

# itDD

## \_Introduction to Techniques in Digital Design

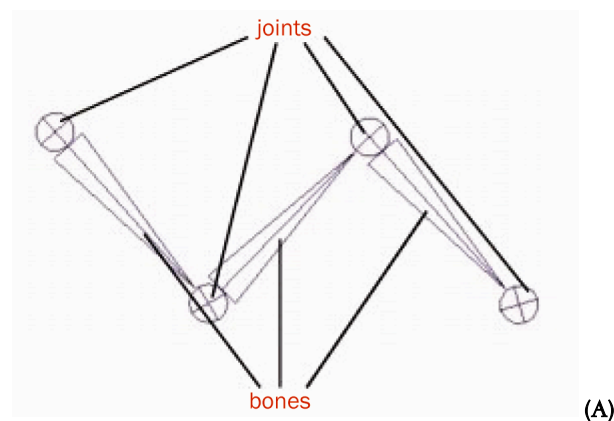
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## Skeletons

**Skeletons** are hierarchical, articulated structures that let you pose and animate bound models. A **Skeleton** provides a deformable model with the same underlying structure as the human skeleton gives the human body. Just like in the human body, the location of **Joints** and the number of **Joints** you add to a **Skeleton** determine how the skeleton's bound model or "body" moves. When you bind a model to a skeleton, it is called Skinning.

A Skeleton is composed of a series of **Joints** and **Bones** that form **Joint Chains**. You can pose and animate these **Joint Chains** using **IK Handles**. **Joints** are the building blocks of **Skeletons** and their points of articulation. Also, **Joints** have no shape and therefore can not be rendered. Each **Joint** can have one or more bone attached to it, and more than one child **Joint**. **Joints** let you transform a **Skeleton** when posing and animating a bound model. **Bones** do not have nodes, and they do not have a physical or calculable presence in your scene. **Bones** are only visual cues that illustrate the relationships between **Joints** (A).



### Creating a Joint Chain:

1. With the **Animation** Pull Down Menu selected in the **Status Line**, click *Skeleton* > *Joint Tool* (Options Dialog Box) in the **Main Menu**
2. From within the **Joint Tool** Options Dialog Box, first select **Reset Tool** to set the Tool to its default settings.
3. In the **Side View** (or whichever **Orthographic** view the majority of your object is visible in), starting from one end of the object, click within the interior of the object. A **Joint** is then created. Make sure that your **Joint** is placed within the

surface, as the rotation of the **Joints** on the model will be based on the location of the **Joint** in the skeleton.

4. As one places the **Joints**, a **Bone** appears, connecting each **Joint**.
5. After placing the final **Joint**, press Enter to complete the action.

With **Inverse Kinematics (IK)**, one moves an **IK Handle** to pose an entire **Joint Chain**, as opposed to moving individual **Joints**. An **IK Handle** is an object you can select and move that affects the joints it is assigned to. A **Joint Chain** that has an **IK Handle** is called an **IK Chain**. When you pose and animate a **Joint Chain** with an **IK Handle**, the **IK Solver** automatically rotates all the joints in the **IK Chain**. The **IK Solver** is what Maya uses to calculate the rotations of all the joints in the **IK Chain** when you position the **IK Handle**.

#### Applying IK to a Skeleton:

1. With the **Animation** Pull Down Menu selected in the **Status Line**, click *Skeleton > IK Handle Tool* (Options Dialog Box) in the **Main Menu**
2. From within the **IK Handle Tool** Options Dialog Box, first select **Reset Tool** to set the Tool to its default settings
3. Set the **IK Handle Setting: Current Solver** to **ikSCsolver**. This solver ensures that the **Joints** in the **Skeleton** will lie along a single plane.
4. In the **Side View** (or whichever **Orthographic** view was used to place the Joints), click on one end of the Joint Chain and then the opposing end of the Joint Chain.
5. An IK Handle is created between these two Joints. The IK Handle is used by the IK Solver to calculate the rotation of the Joints in the IK Chain.

## Smooth Binding

Skinning is the process of binding a deformable object to a skeleton.

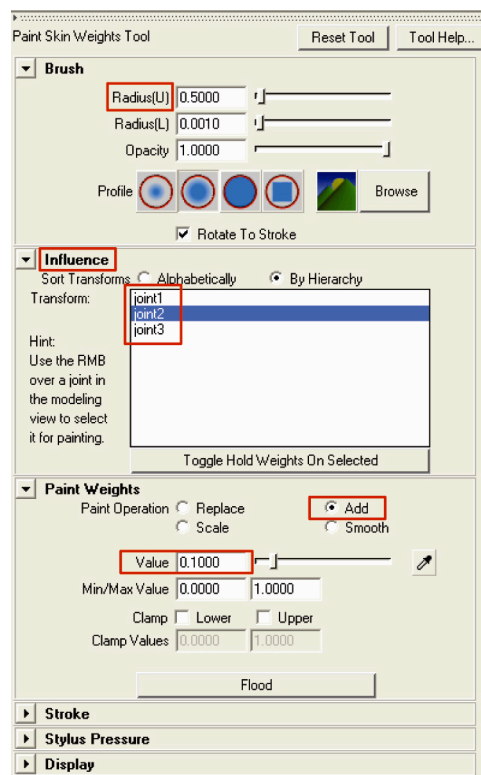
#### Binding a Surface to a Skeleton:

1. In Object Mode, select the object that is to be bound to the **Skeleton**
2. Shift+Select **Joint(s)** that are to be bound to the surface
3. With the **Animation** Pull Down Menu selected in the **Status Line**, click *Skin > Bind Skin > Smooth Bind* (Options Dialog Box) in the **Main Menu**
4. From within the **Smooth Bind** Options Dialog Box, first select **Reset Tool** to set the Tool to its default settings
5. Set **Max Influences** to 3. A **Max Influences** value of 3 specifies that three joints influence each skin point. By default, the **Joint** closest to the point has the most influence. The amount of influence each **Joint** has on any skin point is the **Skin Weight**. The default **Skin Weights** create smooth deformations of surfaces.
6. Click Bind Skin to complete the action

#### Improving the Smooth Skin Deformations:

1. In Object Mode, select the object that is attached to the Skeleton
2. With the **Animation** Pull Down Menu selected in the **Status Line**, click *Skin > Edit Smooth Skin > Paint Skin Weights Tool* (Options Dialog Box) in the **Main Menu**
3. In the **Influence** list of the **Tool Settings** for the **Paint Skin Weights Tool**, select any **Joint**. The grayscale color of the object indicates how much influence that **Joint** has on the objects deformation. White means the skin is maximally influenced by the joint. Black means the skin is not influenced by the **Joint**. The lighter the grey, the more influence (**B**).

4. Select each entry in the **Influence** list of the **Tool Setting** for the **Paint Skin Weights Tool** to determine which **Joint(s)** are causing any irregular deformations within the object. The region will be shaded grey or white when the appropriate **Joint** is selected **(B)**.
5. In the **Paint Weight Menu** section of the **Paint Skin Weights Tool**, set **Value** to 0.1 and check on **Add (B)**
6. Drag the mouse pointer to paint the irregular region of the object. Each stroke **Adds 0.1 (10%) to the Skin Weight**. The weight for a **Skin Point** has a maximum value of 1 (fully white)
7. As opposed to the **Add** tool in the **Paint Skin Weights Tool**, the **Smooth** operation smooths the weights of points by averaging the stroked points with the weights of the surrounding region.



(B)

## Dynamics

Dynamics involves a branch of physics that describes how objects move using physical rules to simulate the natural forces that act upon them. Dynamic simulations are difficult to achieve with traditional keyframe animation techniques, but Maya lets you set up the conditions and constraints that you want to occur, and then automatically solves how to animate the objects in the scene. Particle objects, soft bodies, and rigid bodies are dynamic objects. You typically animate the motion of dynamic objects with dynamic animation—fields, collisions, springs, emission, goals, or particle expressions. In this tutorial, we will review rigid and soft bodies (dynamic objects) and fields (dynamic animation).

## Rigid Bodies

In Maya, a rigid body is a surface which has the attributes of an unyielding shape. Unlike conventional computer surfaces, rigid bodies collide rather than pass through each other during animation and are used for creating dynamic simulations. Rigid surfaces do not deform when they collide with other objects in Maya.

Rigid bodies can be created from polygonal or NURBS surfaces. Rigid body attributes can be assigned to the surfaces so they act and react in a simulation in specific ways. (Examples of rigid body attributes are velocity, mass, and bounce.)

To animate rigid body motion, you can use fields, keyframes, expressions, rigid body constraints, or collisions with particles or other rigid bodies. Rigid body constraints restrict the motion of rigid bodies. The constraints simulate the behavior of real-world items you're familiar with, such as pins, nails, barriers, hinges, and springs.

### Active vs. Passive Rigid Bodies

Maya has two kinds of rigid bodies—active and passive. An active rigid body is animated by dynamics—fields, collisions (and springs)—not by keys. When the rigid body is active, you control its movement using dynamic forces, specifically fields and collisions.

A passive rigid body can have active rigid bodies collide with it. You can key its Translate and Rotate attributes, but dynamics have no effect on it. When a rigid body is passive, rigid bodies will collide with it but will not move it. You can control its movement by setting keys.

### Creating an Active or Passive Rigid Body:

6. Select a NURBS surface to convert to a Rigid Body
7. With the **Dynamics** Pull Down Menu selected in the **Status Line**, click *Soft/Rigid Bodies > Create Active Rigid Body* if you intend to create an active rigid body or select *Soft/Rigid Bodies > Create Passive Rigid Body* if you intend

to create a passive rigid body. (Use the default settings in the Options Dialog Box)

## Soft Bodies

You can recreate a geometric object as a flexible object called a soft body. You can use various animation techniques to make the soft body bend, ripple, and bulge like soft objects in nature.

A soft body is a polygonal surface, NURBS surface, NURBS curve, lattice, wire, or wrap deformer that you convert. When you make a soft body from geometry or a lattice, Maya creates a corresponding particle object. (The particle object is indented under the geometry in the Outliner.) The combination of the geometry and particles is a soft body. The particle object has one particle for each CV or vertex in the geometry. For a polygonal object, the particles exist at the vertices. For a NURBS object, the particles exist at the CVs and are visible in the workspace.

When a field, collision, or expression moves the particles, the corresponding CVs or vertices move in response to the movement of the counterpart particles. You do not render the particles; they exist only so you can influence the geometry with dynamics.

### Creating a Soft Body:

1. Select a NURBS curve or surface, lattice, wire or wrap deformer to convert to a Soft Body
2. With the **Dynamics** Pull Down Menu selected in the **Status Line**, click *Soft/Rigid Bodies > Create Soft Body*

*Make Soft* converts the object to a soft body. Select this option if you haven't animated the object and will animate it with dynamics (for instance, a field). Also use this option if you've used nondynamic animation on the object and want to keep the animation after you create the soft body. Nondynamic animation includes keys, motion paths, non-particle expressions, and deformers. Dynamics that affect the soft body's particles are not affected by momentum from the nondynamic animation. The dynamics occur in the particle object's local space, which are uninfluenced by other animation on the object.

## Fields

Fields are forces that you use to animate the motion of particles, soft bodies, and rigid bodies. You can create a field on an object or as a stand-alone force. You can simulate the motion of natural forces with dynamic fields. A few dynamic fields worth exploring include the following:

### Gravity Field

A gravity field simulates the Earth's gravitational force. It accelerates objects in a fixed direction.

### Newton Field

A newton field pulls objects towards it. This field is based on the principle that a mutual attractive force exists between any two objects in the universe, proportional to the product of their masses. As the distance between the objects increases, the force of the pull decreases.

**Radial field**

A radial field pushes objects away or pulls them toward itself, like a magnet. See Fields > Radial.

**Turbulence field**

A turbulence field causes irregularities in the motion of affected objects. These irregularities are also called noise or jitter. This field is often combined with other fields to mimic the random motion in fluid or gaseous mediums such as water and air.

**Uniform field**

A uniform field pushes objects in a uniform direction.

**Vortex field**

A vortex field pulls objects in a circular or spiraling direction. This field is commonly used with particles to create effects such as whirlpools or tornados.

**Creating a Dynamic Field:**

1. Select a soft or active rigid body upon which the field is to act
2. With the **Dynamics** Pull Down Menu selected in the **Status Line**, select *Fields* from the **Menu Bar**. Select the field you wish to employ

The following tool settings are generally applicable to the various dynamic animation tools listed above:

**Magnitude**

Sets the strength of the field.

**Attenuation**

Sets how much the strength of the field diminishes as distance to the affected object increases. The rate of change is exponential with distance; the Attenuation is the exponent. If you set Attenuation to 0, the force remains constant over distance.

**Direction X, Y, Z**

Sets the direction in which the field acts.

**Use Max Distance**

If you turn on Use Max Distance, connected objects within the area defined by the Max Distance setting are affected by the field. Any connected objects outside the Max Distance are not affected by the field. If you turn off Use Max Distance, all connected objects are affected by the field, no matter how far away they are from the field.

**Max Distance**

Sets the maximum distance from the gravity field at which the field is exerted. You must also turn on Use Max Distance for Max Distance to take effect. Available in Attribute Editor only.