CSE 682: Animation

Winter 2012

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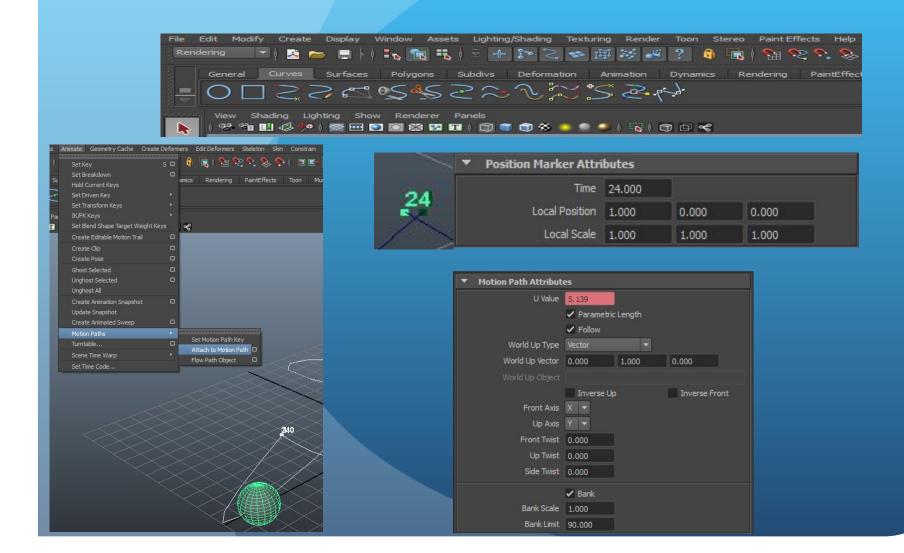
Topics:

- Path animation
- Camera animation
- Keys and the graph editor
- Driven keys
- Expressions
- Particle systems
- Animating FK & IK linkages
- Skinning
- Locators, deformers, manipulators
- Constraints
- Dynamics

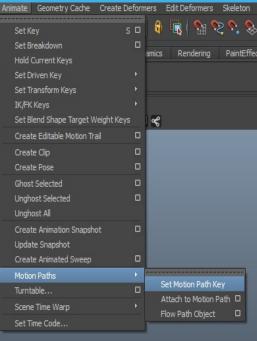
Path Animation

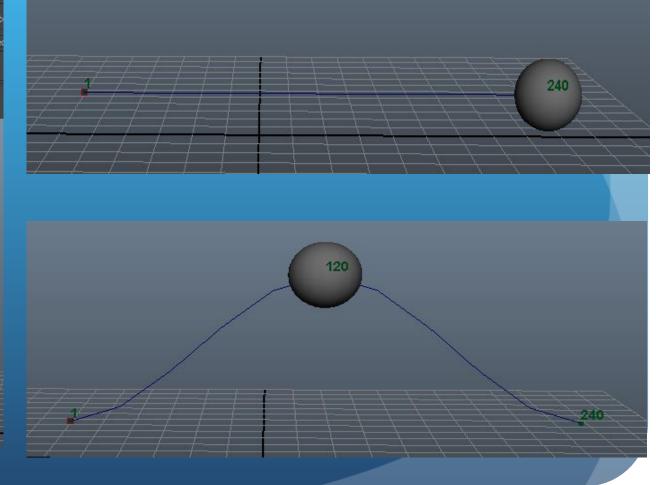
- 1. Attach object to curve
- 2. Set motion path keys
- 3. Flow path object

Attach object to curve



Set motion path keys





Flow path object

| ts | Animate | Geometry Cache | Create Defor | mers | Edit Deformers | Skeleton |
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| Par | IK/FK | Keys | | | | |
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| | Creat | te Animation Snapsh | ot 🛛 | | | |
| | Upda | te Snapshot | | | | |
| | Creat | te Animated Sweep | D | | | |
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| Drawing Ov Node Behav Extra Attrib | ior | | |

Keys

- Set Keys
- Auto Keys
- Hold Keys
- Driven Keys

Set Keys

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Auto Keys

• After initial key is set for object, any transformation done to the object in a different frame will automatically set a another key

Auto key is currently off:

Auto key is currently on:





Hold Keys

• Useful when using auto keys. It locks the objects attributes so it cannot be transformed.

| | Animate Geometry Cache | Create Deformers |
|----|------------------------|------------------|
| þ | Set Key | s 🗆 |
| | Set Breakdown | |
| BU | Hold Current Keys | am |
| •* | Set Driven Key | |
| | Set Transform Keys | · · _ |
| | TIC IT IC | |

Driven Keys

- Does not use time slider for animation
- Attributes of one object change relative to how attributes of another object change
- Useful when you have complex movement:
 - Hand movement
 - Door opening
 - Groups of objects

Driven Keys

| L | Animate Geometry Cache Cro | eate Deformers | Edit Deformers | Skeleton Skin | Constrain Cha | racter Help | |
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| | Set Breakdown | 0 | | | | | |
| Su | Hold Current Keys | amic | s Rendering | PaintEffects | Toon Muscle | Fluids Fur | Hair nCloth |
| 2 | Set Driven Key | • | | | | | |
| Γ | Set Transform Keys | • | Set | | | | |
| aı | IK/FK Keys | | Go to Previous | | | | |
| | Set Blend Shape Target Weigł | nt Keys | Go to Next | | | | |
| 1 | Create Editable Motion Trail | 0 | | | | | |
| I | Create Clip | 0 | | | | | |
| I | Create Pose | 0 | | | | | |
| | Ghost Selected | 0 | | | | | |
| I | Unghost Selected | 0 | | | | | |
| I | Unghost All | | | | | | |
| | Create Animation Snapshot | 0 | | | | | |
| I | Update Snapshot | | | | | | |
| l | Create Animated Sweep | 0 | | | | | |
| I | Motion Paths | × | | | | | |
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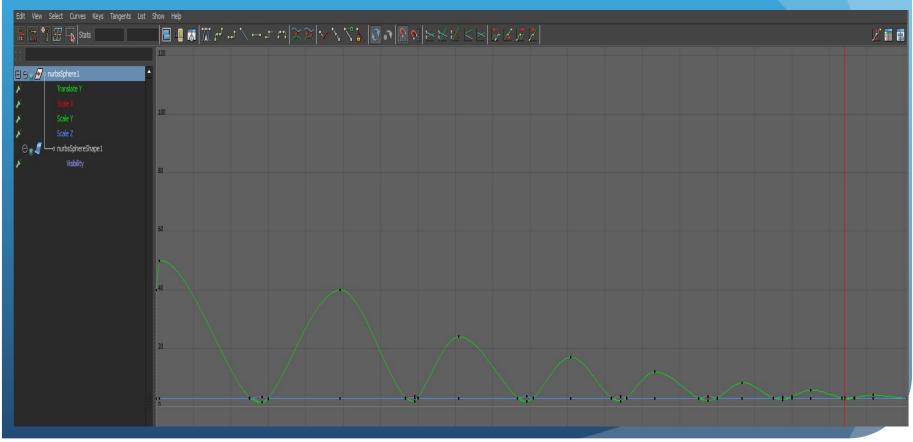
| 📓 Set Driven Key | |
|------------------------------|----------------------------|
| Load Options Key Select Help | |
| | |
| Selected as Driver | |
| Selected as Driven | Visibility |
| Current Driver | Translate X |
| | Translate Y Translate Z |
| | Rotate X |
| | Rotate Y |
| | Rotate Z Scale X |
| | Scale Y |
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| door | Visibility |
| | Translate X Translate Y |
| | Translate Z |
| | Rotate X |
| | Rotate Y Rotate Z |
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| Key Load Driver | Load Driven Close |
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Driven Keys

- Be sure to put the driven keys in different frames for accurate results
- Then animate the ball with key frames or motion paths!

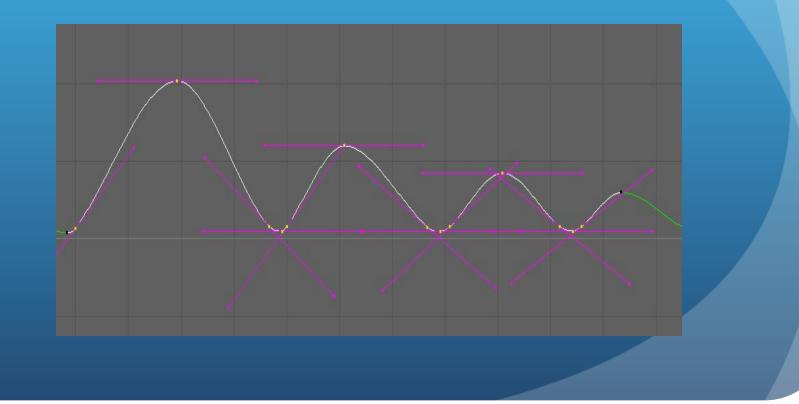
Graph Editor

| | Window | Assets | Animate | Geometry | y Ca | ache | Crea | te De | forme | rs | Ed |
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| - | Relati | ionship Ed | litors | | | | Graph I | | | | |
| | Sattir | ne Drafar | ences | 8 | ×. | | rax Ec | litor | | | |



Graph Editor

- Highlight attributes on graph you want to edit
- Middle click and drag to change it



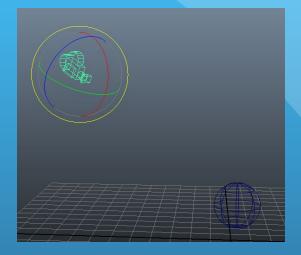
Cameras

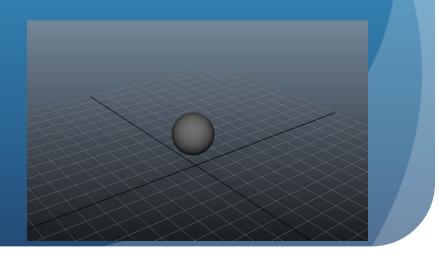
- 3 different types:
 - Camera: Acts like a regular object
 - Camera and Aim: Has location and pointer
 - Camera, Aim, and Up: Acts as a real camera

Camera Basics

| | Create Display W | indow Assets | Animate Geometry C | ache Create | | |
|----------|--|------------------|-----------------------------------|----------------|-------------------|------|
| | NURBS Primitives Polygon Primitives | | tivs Deformation | 詞 Animation | | |
| | Subdiv Primitives Volume Primitives Lights | | ≈1X | \$\$ | | |
| ad | Cameras | | Camera | ٥ | | |
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| | Bezier Curve Tool | ٥ | Stereo Camera | | | |
| | Pencil Curve Tool | ٥ | Multi Stereo Rig | | | |
| | Arc Tools | | | - | | |
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| Surfaces | Polygons | Subdivs | Deformation | Animat | tion Dyna | amic |
| 25 | \$ <u>\$</u> | 22 | \sim | \$\$ | <u>s</u> 44 | |
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| | | Orthog | | | New | |

Look Through Selected 🛛

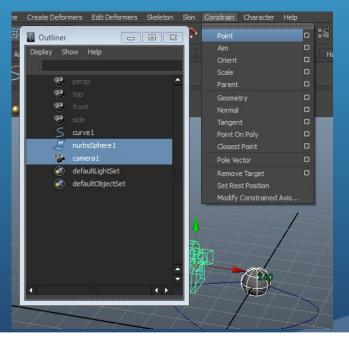




Camera Animation

Control camera with constraints or use motion paths and key frames

| | Window | Assets | Animate | Geomet | ry Ca | iche |
|----|------------------------|--|----------------------|--------|-------|------|
| | Rend Anima Relat | ral Editors lering Edito ation Edito ionship Ed ngs/Prefer | ors ors litors | | | Anin |
| hc | Attrib | oute Editor | | | | |
| | Outlir | ner | | | | 9 |
| Π | Creat | te Node | | | | |
| | Hype | rgraph: Hi | erarchy | | | |
| | Hype | rgraph: C | onnections | | | |
| | Paint | Effects | | | | |
| | | | | | | |



Expressions

What are expressions?

• Program-like instructions that you write to control keyable attributes over time

- Can be comprised of:
 - Mathematical equations
 - Conditional statements
 - MEL commands

What are expressions?

 Ideal for attributes you want to change incrementally, randomly, or rhythmically over time

 Cannot be mixed with other animation techniques for the same attribute of an object

Window >> Animation Editors >> Expression Editor

| 🔞 Autodesk Maya 2010 x6 | 64 - Educational Version: untitled Ball | |
|--|---|--|
| File Edit Modify Creat | ate Display Window Assets Animate | Geometry Cache Create Deformers Edit I |
| Animation 💽 🕴 🐼 🖷 General Curves Su | General Editors Unfaces Polyg Rendering Editors | ▶ 👘 🗢 🦿 🖓 🖏 I 🕅 I 😭 ▶ics Benderina PaintEffects To |
| Display Show Par | Animation Editors Relationship Editors Settings/Preferences Attribute Editor Outliner Hypergraph: Hierarchy Hypergraph: Connections | Graph Editor Trax Editor Dope Sheet Blend Shape Expression Editor Device Editor |
| front fr | Paint Effects UV Texture Editor ItLightSet Playblast | |
| Image: Second state | kObjectSet Saved Layouts Save Current Layout Frame All in All Views | ; |
| | Frame All in All Views Frame Selection in All View Minimize Application Raise Main Window | A ws F |
| | Raise Application Window | /5 |

| Expression Editor | | |
|------------------------------------|---|--|
| Select Filter Object Filter Attrik | ute Filter Insert Functions Help | |
| | Creating Expression | |
| Expression Name | BallTranslateY New Expression | |
| ▼ Selection | | |
| Objects | Attributes | |
| Ball | visibility | |
| | translateX translateY | |
| | translateZ rotateX | |
| | rotateY | |
| Selected Object and Attribute: | Ball | |
| Default Object: | Ball | |
| Convert Units: | , | |
| | Runtime before dynamics C Runtime after dynamics C Creation | |
| Evaluation: | Always 👻 | |
| | | |
| Editor: | Expression Editor | |
| Expression: | - [] | |
| Ball.translateY = time + | 1; | |
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| Create Dele | te Reload Clear Close | |
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time

• Predefined variable that updates as an animation plays

• Contains the elapsed number of seconds from the first frame to the current frame

Ball.translateY = time*5;

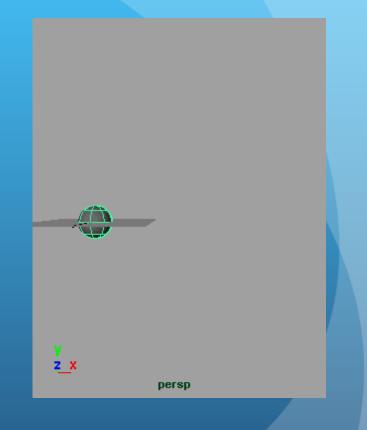


Editing Francessions

| Expression Editor | and the second | |
|------------------------------------|--|------------------------------|
| Select Filter Object Filter Attrik | ute Filter Insert Functions Help | |
| | Editing Expression | |
| Expression Name | BallTranslate | New Expression |
| ▼ Selection | , | |
| Objects | Attributes | |
| Ball | translateY | |
| | translateZ rotateX | |
| | rotateY | E |
| | rotateZ scaleX | |
| Selected Object and Attribute: | Ball.translateY | |
| | Ball | |
| Default Object: | | |
| Convert Units: | | |
| | Runtime before dynamics C Runtin | ne after dynamics C Creation |
| E valuation: | Always 🔻 | |
| E ditor: | Expression Editor 💌 | |
| Expression: | | |
| Ball.translateY = time*3 | ; | |
| Ball.translateX = time*1 | D; | |
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| | | |
| Edit Del | ete Reload | Clear Close |
| | | |
| | | |

Controlling two or more attributes

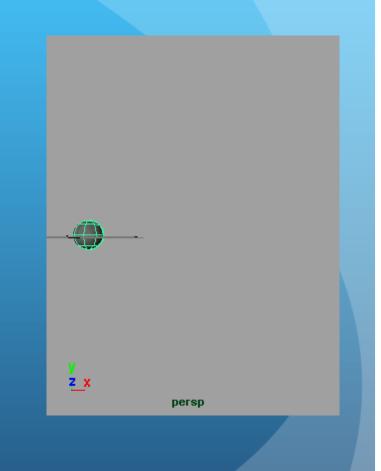
Ball.translateY = time*3; Ball.translateX = time*10;



Linking attributes

Ball.translateY = time*15; Ball.translateX = Ball.translateY;

Advantage: assigning new value updates other values



Multiple Objects

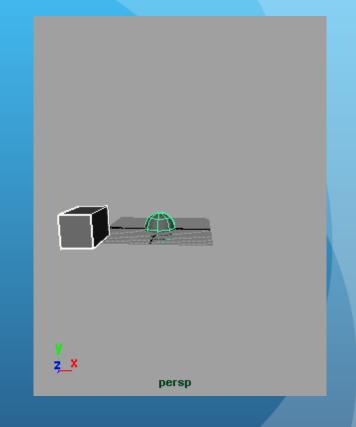
• Can use a single expression to control the attributes of multiple objects

| Expression Editor | | | | | | x |
|--|--------------------------|--------------------|--------------|----------------|--------------|-----|
| Select Filter Object Filter Attril | oute Filter – Insert Fun | ctions He | lp | | | |
| | E diting E | xpression | | | | |
| Expression Name | Ballbox | | N | lew Expression | | |
| ▼ Selection | | | | | | |
| Objects | | Attributes | | | | _ |
| box Ball | | rotateX rotateY | | | | ^ |
| | | rotateZ scaleX | | | | Е |
| | | scaleY scaleZ | | | | - |
| Selected Object and Attribute: | Ball.translateY | | | 1 | | |
| Default Object: | Ball | | | | | |
| Convert Units: | 1 | C | None | | C Angular or | nly |
| Particle: | Runtime before dyn | amics C | Runtime afte | | C Creation | |
| Evaluation: | Always 👻 | | | | | |
| Editor: | Expression Editor 💌 | | | | | |
| Expression: | | | | | | |
| Ball.translateY = time*1 Ball.translateX = Ball.t box.rotateZ = time * 30; | | | | | | |
| Edit Del | ete Re | oad | Clea | ar 📗 | Close | |

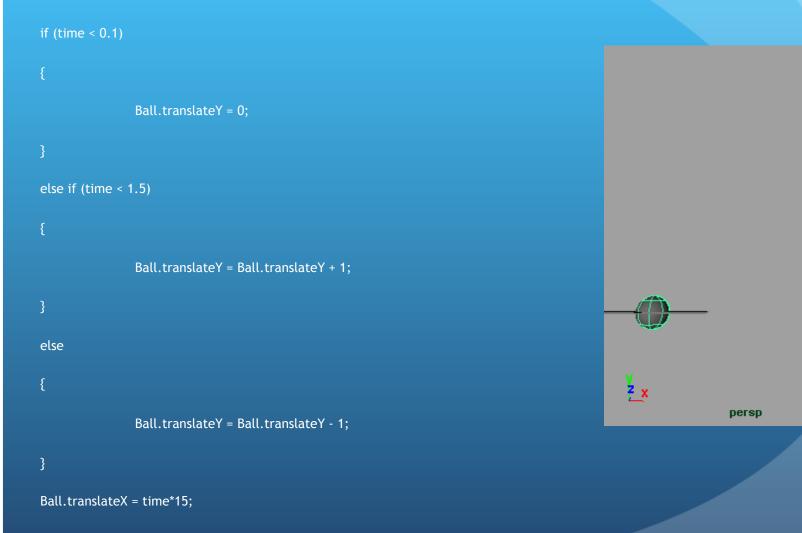
Example with single expression

Ball.translateY = time*10; Ball.translateX = Ball.translateY; box.rotateZ = time*30;

Advantage: having all of your statements in one expression



Conditional Statements



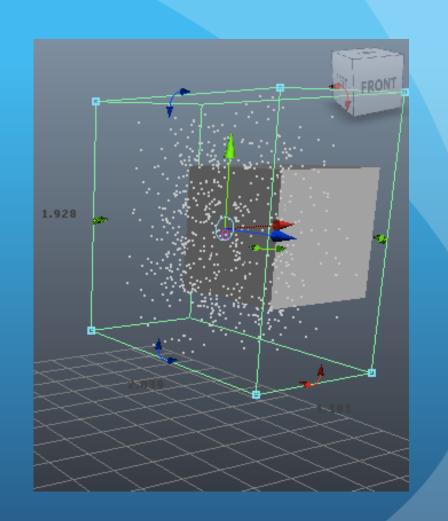
Summary

- Good practice to name expressions
- Full name of attribute
 - Object.Attribute
- Case sensitive
- Semicolon (;) signifies the end of an expression statement
- Keep your conditional statements readable

Particle Systems

Useful for...

- Water
- Smoke
- Fire
- Explosions
- Etc



Particle Systems

• Under Dynamics tab, select "Emitter" (or "Emit from object)

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|------|---------------|--------------|----------|----------|---------------|-----------|----------|
| | General Curve | s Surfaces | Polygons | Subdivs | Deformation | Animation | Dynan |
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| 1 | 🥵 front | | | | | | |

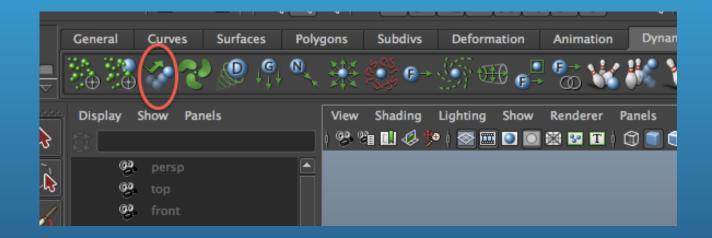
Particle Systems

• Modify Emitter and particle attributes

| List Selected Focus Attributes Show Help | |
|--|--|
| particle1 particleShape1 emitter1 lambert1 time1 | |
| transform: particle1 Focus Presets Show Hide | Basic Emitter Attributes |
| ▼ Transform Attributes | Emitter Type Omni 👻 |
| Translate 0.000 0.000 0.000 | Rate (Particles/Sec) 100.000 |
| Rotate 0.000 0.000 Scale 1.000 1.000 | Scale Rate By Speed |
| Shear 0.000 0.000 0.000 | |
| Rotate Order Xyz 🔻 | Scale Rate By Object Size |
| Rotate Axis 0.000 0.000 0.000 | Use Per-Point Rates (ratePP) |
| ✓ Inherits Transform | Need Parent UV (NURBS/Poly surfaces only |
| Pivots Limit Information | Cycle Emission None (timeRandom off) 🚽 |
| Display mental ray | Cycle Interval 1 |
| Node Behavior | ▼ Distance / Direction Attributes |
| Notes: particle1 | |
| | |
| | |
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| | |
| Select Load Attributes Copy Tab | |

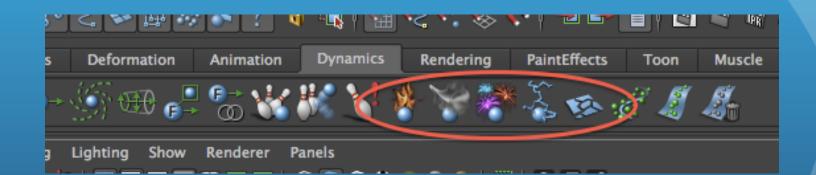
Particle Systems

• For colliding surface, select a particle, then a surface, then select the "Make Collide" button



Particle Systems

• For fire, smoke, fireworks, electricity, broken glass: use specified buttons under Dynamics tab (Maya 2011)



Animating FK & IK Linkages

FK vs. IK

Forward Kinematics

 Joints inherit transformations from parent joints

• Useful for crane-like objects

Inverse Kinematics

 Parent joints are transformed based upon transformations to specified child joint

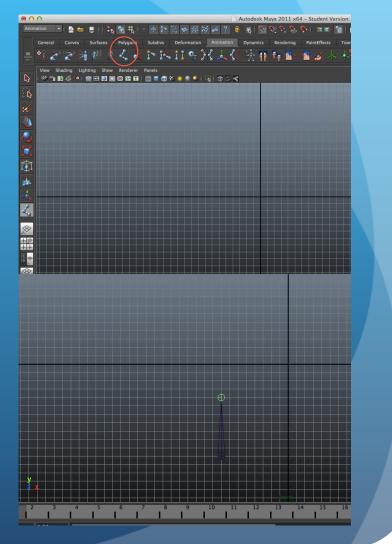
• Useful for body parts

Using Forward Kinematics

• Select "Joint Tool" under the Animation tab

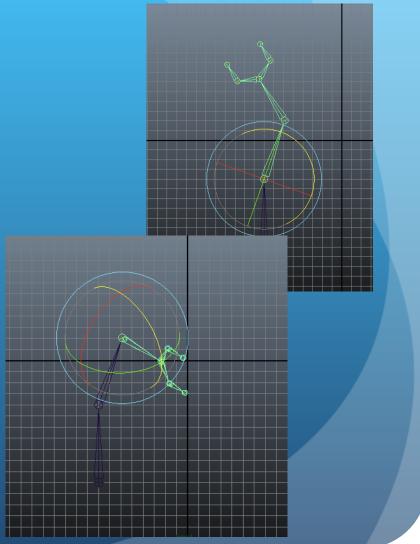
Create Joint Chain:

- Click to place start of joint
- Click again to place end of joint
- Continue for multiple nodes
- Press Enter to finish



Using Forward Kinematics

• Manipulate joints and set keys

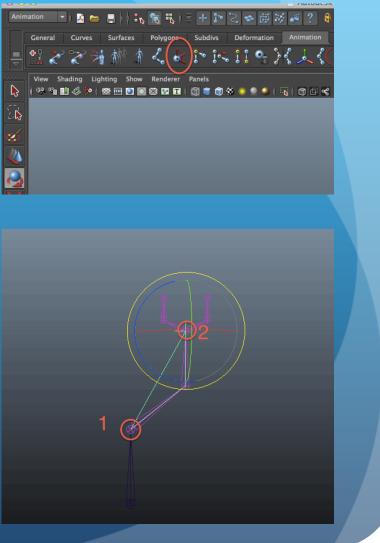


Using Inverse Kinematics

- Must have joint chain
- Select "IK Handle Tool" under the Animation tab

- Click start joint
- Click again on end joint

• Manipulate and set keys

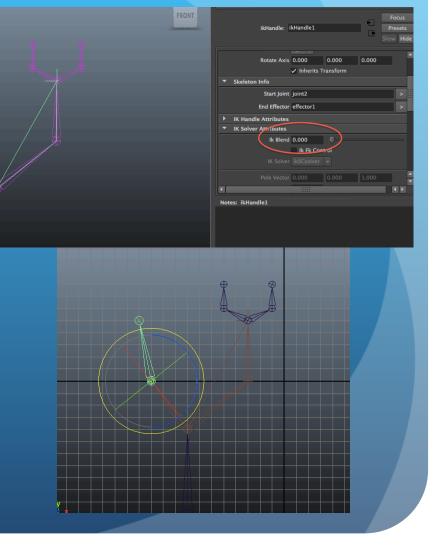


Using Forward and Inverse

• Must have an IK handle

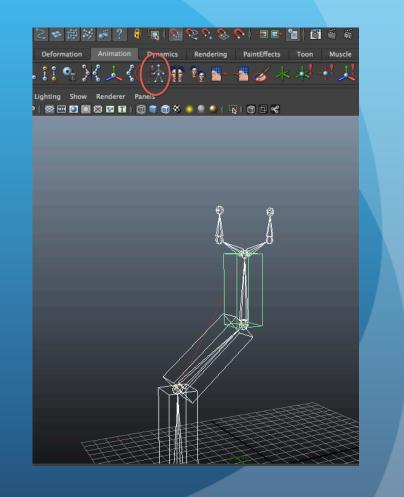
• Manipulate and set keys

• Under "IK Solver Attributes" set IK Blend to 0 when using FK, and to higher values for IK



Skinning

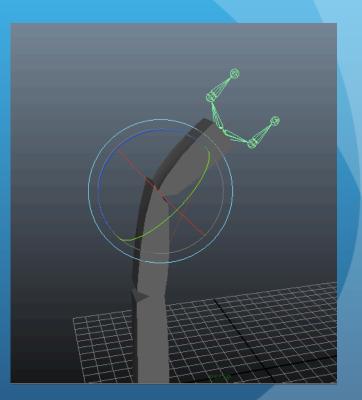
- Draw objects over joints
- Shift-click to select joints and objects
- Select "Blend Tool" under the Animation tab
- Click to place start of joint
- Click again to place end of joint
- Continue for multiple nodes
- Press Enter to finish



Skinning

• Interact with joints to manipulate objects

• Set keys



Locators, Deformers, Manipulators

Useful for...

• Creating a pivot or reference point (locators)

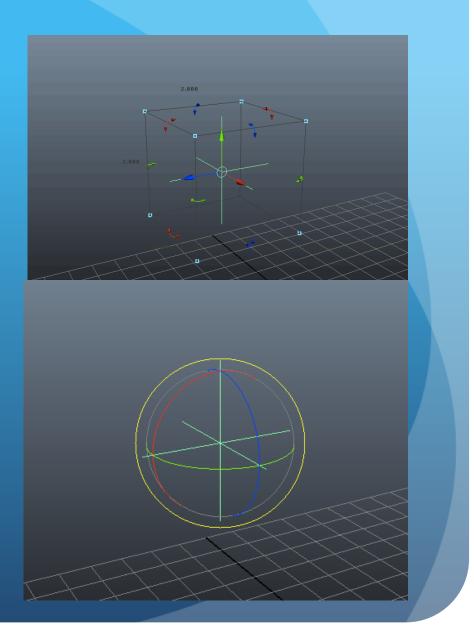
• Transforming the position and shape of an object (deformers and manipulators)

Locators

• Select "Locators" under the Create menu to place a locator on grid

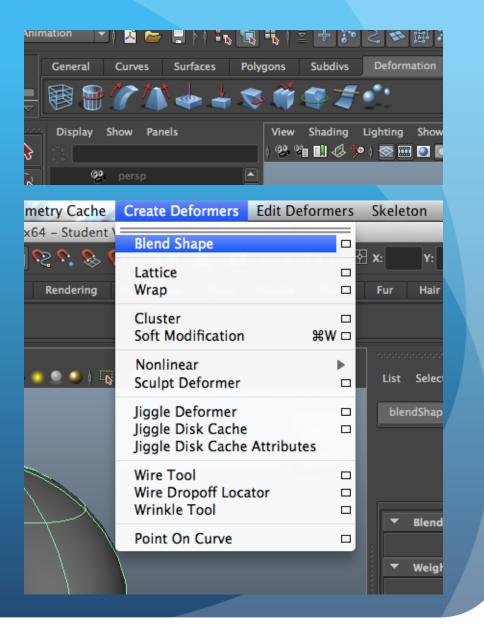
• Can use to manipulate object from a specific point (similar to a pivot)

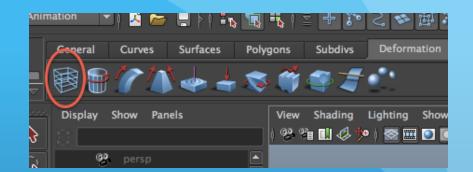
• Can also be used as a reference for directed objects (eyes, spot lights, etc)



• Deformers can be created using the buttons under the Deformation tab, or by using the "Create Deformers" menu

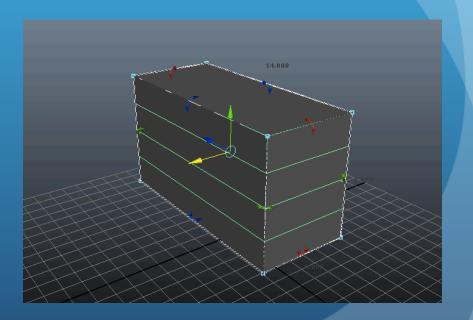
• Useful for any object which can be deformed (NURBs, polygonal surfaces, etc)

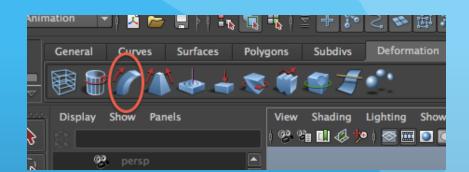




Lattice

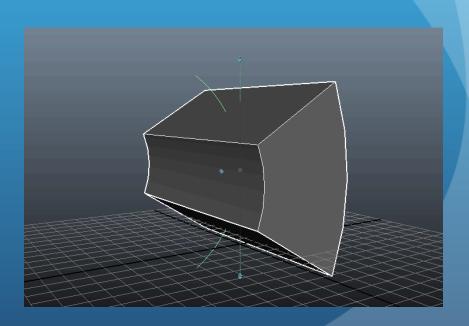
• Creates a grid around an object that can be used to deform an object more precisely

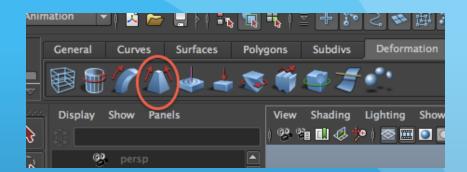




• Bend

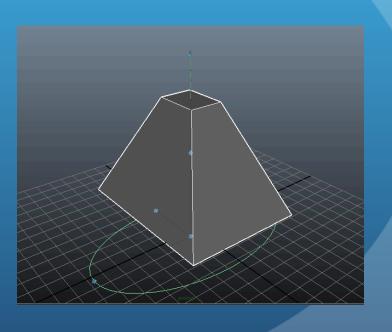
• Bends an object along a specified arc

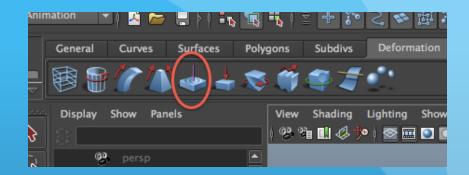




• Flare

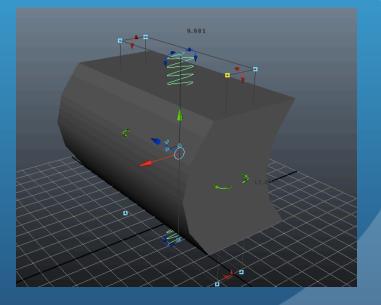
• Modifies an object by resizing specified edges

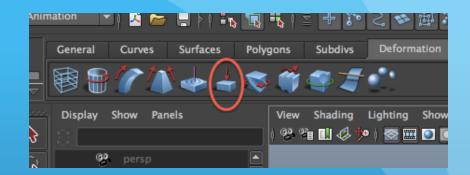




• Sine

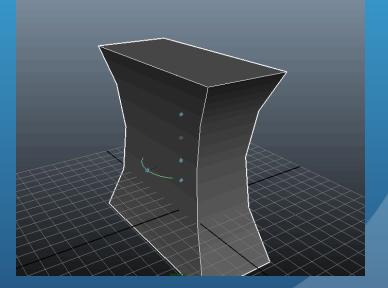
• Creates a "sine wave" deformation along an object

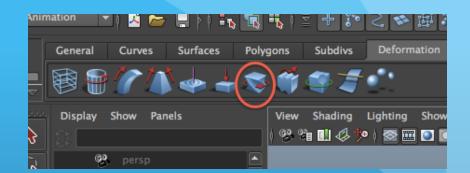




• Squash

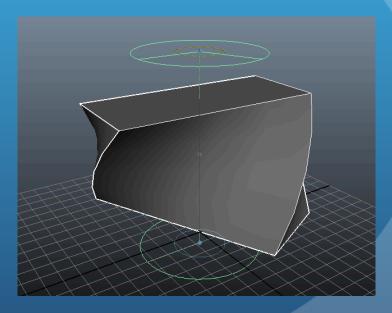
• "Squashes" an object along a particular axis

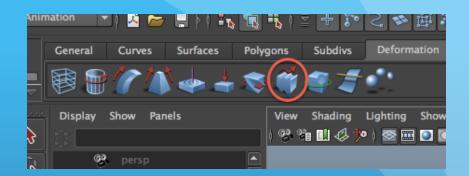




• Twist

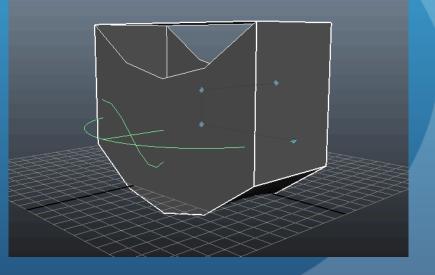
• Twists an object in a specified direction

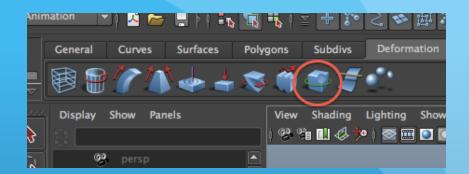




• Wave

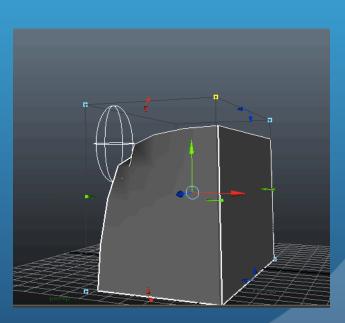
• Creates a wave deformation along an object





• Sculpt

• "Sculpts" out part of an object



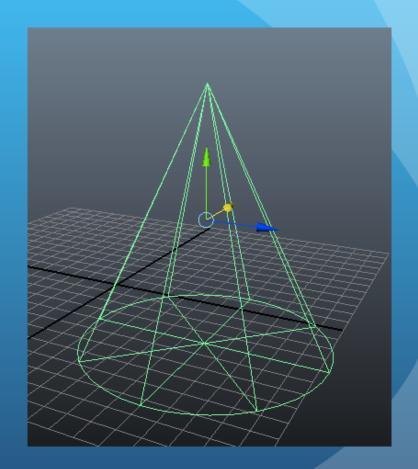
• Tools used to apply transformations to objects

• Move, Scale, Rotate are the main ones, but deformers are considered to be manipulators as well

• Select using icons on side tool bar, or by pressing the default "hot keys"

• Move

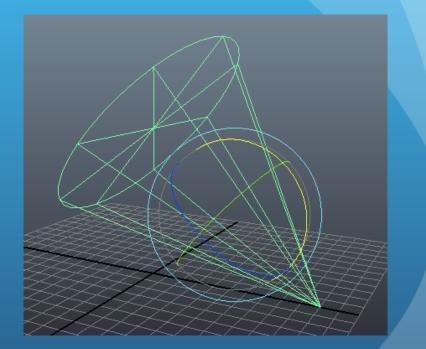
• Translates an object from a starting to an ending point



• Hot key: "w"

• Rotate

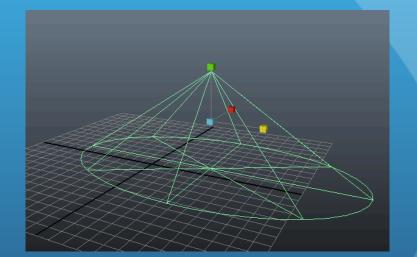
• Rotates an object around a specified point



• Hot key: "e"

• Scale

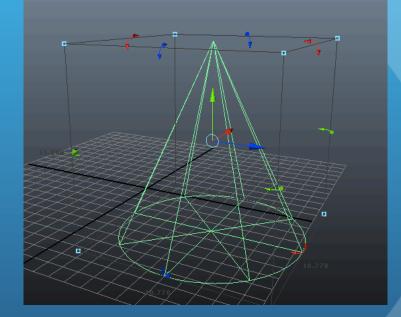
• Scales an object along a specified axis



• Hot key: "r"

• Universal manipulator

• Allows for using Scale, Rotate, and Move without switching between tools



Constaints and Dynamics

Topics

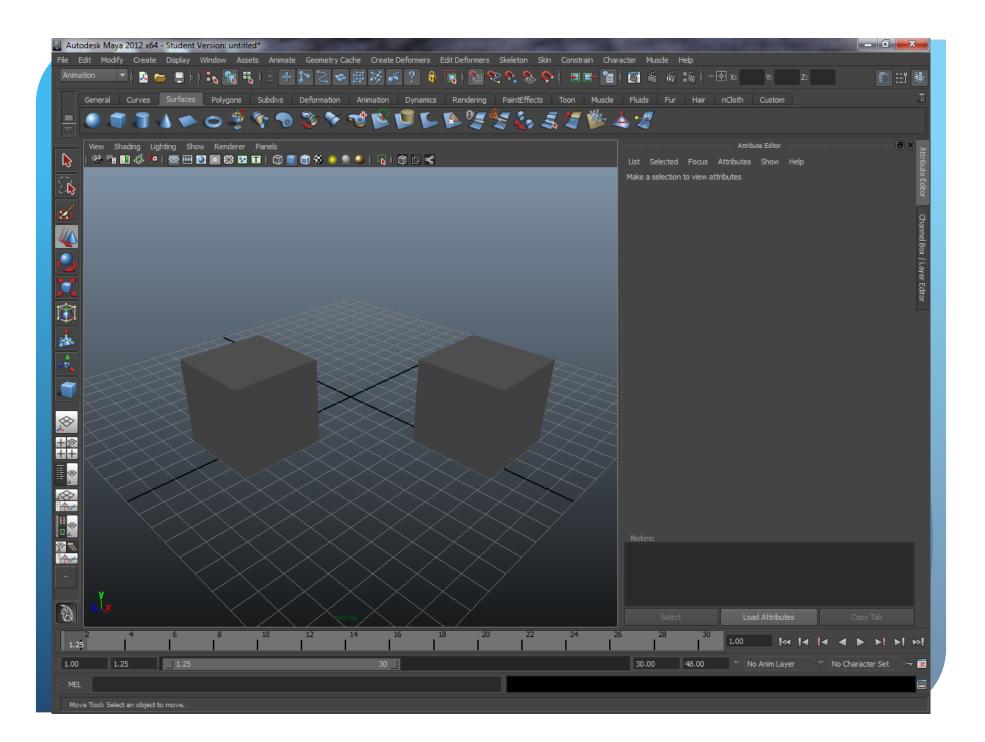
- Animation Constraints
- Dynamics
- Constraints in Dynamics

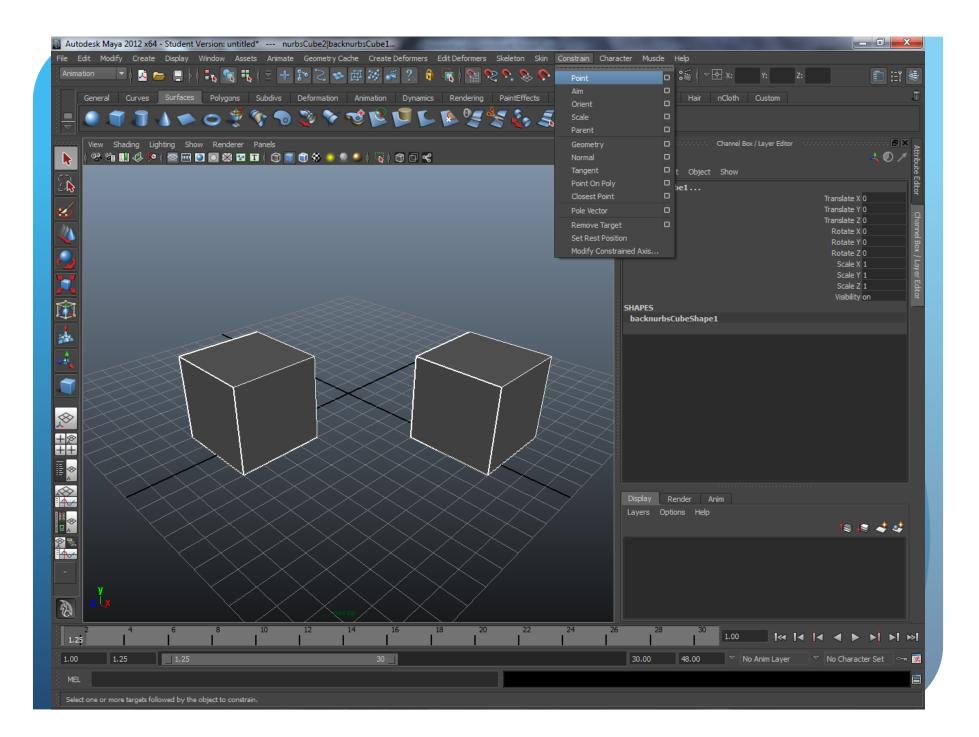
Constaints

- Integrate the environment
 - Link properties of objects
- Examples we will cover
 - Point
 - Aim
 - Orient
 - Scale
 - Parent

Point Constraint

- Ties the transform values of an object to one or more additional objects
- Steps
 - Select the parent object first
 - Select the objects to be constrained
 - Constrain->Point (set options first if needed)

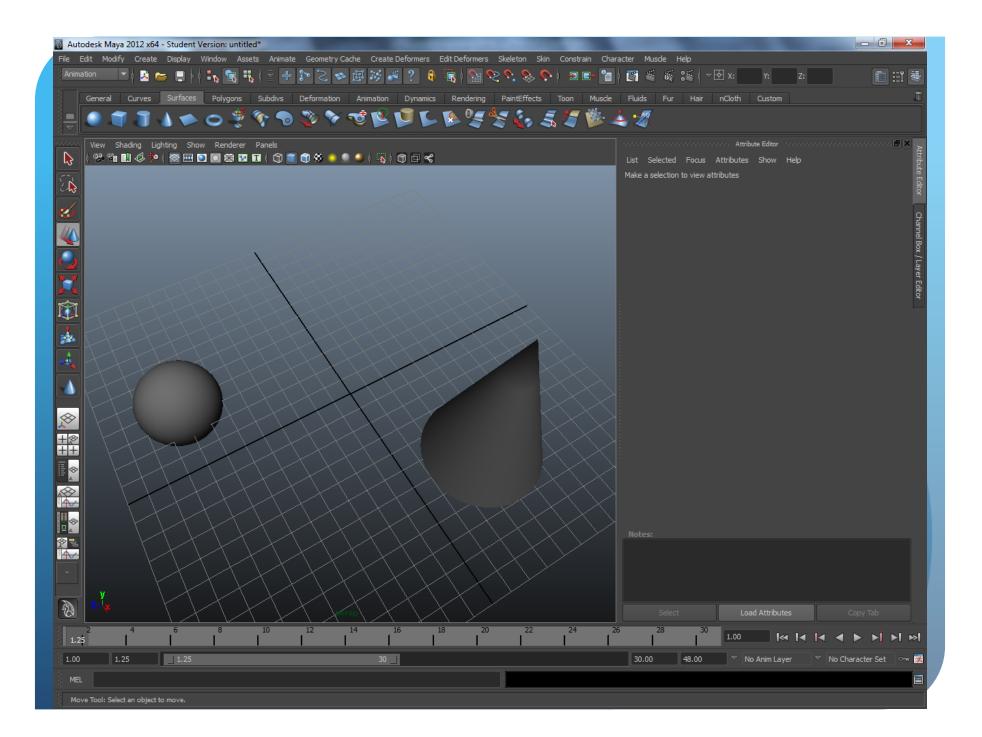




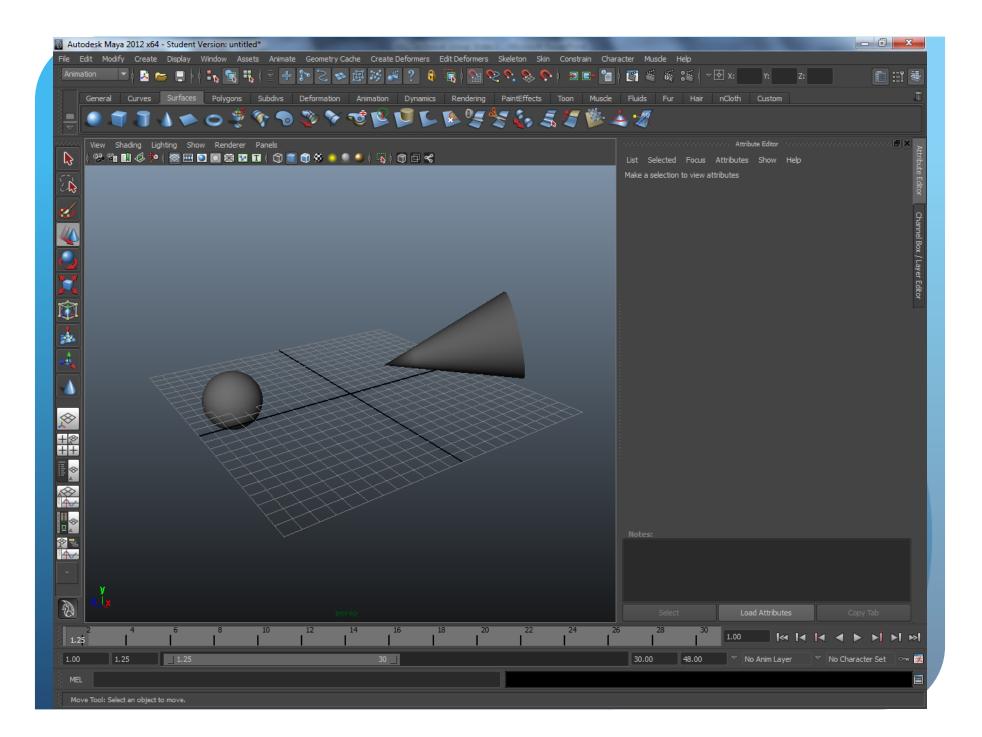
| Point Constraint Options | | - • × |
|--------------------------|--------|-------|
| Edit Help | | |
| Maintain offset: | × | |
| Offset: | | |
| Animation Layer | None 🔻 | |
| Set layer to override: | × | |
| Constraint axes: | | |
| | X Y Z | |
| Weight: | 1.0000 | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| Add | Apply | Close |
| | | |

Aim Constraint

• Causes a child object to aim at a parent object



| Aim Constraint Options | | | | - • × |
|------------------------|--------|--------------|--------|-------|
| Edit Help | | | | |
| Maintain offset: | | | | |
| Offset: | 0.0000 | 0.0000 | 0.0000 | |
| Aim vector: | 0.0000 | 1.0000 | 0.0000 | |
| Up vector: | 0.0000 | 1.0000 | 0.0000 | |
| World up type: | Vector | - | | |
| World up vector: | 0.0000 | 1.0000 | 0.0000 | |
| World up object: | | | | |
| Animation Layer | None 🔻 | | | |
| Set layer to override: | ~ | | | |
| Constraint axes: | 🖌 All | | | |
| | X | | Z | |
| Weight: | 1.0000 | — ()— | | |
| L | | | | |
| Add | | Apply | | Close |



Orient Constraint

- Makes a child have the same rotation as a parent
- Different from the aim.

| Orient Constraint Options | | 2.2.0 | | |
|---------------------------|--------|--------|--------|-------|
| Edit Help | | | | |
| Maintain offset: | | | | |
| Offset: | 0.0000 | 0.0000 | 0.0000 | |
| Animation Layer | None 🔻 | | | |
| Set layer to override: | ~ | | | |
| Constraint axes: | | | | |
| | X | | Z | |
| Weight: | 1.0000 | -• | | |
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| Add | Δ | pply | | Close |
| Auu | | PP17 | | close |

Scale Constraint

• Ensures that the size is mirrored.

| | Scale Constraint Options | | 44.0 | | |
|---|--------------------------|--------|--------|--------|-------|
| ſ | Edit Help | | | | |
| | Maintain offset: | | | | |
| l | Offset: | 1.0000 | 1.0000 | 1.0000 | |
| J | Animation Layer | None 🔻 | | | |
| | Set layer to override: | ~ | | | |
| | Constraint axes: | 🖌 All | | | |
| | | X | | Z | |
| | Weight: | 1.0000 | | | |
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| | Add | 4 | Apply | | Close |

Parent

- Constraints rotation and translation
 - Not Scale
- Rotation has its pivot on the parent
 - Not like the orient
 - Causes an orbit effect.

Dynamics

- Allow animation to be handled by software with more high level input from user
- Key framing
 - State where something should be
 - Software interpolates
- Dynamics
 - Explain how objects should interact
 - Software extropolates

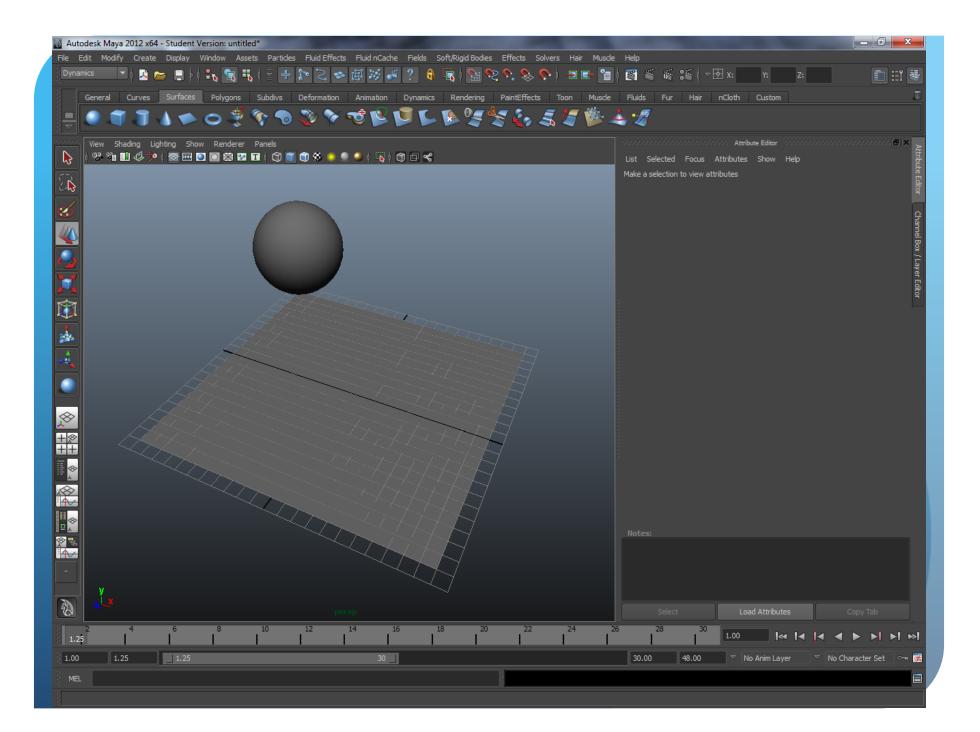
Overview

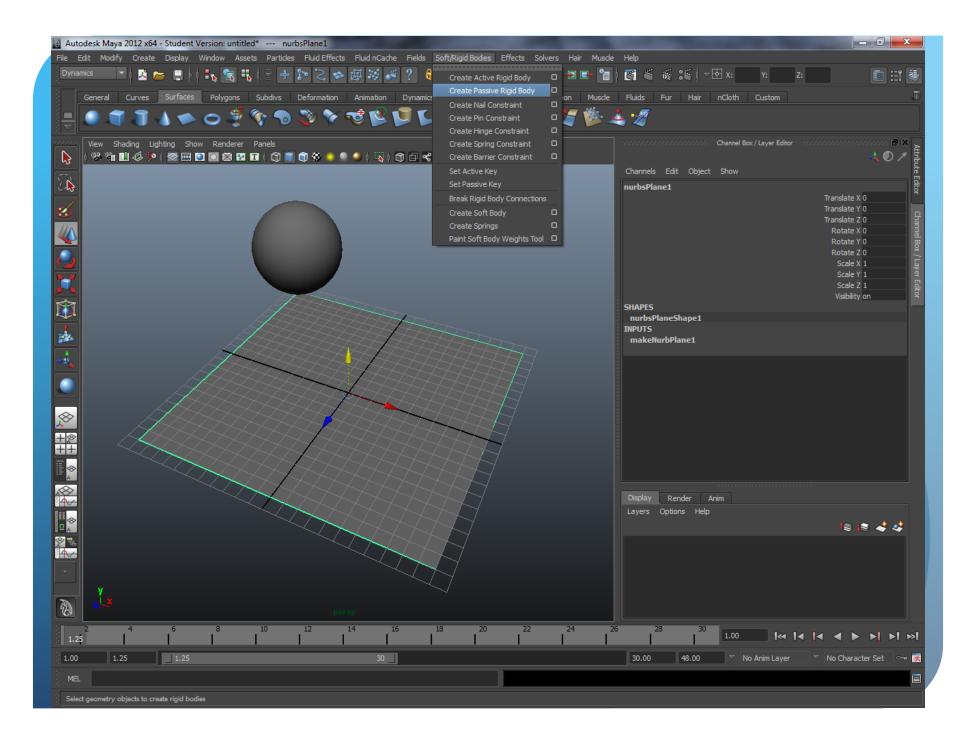
• Types of Objects

- Particles modeling of individual particles
- Soft bodies sold geometry which is updated based on a particle object
- Rigid bodies Sold bodies (book, ball)
 - Focus of today
- Fields Gravity, air, fields such as this which act on other objects.
- Solve updates transforms

Basic Example - Dropping a ball

- Steps to make a ball drop
 - Create a floor
 - Create a ball
 - Move ball above floor
 - Make floor passive solid body
 - Make ball active solid body
 - Add gravity field to ball
 - Press play



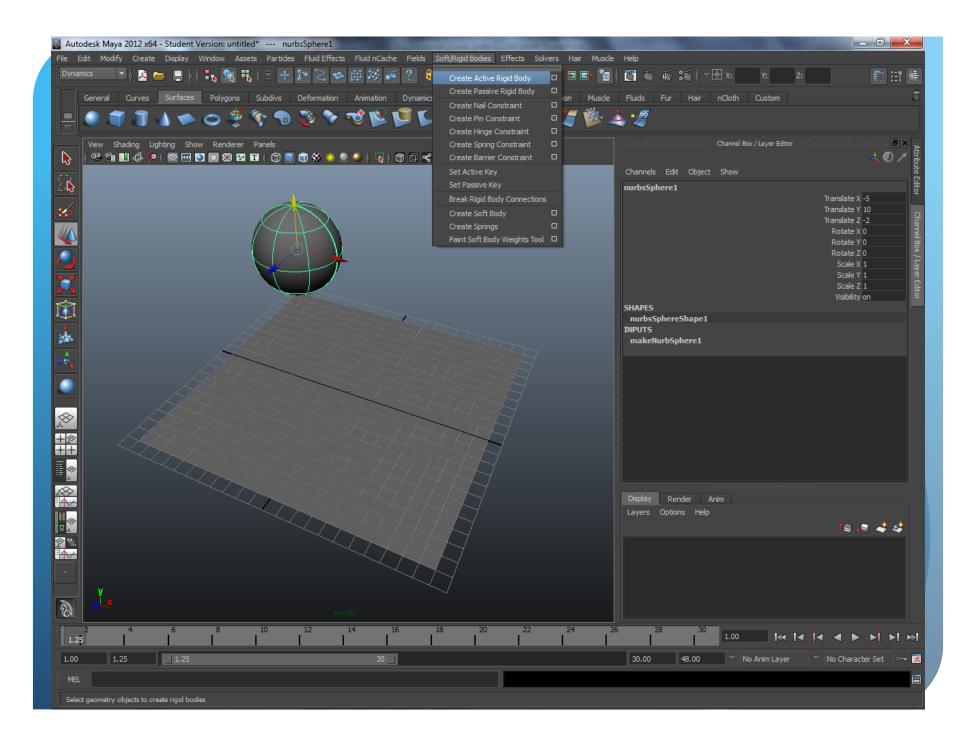


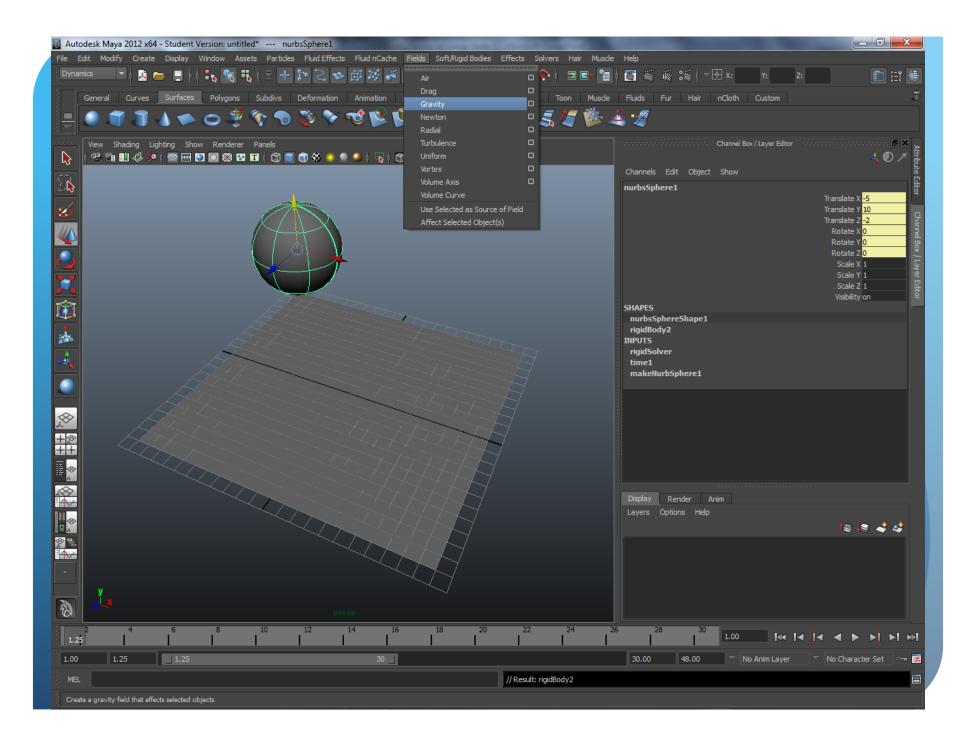
Passive vs Active

- Passive do not move
 - Active can collide with passive
 - Passive still do not move, but active do

• Active move

• Active objects are transformed by interactions with active, passive, and fields.





| Attribute Editor | | Line | | | |
|--------------------------|---|---------------|-------------|----------|--|
| List Selected Focus Attr | ibutes Show | Help | | | |
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| rigidBody: | riaidBodv2 | | | esets | |
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| Rigid Body Attributes | _ | | | _Ê. | |
| | Active Particle Co | llision | | | |
| | Allow Disc | | | | |
| | | | | | |
| Mass | 1.000 | 0 | | | |
| Center Of Mass | 0.164 | 0.000 | 0.000 | | |
| | Lock Cente | er Of Mass | | | |
| Static Friction | 0.200 | — ()— | | | |
| Dynamic Friction | 0.200 | — ()— | | | |
| Bounciness | 0.600 | | | | |
| Damping | 0.000 | | | | |
| Impulse | 0.000 | 0.000 | 0.000 | | |
| Impulse Position | 0.000 | 0.000 | 0.000 | | |
| Spin Impulse | 0.000 | 0.000 | 0.000 | | |
| Velocity | 0.000 | -6.778 | 0.000 | | |
| Spin | 0.000 | 0.000 | 0.000 | | |
| Force | 0.000 | -9.800 | 0.000 | | |
| Torque | 0 000 | 0 000 | 0 000 | | |
| Notes: rigidBody2 | | | | | |
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| Select Load A | ttributes | Copy Tab | Clos | æ | |
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| | Selected Focus Attri | ibutes Show | Help | | | |
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| | rigidBody: | rigidBody2 | | | Focus Presets Show Hide | |
| | Rigid Body Attributes | 5 | | | | |
| | Initial Settings | | | | | |
| | Initial Spin | 0.000 | 0.000 | 0.000 | | |
| | Initial Position | -12.700 | 25.400 | -5.080 | | |
| | Initial Orientation | | 0.000 | 0.000 | | |
| | Initial Velocity | 0.000 | 0.000 | 0.000 | | |
| ► | Performance Attribu | | | | | |
| | Object Display | | | | | |
| | Node Behavior | | | | | |
| | Extra Attributes | | | | | |
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Notes

- You cannot use key frame and dynamics simultainously
- Key set Active and Key Set Passive turn dynamics on/off
- Impulse can be keyed in order to start motion at a given time (e.g. when a bat hits a ball)

Dynamics Constraints

- Help control dynamic behavior
 - Nail
 - An invisible bar connecting something to space
 - E.g. Implement a pendulum.
 - Pin Hinge
 - Causes an object to spin on an axis.
 - Spring
 - Traditional spring behavior
 - Barrier
 - Invisible barrier an object cannot move through.