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AJAX, Rich Internet Applications, and Web Development for Programmers

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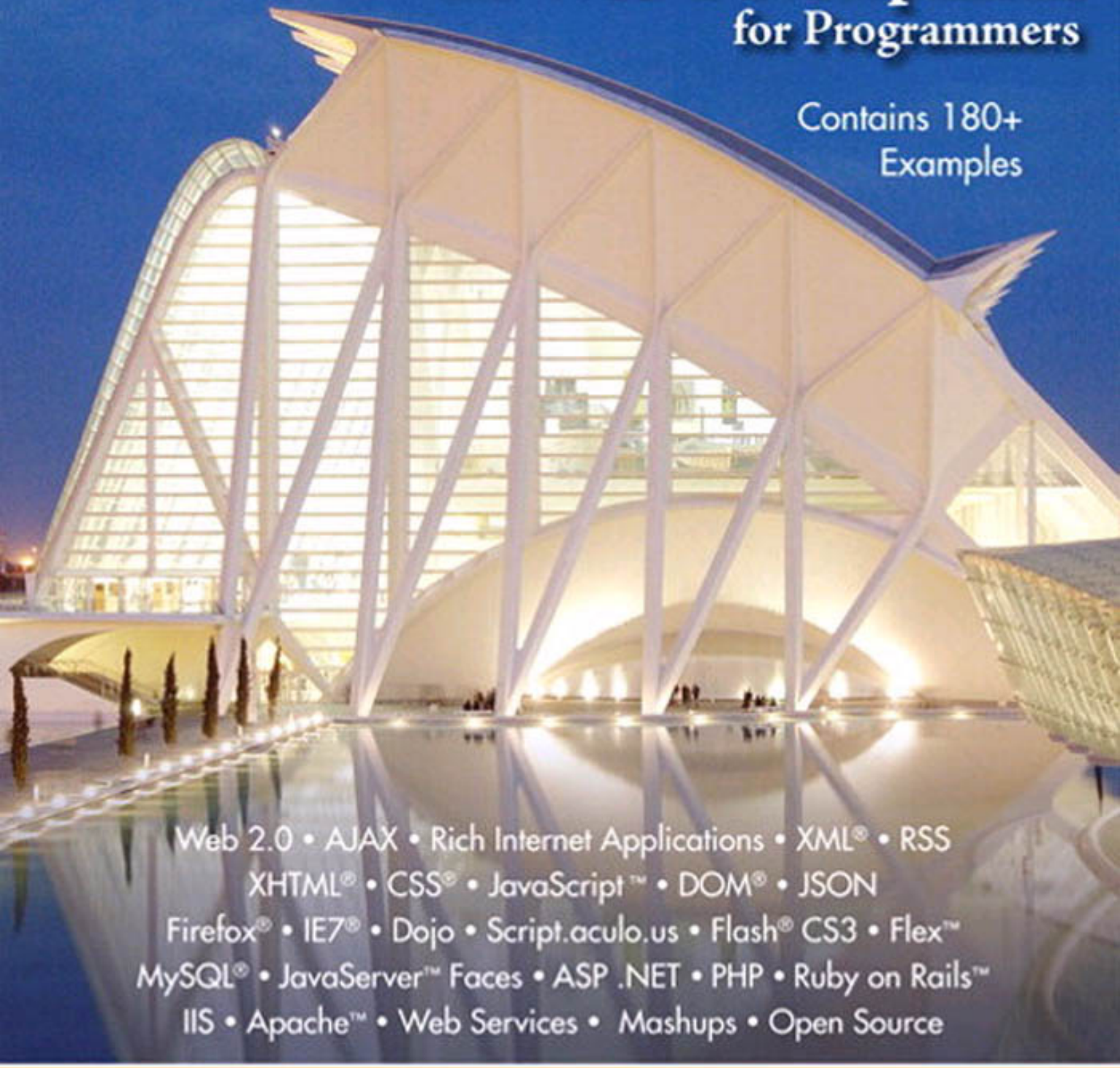

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PAUL J. DEITEL and HARVEY M. DEITEL

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Preface

… the challenges are for the designers of these applications: to forget what we think we know about the limitations of the Web, and begin to imagine a wider, richer range of possibilities. It's going to be fun.

—Jesse James Garrett, Adaptive Path
"Ajax: A New Approach to Web Applications"
(`adaptivepath.com/ideas/essays/archives/000385.php`)

Introduction

Welcome to Internet and web programming and Web 2.0! And welcome to a walkthrough of the Web 2.0 phenomenon from the technical, business and social perspectives. We've worked hard to create what we hope you'll find to be an informative, entertaining and challenging learning experience. At Deitel & Associates, we write programming language professional books and textbooks for Prentice Hall, deliver corporate training worldwide and develop Web 2.0 Internet businesses. This book reflects today's Web 2.0, Ajax-based, Rich Internet Application-development methodologies.

The technologies you'll learn here are appropriate for experienced professionals who build substantial information systems. You'll find "industrial-strength" code examples. We have attempted to write in a clear and straightforward manner using best practices.

Perhaps most important, the book presents hundreds of working code examples and shows the outputs produced when these examples are rendered in browsers or run on computers. We present all concepts in the context of complete working programs. We call this the "live-code approach." All of the source code is available for download from

```
www.deitel.com/books/ajaxfp/
```

under the heading "Download Code Examples and Other Premium Content for Registered Users," once you've registered and logged on to our site.

The early chapters present a carefully paced introduction to "client-side" web programming, using the popular JavaScript language and the closely related technologies of XHTML (Extensible HyperText Markup Language), CSS (Cascading Style Sheets) and the DOM (Document Object Model). The material in the JavaScript chapters presents a solid foundation for the deeper treatment of scripting in the Adobe Flash, Adobe Flex, PHP and Ruby on Rails chapters later in the book. Experienced programmers will read the early chapters quickly and find the treatment of scripting in the later chapters to be rigorous and challenging.

Today's users are accustomed to desktop applications with rich graphical user interfaces (GUIs), such as those used on Apple's Mac OS X systems, Microsoft Windows systems, various Linux systems and more. Users want applications that employ the

multimedia capabilities of graphics, images, animation, audio and video. They want applications that can run on the Internet and the web and communicate with other applications. Users want to apply database technologies for storing and manipulating their business and personal data. They want applications that are not limited to the desktop or even to some local computer network, but that can integrate Internet and web components, and remote databases. Programmers want to use all these capabilities in a truly portable manner so that applications will run without modification on a variety of platforms.

In this book, we present a number of powerful software technologies that will enable you to build these kinds of systems. Early in the book we focus on building the portions of web-based applications that reside on the client side (i.e., the portions of applications that typically run in web browsers such as Mozilla's Firefox or Microsoft's Internet Explorer), using technologies such as the XHTML, JavaScript, CSS, Flash, Flex and Extensible Markup Language (XML). Later in the book we concentrate on using technologies such as web servers, databases, PHP, Ruby on Rails, ASP.NET, ASP.NET Ajax and JavaServer Faces (JSF) to build the server side of web-based applications. These portions of applications typically run on "heavy-duty" computer systems on which organizations' business-critical websites reside. By mastering the technologies in this book, you'll be able to build substantial web-based, client/server, database-intensive, "multitier" applications.

If you have questions as you read this book, send an e-mail to `deitel@deitel.com`—we'll respond promptly. For updates on the book and the status of all supporting software, and for the latest news on Deitel publications and services, visit `www.deitel.com`. Sign up at `www.deitel.com/newsletter/subscribe.html` for the free *Deitel® Buzz Online* e-mail newsletter and check out `www.deitel.com/ResourceCenters.html` for our growing list of Internet and web programming, Internet business, Web 2.0 and related Resource Centers. Each week we announce our latest Resource Centers in the newsletter.

Key Features

Here's some of the key features of *Ajax, Rich Internet Applications and Web Development for Programmers*:

- Reflects today's Web 2.0, Ajax-based, Rich Internet Application-development methodologies.
- Coverage of the two leading web browsers—Internet Explorer and Firefox. All client-side applications in the book run correctly on both browsers.
- Focus on Web 2.0 technologies and concepts.
- Chapter on Web 2.0 and Internet Business (reviewed by leaders in the Web 2.0 community).
- Focus on building Rich Internet Applications with the interactivity of desktop applications.
- Chapter on building Ajax-enabled web applications with "raw" Ajax and with the Dojo JavaScript libraries. Applications in this chapter demonstrate partial-page updates and type-ahead capabilities.
- Chapter on Adobe Flex—a Rich Internet Application framework for creating scalable, cross-platform, multimedia-rich applications for delivery within the enterprise or across the Internet.

- Chapter on rapid applications development of database-driven web applications with Ruby on Rails; also discusses developing Ajax applications with the Prototype and Script.aculo.us libraries.
- Two chapters on Adobe Flash CS3, including building a computer game.
- Significant treatment of client-side scripting with JavaScript.
- Significant treatments of XHTML DOM manipulation and JavaScript events.
- Significant treatment of XML DOM manipulation with JavaScript.
- Chapter on building SOAP-based web services with Java and REST-based web services with ASP.NET (using Visual Basic).
- Chapter on PHP 5.
- Coverage of ASP.NET, featuring ASP.NET Ajax.
- JavaServer Faces (JSF) coverage emphasizing building Ajax-enabled JSF applications.
- Client-side case studies that enable you to interact with preimplemented server-side applications and web services that we host at `test.deitel.com`.
- Case studies including Deitel Cover Viewer (JavaScript/DOM), Address Book (Ajax), Cannon Game (Flash), Weather/Yahoo! Maps Mashup (Flex), Mailing List (PHP/MySQL), Message Forum and Flickr Photo Viewer (Ruby on Rails), Guest Book and Secure Books Database (ASP.NET), Address Book with Google Maps (JavaServer Faces) and Blackjack (JAX-WS web services).

All of this has been carefully reviewed by a team of 38 distinguished industry developers and academics.

AJAX, Rich Internet Applications and Web Development for Programmers Architecture

This book focuses on Web 2.0 and Rich Internet Application (RIA) development. Our goal is to develop webtop applications that have the responsiveness, look and feel of traditional desktop applications. Deitel & Associates, Inc. has evolved into a development organization, while continuing its focus on programming languages textbook and professional book authoring, and corporate training. We're building the infrastructure for the Internet businesses we're designing and developing as part of our Web 2.0 Internet Business Initiative. This book includes discussions of many practical issues we've encountered in developing that infrastructure.

Figure 1 shows the architecture of *AJAX, Rich Internet Applications and Web Development for Programmers.* The book is divided into several parts. Chapter 1 introduces Web 2.0 from the technical, business and social perspectives, and provides a foundation for understanding Rich Internet Application development. If you are a serious web developer, you'll want to test your web applications across many browsers and platforms. The examples for the book execute correctly on both Microsoft's Internet Explorer 7 (IE7) and Mozilla's Firefox 2 (FF2) browsers. Most of the examples will also work in other browsers such as Opera and Safari, but may not work on earlier browsers. Microsoft Windows users should upgrade to IE7 and install Firefox; readers with other operating systems should install Firefox.

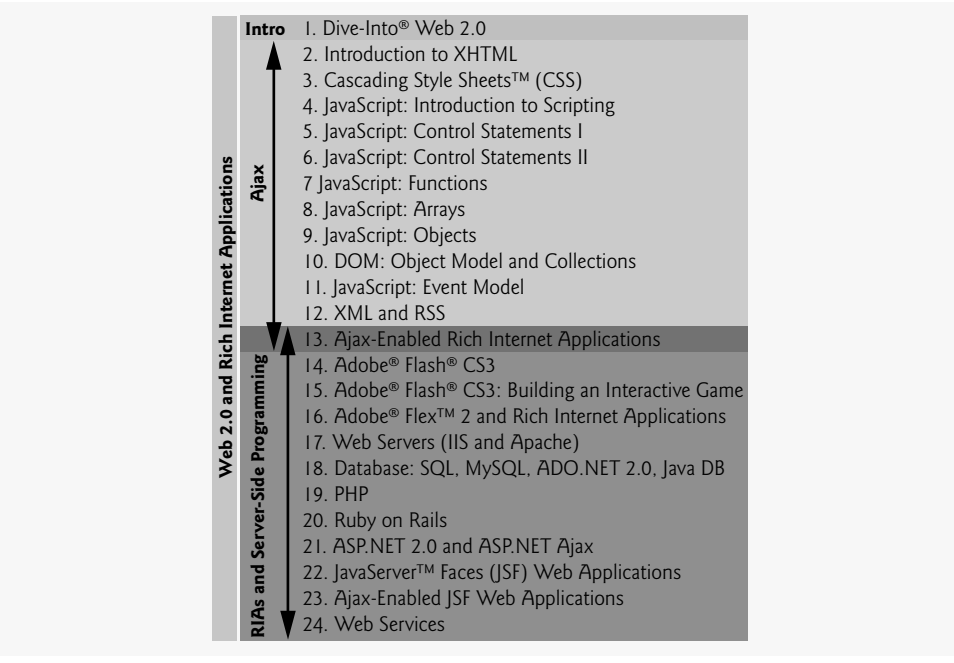


Fig. 1 | Architecture of *AJAX, Rich Internet Applications and Web Development for Programmers*.

The second part of the book, Chapters 2–13, presents a detailed treatment of Ajax component technologies, including a comprehensive treatment of JavaScript that spans nine chapters and concludes with Chapter 13's treatment of Ajax development. Ajax is not a new technology—we've been writing about all but one of its component technologies since 1999, and many of the technologies existed before that. However, Ajax is one of the key technologies of Web 2.0 and RIAs. Chapters 2–13 cover "raw" Ajax programming, where you'll handle the details yourself—several later chapters in the book demonstrate technologies that encapsulate Ajax functionality to help you easily build Ajax-based applications that operate across a wide variety of browsers and browser versions without your having to be concerned with the low-level details.

The third part of the book, Chapters 13–24, focuses on both the client and server sides of the GUI and the graphical part of RIA development. Here we cover client-side technologies such as Adobe Flash and Adobe Flex that use, or can be combined with, Ajax or Ajax-like capabilities to develop RIAs. Each of these technologies also can consume web services. Next, we present the server side of web application development with discussions of web servers (IIS and Apache), databases, server-side scripting languages such as PHP and Ruby on Rails, and several server-side frameworks such as ASP.NET 2.0 and JavaServer Faces. We complete our server-side discussion with a chapter on building both SOAP-based and REST-based web services.

You may have noticed that Chapter 13, Ajax-Enabled Rich Internet Applications, overlaps the second and third parts of the book. Chapter 13 serves as a bridge from "raw" Ajax development to "encapsulated" Ajax development with the Dojo libraries.

Dependency Chart

Figure 2 illustrates the dependencies that exist among chapters in the book. An arrow pointing into a chapter indicates that it depends on the content of the chapter from which the arrow points. For example, Chapter 24, Web Services, depends on both Chapters 21 and 23. We recommend that you read all of a given chapter's dependencies before reading that chapter, though other orders are possible. We've also commented on some additional dependencies in the diagram's footnotes.

Teaching Approach

AJAX, Rich Internet Applications and Web Development for Programmers contains a rich collection of examples. The book concentrates on the principles of good software engineering and stresses program clarity. We are educators who teach leading-edge topics in industry classrooms worldwide. Dr. Harvey M. Deitel has 20 years of college teaching experience and 18 years of industry teaching experience. Paul Deitel has 16 years of industry teaching experience. The Deitels have taught courses at all levels to government, industry, military and academic clients of Deitel & Associates.

Live-Code Approach. *AJAX, Rich Internet Applications and Web Development for Programmers* is loaded with "live-code" examples—each new concept is presented in the context of a complete working web application that is immediately followed by one or more screen captures showing the application's functionality. This style exemplifies the way we teach and write about programming; we call this the "live-code approach."

Syntax Shading. We syntax shade all the code, similar to the way most integrated-development environments and code editors syntax color code. This improves code readability—an important goal, given that this book contains about 18,000 lines of code in complete, working programs. Our syntax-shading conventions are as follows:

```
comments appear in italic
keywords appear in bold italic
PHP, Ruby, ASP.NET, JSP delimiters and errors appear in bold black
constants and literal values appear in bold gray
all other code appears in black
```

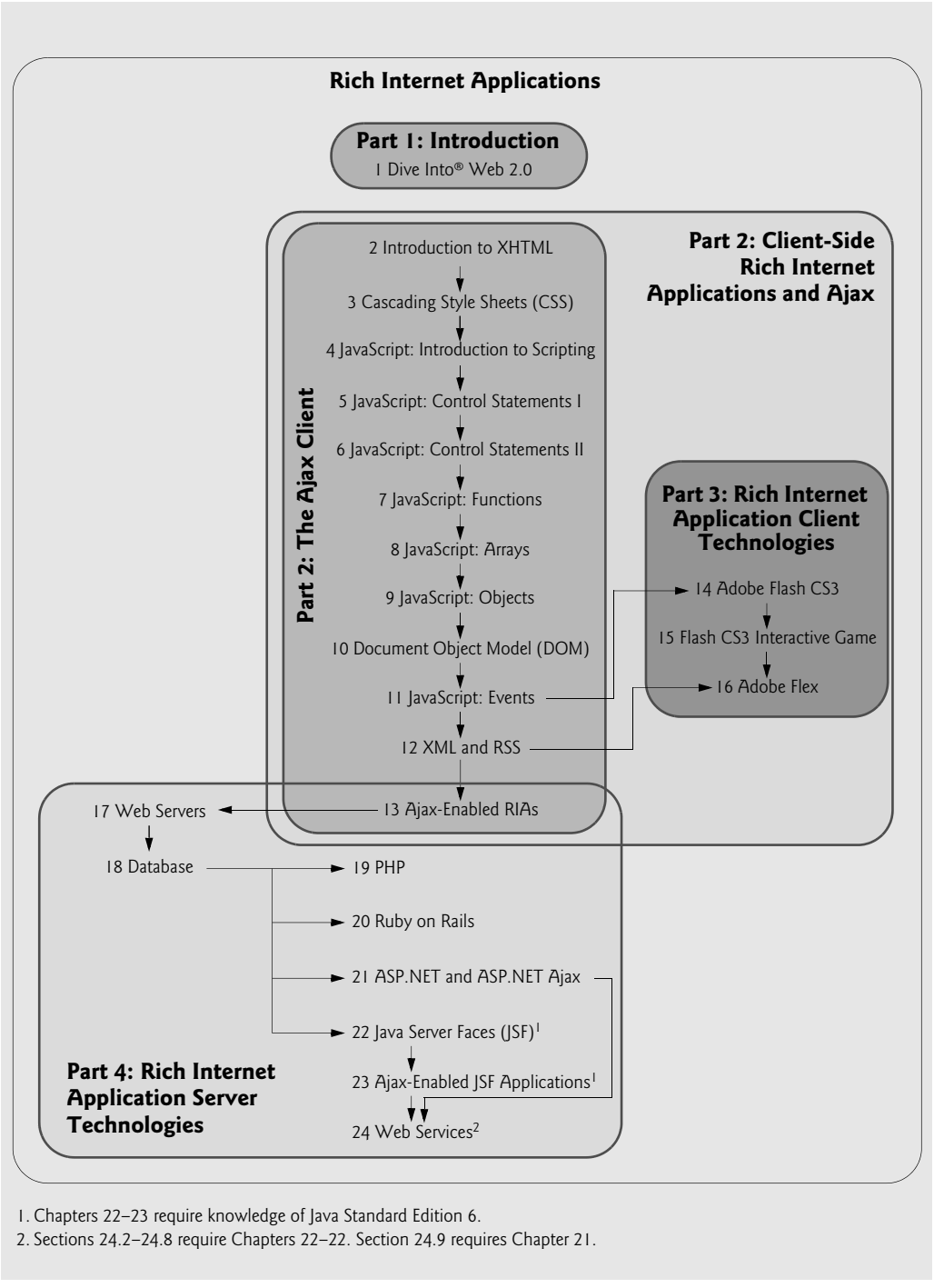
Code Highlighting. We place white rectangles around each program's key code segments.

Using Fonts for Emphasis. We place the key terms and the index's page reference for each defining occurrence in ***bold italic*** text for easier reference. We emphasize on-screen components in the **bold Helvetica** font (e.g., the **File** menu) and emphasize program text in the `Lucida` font (e.g., `int x = 5`).

Web Access. All of the source-code examples for *AJAX, Rich Internet Applications and Web Development for Programmers* are available for download from:

```
www.deitel.com/books/ajaxfp/
```

Site registration is quick, easy and free. Download all the examples, then run each program as you read the corresponding text discussions. Making changes to the examples and seeing the effects of those changes is a great way to enhance your Internet and web programming learning experience.



1. Chapters 22–23 require knowledge of Java Standard Edition 6.
2. Sections 24.2–24.8 require Chapters 22–22. Section 24.9 requires Chapter 21.

Fig. 2 | *AJAX, Rich Internet Applications and Web Development for Programmers* chapter dependency chart.

Objectives. Each chapter begins with a statement of objectives. This lets you know what to expect and gives you an opportunity to determine if you have met the objectives after reading the chapter.

Quotations. The learning objectives are followed by quotations. Some are humorous; some are philosophical; others offer interesting insights. We hope that you enjoy relating the quotations to the chapter material.

Outline. The chapter outline helps you approach the material in a top-down fashion, so you can anticipate what is to come and set a comfortable learning pace.

Illustrations/Figures. Abundant charts, tables, line drawings, programs and program output are included.

Programming Tips. We include programming tips to help you focus on important aspects of program development. These tips and practices represent the best we have gleaned from a combined six decades of programming and teaching experience. One of our readers told us that she feels this approach is like the highlighting of axioms, theorems and corollaries in mathematics books—it provides a basis on which to build good software.

Good Programming Practices

Good Programming Practices *call attention to techniques that will help you produce programs that are clearer, more understandable and more maintainable.*

Common Programming Errors

Programmers tend to make certain kinds of errors frequently. Pointing out these Common Programming Errors *reduces the likelihood that you'll make the same mistakes.*

Error-Prevention Tip

These tips contain suggestions for exposing bugs and removing them from your programs; many describe aspects of programming that prevent bugs from getting into programs in the first place.

Performance Tip

These tips highlight opportunities for making your programs run faster or minimizing the amount of memory that they occupy.

Portability Tip

We include Portability Tips *to help you write code that will run on a variety of platforms and to explain how to achieve a high degree of portability.*

Software Engineering Observation

The Software Engineering Observations *highlight architectural and design issues that affect the construction of software systems, especially large-scale systems.*

Thousands of Index Entries. We have included an extensive index which is especially useful when you use the book as a reference.

"Double Indexing" of Live-Code Examples. For every source-code program in the book, we index the figure caption both alphabetically and as a subindex item under "Examples." This makes it easier to find examples using particular features.

AJAX, Rich Internet Applications and Web Development for Programmers Software Downloads and Additional Resources

Many Internet and web development tools are available. We wrote *AJAX, Rich Internet Applications and Web Development for Programmers* using Internet Explorer 7, Firefox 2 and other free-for-download software. Links to additional resources and software downloads are available in our Internet and Web programming related Resource Centers:

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www.deitel.com/resourcecenters.html/
```

and at the website for this book:

```
www.deitel.com/books/ajaxfp/
```

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www.deitel.com/newsletter/subscribe.html
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The Deitel Online Resource Centers

Our website, `www.deitel.com`, provides scores of Resource Centers on various topics including programming languages, software, Web 2.0, Internet business and open source projects (Fig. 3). The Resource Centers have evolved out of the research we do to support our books and business endeavors. We've found many exceptional resources including tutorials, documentation, software downloads, articles, blogs, podcasts, videos, code samples, books, e-books and more. Most of them are free. In the spirit of Web 2.0, we share these resources with the worldwide community. Each week we announce our latest Resource Centers in the *Deitel® Buzz Online* (`www.deitel.com/newsletter/subscribe.html`).

Acknowledgments

It is a great pleasure to acknowledge the efforts of many people whose names may not appear on the cover, but whose hard work, cooperation, friendship and understanding were crucial to the production of the book. Many people at Deitel & Associates, Inc. devoted long hours to this project—thanks especially to Abbey Deitel and Barbara Deitel.

We'd also like to thank the participants in our Honors Internship program who contributed to this publication—Ilana Segall, a mathematical and computational science major at Stanford University; Jennifer Fredholm, an English and computer science major at New York University; Scott Wehrwein, a computer science major at Middlebury College; Mark Kagan, a computer science, economics and math major at Brandeis University; Andrew Faden, a computer engineering major at Northeastern University; Jessica Henkel, a psychology major and business minor at Northeastern University; and Kyle Banks, a computer science and business major at Northeastern University.

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Adobe Flex
Ajax
Apex
ASP.NET Ajax
ASP.NET
C
C++
C++ Boost Libraries
C++ Game Programming
C#
Code Search Engines and Code Sites
Computer Game Programming
CSS 2.1
Dojo
Facebook Developer Platform
Flash 9
Java
Java Certification and Assessment Testing
Java Design Patterns
Java EE 5
Java SE 6
Java SE 7 (Dolphin) Resource Center
JavaFX
JavaScript
JSON
Microsoft LINQ
Microsoft Popfly
.NET
.NET 3.0
.NET 3.5
OpenGL
Perl
PHP
Programming Projects
Python
Regular Expressions
Ruby
Ruby on Rails
Silverlight
Visual Basic
Visual C++
Visual Studio Team System
Web 3D Technologies
Web Services
Windows Presentation Foundation
XHTML
XML

Computer Science
Regular Expressions

Games and Game Programming
Computer Game Programming
Computer Games
Mobile Gaming
Sudoku

Internet Business
Affiliate Programs
Competitive Analysis
Facebook Social Ads
Google AdSense
Google Analytics
Google Services
Internet Advertising
Internet Business Initiative
Internet Public Relations
Link Building
Location-Based Services
Online Lead Generation
Podcasting
Search Engine Optimization
Selling Digital Content
Sitemaps
Web Analytics
Website Monetization
YouTube and AdSense

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Java
Java Certification and Assessment Testing
Java Design Patterns
Java EE 5
Java SE 6
Java SE 7 (Dolphin) Resource Center
JavaFX

Microsoft
ASP.NET
ASP.NET 3.5
ASP.NET Ajax
C#
DotNetNuke (DNN)
Internet Explorer 7 (IE7)
Microsoft LINQ
.NET
.NET 3.0
.NET 3.5
SharePoint
Silverlight
Visual Basic
Visual C++
Visual Studio Team System
Windows Presentation Foundation
Windows Vista
Microsoft Popfly

Open Source & LAMP Stack
Apache
DotNetNuke (DNN)
Eclipse
Firefox
Linux
MySQL
Open Source
Perl
PHP
Python
Ruby

Software
Apache
DotNetNuke (DNN)
Eclipse
Firefox
Internet Explorer 7 (IE7)
Linux
MySQL
Open Source
Search Engines
SharePoint
Skype
Web Servers
Wikis
Windows Vista

Web 2.0
Alert Services
Attention Economy
Blogging
Building Web Communities
Community Generated Content
Facebook Developer Platform
Facebook Social Ads
Google Base
Google Video
Google Web Toolkit (GWT)
Internet Video
Joost
Location-Based Services
Mashups
Microformats
Recommender Systems
RSS
Social Graph
Social Media
Social Networking
Software as a Service (SaaS)
Virtural Worlds
Web 2.0
Web 3.0
Widgets

Dive Into Web 2.0 eBook

Other Topics
Computer Games
Computing Jobs
Gadgets and Gizmos
Ring Tones
Sudoku

Fig. 3 | Deitel Resource Centers at `www.deitel.com/resourcecenters.html`.

We are fortunate to have worked on this project with the talented and dedicated team of publishing professionals at Prentice Hall. We appreciate the extraordinary efforts of Marcia Horton, Editorial Director of Prentice Hall's Engineering and Computer Science Division, Mark Taub, Editor-in-Chief of Prentice Hall Professional, and John Fuller, Managing Editor of Prentice Hall Professional. Carole Snyder and Dolores Mars did a remarkable job recruiting the book's large review team and managing the review process. Sandra Schroeder and Chuti Prasertsith did a wonderful job designing the book's cover. Bob Engelhardt and Marta Samsel did a marvelous job managing the book's production.

This book was adapted from our book *Internet & World Wide Web How to Program, 4/e*. We wish to acknowledge the efforts of our reviewers on that book. Adhering to a tight time schedule, they scrutinized the text and the programs, providing countless suggestions for improving the accuracy and completeness of the presentation.

Reviewers

Roland Bouman (MySQL AB), Peter Brandano (KoolConnect Technologies, Inc.), Matt Chotin (Adobe), Chris Cornutt (PHPDeveloper.org), Phil Costa (Adobe), Umachitra Damodaran (Sun Microsystems), Vadiraj Deshpande (Sun Microsystems), Justin Erenkrantz (The Apache Software Foundation), Christopher Finke (Netscape), Jesse James Garrett (Adaptive Path), Kevin Henrikson (Zimbra.com), Tim Heuer (Microsoft), Molly E. Holtzschlag (W3C), Ralph Hooper (University of Alabama, Tuscaloosa), Johnvey Hwang (Splunk, Inc.), Joe Kromer (New Perspective and the Pittsburgh Adobe Flash Users Group), Eric Lawrence (Microsoft), Billy B. L. Lim (Illinois State University), Shobana Mahadevan (Sun Microsystems), Patrick Mineault (Freelance Flash Programmer), Anand Narayanaswamy (Microsoft), John Peterson (Insync and V.I.O., Inc.), Jennifer Powers (University of Albany), Robin Schumacher (MySQL AB), José Antonio González Seco (Parlamento de Andalucia), Dr. George Semeczko (Royal & SunAlliance Insurance Canada), Steven Shaffer (Penn State University), Tim Sneath (Microsoft), Karen Tegtmeyer (Model Technologies, Inc.), Paul Vencill (MITRE), Raymond Wen (Microsoft), Eric M. Wendelin (Auto-trol Technology Corporation), Raymond F. Wisman (Indiana University) and Daniel Zappala (Brigham Young University).

Well, there you have it! We hope you enjoy this look at the exciting world of Ajax, Rich Internet Applications and web development in a Web 2.0 world. As you read the book, we would sincerely appreciate your comments, criticisms, corrections and suggestions for improving the text. Please address all correspondence to:

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deitel@deitel.com
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We'll respond promptly, and post corrections and clarifications at:

```
www.deitel.com/books/ajaxfp/
```

We hope you enjoy reading *Ajax, Rich Internet Applications and Web Development for Programmers* as much as we enjoyed writing it!

Paul J. Deitel
Dr. Harvey M. Deitel
Maynard, Massachusetts

About the Authors

Paul J. Deitel, CEO and Chief Technical Officer of Deitel & Associates, Inc., is a graduate of MIT's Sloan School of Management, where he studied Information Technology. He holds the Java Certified Programmer and Java Certified Developer certifications, and has been designated by Sun Microsystems as a Java Champion. Through Deitel & Associates, Inc., he has delivered Internet and web programming, Java, C, C++, C# and Visual Basic courses to industry clients, including IBM, Sun Microsystems, Dell, Lucent Technologies, Fidelity, NASA at the Kennedy Space Center, the National Severe Storm Laboratory, White Sands Missile Range, Rogue Wave Software, Boeing, Stratus, Cambridge Technology Partners, Open Environment Corporation, One Wave, Hyperion Software, Adra Systems, Entergy, CableData Systems, Nortel Networks, Puma, iRobot, Invensys and many more. He has also lectured on Java and C++ for the Boston Chapter of the Association for Computing Machinery. He and his father, Dr. Harvey M. Deitel, are the world's best-selling programming language textbook authors.

Dr. Harvey M. Deitel, Chairman and Chief Strategy Officer of Deitel & Associates, Inc., has 46 years of experience in the computer field. Dr. Deitel earned B.S. and M.S. degrees from MIT and a Ph.D. from Boston University. He has 20 years of college teaching experience, including earning tenure and serving as the Chairman of the Computer Science Department at Boston College before founding Deitel & Associates, Inc., with his son, Paul J. Deitel. He and Paul are the co-authors of several dozen books and multimedia packages and they are writing many more. With translations published in Japanese, German, Russian, Spanish, Traditional Chinese, Simplified Chinese, Korean, French, Polish, Italian, Portuguese, Greek, Urdu and Turkish, the Deitels' texts have earned international recognition. Dr. Deitel has delivered hundreds of professional seminars to major corporations, academic institutions, government organizations and the military.

About Deitel & Associates, Inc.

Deitel & Associates, Inc., is an internationally recognized corporate training and content-creation organization specializing in computer programming languages, Internet and web software technology, object technology education and Internet business development through its Web 2.0 Internet Business Initiative. The company provides instructor-led courses on major programming languages and platforms, such as C++, Java, C, C#, Visual C++, Visual Basic, XML, object technology and Internet and web programming. The founders of Deitel & Associates, Inc. are Paul J. Deitel and Dr. Harvey M. Deitel. The company's clients include many of the world's largest companies, government agencies, branches of the military, and academic institutions. Through its 32-year publishing partnership with Prentice Hall, Deitel & Associates, Inc. publishes leading-edge programming professional books, textbooks, interactive multimedia *Cyber Classrooms*, *Complete Training Courses*, web-based training courses, online and offline *LiveLessons* video courses, and e-content for the popular course management systems WebCT, Blackboard and Pearson's CourseCompass. Deitel & Associates, Inc., and the authors can be reached via e-mail at:

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10

Document Object Model (DOM): Objects and Collections

Our children may learn about heroes of the past. Our task is to make ourselves architects of the future.

—Jomo Mzee Kenyatta

Though leaves are many, the root is one.

—William Butler Yeats

The thing that impresses me most about America is the way parents obey their children.

—Duke of Windsor

Most of us become parents long before we have stopped being children.

—Mignon McLaughlin

To write it, it took three months; to conceive it three minutes; to collect the data in it—all my life.

—F. Scott Fitzgerald

Sibling rivalry is inevitable. The only sure way to avoid it is to have one child.

—Nancy Samalin

OBJECTIVES

In this chapter you will learn:

- How to use JavaScript and the W3C Document Object Model to create dynamic web pages.
- The concepts of DOM nodes and DOM trees.
- How to traverse, edit and modify elements in an XHTML document.
- How to change CSS styles dynamically.
- To create JavaScript animations.

Outline

10.1 Introduction

In this chapter we introduce the ***Document Object Model (DOM)***. The DOM gives you access to all the elements on a web page. Inside the browser, the whole web page—paragraphs, forms, tables, etc.—is represented in an ***object hierarchy***. Using JavaScript, you can create, modify and remove elements in the page dynamically.

Previously, both Internet Explorer and Netscape had different versions of Dynamic HTML, which provided similar functionality to the DOM. However, while they provided many of the same capabilities, these two models were incompatible with each other. In an effort to encourage cross-browser websites, the W3C created the standardized Document Object Model. Firefox 2, Internet Explorer 7, and many other major browsers implement *most* of the features of the W3C DOM.

This chapter begins by formally introducing the concept of DOM nodes and DOM trees. We then discuss properties and methods of DOM nodes and cover additional methods of the `document` object. We also discuss how to dynamically change style properties, which enables you to create many types of effects, such as user-defined background colors and animations. Then, we present a diagram of the extensive object hierarchy, with explanations of the various objects and properties, and we provide links to websites with further information on the topic.

Software Engineering Observation 10.1

With the DOM, XHTML elements can be treated as objects, and many attributes of XHTML elements can be treated as properties of those objects. Then, objects can be scripted (through their `id` attributes) with JavaScript to achieve dynamic effects.

10.2 Modeling a Document: DOM Nodes and Trees

As we saw in previous chapters, the `document`'s `getElementById` method is the simplest way to access a specific element in a page. In this section and the next, we discuss more thoroughly the objects returned by this method.

The `getElementById` method returns objects called ***DOM nodes***. Every element in an XHTML page is modeled in the web browser by a DOM node. All the nodes in a document make up the page's ***DOM tree***, which describes the relationships among elements. Nodes are related to each other through child-parent relationships. An XHTML element inside another element is said to be a ***child*** of the containing element. The containing element is known as the ***parent***. A node may have multiple children, but only one parent. Nodes with the same parent node are referred to as ***siblings***.

Some browsers have tools that allow you to see a visual representation of the DOM tree of a document. When installing Firefox, you can choose to install a tool called the *DOM Inspector*, which allows you to view the DOM tree of an XHTML document. To inspect a document, Firefox users can access the **DOM Inspector** from the **Tools** menu of Firefox. If the DOM inspector is not in the menu, run the Firefox installer and choose **Custom** in the **Setup Type** screen, making sure the **DOM Inspector** box is checked in the **Optional Components** window.

Microsoft provides a *Developer Toolbar* for Internet Explorer that allows you to inspect the DOM tree of a document. The toolbar can be downloaded from Microsoft at `go.microsoft.com/fwlink/?LinkId=92716`. Once the toolbar is installed, restart the browser, then click the » icon at the right of the toolbar and choose **IE Developer Toolbar** from the menu. Figure 10.1 shows an XHTML document and its DOM tree displayed in Firefox's DOM Inspector and in IE's Web Developer Toolbar.

The XHTML document contains a few simple elements. We explain the example based on the Firefox DOM Inspector—the IE Toolbar displays the document with only minor differences. A node can be expanded and collapsed using the **+** and **-** buttons next to the node's name. Figure 10.1(b) shows all the nodes in the document fully expanded. The document node (shown as **#document**) at the top of the tree is called the *root node*, because it has no parent. Below the document node, the **HTML** node is indented from the document node to signify that the **HTML** node is a child of the **#document** node. The **HTML** node represents the `html` element (lines 7–24).

The **HEAD** and **BODY** nodes are siblings, since they are both children of the **HTML** node. The **HEAD** contains two **#comment** nodes, representing lines 5–6. The **TITLE** node

```
1  <?xml version = "1.0" encoding = "utf-8"?>
2  <!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
3     "http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
4
5  <!-- Fig. 10.1: domtree.html -->
6  <!-- Demonstration of a document's DOM tree. -->
7  <html xmlns = "http://www.w3.org/1999/xhtml">
8     <head>
9        <title>DOM Tree Demonstration</title>
10    </head>
11    <body>
12       <h1>An XHTML Page</h1>
13       <p>This page contains some basic XHTML elements. We use the Firefox
14          DOM Inspector and the IE Developer Toolbar to view the DOM tree
15          of the document, which contains a DOM node for every element in
16          the document.</p>
17       <p>Here's a list:</p>
18       <ul>
19          <li>One</li>
20          <li>Two</li>
21          <li>Three</li>
22       </ul>
23    </body>
24 </html>
```

Fig. 10.1 | Demonstration of a document's DOM tree. (Part 1 of 3.)

a) The XHTML document is rendered in Firefox.

b) The Firefox DOM inspector displays the document tree in the left panel. The right panel shows information about the currently selected node.

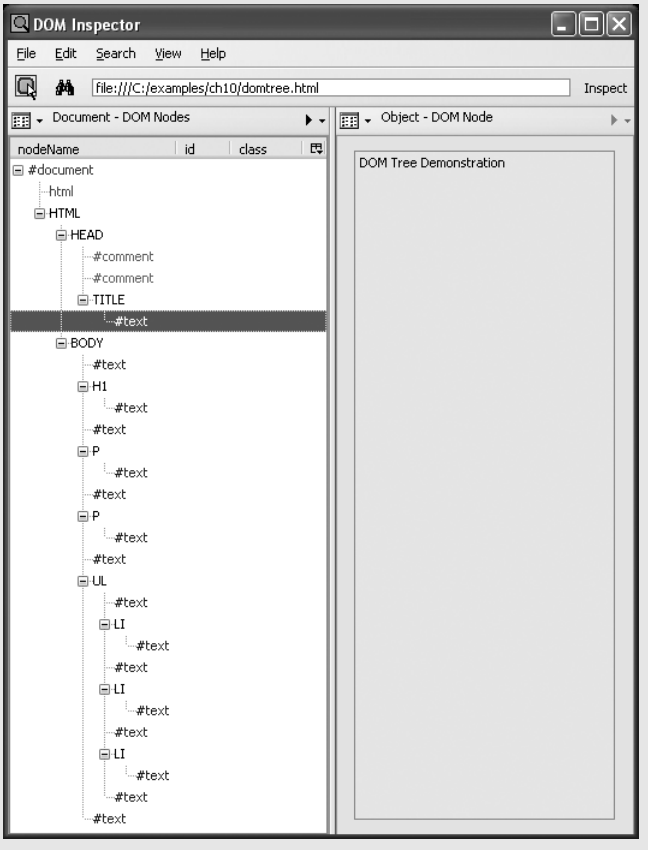


Fig. 10.1 | Demonstration of a document's DOM tree. (Part 2 of 3.)

c) The Internet Explorer Web Developer Toolbar displays much of the same information as the DOM inspector in Firefox in a panel at the bottom of the browser window.

Fig. 10.1 | Demonstration of a document's DOM tree. (Part 3 of 3.)

has a child text node (**#text**) containing the text **DOM Tree Demonstration**, visible in the right pane of the DOM inspector when the text node is selected. The **BODY** node contains nodes representing each of the elements in the page. Note that the **LI** nodes are children of the **UL** node, since they are nested inside it.

Also, notice that, in addition to the text nodes representing the text inside the body, paragraphs and list elements, a number of other text nodes appear in the document. These text nodes contain nothing but white space. When Firefox parses an XHTML document into a DOM tree, the white space between sibling elements is interpreted as text and placed inside text nodes. Internet Explorer ignores white space and does not convert it into empty text nodes. If you run this example on your own computer, you will notice that the **BODY** node has a **#comment** child node not present above in both the Firefox and Internet Explorer DOM trees. This is a result of the copyright line at the end of the example file that you downloaded.

This section introduced the concept of DOM nodes and DOM trees. The next section considers DOM nodes in more detail, discussing methods and properties of DOM nodes that allow you to modify the DOM tree of a document using JavaScript.

10.3 Traversing and Modifying a DOM Tree

The DOM gives you access to the elements of a document, allowing you to modify the contents of a page dynamically using event-driven JavaScript. This section introduces

properties and methods of all DOM nodes that enable you to traverse the DOM tree, modify nodes and create or delete content dynamically.

Figure 10.2 shows some of the functionality of DOM nodes, as well as two additional methods of the `document` object. The program allows you to highlight, modify, insert and remove elements.

Lines 117–132 contain basic XHTML elements and content. Each element has an `id` attribute, which is also displayed at the beginning of the element in square brackets. For example, the `id` of the `h1` element in lines 117–118 is set to `bigheading`, and the heading text begins with `[bigheading]`. This allows the user to see the `id` of each element in the page. The body also contains an `h3` heading, several `p` elements, and an unordered list.

A `div` element (lines 133–162) contains the remainder of the XHTML `body`. Line 134 begins a `form` element, assigning the empty string to the required `action` attribute (because we're not submitting to a server) and returning `false` to the `onsubmit` attribute. When a `form`'s `onsubmit` handler returns `false`, the navigation to the address specified in the `action` attribute is aborted. This allows us to modify the page using JavaScript event handlers without reloading the original, unmodified XHTML.

```
1  <?xml version = "1.0" encoding = "utf-8"?>
2  <!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
3     "http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
4
5  <!-- Fig. 10.2: dom.html -->
6  <!-- Basic DOM functionality. -->
7  <html xmlns = "http://www.w3.org/1999/xhtml">
8     <head>
9        <title>Basic DOM Functionality</title>
10       <style type = "text/css">
11          h1, h3       { text-align: center;
12                         font-family: tahoma, geneva, sans-serif }
13          p            { margin-left: 5%;
14                         margin-right: 5%;
15                         font-family: arial, helvetica, sans-serif }
16          ul           { margin-left: 10% }
17          a            { text-decoration: none }
18          a:hover      { text-decoration: underline }
19          .nav         { width: 100%;
20                         border-top: 3px dashed blue;
21                         padding-top: 10px }
22          .highlighted { background-color: yellow }
23          .submit      { width: 120px }
24       </style>
25       <script type = "text/javascript">
26          <!--
27          var currentNode; // stores the currently highlighted node
28          var idcount = 0; // used to assign a unique id to new elements
29
30          // get and highlight an element by its id attribute
31          function byId()
32          {
```

Fig. 10.2 | Basic DOM functionality. (Part 1 of 8.)

```
33             var id = document.getElementById( "gbi" ).value;
34             var target = document.getElementById( id );
35
36             if ( target )
37                switchTo( target );
38          } // end function byId
39
40          // insert a paragraph element before the current element
41          // using the insertBefore method
42          function insert()
43          {
44             var newNode = createNewNode(
45                document.getElementById( "ins" ).value );
46             currentNode.parentNode.insertBefore( newNode, currentNode );
47             switchTo( newNode );
48          } // end function insert
49
50          // append a paragraph node as the child of the current node
51          function appendNode()
52          {
53             var newNode = createNewNode(
54                document.getElementById( "append" ).value );
55             currentNode.appendChild( newNode );
56             switchTo( newNode );
57          } // end function appendNode
58
59          // replace the currently selected node with a paragraph node
60          function replaceCurrent()
61          {
62             var newNode = createNewNode(
63                document.getElementById( "replace" ).value );
64             currentNode.parentNode.replaceChild( newNode, currentNode );
65             switchTo( newNode );
66          } // end function replaceCurrent
67
68          // remove the current node
69          function remove()
70          {
71             if ( currentNode.parentNode == document.body )
72                alert( "Can't remove a top-level element." );
73             else
74             {
75                var oldNode = currentNode;
76                switchTo( oldNode.parentNode );
77                currentNode.removeChild( oldNode );
78             } // end else
79          } // end function remove
80
81          // get and highlight the parent of the current node
82          function parent()
83          {
84             var target = currentNode.parentNode;
85
```

Fig. 10.2 | Basic DOM functionality. (Part 2 of 8.)

```
86             if ( target != document.body )
87                switchTo( target );
88             else
89                alert( "No parent." );
90          } // end function parent
91
92          // helper function that returns a new paragraph node containing
93          // a unique id and the given text
94          function createNewNode( text )
95          {
96             var newNode = document.createElement( "p" );
97             nodeId = "new" + idcount;
98             ++idcount;
99             newNode.id = nodeId;
100            text = "[" + nodeId + "] " + text;
101            newNode.appendChild(document.createTextNode( text ) );
102            return newNode;
103         } // end function createNewNode
104
105         // helper function that switches to a new currentNode
106         function switchTo( newNode )
107         {
108            currentNode.className = ""; // remove old highlighting
109            currentNode = newNode;
110            currentNode.className = "highlighted"; // highlight new node
111            document.getElementById( "gbi" ).value = currentNode.id;
112         } // end function switchTo
113         // -->
114      </script>
115   </head>
116   <body onload = "currentNode = document.getElementById( 'bigheading' )">
117      <h1 id = "bigheading" class = "highlighted">
118         [bigheading] DHTML Object Model</h1>
119      <h3 id = "smallheading">[smallheading] Element Functionality</h3>
120      <p id = "para1">[para1] The Document Object Model (DOM) allows for
121         quick, dynamic access to all elements in an XHTML document for
122         manipulation with JavaScript.</p>
123      <p id = "para2">[para2] For more information, check out the
124         "JavaScript and the DOM" section of Deitel's
125         <a id = "link" href = "http://www.deitel.com/javascript">
126            [link] JavaScript Resource Center.</a></p>
127      <p id = "para3">[para3] The buttons below demonstrate:(list)</p>
128      <ul id = "list">
129         <li id = "item1">[item1] getElementById and parentNode</li>
130         <li id = "item2">[item2] insertBefore and appendChild</li>
131         <li id = "item3">[item3] replaceChild and removeChild </li>
132      </ul>
133      <div id = "nav" class = "nav">
134         <form onsubmit = "return false" action = "">
135            <table>
136               <tr>
137                  <td><input type = "text" id = "gbi"
138                     value = "bigheading" /></td>
```

Fig. 10.2 | Basic DOM functionality. (Part 3 of 8.)

```
                  <td><input type = "submit" value = "Get By id"
                     onclick = "byId()" class = "submit" /></td>
               </tr><tr>
                  <td><input type = "text" id = "ins" /></td>
                  <td><input type = "submit" value = "Insert Before"
                     onclick = "insert()" class = "submit" /></td>
               </tr><tr>
                  <td><input type = "text" id = "append" /></td>
                  <td><input type = "submit" value = "Append Child"
                     onclick = "appendNode()" class = "submit" /></td>
               </tr><tr>
                  <td><input type = "text" id = "replace" /></td>
                  <td><input type = "submit" value = "Replace Current"
                     onclick = "replaceCurrent()" class = "submit" /></td>
               </tr><tr><td />
                  <td><input type = "submit" value = "Remove Current"
                     onclick = "remove()" class = "submit" /></td>
               </tr><tr><td />
                  <td><input type = "submit" value = "Get Parent"
                     onclick = "parent()" class = "submit" /></td>
               </tr>
            </table>
         </form>
      </div>
   </body>
</html>
```

a) This is the page when it first loads. It begins with the large heading highlighted.

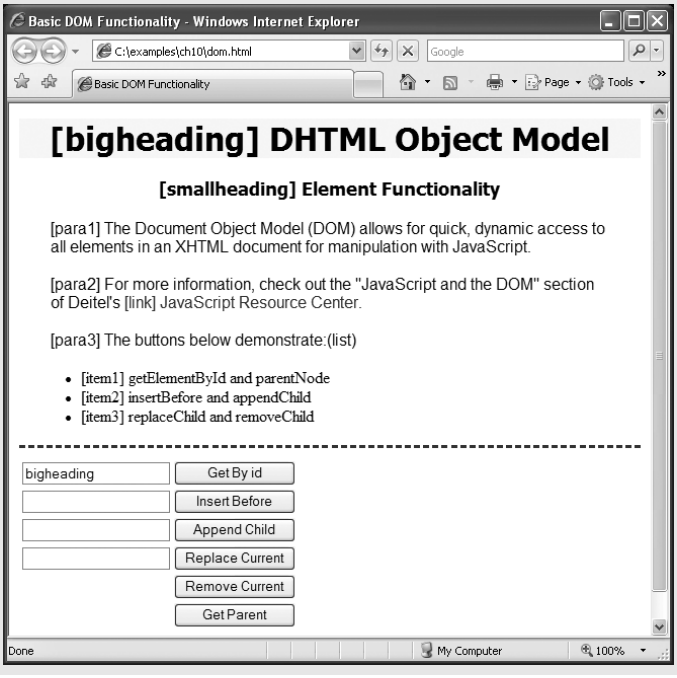
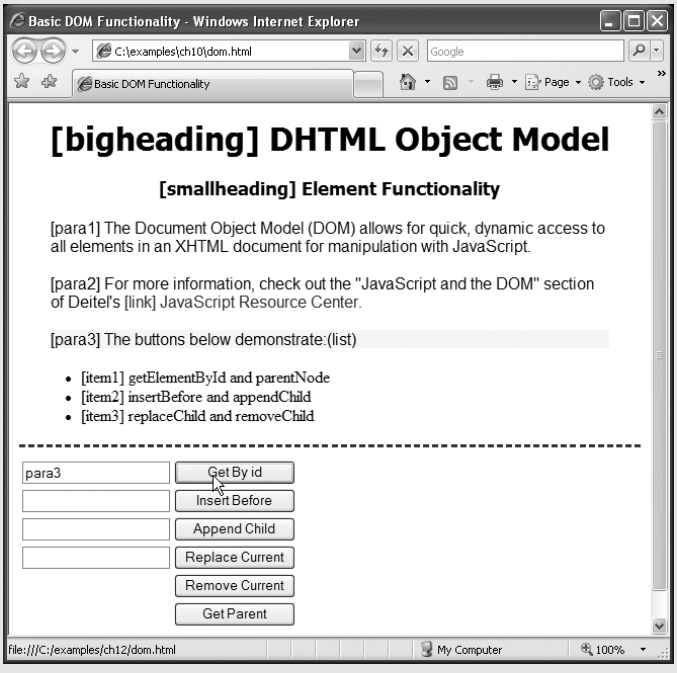


Fig. 10.2 | Basic DOM functionality. (Part 4 of 8.)

b) This is the document after using the **Get By id** button to select para3.



c) This is the document after inserting a new paragraph before the selected one.

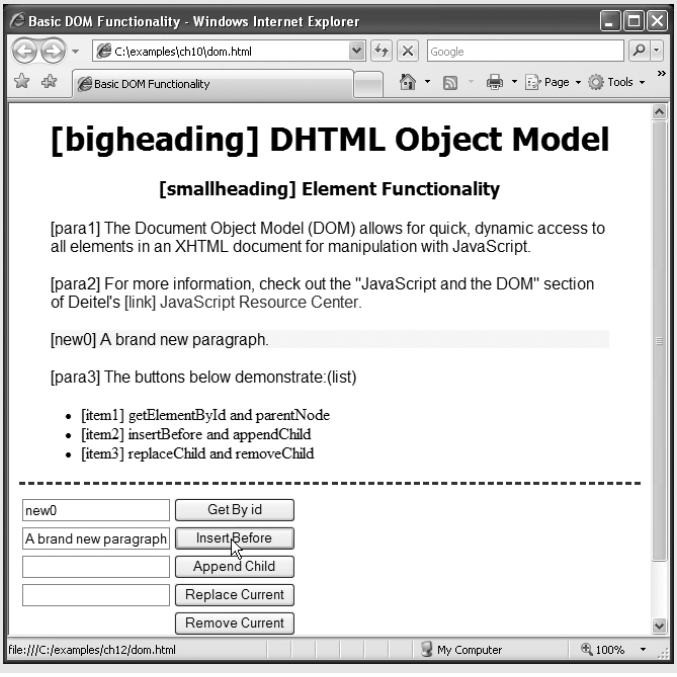
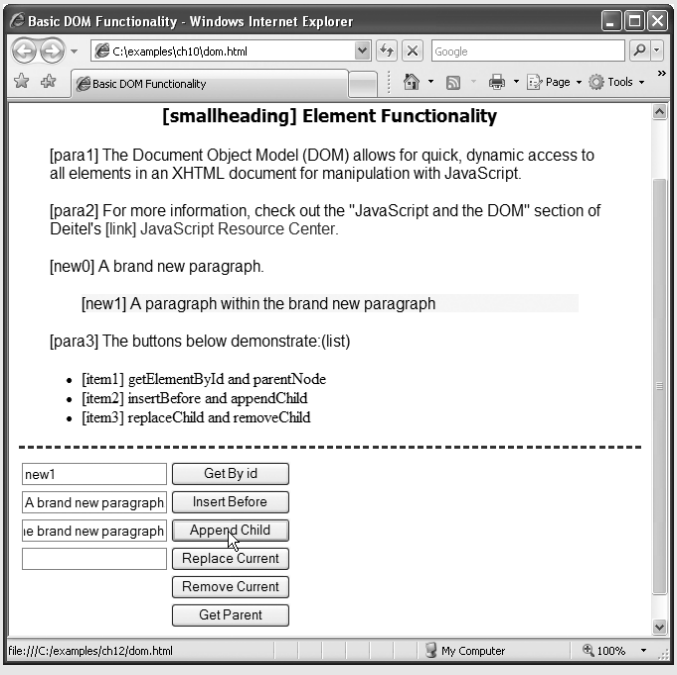


Fig. 10.2 | Basic DOM functionality. (Part 5 of 8.)

d) Using the **Append Child** button, a child paragraph is created.



e) The selected paragraph is replaced with a new one.

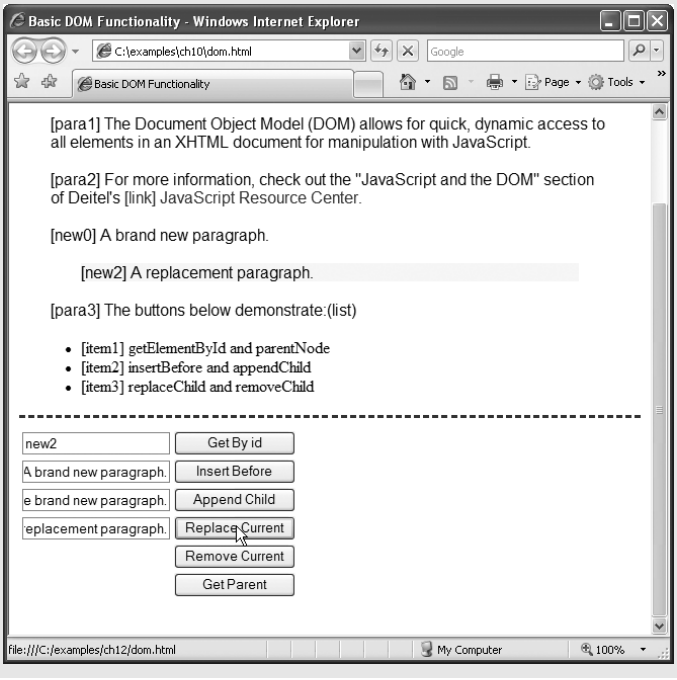
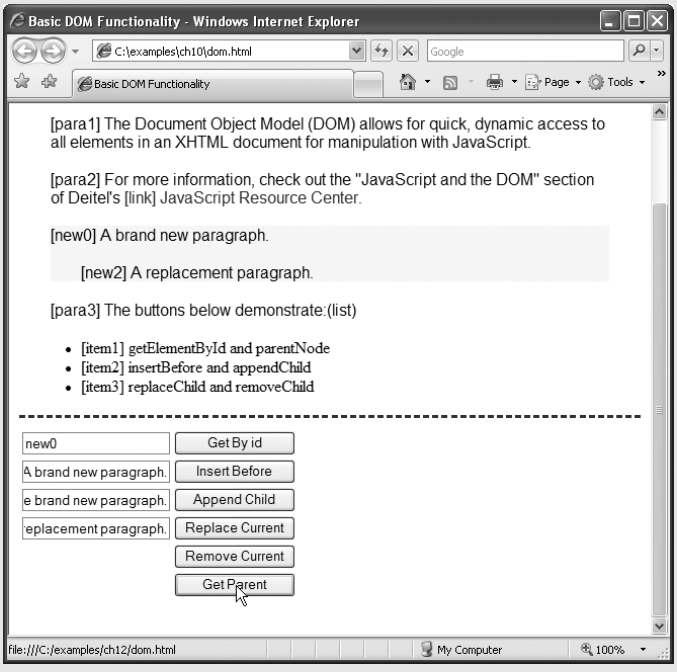


Fig. 10.2 | Basic DOM functionality. (Part 6 of 8.)

f) The **Get Parent** button gets the parent of the selected node.



g) Now we select the first list item.

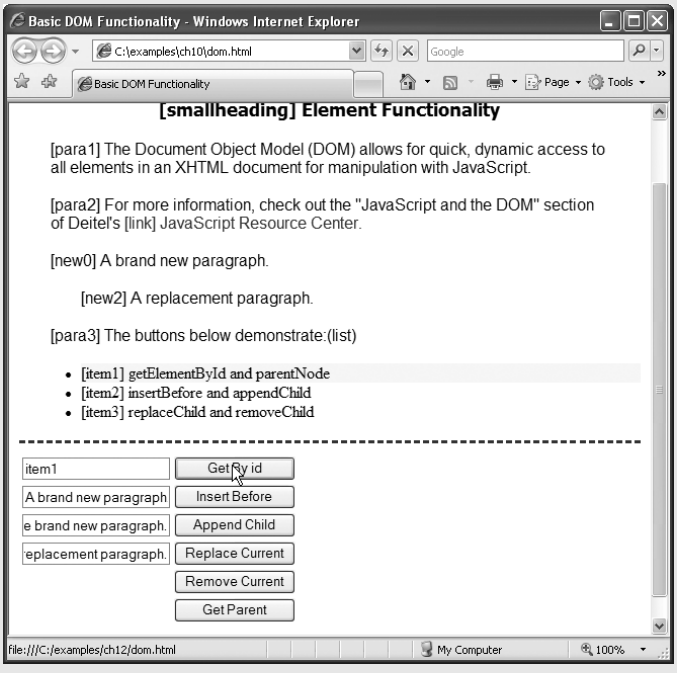


Fig. 10.2 | Basic DOM functionality. (Part 7 of 8.)

h) The **Remove Current** button removes the current node and selects its parent.

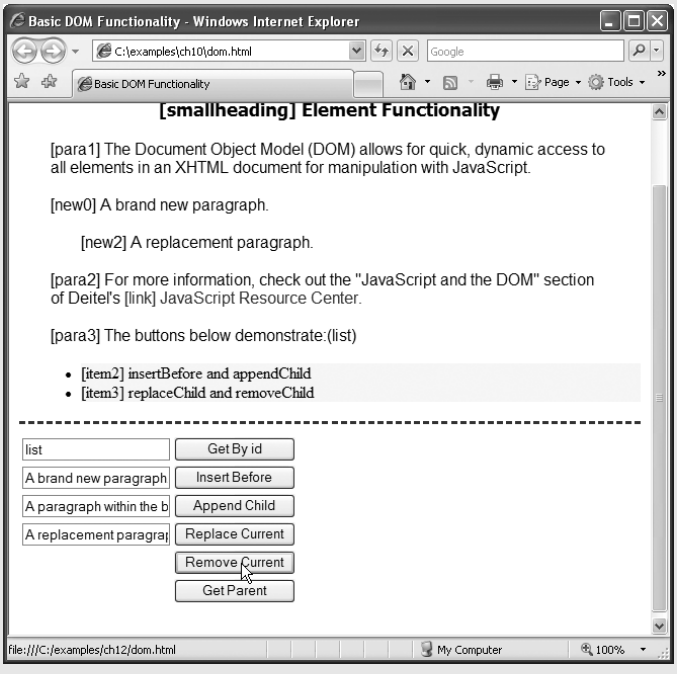


Fig. 10.2 | Basic DOM functionality. (Part 8 of 8.)

A `table` (lines 135–160) contains the controls for modifying and manipulating the elements on the page. Each of the six buttons calls its own event-handling function to perform the action described by its `value`.

The JavaScript code begins by declaring two variables. The variable `currentNode` (line 27) keeps track of the currently highlighted node, because the functionality of the buttons depends on which node is currently selected. The `body`'s `onload` attribute (line 116) initializes `currentNode` to the `h1` element with `id` `bigheading`. Variable `idcount` (line 28) is used to assign a unique `id` to any new elements that are created. The remainder of the JavaScript code contains event handling functions for the XHTML buttons and two helper functions that are called by the event handlers. We now discuss each button and its corresponding event handler in detail.

Finding and Highlighting an Element Using `getElementById` *and* `className`

The first row of the table (lines 136-141) allows the user to enter the `id` of an element into the text field (lines 137–138) and click the `Get By Id` button (lines 139–140) to find and highlight the element, as shown in Fig. 10.2(b) and (g). The `onclick` attribute sets the button's event handler to function `byId`.

The `byId` function is defined in lines 31–38. Line 33 uses `getElementById` to assign the contents of the text field to variable `id`. Line 34 uses `getElementById` again to find the element whose `id` attribute matches the contents of variable `id`, and assign it to variable `target`. If an element is found with the given `id`, `getElementById` returns an object rep-

resenting that element. If no element is found, `getElementById` returns `null`. Line 36 checks whether `target` is an object—recall that any object used as a boolean expression is `true`, while `null` is `false`. If `target` evaluates to `true`, line 37 calls the `switchTo` function with `target` as its argument.

The `switchTo` function, defined in lines 106–112, is used throughout the program to highlight a new element in the page. The current element is given a yellow background using the style class `highlighted`, defined in line 22. Line 108 sets the current node's `className` property to the empty string. The ***`className` property*** allows you to change an XHTML element's `class` attribute. In this case, we clear the `class` attribute in order to remove the `highlighted` class from the `currentNode` before we highlight the new one.

Line 109 assigns the `newNode` object (passed into the function as a parameter) to variable `currentNode`. Line 110 adds the `highlighted` style class to the new `currentNode` using the `className` property.

Finally, line 111 uses the ***`id` property*** to assign the current node's `id` to the input field's value property. Just as `className` allows access to an element's `class` attribute, the `id` property controls an element's `id` attribute. While this isn't necessary when `switchTo` is called by `byId`, we will see shortly that other functions call `switchTo`. This line makes sure that the text field's value is consistent with the currently selected node's `id`. Having found the new element, removed the highlighting from the old element, updated the `currentNode` variable and highlighted the new element, the program has finished selecting a new node by a user-entered `id`.

Creating and Inserting Elements Using `insertBefore` and `appendChild`

The next two table rows allow the user to create a new element and insert it before the current node or as a child of the current node. The second row (lines 141–145) allows the user to enter text into the text field and click the `Insert Before` button. The text is placed in a new paragraph element, which is then inserted into the document before the currently selected element, as in Fig. 10.2(c). The button in lines 143–144 calls the `insert` function, defined in lines 42–48.

Lines 44–45 call the function `createNewNode`, passing it the value of the input field (whose `id` is `ins`) as an argument. Function `createNewNode`, defined in lines 94–103, creates a paragraph node containing the text passed to it. Line 96 creates a `p` element using the `document` object's ***`createElement` method***. The `createElement` method creates a new DOM node, taking the tag name as an argument. Note that while `createElement` *creates* an element, it does not *insert* the element on the page.

Line 97 creates a unique `id` for the new element by concatenating `"new"` and the value of `idcount` before incrementing `idcount` in line 98. Line 99 assigns the `id` to the new element. Line 100 concatenates the element's `id` in square brackets to the beginning of `text` (the parameter containing the paragraph's text).

Line 101 introduces two new methods. The `document`'s ***`createTextNode` method*** creates a node that can contain only text. Given a string argument, `createTextNode` inserts the string into the text node. In line 101, we create a new text node containing the contents of variable `text`. This new node is then used (still in line 101) as the argument to the ***`appendChild` method***, which is called on the paragraph node. Method `appendChild` is called on a parent node to insert a child node (passed as an argument) after any existing children.

After the p element is created, line 102 returns the node to the calling function insert, where it is assigned to variable newNode in lines 44–45. Line 46 inserts the newly created node before the currently selected node. The ***parentNode property*** of any DOM node contains the node's parent. In line 46, we use the parentNode property of currentNode to get its parent.

We call the insertBefore method (line 46) on the parent with newNode and currentNode as its arguments to insert newNode as a child of the parent directly before currentNode. The general syntax of the ***insertBefore method*** is

parent.insertBefore(*newChild*, *existingChild*);

The method is called on a parent with the new child and an existing child as arguments. The node *newChild* is inserted as a child of *parent* directly before *existingChild*. Line 47 uses the switchTo function (discussed earlier in this section) to update the currentNode to the newly inserted node and highlight it in the XHTML page.

The third table row (lines 145–149) allows the user to append a new paragraph node as a child of the current element, demonstrated in Fig. 10.2(d). This features uses a similar procedure to the insertBefore functionality. Lines 53–54 in function appendNode create a new node, line 55 inserts it as a child of the current node, and line 56 uses switchTo to update currentNode and highlight the new node.

Replacing and Removing Elements Using replaceChild *and* removeChild

The next two table rows (lines 149–156) allow the user to replace the current element with a new p element or simply remove the current element. Lines 150–152 contain a text field and a button that replaces the currently highlighted element with a new paragraph node containing the text in the text field. This feature is demonstrated in Fig. 10.2(e).

The button in lines 151–152 calls function replaceCurrent, defined in lines 60–66. Lines 62–63 call createNewNode, in the same way as in insert and appendNode, getting the text from the correct input field. Line 64 gets the parent of currentNode, then calls the replaceChild method on the parent. The ***replaceChild method*** works as follows:

parent.replaceChild(*newChild*, *oldChild*);

The *parent*'s replaceChild method inserts *newChild* into its list of children in place of *oldChild*.

The Remove Current feature, shown in Fig. 10.2(h), removes the current element entirely and highlights the parent. No text field is required because a new element is not being created. The button in lines 154-155 calls the remove function, defined in lines 69–79. If the node's parent is the body element, line 72 alerts an error—the program does not allow the entire body element to be selected. Otherwise, lines 75–77 remove the current element. Line 75 stores the old currentNode in variable oldNode. We do this to maintain a reference to the node to be removed after we've changed the value of currentNode. Line 76 calls switchTo to highlight the parent node.

Line 77 uses the ***removeChild method*** to remove the oldNode (a child of the new currentNode) from its place in the XHTML document. In general,

parent.removeChild(*child*);

looks in *parent*'s list of children for *child* and removes it.

The final button (lines 157–158) selects and highlights the parent element of the currently highlighted element by calling the `parent` function, defined in lines 82–90. Function `parent` simply gets the parent node (line 84), makes sure it is not the `body` element, (line 86) and calls `switchTo` to highlight it (line 87). Line 89 alerts an error if the parent node is the `body` element. This feature is shown in Fig. 10.2(f).

This section introduced the basics of DOM tree traversal and manipulation. Next, we introduce the concept of collections, which give you access to multiple elements in a page.

10.4 DOM Collections

Included in the Document Object Model is the notion of ***collections***, which are groups of related objects on a page. DOM collections are accessed as properties of DOM objects such as the `document` object or a DOM node. The document object has properties containing the ***`images` collection***, ***`links` collection***, ***`forms` collection*** and ***`anchors` collection***. These collections contain all the elements of the corresponding type on the page. Figure 10.3 gives an example that uses the `links` collection to extract all of the links on a page and display them together at the bottom of the page.

```
1  <?xml version = "1.0" encoding = "utf-8"?>
2  <!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
3     "http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
4
5  <!-- Fig. 10.3: collections.html -->
6  <!-- Using the links collection. -->
7  <html xmlns = "http://www.w3.org/1999/xhtml">
8     <head>
9        <title>Using Links Collection</title>
10       <style type = "text/css">
11          body          { font-family: arial, helvetica, sans-serif }
12          h1            { font-family: tahoma, geneva, sans-serif;
13                          text-align: center }
14          p             { margin: 5% }
15          p a           { color: #aa0000 }
16          .links        { font-size: 14px;
17                          text-align: justify;
18                          margin-left: 10%;
19                          margin-right: 10% }
20          .link a       { text-decoration: none }
21          .link a:hover { text-decoration: underline }
22       </style>
23       <script type = "text/javascript">
24          <!--
25          function processlinks()
26          {
27             var linkslist = document.links; // get the document's links
28             var contents = "Links in this page:\n<br />| ";
29
30             // concatenate each link to contents
31             for ( var i = 0; i < linkslist.length; i++ )
32             {
```

Fig. 10.3 | Using the `links` collection. (Part 1 of 2.)

```
33                var currentLink = linkslist[ i ];
34                contents += "<span class = 'link'>" +
35                   currentLink.innerHTML.link( currentLink.href ) +
36                   "</span> | ";
37             } // end for
38
39             document.getElementById( "links" ).innerHTML = contents;
40          } // end function processlinks
41          // -->
42       </script>
43    </head>
44    <body onload = "processlinks()">
45       <h1>Deitel Resource Centers</h1>
46       <p><a href = "http://www.deitel.com/">Deitel's website</a> contains
47          a rapidly growing
48          <a href = "http://www.deitel.com/ResourceCenters.html">list of
49          Resource Centers</a> on a wide range of topics. Many Resource
50          centers related to topics covered in this book,
51          <a href = "http://www.deitel.com/iw3htp4">Internet and World Wide
52          Web How to Program, 4th Edition</a>. We have Resouce Centers on
53          <a href = "http://www.deitel.com/Web2.0">Web 2.0</a>,
54          <a href = "http://www.deitel.com/Firefox">Firefox</a> and
55          <a href = "http://www.deitel.com/IE7">Internet Explorer 7</a>,
56          <a href = "http://www.deitel.com/XHTML">XHTML</a>, and
57          <a href = "http://www.deitel.com/JavaScript">JavaScript</a>.
58          Watch the list of Deitel Resource Centers for related new
59          Resource Centers.</p>
60       <div id = "links" class = "links"></div>
61    </body>
62 </html>
```

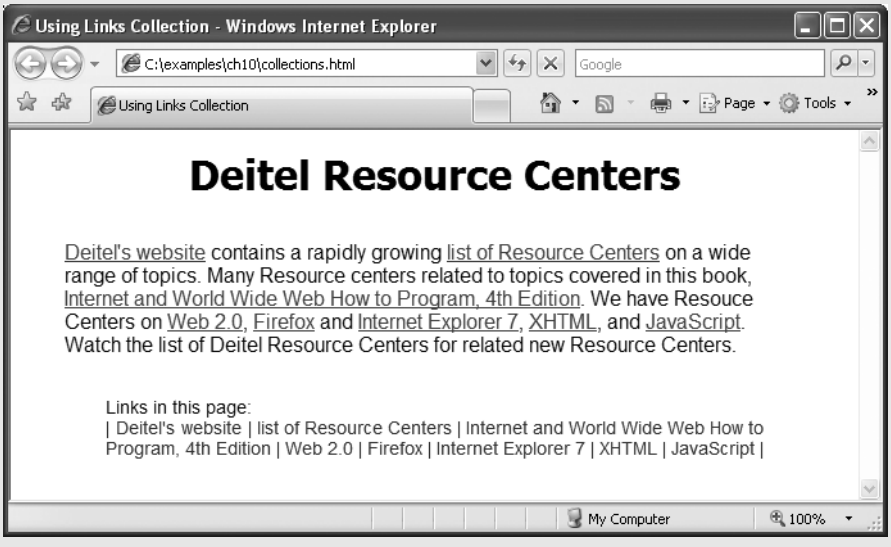


Fig. 10.3 | Using the `links` collection. (Part 2 of 2.)

The XHTML body contains a paragraph (lines 46–59) with links at various places in the text and an empty `div` (line 60) with `id` `links`. The `body`'s `onload` attribute specifies that the `processlinks` method is called when the `body` finishes loading.

Method `processlinks` declares variable `linkslist` (line 27) to store the `document`'s `links` collection, which is accessed as the `links` property of the `document` object. Line 28 creates the string (`contents`) that will contain all the document's links, to be inserted into the `links` `div` later. Line 31 begins a `for` statement to iterate through each link. To find the number of elements in the collection, we use the collection's ***`length` property***.

Line 33 inside the `for` statement creates a variable (`currentlink`) that stores the current link. Note that we can access the collection stored in `linkslist` using indices in square brackets, just as we did with arrays. DOM collections are stored in objects which have only one property and two methods—the `length` property, the ***`item` method*** and the ***`namedItem` method***. The `item` method—an alternative to the square bracketed indices—can be used to access specific elements in a collection by taking an index as an argument. The `namedItem` method takes a name as a parameter and finds the element in the collection, if any, whose `id` attribute or `name` attribute matches it.

Lines 34–36 add a `span` element to the `contents` string containing the current link. Recall that the `link` method of a string object returns the string as a link to the URL passed to the method. Line 35 uses the `link` method to create an `a` (anchor) element containing the proper text and `href` attribute.

Notice that variable `currentLink` (a DOM node representing an `a` element) has a specialized ***`href` property*** to refer to the link's `href` attribute. Many types of XHTML elements are represented by special types of nodes that extend the functionality of a basic DOM node. Line 39 inserts the contents into the empty `div` with `id` `"links"` (line 60) in order to show all the links on the page in one location.

Collections allow easy access to all elements of a single type in a page. This is useful for gathering elements into one place and for applying changes across an entire page. For example, the forms collection could be used to disable all form inputs after a submit button has been pressed to avoid multiple submissions while the next page loads. The next section discusses how to dynamically modify CSS styles using JavaScript and DOM nodes.

10.5 Dynamic Styles

An element's style can be changed dynamically. Often such a change is made in response to user events, which we discuss in Chapter 11. Such style changes can create many effects, including mouse hover effects, interactive menus, and animations. Figure 10.4 is a simple example that changes the `background-color` style property in response to user input.

```
1  <?xml version = "1.0" encoding = "utf-8"?>
2  <!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
3     "http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
4
5  <!-- Fig. 10.4: dynamicstyle.html -->
6  <!-- Dynamic styles. -->
7  <html xmlns = "http://www.w3.org/1999/xhtml">
8     <head>
```

Fig. 10.4 | Dynamic styles. (Part 1 of 2.)

```
 9        <title>Dynamic Styles</title>
10        <script type = "text/javascript">
11           <!--
12           function start()
13           {
14              var inputColor = prompt( "Enter a color name for the " +
15                 "background of this page", "" );
16              document.body.style.backgroundColor = inputColor;
17           } // end function start
18           // -->
19        </script>
20     </head>
21     <body id = "body" onload = "start()">
22        <p>Welcome to our website!</p>
23     </body>
24  </html>
```

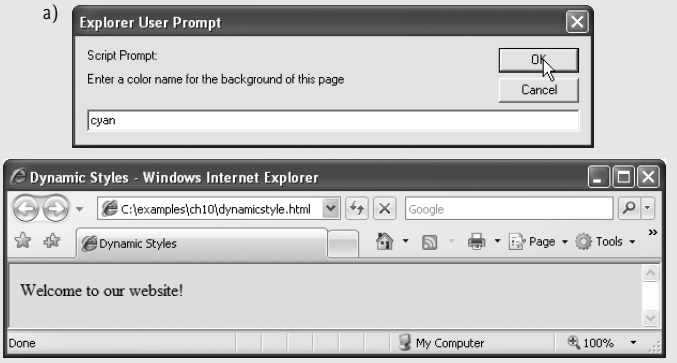


Fig. 10.4 | Dynamic styles. (Part 2 of 2.)

Function `start` (lines 12–17) `prompt`s the user to enter a color name, then sets the background color to that value. [*Note:* An error occurs if the value entered is not a valid color.] We refer to the background color as `document.body.style.backgroundColor`—the ***body property*** of the `document` object refers to the `body` element. We then use the `style` property (a property of most XHTML elements) to set the `background-color` CSS property. This is referred to as `backgroundColor` in JavaScript—the hyphen is removed to avoid confusion with the subtraction (-) operator. This naming convention is consistent for most CSS properties. For example, `borderWidth` correlates to the `border-width` CSS property, and `fontFamily` correlates to the `font-family` CSS property. In general, CSS properties are accessed in the format *node*`.style.`*styleproperty*.

Figure 10.5 introduces the `setInterval` and `clearInterval` methods of the `window` object, combining them with dynamic styles to create animated effects. This example is a basic image viewer that allows you to select a Deitel book cover and view it in a larger size. When one of the thumbnail images on the right is clicked, the larger version grows from the top-left corner of the main image area.

The `body` (lines 66–85) contains two `div` elements, both floated `left` using styles defined in lines 14 and 17 in order to present them side by side. The left `div` contains the full-size image `iw3htp4.jpg`, the cover of this book, which appears when the page loads.

The right `div` contains six thumbnail images which respond to the click event by calling the `display` method and passing it the filename of the corresponding full-size image.

The `display` function (lines 46–62) dynamically updates the image in the left `div` to the one corresponding to the user's click. Lines 48–49 prevent the rest of the function from executing if `interval` is defined (i.e., an animation is in progress.) Line 51 gets the left `div` by its `id`, `imgCover`. Line 52 creates a new `img` element. Lines 53–55 set its `id` to `imgCover`, set its `src` to the correct image file in the `fullsize` directory, and set its required `alt` attribute. Lines 56–59 do some additional initialization before beginning the animation in line 61. To create the growing animation effect, lines 57–58 set the image `width` and `height` to `0`. Line 59 replaces the current `bigImage` node with `newNode` (created in line 52), and line 60 sets `count`, the variable that controls the animation, to `0`.

Line 61 introduces the `window` object's ***`setInterval` method***, which starts the animation. This method takes two parameters—a statement to execute repeatedly, and an integer specifying how often to execute it, in milliseconds. We use `setInterval` to call

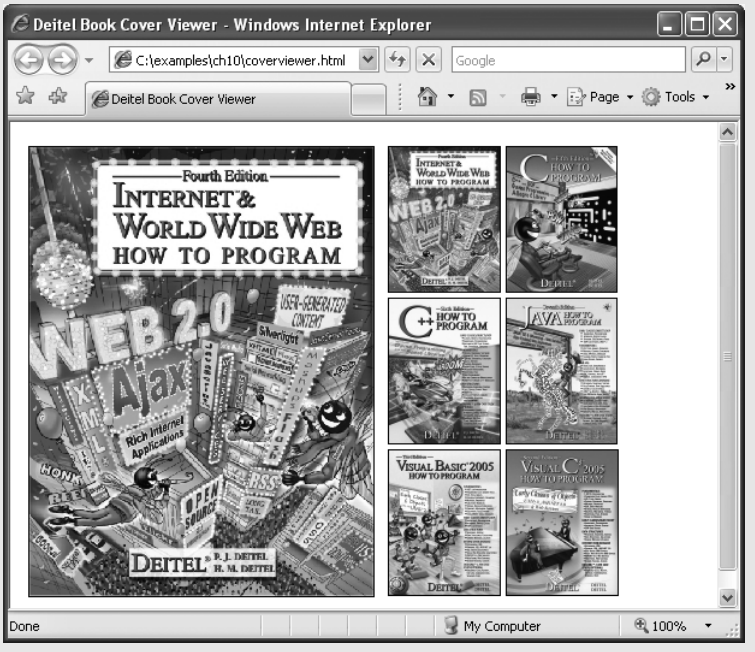
```
1  <?xml version = "1.0" encoding = "utf-8"?>
2  <!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
3     "http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
4
5  <!-- Fig. 10.5: coverviewer.html -->
6  <!-- Dynamic styles used for animation. -->
7  <html xmlns = "http://www.w3.org/1999/xhtml">
8     <head>
9        <title>Deitel Book Cover Viewer</title>
10       <style type = "text/css">
11          .thumbs   { width: 192px;
12                      height: 370px;
13                      padding: 5px;
14                      float: left }
15          .mainimg  { width: 289px;
16                      padding: 5px;
17                      float: left }
18          .imgCover { height: 373px }
19          img       { border: 1px solid black }
20       </style>
21       <script type = "text/javascript">
22          <!--
23          var interval = null; // keeps track of the interval
24          var speed = 6; // determines the speed of the animation
25          var count = 0; // size of the image during the animation
26
27          // called repeatedly to animate the book cover
28          function run()
29          {
30             count += speed;
31
32             // stop the animation when the image is large enough
33             if ( count >= 375 )
34             {
```

Fig. 10.5 | Dynamic styles used for animation. (Part 1 of 4.)

```
35                window.clearInterval( interval );
36                interval = null;
37             } // end if
38
39             var bigImage = document.getElementById( "imgCover" );
40             bigImage.style.width = .7656 * count + "px";
41             bigImage.style.height = count + "px";
42          } // end function run
43
44          // inserts the proper image into the main image area and
45          // begins the animation
46          function display( imgfile )
47          {
48             if ( interval )
49                return;
50
51             var bigImage = document.getElementById( "imgCover" );
52             var newNode = document.createElement( "img" );
53             newNode.id = "imgCover";
54             newNode.src = "fullsize/" + imgfile;
55             newNode.alt = "Large image";
56             newNode.className = "imgCover";
57             newNode.style.width = "0px";
58             newNode.style.height = "0px";
59             bigImage.parentNode.replaceChild( newNode, bigImage );
60             count = 0; // start the image at size 0
61             interval = window.setInterval( "run()", 10 ); // animate
62          } // end function display
63          // -->
64       </script>
65    </head>
66    <body>
67       <div id = "mainimg" class = "mainimg">
68          <img id = "imgCover" src = "fullsize/iw3htp4.jpg"
69             alt = "Full cover image" class = "imgCover" />
70       </div>
71       <div id = "thumbs" class = "thumbs" >
72          <img src = "thumbs/iw3htp4.jpg" alt = "iw3htp4"
73             onclick = "display( 'iw3htp4.jpg' )" />
74          <img src = "thumbs/chtp5.jpg" alt = "chtp5"
75             onclick = "display( 'chtp5.jpg' )" />
76          <img src = "thumbs/cpphtp6.jpg" alt = "cpphtp6"
77             onclick = "display( 'cpphtp6.jpg' )" />
78          <img src = "thumbs/jhtp7.jpg" alt = "jhtp7"
79             onclick = "display( 'jhtp7.jpg' )" />
80          <img src = "thumbs/vbhtp3.jpg" alt = "vbhtp3"
81             onclick = "display( 'vbhtp3.jpg' )" />
82          <img src = "thumbs/vcsharphtp2.jpg" alt = "vcsharphtp2"
83             onclick = "display( 'vcsharphtp2.jpg' )" />
84       </div>
85    </body>
86 </html>
```

Fig. 10.5 | Dynamic styles used for animation. (Part 2 of 4.)

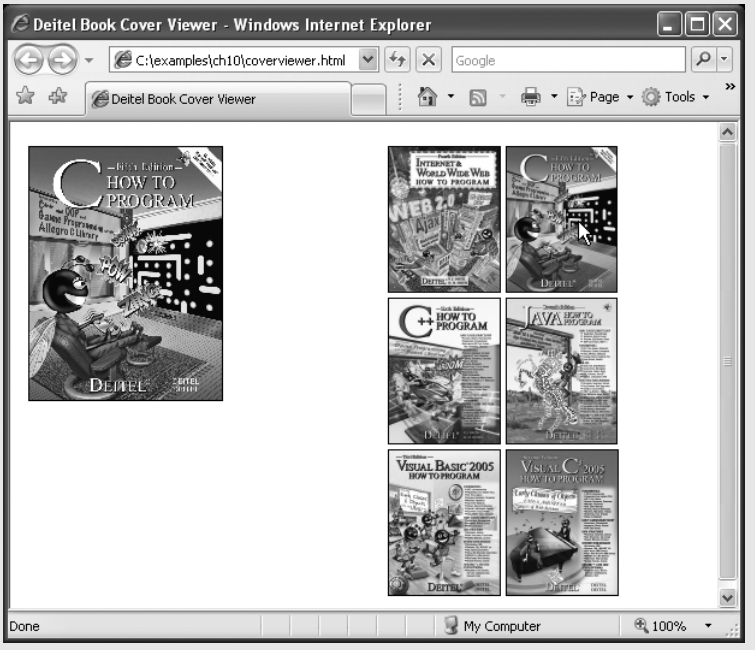
a) The cover viewer page loads with the cover of this book.



b) When the user clicks the thumbnail of *C How to Program*, the full-size image begins growing from the top-left corner of the window.

Fig. 10.5 | Dynamic styles used for animation. (Part 3 of 4.)

c) The cover continues to grow.



d) The animation finishes when the cover reaches its full size.

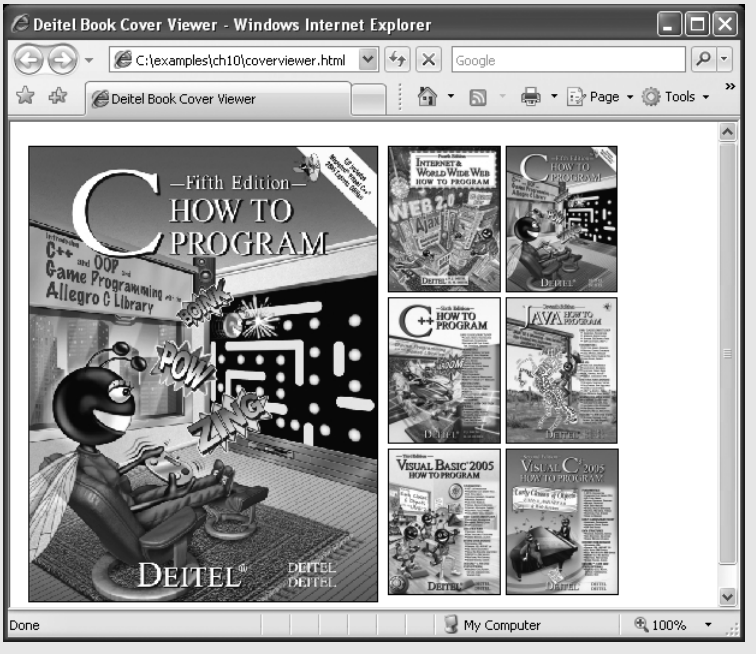


Fig. 10.5 | Dynamic styles used for animation. (Part 4 of 4.)

function `run` every `10` milliseconds. The `setInterval` method returns a unique identifier to keep track of that particular interval—we assign this identifier to the variable `interval`. We use this identifier to stop the animation when the image has finished growing.

The `run` function, defined in lines 28–42, increases the height of the image by the value of `speed` and updates its width accordingly to keep the aspect ratio consistent. Because the `run` function is called every 10 milliseconds, this increase happens repeatedly to create an animated growing effect. Line 30 adds the value of `speed` (declared and initialized to `6` in line 24) to `count`, which keeps track of the animation's progress and dictates the current size of the image. If the image has grown to its full `height` (`375`), line 35 uses the `window`'s ***`clearInterval` method*** to stop the repetitive calls of the `run` method. We pass to `clearInterval` the interval identifier (stored in `interval`) that `setInterval` created in line 61. Although it seems unnecessary in this script, this identifier allows the script to keep track of multiple intervals running at the same time and to choose which interval to stop when calling `clearInterval`.

Line 39 gets the image and lines 40–41 set its `width` and `height` CSS properties. Note that line 40 multiplies count by a scaling factor of `.7656` in order to keep the ratio of the image's dimensions consistent with the actual dimensions of the image. Run the code example and click on a thumbnail image to see the full animation effect.

This section demonstrated the concept of dynamically changing CSS styles using JavaScript and the DOM. We also discussed the basics of how to create scripted animations using `setInterval` and `clearInterval`.

10.6 Summary of the DOM Objects and Collections

As you've seen in the preceding sections, the objects and collections in the W3C DOM give you flexibility in manipulating the elements of a web page. We've shown how to access the objects in a page, how to access the objects in a collection, and how to change element styles dynamically.

The W3C DOM allows you to access every element in an XHTML document. Each element in a document is represented by a separate object. The diagram in Fig. 10.6 shows many of the important objects and collections provided by the W3C DOM. Figure 10.7 provides a brief description of each object and collection in Fig. 10.6.

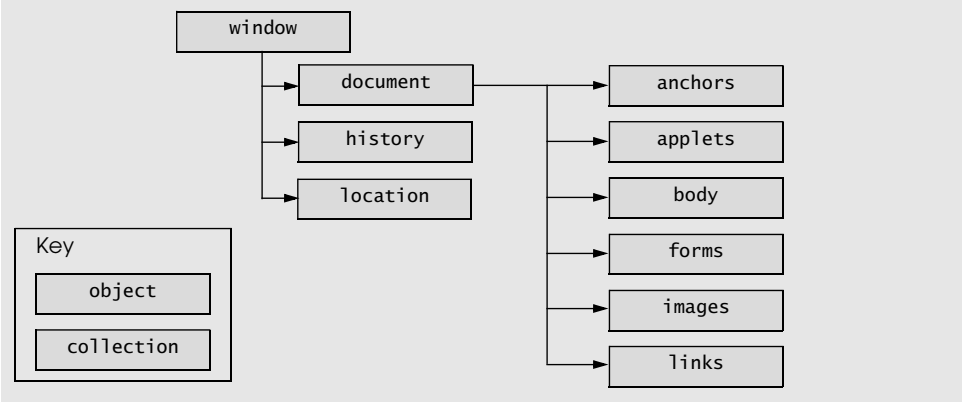


Fig. 10.6 | W3C Document Object Model.

Object or collection	Description
Objects	
`window`	Represents the browser window and provides access to the `window`'s `document` object. Also contains `history` and `location` objects.
`document`	Represents the XHTML document rendered in a `window`. Provides access to every element in the document and allows dynamic modification of it. Contains collections for accessing all elements of a given type.
`body`	Provides access to the `body` element of an XHTML document.
`history`	Keeps track of the sites visited by the browser user. The object provides a script programmer with the ability to move forward and backward through the visited sites.
`location`	Contains the URL of the rendered document. When this object is set to a new URL, the browser immediately navigates to the new location.
Collections	
`anchors`	Collection contains all the anchor elements (`a`) that have a `name` or `id` attribute. The elements appear in the collection in the order in which they were defined in the XHTML document.
`forms`	Contains all the `form` elements in the XHTML document. The elements appear in the collection in the order in which they were defined in the XHTML document.
`images`	Contains all the `img` elements in the XHTML document. The elements appear in the collection in the order in which they were defined in the XHTML document.
`links`	Contains all the anchor elements (`a`) with an `href` property. The elements appear in the collection in the order in which they were defined in the XHTML document.

Fig. 10.7 | Objects and collections in the W3C Document Object Model.

For a complete reference on the W3C Document Object Model, see the DOM Level 3 recommendation from the W3C at `http://www.w3.org/TR/DOM-Level-3-Core/`. The DOM Level 2 HTML Specification (the most recent HTML DOM standard), available at `http://www.w3.org/TR/DOM-Level-2-HTML/`, describes additional DOM functionality specific to HTML, such as objects for various types of XHTML elements. Keep in mind that not all web browsers implement all features included in the specification.

10.7 Web Resources

`www.deitel.com/javascript/`

The Deitel JavaScript Resource Center contains links to some of the best JavaScript resources on the web. There you'll find categorized links to JavaScript tools, code generators, forums, books, libraries, frameworks, tutorials and more. Check out the section specifically dedicated to the Document Object Model. Be sure to visit the related Resource Centers on XHTML (`www.deitel.com/xhtml/`) and CSS 2.1 (`www.deitel.com/css21/`).

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