

UNIVERSITY OF Hull

Windows Presentation Foundation (WPF) User Interfaces

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29c 08120 Programming 2

Design Style and programming

- As programmers we probably start of just worrying about making the program work
 - This is a very good place to start
- But in modern systems the “look and feel” of the user interface is very important
 - No matter how good the code is, if the program is hard to use it will not be popular
- You should pay careful attention to user interface issues when making your programs

Separating User Interface Design and Code

- It turns out that programmers are not always very good at graphic design
 - And that graphic designers are not very good at programming
- To make a good application we need a good user interface design and code that works
- It makes sense to separate programming and design and make it easy for the graphic designer and the programmer to work together

Windows Presentation Foundation (WPF)

- The Windows Presentation Foundation separates the user interface design from the program code by the use of a “markup” language called XAML
 - This stands for “eXtensible Application Markup Language”
 - It describes the arrangement of items on a window
- The designer can create the XAML and the programmer can use the objects defined in it to create the code
- Visual Studio provides an environment where the XAML and the program can be worked on together

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XAML and Windows Presentation Foundation

- A WPF application is made up of pages that contain elements
- These have properties that determine where they are, how they appear and what they can do in an application
- The Visual Studio tool allows us to manipulate the page content by using the design surface and the element properties pane

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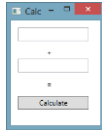
Expressing WPF Elements

- The description of the elements in a WPF application is actually held in a text file
- This file is formatted in a particular way
- Microsoft invented a language, XAML to hold this design information:
 - eXtensible Application Markup Language
- XAML was invented to hold user interface design information
- It is based on the XML standard

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Why do we need XAML?

- XAML allows us to separate the role of graphic designer and programmer
 - The designer should not have to see code objects to work
 - The programmer should not be held back while the design is produced
- The XAML file provides a separation between the code that drives the application and the way the application looks

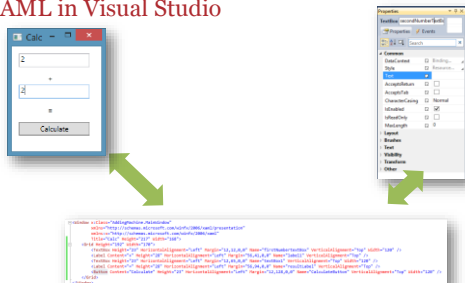


XAML file content

```
<TextBox Height="23" HorizontalAlignment="Left"
Margin="12,12,0,0" Name="firstNumberTextBox"
VerticalAlignment="Top" Width="120" />
```

- This snippet of XAML is the description of a textbox on the screen `firstNumberTextBox` in the `AddingMachine` application
- It contains fields that describe the position and size of the textbox
- This file is managed by Visual Studio as your program is being developed

XAML in Visual Studio



- The XAML file holds the information which is updated by both views

The XAML language

- XAML is a “declarative” language
- It just tells us about things, it does not tell us what they do and how they can do it
- The XAML file has a particular format
 - The characters < and > are used to mark the start and end of some elements in the file
- The format looks a bit like XML
 - eXtensible Markup Language

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Using XAML

- You can actually edit the XAML text in your project to create new display elements and modify existing ones
- This can often be much quicker than using the editing interface provided by Visual Studio
- You just have to type the new values into the XAML window and the properties of the element are changed immediately

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The XAML file at run time

- When a WPF program runs the XAML file is compiled into a set of low level display instructions that are obeyed by the runtime system
- This is the point at which the XAML object descriptions in the text are converted into program objects we can use in our code
- This all happens automatically as far as we are concerned
- The program can just use the display elements as objects in the code, rather like we use the Console object

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XAML and XML

- XAML looks a bit like XML
 - XML means “Extensible Markup Language”
- This means that XML is really a way of designing languages that want to talk about something
- Just like the english language lets us invent verbs and nouns and put them into sentences that have meaning in a particular context

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Quick intro to XML

```
<?xml version="1.0" encoding="us-ascii" ?>
<HighScoreRecords count="2">
  <HighScore game="Breakout">
    <playername>Rob Miles</playername>
    <score>1500</score>
  </HighScore>
  <HighScore game="Space Invaders">
    <playername>Rob Miles</playername>
    <score>4500</score>
  </HighScore>
</HighScoreRecords>
```

- I invented this XML format to hold a video game high score table

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HighScore element

```
<HighScore game="Breakout">
  <playername>Rob Miles</playername>
  <score>1500</score>
</HighScore>
```

- The HighScore element contains two other elements, playername and score
- It also has a property that gives the name of the game
- I could add others, for example the date and time the score was achieved
- It is easy for us to work out what the elements are there for

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HighScoreRecords element

```
<?xml version="1.0" encoding="us-ascii" ?>
<HighScoreRecords count="2">
  <HighScore game="Breakout">
    <playername>Rob Miles</playername>
    <score>1500</score>
  </HighScore>
  <HighScore game="Space Invaders">
    <playername>Rob Miles</playername>
    <score>4500</score>
  </HighScore>
</HighScoreRecords>
```

- The HighScoreRecords element contains a count of the number of HighScore elements

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XML and data structures

- We can invent our own language format whenever we have some structured data that we want to store
- The designers of XAML have done this
- Rather than store high scores they have created a language that lets us design user interfaces

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The XAML data revisited

```
<TextBox Height="23" HorizontalAlignment="Left"
Margin="12,12,0,0" Name="firstNumbertextBox"
VerticalAlignment="Top" Width="120" />
```

- We can see that the XAML content that describes a textbox is very similar to a HighScore element
- The designers of XAML had to work out what data fields are required in a TextBox object
- Each display element has a set of fields
- Visual Studio provides intellisense to help you create these

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What is a Markup Language?

- The “ML” in XML stands for “Markup Language”
- A markup language was originally a set of commands for the printers of a document
 - ‘Put the words “Table of Contents” in bold’
- When the World Wide Web was created the Hyper Text Markup Language was designed to allow a text file to describe a particular web page design
- However, there are lots of other markup languages available

XML and HTML

- The idea of creating your own markup language was such a good one that people wanted a standard form for doing this
- XML came out of this drive for standards
 - It is the way in which the files use the < and /> and other characters to mean the start and end of elements, names and properties
 - It also tells you how to create “schemas” that define the structure and content of XML documents

XML Schema

- An XML schema describes a particular XML document format:
 - “A HighScore element must contain a PlayerName and a Score value, but the Date value is optional”
- Programs can use a schema to make sure that a particular document contains content which is valid
- The schema in use is identified in the header of an XML document
- Microsoft have created a schema for the XAML language

XML and software

- XML allows programs to share data irrespective of what kind of system was used to create the data
- There are many software tools that can create schemas and you can even store the contents of C# directly into XML structured files
- However, for now just remember that the description of a WPF page is a text file containing an XAML document which is formatted according to XML using a schema that determines how all the elements are to be used

XAML and WPF Pages

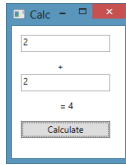
- A WPF application is made up of a number of *pages*
- Each page is expressed using a single XAML source file
- The page will contain descriptions of a number of WPF elements
 - Some elements can contain other elements
- Visual Studio manages the XAML source file as we work on the application
- Items described in the XAML appear as objects in the programs that we create

WPF Components

- There are lots of different components available to be added to a window
 - **Label**: a text label
 - **TextBox**: a box the user can type into
 - **Button**: a button that the user can press
- A program can interact with a component by using the behaviours that it provides
 - We can change the text in a **Label** to display a message
 - We can read the text from a **TextBox** to get user input
 - A **Button** can generate events when it is clicked

Sample Application

- The Calc program just adds two numbers together
- The user enters the numbers and presses the button to start a calculation
- The result is displayed using a label

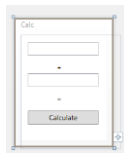


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Designer View

- This is the designer view of the application
- I added each item in turn to the screen
 - Visual Studio provides some very good tools to help line the items up
- I can also change the size of the application window by dragging the handles attached to the window



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XAML View

```
<Grid Height="192" Width="170">
  <TextBox Height="23" HorizontalAlignment="Left"
    Margin="12,12,0,0" Name="firstNumberTextBox"
    VerticalAlignment="Top" Width="120" />
  <Label Content="+" Height="28" HorizontalAlignment="Left"
    Margin="56,41,0,0" Name="plusLabel" VerticalAlignment="Top" />
  <TextBox Height="23" HorizontalAlignment="Left"
    Margin="12,65,0,0" Name="secondNumberTextBox"
    VerticalAlignment="Top" Width="120" />
  <Label Content="=" Height="28" HorizontalAlignment="Left"
    Margin="56,94,0,0" Name="resultLabel" VerticalAlignment="Top" />
  <Button Content="Calculate" Height="23" HorizontalAlignment="Left"
    Margin="12,128,0,0" Name="CalculateButton" VerticalAlignment="Top"
    Width="120" />
</Grid>
```

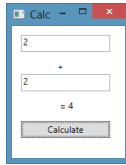
- This is the XAML that describes the items in the window

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Buttons and Events

- The CalculateButton component will appear on the form and the user can click it
- However, at the moment the button doesn't do anything
- What we need to do next is bind an *event* to button
- In other words, we want some C# to run when the button clicked

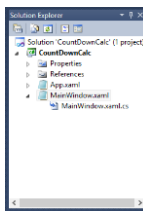


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XAML designs and C# Code

- Each XAML page has a C# program page which is shown in Solution Explorer as being “behind” the window
- Each Window in an application is implemented by a class
- This is where a programmer can put code that makes the user interface work
- This includes the handler for the button clicked event



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An Empty Window Class

```
public partial class MainWindow : Window
{
    public MainWindow()
    {
        InitializeComponent();
    }
}
```

- An empty window just contains a call to the InitializeComponent method
- This call is made when the constructor for the window is called
- The method creates all the components that appear on the screen

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Window Class Methods

```
public partial class MainWindow : Window
{
    public MainWindow()
    {
        InitializeComponent();
    }
}
```

- When we add code that responds to events from the user we will put this code into the `MainWindow` class
- The methods that respond to button press events run in here
- The methods that display values to the user will run in here

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Responding to Events

- When `CalculateButton` is clicked it needs a way of “telling” a program that this event has occurred
- In C# an event is delivered by a call of a method
 - Our program will contain a `calculateButton_Click` method that is called when the finish button is clicked
 - This will read the new text back from the `TextField` and update the name of our customer
- We need a way of connecting the `CalculateButton` component to the method we want it to call when it is clicked

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Referring to Methods using Delegates

- We are familiar with the use of references to refer to objects
 - A reference is a tag that can be tied to a particular object in memory
- Delegates are an extension of references which refer to methods rather than objects
 - The value of a delegate can be set to refer to a method in a class
- We can connect buttons to methods by doing this:
 - Create a delegate that refers to the method we want to use
 - Give this delegate to `calculateButton` so that it knows who to call when the button is clicked

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Connecting to the Component

```
<Button Content="Calculate" Height="23"
HorizontalAlignment="Left" Margin="12,128,0,0"
Name="CalculateButton" VerticalAlignment="Top"
Width="120" Click="CalculateButton_Click" />
```

- The XAML that describes the button can contain a `Click` value that identifies the method to be called when the button is clicked
- Visual Studio will do the “plumbing” behind the scenes to create the method and the delegate and connect it all to the button
- We will discover how this works later in the course

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Creating the Event Handler

- The simplest way to create an event handler for button is to double click on the button in the Visual Studio graphical user interface
- This will update the XAML as shown above and create an event handler in the window class that we can add code to
- You can also manage the events that a component produces by managing its properties
- Each component can generate a particular set of events

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The Event Handler in a Window Class

```
public partial class MainWindow : Window
{
    private void CalculateButton_Click(object sender,
                                     RoutedEventArgs e)
    {
    }
}
```

- This is the empty event handler
- Our program can ignore the parameters (although these can be used so it can determine which object generated the event)
- The method is called each time the button is clicked by the user

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Performing the Calculation

```
private void CalculateButton_Click(object sender,
    RoutedEventArgs e)
{
    int v1 = int.Parse(firstNumberTextBox.Text);
    int v2 = int.Parse(secondNumberTextBox.Text);

    int result = v1 + v2;

    resultLabel.Content = "=" + result;
}
```

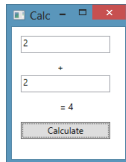
- Visual Studio makes an empty method for the event handler
- We can fill in the code to make it perform the required task
- In this case it calculates the result and displays it

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Running the Program

- The interesting thing about this program is that once it has loaded the window onto the screen it then does nothing
 - There is a Main method in the application, but this just starts off creating the window
- Once the program is active it is simply waiting for the user to press the calculate button



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IMPORTANT MESSAGE

- A Window is just the thing that displays the user interface for your program
 - It provides a link between the user and the data objects that they are working with

**You should not try to store any
of your business data inside
the Window class**

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Sensible Way To Work

```
public partial class MainWindow : Window
{
    Bank activeBank;
    public MainWindow()
    {
        InitializeComponent();
    }
}
```

- The variable `activeBank` contains a reference to the bank that the user is working with
- The bank will contain methods that will let code in the user interface find accounts and get data from them for display

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Stupid Way To Work

```
public partial class Account : Window
{
    string customerName;
    public Account()
    {
        InitializeComponent();
    }
}
```

- The program is trying to store business data (the name of a customer) inside the Window class that is driving the user interface
- This is not the right thing to do, we don't want to have to store buttons and labels when we store a customer

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Very Sensible Way To Work

```
public partial class CustomerEditWindow : Window
{
    string selectdCustomerName;
    public MainWindow()
    {
        InitializeComponent();
    }
}
```

- This is **much** more sensible
- The string is set to the name of the customer account that is currently being edited
- Methods in the window could update this name and save it back in the account

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Windows Presentation Foundation Summary

- Windows are displays on the screen that are manipulated as C# objects
- The design of the objects on the screen is expressed using the XAML language
- Windows can contain components such as `Label`, `TextBox` and `Button`
- The `Button` component can generate an event when it is clicked
- You can use delegates to tell the button which method to call when a click event occurs
