vertically Constrained	
Triangulate first face 📃	
Triangulate last face 🔲	
2	🗸 Apply 📐 🔀 Cancel

23. Click the centre line.

Note: The profile string is applied perpendicularly at each point in the centre line and then these profiles are stitched together to form the object.

24. Choose **Display > Hide everything**.

- 25. Choose **Display > Strings As lines** to see how the solid has been created.
- 26. Zoom in and use the orbit tool to make the solid easier to visualise.
 - The profiles on the centreline are displayed.



Notice that the solid is constructed by applying the profile to each point on the centre line

Note: The centre line and profile function does not save the new file automatically, so if you want the file saved you should specify a new file name.

Vote: To see all of the steps performed in this section, run **_05_centre_line_and_profile.tcl**. You will need to click **Apply** on any forms presented.

Intersecting Solids and DTM Surfaces

Intersecting Solids

Task: Perform Solids Union

- 1. Click the **Reset graphics** icon 🗱.
- 2. Open decline1.dtm.
- 3. Open crosscut1.dtm.
- Click the Zoom all icon
 Union of solids is displayed.



- 5. Choose **Solids tools > Union solids**.
- 6. Enter the information as shown, and then click **Apply**.

🔪 3dm/3dm union results storage 🗙		
Graphics layer name	union_example	
Object number	1	
Additional object number	2	
2	Apply 📐 🔀 Cancel	

Note: The layer name cannot be the same as any existing layer. The new layer will contain the new solid.

7. Follow the prompts by clicking each of the solids.

Note: The order of selection is not important. The program will go through the process of uniting the two solids. Notice that the previous objects have been erased from screen and you are now in the layer you specified with the unioned solid displayed. The solid is merely displayed in this layer. You must save it before exiting.

- 8. Choose View > Surface view options > Hide triangle edges and deselect this option for a more effective display.
- 9. Zoom in to show the area of contact and confirm the result.

The union of the drives is displayed.



 Choose View > Surface view options > Hide triangle faces to see that the underlying strings have been changed as shown.

The union triangles are displayed.



Note: To see all of the steps performed in this section, run **_08a_solids_union.tcl.** You will need to click **Apply** on any forms presented.

Task: Perform Intersection of Solids

- 1. Click the **Reset graphics** icon 🗱.
- 2. Open lev1.dtm.
- 3. Open stope1.dtm.
- 4. Click the **Zoom all** icon **Q**.

These solids represent a stope and a development drive as shown.



- 5. Choose Solids > Solids tools > Intersect solids.
- 6. Enter the information as shown, and then click Apply.

饕 3dm/3dm intersect results storage 🗙		
Graphics layer name	layer_intersect	
Object number	1	
2	🗸 🖌 🖌 🖌 🖌 🖌 🗸 Apply	

- 7. Follow the prompts by clicking each of the solids in turn.
 ✓ Note: The order of selection is not important.
- 8. You will now be in the layer you specified with the solid displayed. The result is that area of the decline that fell within the stope.



Note: To see all of the steps performed in this section, run **_08b_solids_intersection.tcl.** You will need to click **Apply** on any forms presented.

Task: Perform Outersection of Solids

- 1. Click the **Reset graphics** icon ³³.
- 2. Open lev1.dtm.
- 3. Open **stope1.dtm**.
- 4. Click the **Zoom all** icon \bigcirc .
- 5. Choose Solids > Solids tools > Outersect solids.

Sdm/3dm outersect results storage 🗙	
Graphics layer name	layer_outersect
Object number	1
Additional object number	2
2	💞 Apply 📐 🛛 💥 Cancel

7. Follow the prompts by clicking each of the solids - first the ore body and then the decline.



In this case, the order of selection is important. The outersected solid must be selected first, while the outersecting solid (i.e. that one that will cut into the outersected solid) is selected second.

You will be in the layer you specified with the solid displayed. The result is the original solid body with those areas that were common with the decline removed.



Vote: To see all of the steps performed in this section, run **_08c_solids_outersection_solid.tcl**. You will need to click **Apply** on any forms presented.

Task: Clip a Solid Above a DTM

- ^{1.} Click the **Reset graphics** icon \bigotimes .
- 2. Open pit4.dtm.
- 3. Open ore4.dtm.

The ore body is displayed.



- 4. Choose Solids > Solids tools > Clip solid above a DTM.
- 5. Enter the information as shown, and then click **Apply**.

🧐 3dm/dtm above results storage 🛛 🛛	
Graphics layer name	solid_above_dtm
Object number	1
2	Apply 🔀 Cancel

 Click the ore solid and then click the pit DTM. The ore body is displayed.


7. Choose **File > Save > string/DTM** if you wish to save the results for further work.

🛬 Save Fi	e	X
Layer I	Name_solide_above_dtm	
Filer	name ore4_above_pit4	T
Output Format	Type Surpac DTM Files	
Exte	nsion dtm 💌	
Options Purpose String Range File format	 ✓ text ✓ binary 	DTM/3DM Options Force solid validation on save 🔽 Force rigid backwards compatibility 🔽
2		🖌 Apply 🙀 🔀 Cancel

Note: To see all of the steps performed in this section, run **_08d_dtm_above_solid.tcl.** You will need to click **Apply** on any forms presented.

Task: Clip a DTM Outside a Solid

- 1. Click the **Reset graphics** icon 🔀.
- 2. Open pit4.dtm.
- 3. Open ore4.dtm.
- 4. Choose Solids > Solids tools > Clip DTM outside a solid.
- 5. Enter the information as shown, and then click **Apply**.

🔪 3dm/dtm outside results storage 🗙		
Graphics layer name	dtm_outside_solid	
Object number	1	
2	🖌 🖌 🕺 🖌 🖌 🖌	

The output solid above the dtm will be stored in the layer **dtm_outside_solid**.

 Click the solid, and then click the DTM. The pit cut by the ore body is displayed.



7. Save dtm_outside_solid.dtm.

🛬 Save Fil	e	×
Layer N	Name_dtm_outside_solid	
Filer	name dtm_outside_solid	•
Output Format	Type Surpac DTM Files	•
Exte	nsion dtm 💌	
Options		DTM/3DM Options
String Range		Force solid validation on save 🔽
File format	Text	Force rigid backwards compatibility
	C binary	
2		🗸 Apply 🕌 🔀 Cancel

Note: This result is not a solid but is instead a DTM. Only that part of the pit surface that occurred outside the solid ore body is retained.

Note: To see all of the steps performed in this section, run **_08e_dtm_outside_solid.tcl.** You will need to click **Apply** on any forms presented.

Intersecting DTM Surfaces

Task: Perform Upper Triangles Intersection of 2 DTMs

- 1. Click the **Reset graphics** icon 🔀.
- 2. Open topo2.dtm.
- 3. Open dump1.dtm.



4. Choose Surfaces > Clip or intersect DTMs > Upper triangles of 2 DTMs.



6. Follow the prompts by picking each of the DTMs.

Note: The order of selection is not important.

You will be in the layer you specified with the DTM displayed. The result is the waste stockpile surface incorporated into the topographic surface.



Vote: To see all of the steps performed in this section, run **_08f_upper_triangles_of_2dtm.tcl**. You will need to click **Apply** on any forms presented.

Task: Perform Lower Triangles Intersection of 2 DTMs

- 1. Click the **Reset graphics** icon 🗱.
- 2. Open topo2.dtm.
- 3. Open pit2.dtm.
- 4. Choose Surfaces > Clip or intersect DTMs > Lower triangles of 2 DTMs.
- 5. Enter the information as shown, and then click **Apply**.

🔄 Dtm/dtm lower results storage 🛛		
Graphics layer name	combined_surface	
Object number	1	
2	Apply 🔀 Cancel	

6. Follow the prompts by picking each of the DTMs.

Note: The order of selection is not important.

The pit below the topography is displayed.



Note: To see all of the steps performed in this section, run **_08g_lower_triangles_of_2dtm.tcl.** You will need to click **Apply** on any forms presented.

Task: Create a Solid by Intersecting 2 DTMs

- 1. Click the **Reset graphics** icon 🗱.
- 2. Open topo2.dtm.
- 3. Open pit2.dtm.
- 4. Choose Surfaces > Clip or intersect DTMs > Create solid by intersecting 2 DTMs.
- 5. Enter the information as shown, and then click Apply.



6. Follow the prompts by clicking each of the DTMs.
✓ Note: The upper DTM (topography) must be selected first, followed by the lower DTM (pit).

You will be in the layer you specified with the solid displayed. The result is a solid representing the material that will need to be removed from the designed pit.



- 7. Choose File > Save > string/DTM.
- 8. Enter the information as shown, and then click **Apply**.

≷ Save Fik	e	×
Layer N	lame layer_intersect	
Filen	name pit_below_topo_solid	•
Output Format 1	Type Surpac DTM Files	-
Exter	nsion dtm 💌	
Options Purpose String Range File format	⊙ text O binary	DTM/3DM Options Force solid validation on save 🔽 Force rigid backwards compatibility 🗹
2		🖌 Apply 🙀 🔀 Cancel

- 9. Choose **Solids > Solids tools > Report volume of solids** to create a note file with the volume of the pit below the topography.
- 10. Enter the information as shown, and then click **Apply**.

🔄 Object Report 🛛 💽				
Layer name pit_bei	Layer name pit_below_topo_solid.dtm			
Define the report file to create				
Location	volume_report 🛛 💙			
ID number	1			
Report Format	.not 💌			
Decimals	0			
Report by	⊙ Total ○ Interval ○ Elevation Range			
Elevation range				
Elevation interval	10			
Apply X Cancel				

The Solid Modelling object report is displayed.

```
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
```

Note: To see all of the steps performed in this section, run _08h_create_solid_intersecting_
 2dtms.tcl. You will need to click Apply on any forms presented.

Viewing Solids

Task: View Solids

- 1. Click the **Reset graphics** icon 🔀.
- 2. Open **pit1.dtm**. The pit example is displayed.



3. Choose Customise > Display properties > DTM's and 3DM's.

it Style				
Range	Label	Edges	Faces	Markers
Default			-	+, 0.50
m Styles				
Range	Label	Edges	Faces	Markers
1				+, 0.50
2				+, 0.50
3		-	-	+, 0.50
4				+, 0.50
5		-	_	+ , 0.50
6			_	+ , 0.50
7			_	+, 0.50
6				+ , 0.50
9		-	_	+, 0.50
10, 20000, 10			-	+, 0.50

4. Change the colour of the faces for Object 1 and then click **Apply**.

- 5. Open **fault1.dtm** into its own layer.
- 6. Choose Customise > Display properties > DTMs and 3DMs.
- Choose another colour for the faces for **fault1.dtm** (object 10). The pt and fault line example is displayed.



Notice that the changes are reflected in the active layer only and the pit remains the same colour.

8. Open mod12.dtm.

The solid with the pit and the fault is displayed.



9. Choose Display > Surface or solid with colour banding.

🧕 s	📡 Surface or Solid Colour Banding 🛛 🔀		
Draw Displ	Shells ay Properties Layer name Object Range	mod12.dtm	Banding Type
Tr Field	Trisol Range iangle Range I to colour by	Z	 set number of bands range for bands using algebraic expressions
	(Iolour	
1	blue		<u>^</u>
2	green		
3	yellow		
4	red		
5			
6			
/			~
0			Apply X Cancel

The solid with sharp colour banding is displayed.



To display the solid with smooth contours.

11. Right-click on the file **mod12.dtm**.



12. Then tick Smooth shading.

The solid with smooth colour banding is displayed.



Note: To see all of the steps performed in this section, run **_09_view_solid_model.tcl.** You will need to click **Apply** on any forms presented.

Creating Sections

Task: Create Sections Using the Interactive Method

- 1. Click the **Reset graphics** icon \bigotimes .
- 2. Open mod12.dtm.
- 3. Choose Solids > Solids tools > Create sections.

🢐 Define an axis line	×
Section orientation	Press this button to digitise the axis
Perpendicular to axis	
C Parallel to axis	Digitise
Dip -90	- W
Axis start	Axis end
Y 0	Y 0
x 0	x 0
Z O	z 0
	🗸 Apply 🛛 💥 Cancel

- 4. Click the **Digitise** button to use your mouse for defining the axis.
- Click a start point below the bottom centre of the ore body and drag the cursor vertically to the end point of the axis line above the solid. The solid with a centreline is displayed.



Note: When you have created the axis, the form is redisplayed with the real world coordinates of your axis line. Adjust the coordinates manually using the digitised axis start and axis end points as a guide. In this case, the Eastings and elevations for the axis line must be the same to produce slices that are oriented as Northings.

6. Enter the information as shown, and then click **Apply**.

🐚 Define an axis line	×
Section orientation	Press this button to digitise the axis
C Parallel to axis	Digitise
Dip -90	
Axis start	Axis end
Y 10000	Y 11000
X 5350	X 5350
Z 960	Z 960
	🗸 Apply 🙀 🔀 Cancel

7. Enter the information as shown, and then click **Apply**.

💐 Extract slices through objects	×	
Layer name mod12.dtm Define the objects to be sliced and the new layer name		
Slice Layer tmp		
Object range 1,2		
Define the files to be created which contain the slices		
Location int_sec	-	
Section definition method		
O Define sections using a range		
 Define sections using interactive slider controls 		
Select the section start, end and interval		
Start distance 10000 11000		
End distance 10000 11000 11000		
Section spacing 1 1000 50		
Apply K Canc	el	

Note: Click the **Interactive slider controls** button to display your slices in real time. The slide controls enable you to adjust the start and end points of your axis and also the distance between slices. Try moving the slide controls up and down to see the effects of your changes. The slices are taken using the values in the boxes on the right side of the slider bars when you click **Apply**. Values may also be manually entered into these boxes.

The solid object with slices is displayed.



8. Move the object about in 3D space to see how the slices relate to the solid.



Note: To see all of the steps performed in this section, run **_10a_slice_objects_interactive.tcl.** You will need to click **Apply** on any forms presented.

Task: Create Sections by Range

- 1. Click the **Reset graphics** icon 🔀.
- 2. Open mod12.dtm.
- 3. Choose **Inquire > Report layer extents** to determine the Maximum and Minimum Y, X and Z coordinates.

Notice that the data shown in the window extends from 10055 north to 10920 north. By defining a north-south axis, the objects can be sliced.

- Choose Solids > Solids tools > Create sections.
 For this exercise you will be slicing this model on Northings (Y). To do this you will need to define a vertical axis.
- 5. Enter the information as shown, and then click **Apply**.

💐 Define an axis line 🛛 🗙		
Section orientation	Press this button to digitise the axis	
Perpendicular to axis		
C Parallel to axis	Digitise	
Dip -90		
Axis start	Axis end	
Y 0	Y 99999	
x 0	x 0	
Z 0	z 0	
2	🗸 🖌 🖌 🖌 🖌 Vancel	

6. Enter the information as shown, and then click **Apply**.

Extract slices through objects
Layer name mod12.dtm Define the objects to be sliced and the new layer name
Slice Layer tmp
Object range 1,2
Define the files to be created which contain the slices
Location sec
Section definition method
Define sections using a range
C Define sections using interactive slider controls
Define the slices required by a distance range
Range 10140,10880,10
Output file IDs
Apply 🔀 Cancel

The solid with sections is displayed.



Note: To see all of the steps performed in this section, run **_10b_slice_objects_by_range.tcl**. You will need to click **Apply** on any forms presented.

Task: Create Sections Using a Centre Line

- 1. Click the **Reset graphics** icon 🗱.
- 2. Open stope2.dtm.
- 3. Open **cl2.str**.

When slicing a solid, the centreline string and the objects to be sliced may be either in separate layers or in the same layer. For display purposes, it is generally simpler if separate layers are used. Note that if they are in separate layers, the layer containing the solids to be sliced must be set to the active layer.



4. Make stope2.dtm the active layer.



- 5. Choose Solids > Solids tools > Section using centre line.
- 6. As prompted, click the start and end points of your centre line.
- 7. Enter the information as shown, and then click **Apply**.

Number		
	33	Calculate Spacing
irst slice dip	90	degrees
ast slice dip	70	degrees
The slices for will only be cr	any portion of the cent eated in the XY plane re	re line segment that is vertical egardless of the dip values

💽 Extract sli	ces through objects	×
Define the objects	to be sliced and the new layer name	٦
Object range		
Slice layer	ring slices]
Slice Block Model ?		
BM Slice Layer]
Define the files to Location	contain the slices	
ID numbers are	• sequence numbers • C chainages	
Start ID number	1	
Chainage offset	0	
Coordinates	⊙ real world ○ section	
2	🗸 Apply 🔀 🔀 Cancel	

9. Change the Layers Status to make the stope2.dtm layer invisible.



Ring slice is displayed.



Notice how the slices start at 90 degrees and the last slice is at 70 degrees.

Note: To see all of the steps performed in this section, run **_10c_centre_line_slice.tcl.** You will need to click **Apply** on any forms presented.

Reporting Volumes of Solids

Task: Report Volume of a Solid

- 1. Click the **Reset graphics** icon \bigotimes .
- 2. Open mod12.dtm.
- 3. Choose Solids > Solids tools > Report volume of solids.
- 4. Enter the information as shown, and then click **Apply**.

🥘 Object rep	ort X
Layer name mod12	2.dtm
Define the report f	ile to create
Location	volume_report
ID number	1
Report Format	.not
Decimals	0
Report by	● Total ○ Interval ○ Elevation Range
Elevation range	
Elevation interval	10
2	💞 Apply 🚶 🔀 Cancel

The file **volume_report1.not** is displayed.

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

5. Close the report file.

Note: To see all of the steps performed in this section, run **_11_solids_volume_report.tcl.** You will need to click **Apply** on any forms presented.

Intersecting Drill Holes with Solid Models

Task: Intersect Drill Holes with Solid Models

- 1. Click the **Reset graphics** icon \bigotimes .
- 2. Open mod12.dtm.
- 3. Open solids.ddb.
- 4. Choose **Database > Display > Drillholes**.
- 5. Accept the default values, and then click **Apply**.

Traw Holes						
Rescale view to show al	holes in p	an view? 🔽				
Add	constraint	to holes? 🔽				
Trace styles Colla	r styles	Geology patterns	Labels	Graphs	Depth markers	Apparent dip indicators
Colour traces by:					s	
Table		*				
Field		*				
	-					
Default trace colour	forest gre	en	<u> </u>			
Default trace thickness	1	<u></u>				
Tick line weight	1					
Cylinder style	no cylind	ers 💌				
Length/Unit	1.000					
Maximum	50,0	_				
	<u>.</u>	- 22				
0						/ Apply 🔪 💥 Cancel

6. Accept the default values, and then click **Apply**.

🥘 Defi	ine query constraints				×
Table Nam	ne collar				
	Field Name	Operand	Constraint Value		Load
1		=			Save
0			🖌 🗸 Apply	Q	🗙 Cancel

The solid with drillholes is displayed.



The database has an optional table called **Intersect**, where you will store the results of this processing.

- 7. Choose Database > Analysis > Drillhole 3DM intersection.
- 8. On the blank constraint form, click **Apply**.

🥘 D	efine query cons	traints			×
Table N	Name collar				
	Field Name	Operand	Constraint Value		Load
1		=			Save
0			💞 Apply	Ŋ.	🔀 Cancel

🥘 Intersect drill ho	oles and objects 🛛 🗙				
Define the object number to intersect with					
Object 1	•				
Name the layer for saving	the resultant hole trace segments				
Layer name main graphic	s layer 💌				
Save intersections	to database				
Table name	intersect 💌				
Field name	zone				
Intersection code	south				
Define the log file for resu	lts				
Report file name intersec	t 🔽				
Format .not - Surpac Note File					
	🗸 Apply 🙀 💥 Cancel				

The table called Intersection within the database now contains a field called **zone**, in which a character code **south** has now been stored.

The Drillhole Object Intersection report is displayed.

Drillho	le Object Int	ersection	Report J	uly 04,	2008
Hole Id	d Depth From	Depth To	Interse	ction C	ode
10	11.12	69.15	south		
11	7.01	49.37	south		
12	9.11	26.88	south		
15	173.50	175.67	south		
16	159.91	185.20	south		
17	29.89	38.64	south		
17	90.33	164.64	south		
18	90.05	118.37	south		
19	70.32	104.86	south		
2	180.25	197.10	south		
20	14.80	86.73	south		
21	3.44	61.14	south		
22	5.74	37.47	south		
27	71.80	76.80	south		
28	59.95	67.40	south		
28	149.50	156.98	south		
29	49.66	61.99	south		
29	127.89	141.79	south		
3	49.44	55.00	south		

- 10. Close intersect.not.
- 11. Choose **Database > Edit > View table constrained**.
- 12. Enter the information as shown, and then click **Apply**.

🥘 Selec	t the databas	e table to pr	ocess X
Table name	intersect		•
2		🚽 🖌 🖌	🛛 💥 Cancel

🕙 Define view/edit rows template 🗙					
Table I	Table Name intersect				
	Field Name				
1	depth_from				
2	depth_to				
3	hole_id	1			
4	samp_id	1			
5	zone	1			
0	🖌 Apply 🔀 🔀 Ca	1			

14. Enter the information as shown, and then click **Apply**.

🥘 D	Define query constraints				×
Table N	lame intersec	t			
	Field Name	Operand	Constraint Value		Load
1		=			Save
0			Apply		X Cancel

The intersections will be displayed.

S V	EW/EDIT	TABLE R	ows				
Table	intersect						
	hole_id	samp_id	depth_from	depth_to	zone		
1	10		11.12	69.15	south	<u>^</u>	
2	11		7.01	49.37	south		
3	12		9.11	26.88	south		
4	15		173.50	175.67	south		
5	16		159.91	185.20	south		
6	17		29.89	38.64	south		
7	17		90.33	164.64	south		
				V Apply	. 🗙	Cancel)

15. Click **Apply** on the form.

Note: You can also view the results in the intersection table in the geological database.

- 16. Choose **Database > Database > Close**.
- 17. Turn Faces Off and rotate the data to see the intersections clearly.

The drillhole trace is displayed.



Note: To see all of the steps performed in this section, run **_12_intersect_drillholes_solids.tcl.** You will need to click **Apply** on any forms presented.

Optimising Trisolations

Task: Optimise Trisolations

- 1. Click the **Reset graphics** icon \bigotimes .
- 2. Open filter1.dtm.
- 3. Choose Solids > Edit trisolation > Optimise.
- 4. Click anywhere on the object.
- 5. Enter the information as shown, and then click **Apply**.

Optimisation tolerance	×
Tolerance distance 0.2	
Apply 📈 Can	cel

6. Choose **Display > Strings > As lines**.

7. Enter the information as shown, and then click **Apply**

🐚 Drawing	×
Draw Lines	
Layer name	filter1.dtm
String range	
Seg range	
Seg pnt range	
Desc field number	d1 🔽
Text Alignment	< 🔽
Position of text in segment	
	🗸 Apply 🙀 🔀 Cancel

- 8. Choose Solids > Edit trisolation > Delete redundant points.
- 9. Click **Apply** on the form presented.



Notice that more than 90% of the points were deleted and any segments not associated with a triangle have been deleted.

Vote: To see all of the steps performed in this section, run **_13_optimise_trisolation.tcl.** You will need to click **Apply** on any forms presented.

Modelling Underground Data

Task: Model Underground Data

- 1. Click the **Reset graphics** icon 🔀.
- Open lev200.str.
 Floor and back strings are displayed.



- 3. Choose **Display > Strings > With string numbers**.
- 4. Enter the information as shown, and then click **Apply**.

💘 Drawing		×
Draw Strings		
Layer name	lev200.str	-
String range		
Seg range		
Seg pnt range		
Desc field number	d1 💌	
Text Alignment	< 💌	
Position of text in segment	O All points 💿 First point O Centroid	
	🗸 🖌 🖌 🖌 🖌 🖌 🖌	

Note: In this case, the string numbers for the backs are 2 and 30003 and for the floor are 1 and 1001. String 30003 is a spot height string. You will need to create separate DTM files for the backs and the floors.

5. Choose File > Save > string/DTM.

≷ Save Fi	e	X
Layer I	Name lev200.str	
File	name back1	_
Output Format	Type Surpac String Files	•
Exte	nsion .str 💌	
Options		
Purpose		DTM/3DM Options
String Range	2;30003	Force solid validation on save 🔽
File format	• text	Force rigid backwards compatibility
	C binary	
		🗸 Apply 🙀 🔀 Cancel

Note: This creates a string file containing just the back strings. Notice that the separator for the string range is a semi colon.

- 7. Choose File > Save > string/DTM.
- 8. Enter the information as shown, and then click **Apply**.

🥘 Save Fi	e	×
Layer I	Name lev200.str	
File	name floor1	•
Output Format	Type Surpac String Files	•
Exte	nsion str	
Options — Purpose		DTM/3DM Options
String Range	1;1001	Force solid validation on save
File format	text	Force rigid backwards compatibility 🔽
	C binary	
		🗸 Apply 📐 💥 Cancel

Note: This will create a string file containing just the floor strings. Notice that the separator for the string range is a semi colon.

- 9. Click the **Reset graphics** icon 🚟.
- 10. Open back1.str.

Strings 2 and 30003 are displayed.

- 11. Choose **Inquire > Segment Properties** and click on each segment to check its direction. Notice that the pillar segment is anti-clockwise within an enclosing outer boundary segment that is clockwise.
- 12. Choose Surfaces > Create a DTM from layer.

Create a DTM From a Layer 🛛 🗙				
Object ID 1				
Object name				
Creating a DTM using breakline test				
Perform break line test				
Interpolate additional points				
Point interpolation distance 50				
🕜 Apply 📈 Ca	ncel			

- 14. Choose **Surfaces > Clip or intersect DTMs > Clip DTM with string**. You are prompted to select a string.
- 15. Click string 2 (ie. pillar and wall pickup string).
- 16. Enter the information as shown, and then click **Apply**.

Apply a boundary to a DTM				
Selected DTM				
DTM name back1.str				
Object ID 1				
Trisolation ID 1				
Selected boundary string				
Layer name back1.str String number 2				
Define results				
Retain triangles 📀 Inside the boundary				
O Outside the boundary				
New boundary layer				
Apply 🙀 🔀 Cancel				

The underground spot height string is displayed.

>

Note: The DTM has been clipped correctly due to the string directions set for the walls and pillars.

17. Choose File > Save > string/DTM.

🍓 Save Fil	e	×
Layer N	Name back1.str	
Filer	name back1	-
Output Format	Type Surpac DTM Files	
Exte	nsion dtm 💌	
Options		DTM/3DM Options
String Range	,	Force solid validation on save
File format	€ text	Force rigid backwards compatibility 🔽
	C binary	
		🗸 Apply 👷 🔀 Cancel

- 19. Click the **Reset graphics** icon.
- 20. Open floor1.str.
- 21. Choose **Surfaces > Create DTM from layer**.
- 22. Enter the information as shown, and then click **Apply**.

Create a DTM From a Layer			
Object ID 1 Object name			
Creating a DTM using breakline test			
Perform break line test			
Interpolate additional points			
Point interpolation distance 50			
Apply 🙀 🔀 Cancel			

- 23. Choose **Surfaces > Clip or intersect DTMs > Clip DTM with string** You are prompted to select a string.
- 24. Click string 1.

Npply a boundary to a DTI 🔍	M X	
Selected DTM		
DTM name floor1.str		
Object ID 1		
Trisolation ID 1		
Selected boundary string		
Layer name floor1.str String number 1		
Define results		
Retain triangles 💿 Inside the bo	undary	
Outside the boundary		
New boundary layer		
•	Apply 📈 🔀 Cancel	

The underground backs are displayed.



- 26. Save floor1.dtm.
- 27. Click Reset graphics .
 Now that both clipped DTMs have been created, stitch together the sides to create a closed, validated Solid model.
- 28. Open and append back1.dtm and floor1.dtm into the main graphics layer.
 ✓ Note: To append the DTMs to the same layer, hold down the CTRL key and drag and drop the files into graphics.
- 29. Choose Solids > Edit trisolation > Renumber.
- 30. Click back1.dtm.
- 31. Enter the information as shown, and then click **Apply**.

Renumber an object trisolation 🛛 🗙		
Layer name	back1.dtm	
Old Object	1	
Old Trisol	1	
New Object	1	
New Trisol	1	
2	🗸 Apply 🙀 💥 Cancel	

32. Click **floor1.dtm**.

33. Enter the information as shown, and then click **Apply**.

🧐 Renum	ber an Ob	ject Trisolation 🛛 🔀
Layer name	main graphi	cs layer
Old Object	1	
Old Trisol	2	
New Object	1	
New Trisol	1	
0		🖌 🖌 Apply 🛛 🖌 Cancel

Notice that the old trisolation number is 2 in this case.

- 34. Press ESC.
- 35. Save the file as **drives1.dtm**.

Note: When performing Solids modelling, it is good practice to save your work regularly.

- ^{36.} Click **Reset graphics**⁸⁸.
- 37. Choose **Display > Strings > With string numbers**.
- 38. Enter the information as shown, and then click **Apply**.

🔄 Drawing	<u>×</u>
Draw Strings	
Layer name	drives1.dtm
String range	1,2
Seg range	
Seg pnt range	
Desc field number	d1 💌
Text Alignment	< 💌
Position of text in segment	O All points First point Centroid
2	🗸 Apply 🙀 💥 Cancel

- 39. Choose Solids > Triangulate > Between segments.
- 40. Enter the information as shown, and then click **Apply**.

Define the trisolation to be created 🗙		
Function	TRIANGULATE AUTOMATIC	
Layer name	drives1.dtm	
Object	1	
Trisolation	1	
2	🗸 🖌 🖌 🖌 🖌 🖌 🗸 Apply	

- 41. Following the prompts from the function line, click first the outer back string, and then the outer floor string
- 42. Press ESC.

Repeat the process for the pillar.

43. Choose Solids > Triangulate > Between segments.

Define the trisolation to be created 🗙		
Function	TRIANGULATE AUTOMATIC	
Layer name	drives1.dtm	
Object	1	
Trisolation	1	
	🗸 Apply 🙀 🔀 Cancel	

- 45. Following the prompt from the function line, click first the top string of the pillar, and then the bottom string of the pillar.
- 46. Press **ESC**.

The underground result is displayed.

- 47. Save drives1.dtm.
- 48. Choose Solids > Validation > Validate object.
- 49. Enter the information as shown, and then click **Apply**.

Set neighbours and validate ob	ojects X
Layer name drives1.dtm	
Object range	
Location of report file valid	•
Id number 1	
Self-intersection triangles colour	
Duplicate triangles colour yellow	_
Invalid edges triangles colour	T
	🗸 🖌 📈 Apply

The Solids Modelling validation report is displayed.

SOLIDS MODELLING VALIDATION REPORT. DATE: 08-Jul-08
OBJECT 1, TRISOLATION 1
Validated = TRUE Status = CLOSED DUPLICATE TRIANGLES:
NONE TRIANGLES ATTACHED TO INVALID EDGES: NONE TRIANGLES ATTACHED TO INVALID EDGES:
NONE SELF INTERSECTION TRIANGLES:
NONE OPEN SIDES TRIANGLES:
NONE

- 50. Choose Solids > Validation > Set object to solid or void.
- 51. Enter the information as shown, and then click **Apply**.

🥘 Set tri	angle directions for objects 🗙
Layer name	drives1.dtm
Object range	
Solid	
	🖌 Apply 👷 🔀 Cancel

- 52. Choose Solids > Solids tools > Report volume of solids.
- 53. Enter the information as shown, and then click **Apply**.

🍓 Object rep	ort 🗾 🔰
Layer name drives	:1.dtm
Define the report f	ile to create
Location	drives
ID number	1
Report Format	.not
Decimals	0
Report by	⊙ Total ○ Interval ○ Elevation Range
Elevation range	
Elevation interval	10
2	🖌 🖌 Apply 🙀 💦 Cancel

The Solid Modelling Object report is displayed.

```
SOLID MODELLING OBJECT REPORT
Layer Name: drives1.dtm
Object: 1
Trisolation: 1
Validated = true
Status = solid
Trisolation Extents
X Minimum: 14147.967 X Maximum: 14401.569
Y Minimum: 11613.344 Y Maximum: 11702.817
Z Minimum: 716.840 Z Maximum: 745.362
Surface area: 8360
Volume : 12296
```

Note: To see all of the steps performed in this section, run **_15_create_underground_ model.tcl.** You will need to click **Apply** on any forms presented.

Using The Triangulation Algorithm

Task: Use the Triangulation Algorithm

- 1. Click the **Reset graphics** icon 👪.
- 2. Open bifurc2.str.
- 3. Choose View > Data view options > View by bearing & dip.
- 4. Enter the information as shown, and then click **Apply**.

🔍 Spe	cify View by Bearing and Dip	
Bearing	0	
Dip	-15	
0	🖌 🖌 🖌	Cancel

5. Choose **Display > Strings > With string numbers**.

The bifurcation example is displayed.

2	
	\bigcirc

- 6. Choose Solids > Triangulate > Triangulation algorithm.
- 7. Ensure that **new algorithm with transforms** is selected.

🥸 Toggle Stitch Algorithm	
STITCH ALGORITHMS: Enter stitch algorithm	
	Apply Cancel

- 8. Choose Solids > Triangulate > Between segments.
- 9. Enter the information as shown, and then click **Apply**.

Solution to Be Created		
Function	TRIANGULATE AUTOMATIC	
Layer name	bifurc2.str	
Object	1	
Trisolation	1	
Apply		🖌 🖌 Apply

10. Click string 1 then the right hand segment of string 2 as shown:



- 11. Press ESC.
- 12. Click the **Reset graphics** icon 🔀.
- 13. Open bifurc2.str.
- 14. Choose Solids > Triangulate > Triangulation algorithm.
- 15. Ensure that **old algorithm with transforms** is selected.

left Toggle Stitch Algorithm	
STITCH ALGORITHMS: Enter stitch algorithm	
◯ old algorithm ◯ new algorithm ⓒ old algorithm with tr	ansforms 🔘 new algorithm with transforms
@	🛛 🖌 Apply

- 16. Choose Solids > Triangulate > Between segments.
- 17. Enter the information as shown, and then click **Apply**.

Solution to Be Created			
Function	TRIANGULATE AUTOMATIC		
Layer name	bifurc2.str		
Object	1		
Trisolation	1		
Apply X Cancel			

18. Click string 1 then the right most segment of string 2 as shown:

19. Press ESC.

Note: The old algorithm with transforms also achieved a successful result but took significantly longer. This demonstrates the principal difference between the new and old algorithms, ie. the new one is much faster.

- 20. Click the **Reset graphics** icon 👪.
- 21. Open **bifurc2.str** and choose a similar view to that used before.
22. Choose Solids > Triangulate > Triangulation algorithm.

23. Ensure that **new algorithm** is selected.

le Stitch Algorithm	
STITCH ALGORITHMS: Enter stitch algorithm O old algorithm O hew algorithm O old algorithm with transforms	new algorithm with transforms
0	Apply 🔀 Cancel

- 24. Choose Solids > Triangulate > Between segments.
- 25. Enter the information as shown, and then click **Apply**.

Solution to Be Created				
Function	TRIANGULATE AUTOMATIC			
Layer name	bifurc2.str			
Object	1			
Trisolation	1			
2		🖌 🖌 Apply 💦 🖌 Cancel		

26. Click the same segments.

The bifurcation example is displayed.

In this case the segments are too far apart geometrically for either the old algorithms or new algorithms (options 0 and 1 respectively) to work and the options with transforms should be chosen in preference.

Finally, restore the triangulation algorithm to its original value.

- 27. Click the **Reset graphics** icon \bigotimes .
- 28. Choose Solids > Triangulate > Triangulation algorithm.
- 29. Enter the information as shown, and then click **Apply**.

S Toggle Stitch Algorithm
STITCH ALGORITHMS: Enter stitch algorithm O bld algorithm O new algorithm O old algorithm with transforms O new algorithm with transforms
Apply X Cancel

Note: To see all of the steps performed in this section, run **_16_triangulation_algorithm.tcl.** You will need to click **Apply** on any forms presented.

References

For further information on this topic and related articles, log onto Gemcom's Knowledge Base at

www.gemcomsupport.com