ECE4893A/CS4803MPG: Multicore and GPU Programming for Video Games
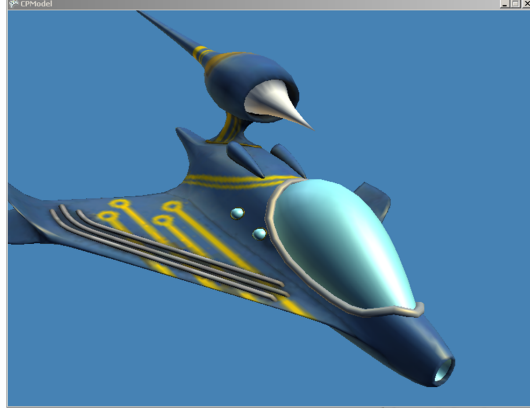
Rendering 3-D Content

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(Based on slides by Prof. Hsien-Hsin Sean Lee)
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How to render a model in the Content Pipeline

http://msdn.microsoft.com/en-us/library/bb203933.aspx
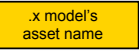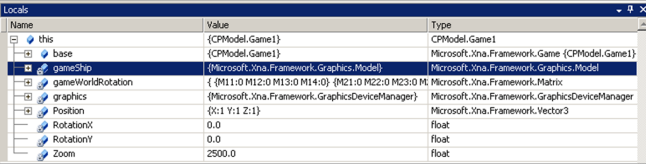
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How to peek at the model structure

```
protected override void LoadContent()
{
    gameShip = Content.Load<Model>("ship");    ← .x model's asset name

    System.Diagnostics.Debugger.Break();

}
```

Locals

Name	Value	Type
⊟ ● this	{CPModel.Game1}	CPModel.Game1
⊞ ● base	{CPModel.Game1}	Microsoft.Xna.Framework.Game {CPModel.Game1}
⊞ ● gameShip	{Microsoft.Xna.Framework.Graphics.Model}	Microsoft.Xna.Framework.Graphics.Model
⊞ ● gameWorldRotation	{ {M11:0 M12:0 M13:0 M14:0} {M21:0 M22:0 M23:0 M	Microsoft.Xna.Framework.Matrix
⊞ ● graphics	{Microsoft.Xna.Framework.GraphicsDeviceManager}	Microsoft.Xna.Framework.GraphicsDeviceManager
⊞ ● Position	{X:1 Y:1 Z:1}	Microsoft.Xna.Framework.Vector3
● RotationX	0.0	float
● RotationY	0.0	float
● Zoom	2500.0	float

- The asset name of input model "wedge_player1.x" has been renamed to "ship" in the "properties" window (Content Pipeline)

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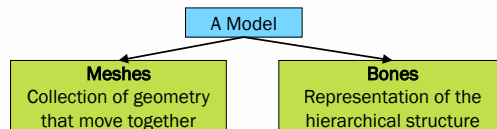
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Peeking at the bones and meshes

⊟ ● gameShip	{Microsoft.Xna.Framework.Graphics.Model}	Microsoft.Xna.Framework.Graphics.Model
⊟ ⊞ Bones	Count = 2	Microsoft.Xna.Framework.Graphics.ModelBoneColle
⊞ ● [0]	{Microsoft.Xna.Framework.Graphics.ModelBone}	Microsoft.Xna.Framework.Graphics.ModelBone
⊞ ● [1]	{Microsoft.Xna.Framework.Graphics.ModelBone}	Microsoft.Xna.Framework.Graphics.ModelBone
⊞ ● Raw View		
⊟ ⊞ Meshes	Count = 1	Microsoft.Xna.Framework.Graphics.ModelMesh
⊟ ● [0]	{Microsoft.Xna.Framework.Graphics.ModelMesh}	Microsoft.Xna.Framework.Graphics.ModelMesh
⊞ ⊞ BoundingSphere	{Center:{X:0.8337776 Y:197.7493 Z:-513.1478} Radi	Microsoft.Xna.Framework.BoundingSphere
⊞ ⊞ Effects	Count = 3	Microsoft.Xna.Framework.Graphics.ModelEffectCol
⊞ ⊞ IndexBuffer	{Microsoft.Xna.Framework.Graphics.IndexBuffer}	Microsoft.Xna.Framework.Graphics.IndexBuffer
⊞ ⊞ MeshParts	Count = 3	Microsoft.Xna.Framework.Graphics.ModelMeshPart
⊞ Name	"single_mesh_object"	string
⊞ ⊞ ParentBone	{Microsoft.Xna.Framework.Graphics.ModelBone}	Microsoft.Xna.Framework.Graphics.ModelBone
⊞ Tag	null	object
⊞ ⊞ VertexBuffer	{Microsoft.Xna.Framework.Graphics.VertexBuffer}	Microsoft.Xna.Framework.Graphics.VertexBuffer
⊞ ● Non-Public members		
⊞ ● Raw View		
⊞ ⊞ Root	{Microsoft.Xna.Framework.Graphics.ModelBone}	Microsoft.Xna.Framework.Graphics.ModelBone
⊞ Tag	null	object
⊞ ● Non-Public members		

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Bones and meshes (1)

A Model

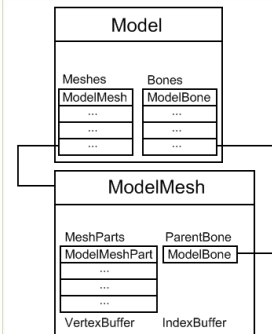| Meshes	Bones
Collection of geometry that move together	Representation of the hierarchical structure

- The model is "flattened" to a single list of meshes
- The bones retain the tree structure from the scene graph
- Each mesh can have a related matrix defining its own transformation

Source: Charles Owen from MSU

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Bones and meshes (2)

Model

Meshes | Bones
ModelMesh | ModelBone
... | ...
... | ...

ModelMesh

MeshParts | ParentBone
ModelMeshPart | ModelBone
...
...

VertexBuffer | IndexBuffer

- Each ModelMesh has a ParentBone
- Each Bone has a transformation matrix
- Rotate the ParentBone will also rates the children and their children, etc.

Source: Charles Owen from MSU

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In meshes: BoundingSpheres and Effects

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In meshes: IndexBuffer & VertexBuffer

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Loading a .X model

.x model's Asset name

```
gameShip = Content.Load<Model>("ship");
```

```
foreach (ModelMesh mesh in m.Meshes)
{
  foreach (BasicEffect effect in mesh.Effects)
  {
      effect.EnableDefaultLighting();

      effect.View = view;
      effect.Projection = projection;
      effect.World = gameWorldRotation *
                 transforms[mesh.ParentBone.Index] *
                 Matrix.CreateTranslation(Position);
  }
  mesh.Draw();
}
```

Draw all the meshes in the model

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DrawModel (Initialization)

```
private void DrawModel(Model m)
{
        // copy any parent transform
        Matrix[] transforms = new Matrix[m.Bones.Count];
        m.CopyAbsoluteBoneTransformsTo(transforms);

        float aspectRatio =
                graphics.GraphicsDevice.Viewport.Width /
                graphics.GraphicsDevice.Viewport.Height;

        Matrix projection =
        Matrix.CreatePerspectiveFieldOfView
(MathHelper.ToRadians(45.0f), aspectRatio, 1.0f, 10000.0f);
        Matrix view =
                Matrix.CreateLookAt(new Vector3(0.0f, 50.0f, Zoom),
                              Vector3.Zero, Vector3.Up);
```

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CopyAbsoluteBoneTransformsTo

□ **Remarks**
In an absolute transform, each bone is transformed according to the position of all parent bones.

This is the same as iterating the Bones collection and applying the transformation matrix of every parent of a ModelBone to the Transform property of each ModelBone and copying the results into an array that can be indexed into by the bone index.

An array of transformation matrices for the meshes of any model can be obtained by calling CopyAbsoluteBoneTransformsTo or CopyBoneTransformsTo. The resulting array contains the transforms that describe how each ModelMesh is located relative to one another in the Model. The transformation matrix that should be applied to each ModelMesh can be obtained using the index of the **CopyAbsoluteBoneTransformsTo** to retrieve a transformation matrix from this collection.

http://msdn.microsoft.com/en-us/library/
microsoft.xna.framework.graphics.model.copyabsolutebonetransformsto.aspx

- In an absolute transform, each bone is transformed according to the position of all parent bones
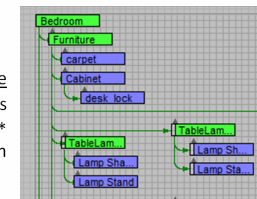
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Example heirarchical model

The Absolute Transform for a Lamp Shade
Product of 4 transformation matrices
LampShade * TableLamp *
Furniture * Bedroom

Source: Charles Owen from MSU

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Ship Example

CPModel Effect
(See Demo in Visual Studio)

Ducky Example

DuckBasicEffect
(See Demo in Visual Studio)

Draw a subset of a model

```
int i = 0;
foreach (ModelMeshPart meshPart in mesh.MeshParts) {
// the third mesh is a plane
    i++;
    if (i == 3)
        break;

    foreach (EffectPass pass in effect.CurrentTechnique.Passes) {
        pass.Apply();

        graphics.GraphicsDevice.Indices = meshPart.IndexBuffer;
        graphics.GraphicsDevice.SetVertexBuffer(meshPart.VertexBuffer);

        graphics.GraphicsDevice.DrawIndexedPrimitives
            (PrimitiveType.TriangleList,
             meshPart.VertexOffset,
             0,
             meshPart.NumVertices,
             meshPart.StartIndex,
             meshPart.PrimitiveCount);
    }
}
```

Draw only MeshPart[0] and [1]

Use your own Draw call
instead of mesh.Draw()

Teapot Example

TeapotBasicEffect
(See Demo in Visual Studio)