



Carlson Software Triangulate & Contour Basics

At the heart of nearly every land design project is at least one terrain model. These models go by several names and one of the most common is that of a "TIN" or Triangulated Irregular Network; another common name is that of a "DTM" or Digital Terrain Model. Since accurate representations of a surface model are significantly important to most land development projects, having a thorough understanding of the Triangulate & Contour controls is very important.

Introduction

Surface models are generally comprised of combinations of the following general data types:

- **Points** Most surface models are comprised of points whose coordinates (x,y,z) contribute to the formation of triangular planes that connect three points that are in close proximity to one another. Within Carlson, most points come from the <u>Draw Field to Finish</u> command and/or the <u>Draw-Locate Points</u> command. Points can be selectively filtered from the triangulation engine through the use of the <u>Tag Non-Surface Points</u> command.
- Breaklines Breaklines (or "fault lines") are used to control the connection sequence between four points which results in two triangles. Common uses of breaklines include ravines, ditches, berms and other areas where distinct grade discontinuity occurs. The "leg" of a triangle can travel along a breakline but cannot cross the breakline. Breaklines must be in the form of 3D polylines or simple lines whose vertices or endpoints define a valid "Z" elevation. A common problem related to breaklines is when two breaklines cross one another in 3D space. In these situations, an impasse results and will result in a "crossing breakline" report. Within Carlson, most breaklines come from the Draw Field to Finish command and/or the <u>3D Polyline</u> command. Breaklines fall into one of two general categories:
 - "Soft" breaklines Unless otherwise specified, all breaklines are considered "soft" breakline. The nature of soft breaklines allows a degree of contour smoothing across the breakline itself resulting in a "weathered-" or natural-looking contour.
 - "Hard" breaklines Breaklines tagged as "hard" breaklines prevent contour smoothing through the breakline. Hard breaklines are generally used to represent man-made terrain breaks that commonly occur during excavation and construction. Breaklines can be changed to hard breaklines through the use of the <u>Tag Hard</u> <u>Breaklines</u> command.

Breaklines and other triangulate-able entities can be selectively filtered from the triangulation engine through the use of the <u>Tag Non-Surface Entities</u> command.

• **Inclusions** - Inclusions (or "boundaries") are used to identify the entities that can be used for triangulation and multiple inclusion regions can be selected for a given surface model. Entities that fall outside of an inclusion boundary and are not otherwise bound by a different





inclusion boundary are ignored by the triangulation engine. Inclusion regions must be in the form of a closed 2D or 3D polylines. Within Carlson, most inclusion polylines come from the <u>Shrinkwrap Entities</u> command.

• **Exclusions** - Exclusions (or "void regions") are the antithesis of Inclusions and are used to prevent triangulation from occurring between points that are bound by an Inclusion region. Common uses of exclusion regions include building footprints and free-standing water limits (*e.g.* ponds). Entities that fall inside an exclusion region are ignored by the triangulation engine. Exclusion regions must be in the form of a closed 2D or 3D polylines. Within Carlson, most exclusion polylines come from the Boundary Polyline command and/or the 3D Polyline command.

Notes:			





Carlson Surface Modeling in Survey, Civil or Hydrology

Creating a Surface Boundary

Load **Site** "DWG" file and we will run through the following exercise.

The steps below are typical recommendations. The first step is to draw a boundary around your site so you don't get any unwanted triangles.

📆 Shrink-Wrap Entities

1. Select Draw/Shrink-Wrap Entities

😻 Shrink-Wrap Enti	ties	×
Method • Across Gaps	C Bounded Linework Only	
Layer Name	P-Surface Boundary	Select
Snap Tolerance	0.0001	
Perimeter Reduction	Medium 💌	
Type of Polyline to Cre 2D Polyline	eate C 3D Polyline	
ОК	Cancel Help	

- **Method**: Across Gaps is set for open polylines, the Gap method works better, as it jumps across the gaps and connects the end points.
- Perimeter Reduction: You can pick None, Low, Medium or High. Select Medium.



• Type of Polyline to Create: Select 2D Polyline so we can adjust it after it's drawn.





BEFORE







A Triangulate & Contour



Creating New Surfaces

1. Select Su	rface/Triangulate & Co	ntour	K Triangulate & <u>C</u> o	ontour
	💐 Triangulate and Contour			X
	Triangulate Contour Labels Se	lection		
	Draw Triangulation Lines	Layer	TRI_LINES	Select
	Draw Triangulation Faces	Layer	SU-TRI-FACE	Select
	Draw Slope Arrows	Setup		
	Write Triangulation File	Browse		
	TIN File:			
	Use Inclusion/Exclusion Areas			
	Shrink-Wrap Perimeter Reduction	None		
	Erase Previous Contour Entities	Current Surfac	e ▼	
	Ignore Zero Elevations	Pick F	Reference Plane	
	Specify Input Elevation Range	Highlig	ght Breaklines	
	Specify Output Elevation Range		plate Ridges and Vall	eys
	Minimize Flat Triangles	Interpo	plate Summits and Pit	s
	🗌 Simplify Surface 🔲 El	evation Method	Tolerance 1.0	0
	Preserve Breaklines	Breakline Angle	35.0 Weig	ght 10.0
	Maximum Triangle Length	Interior 5000	Exterior	10000
	Current Settings: Custom		Load	Save
	ОК	Cancel		Help

- Check on the Draw Triangulation Faces box and select layer. •
- Check on the Write Triangulation File box and type in the Surface Name. •
- Check on the Use Inclusion/Exclusion Areas box. •
- Erase Previous Contour Entities Select Current Surface •
- Check on the Ignore Zero Elevations box. •



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2. Select the Contour TAB

💐 Triangulate and Contour			×
Triangulate Contour Labels Selecti	on		,
Draw Contours	Contour Layer	SU-TOPO2	Select
Interval Method Ocontour by Interval Contour an Elevation	Contour Interval Contour Line Width	2	
Min Contour Length 0.50	Draw Index Cor Index Layer	tours SU-TOPO10	Select
Reduce Vertices	Index Interval	10	
Offset Distance 0.05	Index Line Width	0.00	
Reduce Before Bezier Smoothing	Highlight Depre	ssion Contours	Setup
Offset Distance 0.10 Contour Smoothing Method • No Smoothing • Bezier Smoothing • Polynomial Smoothing • Subdivisional Surfaces • •	Hatch Zones	2	
Current Settings: Custom	Cancel	Load	Save Help

- Select the Proper Layer for Survey and Engineering for Minor and Index.
- Select the Contour Interval and Index Interval.
- Select the **Smoothing Factor to 5**.







3. Select the Labels TAB

😻 Triangulate and Contour					×
Triangulate Contour Labels Selecti	on				
Label Contours					
Label Layer SU-MIN-TEX	Т	Select			
Index Label Layer SU-MAJ-TEX	Т	Select			
Label Style L80		Select			
Label Decimals Auto	•				
Label Text Size Scaler	.08 Min Length t	o Label	3.00		
Positive Contour Prefix	Suffix				
Negative Contour Prefix	Suffix				
Break Contours at Label	Break Buffer	Offset	0.1		
Draw Box Around Text	Box Buffer O	lffset	0.3	1	
Label at Centerline Offset	CL Offset		5.0	·	
Draw Broken Segments	Layer 🚺	TEXT BRK	<u> </u>	Select	
Label Contour Ends				JEIEUL	
Label Index Contours Only	I✓ Hide Dra	wing Under L	abels.		
Align Text With Contour		ext			
Draw on Real Z Axis	I Align Fac	cing Uphill			
Internal Label Intervals C Label Intervals	C Distance Interv	val			
One Label Per Contour	30.00				
Current Settings: Custom		Load		Save	
ОК	Cancel		ł	Help	

- Change Label Layer to SU-MIN-TEXT or P-MIN-TEXT
- Change Index Label Layer to SU-MAJ-TEXT or P-MIN-TEXT
- Select the Align Text With Contour box.
- Select the Hide Drawing Under Labels box.
- Internal Label Intervals: Select One label Per Contour.





4. Select the Selection TAB

😻 Triangulate and Contour			<u>×</u>
Triangulate Contour Labels Select	tion		
Filter Selection By Inclusion/Exclusi	on Areas		
Specify Selection Options			
CAD Points	Lines		
ZD Polylines	3D Polylines		
Carlson Points	3D Faces		
Inserts	Spot/Bottom El	evation Inserts	
Elevation Text	Select All	Clear All	
From File (.CRD or ASCII) or Point G	iroup V.	alue to Process	Z
Carlson Coordinate File (Binary) Pt# North East Elevation Desc (A Pt# North East "Elevation" "Desc Pt# East North Elevation Desc (A North East Elevation Desc (ASCII East North Elevation Desc (ASCII	SCII) s" (ASCII) SCII))		
Current Settings: Custom		Load	Save
ОК	Cancel		Help

• Select OK at the Bottom of the Selection Tab and follow the command prompts below in CAD.





- Select the Inclusion perimeter polylines or ENTER for none.
 Select entities: Select the desired closed polylines that form the bounding inclusion area(s) of the surface model and press Enter when complete.
- Select the Exclusion perimeter polylines or ENTER for none. Select entities: Select the desired closed polylines that form the regions(s) of the surface model where triangulation should not occur and press Enter when complete.
- Select the points and breaklines to Triangulate. Select entities: Select the desired entities from CAD using standard CAD selection methods and press Enter when complete.







Viewing New Surfaces

Select View/Surface 3D Viewer

1. In the box below select your Surface "EG".

cisting			
cent Folders	C:\Projects\Ese-training\Civil\Site		
Name		Browse 🚯	
e Size:	Date Modified:	Files in that folder	
)ata Preview:			
Recently used files:			
Recently used files:	Folder	Size Date	
Recently used files: File name Eg.tin	Folder C:\Projects\Ese+training\Civil\Sit	Size Date e 65,323 Wed Oct 12	
Recently used files: — File name Eg.tin	Folder C:\Projects\Ese+training\Civil\Sit	Size Date e 65,323 Wed Oct 12	
Recently used files: File name Eg.tin	Folder C:\Projects\Ese+training\Civil\Sit	Size Date e 65,323 Wed Oct 12	
Recently used files: — File name Eg tin	Folder C:\Projects\Ese+training\Civil\Sit	Size Date e 65,323 Wed Oct 12	
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Recently used files: File name Eg tin	Folder C:\Projects\Ese+training\Crvil\Sit	Size Date e 65,323 Wed Oct 12	





Optional - 3D Viewer Window

Select View/3D Viewer Window

- 1. This will allow you to select the CAD Graphics and see them in 3D.
- 2. You can also rotate to the side view and change the vertical scale to see if any points or 3D linework is incorrect.











- Check on the Ignore Zero Elevation box.
- Check on the **Color By Elevation** box.
- Change the Vertical Scale to 5.
- Move your mouse onto the surface and move it up and down. To rotate around move your mouse to the side of the surface.
- You will Notice a spike which we need to fix.







Edit Surface

Select Surface/Triangulation Surface Manager



Add Point (AP) adds a triangulation point to the network by picking a point from the screen. The pick must be inside an existing triangle. The elevation for the selected point is interpolated from the surrounding TIN network. This is a good method for adding additional triangulation to the surface in a sparse area. Also, a new elevation can be specified for the picked point. This function does not create Carlson points, and the point will not be saved to the .CRD file.

<u>Add Breakline (AB)</u> adds a breakline to the surface by picking beginning and ending points on the screen. The endpoint snap automatically turns on. Only one breakline can be created at a time. The TIN network will reconfigure to follow the new breakline and update the contours. This does not create 3d polylines in the drawing.

Add Entities (AE) adds a number of points and breaklines into the selection set by selection of existing entities into the current surface.

<u>Remove Point (RP)</u> removes an existing triangulation intersection from the TIN network. The affected triangulation re-adjusts to compensate for the missing intersection. Contours update accordingly. <u>Move Point (MP)</u> is a combination of removing a point and adding it at a new location.

<u>Swap Edge edges (SW)</u> swaps common TIN edges to create two different triangles from the original triangle configuration. Contours automatically update to reflect changes made to the TIN. Some common edges may not be swapped because of the orientation of the two triangles.

<u>Set Elevation (SP)</u> Sets a new elevation for a specified TIN intersection. The affected TIN is adjusted and the contours are updated.

<u>Remove Tri (RT)</u> removes a TIN line from the surface by picking a TIN line or selecting an interior point. Contours are removed from the affected area.





1. Select Remove Point

2. In the CAD Command line: Pick near the point to be removed:



You can see below the Triangles no longer connect to point 1.







Surface has been corrected below.

