

Windows Presentation Foundation

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CSE681 – Software Modeling and Analysis

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References

- Pro C# 5 and the .Net 4.5 Platform, Andrew Troelsen, Apress, 2012
- Programming WPF, 2nd Edition, Sells & Griffiths, O'Reilly, 2007
- Windows Presentation Foundation Unleashed, Adam Nathan, SAMS, 2007
- Essential Windows Presentation Foundation, Chris Anderson, Addison-Wesley, 2007
- <http://msdn2.microsoft.com/en-us/library/aa970268.aspx>
- <http://msdn2.microsoft.com/en-us/library/ms754130.aspx>

WPF Blogs

- [Josh Smith Blog](#)
- [WPFpedia](#)
- [Mike Taulty's Blog](#)

Introduction

- What is WPF?
 - A Graphical User Interface Technology
 - Desktop
 - Little brother Silverlight is used for web applications
 - Uses Markup and Code
 - Together or separately, much like ASP.Net
 - Easy to produce different styles
 - Web browser like navigation and placement
 - Traditional forms
 - Animated Graphics

Markup

- XAML

- eXtensible Application Markup Language
- Tags are names of .Net 3.5 classes
- Attributes are class properties and events

```
<Grid>
```

```
  <Ellipse Fill="blue" />
```

```
  <TextBlock>
```

```
    Name: <TextBlock Text="{Binding Name}" />
```

```
  </TextBlock>
```

```
</Grid>
```

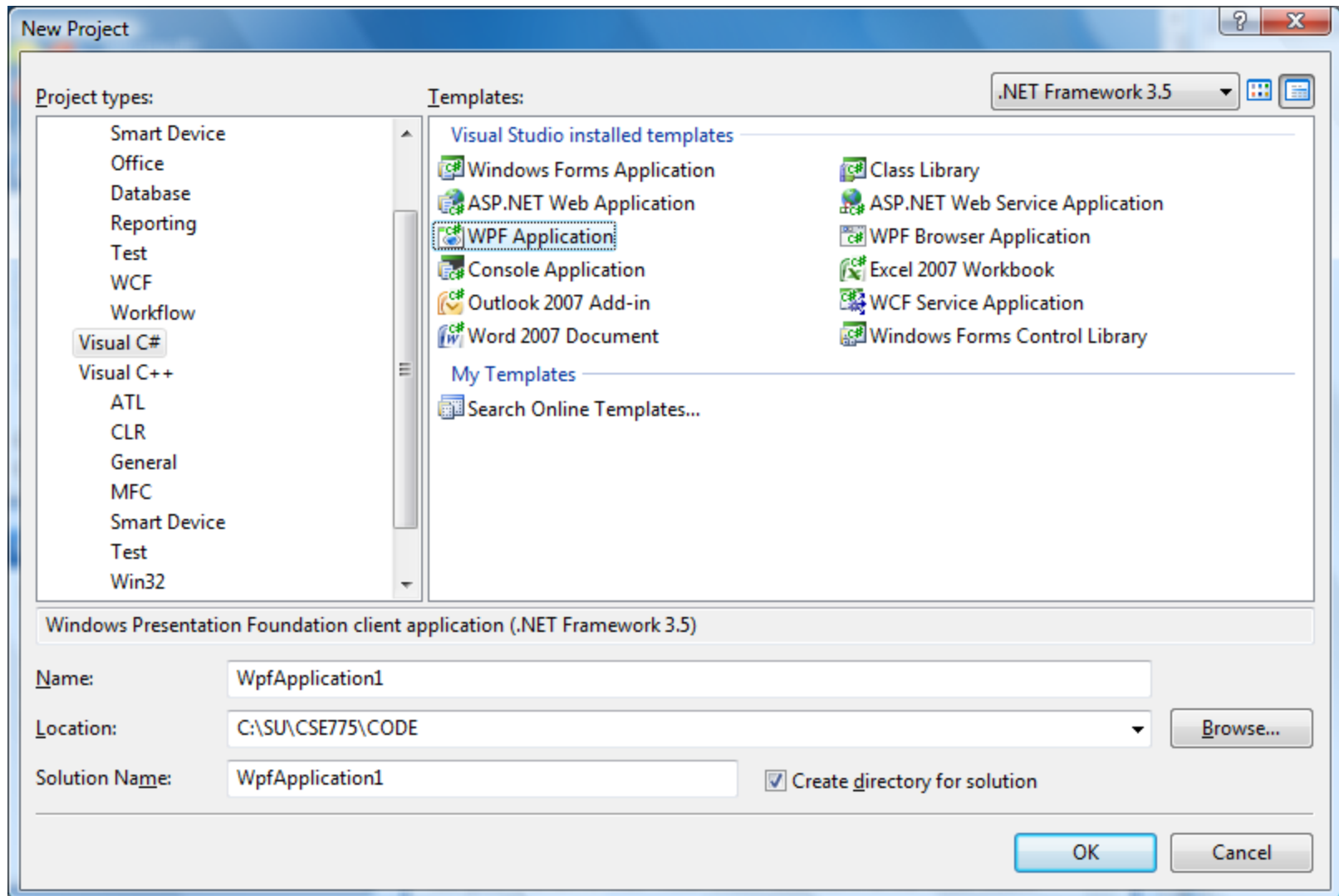
Code Behind

- Often, code provides processing for control events, bound in XAML, like this:
 - XAML in Window.Xaml

```
<Button
  x:Name="button"
  Width="200"
  Height="25"
  Click="button_Click">Submit</Button>
```
 - C# code in Window.Xaml.cs

```
Void button_Click(object sender, RoutedEventArgs e) {
  MessageBox.Show(...) }
```

C# Wizard



Default Grid Panel

The screenshot displays the Microsoft Visual Studio IDE with a WPF application named 'WPF_FirstDemo'. The main design area shows a window titled 'Window1' with a width of 300 and a height of 300. Inside the window, a Grid is used as the layout container. The Grid contains a Button and a TextBox. The Button is positioned at the top center of the Grid, and the TextBox is positioned at the bottom center. The XAML code for the window is as follows:

```
<Window x:Class="WPF_FirstDemo.Window1"
        xmlns="http://schemas.microsoft.com/winfx/2006/xaml/presentation"
        xmlns:x="http://schemas.microsoft.com/winfx/2006/xaml"
        Title="Window1" Height="300" Width="300">
    <Grid>
        <Button Margin="109,108,94,131" Name="button1">Button</Button>
        <TextBox Height="31" Margin="54,48,48,0" Name="textBox1" Vertical
    </Grid>
```

The Solution Explorer on the right shows the project structure, including the 'WPF_FirstDemo' project, 'App.xaml', 'Window1.xaml', and 'Window1.xaml.cs'. The status bar at the bottom indicates the current position is at Line 7, Column 6, and Character 6.

Like WinForms, But ...

The screenshot displays the Microsoft Visual Studio IDE for a WPF application named 'WPF_FirstDemo'. The main window, 'Window1', is shown with a simple UI consisting of a text box and a button labeled 'Button'. The code in the background is as follows:

```
using System;
using System.Windows;
using System.Windows.Controls;

/// <summary>
/// Interaction logic for Window1.xaml
/// </summary>
public partial class Window1 : Window
{
    public Window1()
    {
        InitializeComponent();
    }

    private void button1_Click(object sender, RoutedEventArgs e)
    {
        if (textBox1.Text == "")
            textBox1.Text = "been clicked";
        else
            textBox1.Text = "";
    }
}
```

The Solution Explorer on the right shows the project structure for 'WPF_FirstDemo', including 'App.xaml', 'Window1.xaml', and 'Window1.xaml.cs'. The Output window at the bottom shows the build process:

```
Compile complete -- 0 errors, 0 warnings
WPF_FirstDemo -> C:\SU\CSE775\CODE\WPF_FirstDemo\WPF_FirstDemo\bin\Debug\WPF_FirstDemo.exe
===== Build: 1 succeeded, 0 failed, 0 up-to-date, 0 skipped =====
```

The status bar at the bottom indicates 'Build succeeded' and shows the current file is 'Window1' at line 7, column 1.

It's Easy to do more interesting things

Lab Manager


Physics 201 Lab


Main Budget Personnel Lab Set Up Projects Mentoring Help


Physics Lab 201


This is some text about the physics laboratory.


You can have as many paragraphs as you like. You may even include multiple sentences like this one.


Budget


Personnel






Mentoring

Hello from the Main Page. This is some obscure and not very interesting text, designed to keep you busy.

Status:

Panels

- Layouts, like the previous page can use:
 - Canvas
 - Simplest, placement relative to two edges
 - StackPanel
 - Horizontal or vertical stacking
 - Grid
 - Uses rows and columns
 - Unsized elements fill Grid cells
 - DockPanel
 - Dock to top, right, bottom, left, and all else fills remaining space
 - WrapPanel
 - Horizontal stacking with wrap on overflow
 - All of these can be nested, any one in another

Vector Graphics

- In WPF there is only (usually) one window
 - Controls are not windows!
 - No handles – really, no handles
 - A button is a shape with border, fill, text, animation, and events, like click.
 - There is a Button class, but it is not a .Net control in the traditional sense nor an ActiveX control.
 - Just markup, lines, fills, and events.

Parse Tree


- XAML gets rendered into a parse tree, just like XML – it is XML
 - Inherited properties are based on parent child relationships in the markup tree
 - Events bubble based on those relationships as well
 - You have direct and simple control over that structure
 - The world is yours!

What Makes WPF Unique?

- Vector Graphics with Parse Tree Structure derived from markup
- Routed Events bubble up the parse tree
- Pervasive Publish and Subscribe Model
 - Data Binding
 - Dependency Properties
- Layered on top of DirectX
 - Strong 2D and 3D graphics
 - Animation
- Layout and styles model similar to the best of the web

XamlPad

Auto Parse Refresh Refresh Courier New 12 25%

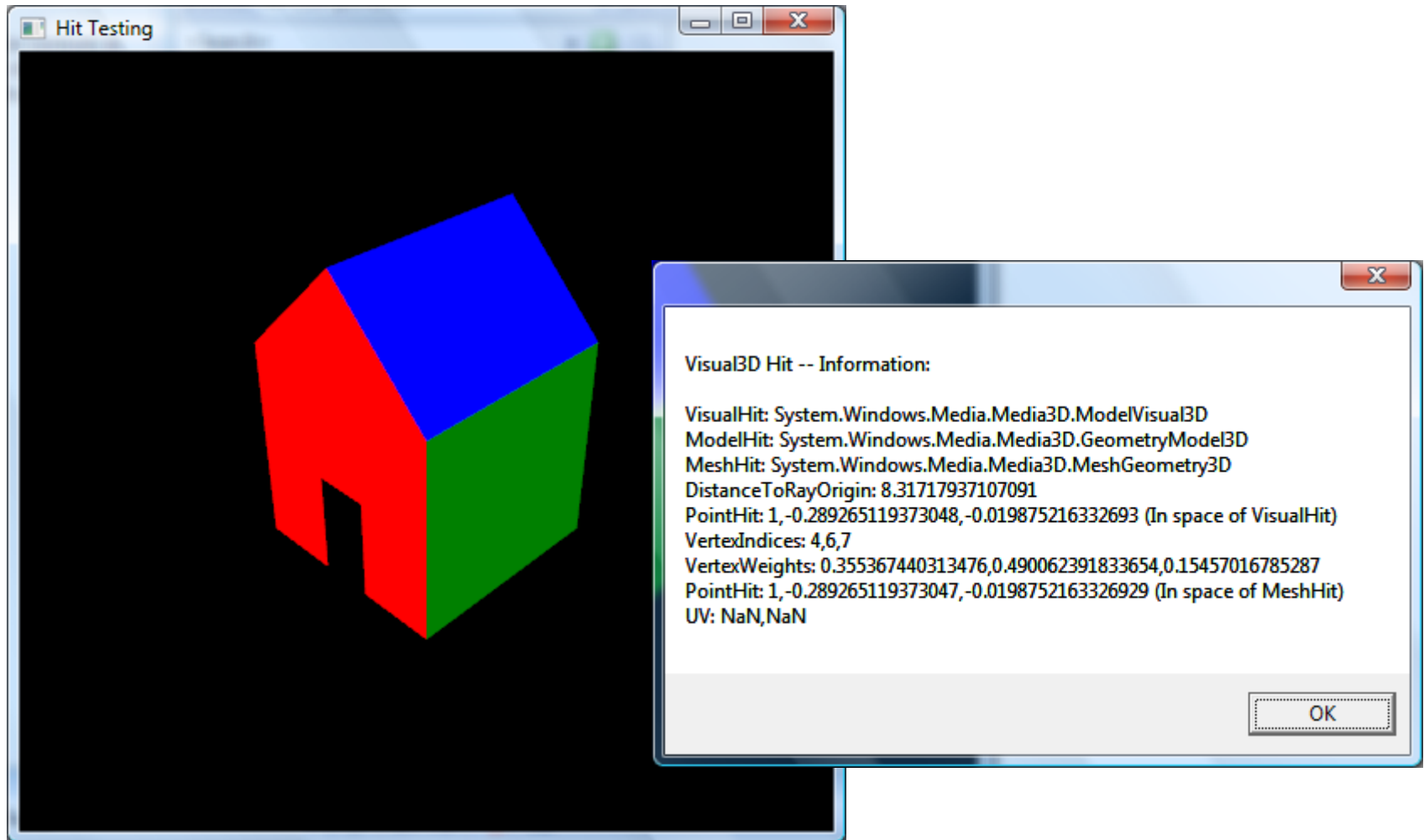


```
TextureCoordinates="0,1 0,0 1,0 1,1 1,1 -0,1 0,-0 1,0 1,1 -0,1 0,-0 1,0 1,0 1,1 -0,1 0,-0 -0,0 1,-0 1,1 0,1 1,-0 1,1 0,1 -0,0"/>
</GeometryModel3D.Geometry>
</GeometryModel3D>
</ModelVisual3D.Content>
</ModelVisual3D>
</Viewport3D.Children>
</Viewport3D>
</ControlTemplate>
</Setter.Value>
</Setter>
</Style>
</Page.Resources>

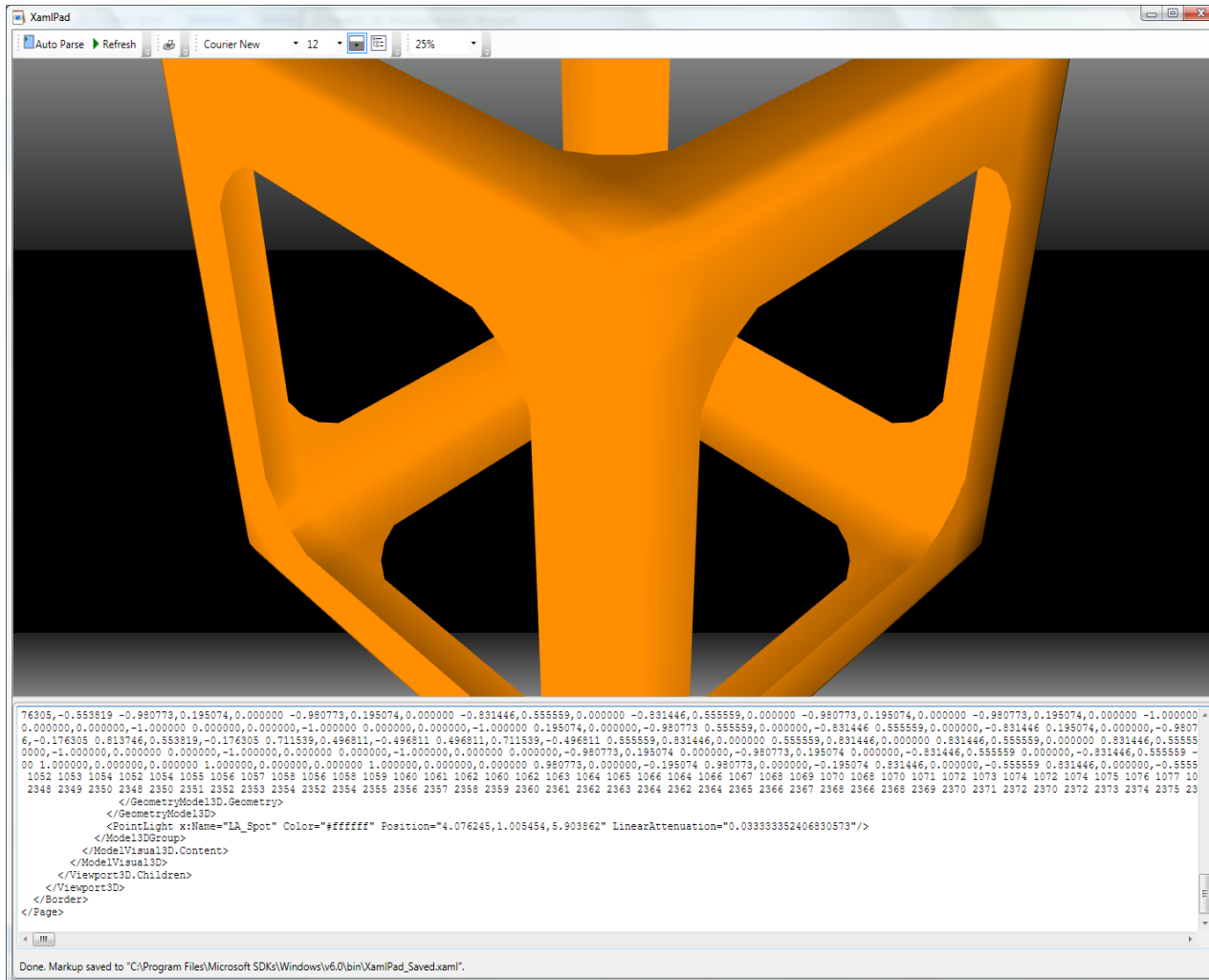
<DockPanel>
  <Button>Click me!</Button>
</DockPanel>
</Page>
```

Done. Markup saved to "C:\Program Files\Microsoft SDKs\Windows\v6.0\bin\XamlPad_Saved.xaml".

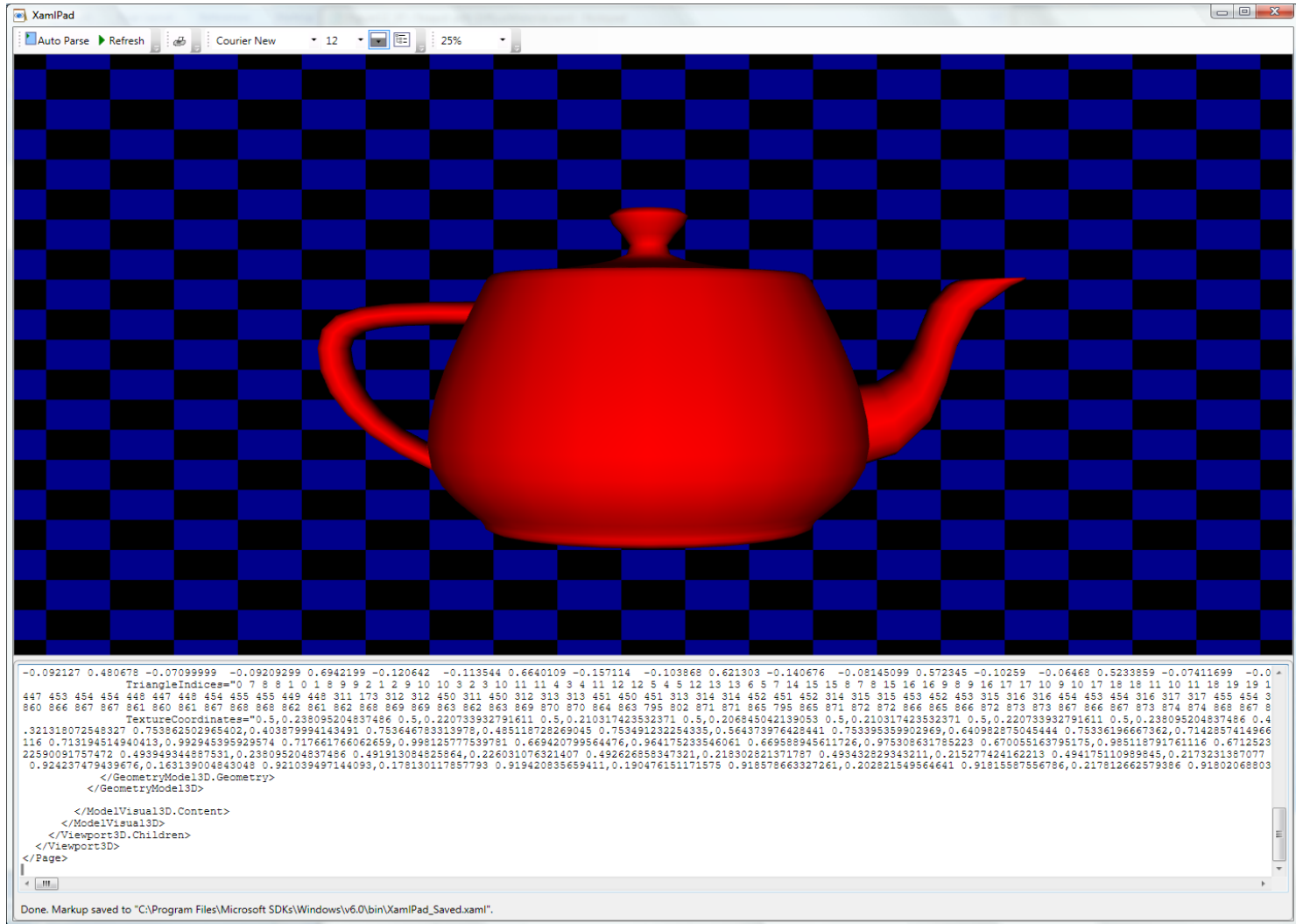
3D Hit Testing



3D Perspective Camera



Famous Teapot



```
-0.092127 0.480678 -0.07099999 -0.09209299 0.6942199 -0.120642 -0.113544 0.6640109 -0.157114 -0.103868 0.621303 -0.140676 -0.08145099 0.572345 -0.10259 -0.06468 0.5233859 -0.07411699 -0.0447 447 453 454 454 448 447 448 454 455 455 449 448 311 173 312 312 450 311 450 312 313 313 451 450 451 313 314 314 452 451 452 314 315 315 453 452 453 315 316 316 454 453 454 316 317 317 455 454 317 860 866 867 867 861 860 861 867 868 868 862 861 862 868 869 869 863 862 863 869 870 870 864 863 795 802 871 871 865 795 865 871 872 872 866 865 866 872 873 873 867 866 867 873 874 874 868 867 87321318072548327 0.75386202965402 0.40387994143481 0.753644753313978 0.485118728269045 0.753491232254335 0.564873976428441 0.75339535909969 0.640982875048444 0.75336196667362 0.7142857414966 116 0.713194514940413 0.992945395929574 0.717661766062659 0.998125777539781 0.669420799564476 0.964175233546061 0.669589945611726 0.975308631785223 0.670055163795175 0.955118791761116 0.6712523 22590091757472 0.493949344887531 0.238095204837486 0.4919130848225864 0.226031076321407 0.492626858347321 0.218302821371787 0.49343229343211 0.215277424162213 0.494175110989845 0.2173231387077 0.924237479439676 0.163139004843048 0.921039497144093 0.178130117857793 0.919420835659411 0.190476151171575 0.918578663327261 0.202821549564641 0.91815587556786 0.217812662579386 0.91802068803  
</GeometryModel3D.Geometry>  
</GeometryModel3D>  
</ModelVisual3D.Content>  
</ModelVisual3D>  
</Viewport3D.Children>  
</Viewport3D>  
</Page>
```

Done. Markup saved to "C:\Program Files\Microsoft SDKs\Windows\v6.0\bin\XamiPad_Saved.xml".

```
Figure12_37 - Teapot with DiffuseMaterial.xml - Notepad
File Edit Format View Help
<Page
  xmlns="http://schemas.microsoft.com/winfx/2006/xaml/presentation"
  xmlns:x="http://schemas.microsoft.com/winfx/2006/xaml">
  <Page.Background>
    <DrawingBrush viewport="0,0,0.05,0.05" TileMode="FlipXY">
      <DrawingBrush.Drawing>
        <DrawingGroup>
          <GeometryDrawing Brush="Black" Geometry="M0,0 L1,0 L1,1 L0,1" />
          <GeometryDrawing Brush="DarkBlue" Geometry="M0,0.5 L0.5,0.5 L0.5,1 L0,1" />
          <GeometryDrawing Brush="DarkBlue" Geometry="M0.5,0 L1,0 L1,0.5 L0.5,0.5" />
        </DrawingGroup>
      </DrawingBrush.Drawing>
    </DrawingBrush>
  </Page.Background>
  <Viewport3D>
    <Viewport3D.Camera>
      <PerspectiveCamera Position="0,0,7" LookDirection="0,0,-1"/>
    </Viewport3D.Camera>
    <Viewport3D.Children>
      <ModelVisual3D x:Name="Light">
        <ModelVisual3D.Content>
          <DirectionalLight/>
        </ModelVisual3D.Content>
      </ModelVisual3D>
      <ModelVisual3D>
        <ModelVisual3D.Transform>
          <x:Static Member="Transform3D.Identity"/>
        </ModelVisual3D.Transform>
        <ModelVisual3D.Content>
          <GeometryModel3D x:Name="Teapot">
            <GeometryModel3D.Material>
              <DiffuseMaterial Brush="Red" />
            </GeometryModel3D.Material>
            <GeometryModel3D.BackMaterial>
              <DiffuseMaterial Brush="Red" />
            </GeometryModel3D.BackMaterial>
            <GeometryModel3D.Geometry>
              <MeshGeometry3D
                Positions="0.6788729 0.330678 0 0.669556 0.358022 0 0.6710029 0.374428 0 0.6804349 0.379897 0 0.6950:
809 0.164722 0.374428 0.6677769 0.167255 0.379897 0.6768779 0.171187 0.374428 0.6910039 0.175771 0.358022 0.7074749
022 0.350969 -0.62291 0.374428 0.351704 -0.6293589 0.379897 0.356498 -0.6411459 0.374428 0.363938 -0.6555929 0.35802:
0.374428 -0.491412 -0.5192369 0.379897 -0.498109 -0.5296319 0.374428 -0.5085049 -0.5417529 0.358022 -0.5206259 -0.55:
99 0.329842 0.358022 -0.5975689 0.330577 0.374428 -0.5988199 0.33537 0.379897 -0.6069819 0.34281 0.374428 -0.6196489
39 -0.183211 0.258573 0.9341959 -0.30387 0.265877 0.9436879 -0.419322 0.268519 0.6813349 0.199602 0.412576 0.7319039
0.8397459 -0.268668 -0.058384 0.8894389 -0.279701 -0.183211 0.929081 -0.287004 -0.30387 0.9553229 -0.289646 -0.41932:
</MeshGeometry3D
  </GeometryModel3D.Geometry>
    </GeometryModel3D.Content>
  </ModelVisual3D>
    </ModelVisual3D.Children>
  </Viewport3D>
</Page>
```

Routed Events

- WPF maps markup elements to UIElements, which derive from ContentControl
 - That means that almost everything can hold content – only one thing unless it's a panel.
 - How does a mouse click **event** on any one of a control's content elements get **routed** to the control?
 - By walking the XAML parse tree until it finds a parent that handles that event.

Adding Event Handlers

- You will find that property sheets show events as well as properties
 - click on the lightning bolt to see the event sheet.
 - You subscribe by clicking on an event entry.
- You can also add event handlers quickly in XAML:
 - Go to the XAML, type a space after the tag for the element you want to handle the event
 - That gets you a context menu (via intellisense) and you just double click on the desired event, which adds an event attribute

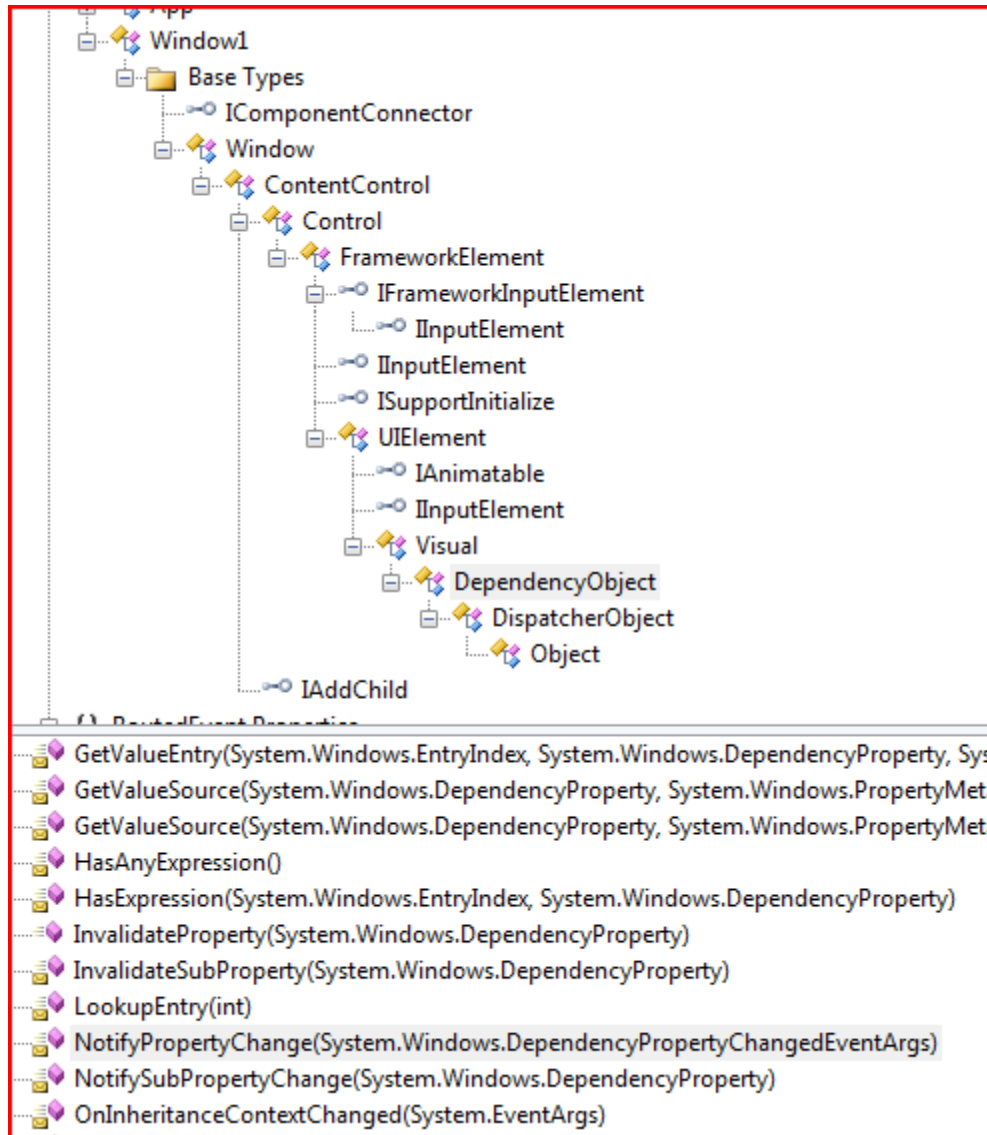
Attached Properties

- Buttons, ListBoxes, Images, etc., do not have Dock properties.
- However, when you place one of these in a DockPanel, you find that it has had Dock *properties attached*.

```
<Image Source="./help.png"  
    DockPanel.Dock="Top" Height="213"  
    ImageFailed="Image_ImageFailed" />
```

DependencyObject Class

- Attached properties work because all WPF controls derive from the DependencyObject class.
 - DependencyObject class supports adding an arbitrary number of dependency properties.



Dependency Properties

- A Dependency Property is a property that is registered with the WPF Dependency property system. Two uses:
 - Backing an object property with a dependency property, provides support for databinding, styling, and animation. Examples include Background and Fontsize properties
 - Creating attached properties. Attached properties are properties that can be set on ANY DependencyObject types. An example is the Dock property.
- You can find an example of the definition and use of a custom Dependency Property [here](#).
- Dependency Properties are a Publish and Subscribe system.

Dependency Property Links

- [Josh Smith's Blog](#)
- [Switch on the Code Blog](#)
- [Learn WPF site](#)

Property Syntax

- Two syntax forms:
 - XAML attribute:
`<button ToolTip="Button Tip />`
 - Property Element Syntax:
`<Button>`
`<Button.Background>`
`<SolidColorBrush Color="#FF4444FF" />`
`</Button.Background>`
`Some Button Text`
`</Button>`

Markup Extensions

- Sometimes you need to assign a property from some source at run-time. For that you use Markup Extensions:

```
<Button Foreground="{x:static  
    SystemColors.ActiveCaptionBrush}" >  
    Some text  
</Button>
```

Inline Styles

- Collections of property values:
 - `<Button.Style>`
 - `<Style>`
 - `<Setter Property="Button.FontSize" Value="32pt" />`
 - `<Setter Property="Button.FontWeight" Value="Bold" />`
 - `</Style>`
 - `</Button.Style>`

Named Styles

- Collections of property values:
 - <Window.Resources>
 - <Style x:Key="myStyle" TargetType="{x:Type Control}">
 - <Setter Property="FontSize" Value="32pt" />
 - <Setter Property="FontWeight" Value="Bold" />
 - </Style>
 - </Window>

Binding

- Binding infrastructure allows you to set up a one-way or two-way updating of property values that happens when the source changes.
- This requires two things:
 - A dependency object
 - Has its own dispatcher thread
 - Support for INotifyPropertyChanged interface

Binding

- Objects that implement `INotifyPropertyChanged` interface raise events when the property has changed.
- Data binding is the process of registering two properties with the data binding engine and letting the engine keep them synchronized.
- You will find an example in the `Wpf_AttachedProperties` demo code.

Binding Links

- [MSDN Article by John Papa](#)
- [CodeProject article by Josh Smith \(part of a tutorial series\)](#)
- [Bea \(Costa\) Stollnitz](#)

Control Templates

- With Control Templates you can change the look and feel of existing controls and support making your own controls:
 - `<Button.Template>`
 - `<ControlTemplate>`
 - `<Grid><Rectangle /></Grid>`
 - `</ControlTemplate>`
 - `</Button.Template>`

Navigation

- You can use instances of the Page and Frame classes to set up a navigation structure resembling web applications.
 - Pages go in NavigationWindow instances and Frames go in Windows and Pages.
 - This is a good alternative to tabbed displays.

Special Classes

- ContentControl
 - All UIElements derive from this.
 - Content can be text, a tree of elements, or a .Net object which can be displayed using a data template
- Dependency Object
 - Derives from Dispatcher Object
 - Supports data binding, styling, animation, property inheritance, and property change notifications
- WindowsFormsHost
 - Supports hosting controls based on HWNDs

Special UIElements

- **ViewBox**
 - Resizes content to fit available space
- **UserControl**
 - Way to build custom controls as collections of elements on a panel
- **Animatable**
 - Provides hooks for DirectX to change elements properties over time, e.g., position, size, color, ...
- **FlowDocument**
 - FlowDocumentScrollViewer
 - FlowDocumentPageViewer
- **MediaElement**
 - Play media on load or on request, e.g., wma, wmv, mp3, ...

End of Presentation