Mastering Ajax, Part 2: Make asynchronous requests with JavaScript and Ajax

Use XMLHttpRequest for Web requests

Skill Level: Intermediate

Brett McLaughlin (brett@newInstance.com)
Author and Editor
O'Reilly Media Inc.

17 Jan 2006

Most Web applications use a request/response model that gets an entire HTML page from the server. The result is a back-and-forth that usually involves clicking a button, waiting for the server, clicking another button, and then waiting some more. With Ajax and the XMLHttpRequest object, you can use a request/response model that never leaves users waiting for a server to respond. In this article, Brett McLaughlin shows you how to create XMLHttpRequest instances in a cross-browser way, construct and send requests, and respond to the server.

In the last article of this series (see Resources for links), you were introduced to the Ajax applications and looked at some of the basic concepts that drive Ajax applications. At the center of this was a lot of technology that you probably already know about: JavaScript, HTML and XHTML, a bit of dynamic HTML, and even some DOM (the Document Object Model). In this article, I will zoom in from that 10,000-foot view and focus on specific Ajax details.

In this article, you'll begin with the most fundamental and basic of all Ajax-related objects and programming approaches: The `XMLHttpRequest` object. This object is really the only common thread across all Ajax applications and -- as you might expect -- you will want to understand it thoroughly to take your programming to the limits of what's possible. In fact, you'll find out that sometimes, to use `XMLHttpRequest` properly, you explicitly *won't* use `XMLHttpRequest`. What in the world is that all about?

Web 2.0 at a glance

First, take this last bit of overview before you dive into code -- make sure you're crystal clear on this idea of the Web 2.0. When you hear the term Web 2.0, you should first ask, "What's Web 1.0?" Although you'll rarely hear Web 1.0, it is meant to refer to the traditional Web where you have a very distinct request and response model. For example, go to Amazon.com and click a button or enter a search term. A request is made to a server and then a response comes back to your browser. That request has a lot more than just a list of books and titles, though; it's actually another complete HTML page. As a result, you probably get some flashing or flickering as your Web browser's screen is redrawn with this new HTML page. In fact, you can clearly see the request and response, delineated by each new page you see.

The Web 2.0 dispenses with this very visible back-and-forth (to a large degree). As an example, visit a site like Google Maps or Flickr (links to both of these Web 2.0, Ajax-powered sites are in Resources). On Google Maps, for example, you can drag the map around and zoom in and zoom out with very little redrawing. Of course, requests and responses do go on here, but all *behind the scenes*. As a user, the experience is much more pleasant and feels a lot like a desktop application. This new feel and paradigm is what you see when someone refers to Web 2.0.

What you should care about then is how to make these new interactions possible. Obviously, you've still got to make requests and field responses, but it's the redrawing of the HTML for every request/response interaction that gives the perception of a slow, clunky Web interface. So clearly you need an approach that allows you to make requests and receive responses that include *only* the data you need, rather than an entire HTML page as well. The only time you want to get a whole new HTML page is when ... well ... when you want the user to *see* a new page.

But most interactions add details or change body text or overlay data on the existing pages. In all of these cases, Ajax and a Web 2.0 approach make it possible to send and receive data *without* updating an entire HTML page. And to any frequent Web surfer, this ability will make your application feel faster, more responsive, and bring them back over and over again.

Introducing XMLHttpRequest

To make all this flash and wonder actually happen, you need to become intimately familiar with a JavaScript object called `XMLHttpRequest`. This little object -- which has actually been around in several browsers for quite a while -- is the key to Web 2.0, Ajax, and pretty much everything else you learn about in this column for the next several months. To give you a really quick overview, these are just a *few* of the methods and properties you'll use on this object:

- `open()`: Sets up a new request to a server.
- `send()`: Sends a request to a server.
- `abort()`: Bails out of the current request.
- `readyState`: Provides the current HTML ready state.
- `responseText`: The text that the server sends back to respond to a request.

Don't worry if you don't understand all of this (or *any* of this for that matter) -- you'll learn about each method and property in the next several articles. What you *should* get out of this, though, is a good idea of what to do with `XMLHttpRequest`. Notice that each of these methods and properties relate to sending a request and dealing with a response. In fact, if you saw every method and property of `XMLHttpRequest`, they would *all* relate to that very simple request/response model. So clearly, you won't learn about an amazing new GUI object or some sort of super-secret approach to creating user interaction; you will work with simple requests and simple responses. It might not sound exciting, but careful use of this one object can totally change your applications.

The simplicity of new

First, you need to create a new variable and assign it to an instance of the `XMLHttpRequest` object. That's pretty simple in JavaScript; you just use the `new` keyword with the object name, like you see in Listing 1.

Listing 1. Create a new XMLHttpRequest object

```
<script language="javascript" type="text/javascript">
var request = new XMLHttpRequest();
</script>
```

That's not too hard, is it? Remember, JavaScript doesn't require typing on its variable, so you don't need anything like you see in Listing 2 (which might be how you'd create this object in Java).

Listing 2. Java pseudo-code for creating XMLHttpRequest

```
XMLHttpRequest request = new XMLHttpRequest();
```

So you create a variable in JavaScript with `var`, give it a name (like "request"), and then assign it to a new instance of `XMLHttpRequest`. At that point, you're ready to use the object in your functions.

Error handling

In real life, things can go wrong and this code doesn't provide any error-handling. A slightly better approach is to create this object and have it gracefully fail if something goes wrong. For example, many older browsers (believe it or not, people are still using old versions of Netscape Navigator) don't support `XMLHttpRequest` and you need to let those users know that something has gone wrong. Listing 3 shows how you might create this object so if something fails, it throws out a JavaScript alert.

Listing 3. Create XMLHttpRequest with some error-handling abilities

```
<script language="javascript" type="text/javascript">
var request = false;
try {
  request = new XMLHttpRequest();
} catch (failed) {
  request = false;
}

if (!request)
  alert("Error initializing XMLHttpRequest!");
</script>
```

Make sure you understand each of these steps:

1. Create a new variable called `request` and assign it a false value. You'll use false as a condition that means the `XMLHttpRequest` object hasn't been created yet.
2. Add in a try/catch block:
    1. Try and create the `XMLHttpRequest` object.
    2. If that fails (`catch (failed)`), ensure that `request` is still set to false.
3. Check and see if `request` is still false (if things are going okay, it won't be).
4. If there was a problem (and `request` is false), use a JavaScript alert to tell users there was a problem.

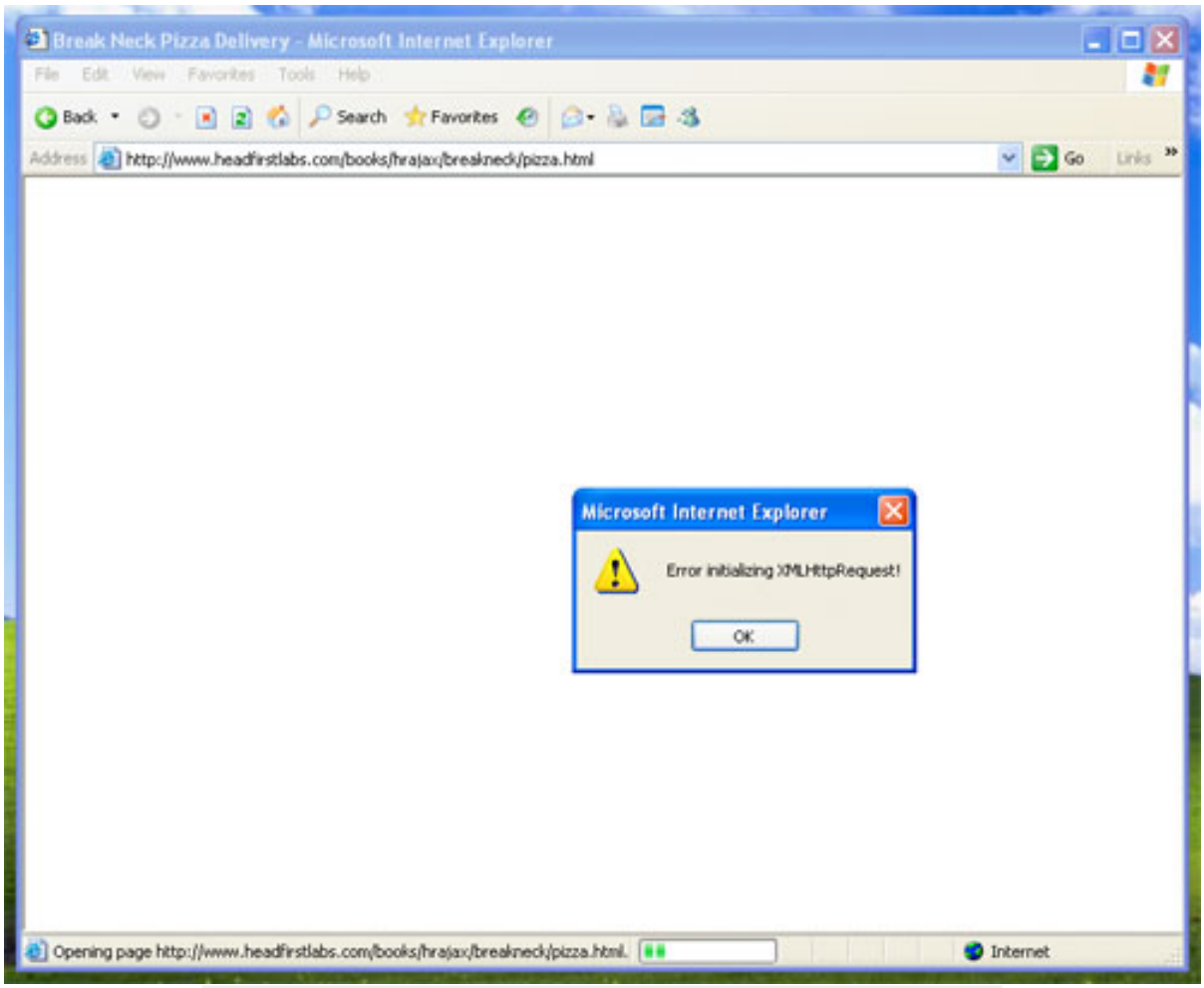
This is pretty simple; it takes longer to read and write about than it does to actually understand for most JavaScript and Web developers. Now you've got an error-proof piece of code that creates an `XMLHttpRequest` object and even lets you know if something went wrong.

Dealing with Microsoft

This all looks pretty good ... at least until you try this code in Internet Explorer. If you

do, you're going to get something that looks an awful lot like Figure 1.

Figure 1. Internet Explorer reporting an error



Microsoft playing nice?

Much has been written about Ajax and Microsoft's increasing interest and presence in that space. In fact, Microsoft's newest version of Internet Explorer -- version 7.0, set to come out late in 2006 -- is supposed to move to supporting `XMLHttpRequest` directly, allowing you to use the `new` keyword instead of all the `Msxml2.XMLHTTP` creation code. Don't get too excited, though; you'll still need to support old browsers, so that cross-browser code isn't going away anytime soon.

Clearly, something isn't working; Internet Explorer is hardly an out-of-date browser and about 70 percent of the world uses Internet Explorer. In other words, you won't do well in the Web world if you don't support Microsoft and Internet Explorer! So, you need a different approach to deal with Microsoft's browsers.

It turns out that Microsoft supports Ajax, but calls its version of `XMLHttpRequest` something different. In fact, it calls it *several* different things. If you're using a newer

version of Internet Explorer, you need to use an object called `Msxml2.XMLHTTP`; some older versions of Internet Explorer use `Microsoft.XMLHTTP`. You need to support these two object types (without losing the support you already have for non-Microsoft browsers). Check out Listing 4 which adds Microsoft support to the code you've already seen.

Listing 4. Add support for Microsoft browsers

```
<script language="javascript" type="text/javascript">
var request = false;
try {
  request = new XMLHttpRequest();
} catch (trymicrosoft) {
  try {
    request = new ActiveXObject("Msxml2.XMLHTTP");
  } catch (othermicrosoft) {
    try {
      request = new ActiveXObject("Microsoft.XMLHTTP");
    } catch (failed) {
      request = false;
    }
  }
}

if (!request)
  alert("Error initializing XMLHttpRequest!");
</script>
```

It's easy to get lost in the curly braces, so I'll walk you through this one step at a time:

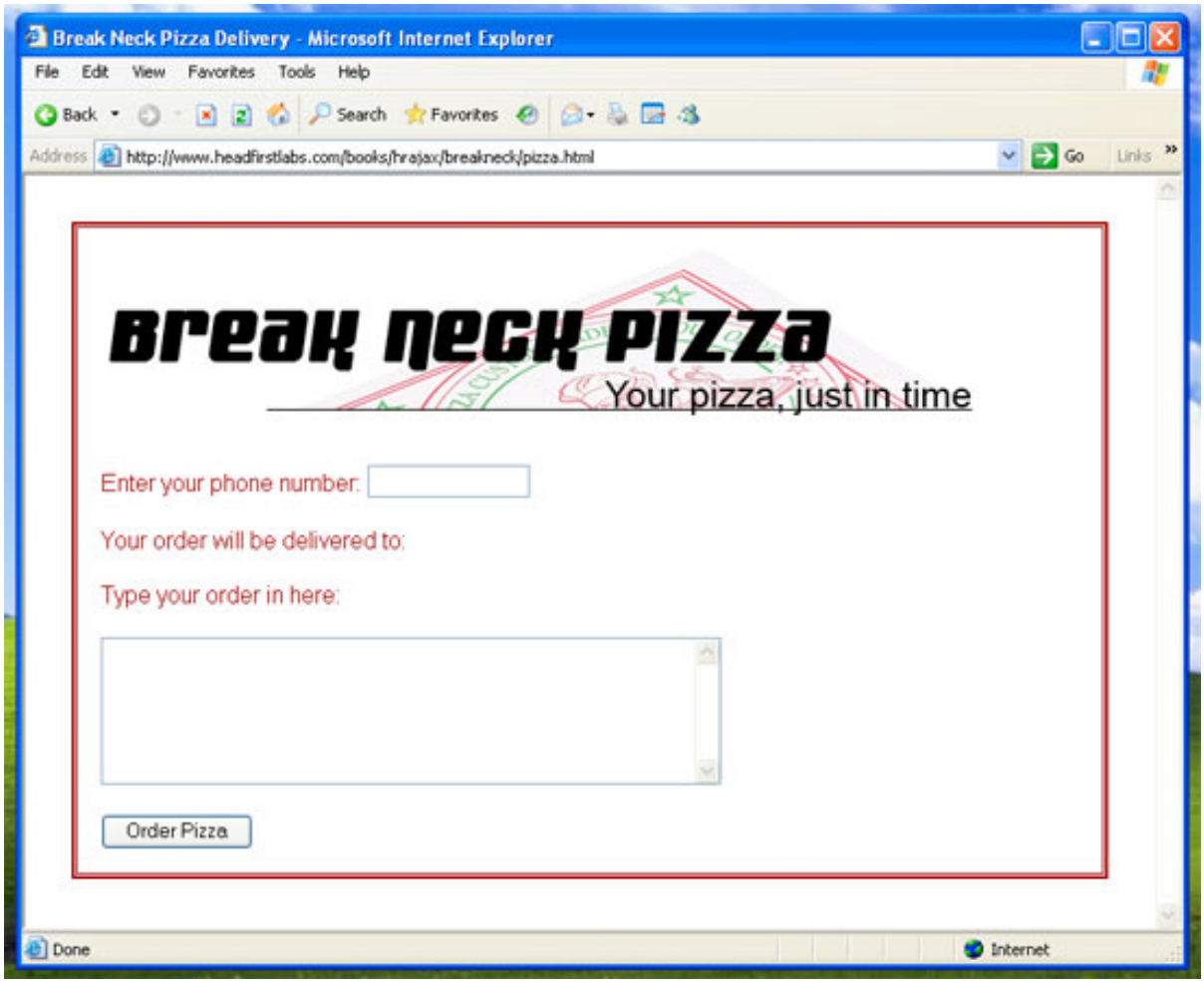
1. Create a new variable called `request` and assign it a false value. Use false as a condition that means the `XMLHttpRequest` object isn't created yet.
2. Add in a try/catch block:
    1. Try and create the `XMLHttpRequest` object.
    2. If that fails (`catch (trymicrosoft)`):
        1. Try and create a Microsoft-compatible object using the newer versions of Microsoft (`Msxml2.XMLHTTP`).
        2. If that fails (`catch (othermicrosoft)`), try and create a Microsoft-compatible object using the older versions of Microsoft (`Microsoft.XMLHTTP`).
    3. If that fails (`catch (failed)`), ensure that `request` is still set to false.

3. Check and see if `request` is still false (if things are okay, it won't be).

4. If there was a problem (and `request` is false), use a JavaScript alert to tell users there was a problem.

Make these changes to your code and try things out in Internet Explorer again; you should see the form you created (without an error message). In my case, that results in something like Figure 2.

Figure 2. Internet Explorer working normally



Static versus dynamic

Take a look back at Listings 1, 3, and 4 and notice that all of this code is nested directly within `script` tags. When JavaScript is coded like that and not put within a method or function body, it's called *static JavaScript*. This means that the code is run sometime before the page is displayed to the user. (It's not 100 percent clear from the specification *precisely* when this code runs and browsers do things differently; still, you're guaranteed that the code is run before users can interact with your page.)

That's usually how most Ajax programmers create the `XMLHttpRequest` object.

That said, you certainly can put this code into a method as shown in Listing 5.

Listing 5. Move XMLHttpRequest creation code into a method

```
<script language="javascript" type="text/javascript">

var request;

function createRequest() {
  try {
    request = new XMLHttpRequest();
  } catch (trymicrosoft) {
    try {
      request = new ActiveXObject("Msxml2.XMLHTTP");
    } catch (othermicrosoft) {
      try {
        request = new ActiveXObject("Microsoft.XMLHTTP");
      } catch (failed) {
        request = false;
      }
    }
  }

  if (!request)
    alert("Error initializing XMLHttpRequest!");
}
</script>
```

With code setup like this, you'll need to call this method before you do any Ajax work. So you might have something like Listing 6.

Listing 6. Use an XMLHttpRequest creation method

```
<script language="javascript" type="text/javascript">

var request;

function createRequest() {
  try {
    request = new XMLHttpRequest();
  } catch (trymicrosoft) {
    try {
      request = new ActiveXObject("Msxml2.XMLHTTP");
    } catch (othermicrosoft) {
      try {
        request = new ActiveXObject("Microsoft.XMLHTTP");
      } catch (failed) {
        request = false;
      }
    }
  }

  if (!request)
    alert("Error initializing XMLHttpRequest!");
}

function getCustomerInfo() {
  createRequest();
  // Do something with the request variable
```

```
}
</script>
```

The only concern with this code -- and the reason most Ajax programmers don't use this approach -- is that it delays error notification. Suppose you have a complex form with 10 or 15 fields, selection boxes, and the like, and you fire off some Ajax code when the user enters text in field 14 (way down the form). At that point, `getCustomerInfo()` runs, tries to create an `XMLHttpRequest` object, and (for this example) fails. Then an alert is spit out to the user, telling them (in so many words) that they can't use this application. But the user has already spent time entering data in the form! That's pretty annoying and annoyance is not something that typically entices users back to your site.

In the case where you use static JavaScript, the user is going to get an error as soon as they hit your page. Is that also annoying? Perhaps; it could make users mad that your Web application won't run on their browser. However, it's certainly better than spitting out that same error after they've spent 10 minutes entering information. For that reason alone, I encourage you to set up your code statically and let users know early on about possible problems.

Sending requests with XMLHttpRequest

Once you have your request object, you can begin the request/response cycle. Remember, `XMLHttpRequest`'s only purpose is to allow you to make requests and receive responses. Everything else -- changing the user interface, swapping out images, even interpreting the data that the server sends back -- is the job of JavaScript, CSS, or other code in your pages. With `XMLHttpRequest` ready for use, now you can make a request to a server.

Welcome to the sandbox

Ajax has a sandbox security model. As a result, your Ajax code (and specifically, the `XMLHttpRequest` object) can only make requests to the same domain on which it's running. You'll learn lots more about security and Ajax in an upcoming article, but for now realize that code running on your local machine can only make requests to server-side scripts on your local machine. If you have Ajax code running on www.breakneckpizza.com, it must make requests to scripts that run on www.breakneckpizza.com.

Setting the server URL

The first thing you need to determine is the URL of the server to connect to. This isn't specific to Ajax -- obviously you should know how to construct a URL by now -- but is still essential to making a connection. In most applications, you'll construct this URL from some set of static data combined with data from the form your users work

with. For example, Listing 7 shows some JavaScript that grabs the value of the phone number field and then constructs a URL using that data.

Listing 7. Build a request URL

```
<script language="javascript" type="text/javascript">
   var request = false;
   try {
     request = new XMLHttpRequest();
   } catch (trymicrosoft) {
     try {
       request = new ActiveXObject("Msxml2.XMLHTTP");
     } catch (othermicrosoft) {
       try {
         request = new ActiveXObject("Microsoft.XMLHTTP");
       } catch (failed) {
         request = false;
       }
     }
   }

   if (!request)
     alert("Error initializing XMLHttpRequest!");

   function getCustomerInfo() {
     var phone = document.getElementById("phone").value;
     var url = "/cgi-local/lookupCustomer.php?phone=" + escape(phone);
   }
</script>
```

Nothing here should trip you up. First, the code creates a new variable named `phone` and assigns the value of the form field with an ID of "phone." Listing 8 shows the XHTML for this particular form in which you can see the `phone` field and its `id` attribute.

Listing 8. The Break Neck Pizza form

```
 <body>
  <p><img src="breakneck-logo_4c.gif" alt="Break Neck Pizza" /></p>
  <form action="POST">
   <p>Enter your phone number:
    <input type="text" size="14" name="phone" id="phone"
           onChange="getCustomerInfo();" />
   </p>
   <p>Your order will be delivered to:</p>
   <div id="address"></div>
   <p>Type your order in here:</p>
   <p><textarea name="order" rows="6" cols="50" id="order"></textarea></p>
   <p><input type="submit" value="Order Pizza" id="submit" /></p>
  </form>
 </body>
```

Also notice that when users enter their phone number or change the number, it fires off the `getCustomerInfo()` method shown in Listing 8. That method then grabs the number and uses it to construct a URL string stored in the `url` variable. Remember: Since Ajax code is sandboxed and can only connect to the same domain, you really shouldn't need a domain name in your URL. In this example, the

script name is `/cgi-local/lookupCustomer.php`. Finally, the phone number is appended to this script as a GET parameter: `"phone=" + escape(phone)`.

If you've never seen the `escape()` method before, it's used to escape any characters that can't be sent as clear text correctly. For example, any spaces in the phone number are converted to `%20` characters, making it possible to pass the characters along in the URL.

You can add as many parameters as you need. For example, if you wanted to add another parameter, just append it onto the URL and separate parameters with the ampersand (&) character [the first parameter is separated from the script name with a question mark (?)].

Opening the request

> **Does open() open?**
> Internet developers disagree about what exactly the `open()` method does. What it does *not* do is actually open a request. If you were to monitor the network and data transfer between your XHTML/Ajax page and the script that it connects to, you wouldn't see any traffic when the `open()` method is called. It's unclear why the name was chosen, but it clearly wasn't a great choice.

With a URL to connect to, you can configure the request. You'll accomplish this using the `open()` method on your `XMLHttpRequest` object. This method takes as many as five parameters:

- *request-type*: The type of request to send. Typical values are `GET` or `POST`, but you can also send `HEAD` requests.
- *url*: The URL to connect to.
- *asynch*: True if you want the request to be asynchronous and false if it should be a synchronous request. This parameter is optional and defaults to true.
- *username*: If authentication is required, you can specify the username here. This is an optional parameter and has no default value.
- *password*: If authentication is required, you can specify the password here. This is an optional parameter and has no default value.

Typically, you'll use the first three of these. In fact, even when you want an asynchronous request, you should specify "true" as the third parameter. That's the default setting, but it's a nice bit of self-documentation to always indicate if the request is asynchronous or not.

Put it all together and you usually end up with a line that looks a lot like Listing 9.

Listing 9. Open the request

```
function getCustomerInfo() {
  var phone = document.getElementById("phone").value;
  var url = "/cgi-local/lookupCustomer.php?phone=" + escape(phone);
  request.open("GET", url, true);
}
```

Once you have the URL figured out, then this is pretty trivial. For most requests, using `GET` is sufficient (you'll see the situations in which you might want to use `POST` in future articles); that, along with the URL, is all you need to use `open()`.

A teaser on asynchronicity

In a later article in this series, I'll spend significant time on writing and using asynchronous code, but you should get an idea of why that last parameter in `open()` is so important. In a normal request/response model -- think Web 1.0 here -- the client (your browser or the code running on your local machine) makes a request to the server. That request is synchronous; in other words, the client waits for a response from the server. While the client is waiting, you usually get at least one of several forms of notification that you're waiting:

- An hourglass (especially on Windows).
- A spinning beachball (usually on Mac machines).
- The application essentially freezes and sometimes the cursor changes.

This is what makes Web applications in particular feel clunky or slow -- the lack of real interactivity. When you push a button, your application essentially becomes unusable until the request you just triggered is responded to. If you've made a request that requires extensive server processing, that wait might be significant (at least for today's multi-processor, DSL, no-waiting world).

An asynchronous request though, does *not* wait for the server to respond. You send a request and then your application continues on. Users can still enter data in a Web form, click other buttons, even leave the form. There's no spinning beachball or whirling hourglass and no big application freeze. The server quietly responds to the request and when it's finished, it let's the original requestor know that it's done (in ways you'll see in just a moment). The end result is an application that *doesn't* feel clunky or slow, but instead is responsive, interactive, and feels faster. This is just one component of Web 2.0, but it's a very important one. All the slick GUI components and Web design paradigms can't overcome a slow, synchronous request/response model.

Sending the request

Once you configure the request with `open()`, you're ready to send the request. Fortunately, the method for sending a request is named more properly than `open()`; it's simply called `send()`.

`send()` takes only a single parameter, the content to send. But before you think too much on that, recall that you are already sending data through the URL itself:

```
var url = "/cgi-local/lookupCustomer.php?phone=" + escape(phone);
```

Although you can send data using `send()`, you can also send data through the URL itself. In fact, in `GET` requests (which will constitute as much as 80 percent of your typical Ajax usage), it's much easier to send data in the URL. When you start to send secure information or XML, then you want to look at sending content through `send()` (I'll discuss both secure data and XML messaging in a later article in this series). When you don't need to pass data along through `send()`, then just pass `null` as the argument to this method. So, to send a request in the example you've seen throughout this article, that's exactly what is needed (see Listing 10).

Listing 10. Send the request

```
function getCustomerInfo() {
  var phone = document.getElementById("phone").value;
  var url = "/cgi-local/lookupCustomer.php?phone=" + escape(phone);
  request.open("GET", url, true);
  request.send(null);
}
```

Specifying a callback method

At this point, you've done very little that feels new, revolutionary, or asynchronous. Granted, that little keyword "true" in the `open()` method sets up an asynchronous request. But other than that, this code resembles programming with Java servlets and JSPs, PHP, or Perl. So what's the big secret to Ajax and Web 2.0? The secret revolves around a simple property of `XMLHttpRequest` called `onreadystatechange`.

First, be sure you understand the process that you created in this code (review Listing 10 if you need to). A request is set up and then made. Additionally, because this is an asynchronous request, the JavaScript method (`getCustomerInfo()` in the example) will not wait for the server. So the code will continue; in this case, that means that the method will exit and control will return to the form. Users can keep entering information and the application isn't going to wait on the server.

This creates an interesting question, though: What happens when the server has finished processing the request? The answer, at least as the code stands right now, is nothing! Obviously, that's not good, so the server needs to have some type of

instruction on what to do when it's finished processing the request sent to it by `XMLHttpRequest`.

> **Referencing a function in JavaScript**
> JavaScript is a loosely typed language and you can reference just about anything as a variable. So if you declare a function called `updatePage()`, JavaScript also treats that function name as a variable. In other words, you can reference the function in your code as a variable named `updatePage`.

This is where that `onreadystatechange` property comes into play. This property allows you to specify a *callback method*. A callback allows the server to (can you guess?) *call back* into your Web page's code. It gives a degree of control to the server, as well; when the server finishes a request, it looks in the `XMLHttpRequest` object and specifically at the `onreadystatechange` property. Whatever method is specified by that property is then invoked. It's a callback because the server initiates calling back into the Web page -- regardless of what is going in the Web page itself. For example, it might call this method while the user is sitting in her chair, not touching the keyboard; however, it might also call the method while the user is typing, moving the mouse, scrolling, clicking a button ... it doesn't matter what the user is doing.

This is actually where the asynchronicity comes into play: The user operates the form on one level while on another level, the server answers a request and then fires off the callback method indicated by the `onreadystatechange` property. So you need to specify that method in your code as shown in Listing 11.

Listing 11. Set a callback method

```
function getCustomerInfo() {
  var phone = document.getElementById("phone").value;
  var url = "/cgi-local/lookupCustomer.php?phone=" + escape(phone);
  request.open("GET", url, true);
  request.onreadystatechange = updatePage;
  request.send(null);
}
```

Pay close attention to *where* in the code this property is set -- it's *before* `send()` is called. You must set this property before the request is sent, so the server can look up the property when it finishes answering a request. All that's left now is to code the `updatePage()` which is the focus of the last section in this article.

Handling server responses

You made your request, your user is happily working in the Web form (while the server handles the request), and now the server finishes up handling the request. The server looks at the `onreadystatechange` property and figures out what

method to call. Once that occurs, you can think of your application as any other app, asynchronous or not. In other words, you don't have to take any special action writing methods that respond to the server; just change the form, take the user to another URL, or do whatever else you need to in response to the server. In this section, we'll focus on responding to the server and then taking a typical action -- changing on the fly part of the form the user sees.

Callbacks and Ajax

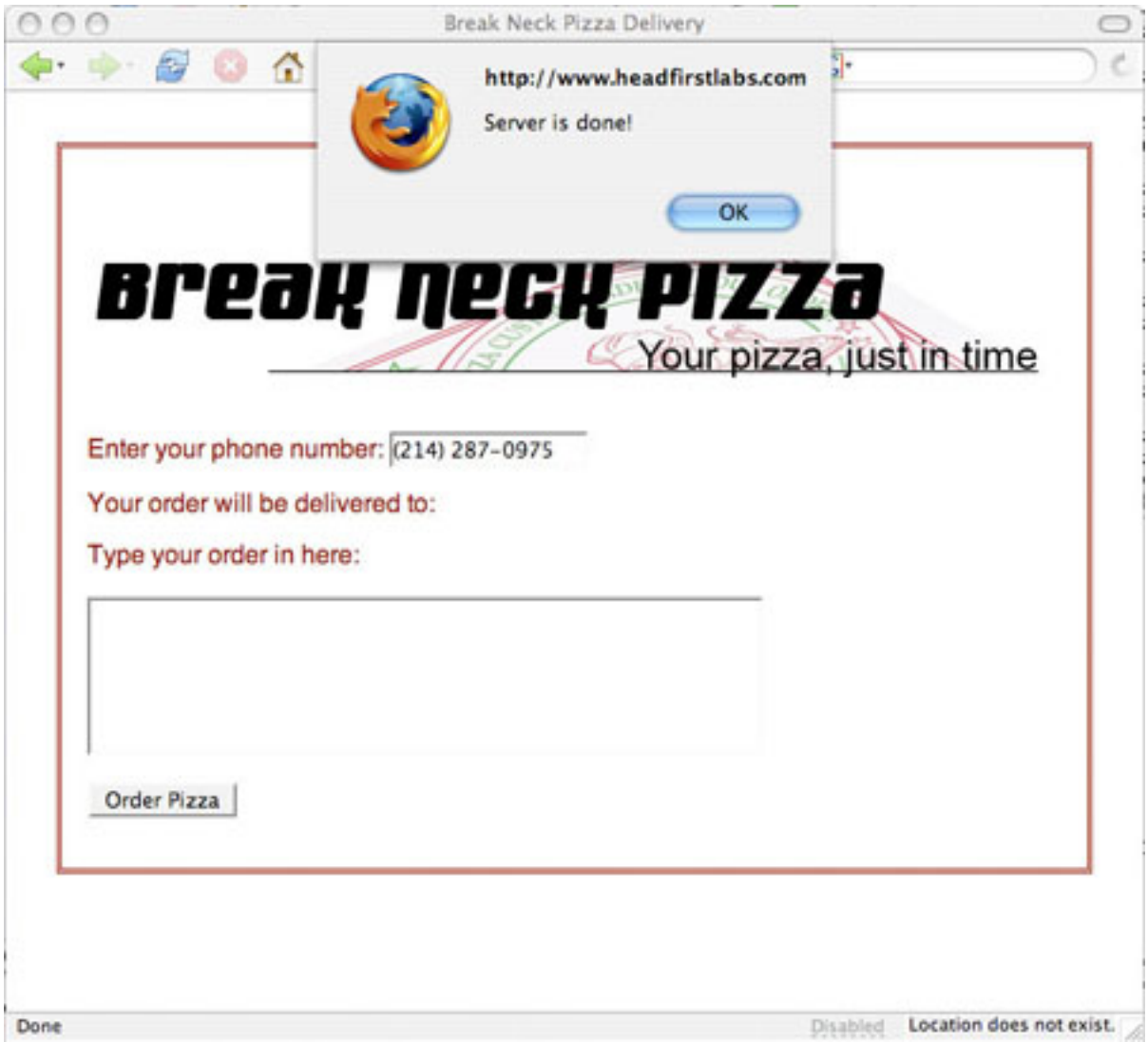
You've already seen how to let the server know what to do when it's finished: Set the `onreadystatechange` property of the `XMLHttpRequest` object to the name of the function to run. Then, when the server has processed the request, it will automatically call that function. You also don't need to worry about any parameters to that method. You'll start with a simple method like in Listing 12.

Listing 12. Code the callback method

```
<script language="javascript" type="text/javascript">
   var request = false;
   try {
     request = new XMLHttpRequest();
   } catch (trymicrosoft) {
     try {
       request = new ActiveXObject("Msxml2.XMLHTTP");
     } catch (othermicrosoft) {
       try {
         request = new ActiveXObject("Microsoft.XMLHTTP");
       } catch (failed) {
         request = false;
       }
     }
   }

   if (!request)
     alert("Error initializing XMLHttpRequest!");

   function getCustomerInfo() {
     var phone = document.getElementById("phone").value;
     var url = "/cgi-local/lookupCustomer.php?phone=" + escape(phone);
     request.open("GET", url, true);
     request.onreadystatechange = updatePage;
     request.send(null);
   }

   function updatePage() {
     alert("Server is done!");
   }
</script>
```

This just spits out a handy alert, to tell you when the server is done. Try this code in your own page, save the page, and then pull it up in a browser (if you want the XHTML from this example, refer back to Listing 8). When you enter in a phone number and leave the field, you should see the alert pop up (see Figure 3); but click OK and it pops up again ... and again.

Figure 3. Ajax code popping up an alert



Depending on your browser, you'll get two, three, or even four alerts before the form stops popping up alerts. So what's going on? It turns out that you haven't taken into account the HTTP ready state, an important component of the request/response cycle.

HTTP ready states

Earlier, I said that the server, once finished with a request, looks up what method to call in the `onreadystatechange` property of `XMLHttpRequest`. That's true, but it's not the whole truth. In fact, it calls that method every time the HTTP ready state changes. So what does that mean? Well, you've got to understand HTTP ready states first.

An HTTP ready state indicates the state or status of a request. It's used to figure out if a request has been started, if it's being answered, or if the request/response model

has completed. It's also helpful in determining whether it's safe to read whatever response text or data that a server might have supplied. You need to know about five ready states in your Ajax applications:

- **0**: The request is uninitialized (before you've called `open()`).
- **1**: The request is set up, but hasn't been sent (before you've called `send()`).
- **2**: The request was sent and is being processed (you can usually get content headers from the response at this point).
- **3**: The request is being processed; often some partial data is available from the response, but the server hasn't finished with its response.
- **4**: The response is complete; you can get the server's response and use it.

As with almost all cross-browser issues, these ready states are used somewhat inconsistently. You might expect to always see the ready state move from 0 to 1 to 2 to 3 to 4, but in practice, that's rarely the case. Some browsers never report 0 or 1 and jump straight to 2, then 3, and then 4. Other browsers report all states. Still others will report ready state 1 multiple times. As you saw in the last section, the server called `updatePage()` several times and each invocation resulted in an alert box popping up -- probably not what you intended!

For Ajax programming, the only state you need to deal with directly is ready state 4, indicating that a server's response is complete and it's safe to check the response data and use it. To account for this, the first line in your callback method should be as shown in Listing 13.

Listing 13. Check the ready state

```
function updatePage() {
  if (request.readyState == 4)
    alert("Server is done!");
}
```

This change checks to ensure that the server really is finished with the process. Try running this version of the Ajax code and you should only get the alert message one time, which is as it should be.

HTTP status codes

Despite the apparent success of the code in Listing 13, there's still a problem -- what if the server responds to your request and finishes processing, but reports an error? Remember, your server-side code should care if it's being called by Ajax, a JSP, a regular HTML form, or any other type of code; it only has the traditional Web-specific

methods of reporting information. And in the Web world, HTTP codes can deal with the various things that might happen in a request.

For example, you've certainly entered a request for a URL, typed the URL incorrectly, and received a 404 error code to indicate a page is missing. This is just one of many status codes that HTTP requests can receive as a status (see Resources for a link to the complete list of status codes). 403 and 401, both indicating secure or forbidden data being accessed, are also common. In each of these cases, these are codes that result from a *completed response*. In other words, the server fulfilled the request (meaning the HTTP ready state is 4), but is probably not returning the data expected by the client.

In addition to the ready state then, you also need to check the HTTP status. You're looking for a status code of 200 which simply means okay. With a ready state of 4 and a status code of 200, you're ready to process the server's data and that data should be what you asked for (and not an error or other problematic piece of information). Add another status check to your callback method as shown in Listing 14.

Listing 14. Check the HTTP status code

```
function updatePage() {
  if (request.readyState == 4)
    if (request.status == 200)
      alert("Server is done!");
}
```

To add more robust error handling -- with minimal complication -- you might add a check or two for other status codes; check out the modified version of `updatePage()` in Listing 15.

Listing 15. Add some light error checking

```
function updatePage() {
  if (request.readyState == 4)
    if (request.status == 200)
      alert("Server is done!");
    else if (request.status == 404)
      alert("Request URL does not exist");
    else
      alert("Error: status code is " + request.status);
}
```

Now change the URL in your `getCustomerInfo()` to a non-existent URL and see what happens. You should see an alert that tells you the URL you asked for doesn't exist -- perfect! This is hardly going to handle every error condition, but it's a simple change that covers 80 percent of the problems that can occur in a typical Web application.

Reading the response text

Now that you made sure the request was completely processed (through the ready state) and the server gave you a normal, okay response (through the status code), you can finally deal with the data sent back by the server. This is conveniently stored in the `responseText` property of the `XMLHttpRequest` object.

Details about what the text in `responseText` looks like, in terms of format or length, is left intentionally vague. This allows the server to set this text to virtually anything. For instance, one script might return comma-separated values, another pipe-separated values (the pipe is the `|` character), and another may return one long string of text. It's all up to the server.

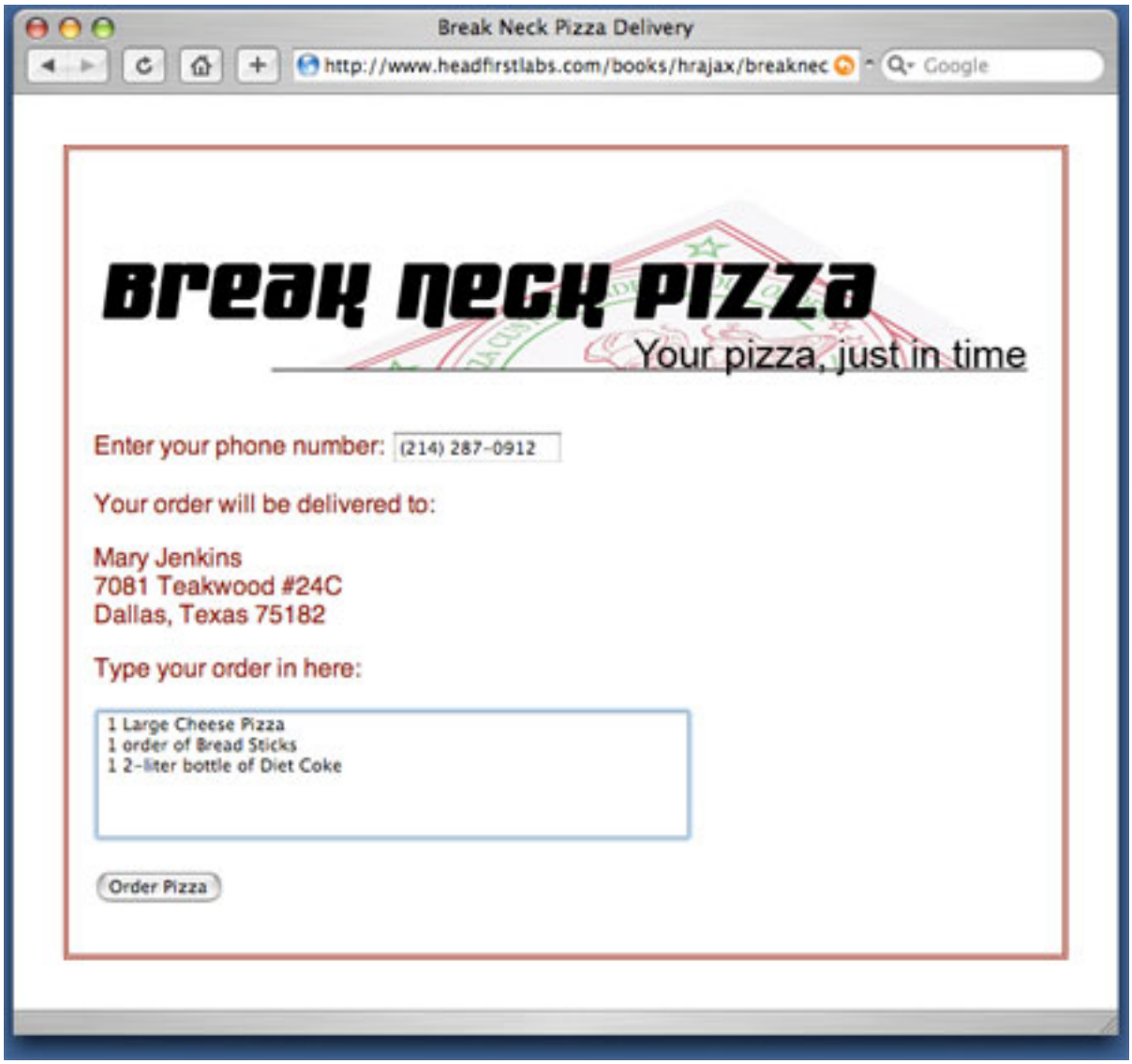
In the case of the example used in this article, the server returns a customer's last order and then their address, separated by the pipe symbol. The order and address are both then used to set values of elements on the form; Listing 16 shows the code that updates the display.

Listing 16. Deal with the server's response

```
   function updatePage() {
     if (request.readyState == 4) {
       if (request.status == 200) {
         var response = request.responseText.split("|");
         document.getElementById("order").value = response[0];
         document.getElementById("address").innerHTML =
           response[1].replace(/\n/g, "
");
       } else
         alert("status is " + request.status);
     }
   }
```

First, the `responseText` is pulled and split on the pipe symbol using the JavaScript `split()` method. The resulting array of values is dropped into `response`. The first value -- the customer's last order -- is accessed in the array as `response[0]` and is set as the value of the field with an ID of "order." The second value in the array, at `response[1]`, is the customer's address and it takes a little more processing. Since the lines in the address are separated by normal line separators (the "\n" character), the code needs to replace these with XHTML-style line separators, `<br />`s. That's accomplished through the use of the `replace()` function along with a regular expression. Finally, the modified text is set as the inner HTML of a `div` in the HTML form. The result is that the form suddenly is updated with the customer's information, as you can see in Figure 4.

Figure 4. The Break Neck form after it retrieves customer data



Before I wrap up, another important property of `XMLHttpRequest` is called `responseXML`. That property contains (can you guess?) an XML response in the event that the server chooses to respond with XML. Dealing with an XML response is quite different than dealing with plain text and involves parsing, the Document Object Model (DOM), and several other considerations. You'll learn more about XML in a future article. Still, because `responseXML` commonly comes up in discussions surrounding `responseText`, it's worth mentioning here. For many simple Ajax applications, `responseText` is all you need, but you'll soon learn about dealing with XML through Ajax applications as well.

In conclusion

You might be a little tired of `XMLHttpRequest` -- I rarely read an entire article about

a single object, especially one that is this simple. However, you will use this object over and over again in each page and application that you write that uses Ajax. Truth be told, there's quite a bit still to be said about `XMLHttpRequest`. In coming articles, you'll learn to use `POST` in addition to `GET` in your requests, set and read content headers in your request as well as the response from the server; you'll understand how to encode your requests and even handle XML in your request/response model.

Quite a bit further down the line, you'll also see some of the popular Ajax toolkits that are available. These toolkits actually abstract away most of the details discussed in this article and make Ajax programming easier. You might even wonder why you have to code all this low-level detail when toolkits are so readily available. The answer is, it's awfully hard to figure out what goes wrong in your application if you don't understand *what* is going on in your application.

So don't ignore these details or speed through them; when your handy-dandy toolkit creates an error, you won't be stuck scratching your head and sending an email to support. With an understanding of how to use `XMLHttpRequest` directly, you'll find it easy to debug and fix even the strangest problems. Toolkits are fine unless you count on them to take care of all your problems.

So get comfortable with `XMLHttpRequest`. In fact, if you have Ajax code running that uses a toolkit, try to rewrite it using just the `XMLHttpRequest` object and its properties and methods. It will be a great exercise and probably help you understand what's going on a lot better.

In the next article, you'll dig even deeper into this object, exploring some of its tricker properties (like `responseXML`), as well as how to use `POST` requests and send data in several different formats. So start coding and check back here in about a month.

Resources

Learn

- Mastering Ajax: Introduction to Ajax (developerWorks, December 2005) helps you understanding Ajax, a productive approach to building Web sites. (The resource list in this article is alone is worth a visit!)
- "Use Ajax with WebSphere Portal" (developerWorks, June 2006) to improve portal performance, create a cleaner portal application architecture, and -- most important -- give your users a much more responsive portal.
- Building Dynamic Java Applications (developerWorks, September 2005) is a look at Ajax from the server side, using a Java perspective.
- Java object serialization for Ajax (developerWorks, October 2005) examines how to send objects over the network, and interact with Ajax, from a Java perspective.
- Call SOAP Web services with Ajax (developerWorks, October 2005) is a fairly advanced article on integrating Ajax with existing SOAP-based web services.
- Google GMail is a great example of an Ajax-based application changing the way the Web works.
- Google Maps is yet another Google-based Web 2.0 application.
- Flickr is a great example of using Ajax to create a desktop feel for a Web-based application.
- Ajax: A New Approach to Web Applications is the article that coined the Ajax moniker and is required reading for all Ajax developers.
- Why Ajax Matters Now will help you understand, well, why Ajax matters (now).
- If you're using Microsoft's browser, Internet Explorer, you can get the scoop at the Microsoft Developer Network's XML Developer Center.
- Learn more about MSXML, the Microsoft XML parser, in the online documentation.
- Check out this entire list of HTTP status codes that a response can contain.
- The developerWorks Web Architecture zone specializes in articles covering various Web-based solutions.

Get products and technologies

- *Head Rush Ajax* by Elisabeth Freeman, Eric Freeman, and Brett McLaughlin (February 2006, O'Reilly Media, Inc.) takes the ideas in this article and loads them into your brain, Head First style.

- *Java and XML* , Second Edition by Brett McLaughlin (August 2001, O'Reilly Media, Inc.) includes the author's discussion of XHTML and XML transformations.
- *JavaScript: The Definitive Guide* by David Flanagan (November 2001, O'Reilly Media, Inc.) includes extensive instruction on working with JavaScript, dynamic Web pages, and the upcoming edition adds two chapters on Ajax.
- *Head First HTML with CSS & XHTML* by Elizabeth and Eric Freeman (December 2005, O'Reilly Media, Inc.) is a complete source for learning XHTML, CSS, and how to pair the two.

Discuss

- Participate in the discussion forum for this content.
- developerWorks blogs: Get involved in the developerWorks community.

About the author

Brett McLaughlin

Brett McLaughlin has worked in computers since the Logo days.(Remember the little triangle?) In recent years, he's become one of the most well-known authors and programmers in the Java and XML communities. He's worked for Nextel Communications, implementing complex enterprise systems; at Lutris Technologies, actually writing application servers; and most recently at O'Reilly Media, Inc., where he continues to write and edit books that matter. Brett's upcoming book, *Head Rush Ajax* , brings the award-winning and innovative Head First approach to Ajax, along with bestselling co-authors, Eric and Beth Freeman. His last book, *Java 1.5 Tiger: A Developer's Notebook* , was the first book available on the newest version of Java technology and his classic *Java and XML* remains one of the definitive works on using XML technologies in the Java language.