Tools, Tips and Workflows

Tips for Defining Stockpile Toes

LP360, versions 2016 and above
Topolyst, 2016

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We have added quite a few tools to LP360 (Standalone)/Topolyst aimed at small unmanned aerial systems (sUAS) data processing (and small area LIDAR, of course). Here are a few tips for defining stockpile toes for volumetric computations.

Automatic Toe Extraction with Overhead:

You will note that the automatic toe extraction Point Cloud Task (LP360 Advanced or Topolyst) has an option for Overhead Points. When selected, this algorithm attempts to segregate overhead points from stockpile points. The classic example, of course, is an overhead conveyor. It is important to note that checking this option when you do have overhead structures aides the algorithm in finding the toe, even if you are not interested in classifying the overhead points.

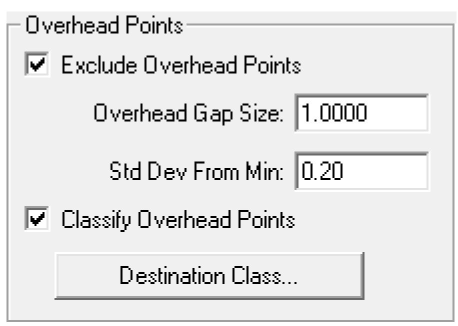

Figure 1: The Overhead section of the Toe Extractor PCT

Figure 2 illustrates the use of the toe extraction PCT without the overhead algorithm enabled. Note in several places where the toe loses track of the chip pile, meandering along overhead structures.

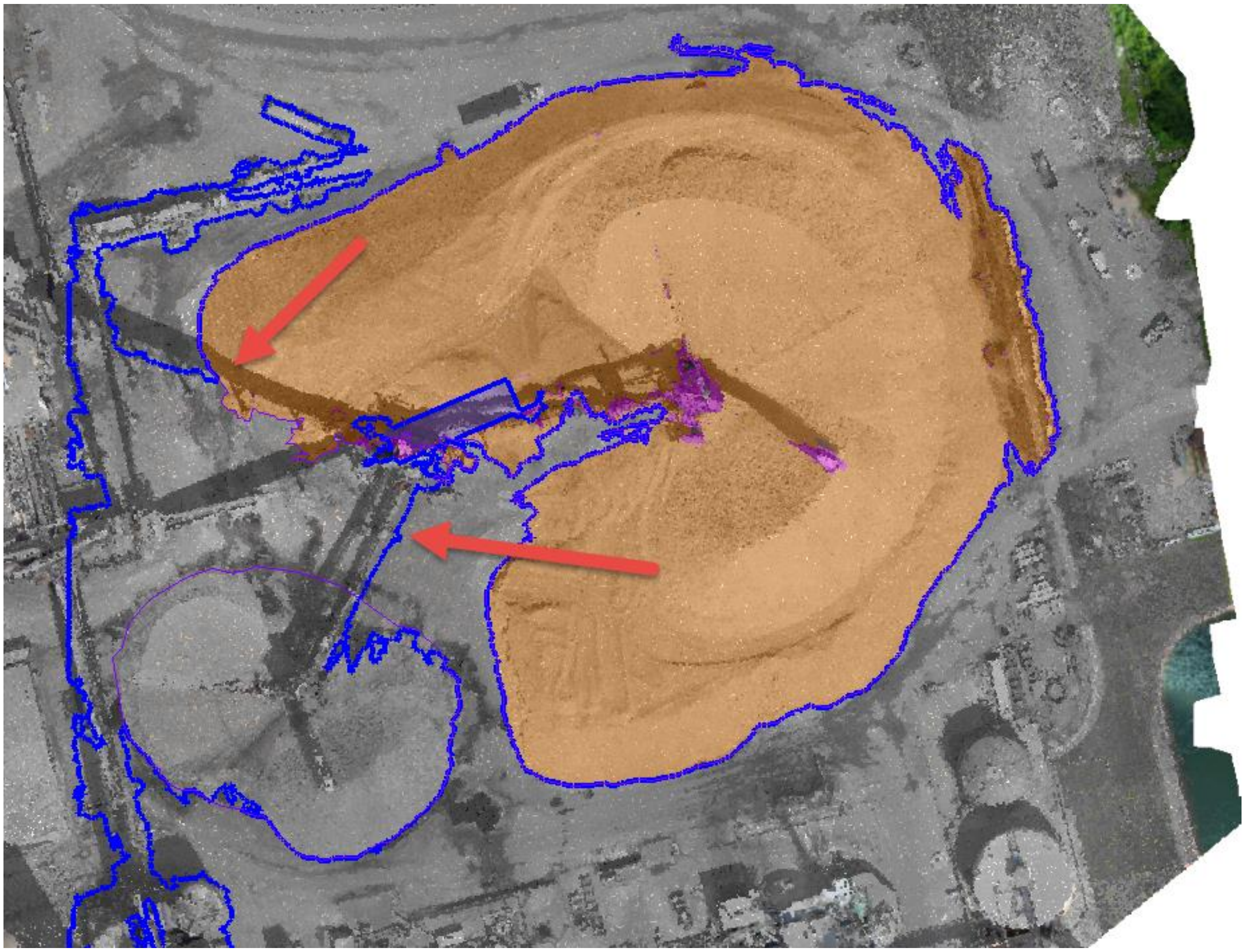

Figure 2: Toe Extraction without Overhead algorithm

Enabling the overhead algorithm (Figure 3) results in a major change in the extracted toe. While the toe wanders about in the ground equipment area (indicated by the arrow in Figure 3), it still remains associated with the stockpile. You will usually also want the algorithm to classify the points that it considers in the overhead. This is enabled with the "Classify Overhead Points" option of Figure 1.

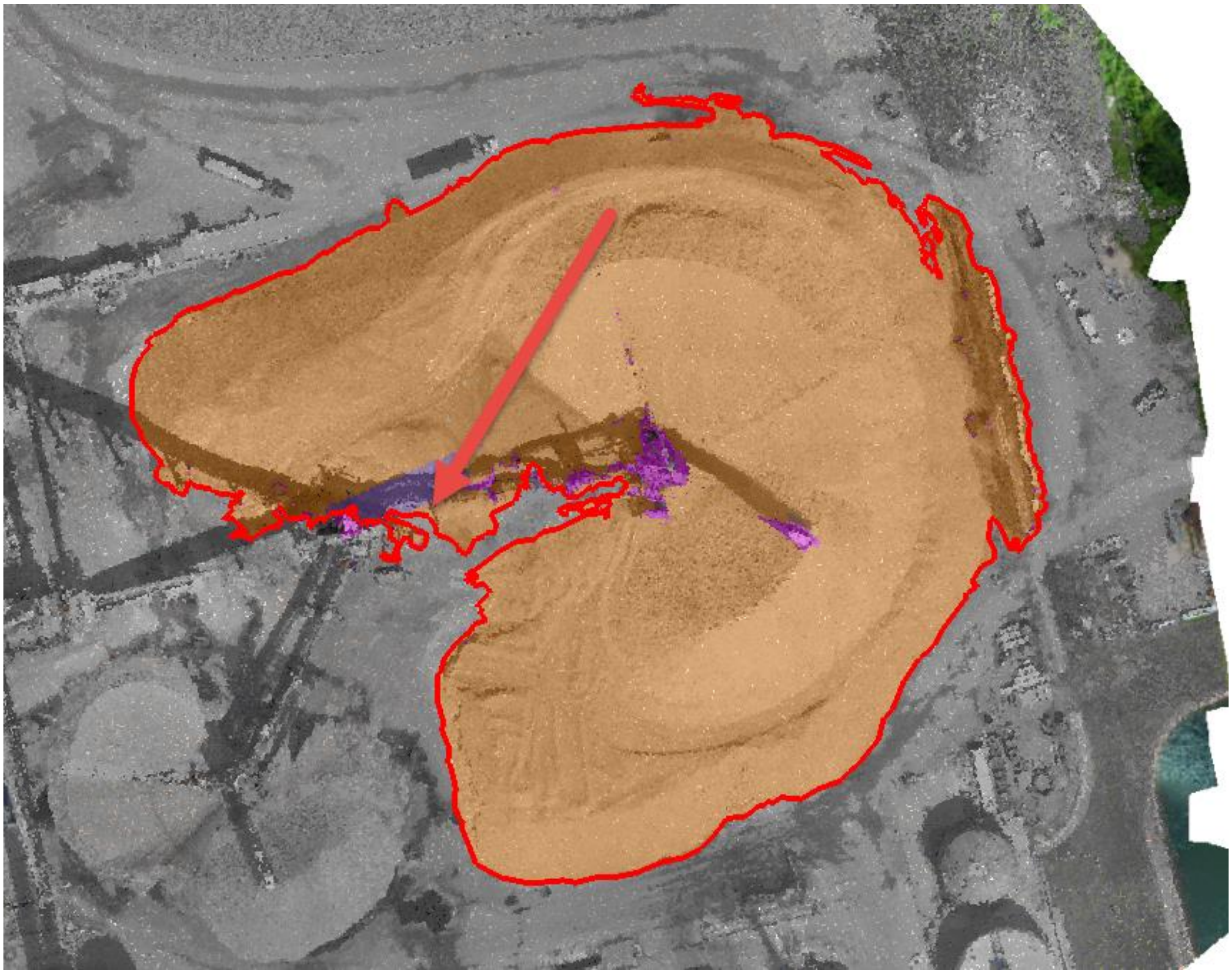

Figure 3: Toe extractor with overhead algorithm enabled

Thinning the Toe:

When a toe is created using the automatic Toe Extractor Point Cloud Task (PCT), the spacing of the vertices will be approximately the same as the Cell Size option of the Toe Extractor parameters settings. This spacing is usually much denser than is needed to define a good toe. A best practice is to thin the vertices of the toe prior to editing. You can accomplish this using two approaches. The first is to combine the Toe Extractor PCT with the Smoothing and Respacing PCT in a macro. The second approach is to use the Simplify Geometry command on the Feature Edit toolbar. This tool implements a variation of the Ramer–Douglas–Peucker algorithm to remove vertices within the constraint of the tolerance that you set on the Geometry tab of the Feature Edit Options dialog (Maximum Move Distance). I typically use 1 foot for US units and 0.25 m for metric. My original toe for the large chip pile of our example contains 4,669 vertices (you can see the number of vertices by looking in the lower right info box at the bottom of the main LP360/Topolyst window when a single feature is selected) and only 490 after thinning.

Interpolate Z:

The new feature edit tools available in the 2016.1 release of LP360 Advanced and Topolyst (these tools are not available in the ArcGIS version of LP360) contain options to automatically compute Z for newly added or edited vertices. These functions make use of the "Conflate Z" point cloud tasks (PCT) that have always been available in LP360/Topolyst. You can set separate conflation PCTs for Edit versus Create on the Auto Z tab of the Feature Edit Options dialog (Figure 4). The drop-down will filter PCTs to show only those suitable for Z conflation. Once set, you can quickly pull up the associated PCT in the PCT dialog by pressing the button to the right of the task name.

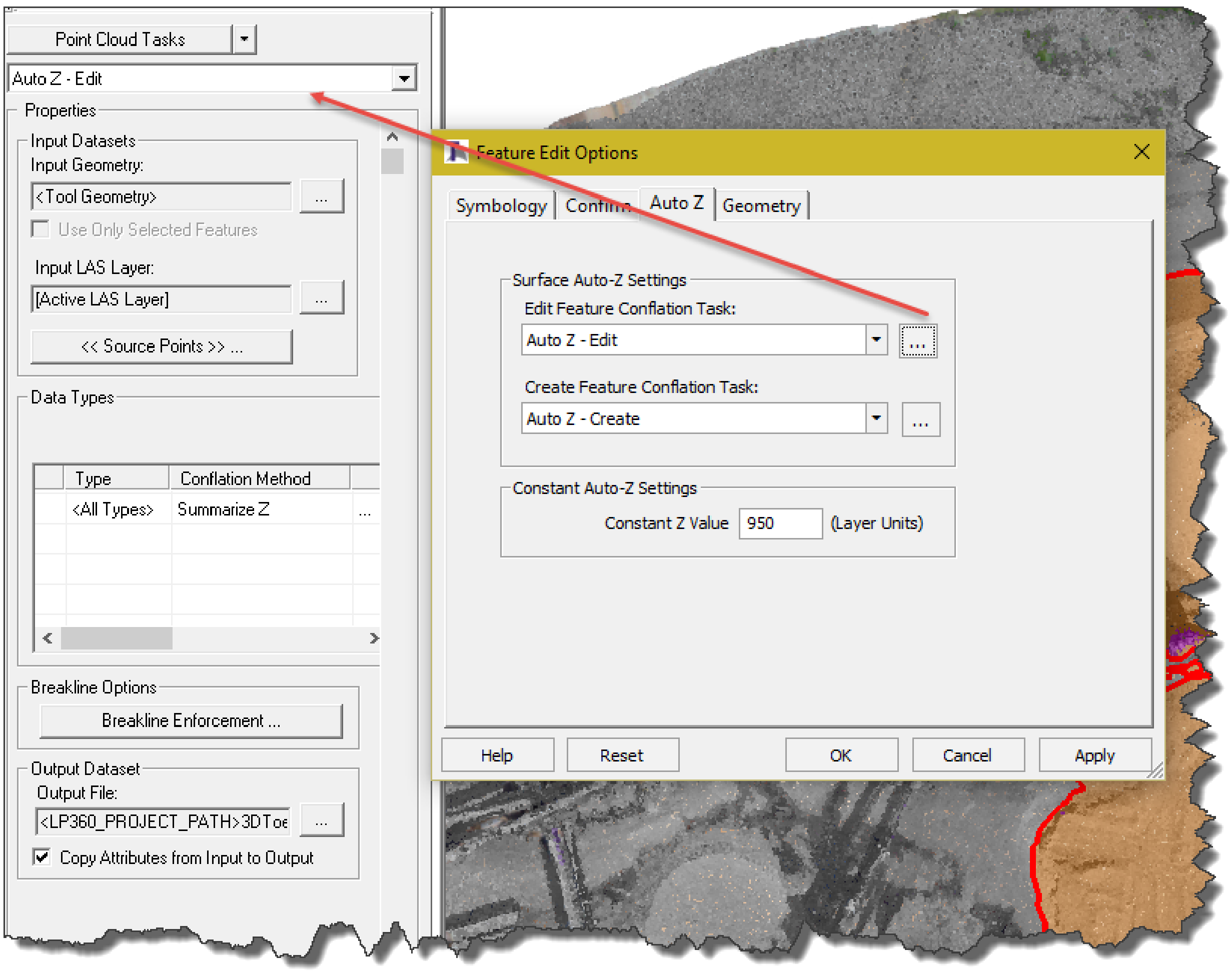

Figure 4: Auto Z Settings

I typically use Summarize Z with the "minimum Z" option (see Figure 5). I have the search distance set to 2 map units (feet, for the example project being used here). This algorithm will collect up all points within a 2 map unit radius (again, feet for my example) and use the Z from the lowest point in the collection. If no points are found within the specified distance, the No Data Value will be applied as the Z (I have this set to the default, -9999).

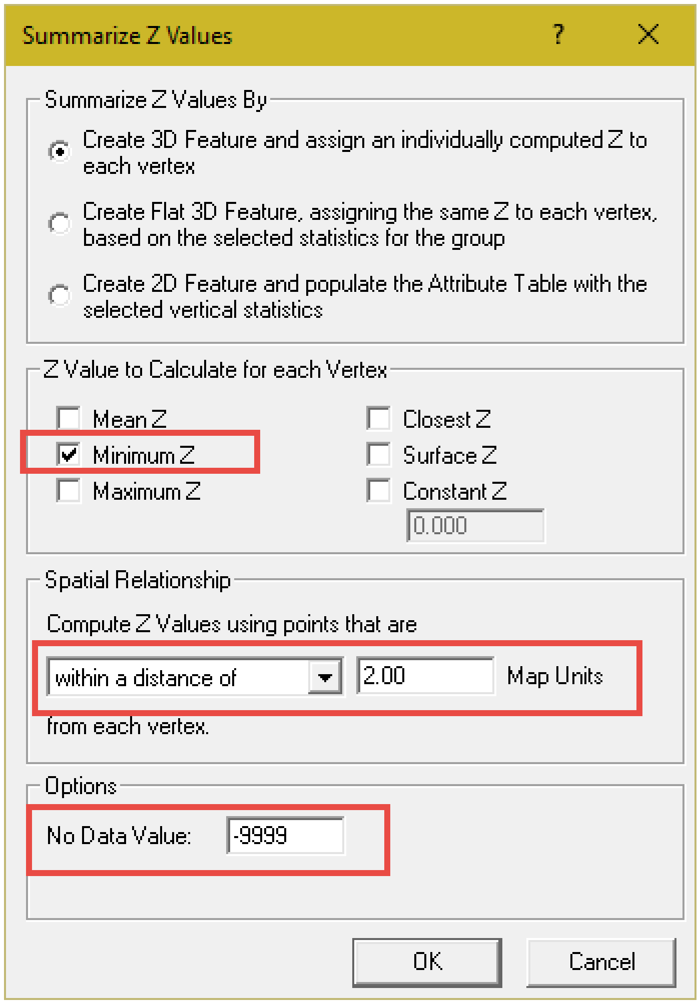

Figure 5: Conflate Z settings

It is not uncommon to have areas within a point cloud generated from Structure from Motion (SfM) with void areas that exceed a reasonable distance for the conflation search area. You do not want to make this search distance too large or you will get Z values that are not representative of the toe location.

A good way to assign Z values in areas of void data is to use the Interpolate Z function on the Right Click Menu (RCM) of the Feature Edit tools. Note in Figure 1 the area void of points below the selected vertices. If I drag this section of the toe into the void area and have Auto Z – Surface set as the Auto Z method for the vertices, they will end up with the null value of -9,999. This will cause these vertices to pull down (in the vertical sense), the toe.

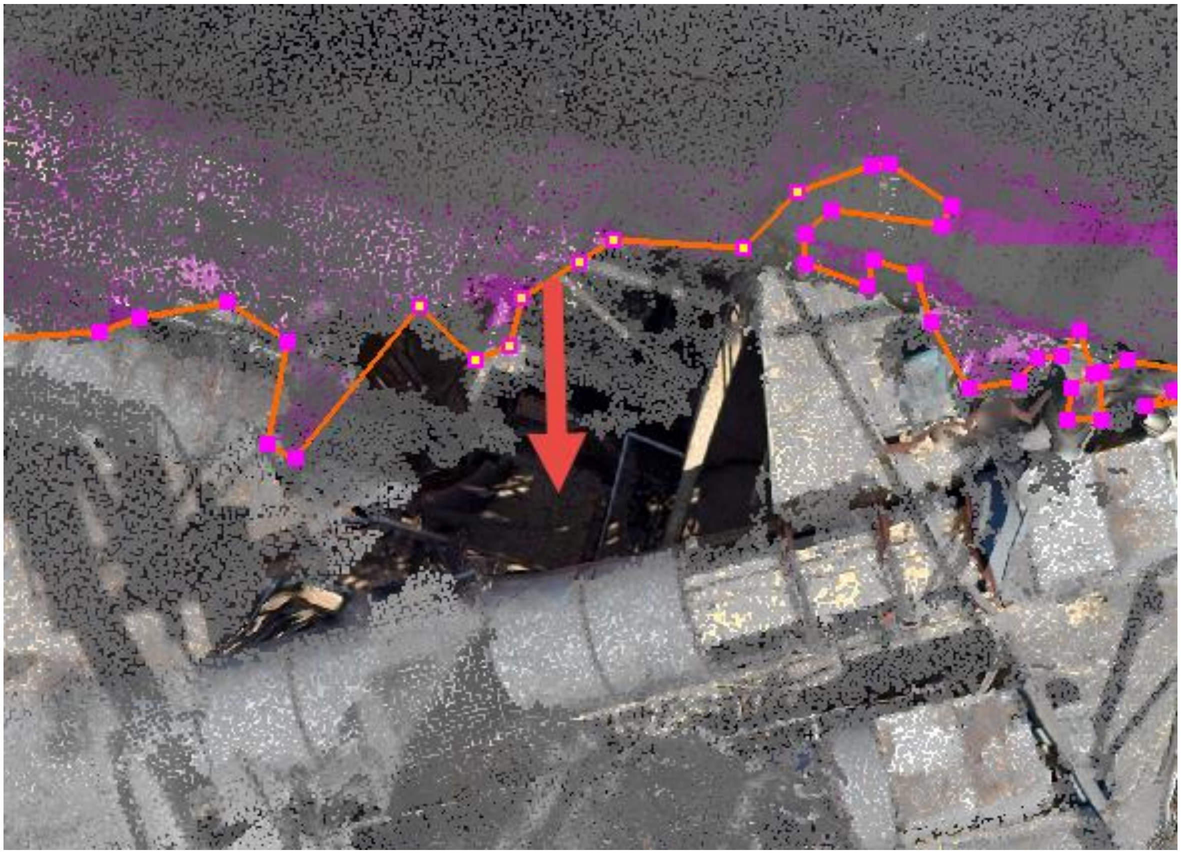

Figure 6: Dragging vertices to a void area

The result of this move is shown in Figure 7.

Figure 7: Auto Z applied to vertices moved over a data void area

A quick way to repair this is to use the Interpolate Z function of the Feature Edit tools. This tool constructs a straight line between the two end points of the selected vertices and adjusts the Z values of the vertices between these two end points to the Z at that point on the interpolation line. The process is:

- Select the vertices to be adjusted by interpolation, making sure you include at least one correct vertex at each end of the selected group.
- Select the "Interpolate Z of Selected Vertices" option from the Right Click Menu

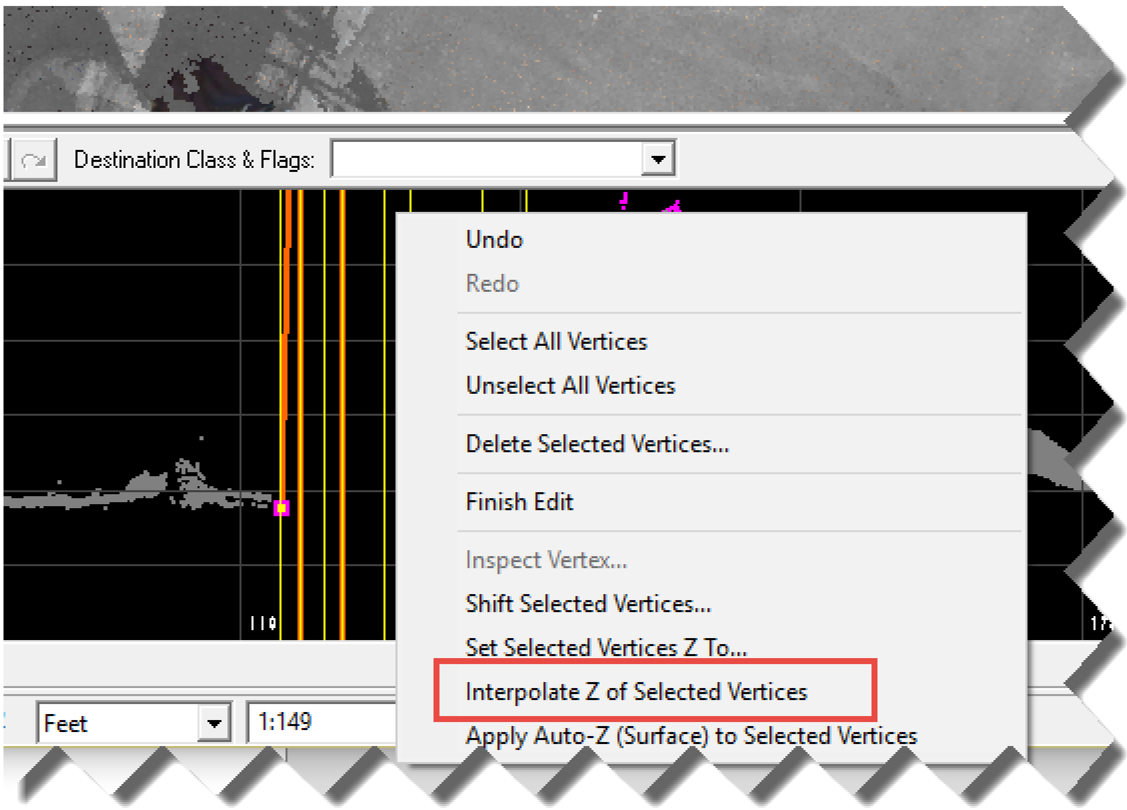

Figure 8: Interpolating Z of vertices

Don't Overachieve!

LP360/Topolyst contains options for computing volumes for a wide variety of scenarios ranging from stockpile computations to cut/fill operations. The technique usually employed in stockpiles is to construct a bottom surface model using the vertices of the Toe. This surface model is then used in the volumetrics algorithm as the base below the "hull" formed by the point cloud. Thus for "clean" stockpiles, you do not have closely follow the edge of the pile. In fact, on a planar surface (even if that surface is not level), a square box as a toe will yield the same volume as a very finely constructed toe that faithfully follows the edges of the pile. I recommend that you do some experimentation to test the sensitivity of your various scenarios.

Reshape and Split Tools:

The Reshape and Split geometry tools are the tools of choice for editing a toe. Don't resort to manipulating the toe at the individual vertex level until after you have performed gross corrections using these two tools. Both of these tools will perform their actions on a feature without the need of preselecting the feature.

The reshape tool is used to replace a section of a feature with the polyline that you draw with the tool. The replaced section will start with the feature segment to the right of your first intersection of the feature and end with your last intersection. If you unintentionally draw in the opposite direction, just use the Undo function to restore the feature.

The Split tool will spilt a feature at each segment where it enters a polygon and then exits the polygon. You can spilt multiple times in a single draw action. Again, you can recover from a bad split by pressing the undo tool in the Feature Edit toolbar.

When you use the Reshape and Split tools, new vertices that you form in the process will have their Z value computed based on the current setting of Auto Z. This is set via the Right Click Menu (RCM) in version up to 2016.2.5 and via a Feature Edit tool in versions 2016.2.6 and later (we moved it to the toolbar to make it more obvious at to what model is being applied). There are three choices for Auto Z:

- Off – This is a bit of a misnomer. When you use the Reshape and Split tools with Auto Z off, the Z value is actually interpolated from the edges of the feature that you intersect with the tool. This is extremely useful when splitting two comingled piles since it tends to place the split line at the base elevation. Note that when you drag vertices during Edit, Off causes them to retain their current Z value
- Surface Mode – The Auto Z, Edit Mode function is applied (this function is set in the Feature Edit Options dialog). This is the mode you will typically use when employing the Reshape tool to clean up the edges of a toe.
- Constant Z Mode – This options sets the Z to the constant value set in the Auto Z tab of the Feature Edit Options dialog. This is useful when you know the elevation value to which you would like to adjust Z

Figure 9 illustrates a toe being editing using the Reshape tool. When I double click the last vertex, the red line will replace all of the blue toe line between the first and last interactions. Note that you can discern the direction of a feature by noting that the second vertex of a polyline or polygon will be drawn as a triangle.

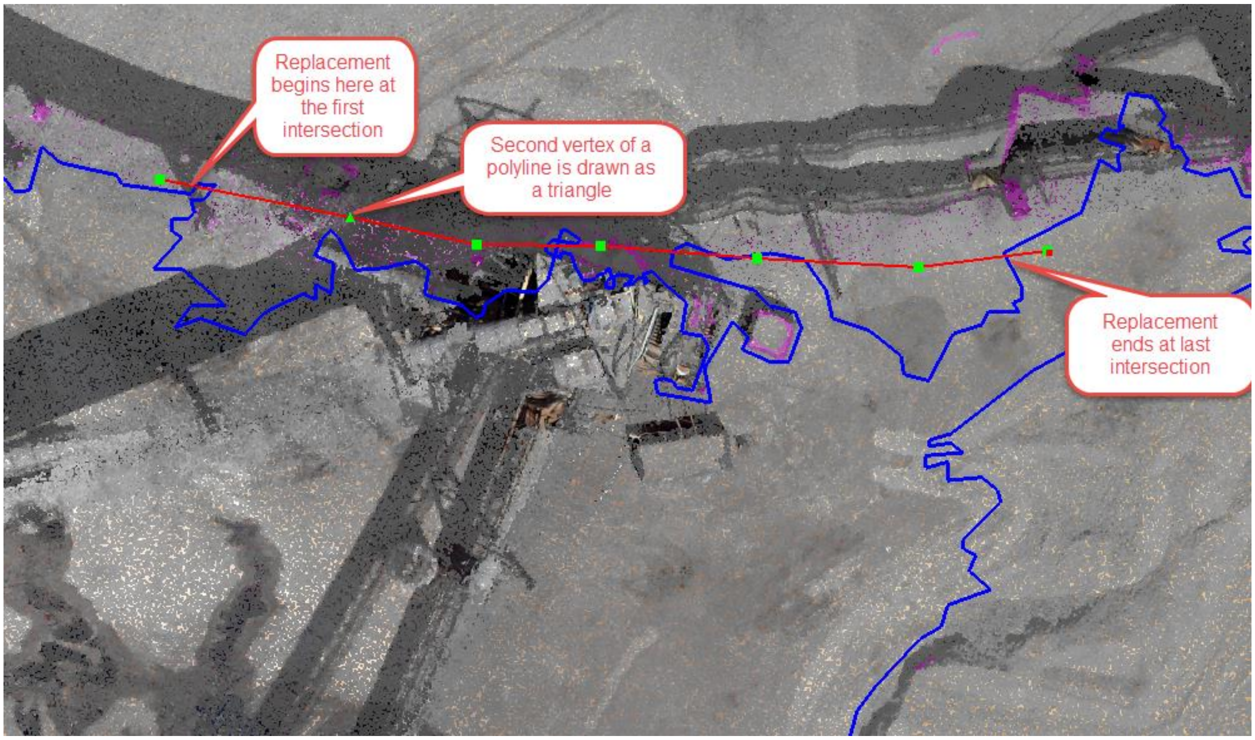

Figure 9: Cleaning a toe with the Reshape tool

Classify to Ground:

After I have completed cleaning (editing) the toe, I typically use the Classify by Feature Point Cloud Task (PCT) to classify points in class 0, 1 and 2 on the interior of the toe to Ground. While this step is not necessary at all for computing volumes, it does make it a lot easier to clean high and low points within the boundary of the toe. Since I started with all points in class 0 (unclassified), classified overhead points via the Automatic Toe algorithm and then classified everything to ground, anything showing as the class 2 color (the default is orange) in the overhead or low will need to be classified out of my data.

Data Cleaning:

Data cleaning is the process of excluding high and low points (non-surface points) from the volume computation. If your point cloud data were created from imagery using a Structure from Motion (SfM) algorithm (as opposed to nice, clean LIDAR data!) you will typically observe collections of low points below areas of clutter such as vegetation, conveyors, overhead lines and so forth. It is necessary to ensure that these data are not included in the "hull" computation of volumes.

You can reclassify low and isolated points using the Low/Isolated points Point Cloud Task (LP360 Advanced or Topolyst). These algorithms were designed primarily for LIDAR data and thus you may not find them suitable for some SfM data.

I typically classify out high and low points by classifying in the profile view. Once you set the class for high points (maybe Conveyor) and low points (Low Noise), these settings are remembered as you switch between the classify above line and classify below line tools.

Summary:

LP360 (Standalone)/Topolyst has the most comprehensive collection of volumetric tools available in the industry. While these may seem a bit overwhelming at first, investing a few hours of time to learn these tools will save you many, many hours of production time. We have a good customer (a paper mill application) who was using tools within Pix4D for toe definition and volumes (since this customer was already using Pix4D for the SfM step). After switching the volume part of the workflow to Topolyst, the time spent defining toes and computing volumes was reduced from 8 hours to less than one hour. This is a true savings that pays for Topolyst in just a few work sessions.

This savings in production time obviously translates into more profitable jobs if you are a service provider. But it can also influence how you do production. If defining toes and cleaning data are extremely time consuming, you may have to dedicate staff to this operation. If the time is significantly reduced, you may be able to optimize your business model in a different way such as having field personnel do the entire processing job.

We are very actively adding tools and improving existing ones in the feature edit area. If this is an activity that is critical to your business, then contact us to receive experimental releases of LP360/Topolyst. We are adding tools almost on a weekly basis to improve these workflows.