TR21681

The Handy Man's Airport Tools from the Autodesk Toolbox

Creg Dieziger
Sr. Civil Engineering Designer
Morrison-Maierle, Inc.

Learning Objectives

- Learn about airspace analysis tools

- Learn about AGIS tools

- Learn about planning tools

- Learn about data incorporation tools

Description

This class will show you several tools from the toolbox for airports from Autodesk, Inc. These tools will help with many types of tasks, such as airspace surface analysis, airport geographic information system (AGIS), planning, and design. They will save you time and money, and give you a powerful visual so everyone can understand the obstacles and outcomes of airport design. This class will cover many everyday tasks and provide tips to help you accomplish them more efficiently and effectively. After this class, you will be able to grab a tool out of your toolbox, look at it, and think to yourself: "I know I can use this tool for this task, why wouldn't it also work for this task in front of me?" This session features InfraWorks 360 and AutoCAD Civil 3D.

Your AU Expert(s)

I have over 27 years of experience in the Civil Engineering field using Autodesk products. I am a 6 time Civil 3D Gunslinger and am a member of Civil BIM International, which is a small users group of Civil Infrastructure CAD power users that have come together across the country to collaborate on issues in our field. I am the Sr. Civil Engineering Designer for Morrison-Maierle, Inc. We have over 200 users of Autodesk products. I also have been an Adjunct at the University of Montana, Missoula College for 6 years where I have taught AutoCAD, Survey, and Civil 3D. I am energetic and love speaking at AU.

Introduction

In this session we will cover the four learning objectives. In covering these learning objectives we will build a Part 77 model for a small GA airport. Along the way we will be covering several basic tools to get you started with adding tools for your Autodesk Toolbox that can be used in the Airport world. These tools are basics, and this class is basic, and is meant for those getting started on this path. There is, I am sure, something for any level of user to gain from this session. The beginning user will gain the most from this session.

What this class is:

- A basic class for the Airport Engineer, Airport Planner, Designer and Drafter

- Will cover basic tools from AutoCAD, Civil 3D, and InfraWorks

- Will cover how to use these basic tools in ways they may not have been intended

- Will give you a basic understanding of the visual design, planning and communication you can gain from using these tools

- Will give you a reason to think outside of the box

Data Incorporation

Data Incorporation is covered throughout this handout. You will be shown work flows for incorporating surveyed data, Civil 3D, InfraWorks, and GIS data.

Airspace Analysis

Airspace Analysis workflow will cover building a 3D solid model of a small GA airport's Part 77 airspace obstruction surfaces. (Part 77 refers to CFR Title 14, Chapter 1, subchapter E, Part 77, which is the regulation for evaluating obstructions around an airport. There are also other obstruction regulations which may need to be considered, but Part 77 is one of them.) Once the Part 77 model is built we will export it from Civil 3D and import it into InfraWorks. We will then use InfraWorks and a model of the small GA airport to analyze the airspace for obstructions.

Part 77 3D Solid Model:

To build the Part 77 3D solid model we will use a Civil 3D surface and grading tools. To start with you need to decide on one of two courses of building the model. The first option is to build each piece of the Part 77 model as its own Civil 3D surface. The second option is to build the entire Part 77 model as one Civil 3D surface. For this example I will be building it using the first option.
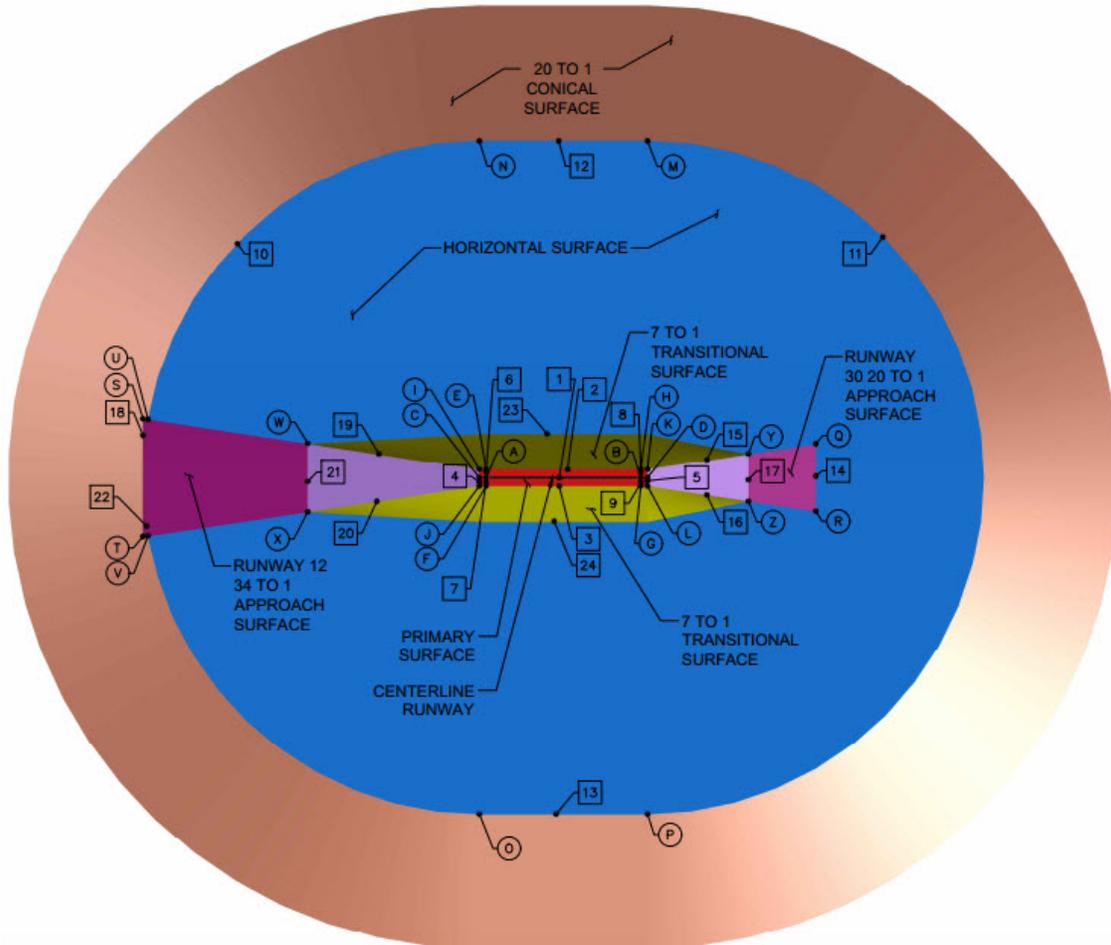
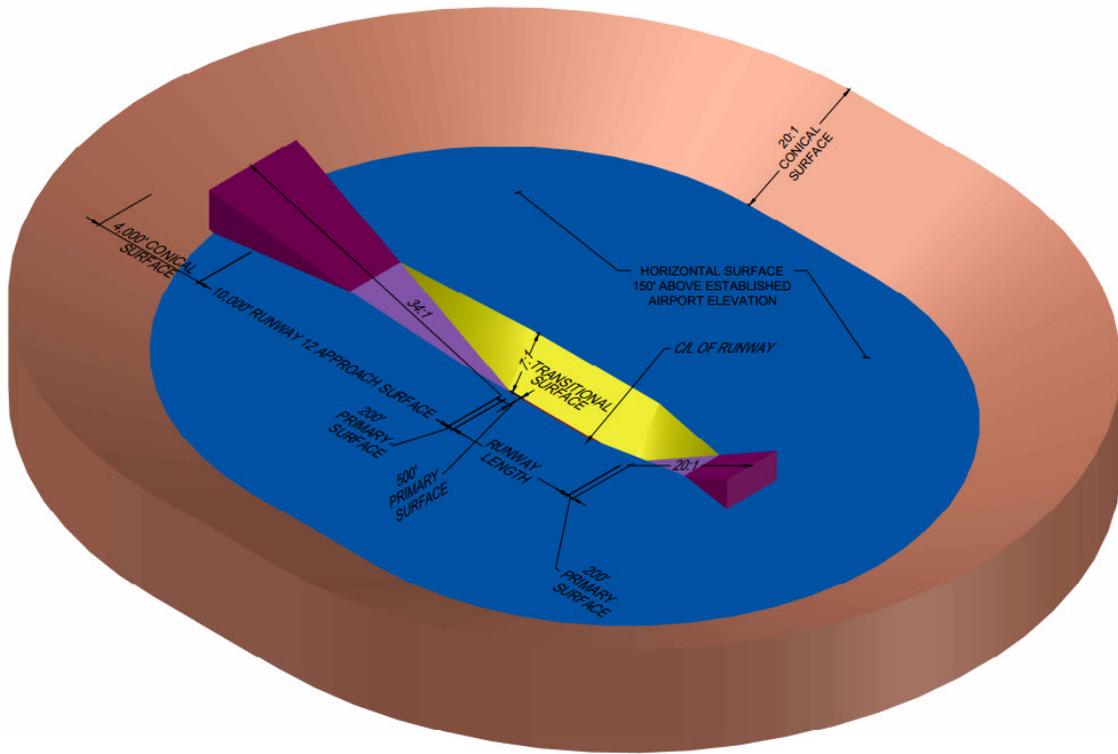*FIGURE 1: PART 77 LINE AND POINT DIAGRAM*

Create a Civil 3D Surface for Each Part of the Part 77

Using Figure 1 and 2 we have the information needed to build the Part 77 for this small GA airport. The first step is to create an empty surfaces for each part of the Part 77. Use the following steps to create the surfaces for the Primary Surface, Transitional North Surface, Transitional South Surface, Horizontal Surface, Runway 12 Approach Surface, Runway 30 Approach Surface, and Conical Surface.

Step 1:

Select "Surface" from the Toolspace Prospector and right-click.

Step 2:

Select "Create Surface…" from the right-click menu.

Step 3:

In the "Create Surface" dialog box select and/or fill in the following;

- Type: Tin Surface

- Surface Layer: Select a logical name i.e. "Surface-Primary"

- Information:

  o Name: Name it the same as the part of the Part 77.

  o Style: The style selected really does not matter. I suggest selecting something that will show you that the surface is built correctly. Once you know the surface is built correctly, I also recommend setting the surface to a no show style.

  o Render: Bylayer

  o Select: Ok

Step 4:

Repeat Steps 1 to 3 for each of the remaining parts of the Part 77. When completed, you will have a total of seven (7) surfaces.

Creating Surface Breaklines for Each Surface

Using either 3D polylines, Feature Lines, or Grading Objects we will create breaklines for each of the surfaces. In this section we will cover a few techniques for creating these breaklines rather than stepping through creating each breakline needed to create these surfaces. These techniques will allow you to create all of the breaklines though. So in this section we will just be building the Primary Surface, the Horizontal Surface and a Transitional Surface. These three (3) surfaces will allow the demonstration of five (5) of my favorite grading tools. These five (5) tools will help you build almost any surface whether they are simple or complex. The following will demonstrate these five (5) simple tools.

Tool 1:

Creating a 3D polyline (or feature line) with the elevation of a surface. We are going to use this tool to generate a 3D polyline that represents the centerline elevations of the existing runway.

Step 1:

Start the 3D polyline by typing "3DPOLY" at the command line.

Step 2:

Snap the first point of the 3D polyline on Point A and the second point on Point B as shown on Figure 1.

Step 3:

Select "Edit from Surface" ⊞ from the "Edit Elevation" panel on the "Modify" ribbon tab.

Step 4:

From the "Set Elevations from Surface" dialog box do the following;

- Pick the surface you wish to pull the elevations for the 3D polyline from.
- Check on "Insert Intermediate Grade Break Points". This will add a PI where ever a TIN line from the surface intersects the 3D polyline.

Step 5:

Select the 3D polyline to add the elevations to.

Step 6:

Select "Enter" to end and accept the results of the command.

This builds the centerline of the existing runway. We still need to add the two (2) 200 foot ends of the Primary Surface, which extend from each end of the runway. We will add in Tool 2 and this will form Line 1 from Figure 1.

Tool 2:

Creating a 3D polyline (or feature line) with manual input elevation. We are going to use this tool to generate a 3D polyline that will be joined to centerline of the existing runway and represent the 200 foot Primary Surface at the end of the runway.

Step 1:

Start the 3D polyline by typing "3DPOLY" at the command line.

Step 2:

Snap the first point of the 3D polyline on Point A and the second point on Point C as shown on Figure 1.

Step 3:

Select this 3D polyline and right-click.

Step 4:

Select "Properties…" from the right-click menu.

Step 5:

From the "Properties" dialog box under "Geometry" enter the runway's end elevation for "Vertex 1" (Point A) and "Vertex 2" (Point B) of the 3D polyline.

Step 6:

Select "Join" ⬚ from the "Geometry" panel on the "Modify" ribbon tab.

Step 7:

Select this 3D polyline and then the 3D polyline for the runway centerline.

Repeat Step 1 through Step 7 for the other end of the runway (Point B and Point D). Once completed we will have Line 1 from Figure 1.

Tool 3:

Creating a 3D polyline (or feature line) from an offset of another 3D polyline. We are going to use this tool to generate the 3D polylines for each of the sides of the Primary Surface.

Step 1:

Select "Stepped Offset" ⬚ from the "Geometry" panel on the "Modify" ribbon tab.

Step 2:

Select the offset distance, for this exercise we'll use 250 feet.

Step 3:

Select Line 1 (centerline 3D polyline).

Step 4:

Specify the side to offset the polyline to.

Step 5:

Specify the elevation difference, for this exercise we'll use 0.

Step 6:

Repeat Step 3 through Step 5 for the opposite side.

We now have Line 2 and Line 3 from Figure 1.

Note:

In Step 5 we could have entered a positive or negative number to change the elevation of Line 1 by that value at each vertex. There are other options to this command that you can also explore in Step 5.

Tool 4:

Temporary Surface to calculate an elevation. This is a tool I use a lot to get to a result rather than constantly pulling out a calculator. I call it a Temporary Surface even though it doesn't have to always be a temporary all the time. Examples of where I my use this tool is when I need to calculate several points along a plane. This plane can be flat or sloped. In this exercise we will build the Horizontal Surface which is a flat surface that is 150 feet above the high point of the centerline of the runway. It will also be used as part of the Part 77 along with being used to calculate the Transition Surface intersection with it.

Step 1:

Draw a 10,000 foot circle with the center being around Point C from Figure 1.

Step 2:

Draw a 10,000 foot circle with the center being around Point D from Figure 1.

Step 3:

Draw a polyline that is tangent to both circles from Step 1 and Step 2 at Points O and P.

Step 4:

Draw a polyline that is tangent to both circles from Step 1 and Step 2 at Points N and M.

Step 5:

Trim the two (2) circles from Step 1 and Step 2. Use the two (2) polylines created in Step 3 and Step 4: as the cutting edge. Leaving the outside edge of the "Horizontal Surface".

Step 6:

Use the Polyline Edit command to join the two (2) remaining arc and the two (2) polylines to form one polyline.

Step 7:

Select this polyline and right-click.

Step 8:

Select "Properties…" from the right-click menu.

Step 9:

For this exercise enter 3763.743 for the "Elevation" under "Geometry" in the "Properties" dialog box.

Step 10:

Expand the "Horizontal Surface" in the surface tree in the "Prospector Toolspace".

Step 11:

Select and right-click on "Breaklines" under the "Horizontal Surface" "Definitions" in the tree.

Step 12:

Select "Add…" from the right-click menu.

Step 13:

Enter the following values in the "Add Breaklines" dialog box;

- Description: Outer Polyline
- Type: Standard
- File Link Options: This should be greyed out and unable to change so leave this as is.
- Weeding Factor: Leave unchecked.
- Supplementing Distance Factors:
    - Distance: Check it on and change the value to 25'
    - Mid-Ordinate Distance: 0.25'
- Select OK

Step 14:

Select the polyline created in this exercise.

We now have a surface to be able to target in the tool to be shown.

Tool 5:

Grading Object Slope to a Surface. This is a tool I like to use to calculate where a slope from a line intersects with a surface. In this exercise, we will use it to build the Transition Surface slope from the Primary Surface to the Horizontal Surface.

Step 1:

Select "Grading Creation Tools" from the "Create Design" panel on the "Home" ribbon tab.

Step 2:

Select "Grading Group"

- Site Name: Site 1
- Group Name: GradingGroup1

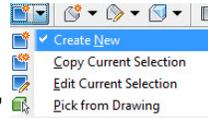**Step 3:**

Set the "Target Surface": "Horizontal Surface"

Step 4:

Select Layer: I like to use a layer called "3D-Grading Objects"

Step 5:

Select a "Grading Criteria" use a slope to a targeted surface criteria with only a cut slope, if available. If you need to create one this is how to do it;

- Step A: From the "Style Picker" select "Create New".

- Step B: From the "Grading Criteria" dialog box on the "Information" tab.
    - Name: Slope To Target Surface (Cut Only)
    - Description: Use this area to describe what the criteria is intended to be used for.

- Step C: Select the "Criteria" tab from the "Grading Criteria" dialog box.

- Step D: From the "Criteria" tab input the following values;
    - Grading Method:
        - Target: Surface
        - Projection: Cut Slope
    - Cut Slope Projection (Up)
        - Format: Slope (Locked)
        - Slope: 7:1 (Unlocked)
    - Conflict Resolution
        - Interior Corner Overlap: Use Average Slope (Unlocked)

- Step E: Select OK to complete the creation of the new grading criteria.

Step 6:

Select "Create Grading" from the "Grading Creation Tools"

Step 7:

Select Line 2 from Figure 1.

Step 8:

Since this is a 3D polyline you are asked to convert it to a Feature Line. Select OK from the "Create Feature Line" dialog box to do this.

Step 9:

Select the side to grade the slope to the "Horizontal Surface" too.

Step 10:

Select "Y" for yes to grade the entire length of the line.

Step 11:

Select "7:1" for the cut slope.

Step 12:

Select the "ESC" (escape key) to end the command.

Step 13:

Use the ACAD "Copy" command to copy the feature line created by the grading objects. Copy it with a base point of "0,0,0" to destination point of "0,0,0". This creates a feature line that is no longer attached to the grading group in the same location.

Step 14:

Select the grading group by picking the green diamond and then right-click.

Step 15:

Pick "Delete Grading…" from the right-click menu.

You now have the top line of the "Transition Surface"

Note:

I have a personal preference of turning the feature lines back into 3D polylines. This can be done by simply using the ACAD explode command on the feature line.

Using these five (5) tools you now can create all of the break lines needed to build all of the Part 77 surfaces.

Create 3D Solids of the Part 77 to import into InfraWorks

Why import the Part 77 into InfraWorks? Well the area covered by the Part 77 is a very large area. For example, this small GA airport covers about 21,000 +/- acres. To generate an existing ground surface covering this area in Civil 3D you are talking about having to use a USGS DEM surface. A DEM surface to cover this size of area in Civil 3D becomes very large and hard to work with. Yes Civil 3D can build this surface and there are things you can do make it workable, however, once you see what you can do using InfraWorks to handle this size surface, you will understand. For example, just to build this DEM surface I saved an estimated 4 hours of time over Civil 3D. You will also save time each time you need to display this DEM surface.

Why create 3D solids? Why can we not just import the Part 77 Civil 3D surfaces? Well InfraWorks currently does not support the display of multiple surfaces. So if you were to import the Civil 3D surface it would merge this surface into the InfraWorks surface object and display as one (1) surface. This will not allow us to see land obstruction if done this way. So the best way I have found to import a surface that I do not want to be merged into the InfraWorks surface is using 3D solids.

To create a 3D solid of a 3D surface is really easy to do. The following will step you through how this is done.

Step 1:

Select the surface to create a 3D solid of in Civil 3D. This will activate the "TIN Surface" contextual ribbon.

Step 2:

Select "Extract Solids from Surface" from the "Extract from Surface" flyout menu on the "Surface Tools" panel on the "TIN Surface" contextual ribbon.

Step 3:

Set the "Extract Solids from Surface" dialog box to the following;

- Surface: Select the surface being used to create the 3D solids

- Vertical Definition
    - Depth: 0.1'

- Drawing Output
    - Select into Current Drawing

- Layer: 3D-Solid-(name of surface)

Step 4:

Select "Create Solids"

Repeat these steps for each of the other Part 77 surfaces to get all of the 3D solids.

Tip:

If you create a render material with transparency set in AutoCAD and apply it to each of the solids. They will show transparency in InfraWorks, allowing you to see through the solid surfaces.

Importing the Part 77 3D Solids into a InfraWorks Model

As stated in the previous section, InfraWorks handles and works with large surfaces with ease. It's also great to use to display and visualize things. In this section we will walk through building a model in InfraWorks. Note this is one way to do it but there are many other ways. This is just the easiest in my opinion.

Creating a InfraWorks Model

Step 1:

From the InfraWorks home page select "Model Builder"

Step 2:

Zoom into the area of your project or airport Part 77.

Step 3:

Use the draw a rectangle around the area of interest (AOI) to draw a rectangle surrounding the desired area.

Step 4:

Enter the name of the project

Step 5:

Select the group to share it with.

Step 6:

Select "Create Model"

Step 7:

Wait for an email telling you that your model is ready.

Step 8:

Once the model is ready download and open it.

Importing 3D Solids into the InfraWorks Model

Step 1:

Select the "InfraWork Intellgent Tool"

Step 2:

Select "Create and Manage Your Model"

Step 3:

Select "Data Sources" to open the "Data Sources Panel"

Step 4:

Select "DWG 3D Model" from "Add File" in the "Data Sources Panel"

Step 5:

Browse to the drawing with the Part 77 3D solids. The drawing will then be processed and added to the model.

Step 6:

Select the drawing from the "Data Source Panel" and right-click.

Step 7:

Select "Configure" from the right-click menu. To open the "Data Source Configuration" dialog box.

Step 8:

From the "Data Source Configuration" dialog box select the following:

- Type: Points of Interest

- Geo Location (TAB): Select the Coordinate System for your project

Step 9:

Select "Close and Refresh"

AGIS Tools \ Planning Tools

There are several tools in the Autodesk toolbox that can be used to help with AGIS. We could actually do a whole session on this topic but unfortunately we don't have enough time.

The tool we are going to cover is exporting Civil 3D Cogo (survey) points of some trees that are believed to be obstructions to the Part 77 and approach surface. We do this using a GIS SDF file format.

Exporting Civil 3D Cogo (Survey) Points to a SDF File.

Step 1:

From Civil 3D open a drawing containing the points you wish to export. I recommend using a drawing that only has the points you wish to export.

Step 2:

Select the command "Export Civil Objects to SDF" from the "Export" panel of the "Output" ribbon tab. This opens the "Export to SDF" dialog box.

Step 3:

In the "Export to SDF" dialog box select the following;

- SDF File Name: Select a location and name for the SDF file to export.

- Drawing Coordinate System: If the drawing has a coordinate system specified, it will be displayed here. If not, set the coordinate system for your project.

Step 4:

Select OK

Step 5:

In the command line, verify what was exported into the SDF file. For this exercise it should read 4 points.

Importing a SDF File into InfraWorks.

Step 1:

Select the "InfraWork Intellgent Tool"

Step 2:

Select "Create and Manage Your Model"

Step 3:

Select "Data Sources" to open the "Data Sources Panel"

Step 4:

Select "SDF" from "Add File" in the "Data Sources Panel"

Step 5:

Browse to the points SDF file.

Step 6:

Select the Points SDF file from the "Data Source Panel" and right-click. It should be located at the top of the "Data Source Panel" under <No Feature Type>.

Step 7:

Select "Configure" from the right-click menu. To open the "Data Source Configuration" dialog box.

Step 8:

From the "Data Source Configuration" dialog box select the following;

- Name: For this exercise let's name it "Tree Points". It's important to name it something logical.

- Type: Trees

- Style: Select a tree that fits the project and area from the 3D Style Panel.

- Geo Location (TAB): Select the Coordinate System for your project. This should already be set from the SDF file if it was exported correctly.

- Source (TAB):
  - Draping Options: Set to "Set Elevations" and use "Elevation" from the field value.

Step 9:

Select "Close and Refresh"

You should now see trees in the location of the four points. They are not the proper height yet but are sitting in the correct location. The next step is to set their heights.

Changing the Heights of the SDF Point Trees

There are many ways this can be done. The best to use varies on the number of trees and the information available. For example if the points we had exported to the SDF had a tree height value with them we could map it to the Z scale. This would scale each tree to the proper height. For this example we are going to manually enter the height for each tree since there is only four.
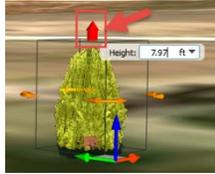
Step 1:

Zoom to the first tree.

Step 2:

Select this tree and right-click.

Step 3:

Select "Edit" from the right-click menu.

Step 4:

Select the height grip.

Step 5:

Enter the desired tree height.

Step 6:

Select the next tree.

Step 7:

Repeat Steps 4 to 6 until all tree heights are entered.

Note:

You do not need to select the tree and right-click to enter the edit mode again because all four of these trees are contained under the same source data.

Step 8:

Once all heights are entered, right-click and select "Exit Edit Mode".

You now have trees that you can use to visually see if they penetrate the Part 77 model we built earlier or any other surface for planning.

Planning

Now that we have stepped through building a Part 77 model and importing some trees to use for comparison in the model, you should be able to bring in other surfaces and objects to use when planning future projects.

An example of a future project you may want to use this model on is a new hangar project. The client building the hangar can tell you the size of the hangar they desire and want to know if there are any available sites to build it on. Well you know what land is available but does the build size work with any of those sites. Now you can build a simple 3D model of the hangar and place it in the InfraWorks model. Move it from site to site to see if it fits under the Part 77 and with any other restrictions. It's a lot easier than trying to hand calculate to see if it does. I do understand that the FAA has tools to calculate this but that takes time. This can be done easily and quickly while the client is sitting there. If the site works then send the information off to the FAA for them to do their final review with their tools.

Another example where I have used this model for planning is approach surface and runway extensions.

Closing

I think you can see the value in the building of this model and these tools. I am also sure there are many other uses that I have not covered. The key is to think outside the box and build on these tools you should now have in your Autodesk Toolbox for Airports.

Please feel free to contact me with any questions or thoughts at the email address provided on the cover of this document. I would also invite you to share your creations with me.

Meet-Up Café

I will be available to answer questions directly after this session at the Meet-Up Café for an hour at a minimum

If you would like to also setup a time to meet during the remainder of AU 2016 please feel free to email me at: cdieziger@gmail.com

Enjoy the remainder of AU 2016 and

Thank You! For attending my session