

Chapter 10.

XAML Markup Extensions

In code, you can set a property in a variety of different ways from a variety of different sources:

```
triangle.Angle1 = 45;  
triangle.Angle1 = 180 * radians / Math.PI;  
triangle.Angle1 = angles[i];  
triangle.Angle1 = animator.GetCurrentAngle();
```

If this `Angle1` property is a double, all that's required is that the source be a double or otherwise provide a numeric value that is convertible to a double.

In markup, however, a property of type double usually can be set only from a string that qualifies as a valid argument to `Double.Parse`. The only exception you've seen so far is when the target property is flagged with a `TypeConverter` attribute, such as the `FontSize` property.

It might be desirable if XAML were more flexible—if you could set a property from sources other than explicit text strings. For example, suppose you want to define another way to set a property of type `Color`, perhaps using the Hue, Saturation, and Luminosity values but without the hassle of the `x:FactoryMethod` element. Just offhand, it doesn't seem possible. The XAML parser expects that any value set to an attribute of type `Color` is a string acceptable to the `ColorTypeConverter` class.

The purpose of XAML *markup extensions* is to get around this apparent restriction. Rest assured that XAML markup extensions are *not* extensions to XML. XAML is always legal XML. XAML markup extensions are extensions only in the sense that they extend the possibilities of attribute settings in markup. A markup extension essentially *provides* a value of a particular type without necessarily being a text representation *of* a value.

The Code Infrastructure

Strictly speaking, a XAML markup extension is a class that implements `IMarkupExtension`, which is a public interface defined in the regular **Xamarin.Forms.Core** assembly but with the namespace `Xamarin.Forms.Xaml`:

```
public interface IMarkupExtension  
{  
    object ProvideValue(IServiceProvider serviceProvider);  
}
```

As the name suggests, `ProvideValue` is the method that provides a value to a XAML attribute. `IServiceProvider` is part of the base class libraries of .NET and defined in the `System` namespace:

```
public interface IServiceProvider
{
    object GetService(Type type);
}
```

Obviously, this information doesn't provide much of a hint on writing custom markup extensions, and in truth, they can be tricky. (You'll see an example shortly and other examples later in this book.) Fortunately, *Xamarin.Forms* provides several valuable markup extensions for you. These fall into three categories:

1. Markup extensions that are part of the XAML 2009 specification, These appear in XAML files with the customary *x* prefix and are:

- *x:Static*
- *x:Reference*
- *x:Type*
- *x:Null*
- *x:Array*

These are implemented in classes that consist of the name of the markup extension with the word *Extension* appended—for example, the *StaticExtension* and *ReferenceExtension* classes. These classes are defined in the **Xamarin.Forms.Xaml** assembly.

2. The following markup extensions originated in the Windows Presentation Foundation (WPF), and with the exception of *DynamicResource*, are supported by Microsoft's other implementations of XAML, including Silverlight, Windows Phone 7 and 8, and Windows 8 and 10:

- *StaticResource*
- *DynamicResource*
- *Binding*

The *DynamicResourceExtension* class is public; *StaticResourceExtension* and *BindingExtension* are not, but they are available for your use in XAML files because they are accessible by the XAML parser.

3. There is only one markup extension that is unique to *Xamarin.Forms*:

- *ConstraintExpression* class used in connection with *RelativeLayout*.

Although it's possible to play around with public markup-extension classes in code, they really only make sense in XAML.

Accessing Static Members

One of the simplest and most useful implementations of `IMarkupExtension` is encapsulated in the `StaticExtension` class. This is part of the original XAML specification, so it customarily appears in XAML with an `x` prefix. `StaticExtension` defines a single property named `Member` of type `string` that you set to a class and member name of a public constant, static property, static field, or enumeration member.

Let's see how this works. Here's a `Label` with six properties set as it would normally appear in XAML.

```
<Label Text="Just some text"
       BackgroundColor="Accent"
       TextColor="Black"
       FontAttributes="Italic"
       VerticalOptions="Center"
       XAlign="Center" />
```

Five of these attributes are set to text strings that eventually reference static properties, fields, and enumeration members, but the conversion of those text strings occurs through type converters and the standard XAML parsing of enumeration types.

If you want to be more explicit in setting these attributes to static properties, fields, and enumeration members, you can use `x:StaticExtension` within property element tags:

```
<Label Text="Just some text">
  <Label.BackgroundColor>
    <x:StaticExtension Member="Color.Accent" />
  </Label.BackgroundColor>

  <Label.TextColor>
    <x:StaticExtension Member="Color.Black" />
  </Label.TextColor>

  <Label.FontAttributes>
    <x:StaticExtension Member="FontAttributes.Italic" />
  </Label.FontAttributes>

  <Label.VerticalOptions>
    <x:StaticExtension Member="LayoutOptions.Center" />
  </Label.VerticalOptions>

  <Label.XAlign>
    <x:StaticExtension Member="TextAlignment.Center" />
  </Label.XAlign>
</Label>
```

`Color.Accent` is a static property. `Color.Black` and `LayoutOptions.Center` are static fields. `FontAttributes.Italic` and `TextAlignment.Center` are enumeration members.

Considering the ease that these attributes are set with text strings, the approach using `StaticExtension` initially seems ridiculous, but notice that it's a general-purpose mechanism. You can use *any* static

property, field, or enumeration member in the `StaticExtension` tag if its type matches the type of the target property.

By convention, classes that implement `IMarkupExtension` incorporate the word `Extension` in their names, but you can leave that out in XAML, which is why this markup extension is usually called `x:Static` rather than `x:StaticExtension`. The following markup is marginally shorter than the previous block.

```
<Label Text="Just some text">
  <Label.BackgroundColor>
    <x:Static Member="Color.Accent" />
  </Label.BackgroundColor>

  <Label.TextColor>
    <x:Static Member="Color.Black" />
  </Label.TextColor>

  <Label.FontAttributes>
    <x:Static Member="FontAttributes.Italic" />
  </Label.FontAttributes>

  <Label.VerticalOptions>
    <x:Static Member="LayoutOptions.Center" />
  </Label.VerticalOptions>

  <Label.XAlign>
    <x:Static Member="TextAlignment.Center" />
  </Label.XAlign>
</Label>
```

And now for a really big syntax leap: This change in syntax causes the property-element tags to disappear and the footprint to shrink considerably. XAML markup extensions almost always appear with the markup extension name and the arguments within a pair of curly braces:

```
<Label Text="Just some text"
  BackgroundColor="{x:Static Member=Color.Accent}"
  TextColor="{x:Static Member=Color.Black}"
  FontAttributes="{x:Static Member=FontAttributes.Italic}"
  VerticalOptions="{x:Static Member=LayoutOptions.Center}"
  XAlign="{x:Static Member=TextAlignment.Center}" />
```

This syntax with the curly braces is so ubiquitously used in connection with XAML markup extensions that many developers consider markup extensions to be synonymous with the curly-brace syntax. And that's nearly true: While curly braces always signal the presence of a XAML markup extension, in many cases a markup extension can appear in XAML without the curly braces as demonstrated earlier, and it's sometimes convenient to use them in that way.

Notice there are no quotation marks within the curly braces. Within those braces, very different syntax rules apply. The `Member` property of the `StaticExtension` class is no longer an XML attribute. In terms of XML, the entire expression delimited by the curly braces is the value of the attribute, and the arguments within the curly braces appear without quotation marks.

Just like elements, markup extensions can have a `ContentProperty` attribute. Markup extensions that have only one property—such as the `StaticExtension` class with its single `Member` property—invariably mark that sole property as the content property. For markup extensions using the curly-brace syntax, this means that the `Member` property name and the equal sign can be removed:

```
<Label Text="Just some text"
      BackgroundColor="{x:Static Color.Accent}"
      TextColor="{x:Static Color.Black}"
      FontAttributes="{x:Static FontAttributes.Italic}"
      VerticalOptions="{x:Static LayoutOptions.Center}"
      XAlign="{x:Static TextAlignment.Center}" />
```

This is the common form of the `x:Static` markup extension.

Obviously the use of `x:Static` for these particular properties is unnecessary, but you can define your own static members for implementing application-wide constants, and you can reference these in your XAML files. This is demonstrated in the **SharedStatics** project.

The **SharedStatics** project contains a class named `AppConstants` that defines some constants and static fields that might be of use for formatting text:

```
namespace SharedStatics
{
    static class AppConstants
    {
        public static Color LightBackground = Color.Yellow;
        public static Color DarkForeground = Color.Blue;

        public static double NormalFontSize = Device.OnPlatform(18, 18, 24);
        public static double TitleFontSize = 1.5 * NormalFontSize;
        public static double ParagraphSpacing = Device.OnPlatform(10, 10, 15);

        public const FontAttributes Emphasis = FontAttributes.Italic;
        public const FontAttributes TitleAttribute = FontAttributes.Bold;

        public const TextAlignment TitleAlignment = TextAlignment.Center;
    }
}
```

The XAML file then uses the `x:Static` markup extension to reference these items. Notice the XML namespace declaration to define a local prefix:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             xmlns:local="clr-namespace:SharedStatics;assembly=SharedStatics"
             x:Class="SharedStatics.SharedStaticsPage"
             BackgroundColor="{x:Static local:AppConstants.LightBackground}">

    <ContentPage.Padding>
        <OnPlatform x:TypeArguments="Thickness"
                    iOS="0, 20, 0, 0" />
    </ContentPage.Padding>
```

```

<StackLayout Padding="10, 0"
              Spacing="{x:Static local:AppConstants.ParagraphSpacing}">

    <Label Text="The SharedStatics Program"
           TextColor="{x:Static local:AppConstants.DarkForeground}"
           FontSize="{x:Static local:AppConstants.TitleFontSize}"
           FontAttributes="{x:Static local:AppConstants.TitleAttribute}"
           XAlign="{x:Static local:AppConstants.TitleAlignment}" />

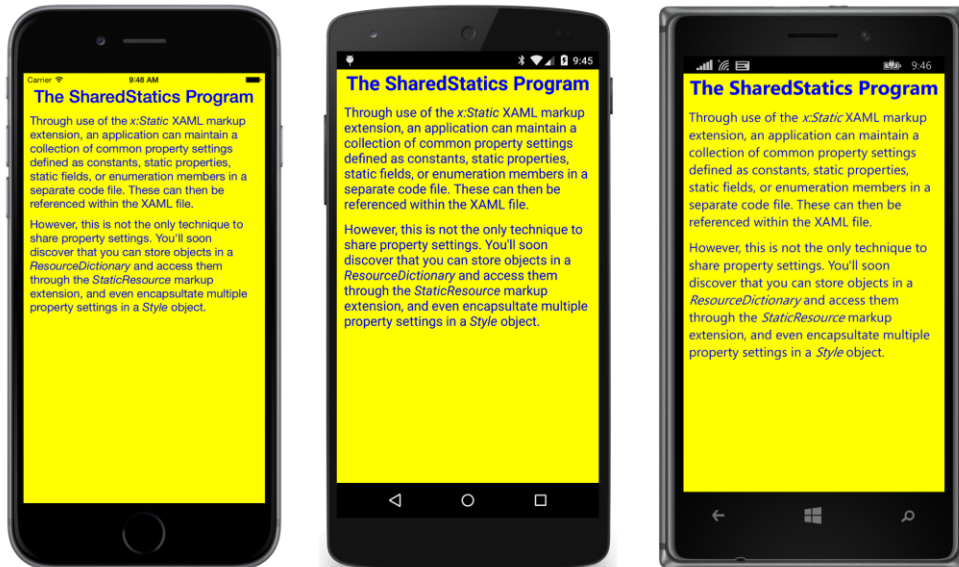
    <Label TextColor="{x:Static local:AppConstants.DarkForeground}"
           FontSize="{x:Static local:AppConstants.NormalFontSize}">
        <Label.FormattedText>
            <FormattedString>
                <Span Text="Through use of the " />
                <Span Text="{x:Static
                           FontSize="{x:Static local:AppConstants.NormalFontSize}"
                           FontAttributes="{x:Static local:AppConstants.Emphasis}" />
                           <Span Text=
" XAML markup extension, an application can maintain a collection of
common property settings defined as constants, static properties or fields,
or enumeration members in a separate code file. These can then be
referenced within the XAML file." />
                </FormattedString>
            </Label.FormattedText>
        </Label>

        <Label TextColor="{x:Static local:AppConstants.DarkForeground}"
               FontSize="{x:Static local:AppConstants.NormalFontSize}">
            <Label.FormattedText>
                <FormattedString>
                    <Span Text=
"However, this is not the only technique to share property settings.
You'll soon discover that you can store objects in a " />
                    <Span Text="ResourceDictionary"
                           FontSize="{x:Static local:AppConstants.NormalFontSize}"
                           FontAttributes="{x:Static local:AppConstants.Emphasis}" />
                    <Span Text=" and access them through the " />
                    <Span Text="StaticResource"
                           FontSize="{x:Static local:AppConstants.NormalFontSize}"
                           FontAttributes="{x:Static local:AppConstants.Emphasis}" />
                    <Span Text=
" markup extension, and even encapsulate multiple property settings in a " />
                    <Span Text="Style"
                           FontSize="{x:Static local:AppConstants.NormalFontSize}"
                           FontAttributes="{x:Static local:AppConstants.Emphasis}" />
                    <Span Text=" object." />
                </FormattedString>
            </Label.FormattedText>
        </Label>
    </StackLayout>
</ContentPage>

```

You might be curious why each of the `Span` objects with an `FontAttributes` setting repeats the `FontSize` setting that is set on the `Label` itself. Currently, `Span` objects do not properly inherit font-related settings from the `Label` when another font-related setting is applied.

And here it is:



This technique allows you to use these common property settings on multiple pages, and if you ever needed to change the values, you need only change the `AppSettings` file.

It is also possible to use `x:Static` with static properties and fields defined in classes in external libraries. The following example named **SystemStatics** is rather contrived—it sets the `BorderWidth` of a `Button` equal to the `PI` static field defined in the `Math` class, and uses the static `Environment.NewLine` property for line breaks in text. But it demonstrates the technique.

The `Math` and `Environment` classes are both defined in the .NET `System` namespace, so a new XML namespace declaration is required to define a prefix named (for example) `sys` for `System`. Notice that this namespace declaration specifies the CLR namespace as `System` but the assembly as `microsoft`, which originally stood for Microsoft Common Object Runtime Library but now stands for Multilanguage Standard Common Object Runtime Library:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             xmlns:sys="clr-namespace:System;assembly=microsoft"
             x:Class="SystemStatics.SystemStaticsPage">
    <StackLayout>
        <Button Text=" Button with &#x00C0; border width "
                BorderWidth="{x:Static sys:Math.PI}"
                HorizontalOptions="Center"
                VerticalOptions="CenterAndExpand">
```

```

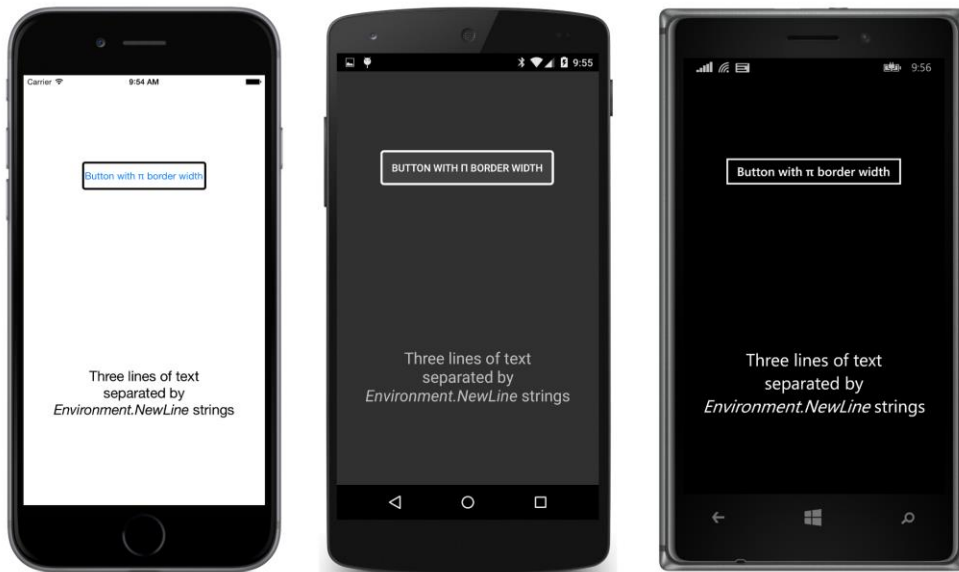
        <Button.BackgroundColor>
            <OnPlatform x:TypeArguments="Color"
                Android="#404040" />
        </Button.BackgroundColor>
        <Button.BorderColor>
            <OnPlatform x:TypeArguments="Color"
                Android="White" />
        </Button.BorderColor>
    </Button>

    <Label VerticalOptions="CenterAndExpand"
        XAlign="Center"
        FontSize="Large">
        <Label.FormattedText>
            <FormattedString>
                <Span Text="Three lines of text" />
                <Span Text="{x:Static sys:Environment.NewLine}" />
                <Span Text="separated by" />
                <Span Text="{x:Static sys:Environment.NewLine}" />
                <Span Text="Environment.NewLine"
                    FontSize="Large"
                    FontAttributes="Italic" />
                <Span Text=" strings" />
            </FormattedString>
        </Label.FormattedText>
    </Label>
</StackLayout>
</ContentPage>

```

The button border doesn't show up in Android unless the background color and border colors of the button are also set to non-default values, so some additional markup takes care of that problem. On iOS platforms, a button border tends to crowd the button text, so the text is defined with spaces at the beginning and end.

Judging solely from the visuals, we really have to take it on trust that the button border width is about 3.14 units wide, but the line breaks definitely work:



The use of curly braces for markup extensions implies that you can't display text surrounded by curly braces. The curly braces in this text will be mistaken for a markup extension:

```
<Label Text="{Text in curly braces}" />
```

That won't work. You can have curly braces elsewhere in the text string, but you can't begin with a left curly brace.

If you really need to, however, you can ensure that text is not mistaken for a XAML markup extension by beginning the text with an escape sequence that consists of a pair of left and right curly braces:

```
<Label Text="{{Text in curly braces}}" />
```

That will display the text you want.

Resource Dictionaries

Xamarin Forms also supports a second approach to sharing objects and values, and while this approach has a little more overhead than the `x:Static` markup extension, it is somewhat more versatile because everything—the shared objects and the visual elements that use them—can be expressed in XAML.

`VisualElement` defines a property named `Resources` that is of type `ResourceDictionary`—a dictionary with string keys and values of type `object`. Items can be added to this dictionary right in XAML, and they can be accessed in XAML with the `StaticResource` and `DynamicResource` markup extensions.

Although `x:Static` and `StaticResource` have somewhat similar names, they are quite different: `x:Static` references a constant, a static field, static property, or an enumeration member while `StaticResource` retrieves an object from a `ResourceDictionary`.

While the `x:Static` markup extension is intrinsic to XAML (and hence appears in XAML with an `x` prefix), the `StaticResource` and `DynamicResource` markup extensions are not. They were part of the original XAML implementation in the Windows Presentation Foundation, and `StaticResource` is also supported in Silverlight, Windows Phone 7 and 8, and Windows 8 and 10.

You'll use `StaticResource` for most purposes and reserve `DynamicResource` for some special applications, so let's begin with `StaticResource`.

StaticResource for Most Purposes

Suppose you've defined three buttons in a `StackLayout`:

```
<StackLayout>
  <Button Text=" Do this! "
    HorizontalOptions="Center"
    VerticalOptions="CenterAndExpand"
    BorderWidth="3"
    TextColor="Red"
    FontSize="Large" />

  <Button Text=" Do that! "
    HorizontalOptions="Center"
    VerticalOptions="CenterAndExpand"
    BorderWidth="3"
    TextColor="Red"
    FontSize="Large" />

  <Button Text=" Do the other thing! "
    HorizontalOptions="Center"
    VerticalOptions="CenterAndExpand"
    BorderWidth="3"
    TextColor="Red"
    FontSize="Large" />
</StackLayout>
```

Of course, this is somewhat unrealistic code. There are no `Clicked` events set for these buttons, and the `BorderWidth` had no effect on Android devices because the button background and border color are their default values. Here's what the buttons look like:



Aside from the text, all three buttons have the same properties set to the same values. Repetitious markup such as this tends to rub programmers the wrong way. It's an affront to the eye and it's difficult to maintain and change.

Eventually you'll see how to use styles to really cut down on the repetitious markup. For now, however, the goal is not to make the markup shorter, but to consolidate the values in one place, so that if you ever wanted to change the `TextColor` property from Red to Blue, you can do so with one edit rather than three.

Obviously you can use `x:Static` for this job by defining the values in code. But let's do the whole thing in XAML by storing the values in a *resource dictionary*. Every class that derives from `VisualElement` has a `Resources` property of type `ResourceDictionary`. Resources that are used throughout a page are customarily stored in the `Resources` collection of the `ContentPage`.

The first step is to express the `Resources` property of `ContentPage` as a property element:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
              xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
              x:Class="ResourceSharing.ResourceSharingPage">

    <ContentPage.Resources>

    </ContentPage.Resources>

    ...

</ContentPage>
```

If you're also defining a `Padding` property on the page using property-element tags, the order doesn't matter.

For performance purposes, the `Resources` property is null by default, so you need to explicitly instantiate the `ResourceDictionary`:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="ResourceSharing.ResourceSharingPage">

    <ContentPage.Resources>
        <ResourceDictionary>

            </ResourceDictionary>
        </ContentPage.Resources>

    ...

</ContentPage>
```

Between the `ResourceDictionary` tags you define one or more objects or values. Each item in the dictionary must be identified with a dictionary key that you specify with the XAML `x:Key` attribute. For example, here's the syntax for including a `LayoutOptions` value in the dictionary with a descriptive key that indicates that this value is defined for setting horizontal options:

```
<LayoutOptions x:Key="horzOptions">Center</LayoutOptions>
```

Because this is a `LayoutOptions` value, the XAML parser accesses the `LayoutOptionsConverter` class (which is private to `Xamarin.Forms`) to convert the content of the tags, which is the text "Center".

A second way to store a `LayoutOptions` value in the dictionary is to let the XAML parser instantiate the structure and set `LayoutOptions` properties from attributes you specify:

```
<LayoutOptions x:Key="vertOptions"
              Alignment="Center"
              Expands="True" />
```

The `BorderWidth` property is of type `double`, so the `x:Double` datatype element defined in the XAML 2009 specification is ideal:

```
<x:Double x:Key="borderWidth">3</x:Double>
```

You can store a `Color` value in the resource dictionary with a text representation of the color as content. The XAML parser uses the normal `ColorTypeConverter` for the text conversion:

```
<Color x:Key="textColor">Red</Color>
```

You can't initialize a `Color` value by setting its `R`, `G`, and `B` properties because those are get-only. But you can invoke a `Color` constructor or one of the `Color` factory methods:

```
<Color x:Key="textColor"
      x:FactoryMethod="FromHsla">
  <x:Arguments>
    <x:Double>0</x:Double>
    <x:Double>1</x:Double>
    <x:Double>0.5</x:Double>
    <x:Double>1</x:Double>
  </x:Arguments>
</Color>
```

A dictionary item for the `FontSize` property is somewhat problematic. The `FontSize` property is of type `double`, so if you're storing an actual numeric value in the dictionary, that's no problem. But you can't store the word "Large" in the dictionary as if it were a `double`. Only when a "Large" string is set to a `FontSize` attribute does the XAML parser use the `FontSizeConverter`. For that reason, you'll need to store it as a string:

```
<x:String x:Key="fontSize">Large</x:String>
```

Here's the complete dictionary at this point:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="ResourceSharing.ResourceSharingPage">

  <ContentPage.Resources>
    <ResourceDictionary>
      <LayoutOptions x:Key="horzOptions">Center</LayoutOptions>

      <LayoutOptions x:Key="vertOptions"
                    Alignment="Center"
                    Expands="True" />

      <x:Double x:Key="borderWidth">3</x:Double>

      <Color x:Key="textColor">Red</Color>

      <x:String x:Key="fontSize">Large</x:String>
    </ResourceDictionary>
  </ContentPage.Resources>
  ...
</ContentPage>
```

This is sometimes referred to as a "resources section" for the page. In real-life programming, almost every XAML file begins with a resources section.

You can reference items in the dictionary using the `StaticResource` markup extension, which is supported by `StaticResourceExtension`, a class private to `Xamarin.Forms`. `StaticResourceExtension` defines a property named `Key` that you set to the dictionary key. You can use a `StaticResourceExtension` as an element within property element tags, or you can use `StaticResourceExtension` or `StaticResource` in curly braces. If you're using the curly-brace syntax, you can leave out the `Key` and equal signs because `Key` is the content property of `StaticResourceExtension`.

The following complete XAML file illustrates three of these options. Do not put an x prefix on the Key property of StaticResource. The x:Key attribute is only for defining dictionary keys for items in the ResourceDictionary:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="ResourceSharing.ResourceSharingPage">

    <ContentPage.Resources>
        <ResourceDictionary>
            <LayoutOptions x:Key="horzOptions">Center</LayoutOptions>

            <LayoutOptions x:Key="vertOptions"
                          Alignment="Center"
                          Expands="True" />

            <x:Double x:Key="borderWidth">3</x:Double>

            <Color x:Key="textColor">Red</Color>

            <x:String x:Key="fontSize">Large</x:String>
        </ResourceDictionary>
    </ContentPage.Resources>

    <StackLayout>
        <Button Text=" Do this! ">
            <Button.HorizontalOptions>
                <StaticResourceExtension Key="horzOptions" />
            </Button.HorizontalOptions>

            <Button.VerticalOptions>
                <StaticResourceExtension Key="vertOptions" />
            </Button.VerticalOptions>

            <Button.BorderWidth>
                <StaticResourceExtension Key="borderWidth" />
            </Button.BorderWidth>

            <Button.TextColor>
                <StaticResourceExtension Key="textColor" />
            </Button.TextColor>

            <Button.FontSize>
                <StaticResourceExtension Key="fontSize" />
            </Button.FontSize>
        </Button>

        <Button Text=" Do that! "
                HorizontalOptions="{StaticResource Key=horzOptions}"
                VerticalOptions="{StaticResource Key=vertOptions}"
                BorderWidth="{StaticResource Key=borderWidth}"
                TextColor="{StaticResource Key=textColor}"
                FontSize="{StaticResource Key=fontSize}" />
    </StackLayout>
</ContentPage>
```

```

        <Button Text=" Do the other thing! "
              HorizontalOptions="{StaticResource horzOptions}"
              VerticalOptions="{StaticResource vertOptions}"
              BorderWidth="{StaticResource borderWidth}"
              TextColor="{StaticResource textColor}"
              FontSize="{StaticResource fontSize}" />
    </StackLayout>
</ContentPage>

```

The simplest syntax in the third button is most common, and indeed, that syntax is so ubiquitous that many longtime XAML developers might be entirely unfamiliar with the other variations.

Objects and values in the dictionary are shared among all the `StaticResource` references. That's not so clear in the preceding example, but it's something to keep in mind. For example, suppose you store a `Button` object in the resource dictionary:

```

<ContentPage.Resources>
  <ResourceDictionary>
    <Button x:Key="button"
          Text="Shared Button?"
          HorizontalOptions="Center"
          VerticalOptions="CenterAndExpand"
          FontSize="Large" />
  </ResourceDictionary>
</ContentPage.Resources>

```

You can certainly use that `Button` object on your page by adding it to the `Children` collection of a `StackLayout` with the `StaticResourceExtension` element syntax:

```

<StackLayout>
  <StaticResourceExtension Key="button" />
</StackLayout>

```

However, you can't use that same dictionary item in hopes of putting another copy in the `StackLayout`:

```

<StackLayout>
  <StaticResourceExtension Key="button" />
  <StaticResourceExtension Key="button" />
</StackLayout>

```

That won't work. Both these elements reference the same `Button` object, and a particular visual element can be in only one particular location on the screen. It can't be in multiple locations.

For this reason, visual elements are not normally stored in a resource dictionary. If you need multiple elements on your page that have mostly the same properties, you'll want to use a `Style`, which is explored in Chapter 12.

A Tree of Dictionaries

The `ResourceDictionary` class imposes the same rules as other dictionaries: All the items in the dictionary must have keys but duplicate keys are not allowed.

However, because every instance of `VisualElement` potentially has its own resource dictionary, your page can contain multiple dictionaries, and you can use the same keys in different dictionaries just as long as all the keys within each dictionary are unique. Conceivably, every visual element in the visual tree can have its own dictionary, but it really only makes sense for a resource dictionary to apply to multiple elements, so resource dictionaries are only commonly found defined on `Layout` or `Page` objects.

You can construct a tree of dictionaries with dictionary keys that effectively override the keys on other dictionaries. This is demonstrated in the **ResourceTrees** project. The XAML file for the `ResourceTreesPage` class shows a `Resources` dictionary for the `ContentPage` that defines resources with keys of `horzOptions`, `vertOptions`, and `textColor`. The `textColor` item incidentally demonstrates how to use `OnPlatform` in a `ResourceDictionary`.

A second `Resources` dictionary is attached to an inner `StackLayout` for resources named `textColor` and `FontSize`:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="ResourceTrees.ResourceTreesPage">

    <ContentPage.Resources>
        <ResourceDictionary>
            <LayoutOptions x:Key="horzOptions">Center</LayoutOptions>

            <LayoutOptions x:Key="vertOptions"
                          Alignment="Center"
                          Expands="True" />

            <OnPlatform x:Key="textColor"
                      x:TypeArguments="Color"
                      iOS="Red"
                      Android="Pink"
                      WinPhone="Aqua" />
        </ResourceDictionary>
    </ContentPage.Resources>

    <StackLayout>
        <Button Text=" Do this! "
                HorizontalOptions="{StaticResource horzOptions}"
                VerticalOptions="{StaticResource vertOptions}"
                BorderWidth="{StaticResource borderWidth}"
                TextColor="{StaticResource textColor}"
                FontSize="{StaticResource fontSize}" />

        <StackLayout>
            <StackLayout.Resources>
                <ResourceDictionary>
                    <Color x:Key="textColor">Default</Color>
                    <x:String x:Key="FontSize">Default</x:String>
                </ResourceDictionary>
            </StackLayout.Resources>
```



```

<Label Text="The first of two labels"
        HorizontalOptions="{StaticResource horzOptions}"
        TextColor="{StaticResource textColor}"
        FontSize="{StaticResource fontSize}" />

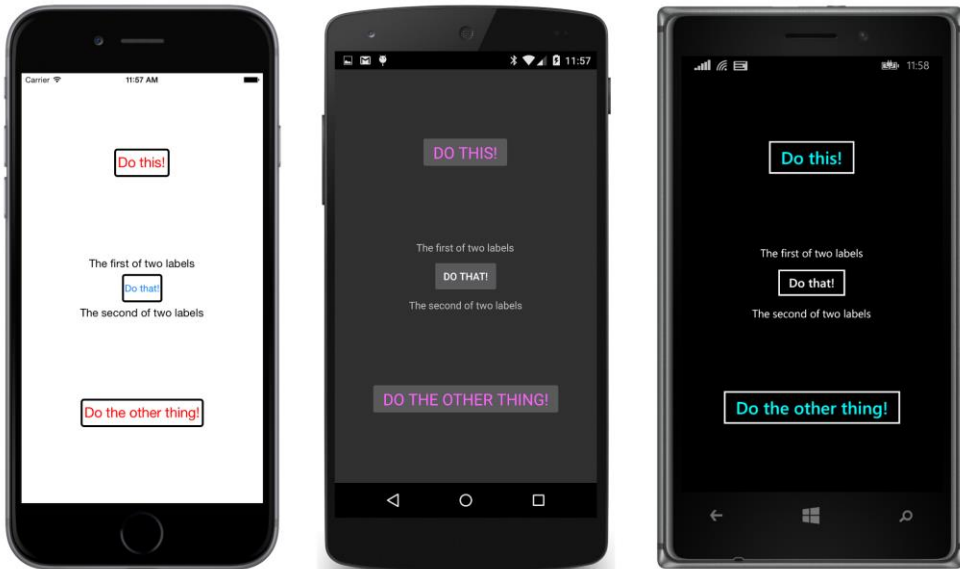
<Button Text=" Do that! "
        HorizontalOptions="{StaticResource horzOptions}"
        BorderWidth="{StaticResource borderWidth}"
        TextColor="{StaticResource textColor}"
        FontSize="{StaticResource fontSize}" />

<Label Text="The second of two labels"
        HorizontalOptions="{StaticResource horzOptions}"
        TextColor="{StaticResource textColor}"
        FontSize="{StaticResource fontSize}" />
</StackLayout>

<Button Text=" Do the other thing! "
        HorizontalOptions="{StaticResource horzOptions}"
        VerticalOptions="{StaticResource vertOptions}"
        BorderWidth="{StaticResource borderWidth}"
        TextColor="{StaticResource textColor}"
        FontSize="{StaticResource fontSize}" />
</StackLayout>
</ContentPage>

```

The Resources dictionary on the inner StackLayout applies only to items within that StackLayout, which are the items in the middle of this screenshot:



Here's how it works:

When the XAML parser encounters a `StaticResource` on an attribute of a visual element, it begins a search for that dictionary key. It first looks in the `ResourceDictionary` for that visual element, and if the key is not found, it looks for the key in the visual element's parent's `ResourceDictionary`, and up and up through the visual tree until it reaches the `ResourceDictionary` on the page.

But something's missing here! Where are the `borderWidth` and `fontSize` dictionary items? They don't seem to be defined in the page's resource dictionary!

Those items are elsewhere. The `Application` class also defines a `Resources` property of type `ResourceDictionary`. This is handy for defining resources that apply to the entire application and not just a particular page or layout. When the XAML parser searches up the visual tree for a matching resource key, and that key is not found in the `ResourceDictionary` for the page, it finally checks the `ResourceDictionary` defined by the `Application` class. Only if it's not found there is a `XamlParseException` raised for the `StaticResource` key-not-found error.

The standard `Xamarin.Forms` solution template generates an `App` class that derives from `Application` and thus inherits the `Resources` property. You can add items to this dictionary in two ways:

One approach is to add the items in code in the `App` constructor. Make sure you do this before instantiating the main `ContentPage` class:

```
public class App : Application
{
    public App()
    {
        Resources = new ResourceDictionary();
        Resources.Add("borderWidth", 3.0);
        Resources.Add("fontSize", "Large");

        MainPage = new ResourceTreesPage();
    }
    ...
}
```

However, the `App` class can also have a XAML file of its own, and the application-wide resources can be defined in the `Resources` collection in that XAML file.

To do this, you'll want to delete the `App.cs` file created by the `Xamarin.Forms` solution template. There's no template item for an `App` class so you'll need to fake it. Add a new XAML page class—**Forms Xaml Page** in Visual Studio or **Forms ContentPage Xaml** in Xamarin Studio—to the project. Name it `App`. And immediately—before you forget—go into the `App.xaml` file and change the root tags to `Application`, and go into the `App.xaml.cs` file and change the base class to `Application`.

Now you have an `App` class that derives from `Application` and has its own XAML file. In the `App.xaml` file you can then instantiate a `ResourceDictionary` within `Application.Resources` property-element tags and add items to it:

```

<Application xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="ResourceTrees.App">
    <Application.Resources>
        <ResourceDictionary>
            <x:Double x:Key="borderWidth">3</x:Double>
            <x:String x:Key="fontSize">Large</x:String>
        </ResourceDictionary>
    </Application.Resources>
</Application>

```

The constructor in the code-behind file needs to call `InitializeComponent` to parse the `App.xaml` file at runtime and add the items to the dictionary. This should be done prior to the normal job of instantiating the `ResourceTreesPage` class and setting it to the `MainPage` property:

```

public partial class App : Application
{
    public App()
    {
        InitializeComponent();

        MainPage = new ResourceTreesPage();
    }

    protected override void OnStart()
    {
        // Handle when your app starts
    }

    protected override void OnSleep()
    {
        // Handle when your app sleeps
    }

    protected override void OnResume()
    {
        // Handle when your app resumes
    }
}

```

Adding the lifecycle events is optional.

Be sure to call `InitializeComponent` before instantiating the page class. The constructor of the page class calls its own `InitializeComponent` to parse the XAML file for the page, and the `StaticResource` markup extensions need access to the `Resources` collection in the `App` class.

Every `Resources` dictionary has a particular scope: A `Resources` dictionary on the `App` class applies to the entire application. A `Resources` dictionary on the `ContentPage` class applies to the whole page. A `Resources` dictionary on a `StackLayout` applies to all the children in the `StackLayout`. You should define and store your resources based on how you use them. Use the `Resources` dictionary in the `App` class for application-wide resources; use the `Resources` dictionary on the `ContentPage` for page-wide resources;

but define additional Resources dictionaries deeper in the visual tree for resources required only in one part of the page.

As you'll see in Chapter 12, the most important items in a Resources dictionary are usually objects of type `Style`. In the general case, you'll have application-wide `Style` objects, `Style` objects for the page, and `Style` objects associated with smaller parts of the visual tree.

DynamicResource for Special Purposes

An alternative to `StaticResource` for referencing items from the Resources dictionary is `DynamicResource`, and if you just substitute `DynamicResource` for `StaticResource` in the example shown above, the program will seemingly run the same.

However, the two markup extensions are very different. `StaticResource` accesses the item in the dictionary only once while the XAML is being parsed and the page is being built. But `DynamicResource` maintains a link between the dictionary key and the property set from that dictionary item. If the item in the resource dictionary referenced by the key changes, `DynamicResource` will detect that change and set the new value to the property.

Skeptical? Let's try it out. The **DynamicVsStatic** project has a XAML file that defines a resource item of type string with a key of `currentDateTime`, even though the item in the dictionary is the string "Not actually a DateTime"!

This dictionary item is referenced four times in the XAML file, but one of the references is commented out. In the first two examples, the `Text` property of a `Label` is set using `StaticResource` and `DynamicResource`. In the second two examples, the `Text` property of a `Span` object is set similarly, but the use of `DynamicResource` on the `Span` object appears in comments:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="DynamicVsStatic.DynamicVsStaticPage"
             Padding="5, 0">

    <ContentPage.Resources>
        <ResourceDictionary>
            <x:String x:Key="currentDateTime">Not actually a DateTime</x:String>
        </ResourceDictionary>
    </ContentPage.Resources>

    <StackLayout>
        <Label Text="StaticResource on Label.Text:"
               VerticalOptions="EndAndExpand"
               FontSize="Large" />

        <Label Text="{StaticResource currentDateTime}"
               VerticalOptions="StartAndExpand"
               XAlign="Center"
               FontSize="Large" />
```

```

<Label Text="DynamicResource on Label.Text:"
       VerticalOptions="EndAndExpand"
       FontSize="Large" />

<Label Text="{DynamicResource currentDateTime}"
       VerticalOptions="StartAndExpand"
       XAlign="Center"
       FontSize="Large" />

<Label Text="StaticResource on Span.Text:"
       VerticalOptions="EndAndExpand"
       FontSize="Large" />

<Label VerticalOptions="StartAndExpand"
       XAlign="Center"
       FontSize="Large">
    <Label.FormattedText>
        <FormattedString>
            <Span Text="{StaticResource currentDateTime}" />
        </FormattedString>
    </Label.FormattedText>
</Label>

<!-- This raises a runtime exception! -->

<!--<Label Text="DynamicResource on Span.Text:"
       VerticalOptions="EndAndExpand"
       FontSize="Large" />

<Label VerticalOptions="StartAndExpand"
       XAlign="Center"
       FontSize="Large">
    <Label.FormattedText>
        <FormattedString>
            <Span Text="{DynamicResource currentDateTime}" />
        </FormattedString>
    </Label.FormattedText>
</Label>-->
</StackLayout>
</ContentPage>

```

You'll probably expect all three of the references to the `currentDateTime` dictionary item to result in the display of the text "Not actually a DateTime". However, the code-behind file starts a timer going. Every second, the timer callback replaces that dictionary item with a new string representing an actual `DateTime` value:

```

public partial class DynamicVsStaticPage : ContentPage
{
    public DynamicVsStaticPage()
    {
        InitializeComponent();

        Device.StartTimer(TimeSpan.FromSeconds(1),
            () =>

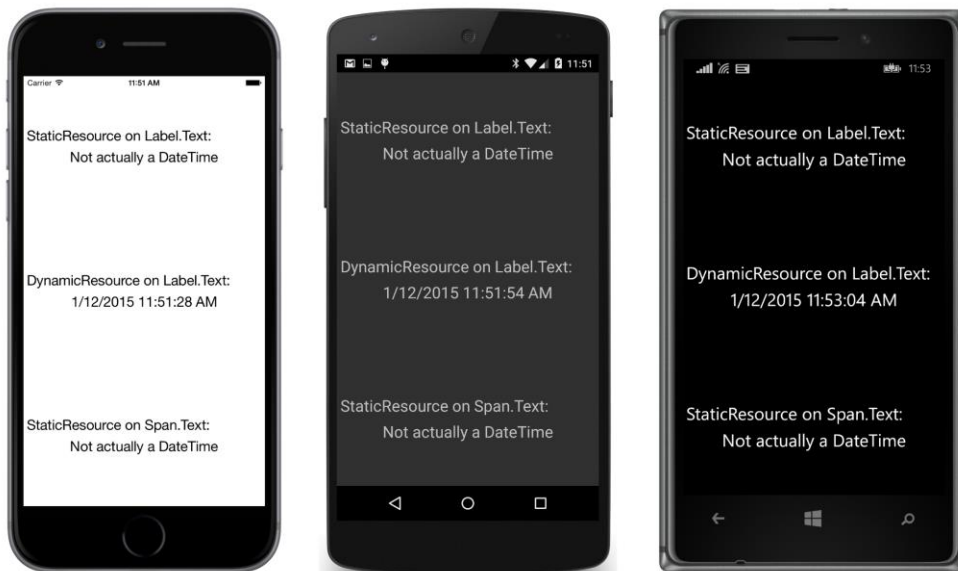
```

```

    {
        Resources["currentDateTime"] = DateTime.Now.ToString();
        return true;
    };
}

```

The result is that the Text properties set with StaticResource stay the same while the one with DynamicResource changes every second to reflect the new item in the dictionary:



Here's another difference: If there is no item in the dictionary with the specified key name, StaticResource will raise a runtime exception, but DynamicResource will not.

You can try uncommenting the block of markup at the end of the **DynamicVsStatic** project and you will indeed encounter a runtime exception to the effect that the Text property could not be found. Just offhand, that exception doesn't sound quite right, but it's referring to a very real difference.

The problem is that the Text properties in Label and Span are defined in two very different ways, and that difference matters a lot for DynamicResource. This difference will be explored in the next chapter, "The Bindable Infrastructure."

Lesser Used Markup Extensions

Three markup extension are not used as much as the others. These are:

- x:Null

- `x:Type`
- `x:Array`

You use the `x:Null` extension to set a property to null. The syntax looks like this:

```
<SomeElement SomeProperty="{x:Null}" />
```

This doesn't make much sense unless `SomeProperty` has a default value that is not null when it's desirable to set the property to null. But as you'll see in Chapter 12, sometimes a property can acquire a non-null value from a style, and `x:Null` is pretty much the only way to override that.

The `x:Type` markup extension is used to set a property of type `Type`, the .NET class describing the type of a class or structure. Here's the syntax:

```
<AnotherElement TypeProperty="{x:Type Color}" />
```

You'll also use `x:Type` in connection with `x:Array`. The `x:Array` markup extension is always used with regular element syntax rather than curly-brace syntax. It has a required argument named `Type` that you set with the `x:Type` markup extensions. This indicates the type of the elements in the array. Here's how an array might be defined in a resource dictionary:

```
<x:Array x:Key="array"
        Type="{x:Type x:String}">
    <x:String>One String</x:String>
    <x:String>Two String</x:String>
    <x:String>Red String</x:String>
    <x:String>Blue String</x:String>
</x:Array>
```

A Custom Markup Extension

Let's create our own markup extension named `HslColorExtension`. This will allow us to set any property of type `Color` by specifying values of hue, saturation, and luminosity, but in a manner much simpler than the use of the `x:FactoryMethod` tag demonstrated in Chapter 8.

Moreover, let's put this class in a separate Portable Class Library so you can use it from multiple applications. Such a library can be found with the other source code for this book. It's in a directory named **Libraries** that is parallel to the separate chapter directories. The name of this PCL (and the namespace of the classes within it) is **Xamarin.FormsBook.Toolkit**.

You can use this library yourself in your own applications by setting a reference to it or by including the project in your application solution. You can then add a new XML namespace declaration in your XAML files like so to specify this library:

```
xmlns:toolkit="clr-namespace:Xamarin.FormsBook.Toolkit;assembly=Xamarin.FormsBook.Toolkit"
```

With this toolkit prefix you can then reference the `HslColorExtension` class in the same way you use other XAML markup extensions:

```
<BoxView Color="{toolkit:HslColor H=0.67, S=1, L=0.5}" />
```

Unlike other XAML markup extensions shown so far, this one has multiple properties, and if you're setting them as arguments with the curly-brace syntax, they must be separated with commas.

Would something like that be useful? Let's first see how to create such a library for classes that you'd like to share among applications:

In Visual Studio, from the **File** menu, select **New** and **Project**. In the **New Project** dialog, select **Visual C#** and **Mobile Apps** at the left, and **Class Library (Xamarin.Forms Portable)** from the list. Find a location for the project and give it a name. For the PCL created for this example, the name is **Xamarin.FormsBook.Toolkit**. Click **OK**. Along with all the overhead for the project, the template creates a code file named `Xamarin.FormsBook.Toolkit.cs` containing a class named `Xamarin.FormsBook.Toolkit`. That's not a valid class name so just delete that file.

In Xamarin Studio, from the **File** menu, select **New** and **Solution**. In the **New Solution** dialog, select **C#** and **Mobile Apps** at the left, and **Class Library (Xamarin.Forms Portable)** from the list. Find a location for it and give it a name (**Xamarin.FormsBook.Toolkit** for this example). Click **OK**. The solution template creates several files include a file named `MyPage.cs`. Delete that file.

You can now add classes to this project in the normal way:

In Visual Studio, right-click the project name, select **Add** and **New Item**. In the **Add New Item** dialog box, if you're just creating a code-only class, select **Visual C#** and **Code** at the left, and select **Class** from the list. Give it a name (`HslColorExtension.cs` for this example). Click the **Add** button.

In Xamarin Studio, in the tool menu for the project, select **Add** and **New File**. In the **New File** dialog, if you're just creating a code-only class, select **General** at the left and **Empty Class** in the list. Give it a name (`HslColorExtension.cs` for this example). Click the **New** button.

The `HslColorExtension.cs` file (including the required using directives) looks like this:

```
using System;
using Xamarin.Forms;
using Xamarin.Forms.Xaml;

namespace Xamarin.FormsBook.Toolkit
{
    public class HslColorExtension : IMarkupExtension
    {
        public HslColorExtension()
        {
            A = 1;
        }

        public double H { set; get; }
    }
}
```



```

    public double S { set; get; }

    public double L { set; get; }

    public double A { set; get; }

    public object ProvideValue(IServiceProvider serviceProvider)
    {
        return Color.FromHsla(H, S, L, A);
    }
}

```

Notice that the class is public so it's visible from outside the library, and that it implements the `IMarkupExtension` interface, which means that it must include a `ProvideValue` method. However, the method doesn't make use of the `IServiceProvide` argument at all, mainly because it doesn't need to know about anything else external to itself. All it needs are the four properties to create a `Color` value, and if the `A` value isn't set, a default value of 1 (fully opaque) is used.

This is a solution with only a PCL project. The project can be built to generate a PCL assembly but it cannot be run without an application that uses this assembly.

There are two ways to access this library from an application solution:

- In the common PCL project in the application solution, add a reference to the PCL assembly.
- Include a link to the library project in your application solution, and add a reference to that library project in the common PCL project.

The first option is necessary if you only have the PCL, and not the project with source code. Perhaps you're licensing the library and don't have access to the source. But if you have access to the project, it's usually best to include a link to the library project in your solution so you can easily make changes to the library code and rebuild the library project.

The final project in this chapter is **CustomExtensionDemo** that makes use of the `HslColorExtension` class in the new library. The **CustomExtensionDemo** solution contains a link to the **Xamarin.FormsBook.Toolkit** PCL project, and the **References** section in the **CustomExtensionDemo** project lists the **Xamarin.FormsBook.Toolkit** assembly.

Now the application project is seemingly ready to access the library project to use the `HslColorExtension` class within the application's XAML file.

But first, there's another step. Currently, a reference to the library from XAML is insufficient to ensure that the library is included with the application. The library needs to be accessed from actual code. You can add a simple statement in the App file to reference the `HslColorExtension` class:

```

namespace CustomExtensionDemo
{
    public class App : Application
    {

```

```

public App()
{
    new Xamarin.FormsBook.Toolkit.HslColorExtension();

    MainPage = new CustomExtensionDemoPage();
}
...
}
}

```

The following XAML file shows the XML namespace declaration for the **Xamarin.FormsBook.Toolkit** library and three ways to access the custom XAML markup extension—using an `HslColorExtension` element set with property-element syntax on the `Color` property, and using both `HslColorExtension` and `HslColor` with the more common curly-brace syntax. Again, notice the use of commas to separate the arguments within the curly braces:

```

<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             xmlns:toolkit="clr-namespace:Xamarin.FormsBook.Toolkit;assembly=Xamarin.FormsBook.Toolkit"
             x:Class="CustomExtensionDemo.CustomExtensionDemoPage">

    <StackLayout>
        <!-- Red -->
        <BoxView HorizontalOptions="Center"
                 VerticalOptions="CenterAndExpand">
            <BoxView.Color>
                <toolkit:HslColorExtension H="0" S="1" L="0.5" />
            </BoxView.Color>
        </BoxView>

        <!-- Green -->
        <BoxView HorizontalOptions="Center"
                 VerticalOptions="CenterAndExpand">
            <BoxView.Color>
                <toolkit:HslColorExtension H="0.33" S="1" L="0.5" />
            </BoxView.Color>
        </BoxView>

        <!-- Blue -->
        <BoxView Color="{toolkit:HslColor H=0.67, S=1, L=0.5}"
                 HorizontalOptions="Center"
                 VerticalOptions="CenterAndExpand" />

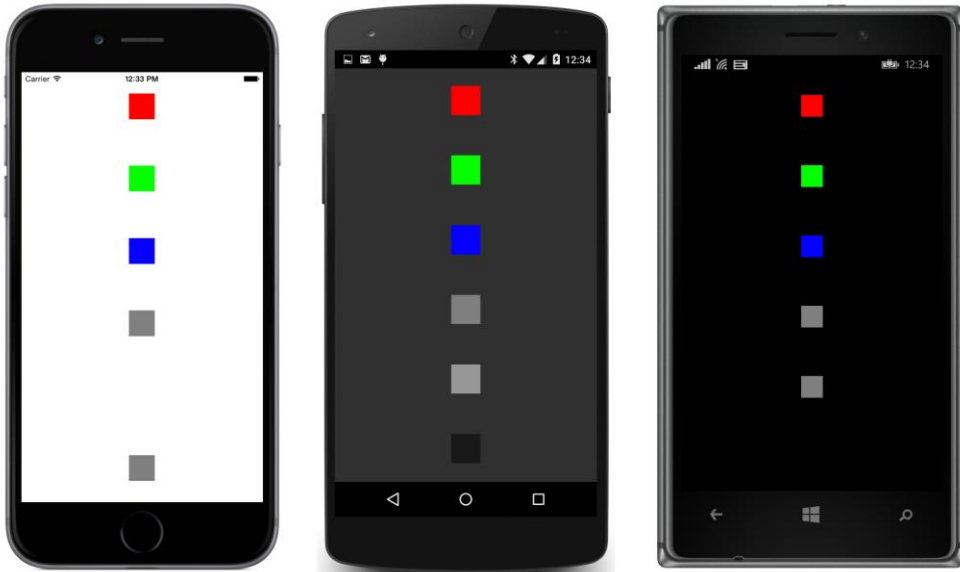
        <!-- Gray -->
        <BoxView Color="{toolkit:HslColor H=0, S=0, L=0.5}"
                 HorizontalOptions="Center"
                 VerticalOptions="CenterAndExpand" />

        <!-- Semi-transparent white -->
        <BoxView Color="{toolkit:HslColor H=0, S=0, L=1, A=0.5}"
                 HorizontalOptions="Center"
                 VerticalOptions="CenterAndExpand" />
    </StackLayout>
</ContentPage>

```

```
<!-- Semi-transparent black -->
<BoxView Color="{toolkit:HslColor H=0, S=0, L=0, A=0.5}"
          HorizontalOptions="Center"
          VerticalOptions="CenterAndExpand" />
</StackLayout>
</ContentPage>
```

The last two examples set the A property for 50% transparency, so the boxes show up as a shade of gray (or not at all) depending on the background:



Two major uses of XAML markup extensions are yet to come: In Chapter 12, you'll see the *Style* class, which is without a doubt the most popular item for including in resource dictionaries, and in Chapter 16 you'll see the powerful markup extension named *Binding*.