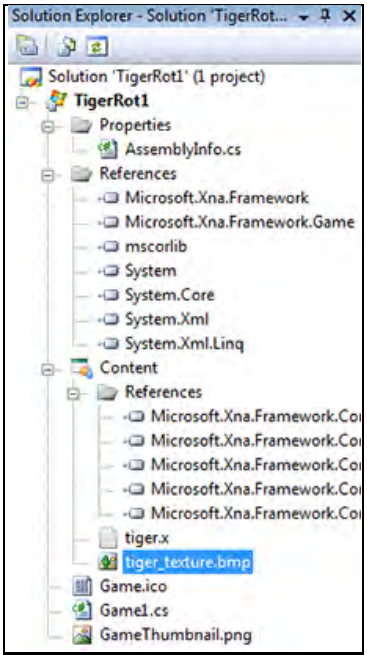
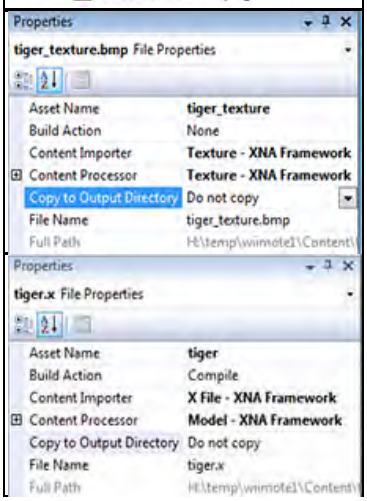
Course 3D_XNA: 3D-Computer Graphics with XNA
Chapter C3: Drunken Tiger

This chapter is a subcompact summary of the first XNA-Tutorial from Microsoft.
You find the tutorial here: VS 2008 → Main Menu `Help` → `Contents` → `XNA Game Studio 3.0` → `Getting Started with XNA Game Studio` → `Going Beyond: XNA Game Studio in 3D` → `Tutorial 1: Displaying a 3D Model On The Screen`.

Project TigerRot1





1. Main Menu after starting VS 2008: `File` → `New Project...` → `Project types: XNA GameStudio 3.1` → `Templates: Windows Game (3.1)` → `Name: TigerRot1` → `Location: C:\temp` → `Create directory for solution:` switch it off → `OK`.
`Solution Explorer - TigerRot1`:
Delete the file `Program.cs` and the default code of `Game1.cs`.

2. If You find no `Solution Explorer`-window, open it via the main menu: `View` → `Solution Explorer`.
Inside the `Solution Explorer`-window click the plus-sign in front of `TigerRot1`. A tree opens. Look for the branch "`References`".
Check if there are (among others) the references: `Microsoft.XNA.Framework` and `Microsoft.XNA.Framework.Game` and `mscorlib` and `System`.

3. Right click this link: **`tiger_texture.bmp`** and store the texture into the project directory `C:\temp\TigerRot1\Content`.
Right click this link: **`tiger.x`** and store the mesh into the project directory `C:\temp\TigerRot1\Content`.
3.1 We have to add the texture image and the mesh file to project `TigerRot1`:
`Solution Explorer` → Right click the branch `Content` → `Add` → `Existing Item...` → Directory: `Content: All Files (*.*)`.
Select both `tiger_texture.bmp` and `tiger.x` and quit by clicking the `Add`-button and check whether both file names arrived underneath the `Content`-branch.
3.2 `Solution Explorer` → Click `tiger_texture.bmp` and in its `Properties`-window change the `Build Action`-property from `Compile` to `None`.
Check if all properties of `tiger_texture.bmp` and `tiger.x` correspond to the screenshots on the right.

Version 1: Minimum

Write the following code into the empty code window of `Game1.cs`:

```
using System;
using Microsoft.Xna.Framework;
using Microsoft.Xna.Framework.Graphics;

static class Program
{ [STAThread] static void Main() { Game1 game = new Game1(); game.Run(); }

public class Game1 : Microsoft.Xna.Framework.Game
{ private GraphicsDeviceManager g;
  private Model model;
  private BasicEffect effect;
  public Game1()
  { g = new GraphicsDeviceManager( this );
  }
  protected override void LoadContent()
  { model = Content.Load< Model >("Content\\tiger");
    effect = (BasicEffect)model.Meshes[0].Effects[0];
    effect.View = Matrix.CreateLookAt( new Vector3( 0f, 0f, 4f ), //camera position
                                       Vector3.Zero, Vector3.Up );
    effect.Projection = Matrix.CreatePerspectiveFieldOfView
                              ( MathHelper.Pi/4, 1f, 1f, 100000f );
  }
  protected override void Draw( GameTime gameTime )
  { model.Meshes[0].Draw();
  }
} // end of class Game1
} // end of class Program
```

Click `Debug` → `Start Without Debugging Ctrl F5`.

Experiments	with camera position
initial	`new Vector3(  0f,  0f,  4f )`
nearer	`new Vector3(  0f,  0f,  3f )`
more distant	`new Vector3(  0f,  0f,  6f )`
to the rear	`new Vector3(  0f,  0f, -4f )`
to the right	`new Vector3(  3f,  0f,  4f )`
to the left	`new Vector3( -3f,  0f,  4f )`
upwards	`new Vector3(  0f,  3f,  4f )`
downwards	`new Vector3(  0f, -3f,  4f )`

Version 2: In a Quadratic Resizable Window

Insert the following event handler below the constructor:
`public Game1() { g = new GraphicsDeviceManager( this ); }`

```
protected override void Initialize()
  { g.PreferredBackBufferWidth  = 600;
    g.PreferredBackBufferHeight = 600;
    g.ApplyChanges();
    Window.Title = "Tiger Rotation";
    Window.AllowUserResizing = true;
    base.Initialize();
  }
```

Click `Debug` → `Start Without Debugging Ctrl F5`.

Version 3: Rotate the Tiger Around the Y-Axis

Insert the following global variable definitions below the constructor: `private BasicEffect effect;`

```
private float trans            = 0,
              transIncrement   = 0.02f,
              zoom             = 1,
              zoomIncrement    = 0.005f,
              rotation         = 0,
              rotationIncrement = 0.01f;
```

Change the `protected override void Draw( GameTime gameTime )` event handler until it looks like this:

```
protected override void Draw( GameTime gameTime )
{ //g.GraphicsDevice.RenderState.FillMode = FillMode.WireFrame;
  g.GraphicsDevice.Clear( Color.DarkBlue );
  effect.World = Matrix.CreateRotationY ( modelRotation += 0.01f );
  model.Meshes[0].Draw();
}
```

Click `Debug` → `Start Without Debugging Ctrl F5`.

Experiments	with the camera	Results
1.	In the `effect.World`-line replace the letter "`Y`" in `CreateRotationY` to "`X`".	looping around the X-axis
2.	In the `effect.World`-line replace the letter "`Y`" in `CreateRotationY` to "`Z`"	looping around the Z-axis
3.	In the `effect.World`-line replace "`0.01f`" by "`0.05f`".	5 times faster ≈ 3°/Draw
4.	In the `effect.World`-line replace "`0.01f`" by "`0.001f`".	10 times slower ≈ 0.06°/Draw
5.	In the `effect.Projection`-line replace "`MathHelper.Pi/4`" by "`MathHelper.Pi/6`".	camera angle shrinks from 45° to 30°
6.	In the `effect.Projection`-line replace "`MathHelper.Pi/4`" by "`MathHelper.Pi/2`".	camera obtains a wide angle of 90°
7.	In the `effect.Projection`-line replace the 2. parameter "`1f`" by "`0.5f`".	distorted image: width = 2*height
8.	In the `effect.Projection`-line replace the 2. parameter "`1f`" by "`2f`".	distorted image: height = 2*width
9.	In the `effect.Projection`-line replace the 3. parameter "`1f`" by "`3f`".	Head an tail closer than 3f are lost.
Experiments	with the `GraphicsDeviceManager g`	
1.	Remove the comment slashes "`//`" in front of the first line of the new `Draw`-function.	triangles without skin
2.	Insert comment slashes "`//`" in front of the second line of the new `Draw`-function.	rotational body

Version 4: Translation and Scaling

Replace `protected override void Draw( GameTime gameTime ) { ... }` by:

```
protected override void Draw( GameTime gameTime )
  { //g.GraphicsDevice.RenderState.FillMode = FillMode.WireFrame;
    g.GraphicsDevice.Clear( Color.DarkBlue );
    if ( trans < -0.8f | trans > 0.8f ) transIncrement *= -1f;
    if ( zoom  <  0.1f | zoom  > 1.2f ) zoomIncrement  *= -1f;
    trans    += transIncrement;
    zoom     += zoomIncrement;
    rotation += rotationIncrement;
    effect.World  = Matrix.CreateScale      ( zoom        );
    effect.World *= Matrix.CreateRotationX  ( rotation    );
    effect.World *= Matrix.CreateRotationY  ( rotation    );
    effect.World *= Matrix.CreateRotationZ  ( rotation    );
    effect.World *= Matrix.CreateTranslation( trans, 0, 0 );
    model.Meshes[0].Draw();
  }
```

There are two faster alternatives to code the cascading movements by `effect.World`-lines:

```
/*1*/effect.World  = Matrix.CreateScale      ( zoom        ) *
                    Matrix.CreateRotationX  ( rotation    ) *
                    Matrix.CreateRotationY  ( rotation    ) *
                    Matrix.CreateRotationZ  ( rotation    ) *
                    Matrix.CreateTranslation( trans, 0, 0 );
/*2*/effect.World  = Matrix.CreateScale           ( zoom                          ) *
                    Matrix.CreateFromYawPitchRoll( rotation, rotation, rotation ) *
                    Matrix.CreateTranslation     ( 0, trans, 0                  );
```

Experiments:
1. Change the values of `transIncrement`, `zoomIncrement` and `rotationIncrement`.
2. Replace `(trans, 0, 0)` by `(0, trans, 0)`.
3. Remove single `Matrix.xxx`-lines by comment-slashes "`//`".

Version 5: Changing the Mesh

In the `Solution Explorer TigerRot1`-window open the `Content`-branch. → Double click `tiger.x`. →
A text file `tiger.x` opens. It contains 3 important parts:
1. 303 lines defining 303 3D-vertices = Vertex Buffer
2. 599 lines defining 599 triangles = Index Buffer and
3. 303 lines defining 303 2D-coordinates = Texture Coordinates Buffer.

This file has been produced by a diligent external designer using 3D modeling software such as **Autodesk 3ds Max** or **Autodesk Maya** (complete list of **3D modeling programs**). He exported his result to this DirectX format file `tiger.x`.
Let us edit `tiger.x` in order to see how x-files work.
1. Experiment: Comment out the last vertex (vertex no. 303) of the Vertex Buffer:
`-0.213423;-0.066057;0.311063;;` and write a new line: `-0.6;-0.066057;0.6;;`.
The end of the vertex Buffer should look like this:

```
//-0.213423;-0.066057;0.311063;;
-0.6;-0.066057;0.6;;
```

Store `tiger.x` and run the program. The tiger's right hind leg looks strange with a big tapered tumor.
2. Experiment: Comment out the first 5 lines (no. of triangles plus the triangle numbers 1, 2, 3, 4) of the Index Buffer and adjust the no. of triangles until theses lines look like this.

```
// 599;
//3;300,301,302;,
//3;299,300,302;,
//3;298,300,299;,
//3;295,296,297;,
595;
3;294,295,297;, ......
```

Store `tiger.x` and run the program.
The tiger's right hind leg looks even stranger with a big defect in and near the tumor.

Version 6: The Complete code

```
using System;
using Microsoft.Xna.Framework;
using Microsoft.Xna.Framework.Graphics;

static class Program
{ [STAThread] static void Main() { Game1 game = new Game1(); game.Run(); }

public class Game1 : Microsoft.Xna.Framework.Game
{ private GraphicsDeviceManager g;
  private Model model;
  private BasicEffect effect;
  private float trans          = 0,
                transIncrement = 0.02f,
                zoom           = 1,
                zoomIncrement  = 0.005f,
                rotation       = 0,
                rotationIncrement = 0.01f;
```

```
  public Game1()
  { g = new GraphicsDeviceManager( this );
  }
  protected override void Initialize()
  { g.PreferredBackBufferWidth  = 600;
    g.PreferredBackBufferHeight = 600;
    g.ApplyChanges();
    Window.Title = "Tiger Rotation";
    Window.AllowUserResizing = true;
    base.Initialize();
  }
  protected override void LoadContent()
  { model = Content.Load< Model >("Content\\tiger");
    effect = (BasicEffect)model.Meshes[0].Effects[0];
    effect.View = Matrix.CreateLookAt( new Vector3( 0f, 0f, 4f ),
                                       Vector3.Zero, Vector3.Up );
    effect.Projection = Matrix.CreatePerspectiveFieldOfView
                              ( MathHelper.Pi/4, 1f, 1f, 100000f );
  }
protected override void Draw( GameTime gameTime )
  { //g.GraphicsDevice.RenderState.FillMode = FillMode.WireFrame;
    g.GraphicsDevice.Clear( Color.DarkBlue );
    if ( trans < -0.8f | trans > 0.8f ) transIncrement *= -1f;
    if ( zoom  <  0.1f | zoom  > 1.2f ) zoomIncrement  *= -1f;
    trans    += transIncrement;
    zoom     += zoomIncrement;
    rotation += rotationIncrement;
    effect.World  = Matrix.CreateScale      ( zoom        );
    effect.World *= Matrix.CreateRotationX  ( rotation    );
    effect.World *= Matrix.CreateRotationY  ( rotation    );
    effect.World *= Matrix.CreateRotationZ  ( rotation    );
    effect.World *= Matrix.CreateTranslation( trans, 0, 0 );
    model.Meshes[0].Draw();
  }
} // end of class Game1
} // end of class Program
```

Version 7: Space Ship

Let us replace the tiger by another 3D-model.

1. Right click this link: **`ship_texture.tga`** and store the texture into the project directory `C:\temp\TigerRot1\Content`.

2. Right click this link: **`ship.fbx`** and store the mesh into the project directory `C:\temp\TigerRot1\Content`.

3. We have to add the texture image and the mesh file to project `TigerRot1`:
`Solution Explorer` → Right click the branch `Content` → `Add` → `Existing Item...` →
Directory: `Content: All Files (*.*)`.
Select both `ship_texture.tga` and `ship.fbx`, and quit by clicking the `Add`-button and check whether both file names arrived underneath the `Content`-branch.

4. `Solution Explorer` → Click `ship_texture.tga` and in its `Properties`-window and change the `Build Action`-property from `Compile` to `None`.

5. We have to call the ship-model instead of the tiger by changing the `Content.Load`-line to:
`model = Content.Load< Model >("Content\\ship");`.

6. The ship is much bigger than the tiger. Thus we have to retract the camera
from `Matrix.CreateLookAt( new Vector3( 0f, 0f,    4f ), Vector3.Zero, Vector3.Up )`
to `Matrix.CreateLookAt( new Vector3( 0f, 0f, 4000f ), Vector3.Zero, Vector3.Up )`.

7. Click `Debug` → `Start Without Debugging Ctrl F5`.