Islands in the Asphalt - Parking Lot Grading for Commercial Site Projects

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CM5272   Parking lot grading is one of the most daunting tasks for a commercial site design project. Knowing the right tricks and techniques is crucial if you want to build models quickly and accurately and be able to modify them easily. In this class we will explore industry-proven design techniques that will result in stunning designs that are accurate, dynamic, and extremely useful in many aspects of the project. Some experience with site-grading design is recommended for attendees of this class.

Learning Objectives

At the end of this class, you will be able to:

- Adjust the model when changes arise

- Model a general grading scheme for a site project

- Model fine detail such as curbs, walls, and steps

- Project site geometry to the general grading scheme to model design elevations

About the Speaker

Eric is a veteran instructor at AU, with this being his eighth consecutive year. He serves as Design Systems Manager for Timmons Group, a Civil Engineering Consulting firm located in Richmond, VA. He is also an employee of Engineered Efficiency, where his duties primarily include writing and developing educational materials for Autodesk® products.   He has also worked for Avatech Solutions (now IMAGINiT) as a Project Manager and Applications Engineer. During his tenure at Avatech, Eric provided training and consulting to hundreds of firms across the country, in addition to authoring seven training manuals for Avatech training courses. Before joining Avatech, Eric worked for ten years in the surveying and civil engineering fields as an employee of the H. F. Lenz Company in Johnstown, PA. Eric is the Author of AutoCAD Civil 3D 2012 Essentials published by Wiley/Sybex.
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Introduction

Successful parking lot grading in Civil 3D requires a good conceptual understanding of the process, the knowledge of several key techniques, along with the patience and ingenuity of a good designer. In this class, we'll explore a procedure that can be applied to many parking lot grading designs as well as important concepts and techniques that will help you achieve your designs faster.

The Process

In my experience I have come to believe that nearly every parking lot grading project can be broken down into these steps:

1. Choosing a grading/drainage scheme
2. Building the grading/drainage scheme
3. Designing the perimeter
4. Checking volumes
5. Adding interior detail
6. Adding driveways

I have also found that completing your grading designs using these steps results in a grading model that is more easily adjusted when design changes are needed. It may take a bit longer to build the model the first time, but after that, design iterations will be much quicker than those that would have been done with "traditional" grading methods.

Choosing a Grading/Drainage Scheme

Before creating any Civil 3D objects you should study your 2D layout of the parking lot and start discussing and sketching the grading scheme. The goal is to establish the general characteristics of the design such as which way your parking lot will slope, where high points and low points will be, etc. This usually ends up with a basic sketch with some arrows indicating slope direction and some boxes representing inlets/low points. You may also decide to develop several schemes, try them all, and choose the best one once they have been partially or completely designed.
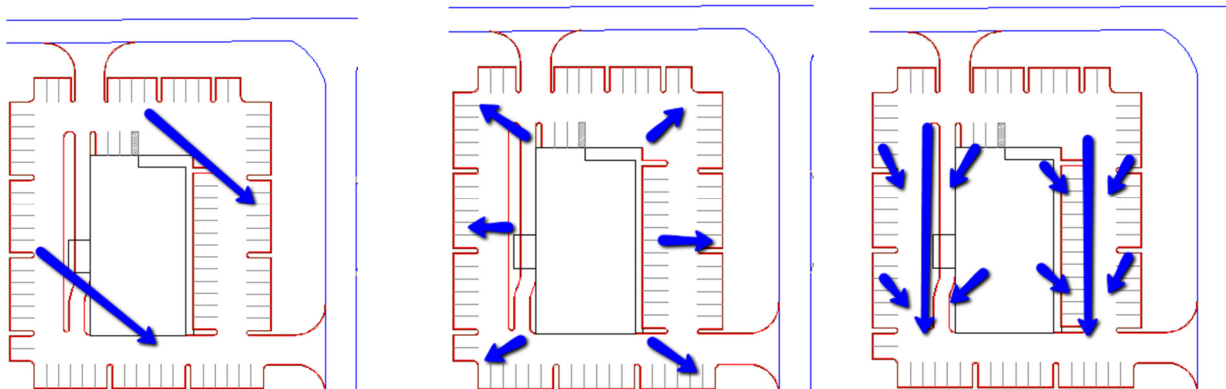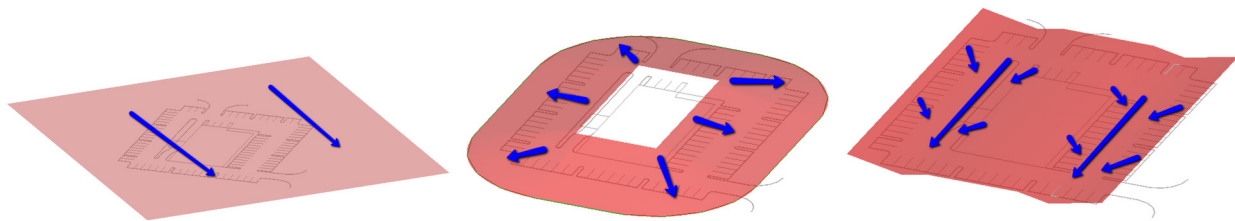

Examples of grading/drainage scheme sketches

Building the Grading/Drainage Scheme

Now that you've got a general idea what the slopes and slope directions will be, you must build a general model of that information. What makes this a general model is that it ignores the layout geometry and treats the parking lot as an "area" rather than a specific geometric shape. This enables quick and easy creation of the grading model due to its geometric simplicity.

The simplest form of a general grading scheme model is two feature lines, one on either side of the parking lot area, that establish a slope across the parking lot area. This simple model can be created in a few minutes. Another common type of general grading scheme is a grading object that projects outward and downward from a simplified version of a building footprint. This models drainage away from the building, which is a common design goal if possible. For more complex designs, swales, ridges, high points, and low points can be added to control the direction of runoff to specific locations. Any other model is either a combination of these designs or variations of them.


Examples of grading/drainage scheme models

Any number of tools can be used to build the general grading/drainage scheme including feature lines, grading objects, and points. The goal of this phase of the design is to quickly produce a surface that the actual layout geometry can be projected to. We'll refer to this as the *general surface*.

Designing the Perimeter

Before getting into too much detail with your design, you will want to determine how the perimeter of your grading is going to tie in to existing ground, and more importantly, whether there is enough room to do what you're envisioning.

To begin, you should establish a simplified version of the perimeter of your layout. The best way to describe this is to imagine shrink-wrapping your site by skipping over fine details along the edges. The easiest way to do this is to draw a polyline around the layout, snapping to key points and skipping over less important ones. Often it is best to offset the perimeter a bit to provide a flat area just outside the layout so that your design doesn't transition to a steep tie-in slope too abruptly. Also, you'll want to ignore driveways at this point.
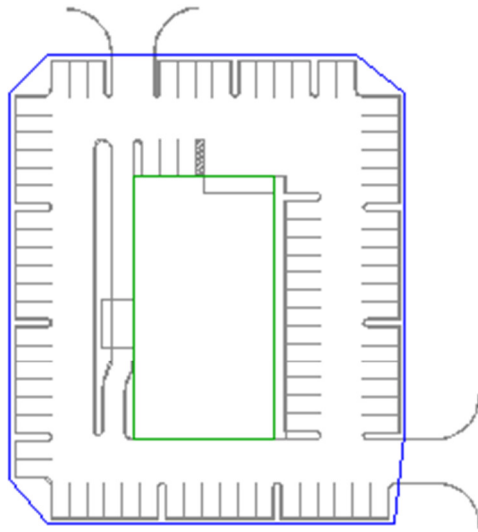
Examples of "shrink-wrapping" a layout

Once you've established the simplified perimeter, you're ready to project that perimeter to your general surface. Start by converting your polyline to a feature line by using the Create Feature Lines from Objects command.
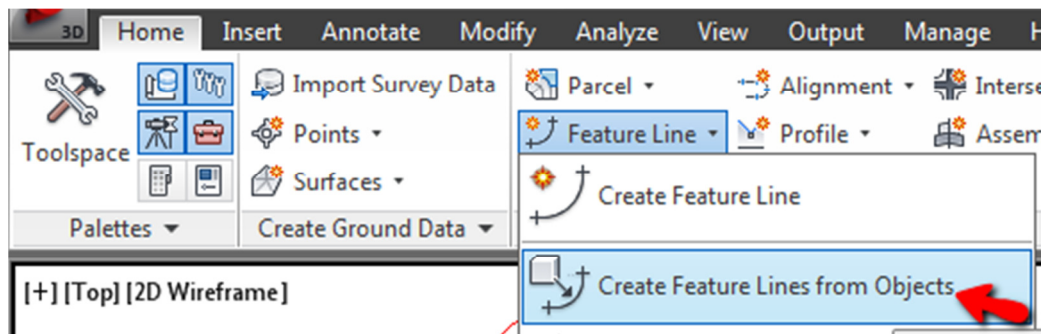

Now that that you have a feature line, you can use the Elevations from Surface command to project your perimeter feature line to the general surface.
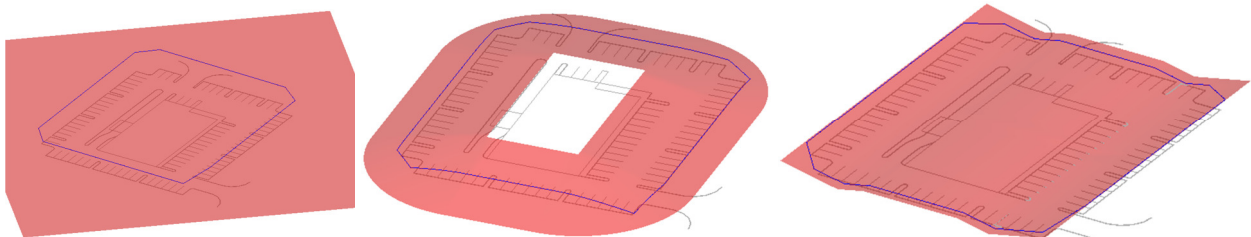

The final step in this phase is to tie the perimeter to existing ground elevations. There are two basic ways to tie into existing ground along the perimeter of the site. The first is to project a uniform slope to existing ground. The second is to tie to existing ground along a specific path

while varying the slope. For the first option, the best choice is a grading object that targets the existing ground surface.
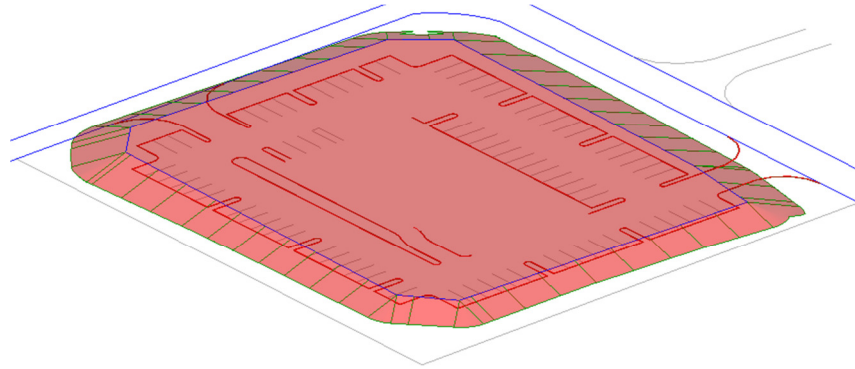

For the second option, you can create a feature line to represent the path along which you would like to tie to existing ground. This path usually follows property lines, existing edges of pavement, etc. Then using the Elevations from Surface command you can project this feature line to the existing ground surface. Now simply create a new surface using the perimeter feature line and the tie-in feature line as breaklines. You can also use the tie-in feature line as the surface boundary.
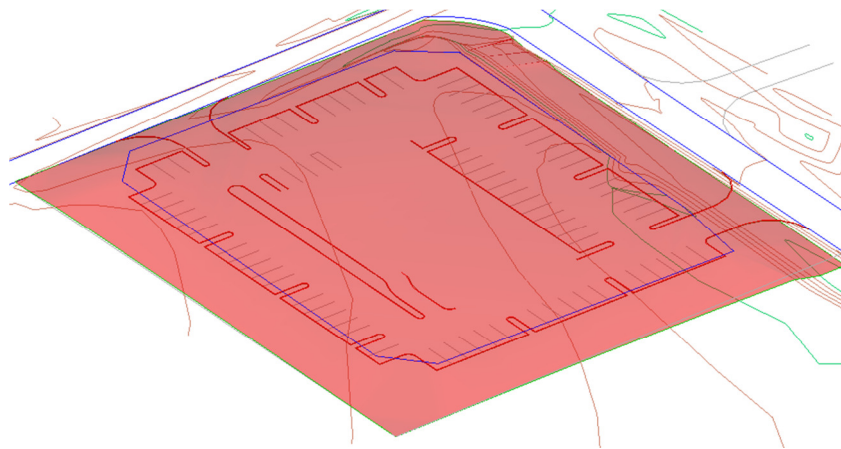

Checking Volumes

Before you get much further in the design, it's a good idea to do a quick volume check to see if your site is balanced. At this point, the model you're working with is fairly simple so making adjustments is quick and easy. If you've used a grading object to model your perimeter grading, all you need is an infill and you can use Grading Volume Tools on the resulting grading group to calculate volumes. The infill is necessary to enable the finished ground surface associated with the grading group to extend across the interior of the parking lot.
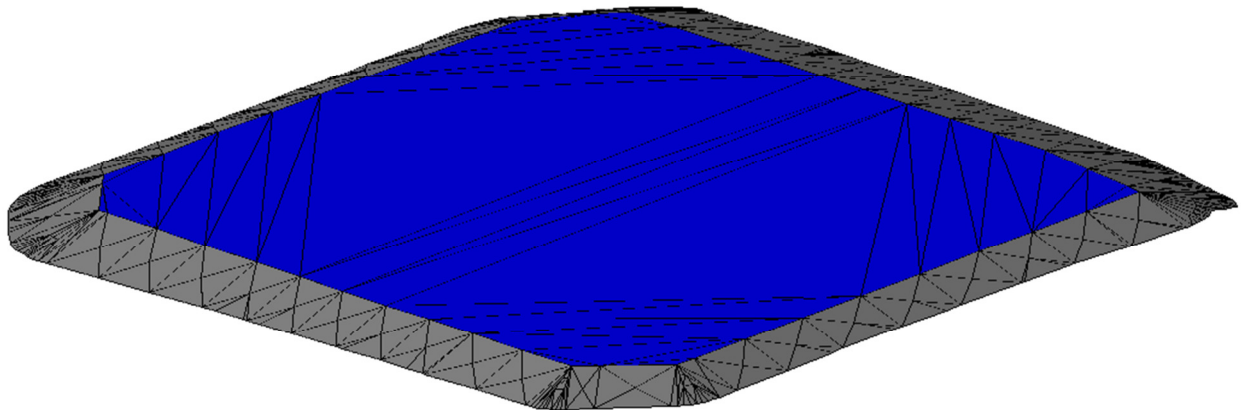
Once this is in place, you can create a surface from the grading group and assign a volume base surface.

After that, the Grading Volume Tools can do the rest. In fact, you can even use the Grading Volume Tools to raise and lower the model or simply balance it.
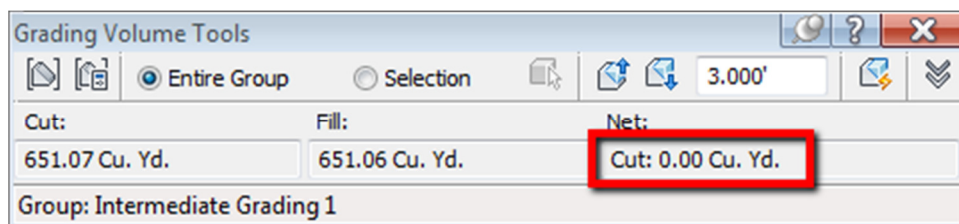

If you cannot use the grading group to analyze cuts and fills, then you will need to use a method that compares surface to surface. This can be done by creating a TIN volume surface or by using the Volume command on the Analyze tab of the ribbon.
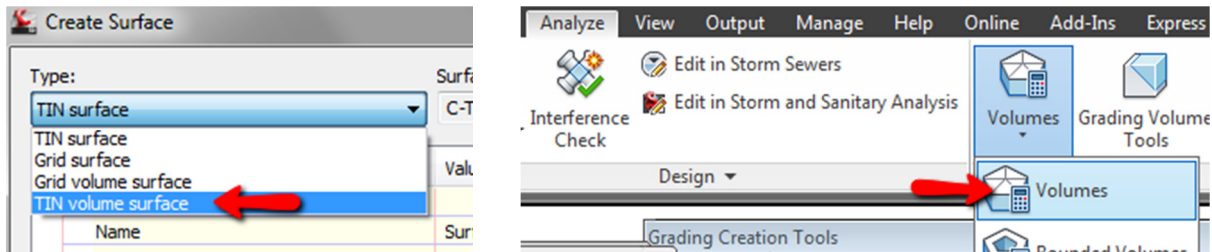
Adding Interior Detail

Once the perimeter grading has been tied in and the perimeter elevations adjusted to meet rough volume requirements, you're ready to begin adding detail to the interior of the model. This detail can be anything but commonly consists of the curbs, islands, swales, and ridges that are required to provide the traffic and drainage control functions of the parking lot. In most cases, this detail can be modeled effectively using feature lines and much of the feature line elevations can be established by projecting them to the general surface or the perimeter grading surface. When dealing with curbs, a useful technique is to first project all curb feature lines to the general surface, then use the Raise/Lower command to lower the feature lines representing the curb flow lines. It is important to use different sites for the perimeter feature grading and the interior grading to prevent unwanted feature line interaction and to reduce the chance for drawing errors and corruption.
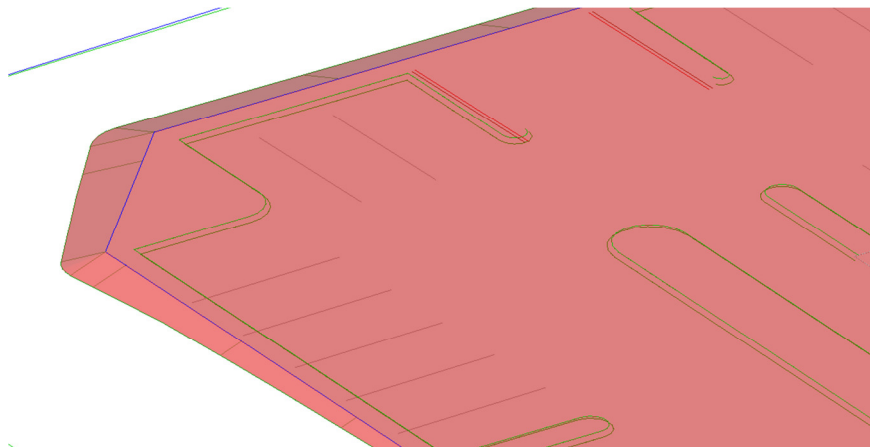

Once all of the feature lines representing interior details are in place, you can use them to make a surface. If necessary, apply a boundary to this surface to provide a nice clean edge along the backs of the curbs. Then you can create a new surface and past the perimeter grading and interior detail surfaces into it. This surface represents a parking lot design that is complete with the exception of the driveways.
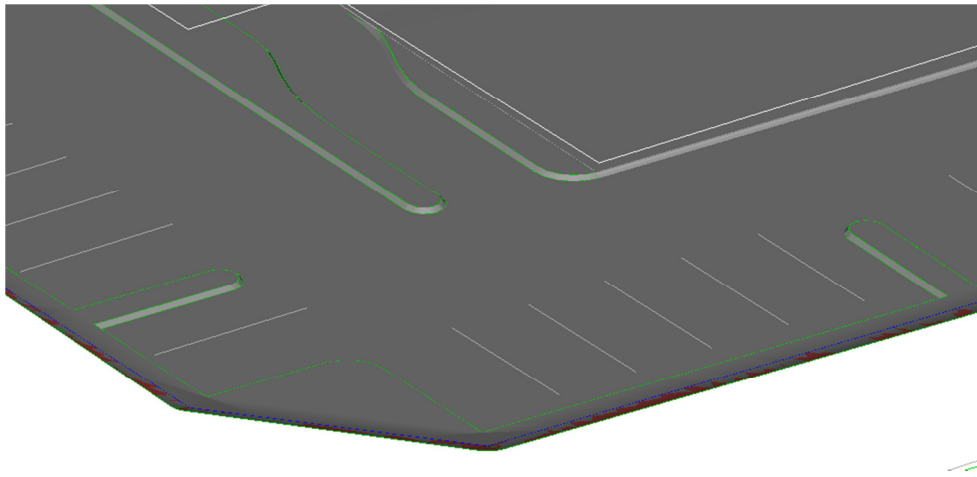
Adding Driveways

Until now, the driveways have been ignored in the parking lot design. A really effective way of handling the driveways is to "pretend" the parking lot has already been built and approach the driveways as a separate design altogether. This begins with a composite surface that combines the design grading of the parking lot with the existing ground surface that it ties into.
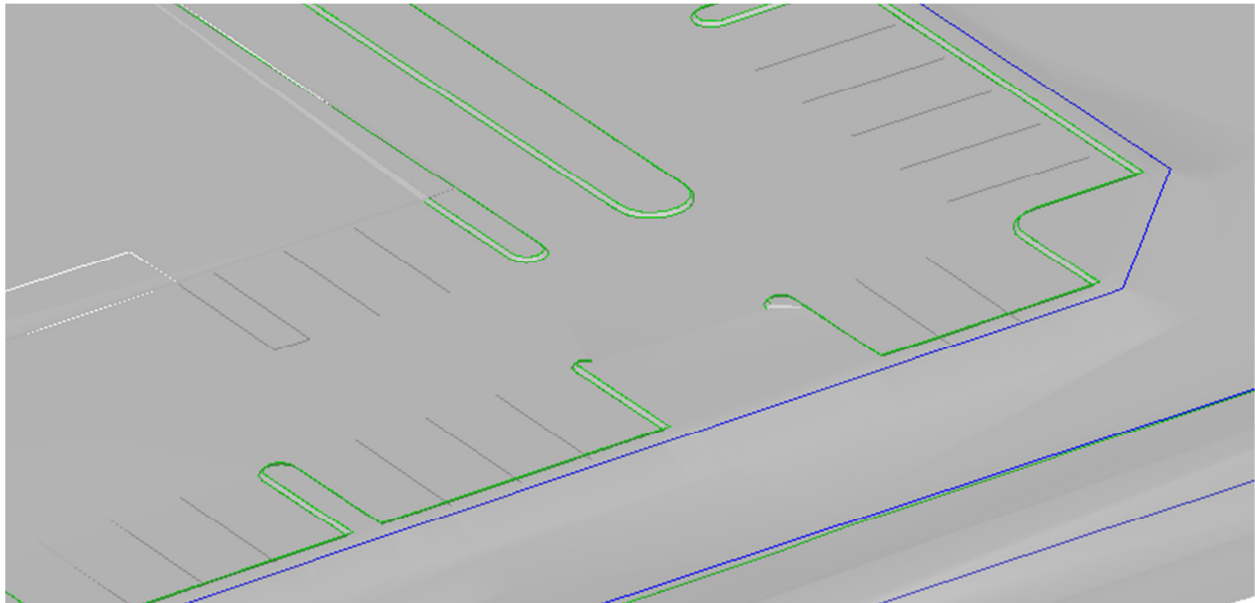

Then driveways can be designed using feature lines and grading objects, for simple designs, or with corridors for more complex designs. In fact, the Intersection Wizard can be a great tool for cases where you expect the parking lot elevations to change frequently. Although the use of the Intersection Wizard will require some additional work up front, it will pay off when you don't have to make manual adjustments to keep the driveway and existing road in sync.
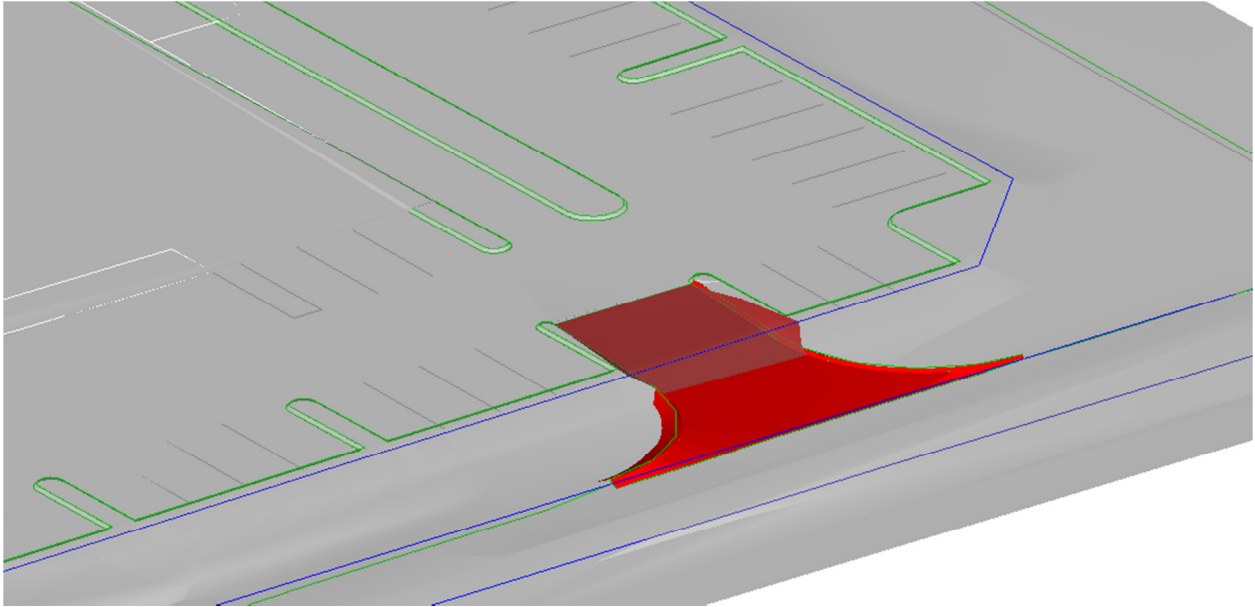
Once a driveway design is complete, you can finalize it by creating a surface that represents it. Then, this surface can be pasted, along with the parking lot surface from the previous step, into a final overall design surface. If there are multiple driveways, then multiple driveway surfaces can be pasted in.
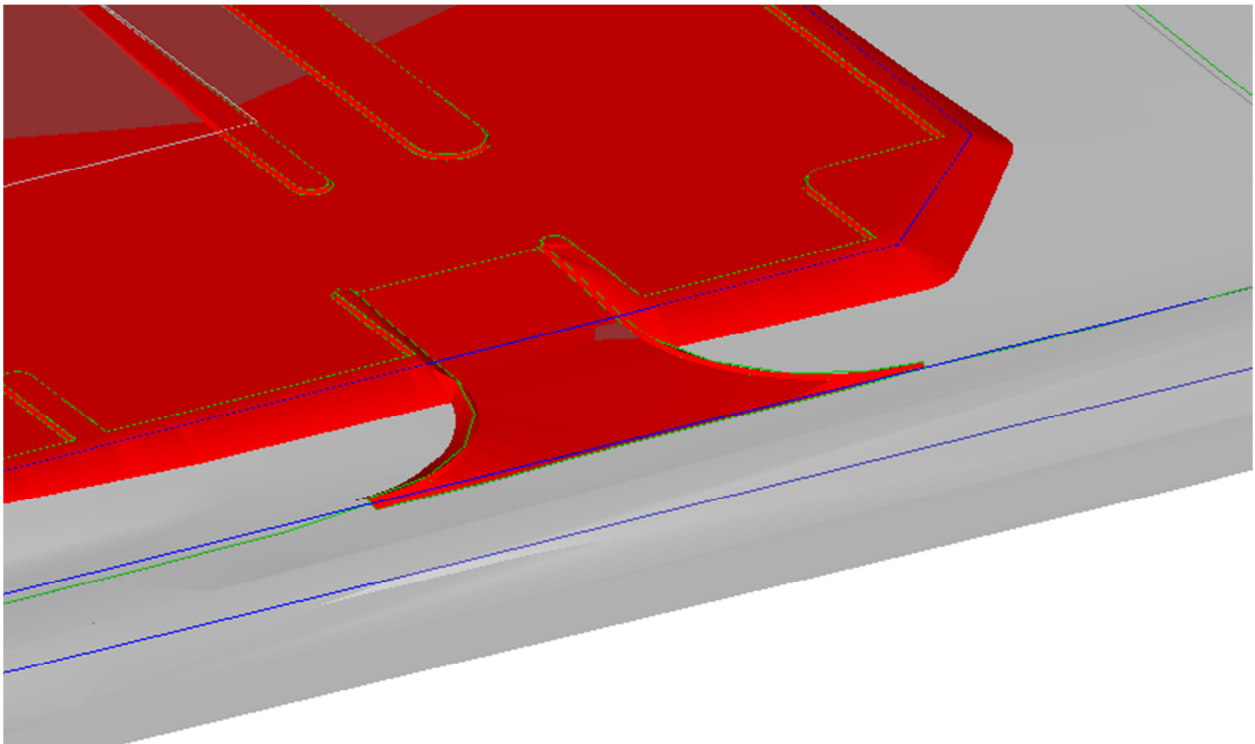
Conclusion

If someone were to ask me "What's the best advice you can give to someone using Civil 3D to perform commercial site design for parking lots?" I would have to say to *modularize your design*. Regardless of what software you're using, grading design is complicated business and by modularizing your design, you are able to break it down into small, manageable "mini-designs". If you try to design it all at once, you're going to run into challenges with limitations of the software as well as your own train of thought.

In this class, you learned to break a design into at least four modules: the general grading/drainage scheme, perimeter grading, interior detail, and driveways. I would have to say that four is your minimum, applying to the simplest of designs. For more complex designs you may need 10 or 15 modules until all is said and done. It may seem that 10-15 mini-designs actually complicates the process rather than making it more simple, but think of it this way: if something goes wrong, it's much easier to troubleshoot one of 15 simple designs with only a few moving parts compared to all 15 of those parts combined into one.

In addition to making the design easier to create in the first place, a modularized design is easier to manage when changes arise. Take advantage of the dynamic nature of Civil 3D to make each module tie into the next. This can be accomplished by simply turning on the Rebuild Automatic feature for surfaces in your drawing, or using dynamic grading objects instead of static feature lines.

Something else you should definitely be aware of is that the grading features of Civil 3D are the least stable of all the software features. Save often, keep your drawings clean, make backup copies, and mentally prepare yourself for software issues. You can make these features work for you but don't expect them to be perfect. If you do, you'll find yourself spending more time trying to force the software to do what you think it should do, instead of what it wants to do at a given time.

Enjoy grading with Civil 3D!