Document Object Model (DOM)

OBJECTIVES

In this chapter you will:

- Use JavaScript and the W3C Document Object Model to create dynamic web pages.
- Learn the concept of DOM nodes and DOM trees.
- Traverse, edit and modify elements in an HTML5 document.
- Change CSS styles dynamically.
- Create JavaScript animations.

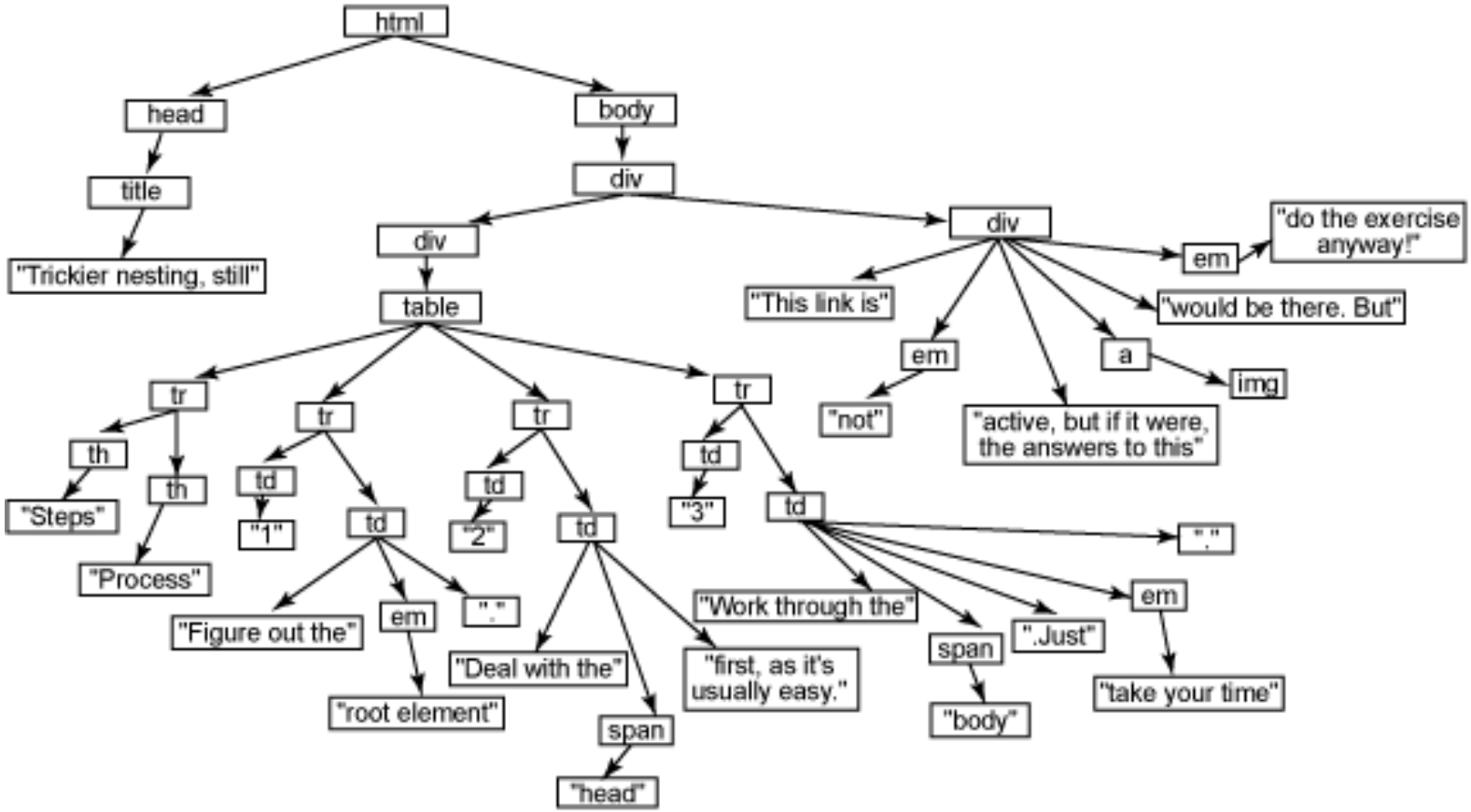
Software Engineering Observation 12.1

With the DOM, HTML5 elements can be treated as objects, and many attributes of HTML5 elements can be treated as properties of those objects. Then objects can be scripted with JavaScript to achieve dynamic effects.

Browser	Command to display developer tools
Chrome	Windows/Linux: *Control* + *Shift* + *i* Mac OS X: *Command* + *Option* + *i*
Firefox	Windows/Linux: *Control* + *Shift* + *i* Mac OS X: *Command* + *Shift* + *i*
Internet Explorer	*F12*
Opera	Windows/Linux: *Control* + *Shift* + *i* Mac OS X: *Command* + *Option* + *i*
Safari	Windows/Linux: *Control* + *Shift* + *i* Mac OS X: *Command* + *Option* + *i*

Fig. 12.1 | Commands for displaying developer tools in desktop browsers.

The Webpage is a DOM Tree



https://vinaytech.files.wordpress.com/2008/11/domimage.png

12.3 Traversing and Modifying a DOM Tree

- The `className` property of a DOM node allows you to change an HTML element's `class` attribute
- The `id` property of a DOM node controls an element's `id` attribute

```
newNode.setAttribute( "id", nodeId );
```

setAttribute可以設定所有HTML中任一個node的attribute，
attribute名稱與值與在HTML當中的寫法一致

12.3 Traversing and Modifying a DOM Tree (Cont.)

- document object `createElement` method
  - Creates a new DOM node, taking the tag name as an argument. Does not insert the element on the page.
- document object `createTextNode` method
  - Creates a DOM node that can contain only text. Given a string argument, `createTextNode` inserts the string into the text node.
- Method `appendChild`
  - Called on a parent node to insert a child node (passed as an argument) after any existing children
- `parentNode` property of any DOM node contains the node's parent

12.3 Traversing and Modifying a DOM Tree (Cont.)

- `insertBefore` method
  - Called on a parent with a new child and an existing child as arguments. The new child is inserted as a child of the parent directly before the existing child.
- `replaceChild` method
  - Called on a parent, taking a new child and an existing child as arguments. The method inserts the new child into its list of children in place of the existing child.
- `removeChild` method
  - Called on a parent with a child to be removed as an argument.

```
1  <!DOCTYPE html>
2
3  <!-- Fig. 12.2: domtree.html -->
4  <!-- Demonstration of a document's DOM tree. -->
5  <html>
6     <head>
7        <meta charset = "utf-8">
8        <title>DOM Tree Demonstration</title>
9     </head>
10    <body>
11       <h1>An HTML5 Page</h1>
12       <p>This page contains some basic HTML5 elements. The DOM tree
13          for the document contains a DOM node for every element</p>
14       <p>Here's an unordered list:</p>
15       <ul>
16          <li>One</li>
17          <li>Two</li>
18          <li>Three</li>
19       </ul>
20    </body>
21 </html>
```

Fig. 12.2 | Demonstration of a document's DOM tree. (Part 1 of 3.)

Fig. 12.2 | Demonstration of a document's DOM tree. (Part 2 of 3.)

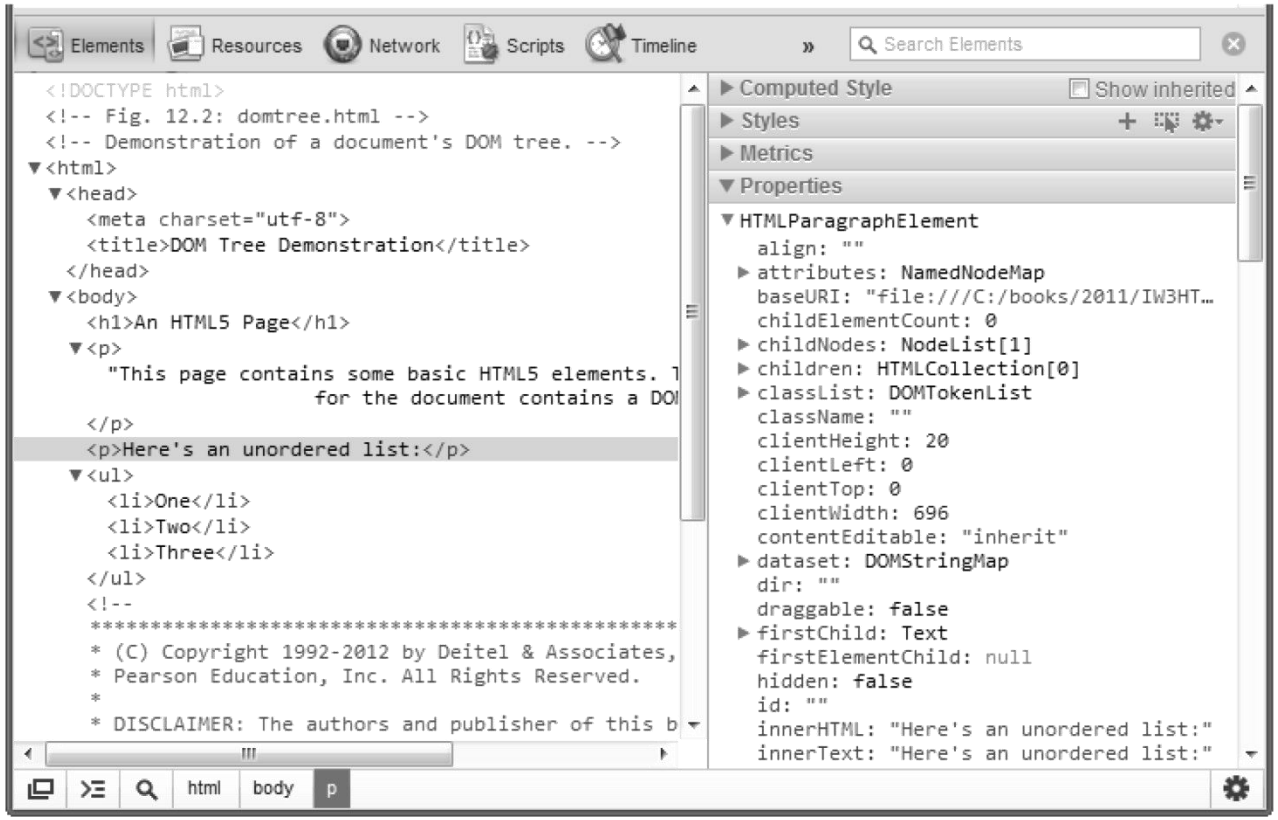


Fig. 12.2 | Demonstration of a document's DOM tree. (Part 3 of 3.)

```
1  /* Fig. 12.3: style.css */
2  /* CSS for dom.html. */
3  h1, h3        { text-align: center;
4                  font-family: tahoma, geneva, sans-serif; }
5  p             { margin-left: 5%;
6                  margin-right: 5%;
7                  font-family: arial, helvetica, sans-serif; }
8  ul            { margin-left: 10%; }
9  a             { text-decoration: none; }
10 a:hover       { text-decoration: underline; }
11 .nav          { width: 100%;
12                 border-top: 3px dashed blue;
13                 padding-top: 10px; }
14 .highlighted { background-color: yellow; }
15 input         { width: 150px; }
16 form > p      { margin: 0px; }
```

Fig. 12.3 | CSS for basic DOM functionality example.

```
1  <!DOCTYPE html>
2
3  <!-- Fig. 12.4: dom.html -->
4  <!-- Basic DOM functionality. -->
5  <html>
6     <head>
7        <meta charset = "utf-8">
8        <title>Basic DOM Functionality</title>
9        <link rel = "stylesheet" type = "text/css" href = "style.css">
10       <script src = "dom.js"></script>
11    </head>
12    <body>
13       <h1 id = "bigheading" class = "highlighted">
14          [bigheading] DHTML Object Model</h1>
15       <h3 id = "smallheading">[smallheading] Element Functionality</h3>
16       <p id = "para1">[para1] The Document Object Model (DOM) allows for
17          quick, dynamic access to all elements in an HTML5 document for
18          manipulation with JavaScript.</p>
```

Fig. 12.4 | HTML5 document that's used to demonstrate DOM functionality for dynamically adding, removing and selecting elements. (Part 1 of 4.)

```
19          <p id = "para2">[para2] For more information, check out the
20             "JavaScript and the DOM" section of Deitel's
21             <a id = "link" href = "http://www.deitel.com/javascript">
22                [link] JavaScript Resource Center.</a></p>
23          <p id = "para3">[para3] The buttons below demonstrate:(list)</p>
24          <ul id = "list">
25             <li id = "item1">[item1] getElementById and parentNode</li>
26             <li id = "item2">[item2] insertBefore and appendChild</li>
27             <li id = "item3">[item3] replaceChild and removeChild</li>
28          </ul>
29          <div id = "nav" class = "nav">
30             <form onsubmit = "return false" action = "#">
31                <p><input type = "text" id = "gbi" value = "bigheading">
32                   <input type = "button" value = "Get By id"
33                      id = "byIdButton"></p>
34                <p><input type = "text" id = "ins">
35                   <input type = "button" value = "Insert Before"
36                      id = "insertButton"></p>
37                <p><input type = "text" id = "append">
38                   <input type = "button" value = "Append Child"
39                      id = "appendButton"></p>
```

Fig. 12.4 | HTML5 document that's used to demonstrate DOM functionality for dynamically adding, removing and selecting elements. (Part 2 of 4.)

```
40               <p><input type = "text" id = "replace">
41                  <input type = "button" value = "Replace Current"
42                     id = "replaceButton()"></p>
43               <p><input type = "button" value = "Remove Current"
44                     id = "removeButton"></p>
45               <p><input type = "button" value = "Get Parent"
46                     id = "parentButton"></p>
47            </form>
48         </div>
49      </body>
50   </html>
```

Fig. 12.4 | HTML5 document that's used to demonstrate DOM functionality for dynamically adding, removing and selecting elements. (Part 3 of 4.)

The document when it first loads. It begins with the large heading highlighted.

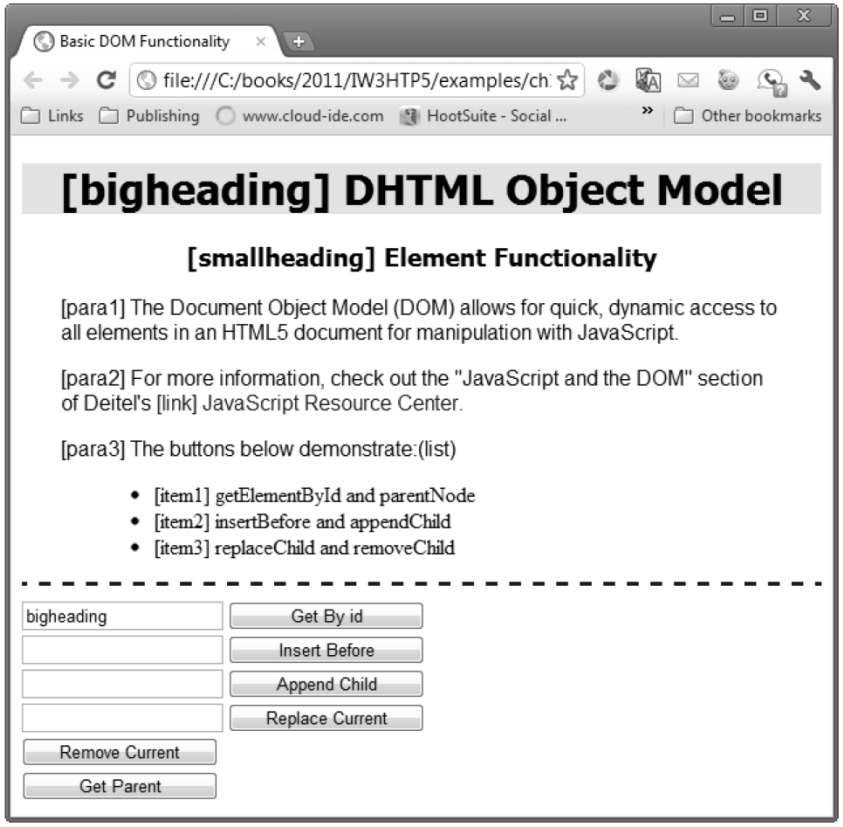


Fig. 12.4 | HTML5 document that's used to demonstrate DOM functionality for dynamically adding, removing and selecting elements. (Part 4 of 4.)

```
1  // Fig. 12.5: dom.js
2  // Script to demonstrate basic DOM functionality.
3  var currentNode; // stores the currently highlighted node
4  var idcount = 0; // used to assign a unique id to new elements
5
6  // register event handlers and initialize currentNode
7  function start()
8  {
```

Fig. 12.5 | Script to demonstrate basic DOM functionality. (Part 1 of 6.)

```
 9      document.getElementById( "byIdButton" ).addEventListener(
10         "click", byId, false );
11      document.getElementById( "insertButton" ).addEventListener(
12         "click", insert, false );
13      document.getElementById( "appendButton" ).addEventListener(
14         "click", appendNode, false );
15      document.getElementById( "replaceButton" ).addEventListener(
16         "click", replaceCurrent, false );
17      document.getElementById( "removeButton" ).addEventListener(
18         "click", remove, false );
19      document.getElementById( "parentButton" ).addEventListener(
20         "click", parent, false );
21
22      // initialize currentNode
23      currentNode = document.getElementById( "bigheading" );
24   } // end function start
25
26   // call start after the window loads
27   window.addEventListener( "load", start, false );
28
```

Fig. 12.5 | Script to demonstrate basic DOM functionality. (Part 2 of 6.)

```
29  // get and highlight an element by its id attribute
30  function byId()
31  {
32     var id = document.getElementById( "gbi" ).value;
33     var target = document.getElementById( id );
34
35     if ( target )
36        switchTo( target );
37  } // end function byId
38
39  // insert a paragraph element before the current element
40  // using the insertBefore method
41  function insert()
42  {
43     var newNode = createNewNode(
44        document.getElementById( "ins" ).value );
45     currentNode.parentNode.insertBefore( newNode, currentNode );
46     switchTo( newNode );
47  } // end function insert
48
```

Fig. 12.5 | Script to demonstrate basic DOM functionality. (Part 3 of 6.)

```
49  // append a paragraph node as the child of the current node
50  function appendNode()
51  {
52     var newNode = createNewNode(
53        document.getElementById( "append" ).value );
54     currentNode.appendChild( newNode );
55     switchTo( newNode );
56  } // end function appendNode
57
58  // replace the currently selected node with a paragraph node
59  function replaceCurrent()
60  {
61     var newNode = createNewNode(
62        document.getElementById( "replace" ).value );
63     currentNode.parentNode.replaceChild( newNode, currentNode );
64     switchTo( newNode );
65  } // end function replaceCurrent
66
```

Fig. 12.5 | Script to demonstrate basic DOM functionality. (Part 4 of 6.)

```
67  // remove the current node
68  function remove()
69  {
70     if ( currentNode.parentNode == document.body )
71        alert( "Can't remove a top-level element." );
72     else
73     {
74        var oldNode = currentNode;
75        switchTo( oldNode.parentNode );
76        currentNode.removeChild( oldNode );
77     }
78  } // end function remove
79
80  // get and highlight the parent of the current node
81  function parent()
82  {
83     var target = currentNode.parentNode;
84
85     if ( target != document.body )
86        switchTo( target );
87     else
88        alert( "No parent." );
89  } // end function parent
```

Fig. 12.5 | Script to demonstrate basic DOM functionality. (Part 5 of 6.)

```
90
91    // helper function that returns a new paragraph node containing
92    // a unique id and the given text
93    function createNewNode( text )
94    {
95       var newNode = document.createElement( "p" );
96       nodeId = "new" + idcount;
97       ++idcount;
98       newNode.setAttribute( "id", nodeId ); // set newNode's id
99       text = "[" + nodeId + "] " + text;
100      newNode.appendChild( document.createTextNode( text ) );
101      return newNode;
102   } // end function createNewNode
103
104   // helper function that switches to a new currentNode
105   function switchTo( newNode )
106   {
107      currentNode.setAttribute( "class", "" ); // remove old highlighting
108      currentNode = newNode;
109      currentNode.setAttribute( "class", "highlighted" ); // highlight
110      document.getElementById( "gbi" ).value =
111         currentNode.getAttribute( "id" );
112   } // end function switchTo
```

Fig. 12.5 | Script to demonstrate basic DOM functionality. (Part 6 of 6.)

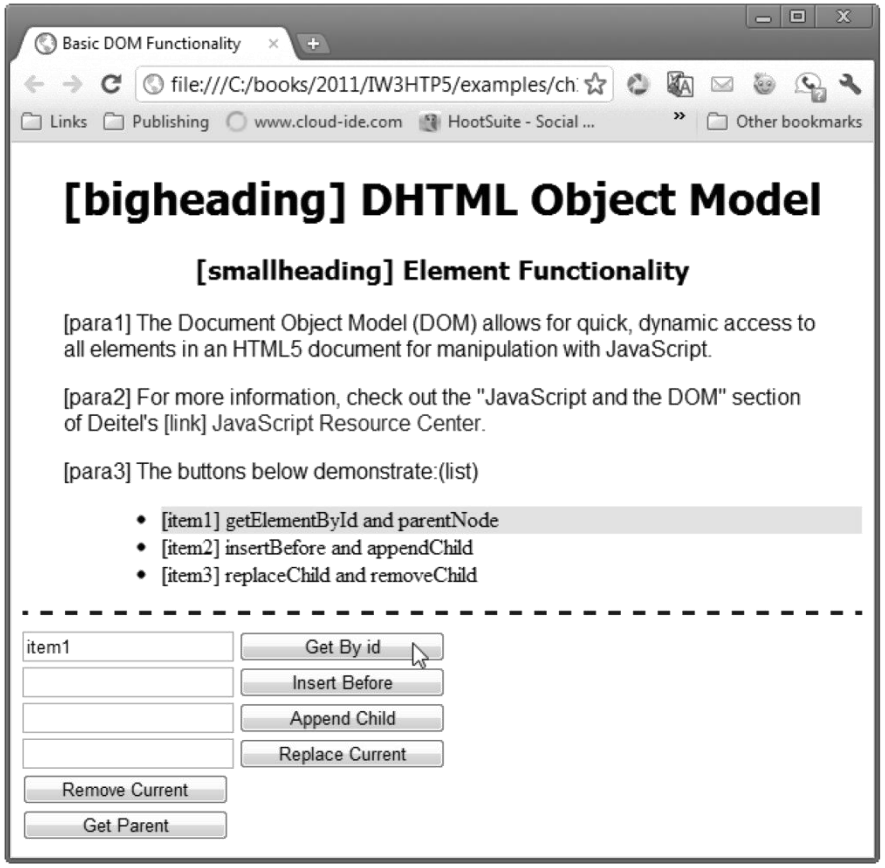


Fig. 12.6 | The document of Figure 12.4 after using the Get By id button to select `item1`.

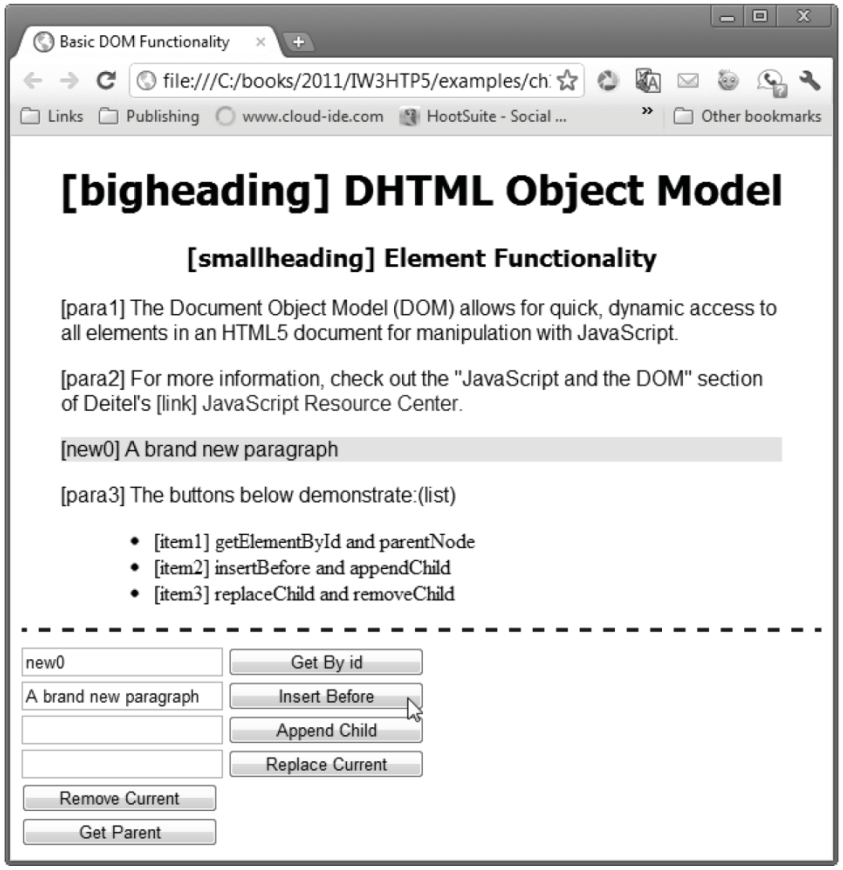


Fig. 12.7 | The document of Figure 12.4 after selecting `para3` with the **Get By id** `button`, then using the **Insert Before** `button` to insert a new paragraph before `para3`.

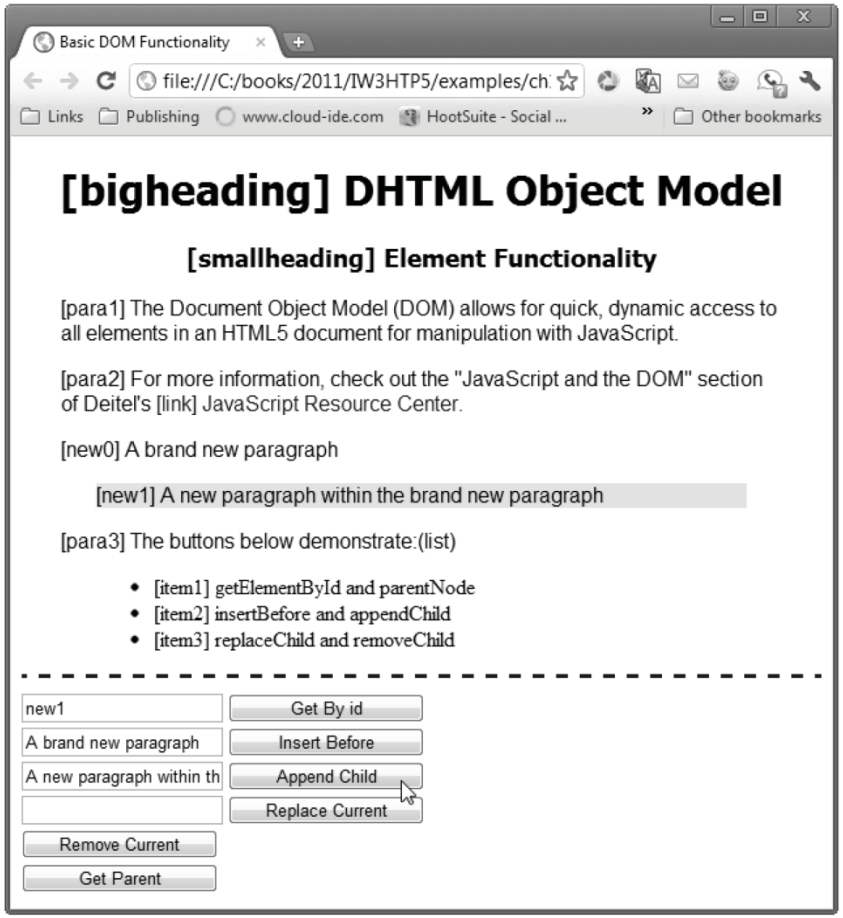


Fig. 12.8 | The document of Figure 12.4 after using the **Append Child** button to append a child to the new paragraph in Figure 12.7.

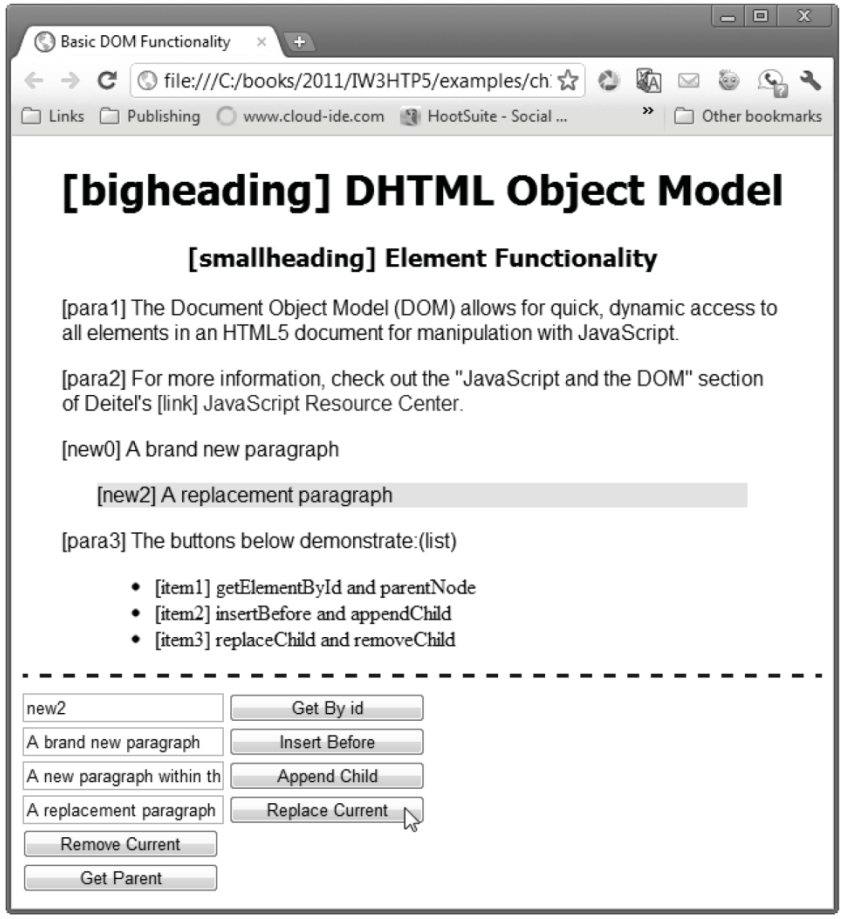


Fig. 12.9 | The document of Figure 12.4 after using the **Replace Current** `button` to replace the paragraph created in Figure 12.8.

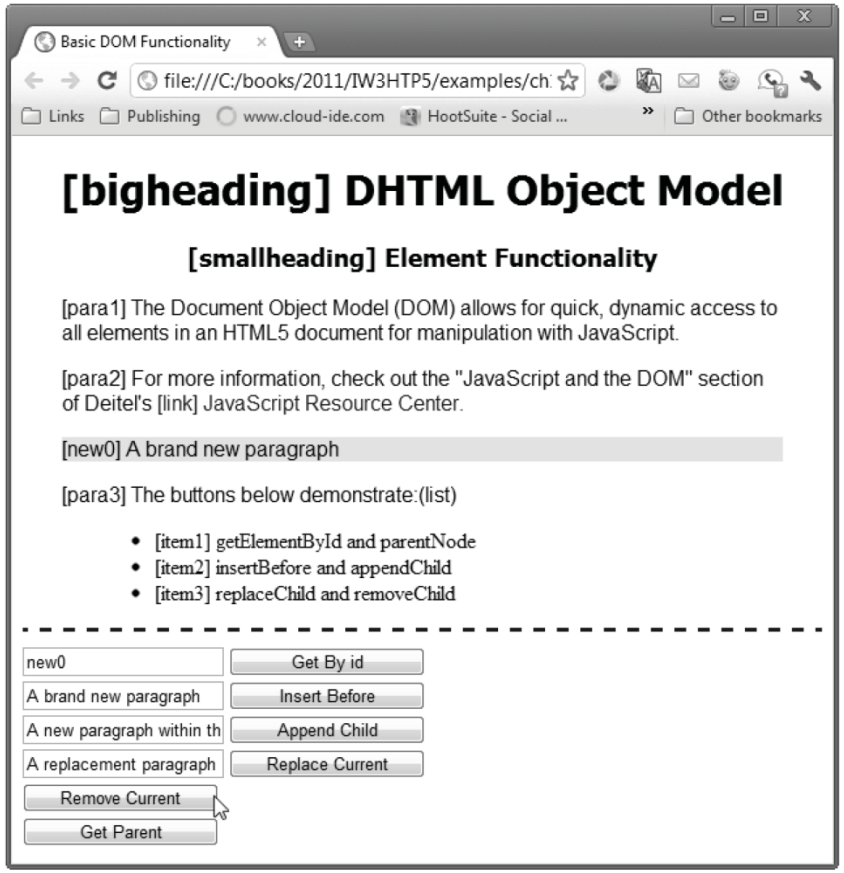


Fig. 12.10 | The document of Figure 12.4 after using the **Remove Current** `button` to remove the paragraph highlighted in Figure 12.9.

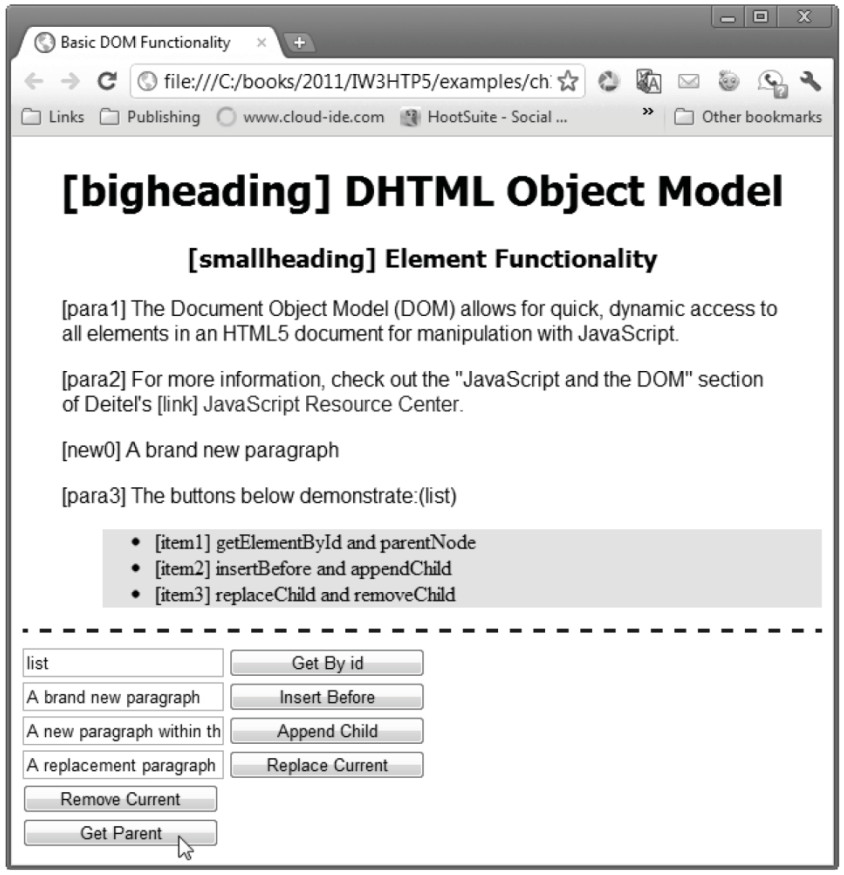


Fig. 12.11 | The document of Figure 12.4 after using the **Get By id** `button` to `item2`, then using the **Get Parent** `button` to select `item2`'s parent—the unordered list.

12.4 DOM Collections

- DOM has collections — 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
  - Contain all the elements of the corresponding type on the page
  - The links property returns a collection of all <area> elements and <a> elements in a document with a value for the href attribute.
- To find the number of elements in the collection, use the collection's length property

12.4 DOM Collections (Cont.)

- Access items in a collection via square brackets
- `href` property of a DOM link node
  - Refers to the link's `href` attribute
- Collections allow easy access to all elements of a single type in a page
  - Useful for gathering elements into one place and for applying changes across an entire page

```
1  /* Fig. 12.12: style.css */
2  /* CSS for collections.html. */
3  body           { font-family: arial, helvetica, sans-serif }
4  h1             { font-family: tahoma, geneva, sans-serif;
5                   text-align: center }
6  p a            { color: DarkRed }
7  ul             { font-size: .9em; }
8  li             { display: inline;
9                   list-style-type: none;
10                  border-right: 1px solid gray;
11                  padding-left: 5px; padding-right: 5px; }
12 li:first-child { padding-left: 0px; }
13 li:last-child  { border-right: none; }
14 a              { text-decoration: none; }
15 a:hover        { text-decoration: underline; }
```

Fig. 12.12 | CSS for `collections.html`.

```
1  <!DOCTYPE html>
2
3  <!-- Fig. 12.13: collections.html -->
4  <!-- Using the links collection. -->
5  <html>
6     <head>
7        <meta charset="utf-8">
8        <title>Using Links Collection</title>
9        <link rel = "stylesheet" type = "text/css" href = "style.css">
10       <script src = "collections.js"></script>
11    </head>
12    <body>
13       <h1>Deitel Resource Centers</h1>
14       <p><a href = "http://www.deitel.com/">Deitel's website</a>
15          contains a growing
16          <a href = "http://www.deitel.com/ResourceCenters.html">list
17          of Resource Centers</a> on a wide range of topics. Many
18          Resource centers related to topics covered in this book,
19          <a href = "http://www.deitel.com/books/iw3htp5">Internet &
20          World Wide Web How to Program, 5th Edition</a>. We have
21          Resource Centers on
22          <a href = "http://www.deitel.com/Web2.0">Web 2.0</a>,
23          <a href = "http://www.deitel.com/Firefox">Firefox</a> and
24          <a href = "http://www.deitel.com/IE9">Internet Explorer 9</a>,
```

Fig. 12.13 | Using the `links` collection. (Part 1 of 2.)

```
25            <a href = "http://www.deitel.com/HTML5">HTML5</a>, and
26            <a href = "http://www.deitel.com/JavaScript">JavaScript</a>.
27            Watch for related new Resource Centers.</p>
28         <p>Links in this page:</p>
29         <div id = "links"></div>
30      </body>
31   </html>
```

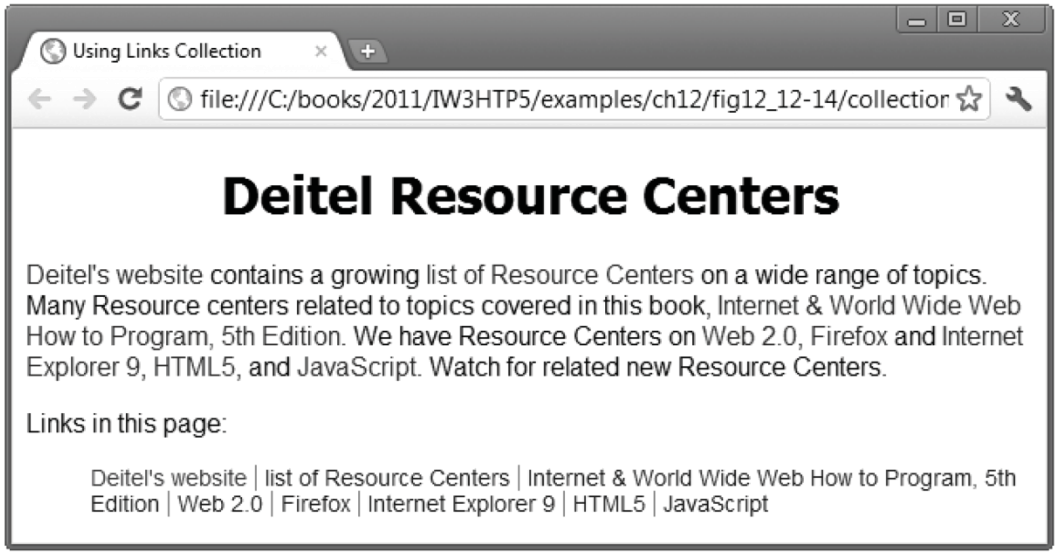


Fig. 12.13 | Using the `links` collection. (Part 2 of 2.)

```
1  // Fig. 12.14: collections.js
2  // Script to demonstrate using the links collection.
3  function processLinks()
4  {
5     var linksList = document.links; // get the document's links
6     var contents = "<ul>";
7
8     // concatenate each link to contents
9     for ( var i = 0; i < linksList.length; ++i )
10    {
11       var currentLink = linksList[ i ];
12       contents += "<li><a href='" + currentLink.href + "'>" +
13          currentLink.innerHTML + "</li>";
14    } // end for
15
16    contents += "</ul>";
17    document.getElementById( "links" ).innerHTML = contents;
18 } // end function processLinks
19
20 window.addEventListener( "load", processLinks, false );
```

Fig. 12.14 | Script to demonstrate using the links collection.

12.5 Dynamic Styles

- An element's style can be changed dynamically
  - E.g., in response to user events
  - Can create many effects, including mouse hover effects, interactive menus, and animations
- body property of the document object
  - Refers to the body element in the HTML page
- `style attribute of body`
  - We can use "inline" way to add CSS rules

```
1  <!DOCTYPE html>
2
3  <!-- Fig. 12.15: dynamicstyle.html -->
4  <!-- Dynamic styles. -->
5  <html>
6     <head>
7        <meta charset="utf-8">
8        <title>Dynamic Styles</title>
9        <script src = "dynamicstyle.js"></script>
10    </head>
11    <body>
12       <p>Welcome to our website!</p>
13    </body>
14 </html>
```

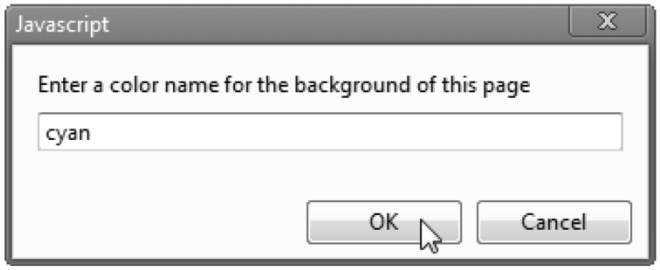


Fig. 12.15 | Dynamic styles. (Part 1 of 2.)

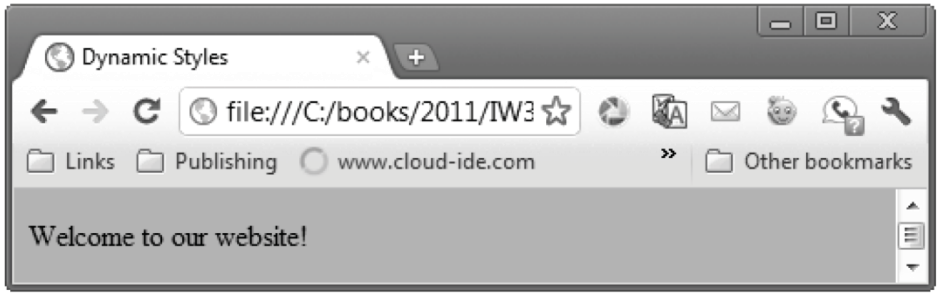


Fig. 12.15 | Dynamic styles. (Part 2 of 2.)

```
1  // Fig. 12.16: dynamicstyle.js
2  // Script to demonstrate dynamic styles.
3  function start()
4  {
5     var inputColor = prompt( "Enter a color name for the " +
6        "background of this page", "" );
7     document.body.setAttribute( "style",
8        "background-color: " + inputColor );
9  } // end function start
10
11 window.addEventListener( "load", start, false );
```

Fig. 12.16 | Script to demonstrate dynamic styles.

12.5 Dynamic Styles (Cont.)

- `setInterval` method of the `window` object
  - Repeatedly executes a statement on a certain interval
  - Takes two parameters
    - A statement to execute repeatedly
    - An integer specifying how often to execute it, in milliseconds
  - Returns a unique identifier to keep track of that particular interval.
- `window` object's `clearInterval` method
  - Stops the repetitive calls of object's `setInterval` method
  - Pass to `clearInterval` the interval identifier that `setInterval` returned

```
1  /* Fig. 12.17: style.css */
2  /* CSS for coverviewer.html. */
3  #thumbs   { width: 192px;
4              height: 370px;
5              padding: 5px;
6              float: left }
7  #mainimg  { width: 289px;
8              padding: 5px;
9              float: left }
10 #imgCover { height: 373px }
11 img       { border: 1px solid black }
```

Fig. 12.17 | CSS for coverviewer.html.

```
1  <!DOCTYPE html>
2
3  <!-- Fig. 12.18: coverviewer.html -->
4  <!-- Dynamic styles used for animation. -->
5  <html>
6     <head>
7        <meta charset = "utf-8">
8        <title>Deitel Book Cover Viewer</title>
9        <link rel = "stylesheet" type = "text/css" href = "style.css">
10       <script src = "coverviewer.js"></script>
11    </head>
```

Fig. 12.18 | Dynamic styles used for animation. (Part 1 of 6.)

```
12      <body>
13         <div id = "mainimg">
14            <img id = "imgCover" src = "fullsize/jhtp.jpg"
15               alt = "Full cover image">
16         </div>
17         <div id = "thumbs" >
18            <img src = "thumbs/jhtp.jpg" id = "jhtp"
19               alt = "Java How to Program cover">
20            <img src = "thumbs/iw3htp.jpg" id = "iw3htp"
21               alt = "Internet & World Wide Web How to Program cover">
22            <img src = "thumbs/cpphtp.jpg" id = "cpphtp"
23               alt = "C++ How to Program cover">
24            <img src = "thumbs/jhtplov.jpg" id = "jhtplov"
25               alt = "Java How to Program LOV cover">
26            <img src = "thumbs/cpphtplov.jpg" id = "cpphtplov"
27               alt = "C++ How to Program LOV cover">
28            <img src = "thumbs/vcsharphtp.jpg" id = "vcsharphtp"
29               alt = "Visual C# How to Program cover">
30         </div>
31      </body>
32   </html>
```

Fig. 12.18 | Dynamic styles used for animation. (Part 2 of 6.)

a) The cover viewer page loads with the cover of *Java How to Program, 9/e*

Fig. 12.18 | Dynamic styles used for animation. (Part 3 of 6.)

b) When the user clicks the thumbnail of *Internet & World Wide Web How to Program, 5/e*, the full-size image begins growing from the top-left corner of the window

Fig. 12.18 | Dynamic styles used for animation. (Part 4 of 6.)

c) The cover continues to grow

Fig. 12.18 | Dynamic styles used for animation. (Part 5 of 6.)

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

Fig. 12.18 | Dynamic styles used for animation. (Part 6 of 6.)

```
1  // Fig. 12.19: coverviewer.js
2  // Script to demonstrate dynamic styles used for animation.
3  var interval = null; // keeps track of the interval
4  var speed = 6; // determines the speed of the animation
5  var count = 0; // size of the image during the animation
6
7  // called repeatedly to animate the book cover
8  function run()
9  {
10    count += speed;
11
12     // stop the animation when the image is large enough
13    if ( count >= 375 )
14    {
15       window.clearInterval( interval );
16       interval = null;
17    } // end if
18
19    var bigImage = document.getElementById( "imgCover" );
20    bigImage.setAttribute( "style", "width: " + (0.7656 * count + "px;") +
21       "height: " + (count + "px;") );
22 } // end function run
23
```

Fig. 12.19 | Script to demonstrate dynamic styles used for animation. (Part 1 of 3.)

```
24  // inserts the proper image into the main image area and
25  // begins the animation
26  function display( imgfile )
27  {
28     if ( interval )
29        return;
30
31     var bigImage = document.getElementById( "imgCover" );
32     bigImage.setAttribute( "style", "width: 0px; height: 0px;" );
33     bigImage.setAttribute( "src", "fullsize/" + imgfile );
34     bigImage.setAttribute( "alt", "Large version of " + imgfile );
35     count = 0; // start the image at size 0
36     interval = window.setInterval( "run()", 10 ); // animate
37  } // end function display
```

Fig. 12.19 | Script to demonstrate dynamic styles used for animation. (Part 2 of 3.)

Return type of setInterval(): a number, representing the ID value of the timer that is set.
We can use this value with the clearInterval() method to cancel the timer.

```
38
39    // register event handlers
40    function start()
41    {
42       document.getElementById( "jhtp" ).addEventListener(
43          "click", function() { display( "jhtp.jpg" ); }, false );
44       document.getElementById( "iw3htp" ).addEventListener(
45          "click", function() { display( "iw3htp.jpg" ); }, false );
46       document.getElementById( "cpphtp" ).addEventListener(
47          "click", function() { display( "cpphtp.jpg" ); }, false );
48       document.getElementById( "jhtplov" ).addEventListener(
49          "click", function() { display( "jhtplov.jpg" ); }, false );
50       document.getElementById( "cpphtplov" ).addEventListener(
51          "click", function() { display( "cpphtplov.jpg" ); }, false );
52       document.getElementById( "vcsharphtp" ).addEventListener(
53          "click", function() { display( "vcsharphtp.jpg" ); }, false );
54    } // end function start
55
56    window.addEventListener( "load", start, false );
```

Fig. 12.19 | Script to demonstrate dynamic styles used for animation. (Part 3 of 3.)

```
document.getElementById( "jhtp" ).addEventListener(
    "click", function() { display( "jhtp.jpg" ); }, false );
```

當event handler是一個需要參數的function時，可用上面的方法註冊event listener (匿名function)