Animation of fish swimming, Maya
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This tutorial shows how to model and animate a fish. Several animation techniques are applied to various parts of the fish. This includes using blend shapes for the head, forward kinematics for the fins, inverse kinematics for the body and a motion path.

This illustration shows the blend shapes sliders used for the head and the skeleton with inverse kinematics used for the body.

The tutorial includes the following steps:

**Part 1- Modeling the fish**

**Step 1 Creation of a closed curve**
- Duplication of the closed curve

**Step 2 Body:** Lofting polygons in between curves

**Step 3 Head:** Creating a planar surface using
- Polygons > Edit Mesh > Append to Polygon tool and
- Polygons > Edit Mesh > Split Polygon tool

**Step 4 Mouth, eyes and thins:**
- Selection of faces for the eyes and mouth
- Polygons > Edit Mesh > Extrude

**Step 5 Creating poses for the mouth and the thins**
- Duplicating the fish and creating poses. Animation > Create Deformer > Lattices
- Creating blend shapes or 3D morphing of the head. Animation > Create Deformer > Blend Shapes

**Part 2- Animating the fish**

**Step 1 Head animation with blend shapes**
- Windows > Animation editor > Blend Shapes, moving the sliders and creating keyframes

**Step 2 Body animation:** Rigging and animating the body
- Animating the fins using Forward Kinematics, using weight maps
- Animating the swimming motion using Inverse Kinematics on a motion path, called Spline IK in Maya
- Editing the curve which is both a path and a spline

Let’s start modeling: **Part 1- Modeling the fish**

**Step 1 Creation of a closed curve / Duplication of the closed curve**
Create a CV closed curve. Go to Create > CV Curve Tool. A circle will be created from 3 points located at equal distance and at equal quarters from the origin XYZ. Select the curve as an object, green selection. Go to Surfaces > Edit Curves > Open/Close Curve. Select “Ignore”. The curve is a perfect circle.

Select the curve as an object, green selection > Rotate the curve in a vertical position on the X axis
Select the curve as an object, green selection. Go to **Edit > Duplicate Special**, check “Instance”, with Translation and Scale parameters on the X axis.

**Step 2 Body:** Lofting polygons in between curves
Shift Select one by one adjacent curves starting with original curve and going towards curve duplicate 1, curve duplicate 2…curve duplicate 6.
Go to **Surfaces > Surfaces > Loft**. Select Polygons, Quads, Count.
Go to **Polygons > Mesh > Smooth**. Although smoothing shows the final design of the fish, you want to continue in a low polygonal mode in order to create the head. Undo the Smoothing in order to continue in low polygonal mode.

Scale the curves in order to design a streamlined body. Scale the first curve in order to prepare the starting point for the head. Smooth and Undo Smooth in order to continue in the low polygon mode.

**Step 4 Head:** Creating a planar surface
Select the body as an object, green selection, **Polygons > Edit Mesh > Append to Polygon tool**, click on each edge following the direction of the purple arrows.

Select the body as an object, green selection, divide existing polygons **Polygons > Edit Mesh > Split Polygon tool**.

Test your design with the Smooth tool. You may want to troubleshoot new intersections of polygons created by the Split Polygon tool. Select the points around a new intersection, go to **Polygons > Edit Mesh > Merge Vertex Tool**.
Move the slider in order to merge the vertices from adjacent polygons.

Select the polygons on the surface of the object. Assign a new material to the selection.

Extrude the selection towards the outside. Extrude the selection towards the outside again, scale down the new selection. Repeat similar steps for the fish fins.
For the mouth, you can select polygons of the head.

You can combine extrude and scale > extrude towards the outside, scale out and towards the inside, scale in.

Repeat the same steps > smooth and unsmooth the model.

**Step 5 Creating poses for the mouth and the fins**
• Select the fish as an object, green selection, go to **Edit > Duplicate Special**, check **Copy**

• Duplicating the fish and creating poses.
Select one of the copy of the fish as an object, green selection, go to **Animation > Create Deformer > Lattices**.
With the lattice selected as an object, green mode.
Go to selection by component > select by vertices, select rows and columns of vertices > move and scale the selections in order to create deformations of the face. You can use any kind of deformation as long as the duplicates or clones of the original fish have strictly the same number of vertices and of polygons. Please note that the body deformation will be created with a skeleton.
SHIFT select the clones and duplicates as objects, green selection + select last the original fish or the target which will be animated with the poses of the clones.
Go to **Animation > Create Deformer > Blend Shapes**
A set of sliders is created, each slider controls the amplitude of a pose from zero deformation = the original fish to maxi deformation = the pose of one of the clones

To see the slider(s), go to **Windows > Animation editor > Blend Shapes** Please note that you can repeat the blend shapes as any times as you want, you can delete sliders or group them following your needs.
Part 2 Animation

The head and body animations are independent and use various techniques: morphing vertices (head) and skeleton Inverse Kinematics (body).

**Step 1 - Head animation**

Go to the Timeline, select a keyframe. Go to **Windows > Animation editor > Blend Shapes**, move the sliders RMB > Set a Key. The yellow color in the box indicates that a key has been created. Playback the animation,

You can hide the clones of the fish by creating a new layer. Go to the SHIFT select the clones meshes NOT the lattices, go to Layers LMB on Layers, select Create Empty Layer. RMB on the new layer, select Add Selected Objects. Make the layer invisible.

**Step 2 Body animation: Rigging and animating the body**

- **Creating the skeleton and animating the fins using Forward Kinematics**

Turn on the Xray mode in order to see the skeleton inside the mesh.
Create the skeleton starting with joint 1 located in the intersection of the axis of the body and the axis of the fins. Follow the direction of the arrows for adding new joints. Go to selection as an object, green mode. SHIFT select, first, the skeleton, second, the mesh. Go to Animation > Skin > Bind Skin > Smooth Bind

- **Using weight maps for the fins of the fish**
You will notice that a rotation of the joints of the fins can also change the shape of the body. We are going to paint Weight Maps in order to leave the body unchanged after rotating the fins.

NO weight maps. Body changes can be influenced by joint rotation
WITH Weight Maps. Body unchanged after joints rotations

How to apply weight maps:
Select the mesh of the fish as an object, green selection.

In the 3D window select the textured mode.
Go to Animation > Skin > Edit Smooth Skin > Paint Skin Weight Tools > go to the Attribute Editor, choose the first joint of the fin from the list of joints.
The white color indicates the area of influence of the selected joint from the list.

Use the color picker in order to select a dark area on the mesh. Use the paint tool in order to paint in black the white areas that should not be influenced by the joint. Remove white areas on all sides of the body. Repeat the next step with the next joint for the fin.

You can now rotate the fins of the fish and keyframes a simple animation of the fins going up and down.

Let’s repeat the animation.

Go to Windows > Animation Editor > Graph Editor, select the animation curve, choose Curves > Pre Infinity > Cycle, choose post-infinity = Cycle. The animation of the fins keeps repeating.

- **Animating the swimming motion using Inverse Kinematics on a motion path**, called Spline IK in Maya. Let’s create the motion of the body of the fish swimming.

Before the skinned fish and a closed curve After applying the IK Spline, the fish is automatically snapped on the curve

We will rig the body using Inverse Kinematics on a motion path, This method called Spline IK in Maya has many advantages

- The curve can be used as a path guiding the animation of the fish swimming
- The fish is automatically snapped on the curve
- The curve can be used as a path to direct the fish
- The curve can be edited after rigging the fish without destroying the rig
- The curve can be scaled, translated and even duplicated after the fact
- This method can be used in games and interactive 3D animations using fishes animated in real time
Let's create a CV curve following the steps at the beginning of this tutorial.

Go to Surfaces > Edit Curve > Rebuild Curve, select number of spans = 20

Go to selection by component > select by vertices. SHIFT select one vertice out of two. Scale the selected vertices towards the inside of the curve. This creates an wave that you can use to animate the fish swimming.

Go to Animation > Skeleton > IK Spline Handle Tool, LMB on joint 1, LMB on end joint, end of the tail, LMB on curve. This attaches the IK Handle to the curve.

The illustration shows only the rig, the mesh is not visible for clarity.
Go to Outliner, select the IK handle NOT the end joint.
Go to Attribute Editor > IK Solver Attributes > Turn on Root on Curve.
Go to Modify > Transformation Tools > Show Manipulator Tool.

The illustration shows only the rig, the mesh is not visible for clarity.

Blue circular manipulators are displayed on joint 1 and on the IK handle.
RMB+Drag the manipulator at joint 1. The fish can follow the curve.
Create several positions of the IK Handle on the curve. Go to timeline, create keyframes for the IK Handle.

The illustration shows only the rig, the mesh is not visible for clarity.
Select the IK Handle, create several keyframes around the curve.

- **Editing the curve**
  1. Try to flip the fish around.
     Select the IK Handle Control, go to the attribute Editor > Advanced Twist > check Enable Twist Controls
     Select Object Up and Up Axis = Positive Z

  2. Reusing the same rig with another fish

Let’s fix the alignment of the tail with the joints in the following illustration.
Scale the curve.

Move the shark on top of the rig. The tail is aligned with the joints.
Binding Skin
SHIFT select joint 1 and the mesh, go to Animation > Skin > Bind Skin > Smooth Bind. Test the animation. With a larger curve, the swimming motion becomes slow and relaxed.

Scale the curve of the path. Test the animation. The swimming motion is tensed and fast.

3- Editing the curve

Surfaces > Edit Curves > Curve Editing tool
4- Using Open or closed curves

Go to **Surfaces > Edit Curves > Open/Close Curves**

Select the curve as component mode > points and vertices, move points from the curve. The following illustrations show motion paths of shark swimming on the surface on close curve and shark following an open curve towards the bottom of the ocean.