



White Paper

Using the Autodesk Civil 3D Dynamic, Relationship-Based Environment

Change is inevitable. If you don't think so, stop reading now and consider taking up collecting dinosaur eggs or Dodo bird feathers. The paradigm shift for the land development community is here, now. Autodesk has engineered the first and only feature-based civil design application where objects in the design are aware of their relationship to other objects in the design.

So what does this mean to the civil engineer and designer? It means that you now have software that is truly a design tool and not just a drafting tool. Autodesk® Civil 3D™ software is the design tool that enables you to design the way you think. Make changes on the fly, and the entire design updates accordingly. The drawing objects are products of the design and automatically react to changes in the design.

With this new shift to modeling rather than drawing static entities to represent alignments, parcels, profiles, and so forth, you model the site with objects that respond to and interact with site constraints such as right-of-way locations or parcel size restrictions. Because objects have relationships with other objects in the design, changes are updated in real time. Design changes and what-if scenarios can be done far faster and in multiple iterations to see how these changes affect the site design.

Many users aren't sure what "object relationship" means and how they are going to incorporate Autodesk Civil 3D. This article attempts to clarify this dynamic, relationship-based environment, and how it will become the standard for civil engineering projects.

Autodesk Land Desktop 2004

Does Autodesk Civil 3D mark the end of Autodesk® Land Desktop? No, it does not. Autodesk Civil 3D is "preview" software released as part of the subscription fulfillment to Autodesk Land Desktop and Autodesk® Civil Design (or Autodesk® Civil Series) subscription members. It gives you a jump on learning as the product matures into a full-fledged civil design solution. Autodesk Land Desktop 2004 and Autodesk Civil Design are still the design tools for day-to-day engineering production, and Autodesk Civil 3D is the perfect companion tool.

CAD managers and power users should start using Autodesk Civil 3D to see how they can use it with Autodesk Land Desktop, thus preparing for Autodesk Civil 3D implementation.

Autodesk Land Desktop is the workhorse software for civil engineering. That said, let's explore object relationships and interaction in Autodesk Civil 3D.

Autodesk Civil 3D Dynamic Relationships

Autodesk Civil 3D is a civil engineering tool that creates relationships between objects so that design changes are dynamically updated. Let's look at the interrelationship between points, surfaces, parcels, alignments, profiles, sections, and labels.

Surfaces

When you build a surface in Autodesk Civil 3D, you create a single object containing all design and display components. Components such as contours, borders, and surface points do not need to be created separately. The appearance of the surface object and its components is controlled through the use of styles. Styles manage how objects are displayed in the drawing. To display a component, such as contours, you simply modify the existing surface style or create a new one and set it as the current style for the surface.

Right-clicking the surface name in the Prospector tab of the toolspace displays a Rebuild Automatic option as well as a manual selection. When you select the Rebuild Automatic option, any surface edits, such as adding or removing points or point groups, automatically rebuild and redisplay the surface. Because of the dynamic relationship between the data used to build the surface and the surface itself, the display of the surface components is always up-to-date.

The software maintains this dynamic link when you copy or insert the surface model into another drawing. For example, when you copy or insert a surface model that was made from points, breaklines, and an outer boundary, Autodesk Civil 3D copies not only the digital terrain model (DTM), but also the points, breaklines, and boundary used to create the surface. This happens because the surface is dependent on the objects that are used to build it, so the relationship has to continue for the surface to be valid in another drawing; therefore, Autodesk Civil 3D copies any objects used to build the surface into the new drawing.

If the surface was created by importing a LandXML file, the LandXML file is then always referenced for surface rebuilds. The LandXML file must accompany the drawing file in the same manner as xrefs. Deleting, moving, or renaming the LandXML file breaks the link, thus making the surface invalid. Although this broken link is easily resolved by reestablishing the path to the source file in the Properties dialog box, this relationship highlights the importance of a clear understanding of this relationship-based model.

Since surfaces are dynamically linked to the data used to create them, deleting the data alters the surface. For example, if you erase a breakline from the drawing, the surface object rebuilds without that breakline. If you erase all the surface data from the drawing, the surface no longer exists since it is dependent on that data; therefore, the surface itself is also deleted from the drawing. For example, if your surface is built from points only and you delete the points from the drawing, the surface is deleted as well. In other words, the surface is the data, and if the data is deleted, the surface (or portions of it) is deleted. If the data is modified, the surface is modified.

Parcels and Object Relationships of the Site Components

Parcels in Autodesk Civil 3D are now topologies, or a series of segments in relationship with each other so that if one is modified, all segments update accordingly. Parcels can be adjoining in the same site; however, they cannot overlap in the site. If the parcels overlap, then a third parcel is created from the overlapping area. If parcel overlap is required without creation of a new parcel, simply place them in separate sites. Objects in different sites do not react with each other.

The site in Autodesk Civil 3D is a collection of objects that interact together and share a common topology. Sites consist of parcels, alignments, and gradings, which are arranged in a tree view displayed in the Prospector tab of the toolspace, as shown in Figure 1.

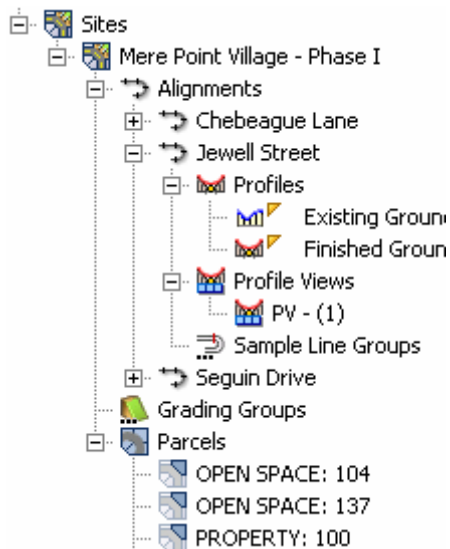


Figure 1: Site view expanded in the Prospector tab of the toolspace.

In this case, a site named Mere Point Village—Phase I consists of three alignments and several parcels. All the objects in this site are part of the same topology, so they interact to dynamically update to reflect changes. Notice that the profile, profile view, and sample line group (sections) are dependent objects to the parent horizontal alignment.

If a site contains a parcel, and you add an alignment that bisects the parcel, the parcel automatically divides into two new parcels. If you do not want the alignment to interact with the parcel, you must create the alignment in a different site. With the exception of the surface, objects must be part of the same site to interact.

Alignments and Profiles

The horizontal alignment in Autodesk Civil 3D is a powerful object that has dependent (or child) objects to the parent horizontal alignment, including profiles and profile views. The horizontal alignment does not have a dependency on a surface; however, it does interact with a surface or multiple surfaces. The horizontal alignment can now be quickly created using constraint-based commands to add fixed, free, or floating entities (lines, curves, spiral-curve-spiral groups, and spirals) to the alignment. These commands provide many ways to solve various problems by using different constraints. With a known start and end point for the alignment, it is easy to create the alignment working inward by using these constraint-based commands.

The profile is generated from the horizontal alignment and subsequently can be displayed in the profile view. The profile can be defined as *static* (a representation of the ground at the time of creation that does not update with changes) or *dynamic* (updating to reflect changes to the surface or the parent horizontal alignment). In short, when you edit either the surface or horizontal alignment, the profile and profile views automatically update to reflect the changes and do not require a manual update. Because they are child objects to alignments, profiles and profile views cannot exist without the parent horizontal alignment. If the alignment is erased from the drawing, the profile and profile view are erased as well.

Sections

Sections work in much the same way as profiles, requiring at least one surface and one alignment before you can generate cross sections. The sample line is the parent object, and the section and subsequent section view are derived from the sample line. Multiple sections

can be associated with a single sample line by referencing multiple surfaces. A sample line at an intersection, for example, can have a section and section view for the existing ground surface and another for the proposed surface. If the parent sample line is erased, the section and section view are also erased. At this time, Autodesk Civil 3D cannot be used to generate proposed cross sections or surfaces from cross sections.

Labeling

Labels in Autodesk Civil 3D have a relationship with the objects they annotate and to drawing orientation and scale. Object labels and tables are dynamically linked so when an object is edited, the label and table update as well. Two excellent examples are parcels and profiles. When parcels in the drawing are subdivided, the labels and parcel tables update to reflect the new area, parcel number, and whatever else the parcel style is set to display. Like profiles, parcel tables can be either static or dynamic.

As discussed earlier, editing the parent alignment automatically updates the profile and profile views. Labels and graphical bands also update, keeping the drawing current.

Until now, ensuring the proper orientation of labels has always been a costly and tedious chore. By associating labels with the objects they annotate, Autodesk Civil 3D provides a solution. Labels for alignments and parcels are always “plan readable” regardless of the twist angle in the Mview. Labels automatically adjust to the orientation of the drawing, eliminating the need to rotate labels or to have multiple copies at different label orientations on different layers for different Mviews.

A powerful tool introduced in Autodesk Civil 3D 2004 SP1 is the ability to make text size relative to the viewport scale. You can now plot one label at the same size regardless of how many viewports it is in and what the viewport scales may be.

Conclusion

Opportunities to improve operational efficiencies in the engineering process are becoming more difficult to find. Knowing that your drawings automatically and accurately update to reflect design changes has a tremendous impact on your business. Autodesk Civil 3D drastically reduces the costs and frustrations of preparing, plotting, and revising plans. Not only are the tools in Autodesk Civil 3D changing the civil design standard, they are taking it to a new level. The interrelationships that objects share in Autodesk Civil 3D change the way you design and increase the profitability of your business.

About the Author

With more than 11 years' experience in the civil design industry, Clay Abajian is a K-TEK Certified Professional, an Autodesk Authorized Consultant, and an Autodesk Certified Instructor. As founder and principal of Cadre Concepts (based in Las Vegas, Nevada) Abajian specializes in training, consulting, implementation, customization, and standardization for civil engineering firms in the Las Vegas Valley and across the country. His experience includes civil engineering drafting and design and CAD management. He was also the training manager for an Authorized Autodesk Premier Training Center (ATC[®] site). His focus is in the civil design field, specializing in the Autodesk Civil Series product line.

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