Visualization Insider
Preparing AutoCAD Linework for 3ds Max
Introduction

The building block of any architectural scene is linework and the vast majority of architectural visualization projects begin with AutoCAD drawings. Knowing how to use the linework in these drawings is a critical factor in fast, efficient work in 3ds Max. This article describes the process of cleaning AutoCAD drawings and preparing linework for importation into 3ds Max and how doing so properly can allow the user to turn linework into 3D models in the shortest amount of time possible. In this article you will see how good preparation of linework in AutoCAD can allow the 3ds Max user to model many complex scene elements in just a few seconds.

The steps that this article will outline to help you prepare AutoCAD linework for 3ds Max are as follows:

- AutoCAD setup
- Explore and examine AutoCAD drawings
- Consolidate drawings
- Clean linework
- Orient linework
- Create new linework as necessary
- Import linework
- Export linework
- Weld endpoints
- Convert linework to 3D

AutoCAD Setup

Since this discussion is based on the idea of 3ds Max's speed and efficiency while preparing AutoCAD linework for 3ds Max, it would be appropriate to first mention some fundamental concepts that deal with how the AutoCAD user interacts with the program. If you started using 2D or 3D software in the days of DOS based software, before icons and toolbars were available and when computer displays were much smaller, you probably have a much better appreciation for keyboard shortcuts and 3ds Max's screen real estate. Whichever is the case, let's take a few moments to look at a few things that might make working in AutoCAD a lot faster.

When you first install AutoCAD, you are presented with numerous toolbars and program settings that are not quite optimized for 3ds Max's speed and efficiency, as shown below.
To 3ds Maximize screen space you can simply right-click any toolbar and deselect those that you don’t want to use or click and drag them to the center of the screen and then close them one at a time. The only toolbars that we keep on our screens at 3DAS are the Layers and Properties toolbars. By typing Config, you can enter the Options dialog box, and do a few more things that can only help your work in AutoCAD. Within the Display tab, I recommend turning off the screen menu and scroll bars, both of which will increase your screen real estate. At the bottom of this tab is an option to increase your crosshair size and whether you use AutoCAD for 2D drafting or for importing into 3ds Max, this option should be set to 100% so that the crosshairs stretch to the entire length of your screen window, thereby allowing you to use the crosshairs as a tool to check the alignment of lines on opposite ends of the screen. When you make these changes, your AutoCAD screen would look like the image below.

Inside the User Preferences tab of the Options dialog box is a button that allows you to customize the right-click button of your mouse. Whether you use keyboard shortcuts or icons to enter commands in AutoCAD, this is an important feature to customize properly because doing so allows you to execute commands that you would otherwise have to execute with your non-mouse hand. In default mode, when no objects are selected, I recommend having a right-click mean Repeat Last Command. In Edit Mode, when one or more objects and selected, I recommend having a right-click mean Shortcut Menu. Finally, in Command Mode, when a command is in progress, I recommend having a right-click mean Enter. Configuring your right mouse button this way allows you to very quickly start the same command over again, open a shortcut menu and end a command in progress, which are perhaps the most commonly executed commands in AutoCAD, with the possible exception of the zoom and pan features which should without a doubt be performed with the middle mouse button...once again a type of mouse configuration.
Explore and examine AutoCAD drawings

One of the first questions a potential client will ask about 3D visualizations is how much does it cost. Pricing your work is arguably the most difficult and important part of your business if you are the owner or manager of a 3D visualization firm. As hard as it is, it would be far more difficult, and certainly more risky, to provide someone a quote on a project before ever looking at the project drawings. At 3DAS, we learned long ago, and sometimes the hard way, never speak a word about prices before seeing a project’s drawings. There are numerous reasons for this, besides the obvious problem of quoting too low before realizing the true scope of work that lies ahead. One is that you don’t give yourself the opportunity to learn more about your client and the project he needs you to work on, both of which can influence the final price you set. Another is that without seeing the drawings, you should estimate high for a worst case scenario, and though you may tell the client you are in fact estimating high, he/she may be completely turned off by your over-inflated proposal. But the biggest reason you should thoroughly examine AutoCAD drawings before quoting a future project is that there are numerous ways that drafters and architects can put a drawing together that will add an enormous amount of time to your work. We will look at most of these ways a little later, but suffice to say, you should avoid quoting a project before you are able to receive a complete, or nearly complete set of architectural drawings.

The next part of this discussion deals with consolidating and cleaning your AutoCAD drawings, but before you can do either of these, you have to first examine all of the drawings your client provides so that you have all of the linework needed to properly create all parts of the project. Our clients usually don’t know much about what we do or how we do it. Sometimes they just don’t care. Sometimes, the person we deal with is an architect, a real-estate agent, a construction company or some other firm that is simply representing the owner who is actually paying the bill and sometimes these contacts don’t even want or endorse the 3D visualizations we produce and only work with us on a project because they are forced to by the owner who does want 3D. Whatever the case may be, we sometimes have to beg, plead, and holler to get all the necessary drawings from our contacts, while other times our contacts simply throw us everything they have and tell us to find what we need.

The image below is an example of a list of AutoCAD drawings an architect provided us, perhaps not knowing or caring what we needed to do our work. As you can see, the list includes floor plans, site plans, elevations, and sections, the heart of what we need to do our work.
As thorough as the list was, and as many unnecessary drawings as we were provided, there were numerous other drawings that we needed to complete our work, to include landscaping, interior elevations, and furniture plans. All of these drawings were important to our project, and though we may provide a fairly accurate proposal without them, it’s an example of missing information that must be discovered early on so that you can account for this lack of information in the schedule you provide in the proposal/contract to your client. In your proposal/contract, you should never specify a product delivery date if you don’t have 100% of the information you need to complete your project. Instead, you should provide your delivery date as a number of days from the time you receive all of the necessary information. For example, the chart below shows a project schedule as specified in the PSA (Professional Services Agreement) for a particular project. Notice that it states that we have been provided with all architectural drawings, yet we still did not have other information we needed to complete our work. Because we had all of the architectural and site drawings, and because the information we lacked had only a minimal impact on the total amount of work to be performed, we were comfortable in providing a proposal. But we did not specify a product delivery date. Instead we stated that the product would be delivered in a certain number of days after all of the information was provided.

**Project Schedule:**

**3.1 Provided by the CLIENT:**
- All architectural and site drawings: Provided
- Signed contract and deposit: To be provided
- Color scheme for all architectural elements: To be provided
- Furniture plan, furniture and material selections: To be provided

**3.2 Provided by 3DAS, LLC:**
- Draft renderings for review of architectural correctness: NLT 3 weeks (21 calendar days) after CLIENT provides all items listed in project schedule 3.1
- Draft renderings for review of furniture and materials: NLT 6 weeks (42 calendar days) after CLIENT provides all items listed in project schedule 3.1
- Draft animation: NLT 2 weeks (14 calendar days) after CLIENT provides final approval of furniture and material selections
- Final animation: NLT 2 weeks (14 calendar days) after CLIENT provides final approval of draft animation

Earliest delivery of final animation: 70 calendar days

One final note about exploring and examining AutoCAD drawings, after the next few section of this discussion, we will look at the basic of how to import AutoCAD linework. When we do, I will make a suggestion to import linework piecemeal, which simply means, import small parts of your linework, one at a time. There is a very good reason for doing this. Although you can certainly import your an entire drawing into 3ds Max all at once, doing so will only convolute your screen, slow down your viewports and increase the time it takes to select and isolate certain objects. More importantly, however, if you import your linework piecemeal, it allows you to spend more time in AutoCAD figuring out what’s going on before you rush into the creation process in 3ds Max. For example, if you import the linework you need to create your walls, it might only be after you create your walls that you realize that you created them wrong in some way. Had you already imported your doors, windows, and roofs, you might not realize that your walls are wrong until after you’ve spent valuable time creating these other objects which then might need modification or in some cases, a complete rebuilding.
Consolidate drawings

The next major step in preparing AutoCAD linework for 3ds Max is to consolidate all the pertinent drawings into one single drawing. This doesn’t mean that you have to or even should consolidate the drawings for numerous different buildings into one single drawing, but when you need to build a single major component of your project, like a single building, you should consolidate each of the pertinent drawings for that individual building into one single drawing file. There are 2 major reasons why this is a good practice to get into. First, it allows you to clean each of your drawings all at once, rather than repeating the same steps over and over for each drawing. Second, it allows you to find contradictory information and linework by having all of the drawings visible in one easy to see space and by allowing you to align different drawings together to see how each drawing compares to the next.

The process of consolidating drawings is very simple. Open each pertinent drawing, usually floor plans, elevations, and sections, copy all of the linework to the clipboard, and then paste each drawing’s linework from the clipboard into a new master drawing. Since many drawings use xrefs, you need to make sure that the drawing you open really contains the linework you need, rather than just an xref of the linework. In addition, always unhide and unfreeze all layers so that you know that when you select and copy linework to the clipboard, you’ve actually copied all of the linework and not left any hidden or frozen linework behind. The image below shows an example of linework from a four-story house consolidated from several different floor plans, elevation, and section drawings.
Clean linework

Once linework is consolidated into one master drawing, the next major step is to clean all of the linework by the simple but often time consuming process of isolating and deleting the linework on individual layers which contain unnecessary information. Sometimes you can select and isolate multiple layers at one time and delete all of the linework at once, however, you must be careful not to delete necessary linework that was placed on an inappropriate layer. It is not uncommon for drafters to place linework on the wrong layer and while it may not negatively affect their ability to produce good construction documents, it certainly can be a problem for 3D users who expect to see a particular type of linework and all of that linework on a layer when that layer is isolated.

The previous image from the four-story house showed an example of a ‘dirty’ drawing full of information that we simply don’t need to do our work, such as dimensions, notes, electrical and plumbing fixtures, just to name a few. The image below shows the cleaned version of the drawing.

I use the term ‘dirty’ to indicate drawings that contain not only information that’s useless for producing visualizations, as in the first image of the project above, but also to indicate drawings that contain linework that is not ideally suited for use in 3ds Max. What you don’t see in the ‘dirty’ image above is some of the many things that make the linework difficult to work with in 3ds Max. I use the term ‘clean line’ to indicate a line or spline that is free from any defects that would cause problems or errors in 3ds Max and I use the term ‘dirty line’ to indicate a line or spline that is created or modified in a way that does contain defects that prevent its use in the creation of 3D objects. There are several reasons why a line may be ‘dirty’, and hence, not work properly when imported into 3ds Max. The following is not an absolutely complete list, but will explain the vast majority of the reasons why linework is unable to work properly when imported into 3ds Max. This list is borrowed from a more comprehensive article on the creation of 3D sites, entitled Creating Site Plans – Part I, which can be found in the Visualization Insider series at CGarchitect.

Overlapping lines – this occurs when a line crosses over itself, as shown in the left image below. When converted to 3D, this type of line often results in a solid that appears hollow or is missing a top and bottom.
**Broken lines** – this occurs when lines that should be continuous are broken into 2 or more individual segments, as shown below. These segments may have endpoints close together, or they may be separated by a significant distance. If the end points are close enough together, they may be automatically welded when imported into 3ds Max, however, it is usually far more effective to identify these broken lines and weld them in AutoCAD. Waiting to fix this problem in 3ds Max will almost certainly take longer because of 3ds Max’s slower and less efficient line editing capabilities. Perhaps more importantly, if you leave the linework ‘dirty’ in AutoCAD, you may have to repeat the cleaning process in 3ds Max if you need to re-import for any reason.

![Broken lines example](image)

**Different layers** – this occurs when lines that should be on the same layer are placed on separate layers, as shown in the multi-layered lines that represent the curbs in the image below. When isolating individual layers, this problem can lead to the user not realizing that he or she has just hidden information (on the wrong layer) and result can be disastrous.

![Different layers example](image)

**Varying elevations** - one of the most frustrating things about working with drawings somebody else created is the eventual occurrence of line segments existing on varying elevations. From a top view, these lines may appear to be otherwise ‘clean’, but the truth soon comes out when you view your linework from a perspective view, as shown in the right image of Figure 6, and endpoints at different elevations can never be welded. The only way to fix this problem and use the linework for 3D purposes is to place the endpoints on the same elevation so that the endpoints can be welded.

![Varying elevations example](image)

The cleaning of this drawing took half a day, but once cleaned, the linework was turned into a complete 3D site in less than an hour. This would not have been possible with any reasonable amount of accuracy, had the linework not been properly cleaned prior to being imported into 3ds Max. This process of cleaning linework will not only help you reduce unnecessary information on your screen and improve viewport navigation, it will further provide you time to explore and examine your scene which can only help reduce your chances of incorrectly building your models.
Orient linework

Once the master drawing has been cleaned, the next major step of the process is orienting linework. The very first thing that should be done when beginning this step is to locate the origin. The linework that you prepare, and therefore the model that you construct in 3ds Max, should always be centered on the origin because 3ds Max is less accurate the farther away objects are away from the origin. So start the orienting process by centering the site or the first floor plan of a building directly at the origin of a drawing.

If you are working on the construction of a site, then once you center the site, your work in AutoCAD may very well be finished. You do need to ensure that your site plan is scaled properly and knowing that most site plans originate from civil engineering drawings, which are usually constructed at a completely different scale from architectural drawings, I would always make sure to scale my site plan properly before importing the linework into 3ds Max. If you are constructing a building, however, then the process of orienting drawings is far more complicated and time consuming. Just like with site drawings, you should always center all of your linework at the origin so that modeling in 3ds Max is done with the highest possible accuracy. The image below shows a four-story house with all of the floor plans, elevations, and sections consolidated into one drawing and cleaned of all useless information. The drawings are not arranged, however, in a manner suitable to importation into 3ds Max.

The image below shows the drawings oriented in a way that makes working in future steps of this process, creating and importing linework, much easier. Notice that each elevation is oriented around each side of the first floor plan and rotated so that lines from the elevations can be projected against the floor plan to check for conflicts. All other floor plans are aligned in a row to the side for reference, as are sections.
So now that we’ve analyzed one project and how linework was prepared for 3ds Max, let’s take a quick peek at another project. The image below shows a rendering of a building…

…and the image below shows the cleaned and oriented linework. As you can see, the elevations are again oriented around the first floor plan.
Create new linework as necessary

Once the linework is cleaned and oriented, then the next step is to either import the linework into 3ds Max as is, or create new linework to facilitate the construction process in 3ds Max. If you use the Edit Poly approach of building your models, also known as the box modeling method, then you may decide at this point to simply import the linework as a reference against which to build your models. While this approach has its advantages, at 3DAS we greatly prefer to use the powerful and versatile loft and sweep features to create our buildings and sites. This article does not cover the construction of models using either of these 2 methods but rather just the process of preparing AutoCAD linework for 3ds Max. In a future article of the Visualization Insider, entitled Building walls – Lofts vs. Edit Polys, we will compare the 2 main methods of building walls, and incorporate the remainder of the steps that go into preparing AutoCAD linework:

- Importing linework
- Exporting linework
- Welding endpoints
- Converting linework to 3D

These same steps can also be found in the three part tutorial entitled Creating Site Plans.

At this point, we will look a little farther into this preparation process that uses the loft/sweep method by looking at how a drawing was arranged for another project. Below is a rendering of the building we’ll be looking at….  

And the image below shows the linework as it was received from the architect. Notice these drawings were already consolidated and quite clean, but they still needed to be oriented.
The image below shows the oriented version of the same drawing, similar to the way it was shown in the previous projects. But notice something else in this drawing. There are lines in the top left corner of the drawing that were used as profiles lofted along paths located in the same place as the 1st floor plan (though it can not be seen in this image). In addition there are numerous lines in the top left corner that were used to help construct some of the more complex trim features positioned on the walls. There is also a copy of each window and door off to the side which are used as a guide to build each type. These windows and doors can be built in AutoCAD or 3ds Max, but lining up a single copy of each type allows you to build these objects in an assembly line fashion. Finally, notice numerous vertical and horizontal lines positioned around each elevation. These are simply guides with which to cut out the 1-inch thick grout lines found throughout all the walls. Whether you use the Boolean or Edit Poly method to create this feature, you will need lines with which to guide your creation. These same types of lines should also be created to help guide the placement of each window and door. So after a single copy of the windows and doors are created, this linework can be imported and used to position each copy properly along the length of its respective wall.

Now let's take a look at what this project looked like a little down the road. The image below shows this building after the walls had been lofted and a copy of each window and door has been placed. Notice the lines that were used as a reference to place these copies. Once they were placed properly along the length of the walls using these lines, we needed to refer back to the AutoCAD drawings to determine the height of the windows and doors off the ground. Once they are in their final position, we can just explode all of these groups we copied and use the Boolean feature to subtract these objects that represent the volume of the windows and doors, from the lofts, thereby leaving behind a void in which those windows and doors are shown.
Now this is just our preferred way of creating these fundamentally important objects - walls, windows, and doors. As mentioned, there are a few other methods that veteran modelers use to create these objects. Some use the box modeling method whereby the edit poly feature is used to carve out the widows and doors, sometimes using an xref set of linework as a reference in a viewport. Some that use this method also incorporate lofts and sweeps to form the walls while others simply extrude the linework to do the same thing. Which method is best is a matter of opinion and based off of the little nuances of how we all work. But what no veteran user will deny is that linework that's not prepared properly in AutoCAD will lead to less efficient and less accurate modeling in 3ds Max. By taking the time to clean up drawings properly in 3ds Max, not only can you work faster and more accurately in 3ds Max, you have one other big advantage as well. The longer you spend in AutoCAD, the more time you have to examine the drawings and figure out how the project is being put together in real life. Not all drawings are easy to read either because of the complication of the design or the lack of skill on the part of the drafter creating the drawings. But if you model your projects one component at a time, i.e. import the linework for the walls, build the walls, import the linework for the windows and doors, build these objects, etc., you can identify and address drafting errors early on, rather than importing all the linework early on and realizing down the road that you have to recreate something because the linework was improperly created. And by importing clean linework piecemeal, you also don't have to look through a mess of linework in 3ds Max to see the lines that you actually need to work with.

Well up to this point, we've only looked at linework for buildings, and for buildings, I would argue that the loft and sweep method is at least as good as any other modeling method mainly because of how you can quickly and easily incorporate complicated trim features that would take an enormous amount of time to create using other methods. But when it comes to creating sites, I would argue that the way we have figured out to create sites is truly the fastest possible. That's a pretty bold statement I know, but after trying every conceivable way of creating site elements, we've found that nothing else even comes close. And I certainly don't have time to teach the creation of sites right now, I could teach at least a 2-day course and not do the subject justice, but this is not a class on creating sites, it's a class on preparing linework for any drawing type in general. If you want to read an in-depth tutorial on this subject, just refer to the 1st 3 tutorials on the Visualization Insider located at CGarchitect. That tutorial is about 60 pages long and does a pretty good job explaining the process of creating sites, both 2d and 3D sites.
So let’s just look at how some site linework was prepared for some past projects and see how that linework can be used in 3ds Max to quickly create the various site objects. So the image below shows an example of a very dirty drawing. This is a site drawing which was created by a civil engineering firm and as is typical with their drawings, there is an enormous amount of information unnecessary to visualization work. Cleaning a drawing this large with this amount of unnecessary linework could take half a day, but the time spent preparing the linework properly here in AutoCAD is well worth it because once this linework is prepared properly, you can easily model the entire site in less than 30 minutes.

The image below shows what the drawing looks like once the linework is cleaned and prepared.

Notice that if I select and isolate the linework representing the roads, it is in fact just one continuous closed spline. If I import this linework in 3ds Max, all I need to do in 3ds Max is convert it to an editable mesh and voila, I have my roads modeled. The same line can be used as the path of a loft or a sweep to create the curbs along the side of the roads. If I select and isolate the lines that represent the mulch beds, you can see that each one of them are good clean closed splines, and these splines can be easily used to cut out these mulch areas from the grass object. This can be done in less than a minute just like many of the different major site elements, such as sidewalks, pavers, bodies of water, curbs, parking lines, etc. Speaking of parking lines, there’s another short demonstration of how proper linework can yield fast, efficient results.
In the image below you can see the linework representing a shopping center. In the parking area around all of the buildings you can see hundreds of parking lines and road lines. When you receive a site drawing with these lines, they are shown as just that – lines. However, if you turn these objects into polylines with a width of 6 inch, the typical real world width of parking lines, you can quickly turn these polylines into a renderable object in 3ds Max.

If the road lines are continuous lines in AutoCAD, as opposed to dashed lines as you would see on many roads in the real world, then you can simply import a drawing file of those lines. However, if you do have dashed lines anywhere in your drawing, such as in the lines shown in the image below, then you can use a unique characteristic of the 3ds file type to have those areas with dashed lines also imported.

This is a really great thing because if you couldn’t have these dashed lines accounted for automatically, it would be very time consuming to manually build these breaks into the linework. So to demonstrate this, I’ll select and isolate these lines, export as a 3ds file and import into 3ds Max. Remember, if I just imported this dwg file, I would lose these spaces that give the lines the dashed appearance so I type export, select all of the linework to export, and give the file a name. Now I can go into 3ds Max, select File>Import and using the 3ds file type, I can import this file and when I do, the dashed lines translate into 3ds Max, and the object itself is an editable spline, that once turned into an editable mesh or poly can be rendered.
Summary

This discussion provided a general overview of how to prepare AutoCAD linework for 3ds Max but it really only scratched the surface of the entire process. With each year seeing improvements in CAD software, we are getting closer to a perfect software package that allows the user to build great projects in 3D, while concurrently using the same software to produce construction documents, which is a process coined by the term BIM (building information modeling). However, no matter how great the software is, I think that we will never see the day when these programs can out-do the speed, efficiency and accuracy of these fundamental modeling techniques outlined in this discussion. Certainly you can create a building in literally seconds with these software packages today; however, you can’t do the same with buildings of any real complexity. Even if you could, you’d have to spend a great deal of time creating all of the unique wall, window, door, and roof styles before you can even start creating your models. The bottom line is, preparing AutoCAD linework properly can be a time consuming process, but it’s an important process that when done effectively can save a tremendous amount of time and grief in the long run.