10

Advanced Modeling

What's in this Chapter:

Modeling Objects

Canoma is great for generating models of man-made objects, almost on any scale—from objects on top of a tabletop, to furnished interiors and buildings, to entire cities.

Canoma is not aimed at modeling highly irregular or complex objects, such as mountains, trees or human beings. MetaCreations has other great software for doing all of those, such as Bryce 3D for landscapes and Poser 3 for human models.

Canoma works by combining well known techniques of perspective projection, first discovered during the renaissance in Italy, with the latest in mathematical techniques and interactive user interface design.

Requiring relatively little user input, Canoma tries to find parameters such as:

- camera location
- focal length (zoom)
- object positions
- object orientations
- object dimensions.

Initially, most parameters are free to take on any value. The process of mapping 3D objects by adding pins, beads or glue constrains parameters into taking on correct values.

As you begin modeling—and while you have only very few pins or beads placed on the wireframe objects—there may be a lot of parameter combinations that could satisfy your constraints. When that is the case, objects may seem to rotate freely or change depth arbitrarily. But, as you add more constraints, you will literally "pin down" the parameter needs for your model.

Adding Source Images

For most projects many photographs are available. In general, that is preferable, because multiple images provide views from different angles, making determination of perspective and object dimensions more accurate. Sometimes, only one source image is available. For the single image case, it is often important to provide additional information to Canoma.

For example, when you create an object, you have a choice of creating it on the ground plane or on top of another object. You can also tell Canoma that a new object has the same orientation as the currently selected one. By default, objects rotate independently. By telling Canoma that two objects have the same orientation, Canoma has to figure out one less parameter (rotation.)

Perspective projection can be ambiguous. For example, does an object appear to be large because it is very close to the camera (but small in size) or does it appear to be small because it is far away from the camera (but huge in size.) Both might look the same on a photograph. Because of this, additional information must be provided in the form of "on creation" constraints or subsequent pin, bead or glue constraints.

If you only have a single image project, the "on creation" constraints become essential, and it is advisable to learn and use them. If multiple images are available, these initial constraints become less critical, although they can still be very useful for improve model accuracy. While the mathematics of these constraints can be complicated, their appearance and meaning is easily understood. It is not necessary to have a deep understanding of the mathematics to effectively make models with Canoma.

Free vs. Constrained Parameters

Usually scenes are modeled from the ground up. Working from a ground plane, you place objects on the ground, then place objects on top of those, and so on. By default, you cannot have an object just "floating in space." These restrictions make modeling a lot easier.

Each object in the Canoma world has a location in three-dimensional space (called the origin, with an x, y, and z coordinate). Each object has three rotation parameters to define its orientation in space. Finally, each object has a number of additional parameters based on its type. For example, a box may have width (the X axis), height (the Y axis), and length (the Z axis), whereas a rectangle has only length and width.

The task Canoma has is to figure out reasonable values for all these parameters. To reduce the workload, by default we reduce the number of parameters that have to be determined. So, objects are created on the ground plane (fixing their origin Y-coordinate to 0) and can only rotate around a vertical axis, fixing the other two rotation angles at 0. degrees.

When you create an object on top of another object, again its origin's Y (height) coordinate is not free, but bound to however high its base object is. If you create an object aligned with another one, instead of having to figure out 2 vertical axis independent rotations, Canoma only has to find a single, common rotation angle. The more information you can provide about an object when it is created, the better.

In general, the default constraints are useful, sometimes you may have to change them: for example if you know an object is not sitting on the ground plane or if it has an arbitrary orientation. In those cases you can "unlock" some or all of the fixed parameters.

For example, to allow an object to float up or down arbitrarily, unlock its origins Y-coordinate. To allow it any orientation in space, unlock all rotations. You should really only do this when you have multiple images of the object from different angles, since Canoma now needs more information, since it has more parameters to figure out.

In general, the more (correct) information you provide to Canoma the better. Use the "on creation" constraints (on Floor/on Top, aligned, concentric etc.) whenever you can and only place pins or beads where you can actually see object corners or edges.

Misleading Canoma and Stressing a Model

It is also important not to "mislead" Canoma. For example, if you tell it a block has the same orientation as another one, but they really do not, then Canoma will yield inaccurate results and the model will feel "stressed" or unnatural. The same is true for pins or beads that you place—if you do not see a corner of an object, don't place a pin where you think it might be, since chances are you will not be putting it into the right place.

Canoma does not know that you're estimating a corner and instead tries to accommodate your input as "the truth". Misleading pins can cause inaccurate models and unexpected discrepancies between the displayed wireframe and the 3D preview. There is a Stress Display, in case you notice such discrepancies. This display helps pinpoint which pins or beads feel the most "wrong" to Canoma and might have been placed by accident or as the result of an incorrect guess. Refer to "Avoiding Model Stress" on page 96 for more information about using Canoma's Stress Display. In these cases, you are better off deleting the offending pins or beads.

In some cases, you can throw Canoma off spectacularly. For example if you glue the top of an object to the base of another one that is actually standing on the floor. The wireframe will move in big jumps in a proverbial "boing" like motion. If this happens, chances are high that you've provided some wrong input. It's best to Undo (always available) and try again—perhaps you just accidentally glued a wireframe to the wrong corner or edge. In Canoma, you can Undo up to 10 times in a row. You can also redo what you've undone.

Listening to the Canoma "Heartbeat"

Canoma is almost always "active". Unlike a draw or a paint program, which only reacts when you have the mouse button down, Canoma tries to calculate decent parameter values, even after you let go of a pin or bead.

If your model is consistent and not under a lot of stress, this "heartbeat" is almost unnoticeable. Nothing much changes on the screen after you stop moving a constraint.

On the other hand, if you provide inconsistent input, Canoma tries to find reasonable parameter values regardless of the incorrect pins or beads. When this happens, it can take a few seconds. During those seconds, you might see wireframes change—not just the object you manipulated, but potentially all the objects in your scene. Canoma tries to minimize the stress (or errors) across all objects simultaneously. A heartbeat display shows Canoma's level of activity.

Using Geometric Tricks

If you are an architect or designer, you are probably familiar with geometry in your daily work. You can apply this knowledge to modeling in Canoma.

For example, if you want to make a number of objects line up, just create a Guide Line object and glue those objects to the Guide Line.

- If you only glue a corner of an object, that corner is on the Guide Line, but the orientation of the object is still arbitrary.
- If you create an object aligned to a Guide Line or glue two corners of an object to a Guide Line, you've fixed the orientation of the object to be parallel with the Guide Line.

You can also create a Guide Line or a Guide Line on top of another object and then glue one of its endpoints to a corner of another object that is floating in space. The other object's corner is then forced to lie at the same height as the Guide Line (which by default is horizontal by the way.) This can be handy to constrain contour points on a translation sweep for example. Refer to "Objects with Editable Polyline Contours." on page 85 for more about translation sweeps.

If you want to make a box with equal length and width, just create a Guide Line, glue it to the corners along one side, duplicate the Guide Line object and glue the copy along the other side of the box. Since the Guide Line objects have the same lengths, they force the box to have equal length and width.

You can create temporary helper objects just for the purpose of "attaching" other objects and later on delete the helper objects. Be careful though. As you delete the helper object, all of its constraints (such as glue) are deleted and this can cause (depending on how you constructed them) other objects to move. Guide Line helper objects are particularly useful because they do not show up in the 3D Preview or 3D file format exports, so you so not need to delete them.

Another example of when a temporary object is useful is for establishing perspective. If you can see tiles on a floor, they might serve as a good starting point to establish perspective. Begin by modeling those. Later, after you add more objects, and maybe a ground plane or floor rectangle, you can delete the original helper tiles (since they are very close - coplanar - with the floor, leaving them in might cause rendering artifacts in the 3D preview or in exported file formats.

If you are modeling a small object on a tabletop that does not really have very explicit shapes (lots of bevels for example), just place a cardboard box (like the one this software came in) alongside your "difficult" object. Model the cardboard box first to establish perspective and then continue with your actual objects. Later, you can delete the box (or "scaffold") object.

Establishing Perspective

Starting Simple

Start modeling with simple objects first, like boxes. These have few internal parameters and help establish a perspective—the camera position, orientation, and focal length—for your scene.

Starting with a box is always a good idea. Don't start with a translation sweep, a polygon, or a curtain. Refer to "Objects with Editable Polyline Contours." on page 85 for more about those objects. These have too many "free" parameters and do not help establish a good camera perspective.

Use simple objects to establish camera perspective.

Modeling the First Image

It's tempting to load in all your images, do a box in one image, switch to another image, try to pin the box there, then go back to the first image to create another object. This is not the best way to get good results.

Choose a good first picture, one that shows a lot of your scene. Model a few objects in that picture, maybe 3 to 10, before even thinking about loading additional images. Once you've done some modeling, then add another image. Using this method, it is easier for Canoma to

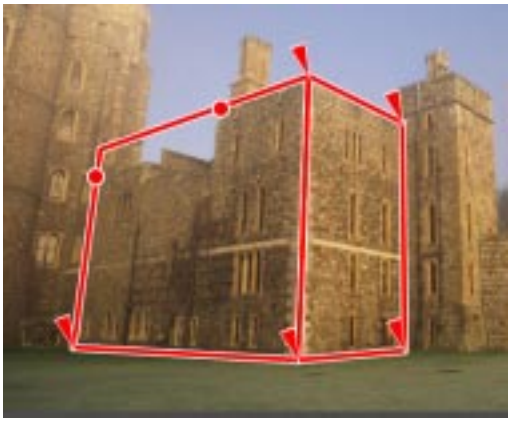
orient models correctly, because it is less likely to confuse rough alignment orientation, than when only one Box or Rectangle is present.

Model several objects in the first picture, before loading in additional photos.

Using Temporary "Helper" Objects

Use temporary objects to "bootstrap" perspective. For example, suppose there is a staircase or translation sweep that needs to be modeled as part of your scene. Try using a box for that element and pinning it into place, even though you know you'll replace it later with the staircase or translation sweep.

Just having the box there initially helps Canoma establish perspective. After a perspective is determined, adding more objects "solidifies" it to such an extent that the temporary helper object can then be deleted.



Temporary objects help establish perspective.

Creating the Same Orientation

Sometimes several objects will share the same orientation. A good example of this is skyscrapers in a typical american grid-like city layout. When this is the case, let Canoma know.

Select one object whose orientation is the same as the one you are about to create. When you create the new object, hold down the Shift key. The two objects will then always be at the same orientation. This improves the quality of your

3D model. It also improves the accuracy of Canoma, since there will be fewer independent parameters (rotations in this case) to calculate.

Select an object whose orientation is the same as the object you are about to create, then use Shift-Create on top to lock in that orientation.

With orientation locked to first object.

Duplicating Objects

When you duplicate objects that have the same dimensions, it results in a more precise model. This is especially useful if you have only one source image.

In the following example, all the balconies are known to be of equal size. After the first box was created and pinned, **Edit menu > Duplicate** was used for subsequent balconies.

All the balconies are known to be of equal size.

In this case, since the balconies are not only the same size but even share the same orientation, Shift + Cmd/Ctrl + (D)uplicate can be used to create aligned clones. If you wanted to get extra fancy you could put spacer objects (like a Guide Line) between them, also duplicated, to ensure that equal spacing between the boxes is also maintained. That's not necessary in this case, but could be handy in other circumstances.

Freeing Necessary Parameters

Each object in your model has parameters, such as a location in three dimensions (X,Y,Z) and an orientation (3 angles). In addition, each object has type-specific parameters. For example, a box has length, width and height. Canoma tries to calculate out all these parameters. To make it easier, Canoma fixes certain parameters to begin with.

For example, all objects are by default created on the ground plane, i.e. their Y-location is initially fixed at 0 (except for on-top objects, which start life at Y=height of their base object.) Similarly, objects are by default only able to rotate around their vertical axis (the X-axis). The other two orientation angles are held fixed at 0 degrees. In many situations that works just fine, but sometimes you'll need to free some of these parameters to avoid getting a wrong model.

A typical "problem" case is a computer monitor. You might be tempted to model the computer screen in front of you. But if you look closely, the monitor is usually on a stand, so it does not rest on the table plane, but rather slightly above it. Second, a monitor is usually tilted slightly backwards.

To selectively free up necessary parameters:

- Select **Model menu > Unfix Y parameter**. This allows an object to float in height, just what is needed for the monitor to rise a little above the table.
- Select **Model menu > Unfix all rotations** or bring up the Object Information dialog for that object and click the Unfix all Rotations button. This allows a selected object to freely rotate in space, like tilting the monitor backwards.

Unfix all rotations in order to position the monitor.

Refer to "Checking Object Information" on page 89 for more about setting object parameters.

Be careful. Freeing parameters comes at a cost. In order to figure out what the height or the other rotations should be, Canoma needs more information. This can come from additional source images or you may be able to use glue as described later in this chapter. To be safe, only unfix parameters when you have multiple source images with which to work.

Monitoring Stress in the Model

When you specify pins and beads in your source images, imagine that you are applying little springs between where you place them and the wireframe beneath. As long as the pins and beads are consistent with perspective projection, everything is fine. But in theory, you can pull a corner of a box to some wildly wrong

location. The wireframe follows (beads try to, but will eventually separate from their edge). When this happens, the underlying 3D model is no longer be what you expect.

Normally, this does not happen, but it can in the following circumstances:

1. You model a beveled or round object and cannot see corners, so you "guesstimate" where the pins should be. You could guess wrongly.
2. You misinterpret the wireframe and put a pin in a spot where it really just should not be.

A good way to monitor model stress is to use the Stress Display frequently. Turn the Stress Display On to check for differences between the wireframes you placed and the 3D objects Canoma constructed according to your pin and bead "instructions."

Another way to detect stress is to watch when you delete a suspected pin or bead, if the wireframe jumps a lot before settling down again (the proverbial "boing" in our spring analogy), something is wrong. You can always undo the deletion to see if another pin on the object is the real culprit.

Canoma tries to minimize stress across all the pins and beads that you place. Sometimes a single wrong pin can introduce a lot of stress. It is best to either delete or correct that wayward pin.

Sometimes a single wrong pin can introduce a lot of stress. Here, the lower left pin causes stress, because the building sits on a slope.

Using Glue to Align Objects

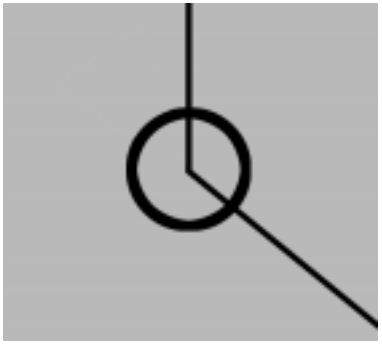
If you know that certain objects are connected, you can tell Canoma, just by using glue. This is useful when you have only a single source photograph in your project. When you have multiple photographs, Canoma can usually figure out on its own that objects are supposed to be connected.

For increased model quality, it can still be a good idea to add this information via glue. The usefulness and techniques for creating glue will now be explained in more detail.

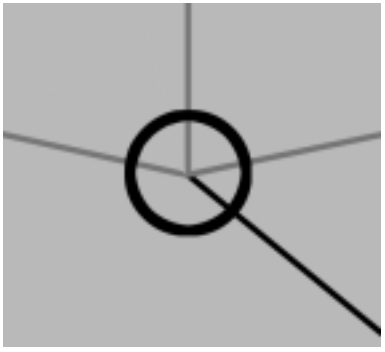
Tip

To create aligned objects, you can use the Align option when creating an object. Glue, however, is more flexible and allows objects to actually be connected, not just aligned.

Using Point To Point Glue

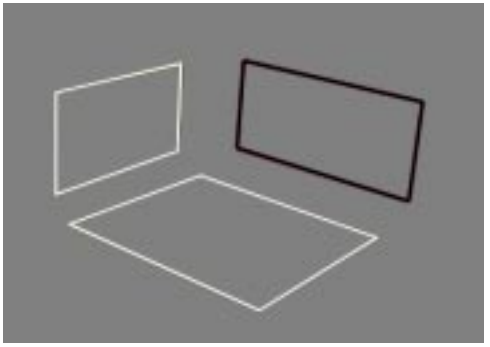


Glue point to point by Cmd/Ctrl + dragging one point over the other.

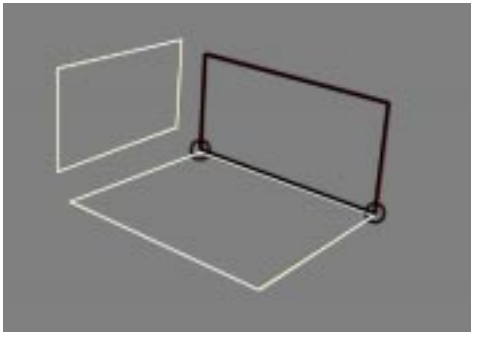


Done. The object moves to satisfy the glue and shows a circle as feedback that there is glue between points.

Don’t "overglue"

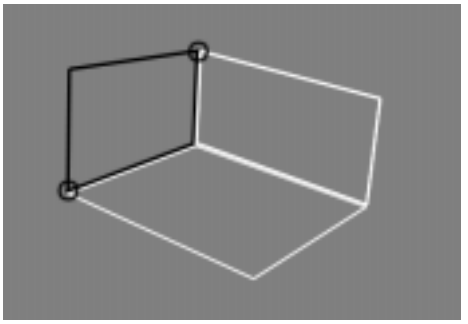


Typical situation. Several rectangles are joined using glue.

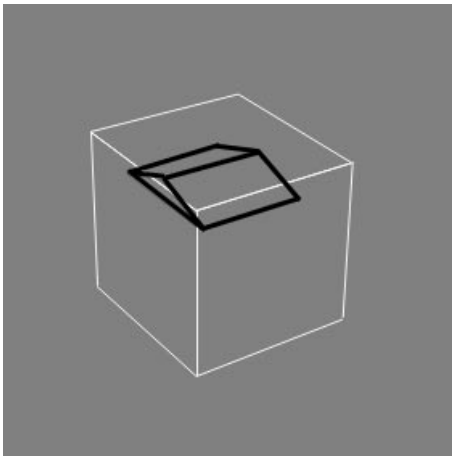


The first rectangle is joined using 2 point to point glue operations. You can see the rings indicating glue.

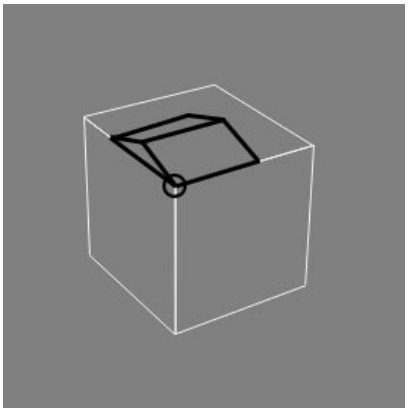
To attach the second rectangle and force it to be the same height as the first vertical one, glue their adjoining bottom corners together. There is no need to put glue at the top corners. The final glue is applied at the far left corner.



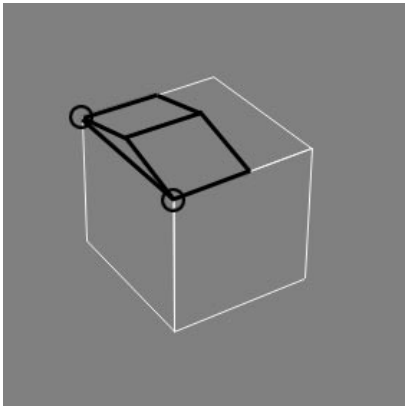
Attaching the second rectangle.



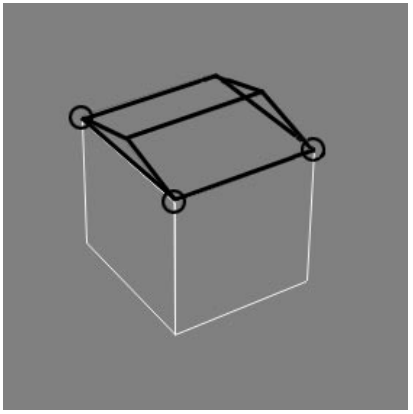
A box with a roof created on top of it.



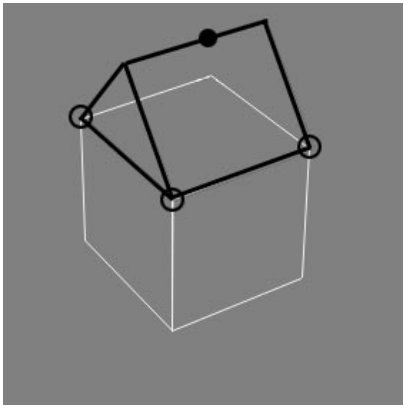
Glue one corner of the roof.



Then another.



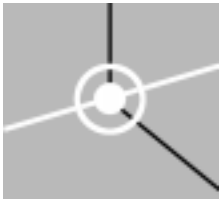
And, finally a third. Three is enough, that determines the orientation and size of the roof's base.



Once the roof base is glued, you can pull up the roof to the desired height with a bead (or you could use pins at the corners).

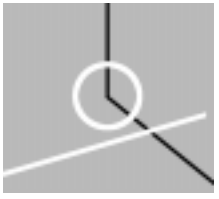
Using Point to Edge Glue

When the points of two objects do not coincide, but you know that the point of one object lies on the edge of the other object, you can use Point to edge glue.



Create point to edge glue by Cmd/Ctrl + dragging one point over the other object's edge.

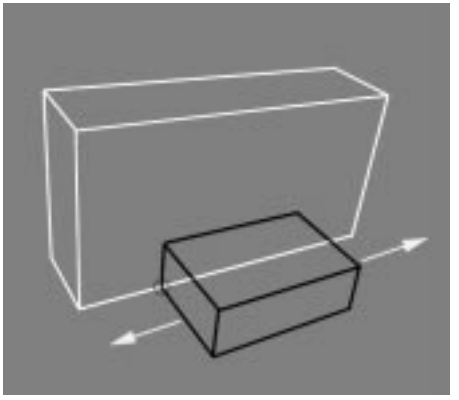
The object moves to satisfy the glue and shows a circle to indicate that there is glue between the points. The glued object can still slide along the edge, but the corner point always stays on the edge.



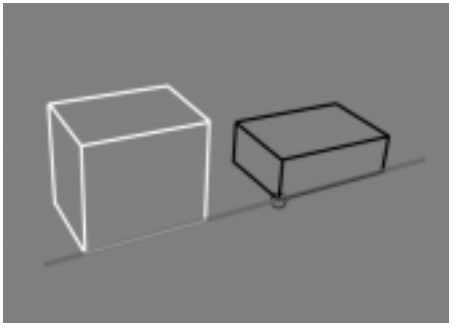
Done.

Point to edge glue can also be applied when a glued object isn't actually touching the other object. Since the glued object is free to slide

along the edge, it can even slide "off" the edge. (In fact, mathematically it still slides along the extension of the edge.)



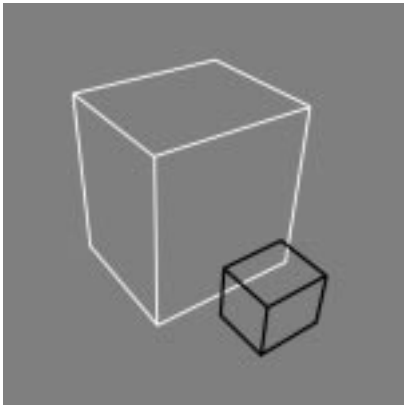
A glued object can slide along or even off an edge.



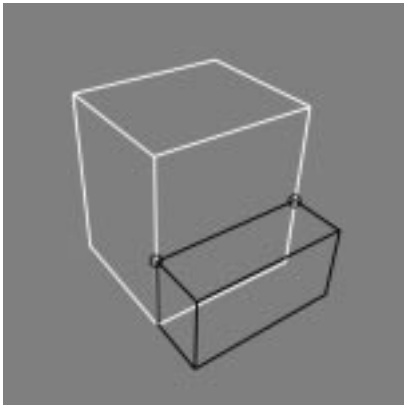
In this case, the two object fronts are aligned.

Another way to do align two objects is to create a Guide Line object (which is only visible in wireframe mode, so you don't need to worry about it messing up your model), then glue both object's front corners to the Guide Line object.

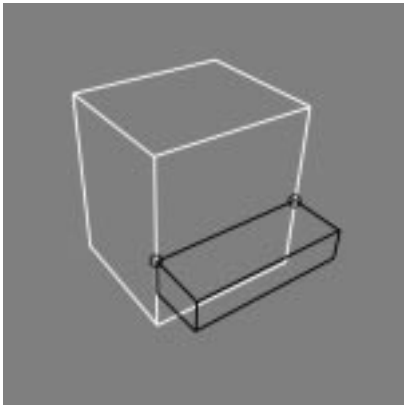
- Positioning an Object on the Side of Another.



Here is an aligned box (created using Shift during creation). Its corners are glued to the indicated vertical edges of the other box.



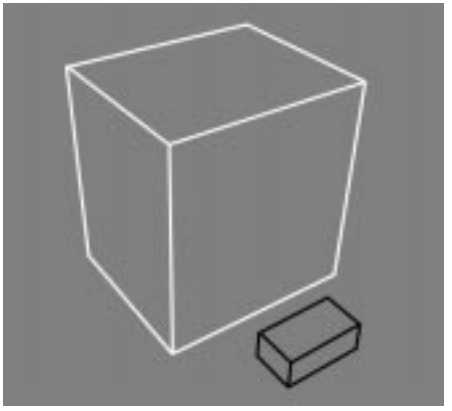
The result after gluing. The bottom of the new box is still fixed to the ground plane. But you can let if float up by selecting Model menu > unfix Y parameter, then use some beads to move the bottom of the box upwards.



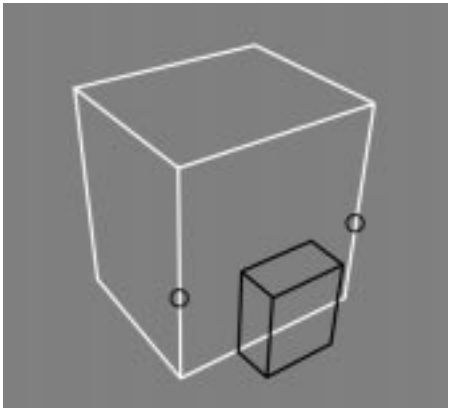
And this is the result. The new box is attached very neatly to the big box and can slide up or down as required.

Creating a Balcony

This technique allows a new object to be attached entirely within the face, rather than to the edges of another object.

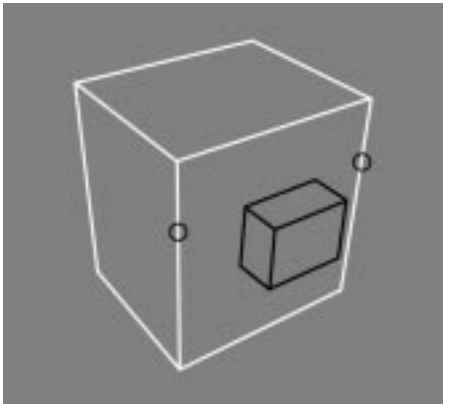


Use an Edge-to-edge glue. Cmd/Ctrl + click the top back edge of the small box and glue it to each of the front vertical edges of the big box as indicated.

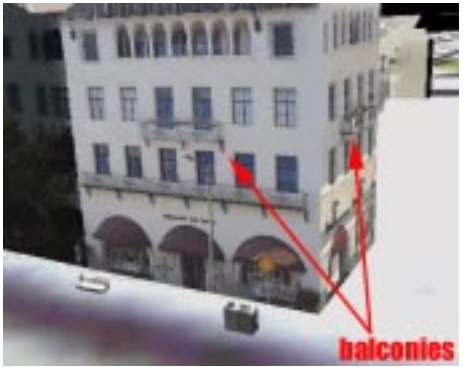


The result after 2 Edge-to-edge glue operations.

The small box's back is now forced to lie on the side face of the big box. It is still sitting on the ground plane. Once again, select **Model menu > unfix Y parameter** and use beads to move the little box upwards.



Voila1 A balcony, neatly glued to the side of a big box, but still free to slide up or down and to change width and height.



A real world example. The two balconies were modeled using this technique.

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