Pro ASP.NET 3.5 Server Controls and AJAX Components

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To my beautiful wife, Ally, and daughters Amanda and Anna,
who bring so much happiness to my life
—Rob Cameron

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ROB CAMERON is employed with Microsoft Corporation in Atlanta, GA. He has been with Microsoft since 2001 assisting communications sector and media and entertainment companies build solutions on the Microsoft platform. Prior to employment at Microsoft, he worked as an independent consultant developing software on the Microsoft platform for over five years. He has a master's degree in information technology management and a bachelor's degree in computer science. A former naval officer and United States Naval Academy graduate, he enjoys spending his free time with his wife and two daughters.

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Rob Cameron

Introduction

With the explosion of the Internet, web development tools evolved as a combination of HTML and a scripting language, such as ASP or Perl, to generate dynamic output. With the advent of Microsoft's .NET Framework, ASP.NET turned web development on its head by combining a design-time interface similar to Visual Basic with an HTML and JavaScript output that requires nothing more than a web browser for rending. With ASP.NET 3.5, HTML and JavaScript are combined in powerful ways via ASP.NET AJAX technology that helps connect client-side and server-side connection without losing point-and-click design-time support. We wrote this book to document the major improvements since ASP.NET 1.1, while also covering the fundamentals for those new to custom server control development.

At the core of ASP.NET is server control technology. From the `Page` class to the `Label` control to web parts, all objects in ASP.NET are server controls. Server controls combine server-side execution in a well defined life cycle with browser-friendly rendering that includes down-level browsers as well as a plethora of mobile clients. Regardless of the target output, all server controls behave in a similar manner. Understanding this technology and how to leverage it in your own development efforts are the subjects of this book.

Who This Book Is For

The target audience for this book consists of developers with an intermediate to advanced experience level looking to deepen their understanding of ASP.NET and its underlying server control architecture. The example code in this book is written in C#. However, if you are a VB. NET developer, the examples translate pretty easily, as ASP.NET development is language agnostic. The .NET Framework and the ASP.NET object model are what's important, not the language.

If you are a developer in need of learning a particular technique, each major facet of control development is presented with simple example code to highlight that particular topic. For example, if you are looking for information on how to add events to your server controls, or how to understand how events work in ASP.NET, you can drill into that chapter to get the details.

If you are a developer looking for full-featured example code, you'll find that here too. One example shows how to implement data binding and templates that can connect to a database backend. The rich example in the last part of the book pulls techniques described throughout this book into a holistic demonstration of how to build a rich, complex server control that is fully localized and includes licensing support.

How This Book Is Structured

This book is about server control technology as the underlying foundation of ASP.NET. It will provide you with a deep understanding of how server control technology works, as well as

explaining how to build your own custom server controls as part of a web development project or for resale in the component marketplace.

The first section of the book provides an introduction to server control technology. We also discuss the different ways to build a server control including inheritance from a base control (such as `Control` or `WebControl`) encapsulation, or composite controls, as well as inheritance from an existing or rich control, like the `TextBox` server control.

The second section of the book dives into deep a discussion on critical topics such as state management, server-side event handling, templates, data binding, and integrating client-side script, as well as considering advanced base classes such as `CompositeControl` and `DataBoundControl`. A common theme for all of these discussions is how the topic relates to the control life cycle. Understanding the control life cycle is critical to server control development as well as to ASP.NET development in general. Of course, there are copious amounts of code to support our discussions as well.

The third section of the book covers advanced development techniques such as building ASP.NET AJAX controls and extenders. We also cover web part development for ASP.NET or SharePoint. We round out the section with a discussion of control adapters for modifying an existing server control's HTML output and device adapters for mobile control development.

The last section of the book covers design-time support in detail. Many of the controls built in earlier chapters include design-time support; however, we centralize discussion of the design-time support capabilities in ASP.NET and server controls to facilitate understanding without cluttering up the earlier chapters. We finish up this last section of the book by walking through how to create a professional-quality server control with a discussion on licensing, globalization, and localization.

Prerequisites

The following applications would be helpful in working through the examples in this book, but access to them isn't required:

- Visual Studio 2008, Express edition
- SQL Server 2005 Express (for a couple of the database samples)
- Internet Information Services (for the mobile web project)

Downloading the Code

The source code for this book is available to readers at `www.apress.com` in the Source Code section of this book's home page. Please feel free to visit the Apress web site and download all the code there. You can also check for errata and find related titles from Apress.

Contacting the Authors

You can contact Rob Cameron via `http://blogs.msdn.com/robcamer`; there is a contact link to send Rob an e-mail there.

CHAPTER 1

Server Control Basics

To create server controls, you need to understand how they work. This chapter provides a very high-level run-through of the various server control namespaces to set the scene for the rest of this book. To begin our journey, we'll start by reviewing what a server control provides to clients and taking a look at some of the prebuilt controls supplied by ASP.NET. We'll study the controls' inheritance bloodlines for the HTML and web controls, examining how the namespaces are organized, so that you become familiar with what is available for immediate use in ASP.NET. Because inheritance and composition of existing server controls are important timesaving control-building techniques available in ASP.NET, this rapid journey through the object model is well worth the effort.

To begin this chapter, we start out with a "Hello, World" form to demonstrate master pages. The `MasterPage` class can trace its inheritance back to the user control functionality introduced in ASP.NET 1.0. We next discuss the basic server control construction, as well as how server controls are organized in an ASP.NET web form. Finally, we cover the root server control namespaces with an example of the types of server controls found in the different namespaces.

Source Code

The source code for this book is available for download from the Apress web site for those who want to follow along by running the code in Visual Studio 2008. The web site project is file based, so having IIS installed and configured isn't required. There is a main solution file titled `ControlsBook2Solution.sln` that, when opened, will load all of the projects. Please refer to the read-me file included with the source code download for detailed instructions on how to get the code running. The full source code is also printed in this book, so those who want to read while not in front of a computer can still enjoy reading the source code.

The Heart and Soul of ASP.NET

Each piece of HTML delivered by an ASP.NET page, whether a `<span>` tag without server-side interactivity, a complex list control such as the `DataGrid` that supports templates, or the web form itself that hosts the HTML tags, is generated by an object that inherits from the `System.Web.UI.Control` base class. These objects, or server controls, are the engine that drives the ASP.NET page-rendering process. The fact that every snippet of rendered HTML exists as a server control allows for a consistent page parsing process that permits easy control configuration and manipulation to create dynamic and powerful content. The clean, consistent object

model provided by ASP.NET also facilitates extension through custom server controls that share a common object model.

A .NET Framework "Hello, World" Web Form

The first stop on our journey through the ASP.NET server controls is construction of a "Hello, World" web form. Before actually creating the "Hello, World" web form, we need to create a master page to provide a consistent UI for the book web site. A master page, one of the many new features in ASP.NET 2.0 and later versions, has a `@Master` directive at the top of the code instead of the `@Page` directive on a standard web form.

■ **Note** ASP.NET 3.5 includes additional master page item templates to support AJAX functionality and nested master pages called AJAX Master Page and Nested Master Page respectively.

The `@Master` directive takes most of the same options as the `@Control` directive. If you have not migrated to ASP.NET 2.0 or later, master pages are a welcome addition in ASP.NET and should often be used for page layout and template purposes in situations where ASP.NET user controls were in ASP.NET 1.1 but came up short. Figure 1-1 shows the master page used in this book's sample web site.

Figure 1-1. *The Controls Book 2 web site's master page*

Web forms added to the project can be configured to use the master page rendering at design time, like Figure 1-2.

Notice in Figure 1-2 that the master page area is grayed out (and cannot be edited) at design time in a web content form. The design-time view displays the master page HTML and the web content form HTML, providing a more accurate view of the rendered web form. Listings 1-1 and 1-2 show the master page source page and code-behind file.

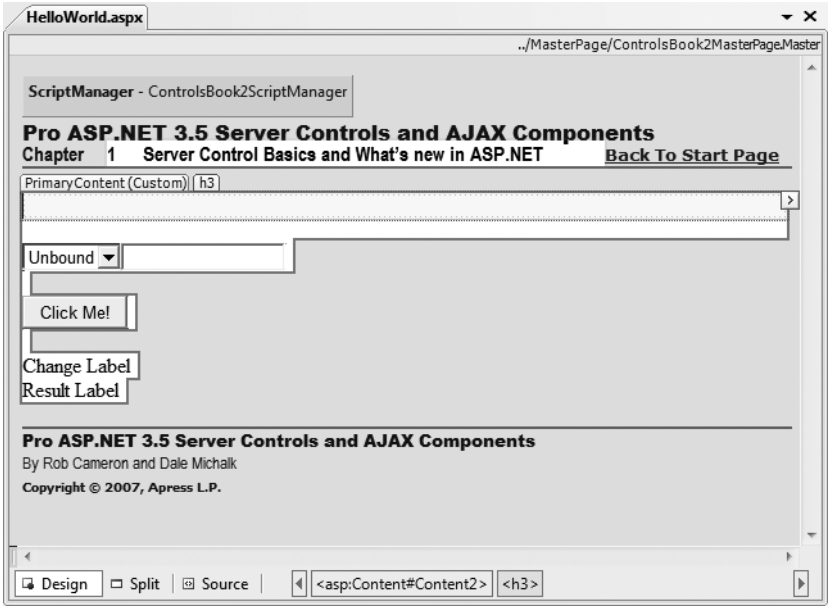


Figure 1-2. *The Controls Book 2 web site's master page displayed in a web content form*

Listing 1-1. *The ControlsBook2 Master Page File*

```
<%@ Master Language="C#" AutoEventWireup="true"
CodeBehind="ControlsBook2MasterPage.master.cs"
  Inherits="ControlsBook2Web.MasterPage.ControlsBook2MasterPage" %>

<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head runat="server">
  <title>Master Page</title>
  <link href="../css/ControlsBook2Master.css" rel="stylesheet" type="text/css" />
  <link href="../css/SkinnedControl.css" rel="stylesheet" type="text/css" />
  <asp:ContentPlaceHolder ID="HeadSection" runat="server">
  </asp:ContentPlaceHolder>
</head>
<body>
  <form id="form1" runat="server">
  <div id="HeaderPanel">
    <asp:ScriptManager ID="ControlsBook2ScriptManager" runat="server">
      <Scripts>
        <asp:ScriptReference Path="../ch09/hoverbutton.js" />
      </Scripts>
    </asp:ScriptManager>
    <asp:Label ID="Label2" CssClass="TitleHeader" runat="server" Height="18px"
Width="604px">Pro ASP.NET 3.5 Server Controls and AJAX Components</asp:Label>
<br />
```

```
    <div id="ChapterInfo" class="Chapter">
      <asp:Label ID="label1" runat="server">Chapter</asp:Label>  
      <asp:ContentPlaceHolder ID="ChapterNumAndTitle" runat="server">
      </asp:ContentPlaceHolder>
      <asp:HyperLink ID="DefaultPage" runat="server" NavigateUrl="~/Default.aspx">
                                Back To Start Page</asp:HyperLink><br />
      <asp:Image ID="Image1" runat="server" ImageUrl="~/img/blueline.jpg" /><br />
    </div>
    <asp:ContentPlaceHolder ID="PrimaryContent" runat="server">
    </asp:ContentPlaceHolder>
    <div id="FooterPanel">
      <asp:Image ID="Image2" runat="server" ImageUrl="~/img/blueline.jpg" /><br />
      <asp:Label CssClass="TitleFooter" ID="Label5" runat="server">
          Pro ASP.NET 3.5 Server Controls and AJAX Components</asp:Label><br />
      <asp:Label CssClass="Author" ID="Label6" runat="server">
           By Rob Cameron and Dale Michalk</asp:Label><br />
      <asp:Label CssClass="Copyright" ID="Label7" runat="server">
            Copyright © 2007, Apress L.P.</asp:Label> 
    </div>
  </div>
  </form>
</body>
</html>
```

Listing 1-2. *The ControlsBook2MasterPage Master Page Code-Behind Class File*

```
using System;

namespace ControlsBook2Web.MasterPage
{
    public partial class ControlsBook2MasterPage : System.Web.UI.MasterPage
    {
        protected void Page_Load(object sender, EventArgs e)
        {

        }
    }
}
```

In the master page for the Controls Book 2 web site, the chapter number and chapter title have `ContentPlaceHolder` placeholder tags to allow content pages to update the chapter number and title.

Each web form sets values for the chapter title and number by simply placing the value in the corresponding `Content` tag in the content page. This is a simple example of providing a consistent user interface in a web site, but still allowing customization.

■ **Tip** ASP.NET User Controls are still present in ASP.NET 3.5. In fact the `MasterPage` class inherits from the `UserControl` class.

The resulting arrangement is shown in Figure 1-3 with a `DropDownList` control, a `TextBox` control, two `Label` controls, and a `Button` control. The resulting source code generated by Visual Studio 2008 is shown in Listings 1-3 and 1-4.

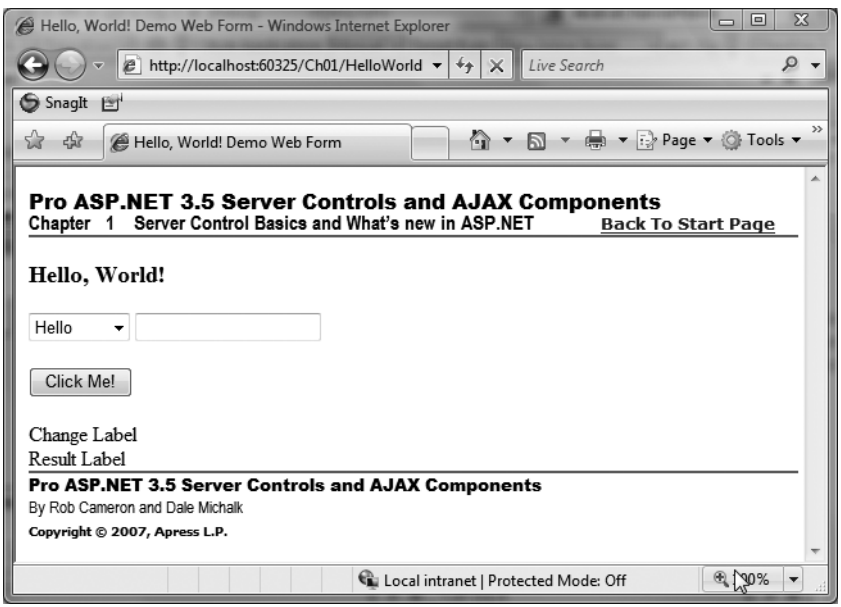


Figure 1-3. *The HelloWorld server control web form*

Listing 1-3. *The HelloWorld Demo Web Form .aspx File*

```
<%@ Page Language="C#"
MasterPageFile="~/MasterPage/ControlsBook2MasterPage.Master"
  AutoEventWireup="true" CodeBehind="HelloWorld.aspx.cs"
Inherits="ControlsBook2Web.Ch01.HelloWorld"
  Title="Hello, World! Demo Web Form" %>

<asp:Content ID="Content1" ContentPlaceHolderID="ChapterNumAndTitle" runat="server">
  <asp:Label ID="ChapterNumberLabel" runat="server"
Width="14px">1</asp:Label>  <asp:Label
    ID="ChapterTitleLabel" runat="server" Width="360px">
Server Control Basics and What's new in ASP.NET</asp:Label>
</asp:Content>
<asp:Content ID="Content2" ContentPlaceHolderID="PrimaryContent" runat="server">
  <h3><asp:Label ID="Label1" runat="server" Text=
```

```
"Hello, World!"></asp:Label></h3>
  <asp:DropDownList ID="Greeting" runat="server" ToolTip="Select a greeting">
  </asp:DropDownList>
  <asp:TextBox ID="Name" runat="server" Font-Italic="True" ToolTip="Enter your name"
    OnTextChanged="Name_TextChanged"></asp:TextBox><br />
  <br />
  <asp:Button ID="ClickMe" runat="server" Text="Click Me!"
OnClick="ClickMe_Click"></asp:Button><br />
  <br />
  <asp:Label ID="ChangeLabel" runat="server">Change Label</asp:Label><br />
  <asp:Label ID="Resultlabel" runat="server">Result Label</asp:Label>
  <br />
</asp:Content>
```

Listing 1-4. *The HelloWorld Server Control Demo Code-Behind Class File*

```
using System;
using System.Collections;

namespace ControlsBook2Web.Ch01
{
  public partial class HelloWorld : System.Web.UI.Page
  {
    protected void Page_Load(object sender, EventArgs e)
    {
      ArrayList list = new ArrayList();
      list.Add("Hello");
      list.Add("Goodbye");

      Greeting.DataSource = list;
      Greeting.DataBind();
    }

    protected void ClickMe_Click(object sender, EventArgs e)
    {
      Resultlabel.Text = "Your new message: " + Greeting.SelectedItem.Value +
     " " + Name.Text + "!";
    }

    protected void Name_TextChanged(object sender, EventArgs e)
    {
      ChangeLabel.Text = "Textbox changed to " + Name.Text;
    }
  }
}
```

The server controls on our "Hello, World" web form (specifically, the `Label`, `TextBox`, and `DropDownList` objects) render as HTML and, for the `TextBox` control, remember what is typed in the control between postback cycles. The HTML rendered to the browser is backed by powerful objects that can be wired up to programming logic to perform useful work on the web server. During server-side processing, the object-oriented nature of server controls provides us with three main constructs to interact with controls as objects: properties, methods, and events. We discuss these constructs in the sections that follow.

Control Properties

The most common means of working with a server control is through the properties it exposes. Properties allow the control to take information from the web form to configure its output or modify its behavior in the HTML-generation process.

■ **Note** Properties are different and more powerful than public data members. Properties provide an additional layer of abstraction through the use of `get` and `set` methods; `get` and `set` methods or function calls provide a convenient location for programming logic, such as displaying an error if a value is out of range or otherwise invalid, enforcing read-only access (implementing a `get` method only), and so on. Properties can be declared as public, protected, or private.

Properties are easily viewable in the Properties window available when you select a control in the Visual Studio Design view of the `.aspx` page. Figure 1-4 shows the Properties window when the `Name` `TextBox` is selected. Notice that the `Font` property has been configured to show the `TextBox`'s `Text` property text in italics.

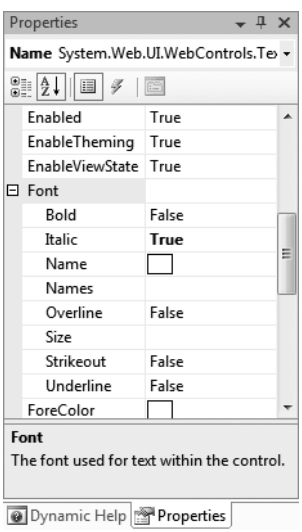


Figure 1-4. *The Properties window for the TextBox control*

The Visual Studio Designer translates the entries in the Properties window into attribute values on the HTML view of the .aspx page. To see this, set a property for a control in the Properties tool window and then switch to HTML view. Likewise, if you modify attribute values in the HTML view of the .aspx page, these changes will be reflected in the Designer, assuming you typed in the values correctly. This behavior can be very handy for quickly duplicating attributes between controls. Simply copy the HTML version of the attributes and then paste the HTML into the target control that you want to match the original. You can think of the Designer as a code generator that allows you to declaratively work with the look and feel of the ASP.NET application without having to write the code. As an example, the Font settings set in the Properties window for the TextBox control described previously map directly to Font attributes:

```
<asp:TextBox id="Name" runat="server" Font-Italic="True"
             ToolTip="Enter your name" OnTextChanged="Name_TextChanged">
</asp:TextBox>
```

The Label and TextBox controls work a little differently than most, in that the content between the opening and closing tags is controlled by the Text property:

```
<asp:Label id="Resultlabel" runat="server">Result Label</asp:Label>
```

You can also set a control's properties programmatically in the code-behind class file. The "Hello, World" demonstration sets the Text property for Label1 to a blank string each time the web form is loaded, to overwrite the Label value that is declaratively set in the .aspx page. The activity happens in a method named Page_Load that is mapped to the Page object's Load event:

```
protected void Page_Load(object sender, EventArgs e)
{
  Resultlabel.Text = "";
  ChangeLabel.Text = "";

  if (!Page.IsPostBack)
  {
    UpdateMaster();
    LoadDropDownList();
  }
  DataBind();
}
```

You can also use the properties exposed by the control to read input from the client browser during postback on the server side. The Button click event handling routine in the "Hello, World" web form reads the Text property of the TextBox control and the Value property of the SelectedItem property on the DropDownList control to display the greeting to the client of the web browser:

```
 protected void ClickMe_Click(object sender, EventArgs e)
{
  Resultlabel.Text =
    "Your new message: " + Greeting.SelectedItem.Value + " " + Name.Text + "!";
}
```

Control Methods

The second feature exposed by a server control is a collection of object methods. Functionality implemented using methods typically goes beyond the features of a property's `set` or `get` method; they usually perform a more complex action against the control. One of the best examples in ASP.NET of using methods for a server control is the data-binding process that links a control with a data source.

In the "Hello, World" web form example, the `Page_Load` event checks to see if the page is requested via a form postback or if it was called for the first time using HTTP `GET` so that the page can generate the initial HTML for the browser, creating the option list. In the postback scenario, the code to create the option list is not necessary for the `DropDownList` control via the `LoadDropDownList()` method, because the server control `DropDownList1` maintains its internal option list via the web form `ViewState` mechanism for subsequent postback operations to the server. We cover `ViewState` extensively in Chapter 3.

The page's `LoadDropDownList()` method's first task is to create an `ArrayList` collection and load it with the string values "Hello" and "Goodbye". It also links the `ArrayList` to the `DropDownList` by setting the `DataSource` property to the `ArrayList`:

```
private void LoadDropDownList()
{
  ArrayList list = new ArrayList();
  list.Add("Hello");
  list.Add("Goodbye");

  Greeting.DataSource = list;
}
```

Note that we do not call the `DataBind()` method directly for `DropDownList`. Instead, we call the `DataBind()` method on the `Page_Load` handler itself. The `DataBind()` method of the `Page` class recursively calls the `DataBind()` methods for all its child controls that have references to a data source. In this case, when the `Page` class's `DataBind()` method is invoked, the `DropDownList` control data binds to the `ArrayList` object as shown previously.

Control Events

Events are the final constructs used for interacting with controls that we discuss in this chapter. Events provide a mechanism to notify clients of state changes inside the control. In ASP.NET, events always coincide with an HTTP `POST` submission back to the web server. Through the automatic postback mechanism, events in ASP.NET appear to behave very much like their counterparts in a Windows Forms application.

■ **Note** Events provide an object-oriented mechanism for a control to communicate with other controls that care to know about state changes within that control. If events did not exist, objects would have to resort to polling to know about state changes in other objects. The asynchronous nature of events provides an elegant means for communicating between objects. Event handler methods are generally protected to the control class (the event subscriber), as it would not make sense to call event handlers outside the consuming class.

The Page class in the "Hello, World" example consumes the Click event raised by the Button to read values and sets the first Label control. The Button Click event is easy to map in the Designer by simply double-clicking the button. Double-clicking a control in Visual Studio automatically generates the default event handler for the control. In the case of the Button, it is the Click event. In addition, Visual Studio performs other housekeeping tasks, such as wiring up the event delegate exposed by the Button control to the generated method (in this case, Button1_Click) in the Page class.

■ **Note** In the .NET Framework 2.0 and later, the concept of a partial class exists where a class can be split across multiple files. This allows Visual Studio or similar non-Microsoft tools to provide better design-time support.

Events in ASP.NET take advantage of delegates as the infrastructure for this communication among objects. In Chapter 5, we discuss how to work with events in detail.

The Properties window in the Design view of the Visual Studio Designer can help map the events from a control that don't result from double-clicking the control.

■ **Note** Click the yellow lightning bolt icon at the top of the Properties window to filter the view to show only events exposed by a particular control.

Each available event for a control is listed on a separate line, and creating a wired up event handler is as simple as either double-clicking the blank area next to the event name to generate an event with the default naming scheme (ControlName_EventName) or typing a name and pressing the Enter key. Figure 1-5 illustrates creating the event handler for the TextBox control.

The end result of using the Properties window to add the protected event handler to the Page class is a method named TextBox_TextChanged that is wired to the TextChanged event of the TextBox control. You can add code to this handling routine to announce the state change of the TextBox control by setting the Text property of the Label2 control on the web form:

```
protected void Name_TextChanged(object sender, EventArgs e)
{
  ChangeLabel.Text = "Textbox changed to " + Name.Text;
}
```

Visual Studio 2008 provides much cleaner code generation when compared to Visual Studio .NET 2003. There is no longer a code region named "Web Form Designer generated code" present in the code file. Much of the boilerplate code that existed in ASP.NET 1.1 is no longer present, which makes developers' lives a bit simpler.

The result of all the not-so-hard work to this point is the browser view in Figure 1-6, which shows what happens when Rob enters his name and selects a polite greeting.

Figure 1-5. *Adding an event handler to the TextChanged event of the TextBox control*

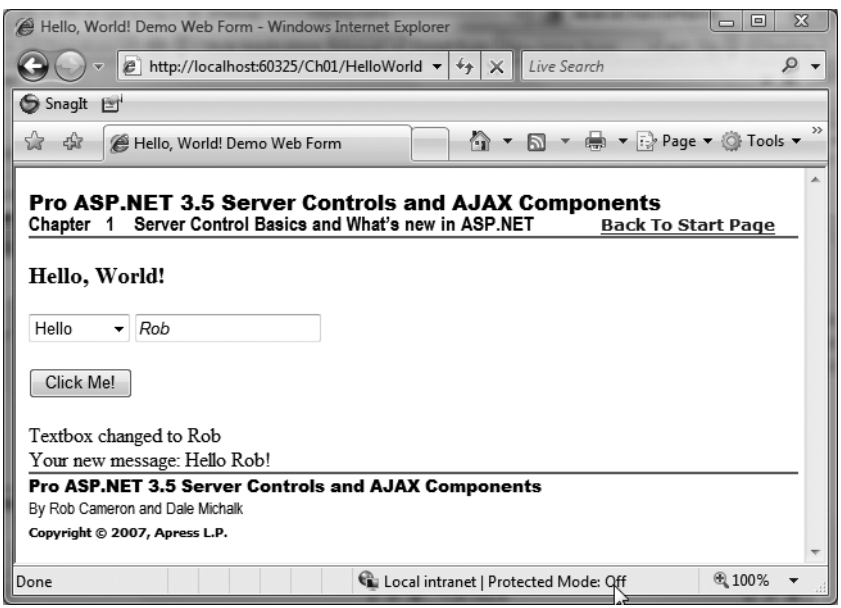


Figure 1-6. *The completed "Hello, World" demonstration web form*

The Web Page As a Control Tree

ASP.NET provides full programmatic access to the tags on an HTML page in an object-oriented way. The architecture in ASP.NET that provides this capability is the `.aspx` page control tree. In this section, we discuss the control tree as it relates to the "Hello, World" example.

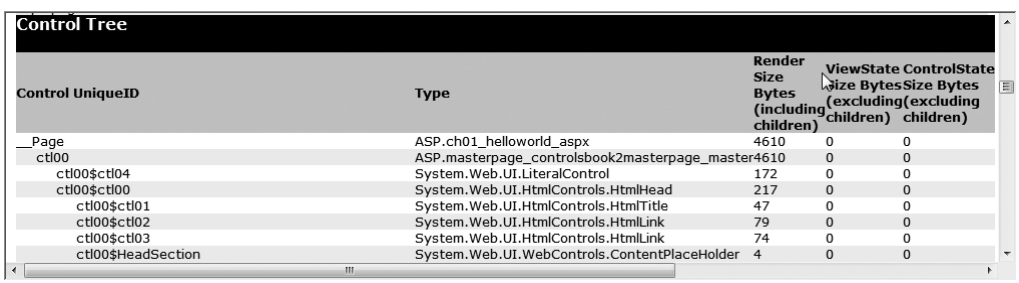
At first glance, the "Hello, World" web form would seem to contain only a few visible server controls that were explicitly placed on the form. The reality is that the entire display surface of the `.aspx` page becomes a cornucopia of controls during processing. Any HTML content in the web form that is not part of the server controls laid out in the Visual Studio Designer is packaged into a server control that renders the HTML. The control structure of the web form can be seen by turning on the trace features of ASP.NET through setting the `Trace=True` attribute on the `Page` directive:

```
<%@ Page Language="C#" Trace="true"
         MasterPageFile="../Master Page/ControlsBook2MasterPage.master"
         AutoEventWireup="true" CodeFile="HelloWorld.aspx.cs"
         Inherits="Ch01_HelloWorld" Title="Ch01 Hello World!"  %>
```

You no longer need to make sure that tracing is enabled in the `<trace>` XML element inside of the `web.config` configuration file for the web application with .NET Framework 2.0 and later. However, if you wish to enable and customize the trace functionality, you have to paste the element within the `<system.web>` element of the `web.config` file for the application:

```
<trace
enabled="true"
requestLimit="10"
pageOutput="false"
traceMode="SortByTime"
localOnly="true"
/>
```

Figure 1-7 shows the portion of the trace output that displays the control tree for the web form.



Control Tree

Control UniqueID	Type	Render Size Bytes (including children)	ViewState Size Bytes (excluding children)	ControlState Size Bytes (excluding children)
__Page	ASP.ch01_helloworld_aspx	4610	0	0
ctl00	ASP.masterpage_controlsbook2masterpage_master	4610	0	0
ctl00$ctl04	System.Web.UI.LiteralControl	172	0	0
ctl00$ctl00	System.Web.UI.HtmlControls.HtmlHead	217	0	0
ctl00$ctl01	System.Web.UI.HtmlControls.HtmlTitle	47	0	0
ctl00$ctl02	System.Web.UI.HtmlControls.HtmlLink	79	0	0
ctl00$ctl03	System.Web.UI.HtmlControls.HtmlLink	74	0	0
ctl00$HeadSection	System.Web.UI.WebControls.ContentPlaceHolder	4	0	0

Figure 1-7. *Tracing the control tree of the "Hello, World" web form*

The X-ray vision into ASP.NET provided by the trace feature dissects the web form in gory detail. At the top is the `Page` control that represents the web form of type `ASP.ch01_helloworld_aspx`. Below it are the server controls that you would expect to be there: `DropDownList`, `TextBox`, `Button`, and `Label`. What you might not expect to see are the `HtmlForm`, `DataBoundLiteralControl`, and `LiteralControl` objects in the control tree trace.