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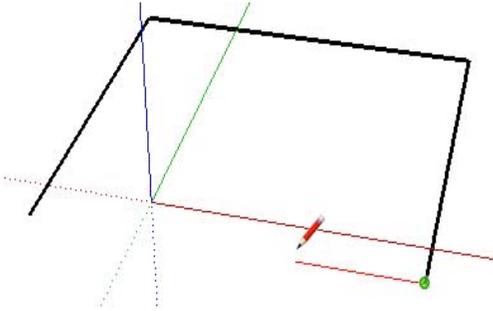
This guide covers the numerous 3D design and SketchUp concepts found within the product and in the user community. This section was primarily written for users who are new to 3D modeling or SketchUp.

Note: This section does not cover how to do something in SketchUp, but covers important concepts necessary to model in 3D.

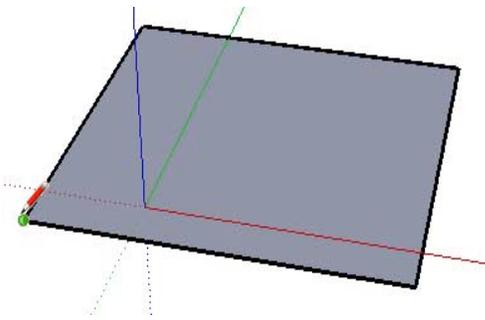
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Designing in SketchUp

SketchUp models are fundamentally created by joining lines as the edges of the model. Faces are automatically created when any three or more lines or edges are in the same *plane* (an infinite flat 2D space), or *coplanar*, and form a closed loop. These edge and face combinations are combined to create 3D models. The following image shows three unconnected coplanar lines. These lines were drawn with the Line tool (this tool looks like a pencil).

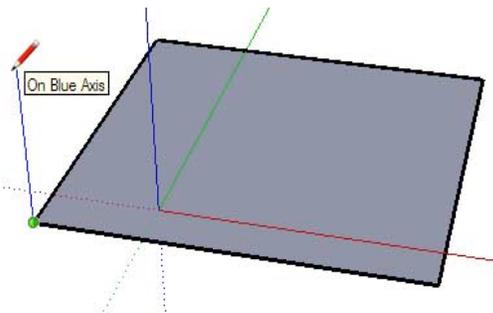


The following image shows four connected coplanar lines and the subsequently created flat, 2 dimensional, face.

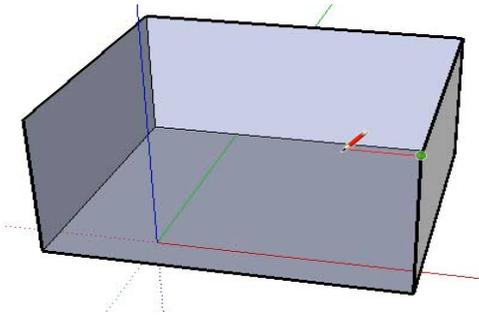


Note: Everything you draw in SketchUp is generically referred to as *geometry*.

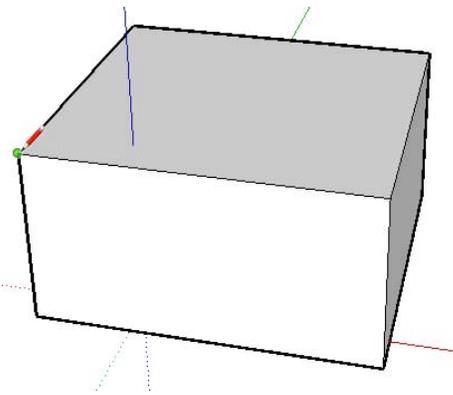
To create a 3D model, simply draw up or down in the blue direction (parallel to the blue axes). The coordinate system (axes) is covered later in this section. The following image shows the first line created in 3D space.



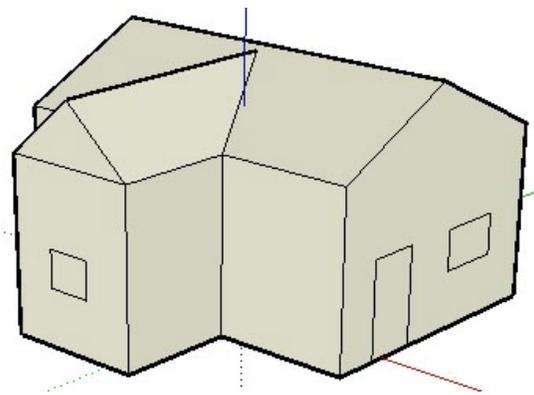
As you continue to draw lines, following the colored axes, faces are created. The following image shows four faces created simply by drawing lines parallel to the three axes directions (red, green, and blue).



There is one line left to draw to finish a 3 dimensional box. Notice that when this one line is drawn in, two faces are created (the top and front faces).



You can do a lot in SketchUp simply by drawing lines to form faces using the Line tool. And, you can draw lines starting anywhere (on another line, on a face, at a point, and so on). Can you recognize the previous 3D box within the model of the following house?



Look around the room you are in. Notice how everything you look at has faces. Some faces might be rounded, some might be flat. Additionally, everything has edges that bound the face, such as the edge of a shelf in a bookshelf.

Note: SketchUp is not the same as *Computer Assisted Design* or CAD. CAD applications are designed specifically for representing concrete information, while SketchUp is for exploration and design of concepts and ideas (though you are not prohibited from designing models that are as concrete or accurate as those designed in CAD).

PRO SketchUp files can be imported into several different CAD applications for further processing and several different CAD files can be imported into SketchUp to quickly create 3D models.

Introduction to entities

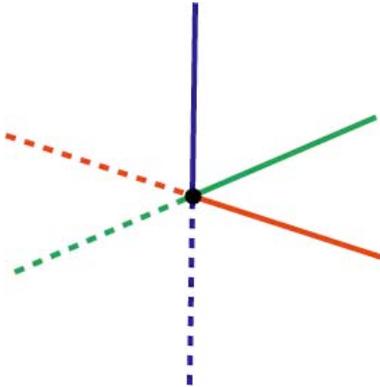
As mentioned previously, lines are combined to create faces in SketchUp. Lines (also called edges) and faces, are just two of the many building blocks (called *entities*) used for creating models in SketchUp. A full list of SketchUp entities follows.

Name	Notes
Line	Lines in SketchUp are straight. Lines, also referred to as edges, are the most basic building block for all SketchUp models.
Face	Faces are created automatically when three or more coplanar edges form a closed loop. Faces have a front side and a back side. SketchUp attempts to put the front side of all faces on the outside (facing out) of all of your models, though sometime you might have to tell SketchUp the direction for your faces.
Circle	Circle, arcs, and curves are comprised of several lines or edges.
Arc	
Polygon	
Curve	
Polyline	
Group	<i>Group entities</i> are used to combine two or more entities in your model for quick operations such as a copy.
Component	<i>Component entities</i> are like groups but can be reused in all of your SketchUp models. Components are just SketchUp models used within other SketchUp models.
Guide Line	A <i>Guide Line entity</i> is a temporary line used as a drawing guide.
Dimension	A notation indicating length of an edge or a radius.
Surface	<i>Surface entities</i> are the result of combining a number of faces to give the impression of smoothness.
Section Plane	
Image	An imported raster, or pixel-based, image.
Text	Text can be unattached (floating) or attached to a specific entity using a leader line.

The SketchUp coordinate systems

SketchUp uses a 3D coordinate system whereby points in space are identified by position along three *drawing axes*: plus or minus X, Y, and Z (above ground/below ground) values. In SketchUp, plus or minus X is represented by solid red and dotted red lines respectively; plus or minus Y are represented by a solid green and dotted green axis lines respectively; plus or minus Z (above and below the ground plane) are represented by solid blue and dotted blue lines respectively. The plane where the red and green axes lines lie is called the *ground plane*. Finally, the term *origin* is used to define the place where all of axes lines start or originate.

The following image shows the drawing axes in SketchUp (the lines have been thickened to make the axes easier to read). The black circle represents the origin.

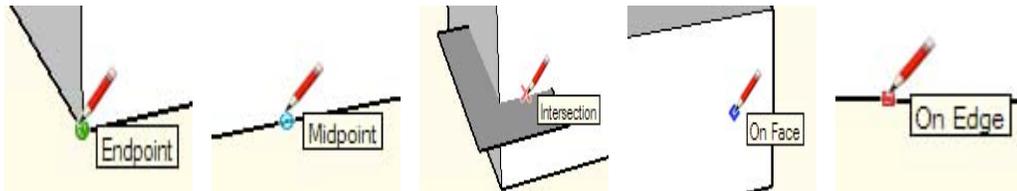


Understanding SketchUp's coordinate system is important because SketchUp's inference engine (explained next) provides you help with drawing accurately.

Following the inference engine

SketchUp has an invisible *inference engine* to help you draw accurate and realistic models. The inference engine locates or infers points from other points in your model, such as the center of a circle, the midpoint of a line, a line that is perpendicular to the ground plane, a point on a face, a point on an edge, and so on.

SketchUp notifies you of these points by using both color indicators and tool tips, which are on-screen messages indicating the location of the cursor as you draw an entity. For example, SketchUp displays the string 'On Face' when the cursor is touching a face. The following image contains five common inference tool tips .



Additional information on the inference engine, including inference types, is in the section of this guide.

The first step to drawing in SketchUp is to learn how to draw accurately by following the cues of the inference engine. Simply select the Line tool (it looks like a pencil in the toolbar or tool pallet) and start drawing. Pay attention to the on-screen tool tips from the inference engine as you draw. Most everything you will create in SketchUp can be created by inference using the Line tool.

You can move on to learning how to draw quickly after you master using the inference engine.

PRO = Functionality only available in SketchUp Pro

Drawing quickly

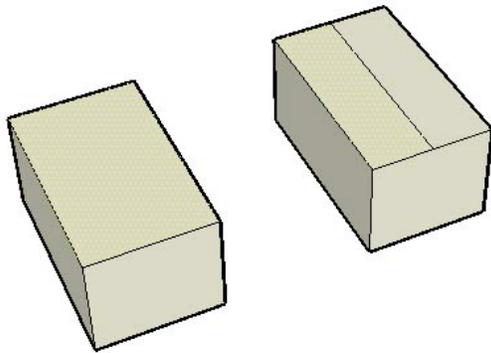
As mentioned in the Design in SketchUp topic, you can use the Line tool and the inference engine, to draw just about anything in SketchUp. It is recommended that you use the Line tool and inference engine to create your initial models.

Learn to draw accurately before you learn to draw quickly and you will master SketchUp in a shorter amount of time.

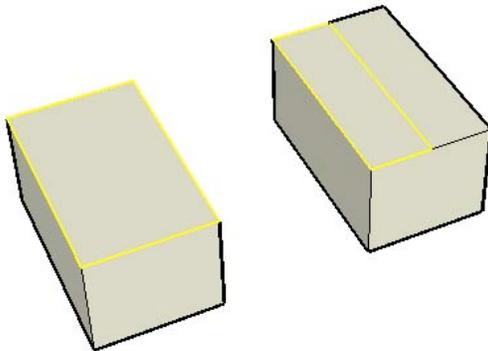
SketchUp implements several concepts which you will use to help you draw quickly. These are dividing and healing, pushing and pulling, sticky geometry, autofold, and intersections.

Dividing and healing geometry

Some tools speed up design dramatically by allowing you to perform modifications on existing geometry. For example, the Line tool allows you to *split* faces and edges to create additional independent faces and edges. Simply divide the face or edge with another edge. This concept is similar to cutting a piece of paper in half and having two separate remaining pieces. The following image shows how two faces are created when dividing the face with a line. Notice the image on the left has one solid top face, while the image on the right has two independent faces when split with a line. Note that the dividing line does not cut through the model from top to bottom, but just cuts the top face in half.



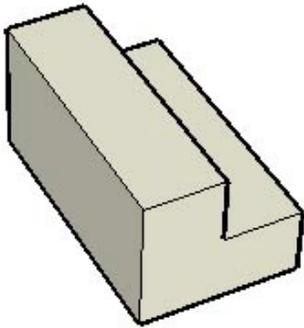
The following image shows how the edges at each end of the face have been split to create additional edges. Note four edges bounding the face in the left image, while four edges bounding each of two faces in the image on the right (the middle edge being common to both top faces).



If you remove the line that shared by the two faces in the image on the right, the two faces will be glued back together or *healed* back into one face. It is common in SketchUp to perform these dividing and healing operations to your model.

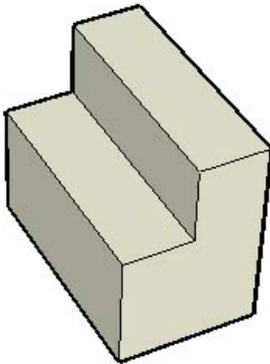
Pushing and pulling

The Push/Pull tool allows you to take any non-curved face in SketchUp and push it away or pull it toward a starting point (these operations are also referred to as *extrusions*). Pushing is the process of reshaping a portion of your model by shrinking the portion away from its starting point and along a single axis. The following image shows the right-most face of the split face (shown earlier) pushed down toward the ground plane.



In the previous image, there are eight faces that can be pushed, can you find them (some are hidden out of view)?

Pulling is the process of expanding a portion of your model away from the starting point along a single axis. The following image shows the same face having been pulled up toward the sky. Any face in SketchUp can be pushed and pulled (with some minor limitations).

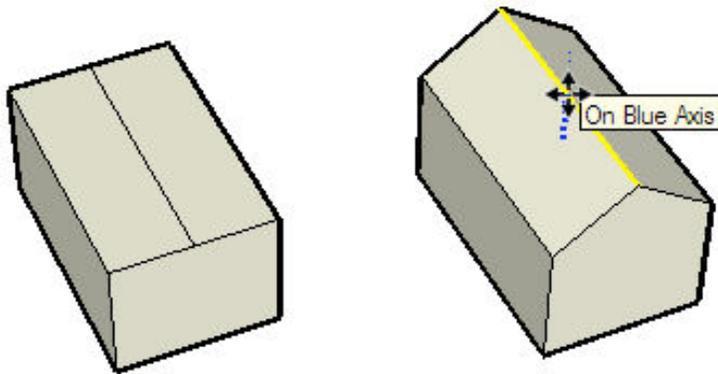


In both of the images, the left side of the cube remained the same size, while the right side was pushed and pulled (shrunk and expanded) independently. The Push/Pull tool is one of the most commonly used tools in SketchUp to add the sense of volume to your model.

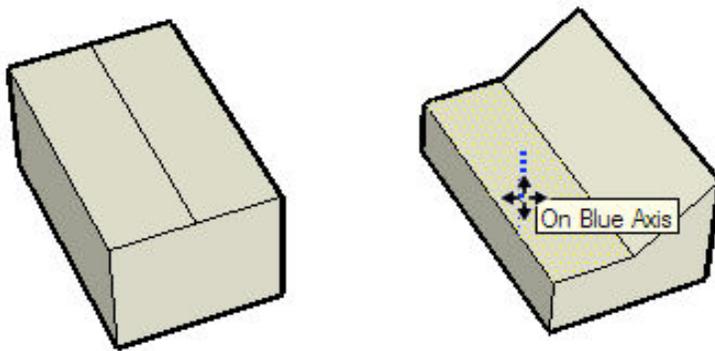
Manipulating connected faces

Geometry in SketchUp is *sticky* meaning that it can be manipulated (skewed, distorted, or folded) by selecting an edge or face and moving the edge or face with the Move tool (causing all entities attached or 'stuck' to the edge or face to move too). Following are three examples of sticky geometry in SketchUp:

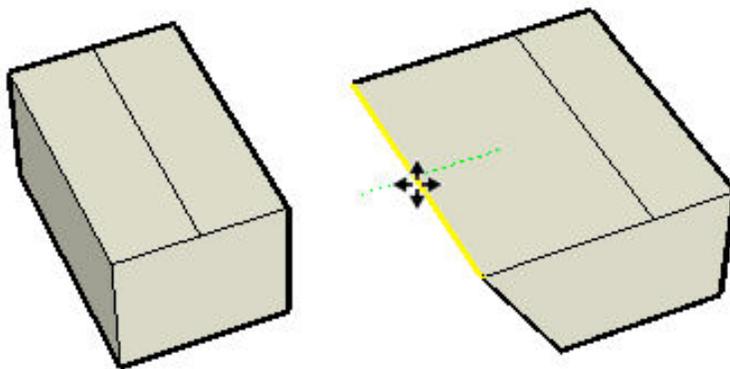
1. The following image shows a line dividing the top face of a box being moved up with a Move tool. The faces that were connected to the middle line followed the line as it was moved to create a roof-like effect.



2. The following image shows the left-most top face being moved down in the blue direction. This action causes the right-most top face to angle to create a slant on one side.



3. Finally, the following image shows the left-most top-edge being moved to the left. The model is skewed into a trapezoid-like shape.

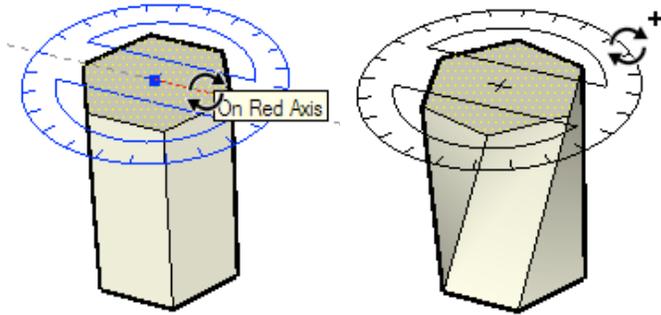


Be sure to use the Move tool to grab and move edges and faces while you begin to experiment with modeling in SketchUp.

Experimentation and play is highly important in learning how to draw in SketchUp! Learn how to draw accurately first, then learn how to draw quickly using the concepts in this portion of the user's guide.

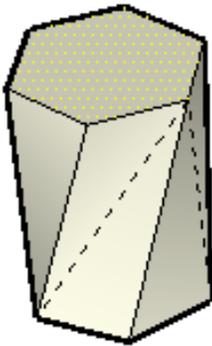
Autofold

Faces must remain planar at all times in SketchUp. Therefore, SketchUp will Autofold, or *score*, faces as necessary to accommodate any operation that will result in warped faces.



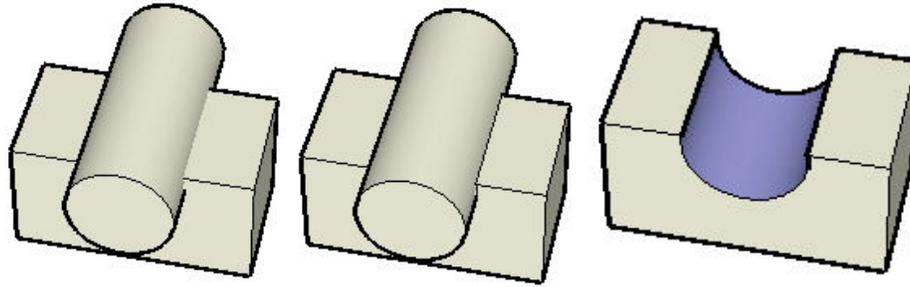
In the left-most image above, a six-sided polygon volume's top face (created with the Polygon tool followed by the Push/Pull tool) was rotated using Rotate tool. Because of SketchUp's sticky nature, the sides of the shape, which share common edges with the top face, twisted and folded with the rotate operation (right-most image).

What you are not seeing is that SketchUp has created *hidden geometry* when performing this Autofold operation. The following image shows the 3 dimensional shape with the hidden geometry shown (dotted lines). Notice that each twisted face is actually comprised of two triangular faces.



Intersections (boolean operations)

SketchUp allows you to easily create complex geometry by intersecting two geometrical forms, such as a box and a tube, creating new edges where the elements intersect, merging the geometry, and subtracting parts of the combined geometry.



In the left-most image above, a cylinder shape was moved into a cube shape. Notice, that no lines appear where the two shapes intersect, indicating that the shapes have not truly merged. A special tool, called the Intersect with Model tool, is used to create intersection lines (the middle image), merging the two shapes together to form one new shape. Finally, the cylinder shape is deleted (using the eraser tool on the cylinder's edges) and because the intersection lines were created, the resulting curved face is left within the cube creating a new complex geometrical shape (right image).

SketchUp tools

Most entities in SketchUp, including arcs and circles, are actually just a combination of small lines or edges. Thankfully, you do not have to use only the Line tool to sketch your models. Instead, SketchUp provides many other tools to help you draw quickly. Some of these tools are for creating common entities such as a circle, arc, polygon, or freehand line. Other tools allow you to quickly draw complex models by modifying your models (splitting, skewing, and even merging geometry together).

Tools in SketchUp are divided into five categories: *principal tools* (tools that are used a lot to select and modify geometry), *drawing tools* (tools used to create geometry), *modification tools* (tools used to modify existing geometry), *construction tools* (tools used to create construction lines or points, and document your model), *camera tools* (tools used to view geometry; discussed later), and *walkthrough tools* (tools to explore your model). The following table lists all of the Drawing, Principal, Modification, and Construction tools:

Tool	Type	Notes
Line	Drawing	Can be used to create, intersect, or divide a face or other line (edge)
Arc	Drawing	Can be used to create, intersect, or divide a face or other line (edge)
Freehand	Drawing	Can be used to create, intersect, or divide a face or other line (edge)
Rectangle	Drawing	Can be used to create, intersect, or divide a face or other line (edge)
Circle	Drawing	Can be used to create, intersect, or divide a face or other line (edge)
Polygon	Drawing	Can be used to create, intersect, or divide a face or other line (edge)
Select	Principal	Used to select entities
Eraser	Principal	Used to delete geometry and heal faces
Paint Bucket	Principal	Used to apply <i>materials</i> (combinations of color and <i>texture</i>)
Position Texture*	Modification	Used to manipulate materials painted on a surface.
Move	Modification	Used to move, distort (autofold), and copy entities
Rotate	Modification	

Scale	Modification	
Push/Pull	Modification	Used to expand and shrink geometry
Follow Me	Modification	Used to duplicate a profile along a path
Intersect With Model*	Modification	Used to create complex geometry by piecing together separate geometry
Offset	Modification	
3D Text	Construction	Used to draw 3 dimensional text geometry
Tape Measure	Construction	Used to get a measurement and create construction line entities
Protractor	Construction	Used to set angles
Axes	Construction	
Dimension	Construction	Used to calculate and display a dimension
Text	Construction	
Section Plane	Construction	Used to create section cut effects

*These menu items are available in menus, not from the toolbar (Microsoft Windows) or tool palette (Mac OS X), and are discussed in the tools sections of this user's guide.

Each of these tools is discussed further in this guide. As a recommendation, however, learn the Line tool and Eraser tool first, followed by the Orbit tool (discussed in the next section), Push/Pull, and Move tools.

Note: Most drawing tools can perform modifications as well, such as the Line tool being used to draw a line to divide a face.

Viewing models in 3 dimensions

SketchUp implements the concept of a *camera* to represent your *point of view* of the model. Simply, you (the user) are treated as though you were a camera looking at your model as you work. This concept is particularly important when your model is something that you want to tour, such as a house, as though you were walking through it in the real world. In this case, SketchUp allows you to change your point of view to a specific height and angle to the model and walk through the model as though it were real.

Manipulating the camera

You can manipulate the camera (your view) in a number of ways to aid you in your designing.

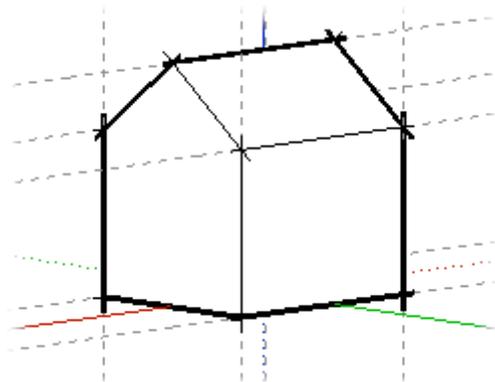
Camera tools

There are other ways to manipulate the camera (your point of view) in SketchUp, including zooming in and out and panning. The following table lists all of the camera tools in SketchUp:

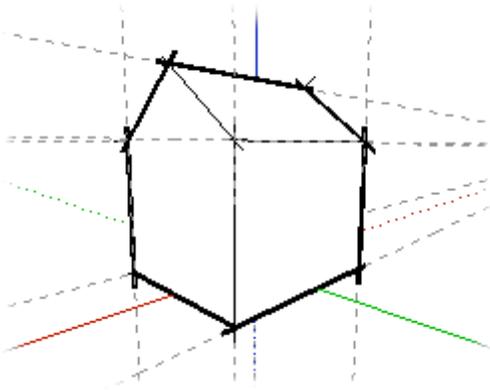
Tool	Type
Orbit	Camera
Pan	Camera
Zoom	Camera
Zoom Window	Camera
Zoom Extents	Camera
Position Camera	Walkthrough
Walk	Walkthrough
Look Around	Walkthrough

Perspective and paraline projections

In addition to your point of view, you can view items in SketchUp in a paraline (also called *axonometric*) projection or in a *perspective* projection. Axonometric means 'measurable from the axes' and an axonometric projection is a view of a model in which lines appear parallel in both 3 dimensional and 2 dimensional space. Also, lines have a length that is to some scale in an axonometric projection when printed (for example 4' in SketchUp = 1" on paper). The following image shows a axonometric or paraline projection, notice how the roof, and wall lines appear parallel.



Perspective, however, distorts the view such that it represents the model as though the lines were vanishing to a horizon (certain items appear closer while other items appear to be far away; entities are not to scale). The following image shows a perspective projection.



SketchUp defaults to a perspective view, but can be toggled into a parallel view for those who prefer a point of view that is similar to what you would see when drawing 3D objects in a 2D space (such as when drawing a cube on flat paper).

Note: The iso camera view in SketchUp is not the same as an isometric projection in which anything along the x, y or z axis are in proportion. This view simply shows you all of your model and is a standard camera angle for viewing models in a 3D space.

Layers

SketchUp *layers* are used to control the visibility of geometry within large models. A SketchUp layer is an attribute with a name, such as 'Layer0,' 'Layer9,' or 'Chairs.' Elements can be assigned different layers. For example, all Component entities that are chairs can be assigned to the 'Chairs' layer. This layer can be then be hidden temporarily to hide everything on the layer from view.

Note: Geometry on one layer is not separated from geometry on another layer. For example, faces sharing a common edge will both be affected by a modification to that edge regardless of what layer the faces are on.

Default "Layer0"

There is one Layer, Layer0, in SketchUp, by default. All entities are automatically placed on this layer unless you create another layer, designate the new layer as the active layer, and create entities on the new layer.

Adding detail to your model

You will likely want to create progressively more detailed models as you become more proficient with SketchUp. SketchUp contains several features allowing you to quickly create detailed or life-like models. These features include components, materials, shadows, and styles.

Materials

SketchUp allows you to paint *materials* on faces to add detail and realism to your models. Materials are essentially paints that have a *color* and optional *texture* (defined within a image file). For example, a siding material with the color of grey and an appearance or texture simulating real overlapped composite siding. Following is a building painted with grey composite siding and grey shingle roofing materials. A grass material is also used on the ground.



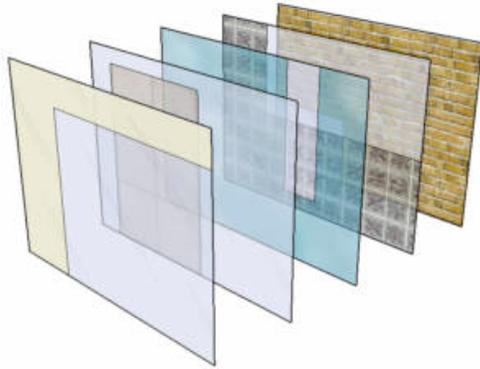
As with components, SketchUp comes with a collection of materials. You can paint these materials on your models using the Paint Bucket tool. Additionally, you can create your own materials within SketchUp (using the color wheel), or by importing texture-like images (such as the image of a wood flooring). In fact, you can import an entire image of a real-world object (such as a picture of a car), and manipulate it over your 3D model to give your model a truly realistic appearance.

Default material

Geometry in SketchUp is assigned a *default material* as it is created. The default material can be changed by painting the geometry with a material.

Material Transparency

Materials also have an opacity property (a number between 0 and 100%) allowing you to create materials that behave like glass. Paint these materials on faces to create windows.



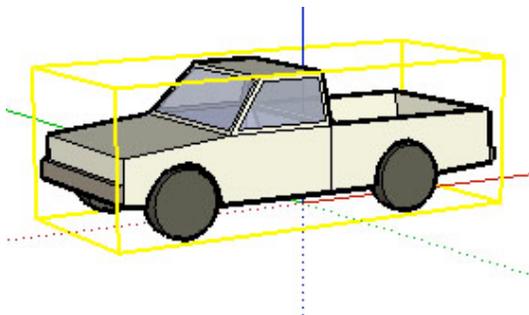
Faces have two sides. SketchUp materials are normally applied to a single side of a face at a time. Painting a default colored side with transparent material will result in both sides of that face being treated as transparent allowing the surface to be transparent when viewed from both sides. If the back side of a face has already been painted with some non-transparent material, applying a transparent material to the front side will not cause the back side to also display as transparent. Likewise, if you paint the back side of a face with a different transparent material, it will not effect the front side. Thus, by specifically applying a material to both sides, it is possible to have transparent faces that can have different colors and levels of transparency on each side.

Groups and components

Groups and *components* are entities that can hold other entities. Groups are commonly used to combine several entities into a single entity for the purposes of performing a quick operation on the group (such as a copy or move). For example, you might draw a model, group the entities that compose model and move the entire model. The characteristics of groups are:

- Quick selection. When you select a Group, all elements within that group are selected as well.
- Isolation of geometry. Entities within groups are protected from the rest of the model. Geometry outside of the group does not affect the geometry within the group
- Model organization. Groups can be nested within other groups resulting in hierarchical collection of subgroups.
- Group material. The group as a whole can be assigned a material of its own, which is separate from the materials painted on individual entities within the group. See the Materials section within this topic for further information.
- Drawing Axes. Groups maintain their own internal drawing axes.
- Alignment and Hole Cutting. Groups have a special behavior that allows them to properly align themselves and stick to faces on which they are placed (as well as cut holes in those faces).

Components are just a group with special behaviors, namely behaviors allowing them to be inserted in other models. For example, you might create a model of a car that you want to bring into other SketchUp models, such as the model of a house. Any models you create can be a component.



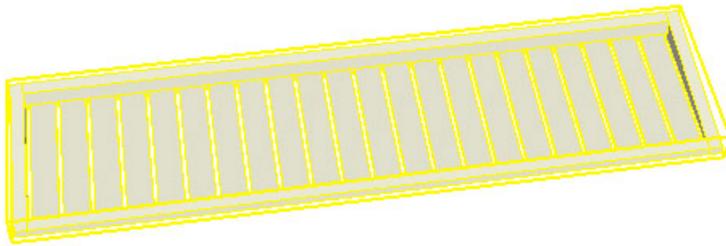
Components have the following characteristics, in addition to the characteristics of groups:

- **Component definition.** The component definition is the blueprint that defines the appearance and behavior of all component instances (created when you insert the component in the model). Editing a component instance edits the definition and all instances accordingly. However, some actions, such as scaling an instance, only affects the instance itself.
- **Improved Performance.** Components allow SketchUp to more efficiently use your computer's resources because the information necessary to describe a component is only stored once, in the component definition, and then referenced for every component instance.
- **Drawing Axes.** Components display their own internal drawing axes when you are editing the component.
- **Alignment and Hole Cutting.** You can define alignment and hole cutting behavior when creating components (it is automatically defined for groups).

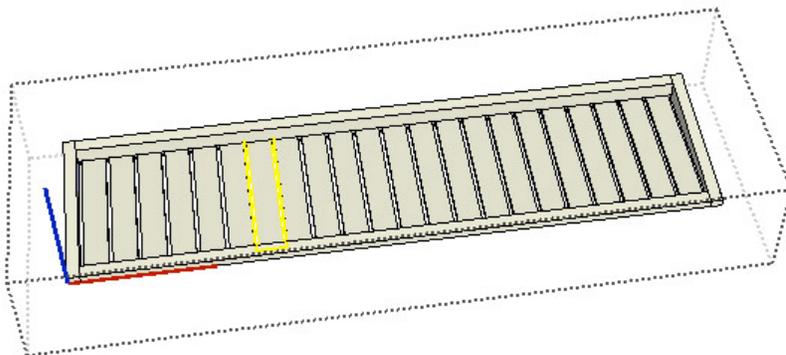
Note: You can define the characteristics of the component during component creation.

Group and component context

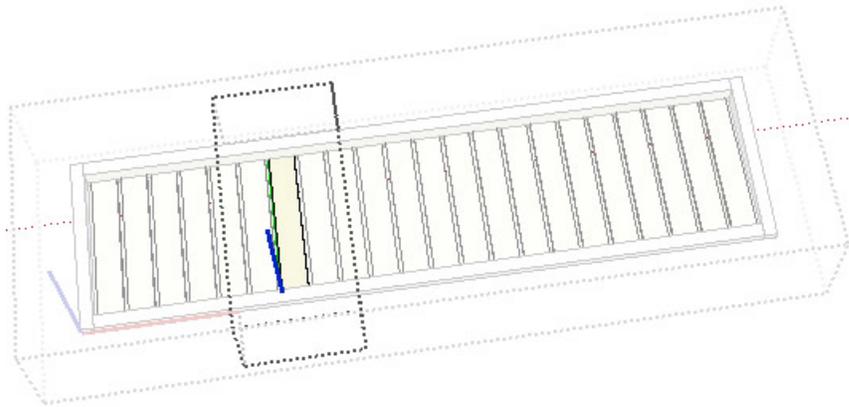
Entities within a group or component are said to exist within the group or component's scope or *context*. You can modify a group or component as a whole (affecting all of the entities within the group or component) or edit the group or component's individual entities (within the group or component's context). Additionally, you can nest components within other components, groups within components, components within groups and so on. The following image shows a shelf component has been selected (as indicated by the yellow selection color) using the Select tool. This shelf is composed of several subcomponents, such as slats.



The following image shows the shelf component being edited. Notice that it has a dashed bounding box to indicate you are in the component's context. In this case, a subcomponent, one of the slats in the shelf, has been selected. That slat is within the context of the shelf. Also notice that the component's axes are displayed in the lower left-hand corner.

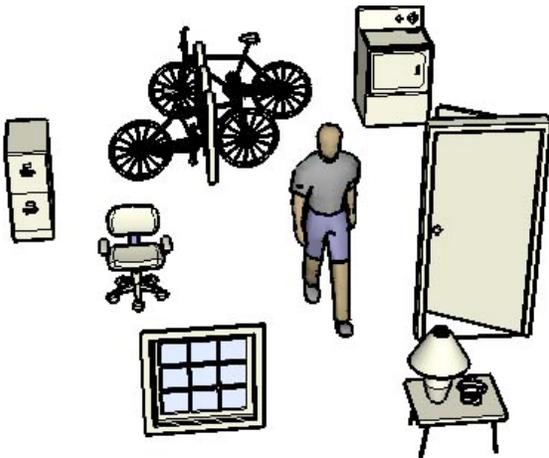


Finally, the following image shows the slate component being edited. Notice now that there is a dashed bounding box around the component, and around the slat being edited. The entities, such as the lines and face, that compose that individual slat are said to be in the context of the slat.



Component collections

Component collections have been created and included with SketchUp to allow you to easily add detail to your models. These components range from standard architectural components (doors, windows, and so on) to people, cars, trees, and geometric shapes. You can also create your own collections of components from pre-existing components or components you create yourself.



Note: Individual components and collections of components are available on the Google 3D Warehouse.

Component axes

Components have their own axes which, by default, are aligned to the global axes in the drawing area. These axes can be moved affecting component placement in the model.

Cutting and gluing behavior

Components, such as doors and windows, can be designed such that they can be placed on specifically-oriented surfaces such as vertical wall surfaces. This behavior is referred to as the *gluing behavior* of a component.

Additionally, components can be designed to automatically cut holes in surfaces, such as in the case of a window component being able to cut a hole in a wall. This behavior is referred to as the *cutting behavior* of a component.

Layers, groups and components

Layers are a mechanism for controlling the visibility of entities within a model. Entities can be assigned to different layers in a model and those layers, and their contents, can be displayed independently. Groups and Components are used to isolate geometry as sub-models within an overall model, such as a component of a chair within a model of a room.

Note: Entities within a group or component can be on several different layers.

Styles

A style is a predefined set of display settings that can be applied to a model, and the drawing area, to give it a specific look-and-feel. A style can consist of a specific edge type, face type, sky and background color, *watermark*, and other drawing area effects (such as the color used to represent selected geometry).

SketchUp has multiple styles, some best used while drawing a model (because they don't use any intensive rendering effects), others are best suited for printing or presenting a model (because they use rendering effects to give a model a hand-drawn appearance). For example, a pre-defined style might have an edge type of jitter edges, a face type of hidden line mode, a background color of white, a sky color of blue, a ground color of brown, and so on.

Sketchy edges

SketchUp allows you to apply various edge types, including hand-drawn *sketchy edges*, to your model. Sketchy edges are edges that can be unique from any other edge style in SketchUp because, unlike other pre-defined edge types, you can create your own sketchy edge using a drawing program like PhotoShop. Sketchy edges are simply a collection of different hand-drawn strokes that, when combined and applied to model, give the a model a unique hand-drawn appearance.

Watermarks

Watermarks are images placed in the background or foreground of the drawing area and span the entire area just as sky and ground. Watermarks are great for creating backgrounds, such as simulating paper textures beneath a model. Watermarks can also be used to place logos and other graphics directly on the screen.

Shadows

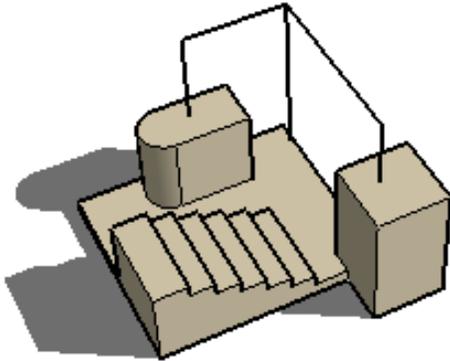
SketchUp allows you to cast shadows on your model as though the model were in a real-world environment. These shadows can be cast based on time of day and virtual location of the model in the real-world. For example, you can set shadows to see exactly what a model of a house would look like at 10:20 am, December 10, in Boulder, Colorado, which is the default location. Finally, SketchUp's shadows are designed to provide dynamic feedback as you change geometry and your camera viewpoint. The shadow casting feature in SketchUp is a great way to give your models a better sense of depth and realism.



Note: While SketchUp's projected shadow angles are accurate, the rendering effect is not intended to be photorealistic. Fortunately, SketchUp can export models to other many other applications that excel at photo-realistic renderings.

Ground shadows

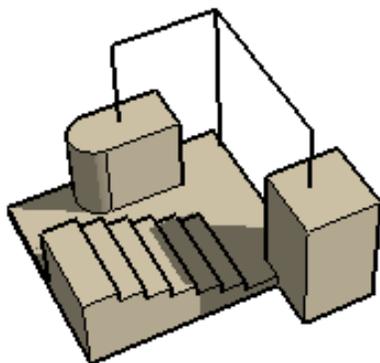
Ground shadows use the faces in your model to create a flattened set of faces on the ground plane. These faces are colored and positioned based on the background color and the angle of the sun. Although faster than face shadows, the illusion that ground shadows provide only works on the ground plane. The following figure shows a model whose geometry all lies on or above the ground plane.



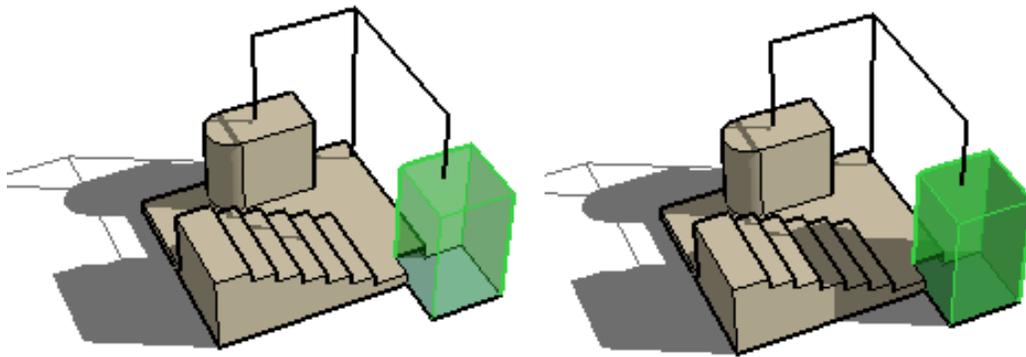
Note: Ground shadows create unexpected geometry, called *artifacts*, when your model contains geometry beneath the ground plane. Ground shadows works well for models with solid color backgrounds and in which all geometry is above the ground plane.

Face shadows

Face shadows use the sun angle to project shadows based on the location of faces relative to other faces. For example, a shadow is cast on the stairs in the following figure, based on the face of the vertical 3d rectangle. The calculation used to create face shadows is processor-intensive, however, and will slow down performance with large models.



Note: Faces with less than 70 percent opacity are considered transparent, and do not cast shadows. Faces with 70 percent opacity or greater cast shadows. Transparent faces cannot receive shadows. The following image shows a transparent (less than 70% opacity) rectangle that does not cast a shadow (left) and a opaque (70% or greater opacity) rectangle that does cast a shadow (right).



The two shadow systems are designed to be complimentary, and you may often wish to have both types enabled simultaneously.

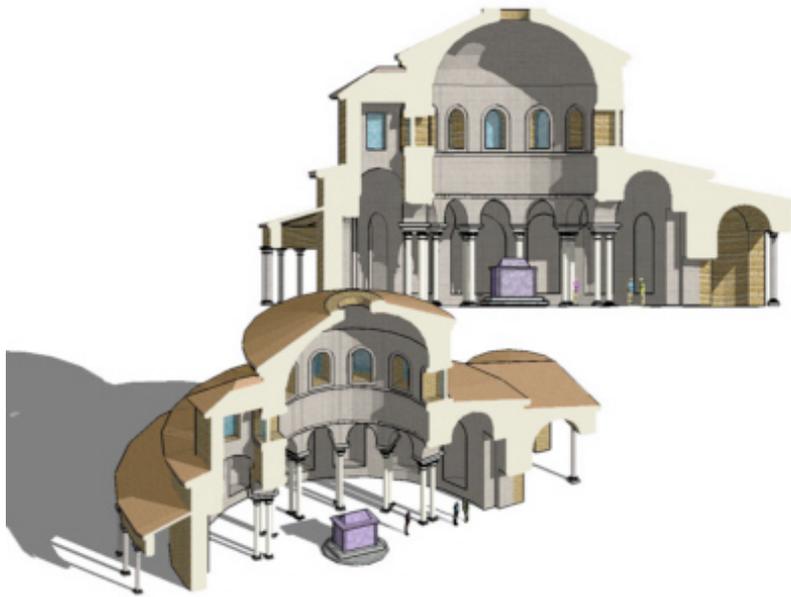
Presenting your model

There are several things you can do after you create a model. For example:

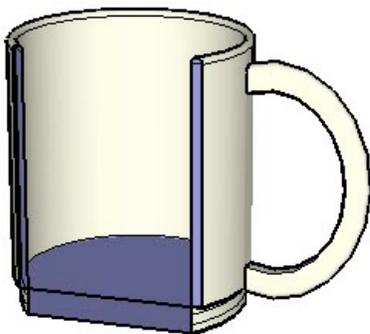
- You can add dimensions, section cut effects, and other entities to your model for use in documenting the actual physical item.
- You can present the model within SketchUp as an animation.
- You can print your model
- You can export all or portions (such as a section slice) of the model for post processing in another application

Section cut effects

SketchUp allows you to create *section cut effects* which are the result of slicing through your model to see and work inside its interior. The following image shows a model of a building with a section cut affect active allowing the designer to work inside the model or present interior detail to a client.

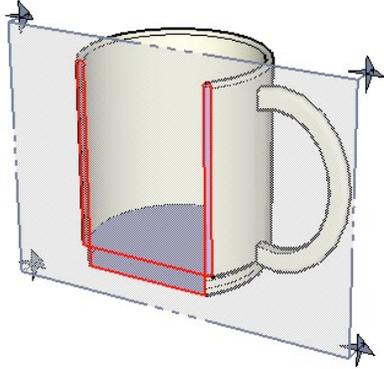


The following model shows the section cut effect resulting from slicing through the model of a cup.



Section planes

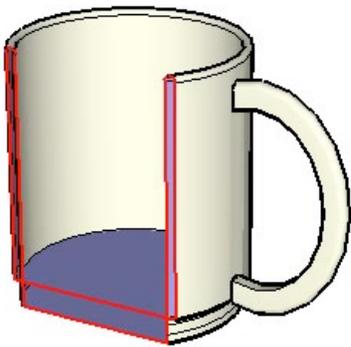
Section cut effects are created by *section planes* which are special entities used to control the selection, placement, orientation, direction, of the *section slice*. Section planes are generated using the Section Plane tool.



The previous image shows a section plane entity intersecting the cup and creating a section slice through the cup.

Section slices

The term *section slice* refers to the edges that are highlighted after intersecting geometry with a section plane. The following image shows a section slice in red.



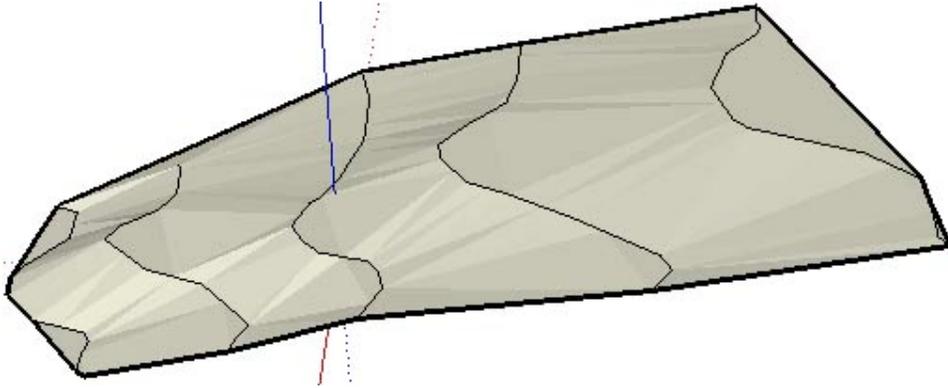
These edges act as dynamic virtual edges in that they continually change as you move the section plane through your model with the [Move tool](#). You can create a group from these edges, such as when slicing horizontally through a house, to create a wire frame of the model (such the outline of a floor plan). Then, export this section slice for use in a CAD program to add additional detail (such as wall construction detail).

Animations

SketchUp allows you to create different [scenes](#), similar to slides in traditional presentation software, each containing different settings for your model (point of view, section cut effects, and so on). These scenes can be combined and executed sequentially as an [animation](#). The animation engine can be set to gradually transition between effects on different scenes for a truly dynamic presentation.

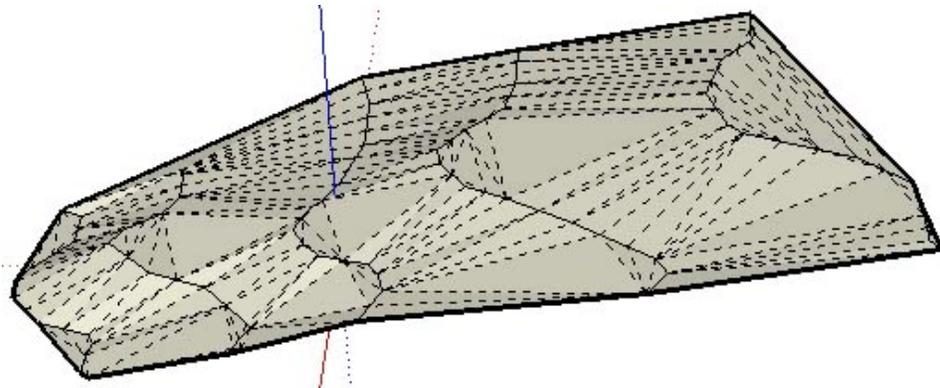
Modeling terrain and organic shapes

SketchUp implements the concept of a sandbox which refers to a surface that can be generated and manipulated using sandbox tools. A sandbox in SketchUp (and in other 3D modeling tools) is commonly referred to as a *triangulated irregular network* or TIN in terrain Modeling terminology. The following image shows a TIN (sandbox) in SketchUp.



Note: This documentation uses the term TIN, sandbox, and terrain interchangeably. A TIN is like a sandbox because it has a boundary and contains a sculpted surface (sand). Sandbox tools are those tools that are included in SketchUp for creating and manipulating TINs.

The following image shows a TIN in SketchUp with hidden geometry displayed (so you can see the triangles that are the foundation of the TIN).



There is nothing special about a TIN, it is simply several connected triangular faces that, when smoothed, appear like one continuous smooth surface. Note that you are not limited to creating terrain with the sandbox tools, you can create other *organic shapes* (shapes that appear to be crafted by hand) using these tools. For example, you might create a person's face, a bowl, or a swimming pool using the sandbox tools.

Another type of TIN-like surface, which the sandbox tools can work with, is called a *polygon mesh*. A polygon mesh is similar to a TIN, but contains faces with more than three vertices.

Note: SketchUp's Sandbox From Scratch tool and Sandbox From Contours tool only create TINs, but you can import a polygon mesh or create a polygon mesh (manually) using other SketchUp tools.

Triangulation

Triangles in a TIN can be oriented in different directions. The orientation of triangles is referred to as *triangulation*. Notice in the previous image that some triangles are oriented vertically while others are oriented horizontally. This concept is important because some sandbox tools allow you to change the direction of the triangles as a way to further smooth TINs.

Creating a TIN

There are several ways to obtain a starting TIN as the foundation of your model. These are:

- Create or import contour lines and use the Sandbox From Contours tool to create a TIN.
- Import an image of a site plan or contour map and trace its contours with the Freehand tool. Then, adjust the contours to their proper elevation and use the Sandbox From Contours tool to create a TIN.
- Import a TIN using the SketchUp ArcGIS Plug-in available on the [SketchUp Plugins](#) page. ArcGIS is an industry standard application suite or Geographic Information System for working with geographical information such as the location of buildings within a world-wide global coordinate system.
- Import a digital terrain Model (DTM) file.
- Create sandbox (TIN) using the Sandbox From Scratch tool.

Modifying a TIN

SketchUp contains several tools for modifying TINs. The following table lists all of the sandbox tools in SketchUp.

Tool	Type	Notes
Sandbox From Scratch	Create TIN	Creates a flat, rectangular shaped, TIN or sandbox that can be modified by other sandbox tools.
Sandbox From Contours	Create TIN	Creates TIN or a sandbox from contour lines at various elevations.
Smooove	Large Modifications	Allows you sculpt or make large modifications to a TIN by moving groupings of vertices to create hills, berms, or other features.
Stamp	Large Modifications	Allows you to sculpt or make large modifications to a TIN by stamping footprints into the TIN, such as the footprint of a building.
Drape	Large Modifications	Allows you to drape the outlines of roads, paths and buildings, drawn on a flat plane, onto a TIN.
Add Detail	Small, Detailed, Modifications	Allows you to sculpt or make small, detailed, modifications to the a TIN by adding additional triangles to a TIN.
Flip Edge	Small, Detailed, Modifications	Allows you to sculpt or make small, detailed, modifications to the TIN by adjusting the triangulation of a TIN.

Note: The sandbox tools can also be used to create organic geometry or geometry that appears to be hand-crafted.

Functional terrain

The term *functional terrain* is used to describe terrain that has no portion bending back upon itself creating overhangs, underhangs, or caves. If you draw a vertical line through your terrain at any point and the line only touches the terrain at one point, your terrain is functional.

This concept is important because certain tools, such as the Smoove tool, can create unexpected results when working on nonfunctional terrain (the neighboring points included in the sculpting operation by the Smoove tool are often undesirable).