

# **Carlson Point Cloud Primer**

The following is an introductory primer (tutorial) for Carlson Point Clouds. Although this primer is not a comprehensive tutorial (all point cloud projects pose their own unique set of challenges), the intent of this primer is to work through some basic procedures with a goal of creating a representative surface model (e.g. TIN) of the project site. If you wish to follow along with the tutorial and use the same Scan files, you can download them from the following DropBox file sharing URL:

https://www.dropbox.com/s/gjekk0vmib6kcdz/PointCloudPrimer.zip?dl=0

### **Assumptions and Notations**

The illustrations provided throughout this primer assume Carlson Point Cloud Basic version 2019 (or earlier) is installed (screen captures subject to change without notice). Carlson Software would like to gratefully recognize and thank the professionals at <u>Allgeier, Martin and Associates, Inc, Joplin, MO</u>, for their efforts toward the gathering and contribution of the data (used and shared with permission) throughout this primer.

# **Getting Started**

### Load the Point Cloud Menus

Work done in Carlson's Point Cloud module is done on a per-project basis. To create a new project, you must first have a CAD drawing open in AutoCAD or IntelliCAD. To load the Point Cloud menu structure, load it through the menus by going to Settings  $\rightarrow$  Carlson Menus  $\rightarrow$  Point Clouds (or click on the Lightning Bolt icon found on the Carlson Menus tool-bar). This will display the menu structure for Point Clouds.

## **Configuring Point Cloud**

Carlson Point Cloud features different cloud-processing "engines" that provide different degrees of functionality. For the purpose of this primer, let's verify the engine we'll be using.

1. From the Point Clouds menu, click Point Cloud Setup:



2. Specify the Point Cloud Engine as illustrated above and click OK.

### **Create a Point Cloud Project**

Our next task will be to create a Point Cloud "project" that is a structured organization of the file(s) and output of the Point Cloud data.

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1. From the Point Clouds menu, click Project Manager to display the Point Cloud Project Manager "docked dialog" box:

PointCloud Basic (Feb 14 2019)					
🍠 Project 🥶 Scene 🎙 Camera 🤏 Action 🧿 Data					
Image: NewOpenImage: CloseImage: CloseIma					
Current Project					

- 2. Click the New button.
- 3. Indicate the File Name as shown below and then click on Save:

۲				oud Project	t - (pc)
Folder	C:\Carlson Projects\				💌 💽 🚺
File Name	Point Cloud Primer				Browse
- Recent Files					
File name		Folder	Size	Date	
	daa ah dada baada dada	*****	A 114 A 44 4 4 4		A A A A A A A A A A A A A A A A A A A

Your initial project should look like the following image. In the organized "tree" structure, you will see your Project with various defaults:



PointCloud Basic (Feb 14 2019)
🥌 Project 🤓 Scene 🏮 Camera 🤏 Action 🧿 Data
Image: NewOpenImage: CloseImage: CloseIma
Current Project
Point Cloud Primer [C:\Carlson Projects\Point Cloud Primer.pc]
🚊 📲 Processed Data
🛶 Layers
Scenes

### **Point Cloud Settings**

It is often desirable to validate (or possibly change) settings used by Point Cloud.

**NOTE:** Each of the items in the Point Cloud Project react to a mouse right-click. For categories of data in the tree-view that have [square bracket] numbers, a mouse double-click action can also be used to activate the entry.

- 1. Let's explore and validate some general project settings. Click the Settings button.
- 2. In the Units and Ranges section, set the values as shown below:

123		Units, Precision a	nd Ranges	
Units and Ranges	Units and Precision			
ABC		Units:	Precision:	
Naming	Distance:		3	~
onventions	Angle:	Degrees	√ 4	×
<b>§</b>	Ranges and Precision			
Viewer	,, <b>,</b>	Range:	Precision:	
	Intensity:	[0.0 1.0]	√ 5	×
Dialog	Color:	[0.0 1.0]	✓ 5	* *
Settings			· · · · · · · · · · · · · · · · · · ·	



3. Explore the Naming Conventions section. This allows you to change the names associated with the various project items:

			Pr	oject Settings				x
123				Naming Conve	ntions			
Units and	- Project Items							
Kanges			Prefix:			Digits:		
Naming	Scan Positions:		Scan Po	sition		2		<u>^</u>
Conventions	Scans:		Scan			2		×
5	Clouds:		Cloud			2		<b>^</b>
Viewer	TINs:		TIN			2		^ V
	Grids:		Grid			2		~
Dialog	Planes:		Plane			2		~
Settings	Polylines:		Polyline	2		2		~
	Scenes:		Scene			2		~
History	Scene Items							
			Prefix:			Digits:		
	Cameras:		Camera	I		2		<u>^</u>
	Processed Data Sets							
		Cleaned:		Filtered:	F	Resampled:	Simplified:	
	Suffix:	- Cleaned		- Filtered		- Resampled	- Simplified	
	Data Items							
			Prefix:			Digits:		
	Reflectors:		REF			2		~
	Control Points:		СР			3		^ V
	Target Points:		TP			3		^ ~
	Coordinate Points:					1		<u>^</u>

- 4. Finally, take a look at the Viewer section and make any changes to the defaults if you desire.
- 5. Once complete, click on green-check button to accept the Project Settings.

**NOTE:** To accept (or commit) the results of (or to continue with) a function, you should click the "green-check" button. If you want to cancel a process, click the "red X" button.

## **Adding Data**

In most terrestrial scanning situations, a site might be scanned from several scanner positions to allow for the site to be seen from different angles so a true 3D representation of the site can be achieved. The reader should be aware that Point Cloud can handle different scanner setups, each having obtained a scan in their own scanner coordinate system. Included with these scans are target scans and control coordinates for the site. This allows the individual scans to be merged into one entity for further manipulation.



In this data set, however, we have been given a "processed point cloud" from an unmanned aerial vehicle (UAV) that can be directly modeled without further manipulation.

## **Cloud Import**

- 1. Right click on Clouds category of the project tree.
- 2. Choose Import  $\rightarrow$  LIDAR.
- 3. It will now display another dialog box asking you for the file that has the necessary data in it. Navigate to where the file resides and open the file.
- 4. Based on units used to process the data, additional scaling may be desired. For this particular example, indicate the scaling option as shown below:

۲	Choose Classifications to Import	x
Class Name Ground Low Vegetation High Vegetation Road Surface	ו ח	
Add as Regions		
Conversion Type None Metric to US Fe US Feet to Met	eet tric	
ОК	Cancel	

**NOTE:** The \*.LAS file should import as a Cloud component to your project tree. Depending on the processing capabilities of your computer, this action may take just a few seconds to several minutes to complete.

**NOTE:** For the sake of brevity and consistency in this discussion, let's rename the cloud object to simply be **Cloud-00**:

- 1. Right-click on the first cloud data set we imported and choose *Rename*.
- 2. Give the cloud object a name of **Cloud-00** and press the Enter key to commit the new name.

**NOTE:** To get an idea of how many points were imported, right-click on the **Cloud-00** entry and choose Properties and dismiss the dialog box when complete; your values may differ from those shown below:

UC <b>19</b>	
Carlson Software User Conference May 7-9 <sup>th</sup>   Maysville, KY	

•		Cloud Prope	rties - [Cloud-00]	×
Cloud Notes				
Data				]
Points:	3,844,846			
Position: On	Intensity: Off	Color: On	Classification: On	
Position				
	Minimum:	Maximum:	Range:	
X:	2813685.056	2813961.710	276.654	
Y:	326464.012	326762.965	298.953	
Z:	956.127	986.315	30.188	

## Creating a View of the Cloud

Now we will create a view for further manipulation.



 Select Cloud-00 by either a double left-click or right-click → View and it will open a dialog box as seen below:

View C	loud - [Cloud-00]
Action	
• Create new	<ul> <li>Append to existing</li> </ul>
Name	
Scene-00	
Mode	
0 2D	• 3D
Color	
Category:	Туре:
Color	V Direct V
Orientation	
Plan View	
○ Isometric	
The Mindeuse	

- 2. Select the Create New option, and set the Scene name as shown.
- 3. In the color panel, choose Color for the category and Direct for the type.



4. After clicking green-check, a new window should pop up after the scan has loaded that shows a scene similar to the one below:



## Making a "Sub" Cloud

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Rather than processing the limits of the entire cloud that we've imported, our next goal will be to make another cloud that is a subset of **Cloud-00**.

### **Isolating the Area of Interest**

The UAV has picked up some points outside our area of interest. In effort to narrow the data set, we'd like to limit our study to a portion of **Cloud-00**.

1. From the Scene created above, click Selection  $\rightarrow \text{Add} \rightarrow \text{Perimeter: Inside.}$ 



2. Identify a region similar to that shown below:



#### Make the "Sub" Cloud

Let's physically make the sub-cloud:



1. From the Scene created above, click Create  $\rightarrow$  Cloud:

Create Cloud - [Scene-00]	
Action	
• Create new	
Name	
Cloud-01	
Cloud-00	
Attributes	
Intensities: Off Colors: On	
Provide the name shown below and click green-check w	when ready:
Create Cloud - [Scene-00] X	
Action	
Create new	

Action	
Create new	
Name	
Cloud-01	
Cloud-00	
Attributes	
Intensities: Off	Colors: On
	🖌 🌠 🔇

The new Cloud will be added to the Clouds group and can be acted upon like any other Cloud.

### **Cleaning the Point Cloud Data**

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2.



As a subset of Cloud-00, the new point cloud contains the same data as the original

but only in our defined area. Inevitably, we'll probably have extraneous data (*i.e.* "noise") that can be removed that should improve the final result (that being a surface model TIN). Let's eliminate unwanted data points.

1. Right-click on the new cloud in the Project tab and select the Clean option. This will bring up the Clean Cloud dialog box:

Clean Cloud	- [Cloud-01]
Name	
Cloud-01 - Cleaned	
Attributes	
Intensities: Off	Colors: On
Duplicated Points	
Remove duplicated point	5
Distance threshold	0.100
• 3D • 2D	
Isolated Points	
Remove isolated points	
Distance threshold	1.000
Minimum neighbors count:	1
Redundant Points	
Remove redundant point	s
Box length and width	0.500
Box height	0.250
Residual tolerance	0.030
Color variance (3-255)	255
Process Planes	Horizontal V
Recursion depth	3 🗸
Strong Filtration	

2. Set the values as shown and tap Green Check when ready.





"Redundant" points within the threshold value(s) are removed from the cloud and a new (and smaller) cloud is added to the Point Cloud tree.

## **Re-sampling (Decimating) the Point Cloud Data**

In an effort to further reduce the density of the point cloud data, a common practice is to "re-sample" (or decimate) the data within the point cloud.



1. Right-click on the new cloud in the Project tab and select the Resample option. This will bring up the Resample dialog box:

Name Cloud-01 - Resampled Attributes Intensities: Off Colors: On	
Cloud-01 - Resampled Attributes Intensities: Off Colors: On	
Attributes Intensities: Off Colors: On	
Intensities: Off Colors: On	
Method	
● Step Oc-Tree	
Step	
Step: 16	
O a Tara Dimensiona	
- Uc-Tree Dimensions Minimum: Maximum:	
X: 2012695.064 2012017.6	00
V: 235454.015 235753.02	09
Z: 056 127 026 210	
550.121	
Oc-Tree Resolution	
X: Y:	Z:
Delta: 2.325 2.989	0.301
Resolution: 100 100	100
Oc-Tree Nodes	
Minimum: Maximum:	
Item count: 8 32	
	V 🌾 🕐

2. Specify the values shown. When ready, click Green Check to create your new "decimated" point cloud.

**NOTE:** Generally, the Oc-Tree resampling method typically provides the best results but may take several minutes to complete. After it is complete, you will have a new "cleaner" cloud under Project  $\rightarrow$  Clouds.

### Getting to "Bare Earth" (optional)



Depending on the application used to gather the original point cloud data, it may be necessary to remove vertical components (*e.g.* trees, builds, vehicles, utility poles, *etc*) from the data set so these types of components don't impact (or contribute to) the surface model we're attempting to create. The process of removing these elevated points is achieved by passing the point cloud data through a "bare earth" extraction algorithm.

**NOTE:** Generating a bare earth data set requires a View to be active and the View must be oriented with a "Top" display perspective.

1. Right-click on the new cloud in the Project tab and select the View option. This will bring up the View dialog box:

View Cloud - [Clou	ud-01 - Resampled] 🗶
Action	
• Create new	○ Append to existing
Name	
Scene-01 - Resampled	
Scene-00	
Mode	
○ 2D	• 3D
Color	
Category:	Туре:
Color 🗸	Direct v
Orientation	
Plan View	
○ Isometric	
V Tile Windows	

15



2. Tap Green Check to display the View and make sure the "Top" display perspective is current by clicking on the button illustrated below:





3. From the Project tree, right-click on the Cloud name and select **Bare Earth by Grid**:

leare Earth by Grid 🛛 🗙			
Name: Clo	ud-01 - Bare Earth		
Cell Size:	4.000000		
Pothole Depth:	0.500000		
Curb Height: 0.800000			
Cut Curbs Lower Low-Point Noise Filtration (0-1): 0.750000			
Add to Regions OK Cancel Help			

### **Additional Clean-up**

In certain situations, it might be necessary to further (and manually) remove points from the cloud that were not removed as part of the exercise(s) above. Let's explore this process now.



1. Right-click on the new cloud in the Project tab and select the View option. This will bring up the View dialog box:

View Cloud - [Cl	oud-01 - Bare Earth]	x
Action		_
• Create new	$\bigcirc$ Append to existing	
Name		
Scene-01 - Bare Earth		
<mark>Scene-00</mark> Scene-01 - Resampled		
Mode		
○ 2D	• 3D	
Color		
Category:	Туре:	
Color	✓ Direct	*
Orientation Plan View  Isometric		
✓ Tile Windows		
		?

2. Tap Green Check to display the View and make sure a "Front" or "Side" or "Back" display perspective is current by clicking on a button illustrated below:







**NOTE:** This action will allow us to inspect the cloud from a "profile" (or "elevation") perspective.

3. Our next task will be to build a selection set of points that we will eventually want to discard from the cloud. From the Selection menu, click Add → Window and place a small "box window" around the points you will



💱 Scene-01 - BareEarth × File Edit Selection View Create Tools EL 🝠 🗗 🗗 🗗 🗊 🐩 🛇 🗗 🥘 🤁 🍋 🗾 🗎 🚥 ~ 🔍 🕰 Picked Location Here Points to be deleted Pick other corner point Vertical Exaggeration 1.0  $\sim$ Y: 326685.823 X: 2813738.141 Z: 961.255

4. Examine the scene from different perspectives and continue to refine the selection set via the Selection menu commands. As points are added into the selection set they will turn **red**.

5. When your selection set of points to points to discard is complete, issue the Selection → Invert command. This should "activate" all of the good points and de-activate all of the points you wish to discard.

eventually want to discard (as needed) as illustrated below:



6. Let's now create a new cloud out of the selection set of "good" points. From the Create menu, click Cloud and provide the name as indicated below:

Create Cloud - [Scene-01 - Bare Earth]	x
Action	
<ul> <li>Create new</li> </ul>	
Name	
Cloud-02	
Cloud-00 Cloud-01 Cloud-01 - Bare Earth Cloud-01 - Cleaned Cloud-01 - Resampled	
Attributes	
Intensities: Off Colors: On	
1	)

# **Creating a TIN Surface**

Now that you have isolated, cleaned and resampled your area of interest that should also (effectively) be bare earth, you can make a triangulated TIN surface from your data points.

1. Right click on the new point cloud and select Create TIN to launch the Create TIN dialog box:

Create TIN -	- [Cloud	-02] ×
TIN Faces		
✓ Use Filters		
Maximum edge length:		100.000
Maximum incident angle [deg]:		90.000
TIN Vertex Limits		
TIN Vertex Limit:	500,000	~
		1 🛠 📀

2. Set the values as shown and click Green Check to create the TIN. This process may take a few minutes.



3. Continue with the TIN creation process and name as follows:

٨			Export	t TIN - (tin)	
Folder	C:\Carlson Projects\				💌 💽 🚺
File Name	Existing.tin				Browse
-Recent Files					
File name		Folder	Size	Date	

The newly created TIN can now be used (and/or viewed) in other Carlson applications and/or exported to other file formats including LandXML for use in other applications.

This completes this introduction to Carlson Point Cloud.