

Understanding Architectural Drawings



THE FOUNDATION OF ANY 3D visualization is the linework found in its architectural drawings. Just like a contractor needs drawings to erect a building, a 3D artist needs drawings to create a visualization. Understanding a set of architectural drawings is critical to efficient and accurate work in 3ds Max, and without knowing exactly how drawings are put together and what each component of a drawing indicates, a 3D artist is likely to spend a great deal of time trying to make sense of the madness that can be a set of architectural drawings.

Today, nearly all building projects utilize CAD to create architectural drawings, and more specifically, AutoCAD. However, many visualization projects begin long before the final construction drawings are generated. Construction drawings are the final set of drawings submitted to a city or county building department and supplied to contractors that intend to bid on the project. These 'final' drawings often lead to addendums and on-site adjustments, but construction drawings will always have a certain acceptable level of quality and engineering. The same cannot be said for the drawings that those of us in the 3D world are often forced to work with. Since our work often begins at the design development stage or before final construction drawings are generated, we often face the challenge of working with incomplete drawings containing numerous errors or conflicting data. Whatever the case maybe, architectural drawings can be a difficult thing for many 3ds Max users to grasp, especially for those that haven't had the benefit of working as an architect, engineer, or draftsman.

I decided to make the first few chapters in this book a discussion on architectural drawings and AutoCAD because many intermediate level users in 3ds Max do not have a solid background in architecture or even a fundamental level of knowledge on AutoCAD, yet both of these areas are so critical to our work. Not being able to create a roof plan, interpret a door schedule, or how to recognize the difference between a block and an xref in AutoCAD are just a few examples of the countless difficulties many talented 3ds Max users face when working in the visualization industry. Many students find learning 3ds Max quite simple compared to the difficulties of learning the fundamentals of architecture, and of course, many talented 3ds Max users from other industries have migrated to the visualization industry in recent years. There is very little documentation to guide users in their progression and so these chapters are an attempt to help 3ds Max users understand

the very important stage of working with architectural drawings. As mentioned in the introduction of this book, much of what is discussed about the architectural industry in this book can be applied to the building industry as a whole, including other sectors such as civil engineering, structural engineering, and landscape architecture.

The Architectural Design Process

Architectural drawings undergo a long and often tumultuous journey before landing in the hands of a contractor who wants to bid on the project. While no two projects follow identical paths during this journey, there are common phases that most projects go through as well as common road-blocks and obstacles that most projects will encounter. This section aims to illustrate the evolution of architectural drawings from the time a project is conceived up to the point where the drawings are government approved and ready for use.

All projects start with an owner who approaches an architectural firm with a concept in mind. The architect's primary job is to take the owner's concept and design a structure with all the appropriate engineering in place to satisfy local, state, and federal guidelines. When a design is complete, architects then submit a set of construction drawings to local building departments for review and approval. Figure 1-1 shows an example of a complete set of construction drawings for a commercial building. Once approved and once a contractor has been selected, the project can proceed with construction under the careful watch of the architect who makes sure that the construction conforms to the guidelines specified in the architectural drawings. That is, in a nutshell, the process of architectural design. Needless to say, the actual process involves a little more work, and the following sections briefly illustrate some of the most important details of this process. By knowing the basics of the architectural design process, you will be much better prepared for the 3D design process and many of the obstacles and pitfalls that can hamper your workflow.

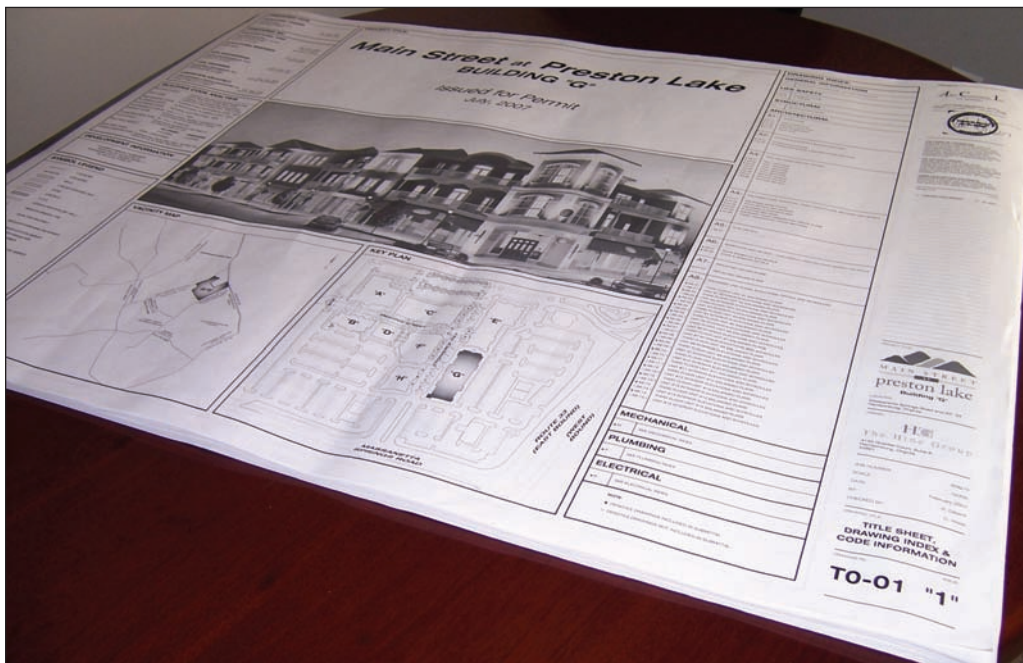


Figure 1-1. An example of a set of construction drawings

When a 3D artist receives a project from an architect or an owner, it is absolutely critical for the artist to know exactly what phase an architectural project is in. Without knowing the phase, the artist has little chance of knowing just how likely a design is to change. Clients often leave out this very important piece of information, and when asked directly, some clients may not always provide a complete answer. If you at least know what phase a project is in, and understand what each phase entails, then you at least have a good understanding of how likely you are to see changes coming. If you don't iron out the specifics of how changes will be billed in your contract, then it's only a matter of time before you run into a difficult situation. Fortunately, the sample contract provided with this book provides the necessary protection against project changes. Feel free to adopt the wording in this contract as your own.

According to AIA, the American Institute of Architects, there are five major phases of the architectural design process. They are as follows:

- Schematic Design (SD)
- Design Development (DD)
- Construction Drawings or Construction Documents (CD)
- Bidding and Contract Negotiation (BID)
- Construction Administration (CA)

Schematic Design

The first phase of architectural design is the **Schematic Design** phase, or **SD** for short. The primary objective of this phase is to develop a clearly defined, feasible concept and to present it in a form that the client can understand and accept. Secondary objectives include clarification of the project's program, exploration of alternative designs, and estimations of construction costs.

During this phase, an architect works closely with the client to determine the appropriate **program**, or set of needs that a building must fulfill. The program includes the project's functions, goals, design expectations, budget, and site requirements (such as building code, zoning, and accessibility issues). Preliminary construction costs are also estimated during this phase so that the client can know as early as possible if the project is feasible from a financial standpoint.

In the first part of the SD phase, the architect researches the project to determine what its current problems are and what kind of problems might develop in the future. Once a program has been established through this research, the architect's focus shifts from figuring out what the problems are to how the problems can be solved. In the course of solving a project's problems and fulfilling a project's need, a more practical schematic design is born. Architects often provide multiple versions of a design that reflect different options that the client may or may not be willing to pay for, based on preliminary cost estimates. Minor details are ignored in the SD phase, and instead, the architect focuses on the overall big picture, making sure that no major problems exist in the project's design before continuing with work in the next phase.

During SD, architects usually provide their clients with concept sketches, either by hand or CAD, as well as feasibility studies based on site and building code restrictions. It is quite rare for an architect or owner to request 3D work at this early in the architectural design process, simply because the architect can very quickly hand-draw low detail 3D perspective renderings that would satisfy the clients need for visual representation. Even if architects sub 3D work out to an outside source and 3D work is desired during the SD phase, many architects can still produce this type of low quality mass modeling 3D work in house at this point.

In recent years, city and county officials throughout the U.S. (and I presume other countries) have placed a greater emphasis on the need for architects to provide more accurate illustrations of

their designs as early as possible, so that officials can provide the architects with preliminary approval or denial of a design and prevent unnecessary work on a project that has no hope of being approved in its current design. These preliminary illustrations usually include such details as landscaping because of its impact on the overall look of a project. Regardless, few 3D firms are utilized in the SD phase for the reasons just mentioned. If approached by an architectural firm, 3D artists must understand exactly what the client wants and be careful not to waste time on details that the client does not need.

The typical documentation developed by the end of the SD phase include:

- A site plan
- All floor plans
- All exterior elevations
- Building sections of critical areas
- Landscape plans
- Preliminary construction cost estimate
- Hand or CAD renderings

The final step in the SD phase, or any phase for that matter, is to obtain formal client approval of the provided documents. Once an architect receives approval, the next phase of the design process can begin.

If a client approaches you with a request for 3D services on a project in the schematic design phase, you should make absolutely certain that both of you come to a clear understanding about the level of detail to be provided and the cost of making 3D changes during later phases.

Design Development

The second phase of the architectural design process is **Design Development**, or **DD** for short. During this phase, the design is refined into a clear, coordinated set of drawings covering all aspects of the design. This set of drawings typically includes fully developed floor plans, exterior elevations, building sections, and a fully developed site plan. For critical areas of a project, architects may choose to develop interior elevations, reflected ceiling plans, roof plans, wall sections, and details. These drawings may or may not include dimensions and notes, and even when they do, they typically see a great detail of refinement until the point at which the drawings are submitted to the building department for approval. The drawings produced during DD become the basis for the construction drawings submitted for government approval.

In the SD phase, most of the work is performed by the architect(s) because almost all of the work is design oriented and above the normal qualifications of a draftsman. During the DD phase, however, the work is fairly evenly split between the architect(s) and draftsman. At the beginning of the DD phase, an architect will create what's known as a cartoon set of drawings, which is usually nothing more than a set of hand-drawn letter size sheets of paper with a tentative layout of the full working set of construction drawings, as shown in Figure 1-2. Once that cartoon set is created, the drafter will spend a great deal of time setting up the DD drawings per the cartoon set and adding all of the generic information required, such as dimensions, scales, sheet titles, and building/wall section callouts.

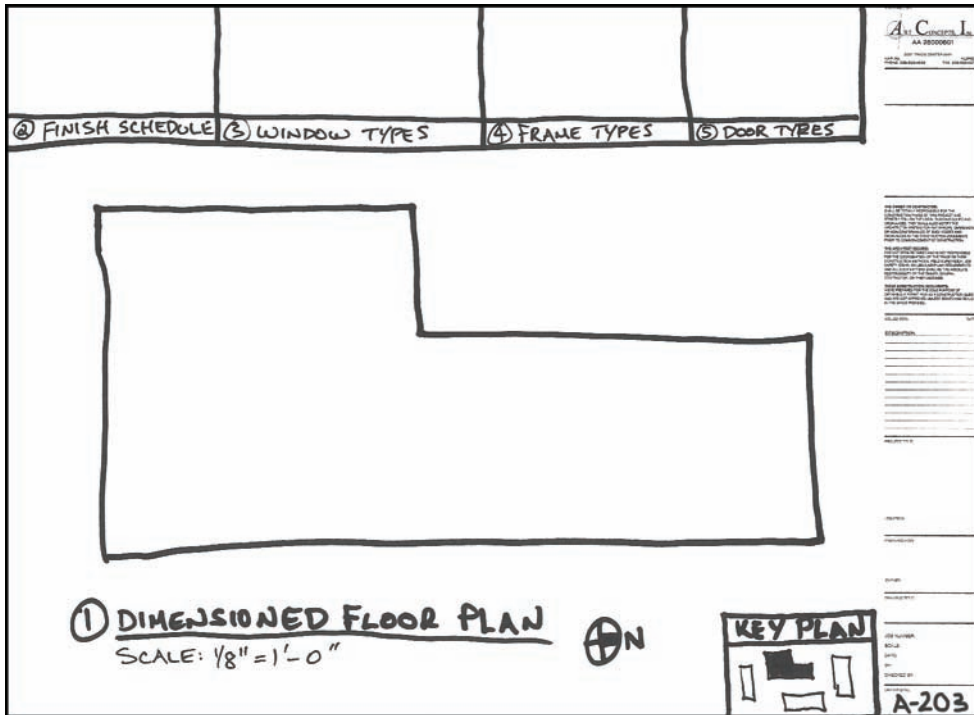


Figure 1-2. An example of a cartoon set drawing

In the SD phase, architects do not always utilize the services of engineers because at such an early stage in the design, an architect is usually more than capable of determining the feasibility of the overall design. For example, if the design calls for a 100-foot roof span without any supporting columns in place, the architect may not know what the ideal beams to use are, but would know enough to know that a sufficient and affordable type of beam *can* be utilized to allow for the design to progress. Once the DD phase begins, numerous engineers are usually needed for all but the smallest and simplest of projects. Even though architects are experts in the design of buildings, with the exception of these simplistic projects, they are usually not legally permitted to *sign and seal* a set of architectural drawings without the subsequent signature and seal of the appropriate subcontractors. These subcontractors usually include civil, structural, mechanical, plumbing, electrical engineers, as well as landscape architects. Depending on the type of project being built and its location, a project may require a certified approval from one or more of these subcontractors. When architects or engineers certify a set of drawings, they stamp or press their seal into each drawing and sign on top of that seal, as shown in Figure 1-3.

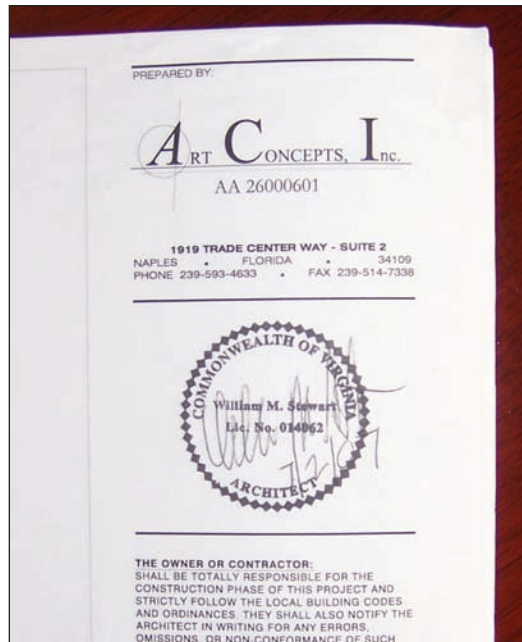


Figure 1-3. An example of a 'signed and sealed' drawing

During the DD phase, architects usually provide these subcontractors with CAD files in their most up-to-date form, and then based on these CAD drawings, the various subcontractors develop an accurate design for their specific areas of responsibility and provide the architect with enough guidance to proceed with construction drawings. Before developing construction drawings, the architect must ensure that no major design flaws or issues exist that could lead to a redesign.

For many architectural firms, the typical documentation developed by the end of the DD phase can appear very similar to the final construction drawings, although the DD drawings will typically not contain as many details, dimensions, and notes. Unlike the SD drawings, the DD drawings will also include initial material and color selections, selections for engineering systems (such as sprinkler systems), and preliminary engineering drawings with all the information the architect needs to move into the construction drawings phase. For example, structural engineers will include on their version of the floor plans, the sizes of all beams needed to support the floors or ceiling above. Without this information, the architect can not finalize the sizing of the wall components surrounding the beams or the space between walls containing those beams.

Just like in the previous phase, the final step in the DD phase is to obtain formal client approval of the provided documents. Once an architect receives approval, the next phase of the design process can begin.

Beginning a 3D project in the design development stage can be quite risky – even more so than in the schematic design phase. In the SD phase, there's usually no doubt on anyone's behalf that the project is going to undergo numerous and major design changes and that continuing 3D work into future phases can easily require starting over from scratch. In the DD phase, however, there is usually sufficient detail provided to allow for a complete visualization, and clients often don't understand how even small changes in a building or site design can lead to enormous amounts of work, or in many cases, starting over from scratch. Furthermore, the number of hours needed to achieve the level of detail shown in the DD drawings is always going to be far greater,

which means that starting over from scratch will require far more work. If a client approaches you with a request for 3D services on a project in the design development phase, you should make absolutely certain that the client knows the costs and implications of making changes to the 3D visualization which are certain to come in the design development or construction drawings phase. Depending on what the visualization is to be used for, the client may elect to use the visualization provided in the DD phase, rather than paying for changes made in the construction drawings phase. If the visualization is to be used for marketing purposes, then a DD visualization will often suffice. However, if the client needs to present the final building design to the city or county for its approval, the visualization will usually need to be a highly accurate reflection of the final design.

Construction Drawings

The third phase of the architectural design process is the **Construction Drawings** phase, or **CD** for short. This phase is often referred to as the Construction Documents phase, but for the purpose of this book, I will usually refer to this phase as Construction Drawings. During this phase, additional design issues emerge and the architectural team works to address these issues. Just like with the previous two phases, there are numerous reasons why a project may undergo significant design changes during the construction drawing phase. These can include city or county officials denying certain aspects of a project's design, the realization that the cost of construction was underestimated, a lack of funding for the design as it currently stands, and the client simply deciding that he doesn't like the design any more. It is often this last example that best illustrates how the design process never really stops but rather continues through construction and the everyday use of the buildings and facilities developed.

Construction drawings (CDs) must include all details required per city, county, and federal guidelines. Every aspect of how a project is to be put together must be included in the CDs. These are the documents to which the architect, owner, and/or government officials will hold the contractor responsible. Likewise, these are the documents that contractors use to determine construction cost, so the importance of these documents being accurate can not be underestimated. This does not mean that changes to designs can not occur after CDs are submitted. If changes are required, addendums are simply added to the CDs and those addendums are submitted to the building department for approval. In most cases, changes at this point are usually quick to fix, even when the scope of the change is large. For example, even with something as significant as a roof changing from concrete tile to shingle, a few small changes to the notes found on the elevations and sections will usually suffice.

It is extremely important to remember however, that some design changes that appear at first to be simple, can in fact take much longer to correct than the example of the roof. In the rush to meet deadlines, drafters or architects often decide to cut corners and a perfect example of a change that can take an enormous amount of time to make properly, and one that is often corrected with a quick fix instead, is a change to the length of a wall. If, for whatever reason, an architect or drafter has to change the length of a wall by even a few inches, that change might be seen on every major drawing to include one or more floor plans, interior and exterior elevations, sections, the foundation plan, and so on. The quick fix would be to simply change the dimension on the floor plan without actually changing the linework that the dimension annotates. For small changes in length, this might not be a big deal, especially since contractors are required to build per the dimensions anyway and other drawings like elevations are supposed to be for reference only. However, if the change to the length of the wall is a little more substantial, then even an experienced 3D artist is likely to not know that the linework is erroneous and the resulting 3D models might be inadequate.

Bidding and Contract Negotiation

The next phase in the architectural design process is **Bidding and Contract Negotiation**, or **BID** for short. When an architect submits a set of construction drawings to the building department, his work is usually far from over. Although contractors are often pre-selected before a project even begins, most construction projects go through a bidding process, whereby the architect will serve as the manager of the bidding. When contractors are invited to bid on a project, they pick up a set of CDs and any addendums that may have developed, they study the project closely to determine their cost of construction, and they place a bid on the project. Sometimes the project owner looks only for the lowest bidder, but in many cases being the lowest bidder doesn't ensure winning the project. If an owner has a preference towards one firm and the bids are close enough, the lowest bidder might not win the project.

Construction Administration

The last phase in the architectural design process is **Construction Administration**, or **CA** for short. Between the time CDs are submitted to the building department and the project is fully constructed, numerous changes can be made to the design. As an example, many cities and counties have a certain minimum type of landscaping that must be provided for a project. Landscape architects will often create landscape drawings that satisfy minimum landscaping code, but when it comes time to actually plant that vegetation, the landscape architect may, at the request of the owner, completely change the landscaping. There are numerous reasons for this, such as the owner not wanting to decide until the last possible moment how much money he wants to spend, how much he can spend, or the owner simply not knowing what he would like to see planted until he sees the project nearing completion. As a 3D artist, it is very important to understand how concrete a project's landscaping drawings are, and what the client wants. Even though landscaping is usually not the focus of a project, it is nonetheless a critical component of a realistic 3D scene. The real landscaping that an architect or owner has in mind or the real landscaping that actually gets planted on site is often so drastically different from the original landscape drawings, if one creates a 3D scene using these original landscape drawings without the client's express consent, problems are bound to arise. Many clients are not experienced enough with 3D to know to volunteer this type of information. Therefore, you should always get clarification on such details.

Another example of a change that is often made after CDs are submitted and one that can greatly affect the progress of a 3D visualization is the changing of a building's colors. Architects or owners often change their minds at the very last minute after having the opportunity to test real color samples on a building as it nears completion. Figure 1-4 shows a commercial development nearing completion and a newly developed paint scheme being tested with the benefit of real world conditions. The paint colors being tested are relatively unorthodox for the location and without the ability to apply actual paint samples like this, an architect or owner is often unsure about the selection. By utilizing the services of a 3D visualization company, clients can often identify poor color schemes before it's too late and so it is because of our work that clients often change design characteristics like this at the last minute. During the design development phase of the project shown in Figure 1-4, an initial color scheme was submitted by the architect and approved by the city planning board, but it was not until the building was almost completely finished that the architect and owner determined that the chosen color scheme was not appropriate. As always, you should try to determine as early as possible how much something like a color scheme is likely to change, and you should reflect the consequences of such changes in the project's contract.

COLORS:

- Fusion: SW6919 + 4 additional same color with increased values
- Venture Violet: SW6970 (accent as shown)
- Heron Plume: SW6070 (use on 4' band same as before)
- Repose Gray: SW7015 (general building color plus cmu wall in window system)
- Tricon Black: SW6258 (all steel columns)

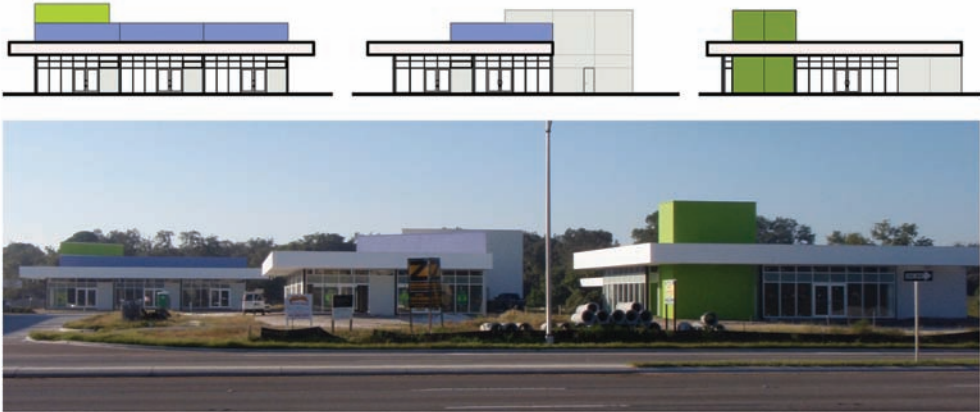


Figure 1-4. A paint scheme created after CD submission

One of the biggest responsibilities an architect has for most projects is monitoring the progress of a building during its construction, hence the true meaning behind the term Construction Administration. Throughout the entire construction process, there will always be questions or problems that arise which require the architect's attention. Besides having to deal with these questions, architects are paid to ensure that the project is being built according to the plan. Architects make site visits to observe the progress and quality of construction and notify the owner when problems arise.

When a project is complete to the satisfaction of the architect, the architect will issue a certificate of substantial completion **Certificate of Substantial Completion** and at that point, the architect's responsibility is usually over.

The Anatomy of Architectural Drawings

If you have never worked in an architectural office before or never had formal training in the architectural field, then a full set of architectural drawings can be quite an intimidating sight. Even for small projects a full set can easily contain over 100 individual sheets. For a very large project, several hundreds are not unusual. The drawings shown earlier in Figure 1-1 were over 120 sheets in all and that was for a relatively small building. The image in Figure 1-5 shows an example of **Specifications** that often accompanies a set of construction drawings. Specifications clarify in words many of the important details shown in the architectural drawings. As you can see from the image on the cover, the building is quite small, yet the specifications for this building are over 200 pages in length.

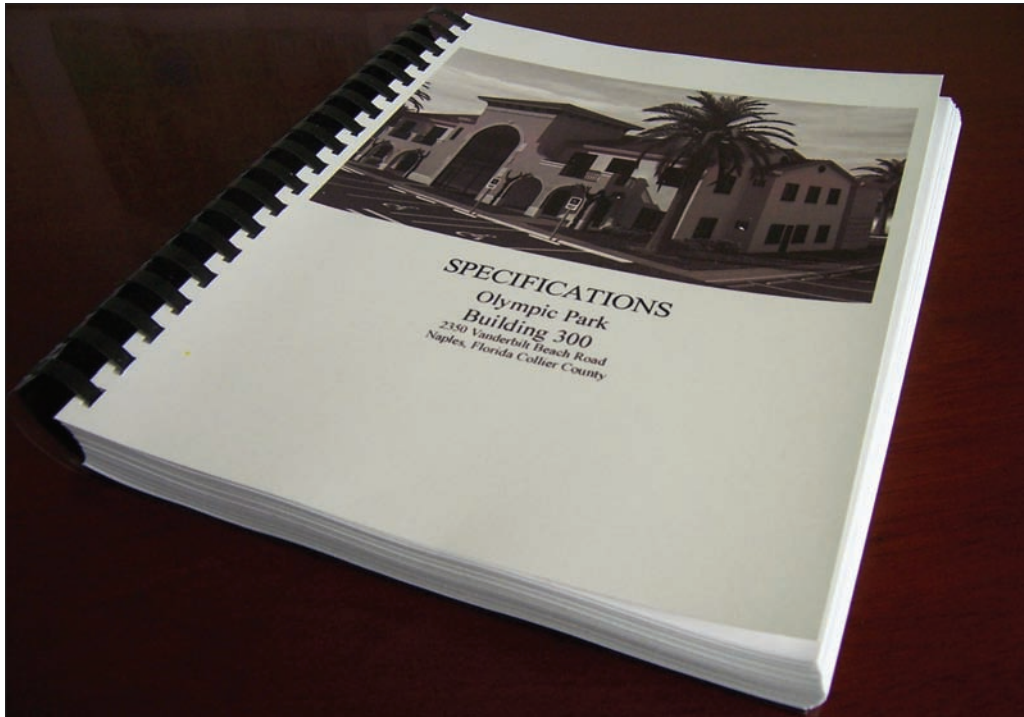


Figure 1-5. A typical set of specifications for an architectural project

Receiving this much information to decipher at the beginning of a visualization project can be extremely difficult. Unfortunately, the flip side isn't much better. Receiving too little information usually leads to even more problems. Fortunately, for the majority of what we do, we only need to rely on a few critical drawings to do our work.

As I mention several times throughout this book, you should never price a job without seeing the architectural drawings that you will have to work with. At the very least, you should price very conservatively to account for the numerous different ways that poor drawings and missing information can hinder your work. This is discussed more in later chapters. But unlike a contractor who needs every drawing to know exactly how to put the project together inside and out, a 3D artist only needs to focus on the drawings that depict the physical structures that will actually be seen. This usually means that the drawings most critical to a visualization are as follows:

- Elevations
- Floor plans
- Sections
- Site plans
- Landscape plans
- Roof plans
- Reflected ceiling plans

Of course in a perfect world, you would receive all of these drawings in complete CD form, but as is often the case, much of this information will either be lacking or incomplete. Notwithstanding the precautions mentioned earlier about beginning a project before receiving all the necessary

information, once the necessary drawings are received and you decide to begin your work, the first step in the 3D creation process is the preparation of AutoCAD linework for importation into 3ds Max. Obviously many 3ds Max users choose to model in other programs like Architectural Desktop and Revit, in which case preparing this linework is not really a necessary step. If you do choose to model in other programs, I highly recommend to at least explore the benefits of modeling solely in 3ds Max. Regardless, the first step in the 3D creation process is preparing the AutoCAD linework. But before beginning a discussion on this subject, I want to delve into an in-depth discussion on the various drawing types 3D users typically work with during a visualization project. The remainder of this chapter looks closely at how architects and drafters put each of the critical drawings together so that you can better understand what you're looking at when inside one of these drawings and better understand how to handle the linework. In Chapter 2, we will explore the basics of AutoCAD for those that have little or no experience in the program so that they may become familiar enough with the program to follow the procedures and techniques outlined in many of the remaining chapters. However, the focus of Chapter 2 is preparing AutoCAD linework for importation in 3ds Max and this subject will be covered thoroughly in Chapter 2 as well as many of the tutorials throughout this book.

Every architecture and engineering firm has their own standards for creating drawings and working with so many different standards can be difficult and time consuming for even experienced artists. What's more is that even when firms create their own standards, they don't always follow them. If you assume the worse when you receive drawings, then you will probably be more likely to find any problems and inconsistencies that exist.

Most of what is discussed in the remainder of this chapter deals with problems you might run into when working with architectural drawings and things that you should always be on the lookout for. Having spent several years as a drafter in architectural firms, I am aware of the numerous challenges that drafters and architects face when trying to get a set of drawings out the door. These challenges, if not dealt with properly in the architectural office, tend to migrate over to the desk of the 3D artist trying to make sense of what is sometimes an apparent mess of linework. So in the remainder of this chapter, I will attempt to make understanding architectural drawings a little easier for the less experienced 3ds Max user.

Sheet layout

Before discussing each of the important drawing types, I want to make a quick mention about the paper architectural drawings are printed on and the way sheets are ordered.

An individual piece of paper on which an architectural drawing is printed is usually referred to as a sheet. In the U.S., there are 5 standard sizes used for the vast majority of all sheets printed in architecture. They are as follows:

- ARCH A – 9"x12"
- ARCH B – 12"x18"
- ARCH C – 18"x24"
- ARCH D – 24"x36"
- ARCH E – 36"x48"

As you can see from the dimensions shown, each larger drawing is exactly twice the size of the previous drawing. Sizes A, B, and C are usually reserved for addendums, for showing small areas of a project, or for showing large areas at a small scale. Very large projects often make use of the E size drawings, but the most commonly used drawing size is the D size drawing.

For all but very small projects, a set of construction drawings will contain drawings grouped together in different sections. The drawings an architect creates in-house will be together in one area of the set (usually towards the very top of the set), the structural engineering drawings will be grouped together in another area, and the electrical, mechanical, landscape drawings, etc. will be grouped together as well, as shown in Figure 1-6.

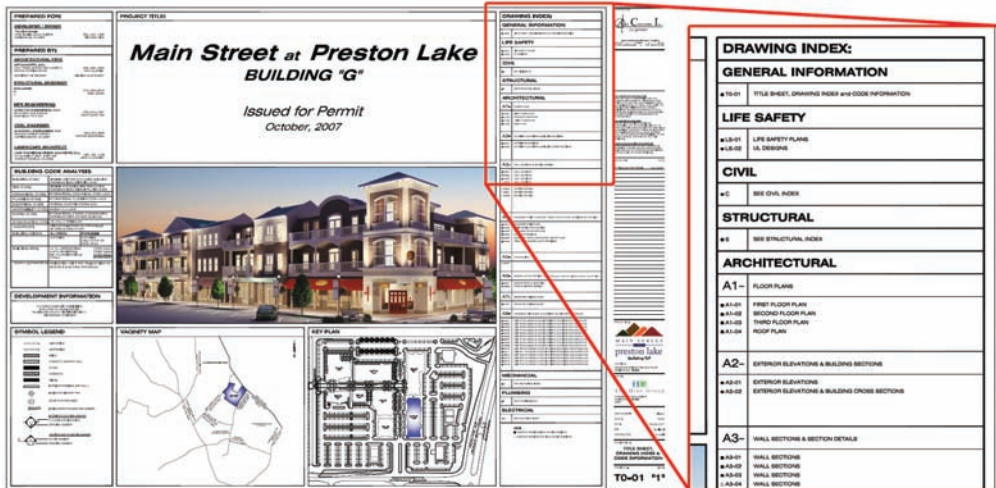


Figure 1-6. The title sheet of a set of construction drawings

Much of the information presented in the architectural drawings simply reiterates what is discussed in other drawings and many times the architect will simply make annotations on a drawing telling the reader to refer to another drawing. For example, if an architect decides that a column should go in a certain location, he is usually not allowed by law to select a column without the approval of a structural engineer. Not knowing what column type or size the engineer will ultimately decide to use, and not wanting to worry about updating his plans if the engineer decides to change the structural drawings, the architect will often just place a note on his floor plan that reads something like, "Column – See Structural Drawings". The architect still needs to show a column on his floor plan and foundation plan, but he is not required to specify any pertinent information about it. Understanding this relationship between the architect and all of the subcontractors that work for him, makes reading a set of architectural drawings a lot easier.

Elevations

Elevations provide viewers a better understanding of the scope and complexity of a project than any other drawing type. If this weren't true, then you wouldn't see elevations sitting in front of a project sight, as shown in Figure 1-7; you would see other drawing types, such as floor plans or sections. Although I always recommend reviewing all the important CAD drawings firsthand before quoting a project, it is not difficult to estimate a project based on what is visible in the elevations alone. An elevation is one of the 1st drawings created for a new project, if not the very 1st, because with it an architect can show a building's style, size, and complexity all at once. If an architect or owner does not approve of the 1st elevation, then a new elevation can be generated without having had wasted time working on floor plans or any other drawings.



Figure 1-7. A 3D rendering used to advertise a project under construction

When working on a building, a contractor can only use elevations as a visual aid. The contractor will never take measurements from an elevation and use that to determine things like window sizes, wall lengths, and door types. Because of this, some architects place a minimal amount of information on elevations and specify the critical dimensions and notes on other drawings such as floor plans and wall sections.

Since architectural drawings are printed in black and white, the only way to delineate differences in all of the lines on paper is by adjusting the line weight, or line thickness. In all drawings, heavier line weights usually indicate more important features in a project. For example in the left image in Figure 1-8, the outline of the standing seam roof is shown in heavier line weight than the thin vertical lines that indicate the standing seams. But in some drawing types, such as an elevation, heavier line weights can also indicate objects that are closer to view. Since all elevations show orthographic views, such as the left image in Figure 1-8 (rather than perspective views, such as the right image), line weights are the only way to show the viewer that objects are in the foreground or background. For example, notice that in the left image of Figure 1-8, there is a column just to the left of the building entrance on the 1st floor. The lines that delineate the outside of the column are thicker than the lines that delineate the same column just to the right of the door, because the column to the right is farther away from the viewer. Without this change in line weight for the two columns, there would be no way to know from just this one view that one column was farther away than the other. Regardless of what you perceive in this type of situation, if there is any doubt in your mind whatsoever, a quick check of the floor plan should confirm or refute what you visualize in the elevations.



Figure 1-8. The difficulty in determining depth in an orthographic image (left)

As mentioned, elevations provide the viewer with the best overall look and feel for a project. But just like all drawings, they have to be scaled down to fit within a sheet of paper, and because of this, the elevations can not show every little detail that goes into a building's construction. For example, the window elevations shown in Figure 1-9 only show one line to indicate window mullions. This is because at the scale that elevations are printed, drawing lines for every bend or corner in a window's profile would only result in one very thick solid line being shown. It is common practice among veteran 3D users to limit the amount of detail placed in a structure to that which is shown in the elevations. In other words, if it's an important enough feature for the client to want to see it in 3D, then it is usually important enough to place in the elevations. In fact, the contract that 3DAS sends out with every job indicates that all details shown in the architectural elevations will be included in the 3D model, and any detail not shown in the elevations will not be included in the 3D model unless expressly requested by the client. This kind of practice leaves little doubt for both the 3D user and client as to what will be included in the 3D model.

Obviously, this way of thinking requires some common sense. For example, if the architectural drawings show a single line to represent the mullions, then you clearly have to do a little research into the section details of the windows to determine what the mullion thickness should be. Likewise, when an architect can not draw all of the lines for every bend and corner of a window's profile, it's a good indication that it's not necessary to model every bend and corner. In the left image below, you can just barely distinguish separate lines indicating two major components of the window frame. Seeing these separate lines would be a good indication that the window frame you create in 3D should have at least one bend in its profile, i.e. two different parts at different depths.

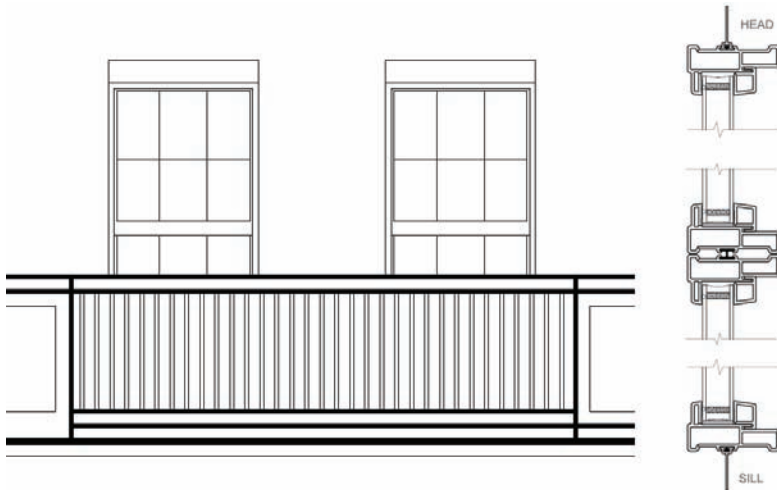


Figure 1-9. A typical elevation of a window (left) and the more detailed section view (right)

Elevations often provide clues about an object's structure that might at first go unnoticed. For example, in Figure 1-10, it might at first appear that the vertical bars in the railing are *completely* vertical, when in fact they are curved in two different places along their length. You can not see the curvature in this single orthographic view but a clue to their true shape can be found in the tightly spaced horizontal lines that run up the length of the bars. These lines indicate some sort of bend or corner and since there can not be that many corners in such a small area, the only logical reason those lines exist is to denote a curve to the shape of the bars. What makes these lines even more important is that another elevation from the side may not even show these curves because they might be hidden from view by other parts of the building. In fact, the corresponding floor plan probably won't give any indication of these curves either, and therefore, whenever you see these types of clues, it would be wise to look at the railing details or any building or wall section that shows a section cut of these railings.

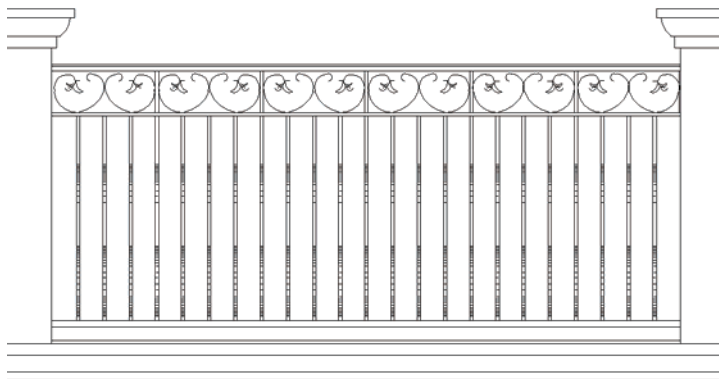


Figure 1-10. An elevation that reveals a clue that there's more than meets the eye

An additional point that I would like to make about the railings in Figure 1-10 is that unless you look at a detail drawing of the railing, there's simply no way to know whether the various parts of the railing have a square or circular cross section. In reality, it usually shouldn't matter because even if you know the cross section is circular, you shouldn't add the extra polygons if you don't need to, and unless your camera is extremely close to the railings, you would never be able to tell anyway. For railings that are completely straight, i.e. do not contain bends and curves, it wouldn't be too detrimental to build the railings with a circular cross section. But the railings in Figure 1-10 clearly have a significant amount of curvature, especially the intricate design in the top section. Adding a circular cross section to these railing could easily increase the polygon count 5-fold or more. Simply put, knowing how much detail to build into your objects is a critical part of scene optimization.

Floor plans

The heart of any set of architectural drawings is the floor plan. From the drafter who labors over its creation, to the engineer who uses it as a template for his or her drawings, to the builder who methodically erects the building to its specifications, no other drawing type receives as much attention and analysis as the typical floor plan. Floor plans show and delineate important building components of a single floor as seen from a top view and as seen from a particular vertical position between the floor and ceiling. The primary responsibility of a floor plan is to show precisely where walls, windows, and doors are located, and depending on the type of project and drawing practices of the architectural firm, may include other critical building components such as beams, columns, roof overhangs, and floor and wall finishes (or surfaces).

When a builder starts the construction process, the drawing that the builder will be most focused on is the foundation plan, because you can't erect walls, windows, doors, etc, without a foundation in place. On very small projects, the information usually placed on a foundation plan might be incorporated in the floor plan, but in most construction drawings, the foundation plan is a self contained drawing that delineates important structural information. This critical information including footing sizes, slab thickness, beam and column locations, etc., comes from a structural engineer, but that information starts with a floor plan. During the design development stage, an architect will provide the structural engineer with a floor plan, and using that floor plan as a template the engineer can design the structural components of the building. If the structural engineer decides that walls have to be moved or columns have to be changed, architects will then adjust the floor plan within the construction drawings to accommodate the necessary structural design change. The same kind of process is repeated with each of the engineers (mechanical, electrical, plumbing) involved in the design, so it should be easy to see how the floor plan serves as a central authority from which all other drawings are generated.

On a floor plan, lines representing the exterior of a wall usually do not actually indicate the exterior surface but rather the outside surface of the load bearing component within the wall. This means that even if the exterior side of a wall contains a 1-inch trim feature running along the bottom of the wall, as shown in Figure 1-11, the floor plan will still reflect where the main load bearing part of the wall is (in this case the concrete block). The line on a floor plan representing the exterior of a wall will still almost always represent the outside surface of the concrete block, or whatever load bearing component the wall is made from. When you begin setting up your linework for importation into 3ds Max, I recommend aligning all the available elevations to the floor plan in this manner. If drawn correctly, both sides of the elevation will align to the floor plan as shown in Figure 1-11.

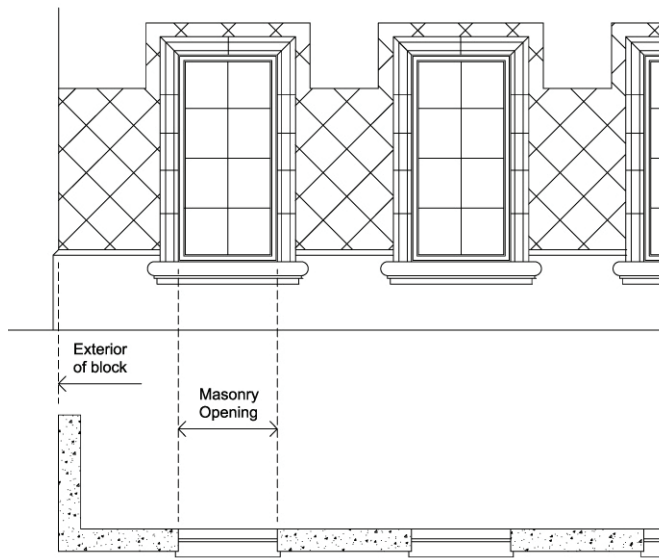


Figure 1-11. Projecting a floor plan onto an elevation

If a project involves creating an exterior visualization only, then you don't need to be concerned with anything inside the building, except for those elements that you want to see through the windows. Therefore, you usually don't have to be concerned with something as insignificant as the exact location of the interior surface of an exterior wall. When preparing the CAD linework for importation into 3ds Max, in most cases I will simply trace the linework representing the exterior surface of the walls, and offset these newly created lines 8 inches. Tracing the existing linework ensures that the linework I import is flawless and offsetting the linework 8 inches ensures that I have a sufficient wall thickness to house all windows and doors. The fact that the walls may actually be 8.5 inches, 9.25 inches, 10.1 inches, etc, really is an irrelevant thing that will never be noticed. Perhaps if the wall thickness were as large as 12 inches, I would then offset the exterior lines 12 inches.

This same type of mentality should also apply to a project where all you need to create is an interior visualization. For an interior scene, you would obviously need to use the linework on a floor plan that represents interior walls; however, every architect has their own unique way of representing interior walls. Some choose to depict walls with two lines showing a rough approximation of the actual wall thickness, while some choose to show two lines representing stud thicknesses along with an additional line on either side depicting a particular wall finish. Some choose to dimension their walls and others choose to label their walls with an annotation that directs viewers to look at a wall schedule to determine the exact wall thickness. Regardless of how interior walls are depicted on a floor plan, 3D artists should not be concerned with what's inside a wall, but rather that the linework is located in an approximately accurate location. Accuracy in 3D is a difficult concept for many users to prioritize, and it's important to understand how to prioritize the accuracy of the linework you prepare for 3ds Max. For example, if you have a tiny one-quarter inch gap showing between two walls that should be perfectly joined, that is a really bad thing because light can easily seep through and the viewer will almost always see this kind of inaccuracy. However, if your wall thickness is off by that same amount or if your wall placement is off by that same one-quarter of an inch, the viewer will never know or care.

Checking floor plans against elevations is an important part of preparing the CAD drawings for use in 3ds Max. In Figure 1-11, notice that in addition to the side of the building being aligned properly, the masonry openings are also aligned. If this were not the case, then the client will usually want you to build per the elevations, since they best reflect what the client understands the building will look like. One more point I would like to make about this image is that the windows have a substantial trim feature around the top, left, and right sides of each window. It would be impossible to know for sure what the cross-section of this trim feature looks like for sure without referring to a section drawing or a detail drawing that includes a section cut through the window.

Perhaps the most important feature found on a floor plan is the dimension. Engineers will always use a floor plan's dimensions to design their elements and builders will always use dimensions to guide their construction. 3D artists have little need for dimensions, however, because as just mentioned, the linework used in 3D doesn't need to be as accurate as the linework used by the actual builder. For example, if a drafter modified a floor plan dimension at the very last minute without adjusting the linework properly, which happens all the time, this should be of no concern to the 3D artist. So after receiving a drawing from an architect, one of the very first things I will do is remove all of the dimensions. Floor plans tend to also contain a great deal of notes, and while some of these notes may provide important reference information that would be useful further along the 3D creation process, much of what is found can be removed along with the dimensions. The idea is to remove everything from all drawings that is simply not going to prove useful in 3ds Max. Importing hundreds of dimensions, notes, hatch patterns, etc., will only slow your work down in 3ds Max.

Sections

Section drawings provide a cutaway view of a building from the side to reveal what lays beneath the surface of each building element the section cuts through. In a set of architectural drawings, there is usually one or two building sections that show a complete section view of the entire length of the building, and several wall sections that provide a partial section view of areas that need special emphasis, as shown in 1-12.

The main purpose of a section drawing is to illustrate information that cannot be easily derived from other drawings. For example, the left image of Figure 1-12 shows part of an elevation, but it can not be determined from this elevation alone or any other drawing type (beside a section) where the roof of the building is located. If the elevation contained an elevation marker indicating that the roof is located, for example, 15'-0" A.F.F. (above finish floor), then you would not need to refer to a building or wall section. However, as mentioned, every architectural firm has their own way of creating drawings and this is not something you are guaranteed to find on a drawing. If such a note does exist on an elevation, then that would be an example of a note that is worth keeping for later reference when the time comes to create the roof. So if you want to determine where the roof is positioned in the elevation of Figure 1-12, simply refer to drawing B on sheet A5.1 and you would see the appropriate section and the true location of the roof.

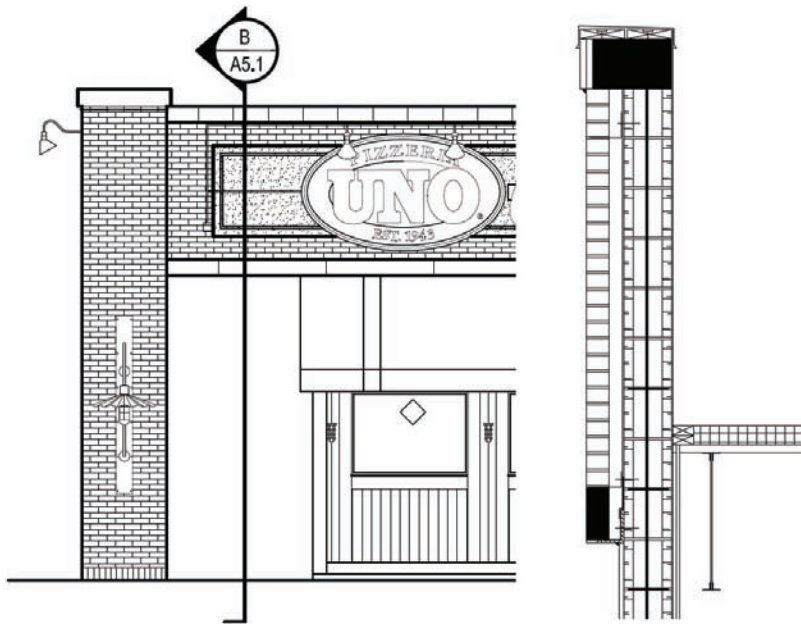


Figure 1-12. A section drawing revealing the location of the roof - information missing from the elevation

It's important to note that while every firm has their own unique way of creating drawings, there are some general guidelines that most firms follow in the creation of section drawings. First, when a section view cuts through an object, that object is usually shown with a hatch pattern. In the right image of Figure 1-12, notice that the roof that was just discussed contains numerous horizontal and vertical lines. This is nothing more than a hatch pattern to indicate that the roof is not just some object in the background of the section but rather is an object being cut by the section. Notice also in this image that there are two rectangular areas that contain a solid hatch. This type of hatch is usually reserved for beams or areas where concrete is poured into place.

As 3D artists, we shouldn't be too concerned about what the inside of a wall looks like or what materials make-up the floor or ceiling of our visualization. However, it is important to understand what each component of a section drawing is depicting, so that we know where to find the missing information that we can not find on other drawings.

As an additional note about section drawings, they are often very helpful in the creation of lofts or sweeps. As a matter of preference, I always create walls using the loft or sweep feature rather than extruding splines or using the Edit Poly feature that some users prefer. If you want to ensure that the shapes which you loft or sweep contain the highest level of detail possible, you might need to generate your shapes using the section drawings. Due to the large scale that elevations are usually printed at, such as 1/8"=1'-0", there is only so much detail that architects want or need to put into the elevations. Earlier I had mentioned that if the detail is not shown in the elevations then it typically does not need to be seen in 3D (except for close-up views). While this is a good rule of thumb, when detail *is* needed, you might simply have no choice but to build your shape from a section drawing. In Figure 1-13, you can see an elevation that doesn't contain as much detail about the soffit and fascia as the section drawing. By using the section drawing as a guide, rather than the elevation, you can trace a much more detailed shape to use for your loft or sweep, as shown on the right side of the image.

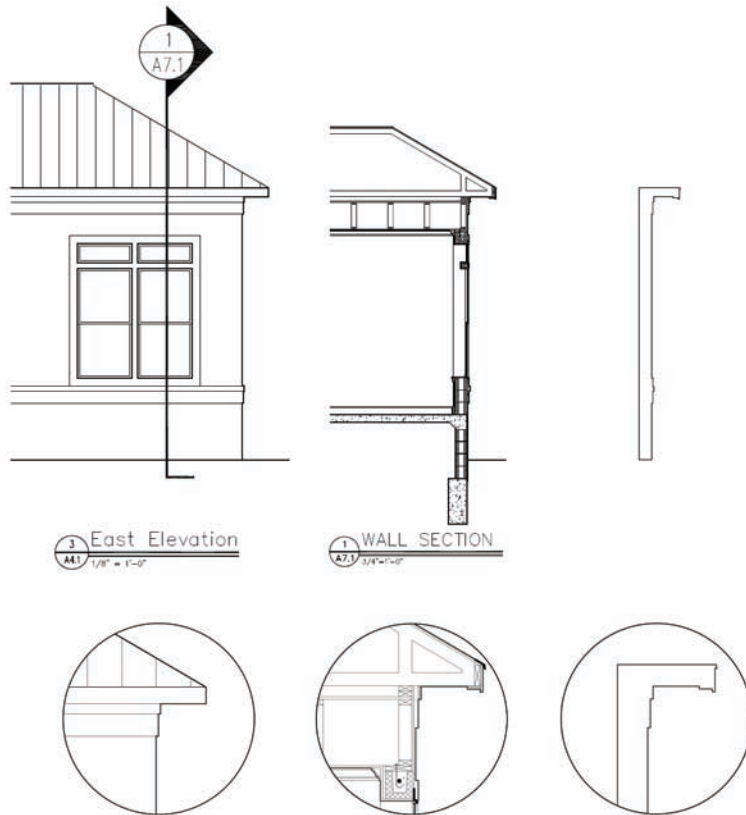


Figure 1-13. A section drawing used to create a more detailed shape than what the elevation can provide

Site plans

I believe that if there is any drawing type that 3D artists struggle with understanding more than any other, it would have to be the site drawing. This is primarily because site drawings are convoluted with far more information than a 3D artist would ever care to see or know about and while the information is important and necessary to the contractor building the project, the majority of information found on most site plans only makes understanding the linework more difficult. Figure 1-14 illustrates this problem quite clearly. The top image shows a large site drawing over 300 acres and the bottom left image shows a close-up of one area. As you can see, there is an enormous amount of linework that is simply unnecessary for the 3D artist. The bottom right image shows the same close-up with all of the unnecessary information removed. Taking this 'dirty' site plan, as I call it, and turning it into a 'clean' site plan can be quite a challenge for even an experienced 3D artist if he or she does not understand some basic principles about how site plans are created.

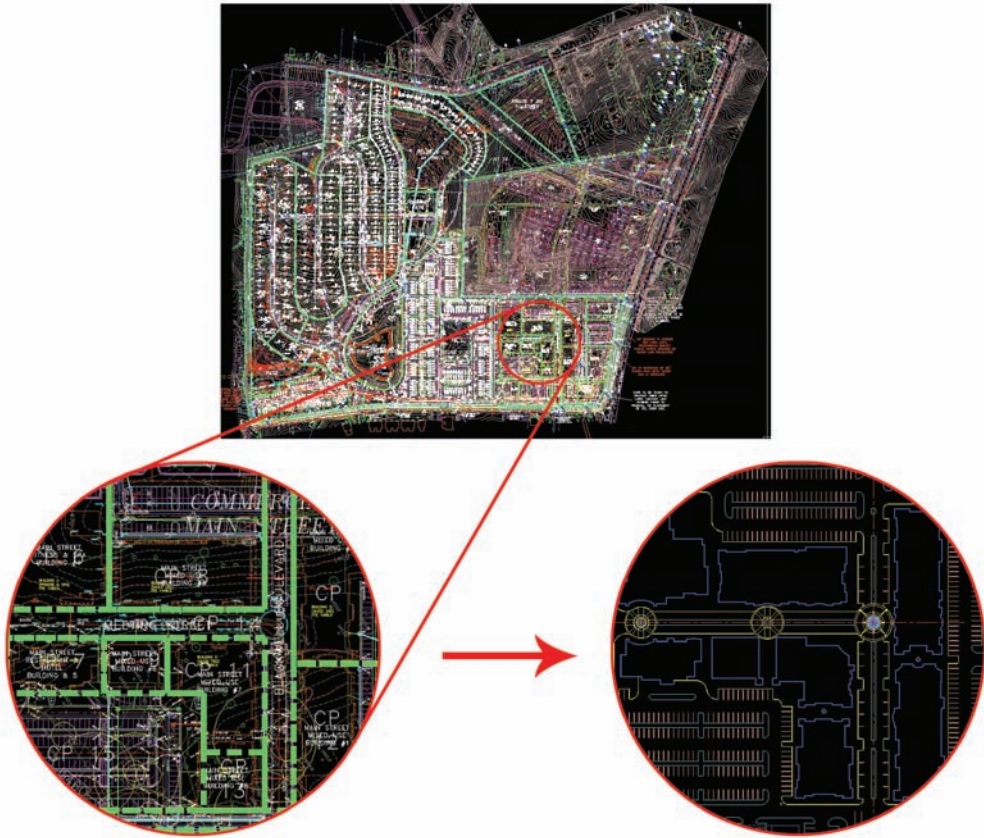


Figure 1-14. An example of a 'dirty' and 'clean' site drawing

As mentioned earlier, architectural drawings reiterate a great deal of information presented by the subcontractors. In the case of a site drawing, architects will usually always include their own watered down version of a site plan that contains a fraction of the information provided by the civil engineer that creates the master site plan. The primary reason for this is so that the building department and the other subcontractors involved in the project can see and understand the overall site concept without needing a degree in civil engineering. If an architect presented the more convoluted site plan to the building department, some of the members deciding whether or not to approve the project might have no clue as to what they were looking at. So the architect's job is to take the civil engineer's drawing and remove all but the most important features that are critical to winning approval by the building department and critical to helping the other subcontractors design their respective areas of the project. Figure 1-15 shows an example of an architectural site plan with just the most important information, such as setbacks, property lines, retention areas, new walkways, etc. In this particular drawing, the fire protection plan is combined with the site plan because of the simplicity of both individual drawings.

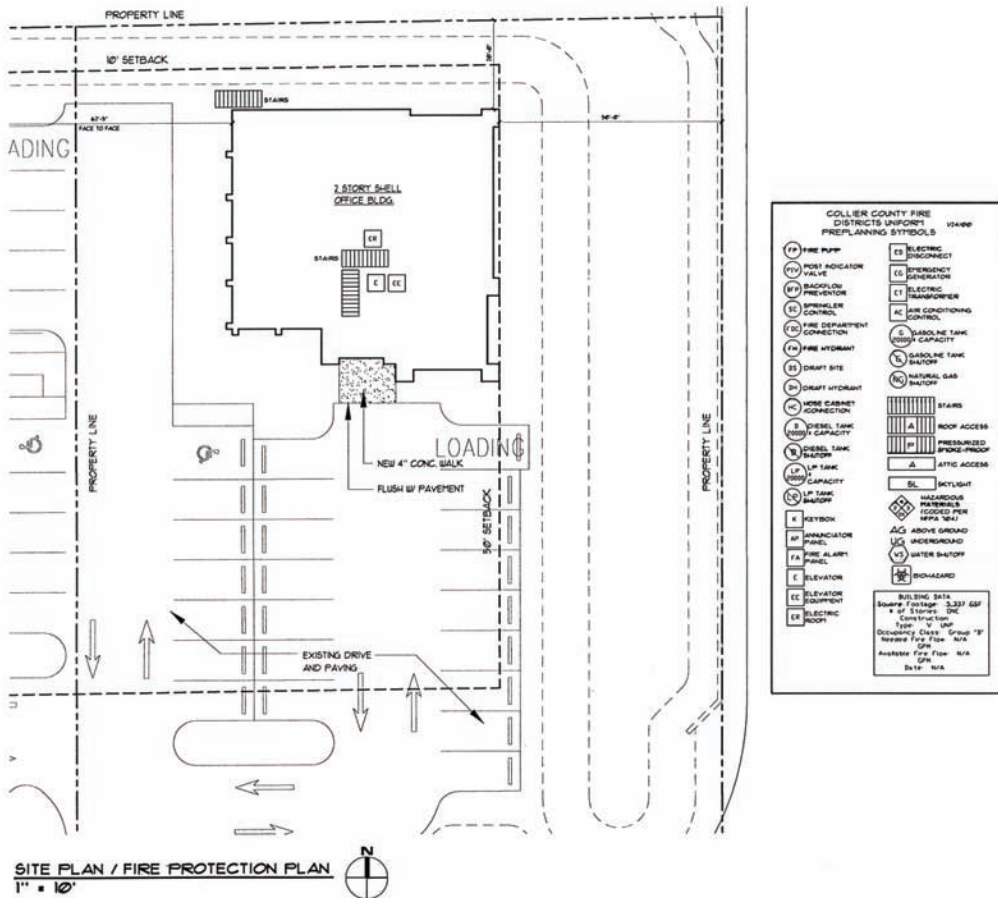


Figure 1-15. A typical architectural site drawing

Civil engineers use a different scale than architects and because of this, the drawings that you receive from an architect may need to be scaled properly before they can be superimposed with the drawings used to create the buildings in your project. Civil engineers use decimal units with 1 unit equal to 1 foot. Architects, on the other hand, use architectural units with 1 unit equal to 1 inch. It should be mentioned here, however, that in most countries besides the U.S., architects and engineers both use the metric system. Regardless, civil engineers in the U.S. create their drawings with 1 unit equal to 1 inch, which means that the drawings are created at 1/12th the scale of the drawings that an architect creates. This means that if you want to superimpose a building's linework on the site drawing, you will need to scale the site drawing up twelve-fold in order for the footprints to match.

Another thing that makes understanding site plans difficult for some users is that when an architect sends a site plan for a project, it usually does not come with such details as the one shown in Figure 1-16. Many architects don't think to send this type of drawing to the 3D artist and many 3D artists don't think to ask for it. But without this kind of detail, the 3D artist is left to guess at the details of key features. In this image, you can see a particular type of curb profile, and in this drawing it's actually given the callout, 'Type F'. This means that somewhere in the civil engineering drawings, there's a detail drawing entitled 'Type F' and if the 3D artist creates anything other than this curb type, there is a good chance that the owner or architect will have something to say about

it. Whenever you work on a drawing (such as a site plan) where it's impossible to know exactly what is going on, it's better to ask the client for more drawings or more information. Otherwise, the consequences could be costly and time consuming.

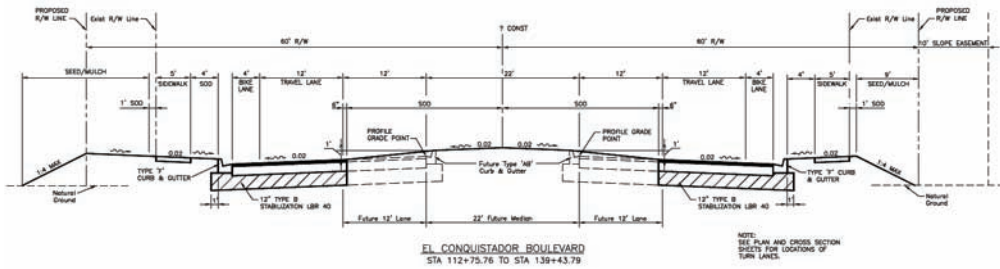


Figure 1-16. An example of a site drawing detail

Landscape plans

In the previous discussion about site plans, I stated that *"I believe that if there is any drawing type that 3D artists struggle with understanding more than any other, it would have to be the site drawing."* I certainly believe this to be true, but if there is one drawing type that users actually struggle with conforming to, it would without a doubt be landscape drawings. Landscape drawings present a challenge to many users because vegetation is one of the most difficult, if not *the* most difficult type of visualization content to create realistically. Just like poor lighting can ruin a perfectly modeled and textured scene, poor landscaping can ruin a perfectly illuminated exterior. In my experience, I have found that landscaping is rarely ever a focal point of a project. However, when not created realistically, it quickly becomes the most distracting component of a visualization.

There are numerous reasons why landscaping is such a difficult part of architectural visualization. One reason is that many clients don't have a landscaping plan prepared at the time they ask for your services, and when asked about the landscaping, their typical answer might be, "just throw in something that looks nice" or "just make it tropical looking". But because most of us aren't landscape architects, these requests are easier said than done. Another reason is that there are tens of thousands of plant and tree species in the world and if the client wants the same vegetation that is specified in the landscape drawings, it is often very difficult to find a suitable match in one's library. Even if you own an extremely large library or own a plugin that allows you to create vegetation from scratch, it is often very difficult to replicate the look of the actual vegetation specified in the landscape drawings.

Before accepting or quoting a project, I highly recommend asking the client exactly what he wants to see for landscaping. Specifically, it would be wise to ask the following questions at a minimum:

- Are there landscape drawings? If so, are the drawings just temporary and made only to satisfy code or will there be a new landscape plan designed down the road?
- How closely does the vegetation in 3D have to match the vegetation that will actually be planted? Can I, for example, use a Foxtail palm in lieu of a Queen palm.
- Do you want to see fully matured vegetation or younger vegetation like the kind that will actually be planted?
- Are the hardscape elements (pavers, coping, etc) finalized? If not, when will they be?

The answers to these questions can greatly affect the amount of rework you have to perform so it would be wise to cover yourself by stating in the contract what the consequences are of the different possible answers you might receive. For example, if there are no landscaping plans, and the client wants you to play the role of landscape architect, are you going to charge extra for this work and what happens if the client doesn't like your design?

As indicated in the last question, landscape architects are usually responsible for designing hard-scape elements like pavers, coping, pool decks, walkway patterns, etc. If you do not see these details on the architects site plan, which in my experience is rare, don't assume that they will not be needed. One of the great marketing advantages of working with a client on a 3D visualization is that you will often be asked by the client to contact the various subcontractors directly to obtain the information or drawings you need. Take advantage of this opportunity and place a call to the landscape architect (or any sub) and ask them directly the type of questions just mentioned. You will often find the landscape designer giving you significantly different and more accurate information than the project architect. Of course this is true for any sub contractor that you deal with, so it's always good to ask questions.

Landscape architects usually delineate their vegetation selections in one of two ways; by placing annotations next to groups of plant and tree symbols, as shown in the left image of Figure 1-17 or by creating a legend of symbols and using those different symbols in the landscape plan to indicate the different types of vegetation, as shown in the right image. In the left image, notice that there is a callout for 4 Foxtail palms and that the callout is pointed to only one symbol. Since the annotation refers to 4 Foxtail palms, you should see 3 other identical symbols close by, as the image shows. Underneath each callout in the left image and under the Specification header on the right image is the information for the size of the vegetation to be planted. It is obviously important to create your vegetation at the correct size, however, I find it easier and perfectly sufficient to just import the vegetation symbols and use their canopy sizes to scale the vegetation to proper size.

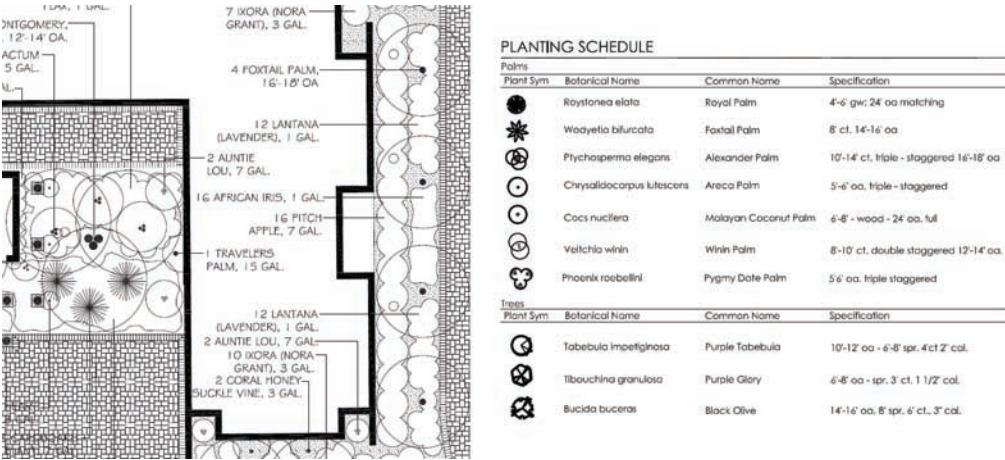


Figure 1-17. Examples of landscape annotations

As a final note about landscaping, the larger the vegetation, the more important it is to create correctly. In the left image of Figure 1-17, for example, it is far more important to make sure that the large Foxtail palms look like Foxtail palms than it is to make sure that the very small African Iris plants look correct. You should obviously try to match vegetation as well as you can, but when you simply don't have the correct model in your library or when you don't have the time to create it from scratch, it is far better to sacrifice accuracy on the smaller vegetation. In fact, as long as your camera isn't too close to the vegetation in question, you can use the **Scatter** feature to very quickly create vegetation that has the general look you need to achieve. For example, if you want to create a large number of small hibiscus plants with white flowers, simply scatter an individual face with an appropriate image of a green leaf around a volume that represents the location of the plants and then scatter a face with an image of a white flower. By controlling the number of duplicates you can easily control the density of the green leaves and white flowers and by controlling the size of the individual faces that get scattered, you can control the quality (or accuracy) of the vegetation and the shadows that get cast. Techniques like these are discussed throughout the rest of this book.

Roof Plans

Except for flat, simple roof designs, a roof can be another extremely difficult object type for 3D artists to create. With some programs like Revit or Architectural Desktop, you can create simple roofs in literally just a few seconds. However, with roof designs of any degree of complexity, these programs simply don't make things any easier. Once you start introducing curves, changes in elevation, or unique frame structures, creating a 3D roof in 3ds Max becomes much more practical and efficient.

I think it would be safe to say that before you can create a roof in 3D, you must know how to create one in 2D, and unless you've worked in an architectural office doing just such a thing, this might be quite a difficult undertaking. Having spent several years as an architectural draftsman, I've probably drawn over 100 roof plans for all types of buildings, but for very complex roof structures I still find myself struggling today. Unfortunately, roof plans are not always available when a client approaches you for a 3D visualization, and when this is the case, your only choice is to wait on the architect to provide one or to create one yourself. Regardless, unless you know how to draw a plan in 2D, you probably won't have much success creating one in 3D.

Relatively speaking, roof plans do not usually contain a great deal of linework because there are really only a few critical things that the architect needs to delineate. The most important thing to show is the location of roof ridges, hips, and valleys, but other important things include, roof pitches, gutter locations, roof surface materials (i.e. tile, shingle), and exterior wall locations, all of which can be seen in the example in Figure 1-18.

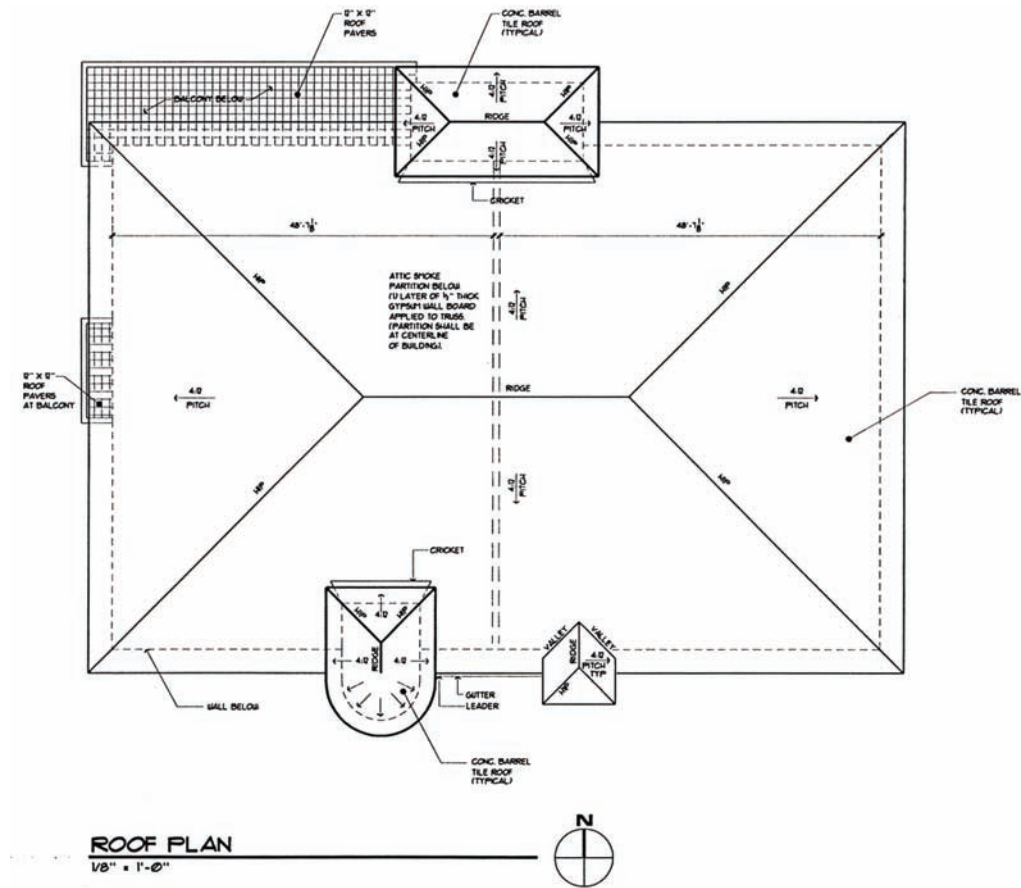


Figure 1-18. An example of a roof plan

Unless a very unique roof design is called for, two adjacent roof planes 90 degrees apart in orientation, will always meet to create a hip at exactly 45 degrees, as shown in Figure 1-19. When one roof structure joins into a completely separate roof, a valley will be created, also shown. Notice also in this image that the apex of this roof is labeled ridge and that the slope of the roof, known also as pitch, is labeled as 4:12. The 4:12 is also known as the rise over run because the roof rises 4 feet for every 12 feet it runs horizontally. The only reason the hip lines would not be exactly 45 degrees in orientation is if the adjoining roof surfaces were not at the same slope. Because of the annotation **TYP** (short for **typical**) in Figure 1-19, we can clearly see that all three roof surfaces have the same 4:12 slope.

Knowing this basic information, you can very quickly create the 2D linework for many simple roof designs by drawing lines representing the roof overhangs (the distance from the exterior walls to the edge of the roof), and connecting the various roof surfaces with straight 45 degrees lines and horizontal/vertical lines representing the ridges.

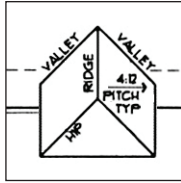


Figure 1-19. An example of a hip and valley connection

Figure 1-20 illustrates some other features commonly found on a roof plan. Notice that the top side of this image shows a horizontal line for the roof's edge rather than two valley lines where one roof join into another. This is a clear indication that this particular roof is completely separate from the main roof and in fact stands well above it. If this small roof ran into the larger roof, we would see two valley lines at 45 degrees. Another indication that this smaller roof is independent of the larger roof is the dashed line representing the exterior wall surfaces below. Dashed lines are used to delineate structures below or above the view of whatever is being displayed. In this case, we can see a completely separate set of lines for this roof, which would only be shown if this roof was rising through and above the main roof. Yet another indication that this roof is elevated above the main roof is the annotation of a building element known as a cricket. A cricket is a structure that redirects rain water so that it runs off the roof rather than collecting behind a wall that rises through a roof. Because we see a cricket callout on the roof plan, we know that there is a wall coming up through the main roof.

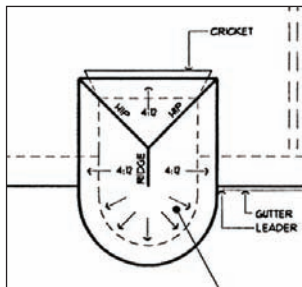


Figure 1-20. An example of a cricket

This section has highlighted just a few things to help make understanding roof plans a little easier. Later in this book, we'll look at various methods used to create 3D roofs from this 2D linework.

Reflected Ceiling Plans

The last drawing type that I want to discuss is the reflected ceiling plan. This drawing type, shown in Figure 1-21, gets its name from the idea that if you look straight down on a mirror lying on a floor, you would see the reflection of the ceiling in the mirror. This drawing is usually only needed for interior scenes, but without it, you would probably find yourself playing the role of an architect designing the layout of important building elements such as light fixtures, ceiling fans, suspended ceilings, soffits, etc., all of which are found on the reflected ceiling plan.

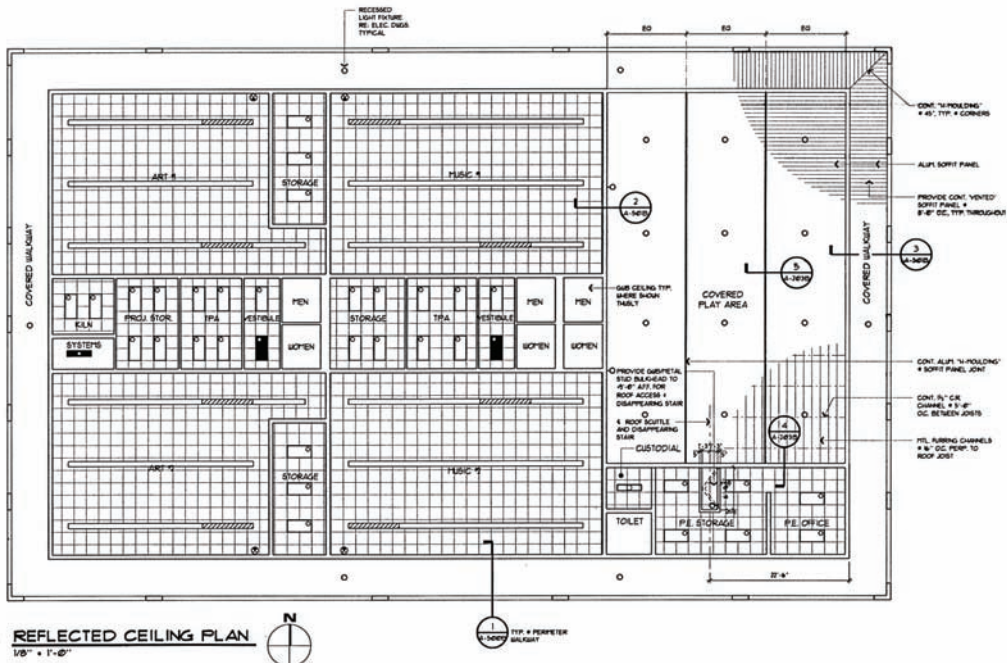


Figure 1-21. An example of a reflected ceiling plan

Like a floor plan, the reflected ceiling plan shows certain building elements cut through. But unlike a floor plan, where the cut plane usually exists about half way between the floor and ceiling, the cut plane for the ceiling plan occurs just below the ceiling, thereby excluding windows and doors from the cut. Notice in Figure 1-21 that no doors or windows are shown. However, the magnified image in Figure 1-22 gives a clear indication of columns along the covered walkway being intersected by the cut plane. The columns are shown with a bolder line weight while beams that run between them are shown in a lighter line weight. This allows the architect to highlight the location of important building elements (like beams) that might be excluded from the floor plan. The architect *could* show the cut running through windows and doors, but this would serve no purpose and would only convolute the drawing with unnecessary linework. Notice also in Figure 1-22 that other important features like soffit panels can be detailed. With the exception of a section drawing, this kind of information could not be found anywhere else. One other important piece of information commonly found on reflected ceiling plans is ceiling height. The plan shown in Figure 1-22 does not show ceiling height because there is only one ceiling height used throughout the entire building and this was noted on the floor plan; however, the reflected ceiling plan is often the main reference point for specifying ceiling heights.

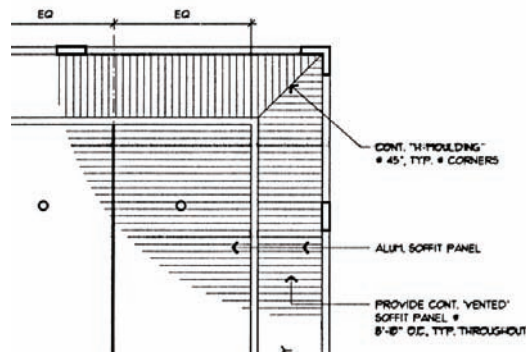


Figure 1-22. An example of a reflected ceiling plan

Summary

The purpose of this chapter is to help 3D users understand the process of creating architectural drawings and some of the important characteristics of the most important drawing types for work in 3D. Many visualization artists migrate from other industries and understanding architectural drawings can be quite difficult. Unfortunately, being an expert in 3ds Max doesn't help much when it comes to reading architectural drawings or understanding how they are put together. Without knowing how to read drawings, there's really no way to create what you need to in 3D and without knowing the process of creating architectural drawings, you are far more likely to run into some of the many problems mentioned in this chapter that can come up along the way. Hopefully, before continuing on with the remainder of this book you have a thorough understanding of concepts discussed in this chapter. If so, the techniques described throughout this book will be much easier to understand.

