Getting Started in Maya

Make sure you view the “Essential Skills Movies”. If this menu does not appear when you start Maya, you can find it by invoking the Maya menu command: Help-1-MinuteStartupMovies.
The location of a point in three-dimensional space is specified by three numbers.
Measurement in a Coordinate System
A function is a rule for changing one thing into another thing.
For example, the function $f(x) = x + 1$ changes a number $x$ into the next higher number $x+1$.
Think of a function as a box with an input and an output:
A transformation is a function that changes one point \((x,y,z)\) into another point \((x',y',z')\).
A transformation may be applied to each point of a shape. We may say that the transformation changes the entire shape at once.
Move each point by the same amount \((\Delta x, \Delta y)\) along each axis of the coordinate system.
Rotate each point by the same angle $\theta$ around the origin of the coordinate system.
Scale each point by the same factor \((s_x, s_y)\) along each axis of the coordinate system.
Pivot

• In Maya, the origin of a coordinate system is called a “pivot”.

• The effect of a transformation generally depends on the pivot.
  – Rotate: All points rotate around the pivot, which itself is unchanged.
  – Scale: All points more toward or away from the pivot, which itself is unchanged.

• If we change the pivot, then we change the kinds of transformations we can apply.
Rotate each point by the same angle $\theta$ around the origin of the coordinate system.
Scale each point by the same factor \((s_x, s_y)\) along each axis of the coordinate system.
Moving an Object’s Pivot

• Select the object.
• Select the Move, Rotate or Scale tool.
• Press the Insert key.
• The transform tool handle changes to a pivot handle.
• Use the Left Mouse Button (LMB) to move the pivot to a new position.
• Press the Insert key again.
• The pivot handle changes back to a transform tool handle.
Scaling with Original Pivot

Before

After
Scaling with New Pivot

Before

After
Rotating with Original Pivot

Before

After
Rotating with New Pivot

Before

After
Scene Hierarchy

• Organize a scene into a tree-like structure.

• One object may be “parented” to another.
  – The objects are related as “parent” and “child”.
  – We say the child is “parented to” the parent.

• Multiple objects may be “grouped” together.
  – A non-visible “group” object is the parent of each object in the group.

• Transformations applied to an object will also affect all the object’s descendants, i.e., its children, grandchildren, great grandchildren, etc.
Solar System in Maya
Flat Solar System in Hypergraph

demo-02-01-solar-system-flat.mb
Flat Solar System in Outliner

demo-02-01-solar-system-flat.mb
Problems

• How can we make the earth stay in its orbit while it moves around the sun?

• How can we make the moon stay in its orbit while it moves around the earth (which itself is moving around the sun)?
1. Select earth, moonOrbit and moon.
2. Invoke menu command Edit-Group.
3. Name the group “earthSystem”.
4. Select earthSystem.
5. Move the earthSystem pivot to the earth’s location.
6. Select sun, earthOrbit and earthSystem.
8. Name the group “solarSystem”.
9. (The solarSystem pivot is already at the sun’s location.)
Hierarchic Solar System in Hypergraph

- The solarSystem has three children: sun, earthOrbit and earthSystem.
- The earthSystem has three children: earth, moonOrbit and moon.

demo-02-02-solar-system-hierarchic.mb
Hierarchic Solar System in Outliner

- The solarSystem has three children: sun, earthOrbit and earthSystem.
- The earthSystem has three children: earth, moonOrbit and moon.

demo-02-02-solar-system-hierarchic.mb
Each Tree “Node” Stores a Transformation and (Possibly) a Geometric Shape

Transform Node
Transform & Shape Node
Transform & Shape Node
Transform & Shape Node
Transform Node
Transform & Shape Node
Transform & Shape Node
Transform & Shape Node
Transform & Shape Node
Transform & Shape Node
Use the menu item: Options-Display-ShapeNodes to show transform & shape nodes separately.

Notice that each shape node has split into a transform node and a shape node.
Transformations are Applied in Bottom Up Topological Order

• Leaf transformations are applied first.
• Each child’s transformation is applied before its parent’s transformation.
• The transformation series replays the process in which a geometric object:
  – Is created at the origin.
  – Moved, rotated and scaled.
  – Grouped with other objects.
  – Repeatedly.
Parenting

• Create a NURB sphere: nurbSphere1.
• Create another NURB sphere: nurbSphere2.
• Select nurbSphere2.
• Shift-Select nurbSphere1.
• Invoke menu item: Edit-Parent.
• Now nurbSphere1 is the *parent* of nurbSphere2.
• Transformations on nurbSphere1 (parent) also transform nurbSphere2 (child).
Parent Node

demo-02-06-parenting.mb

Child Node
Parenting versus Grouping

• The *parent* command establishes a parent/child relationship between two existing nodes.

• The *group* command creates a new transform “group” node and also establishes parent/child relationships between the group node and the nodes being grouped together.
NURB Cube is a Hierarchy

A NURB cube is really six planes grouped under an invisible parent.
Transforming a Group Object

- A group object can be used as a mechanism for transforming its children.
- E.g., Stretch a cube along a diagonal axis.
- First we make a group object to be a parent of the original cube.
- Then we rotate the cube relative to its parent.
- Then we scale the parent.
Creating a New Group

• The newCubeGroup has one child: nurbsCube1.

• The nurbsCube1 has six children, each of which is a plane.
Rotate Original Cube by 45 Degrees

Before

After
Scale newCubeGroup on X Axis

Before

After
Cube Deformed by Non-Uniform Scaling of Parent Group

demo-02-03-deformed-cube.mb
Warning! Rotation Under a Non-Uniformly Scaled Group Node (It may surprise you!)

• Go to a Top view.
• Select the nurbsCube1 object.
• Rotate around the Y axis.
• Notice that the cube shape is deformed.
Before

After

demo-02-03-deformed-cube.mb
Exercise

1. Go to a Side View and use Create-NURBSPrimitives-Cone[] and SingleClickSettings to create a NURB cone at the origin with 1.0 radius and 2.0 height that is aligned with the Y axis and has Caps set to None.

2. Move the cone’s pivot down to its base and then move the cone off to the left side of the window.

3. Duplicate original cone and move the duplicate to the origin.

4. Do the following 9 times (in Side View):
   a. Move the shape at the origin up 2 units on the Y axis.
   b. Scale the shape by $s=0.75$ on the X, Y and Z axies.
   c. Rotate the shape by $r=15$ degrees on the X axis.
   d. Duplicate original cone and move the duplicate to the origin.
   e. Parent the old shape (root) to the new shape.
Exercise Interpretation

• Each object in the transform hierarchy was scaled and rotated once.
• The position, orientation and size of each object is determined by its own transforms, as well as the transforms applied to all its ancestors.
• Nodes farther down the hierarchy have more ancestors.
• Therefore they see a greater cumulative rotation and scaling effect.
Operating in Coordinate Systems

- Each transformation tool comes with a choice of coordinate systems.
- The coordinate system can be selected using the menu item: Modify – TransformationTools[].
- The Move transformation may be carried out in Object, Local or World coordinates.
- Similar choices are available for the other transformation tools.
Moving in Object Coordinates

In the illustration, the child cube is about to be moved. It is parented to the other cube.

The coordinate axies are aligned with the cube to be moved.
Moving in Local Coordinates

In the illustration, the child cube is about to be moved. It is parented to the other cube.

The coordinate axies are aligned with the parent of the cube to be moved.
Moving in World Coordinates

In the illustration, the child cube is about to be moved. It is parented to the other cube.

The coordinate axies are aligned with world.
Copying

- Create a sphere: nurbSphere1.
- Invoke menu item Edit-Duplicate-Special-[].
- Press the “Copy” button and confirm by pressing the “DuplicateSpecial” button.
- Move one of the spheres away from the other one.
- Go into component mode and modify the shape of nurbSphere1.
- Notice that the shape of nurbSphere2 remains unchanged.
Instancing

- Create a sphere: nurbSphere1.
- Invoke menu item Edit-Duplicate-Special-[].
- Press the “Instance” button and confirm by pressing the “DuplicateSpecial” button.
- Move one of the spheres away from the other one.
- Go into component mode and modify the shape of nurbSphere1.
- Notice that the shape of nurbSphere2 has changed as well.
demo-02-08-instancing.mb
Instancing versus Copying

• The copy command creates a new transform node and a new shape node.
• The instance command creates a new transform node, but does not create a new shape node.
  – The two transform nodes share the one original shape node.
  – Changes to the original shape are also seen in the duplicate shape.
“Car” Example

- Create a “tire” group out of a torus (wheel) and two cylinders (spokes).
- Form an “axleGroup” from two wheels and a cylinder (axle).
- Form a “body” and a “canopy”, each from a scaled sphere (ellipsoid).
- Combine the body, canopy and two axle groups into a “car”.
demo-02-05-car-instancing.mb
demo-02-05-car-instancing.mb