WEB PROGRAMMING AND INTERNET TECHNOLOGIES

An E-Commerce Approach

SECOND EDITION

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DEDICATION

To the memory of my mother and father, who likely would not have read it, but would have liked a copy for their coffee table; and to Patricia, who might even read it, but would insist that its sojourn on our coffee table be short-lived.
—PORTER SCOBEY

To my family, who may have a similar vague and equally short-lived sense of joy and pride.
—PAWAN LINGRAS

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PREFACE

This second edition of *Web Programming and Internet Technologies: An E-Commerce Approach*, like the first, is designed to be used as a textbook for first- or second-year Computer Science or Information Technology courses. It can also be used for independent study by anyone interested in getting a broad introduction to a useful subset of the many technologies commonly used to develop commercial and recreational websites. The text has undergone a major revision, which is described in detail in **What's New in the Second Edition**.

It is once again the authors' hope (and belief) that if a student exercises due diligence by working through all of the questions, exercises, and other activities that the book provides, he or she will be well on the way to becoming a competent web developer. Because such a diverse set of technologies is required to create anything beyond a trivial website, it is not possible for any book to provide in-depth discussion of every topic without overwhelming the reader with the sheer volume of information. Therefore, this cannot be a full text on any of the technologies described. However, each chapter has a section at the end entitled **What Else You Might Want or Need to Know**. This section contains material that, if pursued, can take the reader well beyond the text material. There is also a **References** section, which contains annotated links pointing the way to further professional development. A developer must always try to be aware of alternative technologies, but our main focus here is to develop a single cohesive example that illustrates a particular collection of open source and widely used technologies. However, our focus in this text is still on the basics, and our goal is to supply key knowledge that will continue to be useful for web development long after whatever currently fashionable libraries or frameworks have disappeared or been replaced.

Chapter-by-Chapter Overview

Chapter 1, **Setting the Scene**, is the first of two foundational chapters. It provides an introduction to the Internet and the World Wide Web and the relationship they share. A discussion of web servers and browsers helps readers understand the nature of communication on the World Wide Web. The chapter also discusses some essential Internet concepts, including the *Internet Protocol* (*IP*), *IP addresses*, *domains*, and *domain name servers*. Knowledge of these basic Internet terms and concepts will help readers understand how to establish a presence on the web. At the end of this chapter readers get a feel for where we are going by looking at a real-world commercial website and identifying the features that we will explore at some length in subsequent chapters.

Chapter 2, **Establishing a Web Presence**, provides readers with the first of many "hands-on" experiences to come. We begin with a discussion of *Internet Service Providers* and some of the tools readers can use to begin web page development. Then we discuss the creation of a very

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simple web page and how to "put it up on the web", using the occasion to introduce the notion of a *MIME type*. Our goal in this chapter is to get a first web page "up and running" in the simplest possible way, while introducing a selection of the minimal tools needed to do so. We also discuss file permissions as a first step toward making a website secure.

Chapter 3, **HTML for Content Structure**, begins the development of an e-commerce website that will expand in functionality with each succeeding chapter of the text. This is a unique feature of our approach: a strict policy of applying each new topic discussed to a single, extended example. This example will show the development of a website for a real commercial enterprise, and will run throughout the text. The initial version seen in this chapter is a very simple website that uses only some very basic features of the *HyperText Markup Language* (*HTML*). A very important point that we emphasize here is that HTML is concerned *only* with the *structure* of the content, or information, contained in our web pages, and *not* with the presentation or behavior of the content on those pages. In addition to many of the "legacy" HTML elements, such as headings, paragraphs, lists, tables, links, images and entities, we introduce several of the new HTML5 *semantic elements*. HTML tags attributes are introduced as necessary for the HTML elements we discuss. The chapter also introduces *Server-Side Includes* (*SSI*) as one mechanism for including common markup in many different web pages.

Chapter 4, **CSS for Content Presentation**, immediately addresses one of the problems we ignored in the previous chapter, that of the *presentation* of our web page content. We continue to emphasize how important it is to keep structure and presentation separate as we think about and build our web pages. This will be particularly important as our site becomes more complicated and populated with a larger number of pages. We want our users to experience the same "look and feel" as they "surf" from one of our pages to the next, and we need a mechanism to provide this consistency. The use of *Cascading Style Sheets* (*CSS*) allows us to define a presentation style that can be applied consistently to all the web pages on our site and also permits us to easily change any aspect of the presentation that we wish to modify. We discuss selectors and a number of property/value pairs for color, fonts, and other presentation aspects of web pages, as well as the use of a *CSS reset* and an overview of the CSS *cascade* and *inheritance*. We also discuss the very important CSS *box model*, and show how CSS combined with some of the new HTML5 semantic elements can give much more "meaning" to the various parts of your web pages. We introduce some new CSS3 features and give a simple example of *responsive web design*. The final version of our **Nature's Source** website in this chapter also introduces the new HTML5 video element to replace the static home page image in earlier versions.

Chapter 5, **HTML Forms for Data Collection**, extends the HTML of Chapter 3 to provide the forms and associated "widgets" (form controls) that allow users to enter data on a web page. Generally that data is then submitted across the web by the browser to a server, where it may be stored in a database or processed in some other way. The submission process and server-side processing will be discussed in more detail in later chapters. Here we are focused on just the forms themselves. We present the `form` element itself, as well as form controls for single and multiple lines of text input, radio buttons and checkboxes, dropdown list boxes, and the buttons for the (eventual) submission of form data, and for resetting the form during submission if necessary. We also discuss form organization with fieldsets and legends, and enhanced accessibility via

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the `label` element. At the end of this chapter we begin our discussion of how some of the new HTML5 form controls will allow us to perform data validation that used to require JavaScript, which provides a convenient segue into the next chapter.

Chapter 6, **JavaScript for Client-Side Computation and Form Data Validation**, introduces the JavaScript programming language, which we use here to perform some simple arithmetic calculations and to check the data entered by our users into our forms for validity. The language is relatively easy to learn and use, even for nonprogrammers, and we discuss data types, variables, expressions, functions (built-in and programmer-defined), and simple decision making. We also learn about the *Document Object Model* (*DOM*), an *Application Programming Interface* (*API*) that provides a programmer with access, via JavaScript in our case, to various parts of a web page for examination and manipulation. Validation of form data can be performed using JavaScript and regular expressions, and we illustrate both this approach to validation, as well as the more recent approach in which HTML5 form controls can perform their own validation, without any assistance from JavaScript. Because this kind of HTML5 support is not universally supported by browsers, we also introduce the **Modernizr** tool, which permits a web developer to check for the availability of a particular form control in a particular browser. These features are part of what we need to know if our business is to carry on a successful and secure two-way communication with our users.

Chapter 7, **JavaScript for Client-Side Content Behavior**, discusses additional capabilities of JavaScript and the DOM. There are many ways in which JavaScript can be used to add some "dynamic" activity to our web pages, which have been quite "static" up to now. In particular, readers learn how to place a rotating sequence of business-related images on the home page, and how to implement a simple dropdown menu. Implementing these features permits us to introduce more JavaScript language features (loops and decision making with switch), as well as JavaScript events, HTML event attributes, and the idea of using a JavaScript global function for controlling image rotation.

Chapter 8, **PHP for Server-Side Preprocessing**, introduces another programming language, PHP. Unlike JavaScript, which works on the client side, PHP is a server-side technology. Our web pages up to this point have essentially been served from the server to the user's browser in the form they were created. This chapter changes all that. PHP is a programming language in which programs[1] can be used to create or modify web pages "on the fly". This means that the user receives an HTML document that has been created using instructions from the PHP program, possibly based on input that has previously been received from the user on the client side. A single PHP program can potentially be used to create an arbitrary number of different HTML pages. We begin the chapter by demonstrating how an existing web page can easily be enhanced with the addition of a simple PHP script (embedded within the HTML) that displays a Welcome message including the date and time. This gives us an excellent opportunity to introduce AJAX and show how we can combine JavaScript and PHP to update the Welcome message periodically to keep the date and time current. Next we discuss the GET and POST methods, and when to use each. Then we move on to perform more sophisticated actions like sending our form data to the server

[1] The "programs" written in both PHP and JavaScript are also frequently called scripts.

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for processing and providing email feedback to users after they have submitted their form data, while simultaneously recording the form data on the server for later analysis by our "business", if desired. Throughout the chapter we discuss the necessary features of PHP as a programming language, highlighting as we go the similarities and differences when comparing it with JavaScript.

Chapter 9, **MySQL for Server-Side Data Storage**, introduces MySQL,[2] one of the most widely used (and open source) database systems on the web. Any business will sooner or later need to make use of a database of some sort to keep track of inventory and customer contact information, as well as customer preferences and similar kinds of information. Furthermore, the information stored may be represented in various formats. Users browsing the website of a business will often need access to this database in order to see information on a product or service, to provide personal information to the business, and to conduct transactions such as placing online orders and paying for them. This chapter discusses some of the most fundamental database concepts in the context of the **MySQL** database management system. Database design goals and what makes a "good" database are the first order of business, including a brief introduction to database normalization. We discuss the design of our **Nature's Source** database and how to work with it (or any MySQL database) using both **phpMyAdmin** (as a "front end" to MySQL) and the command-line interface.

Chapter 10, **PHP and MySQL for Client-Server Database Interaction**, once again proves the old maxim that sometimes the whole is greater than the sum of its parts. The real power of PHP programs to generate dynamically an unlimited number of pages that change over time without the web developer changing the program can be exploited with the help of web databases. These databases can be continuously updated through automatic or human-assisted data collection programs. For example, the website **amazon.com** makes suggestions such as, "Those who purchased this item also purchased the following items." Such purchase-inducing suggestions can be generated using information retrieved from a database consisting of all purchase records. Or, we can have a store manager enter new products and information about them, such as their descriptions, prices, and pictures of the items. A PHP program can then read the information from a database and dynamically create an online catalog, prepare an invoice for a user's purchase order, accept payment from the user and provide the user with a comforting confirmation of payment, and then (finally) send the order information to the warehouse for processing. An introduction to the interaction of PHP and a MySQL database is covered in this chapter by showing how various PHP `mysqli_xx()` functions can be used to communicate with a MySQL database. The features discussed and implemented include registration of new users in the database of a business, logging in and logging out with a typical username/password combination, displaying to the user product information from the database, and simulated online purchasing of products, with corresponding database inventory updates.

[2] Sun Microsystems acquired MySQL in 2008, after which Sun itself was acquired by Oracle, in 2010. Given that Oracle is the vendor of one of the world's most successful enterprise database systems, some concerns have been raised about the long-term viability of MySQL, which began life as an upstart, open source alternative to Oracle's product. In the way these things happen on the Internet and the World Wide Web, MySQL is likely to survive in some form, with a dedicated group of support volunteers, even if an attempt is made to kill it off.

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Chapter 11, **XML (eXtensible Markup Language) for Data Description**, introduces XML, the high-level, data-driven markup language that, for many different applications, is a kind of "lingua franca" for the World Wide Web. One of the difficulties in web communication is the wide variety of formats that have been (and still are) used to represent the many kinds of data that appear all over the Internet. XML represents the best attempt yet to provide all web users with a standardized way of representing most, if not all, forms of data. For example, HTML was "rewritten" as an XML "application" and became XHTML. This illustrates how XML may be regarded as a *metalanguage* for describing a wide variety of other languages. Business applications can use those languages to communicate and exchange data on the Web. We could also use it in a similar way to describe the kind of data we deal with in our online business. In this chapter readers will again study just some of the basics of this powerful technology and we will suggest how you may wish to employ it to describe your own business data. We discuss the (relatively few) rules of XML, draw the distinction between *well-formed* XML documents and *valid* XML documents, with reference to both the *Document Type Definition* (*DTD*) and the *XML schema*. We also show how to use CSS to style an XML document when it is displayed in a browser.

Chapter 12, **Collecting, Analyzing, and Using Visitor Data**, discusses some techniques, such as the collection of web logs for collecting information about the browsing and buying habits of your customers. That information can be put to use in various ways, from enhancing the experience of users when they visit your website, to encouraging your customers to explore other parts of your website and perhaps make additional purchases.

The text is designed to be most useful for students who enjoy a hands-on learning experience, with a need-to-know approach to the introduction of new topics. This is consistent with our view that the bulk of what we discuss should be directly applicable to the development of the website for our simple sample business that proceeds throughout the text.

How to Use This Text

With the book organized into 12 chapters, a very intense 3-month course could cover the entire text at the rate of approximately one chapter per week. The first couple of chapters could easily be covered more quickly, depending on the background and maturity of the audience, and individual instructors may want (or need) to spend more than a week on one or more of the later chapters.

In any case, a course delivered at this pace would necessarily need to omit much of the material in the **What Else You May Want or Need to Know** sections. However, if most or all of this material is used to supplement the core material, and a more leisurely pace is followed, there is enough material in the text for two courses that would span two semesters, with the split occurring at the end of either Chapter 6 or Chapter 7. If an instructor desires to cover fewer topics in greater detail in a single course, Chapters 11 and 12 could be omitted, and this is an option that has worked well for one of the authors during class testing of the text material. In fact, in a 12-week course that includes some of Chapter 11 on XML, it has been difficult to complete all parts of Chapter 10.

Information technology courses could use the same sequences, but focus on the e-commerce design and perhaps leave some of the programming-based activities to their more technically oriented compatriots.

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What’s New in the Second Edition

First, users of the first edition should be aware that what hasn’t changed is our overall goal and approach, which is to use the continual development of a single online health-products business example to introduce and make use of the fundamental techniques of website development. This is a text about the basics, about producing a reasonably full-featured website “from scratch”, and not about any of the many (and rapidly changing) libraries and frameworks that are available. We start from scratch and take the student or reader through one path to the end product of an online store with simulated purchases via web browser communication with a database of products and customers. Along the way, the student learns enough HTML5, CSS3, JavaScript, PHP, and MySQL to construct his or her own online business website that “parallels” the one we develop in the text. The first 10 chapters of the text cover this development. The last two chapters are not essential to this unified flow, but give brief introductions to XML for data description and some techniques for analyzing website visitor data.

Updates to the second edition include:

- The first 10 chapters have been completely revised to bring them up to date with HTML5 and CSS3. All files have been revised accordingly and will validate according to the W3C HTML5 and CSS3 standards (using the W3C validation sites). The new HTML5 markup from Chapter 4 onward incorporates many of the new HTML5 “semantic” tags for better page structure and some new CSS3 features for improved styling. All the figures in the text for these chapters have also been updated to reflect these changes.
- Our discussion of CSS now includes an introduction to the idea of “responsive” design, in which we make use of a “media query” to invoke a different CSS layout for our website pages when a tablet-size viewport is detected.
- Our website structure makes improved use of the HTML base tag and SSI (Server-Side Includes) to include common parts of multiple pages from one location, thereby avoiding the “maintenance nightmare” of having to keep multiple copies of the same information up to date as the website is updated and/or modified. When we get to our discussion of PHP, the SSI facility is replaced by PHP includes.
- Although we still use JavaScript for some form data validation tasks, we also show how the new HTML5 form controls can perform validation on their own, without resorting to JavaScript. Because so much on the web is a moving target and because cross-browser implementation of these new form controls is not uniform, we also show how to use the Modernizr tool to determine which new HTML5 and CSS3 features have actually been implemented in your browser.
- We introduce AJAX and put it to work in a simple use case on our website: refreshing the date and time in our Welcome message.
- All `mysql_xx()` function calls have been upgraded to use the improved `mysqli_xx()` versions. We still feel that the procedural approach in this context is preferable (and easier) for students coming to these ideas for the first time. In other words, if you don’t already have an object-oriented mind-set, this may not be the best place to develop one.
- We now include more “utility scripts” to illustrate some concepts in a very simple context before incorporating them into our live website (AJAX, GET vs. POST, and sessions, for example).

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- We also include some utility scripts for command-line monitoring of MySQL database tables when developing and testing the PHP interface between a website and a database.
- Each directory of our website corresponding to a text chapter now has one or more "readme" files containing useful information about the files in that directory, such as brief descriptions of file content, the order in which they should be studied, or how a given file relates to others in the same location.
- Student exercises on the "parallel project" now contain more detail on how to proceed with emulating the text example. This should be particularly helpful by the time the student gets to Chapter 10, which is a long chapter in which "everything comes together".
- In addition to updating our HTML, CSS, and code files, we have also done a lot of "refactoring". That is, we have tried to improve the names of variables, the names of files, and formatting of markup and code, in order to enhance file readability, as well as to clarify file grouping and organization.
- We now include some discussion of some very useful tools for helping web developers deal with all the things that can go wrong when developing websites, such as the Web Developer toolbar and Firebug for the Firefox browser, and analogous tools for other browsers.
- We have better business-related images for the "rotating image" feature of our home page. They have better resolution and are uniformly sized so that they better fill the allotted space. Also, the product images for our online store are now simply different-colored "placeholder" images, rather than the fuzzy images of products that often did not correspond to the product descriptions (in the first edition of the text).
- The index has been expanded and improved, and we hope it will prove more useful.
- Users of the text will be able to download and install their own complete copy of the **Nature's Source** website used as the sample website in the text, including the product and customer database necessary for the final e-store version of the site as described in Chapter 10 of the text. For access to the webpages and programs, as well as details on how to install, please visit go.jblearning.com/Scobey2e.

End-of-Chapter Exercises and Resources

Each chapter of the text has five important end-matter sections:

1. **Quick Questions to Test Your Basic Knowledge** is a group of questions that have short answers that can be found in, or deduced from, the current chapter material. Instructors may download the answers to these questions from go.jblearning.com/Scobey2e.
2. **Short Exercises to Improve Your Basic Understanding** are short activities that usually involve some hands-on effort and are based on the material in the current chapter. These are the kinds of exercises that don't necessarily have "answers", because some of them simply direct students to perform certain actions to gain familiarity with a particular topic, or just to see the result.
3. **Exercises on the Parallel Project** are activities involving the project each student will have chosen to run in parallel with the one in the text, and in which he or she

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implements, in that chosen project, the same (or similar) features seen in the sample project of the text. These exercises are designed to be open-ended in the sense that they do not have specific answers, nor will each student or team of students (as the case may be) come up with the same "answer". Indeed, these exercises are posed in such a way that different solutions are practically mandated.

4. **What Else You May Want or Need to Know** contains material that should help students consolidate and extend their knowledge and understanding of the current chapter. This material, combined with links from the References, can serve as a springboard for the instructor or student who wishes to go beyond what is presented in the text. An instructor may wish to use something from this section for an additional short class presentation or as the basis for additional assignments or projects for students.
5. **References** will contain, for the most part, links to websites that give further details or explanations of the topics covered in the current chapter.

Instructor and Student Resources

Additional instructor and student resources are available via Jones & Bartlett Learning's catalog page go.jblearning.com/Scobey2e. These include:

- Slides in PowerPoint format.
- Answers to end-of-chapter Quick Questions.
- Test Bank.
- Suggestions for how to use the text.
- A zip file containing the complete **Nature's Source** website for local installation. All of the web pages and programs available in the zip file have been tested. Some of these require certain facilities on an actual web server, and instructions have been provided in the accompanying document "How to Install Your Own Copy of Our Nature's Source Website".

Constructive criticism of any kind is always welcomed by the authors. In particular, specific suggestions for clarification in the wording, changes in the order of topics, or the inclusion or exclusion of any particular items that would contribute to the overall goals of the text are appreciated. An errata page for the textbook is available at go.jblearning.com/Scobey2e.

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TYPOGRAPHIC AND OTHER CONVENTIONS

This section contains a summary of the typographic styles we use throughout the text to identify various entities, including a list of our file extension conventions.

1. An italic font *like this* is used for technical terms (and possibly variations thereof) that are appearing either for the first time, or later in a different context, or perhaps to call your attention to the term again for some reason, as well as for emphasizing ordinary words like *this*. The reader should have no difficulty in telling from the context which usage is in effect.
2. **A bold font like this is used from time to time for a longer passage that is of particular importance, either in context, or for the longer term.** It may also be used to emphasize the name of a software program, like **HTML-Kit**, or the name of an organization or company, like **W3C** or **Microsoft**, and help it to stand out from the surrounding text in a particular context, if required. This font is also used to refer to other sections of the text, such as **References**.
3. A `typewriter-like monospaced font like this` is used for all code, for showing input to and output from programs, for links, for keystroke shortcuts, and for showing contents of text files.
4. A bold sans-serif font **like this** is used for top-level menu choices and submenu choices.
5. Each figure in the text that shows either the full or partial contents of a file, the display of a file as it would appear in a browser window, or a diagram, is accompanied by two pieces of information:

   - The full pathname of the relevant file (including the files that are display images)
   - A caption detailing the (possibly partial) contents of the file (or what the display image is showing you)

   All of these files are available from the book's website.

6. Table 1 shows the file extension conventions that we will follow in this text to refer to its associated files. Most markup and source code files will have the name of the file in a comment line at or near the beginning of the file. This first file-naming comment line may be accompanied by a second comment on one or more lines, indicating briefly the nature or purpose of the file content. Exceptions to this convention are those very simple files we use to begin the discussion of some topics.

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TABLE 1 FILE CONTENT TYPES AND THEIR CORRESPONDING FILE EXTENSIONS.

File Contents	File Extension
Ordinary text	.txt
HTML markup	.html
Cascading Style Sheets	.css
`JavaScript code`	`.js`
PHP code	.php
XML markup	.xml
A textfile containing comma-separated values	.csv
A textfile containing SQL commands	.sql
An image file, usually a screen capture	.jpg
A zip file	.zip

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