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Coordinate Systems

by Ted Boardman

Starting off, I'd like to thank everyone who stopped me at Autodesk University to mention they had been reading the column. I appreciate the feedback and the suggestions on possible topics for upcoming columns.

Remember that these columns are intended to help you increase your productivity and try to make your experience with VIZ and MAX more fun. That's right folks, this stuff should be fun. Don't tell the boss that, though.

Feedback from readers is helpful in gauging the topics you perceive as important for getting the job done. I can plan my columns to try to fit as many solutions and alternate work methods for those problems and bottlenecks that commonly slow those pesky budgets and schedules. Thanks again.

For those of you who missed Autodesk University this year, the event was held in Las Vegas in the last week of November. For whatever else Las Vegas may or may not be to you, it is the absolute best place in the world to study lighting and materials. The Mr. Potatohead School of Interior Design practice of putting every conceivable wood, plastic, chrome and fabric treatment in the same room and lighting it with any and all light types is a paradise to those of us who study the interaction of light and surfaces. It's not to be missed.

Where in the World...

One issue in 3D Studio MAX and VIZ that I see as a fundamental hindrance to production for many users, both new and experienced, is a lack of understanding of the coordinate system. The effective use of several important commands in both VIZ and MAX requires users to understand the various coordinate systems in the software, Align and Array being the most notable. In both Align and Array you are asked to enter numeric data to align or array objects along the x, y or z axes. However, the direction of x, y or z depends on the active coordinate system and, often, the active viewport.

Many users are familiar with the Absolute World coordinate system in VIZ or MAX because it is the default Grid plane with which VIZ and MAX start. However, the World Coordinate System is the active coordinate system for each viewport.

Reference Coordinate System

In the Toolbar menu, you will see a field with View in it by default. This is the Reference Coordinate System that is currently active. Click on the View field, and you will see a pop-up menu of the different Reference Coordinate Systems available, as shown in Figure 1.

Figure 1: This menu shows avaiable Reference Coordinate Systems.

I will take you through a simple exercise that will illustrate some of the differences between the various Reference Coordinate Systems. You can either try the exercise on your computer or, better yet, just read along to get the idea, then go to the computer and do the exercise. In any case, at some point you should sit down and just play with simple objects to get a feel for how the system works. As with many VIZ and MAX tools, don't try to learn this during the deadline crunch on a large project. With a little practice the Reference Coordinate Systems will become second nature and your productivity will increase accordingly. At the end of this column I will summarize the attributes of each system.

Getting the Lay of the Land

Start with a clean session of either VIZ or MAX with the display set to four viewports: Top, Front, Left and Perspective. In the Top viewport, create a cylinder in the middle of the display and click the Zoom Extents All button, as shown in Figure 2.

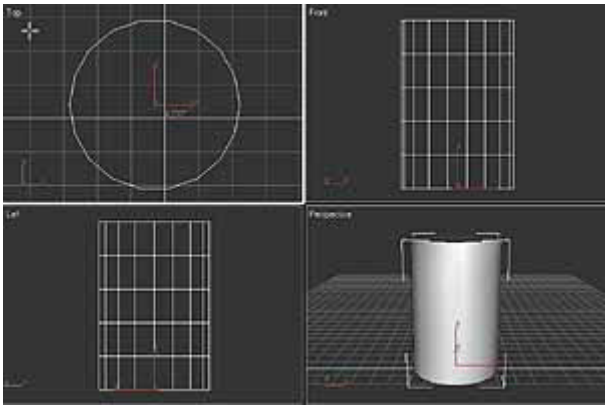

Figure 2: The Cylinder is zoomed to the extents in four viewports.

View Reference Coordinate System

Notice that the Axis Tripod shows positive x to the right, positive y up and positive z out toward the viewer and that the current active Reference Coordinate System is set to View. Right-click in the Front viewport and notice that the Axis Tripod adjusts to make the positive axis's point in the same directions as in the Top viewport. Right-click in the Left viewport to see a similar change. The Axis Tripod adapts itself to the orthographic viewports while in View Reference Coordinate System.

Now, right-click in the Perspective viewport and notice that the Axis Tripod corresponds to the World Coordinate System as indicated by the tri-color tripod in the lower left corner of each viewport. This is true for all non-orthographic viewports while in View Reference Coordinate System.

Screen Reference Coordinate System

Right-click in the Top viewport, then click View in the Toolbar and choose Screen Reference Coordinate System in the list. Right-click in the other viewports and watch the Axis Tripod. Screen Reference Coordinate System is exactly the same as View for orthographic viewports. However, for non-orthographic viewports the positive z axis points out of the screen toward the viewer. Arc-Rotate in the Perspective viewport and watch the Axis Tripod move in the other viewports. Screen Reference Coordinate System allows you to move objects in space based on your line of site in non-orthographic viewports.

World Reference Coordinate System

Right-click in the Top viewport and switch to World Reference Coordinate System. Right-click in the other viewports, and you will see that the World Coordinate System is always active for all viewport types.

Parent Reference Coordinate System

The next Reference Coordinate System in the list is Parent, which requires an object to be hierarchically linked to another object in the parent/child relationship. In Parent Reference Coordinate System, the child always uses the parent's Local coordinate system, which will be explained next.

Local Reference Coordinate System

Right-click in the Top viewport and choose Local in the Reference Coordinate System list. Right-click in the other viewports and the Axis Tripod is the same as it was for the World Reference Coordinate System. This is a coincidence because you created the cylinder in the Top viewport. Right-click in the Perspective viewport and rotate the cylinder about 45 degrees in both the x and y View Reference Coordinate System, as shown in Figure 3.

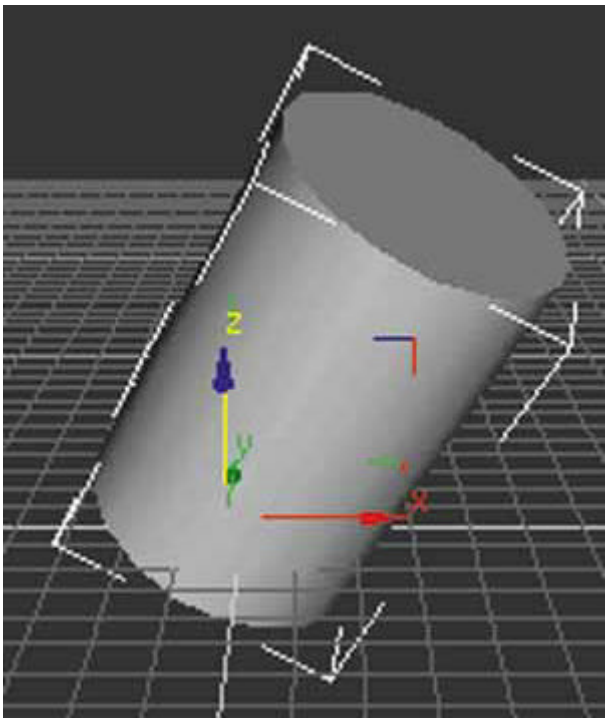

Figure 3: Here I've rotated the cylinder about 45 degrees in the x and y View coordinates of the Perspective viewport.

Grid Reference Coordinate System

At this point you will notice that even though you had the Reference Coordinate System set to Local, it switched automatically to View when you picked the Rotate button. The current Reference Coordinate System is sticky for each Transform: Move, Rotate and Scale. Once you set the Reference Coordinate System it will be retained for that Transform, until you change it again. The Axis Tripod also changes to the Transform Gizmo when the Transform buttons are picked.

Right-click in the Top viewport, click the Move Transform button and set the Reference Coordinate System to Local. Right-click in the other viewports, and you will see that the Axis Tripod stays oriented to object as it was created. This is an especially powerful tool for production with which you will want to familiarize yourself.

The Grid Reference Coordinate System requires you to create a new Grid Helper object as the active work plane. Right-click in the Top viewport to activate it. In the Status bar, toggle the Autogrid feature on. As you move your cursor over the cylinder, you will notice a tri-color cursor track the

Face Normal that it is over. In the Create panel, pick Box, hold the Alt key and pick and drag a Box primitive on the end cap of the cylinder, as shown in Figure 4.

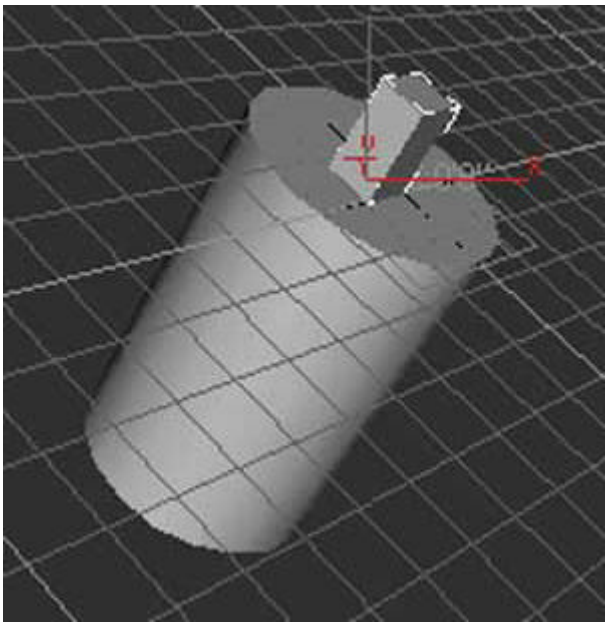

Figure 4: Using Autogrid, hold the Alt key and create a Box on the end cap of the cylinder.

Holding the Alt key while creating an object in Autogrid mode concurrently makes the new grid in the scene and makes it the active grid. Switch to Grid Reference Coordinate System and the x, y and z axes of the grid are used for the current transform. (Note: in this example the fact the new grid corresponds to the local axis of the cylinder is a coincidence.)

Click the Select button, pick the new Grid object in the active viewport, right-click on the Grid and, in the pop-up menu, choose Activate Grid then Home Grid to return to the default grid system. You can have as many of these grid helpers as you want, but only one can be active at any time. You can reactivate the new grid at any time. Grid helpers are similar to UCS grids in AutoCAD.

Pick Reference Coordinate System

In the Pick Reference Coordinate system you can use the coordinate system of another object in the scene as the current system. Right-click in the Top viewport to activate it and create a small Sphere to one side of the cylinder. Change the Reference Coordinate System to Pick, and pick on the cylinder in the Top viewport. The sphere now uses the cylinder's Local Reference Coordinate System as its own. Also, Cylinder01 is added to the list of available Reference Coordinate Systems.

Pivot Point Options

Another aid to production that goes hand in hand with the Reference Coordinate System is the active Pivot Point type. Just to the right of the Reference Coordinate System window is a flyout menu with three choices of Pivot Point types. Understanding the different options makes

transforming objects with Reference Coordinate Systems a more flexible and powerful tool, as shown in Figure 5.

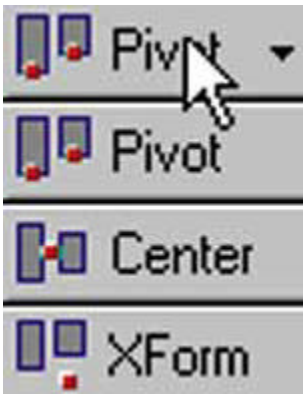

Figure 5: Here is the Flyout menu of Pivot Point options.

Pivot Point Center

In the Top viewport, select all the objects in the scene. With the Pivot Point Center option set you will notice that each selected object will be Transformed based on its current active Reference Coordinate System around its own individual pivot point. This is especially interesting when you are in Rotate or Scale Transform. (Caution: Never Scale objects in either VIZ or MAX. Always apply an Xform modifier and scale the Xform Gizmo.)

Selection Center Choose Use Selection Center in the flyouts, and you will see that the entire selection set of objects uses a single Pivot Point in the geometric center of the bounding box of the selected objects. This is most appropriate for rotations.

Transform Coordinate Center

The Transform Coordinate Center uses the 0,0,0 Absolute World Coordinate point except when Pick Reference Coordinate System is active. The selected object then uses the Pick objects Pivot Point as its own.

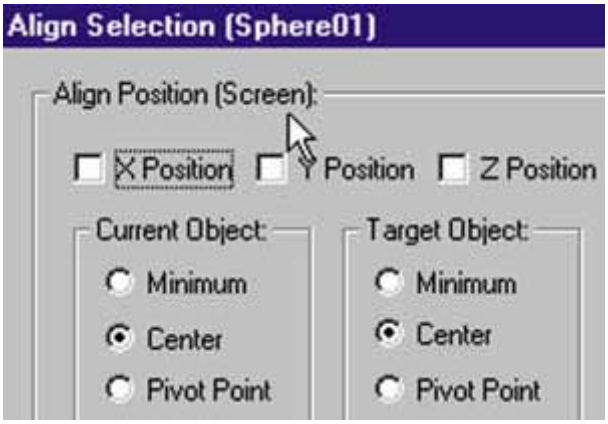

Figure 6: The Active Reference Coordinate System is shown in parentheses in the Align dialog box.

Summary

The attributes of the various Reference Coordinate Systems are:

View. The Axis Tripod adapts itself to each orthographic viewport so that positive x axis is to the right, positive y axis is up and positive z axis is perpendicular out of the display. Non-orthographic viewports resort to using World Reference Coordinate System.

- Screen. This is the same as View in orthographic viewports. In non-orthographic viewports the positive z axis always points at the viewer.
- World. The World Coordinate System always corresponds to the Absolute World Coordinates.
- Parent. The child object uses the parent's Local coordinate system in a hierarchically linked parent/child relationship.
- Local. The coordinates always remain with the object as it was created, regardless of the rotation angle of the object.
- Grid. This uses the active Grid System's coordinate system.
- Pick. This uses the Local Coordinate System of another object picked in the scene.

For the ALIGN, ARRAY and MIRROR commands in VIZ and MAX, always check the current active Reference Coordinate System to see which x, y and z axes is being used by the command. The mode is noted in the Align or Array dialog, as shown in Figure 6. (Hint: The View Reference Coordinate System is never listed in ARRAY, ALIGN or MIRROR commands. You will always see Screen, which is the same.)

As I mentioned at the outset of this column, these incredibly powerful tools and options are simple to learn. You are doing yourself a great disservice if you aren't using these effectively in daily production tasks. Start with simple examples to get the feel of the options, and it will come naturally as you work. Good luck and have fun.

Ted Boardman is one of a dozen Discreet Training Specialists from around the world; not a Discreet employee but a consultant for training 3D Studio VIZ and 3D Studio MAX dealers, Discreet Application Engineers and some Discreet major account clients. However, his primary business is custom professional-level training and some scheduled training sessions around the world. You can reach him at tbdesign@cybertours.com.

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