



# Patterns of Enterprise Application Architecture

By Martin Fowler

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*Patterns of Enterprise Application Architecture* is written in direct response to the stiff challenges that face enterprise application developers. The author, noted object-oriented designer Martin Fowler, noticed that despite changes in technology--from Smalltalk to CORBA to Java to .NET--the same basic design ideas can be adapted and applied to solve common problems. With the help of an expert group of contributors, Martin distills over forty recurring solutions into patterns. The result is an indispensable handbook of solutions that are applicable to any enterprise application platform.

This book is actually two books in one. The first section is a short tutorial on developing enterprise applications, which you can read from start to finish to understand the scope of the book's lessons. The next section, the bulk of the book, is a detailed reference to the patterns themselves. Each pattern provides usage and implementation information, as well as detailed code examples in Java or C#. The entire book is also richly illustrated with UML diagrams to further explain the concepts.

Armed with this book, you will have the knowledge necessary to make important architectural decisions about building an enterprise application and the proven patterns for use when building them.

The topics covered include

- Dividing an enterprise application into layers
- The major approaches to organizing business logic
- An in-depth treatment of mapping between objects and relational databases
- Using Model-View-Controller to organize a Web presentation
- Handling concurrency for data that spans multiple transactions
- Designing distributed object interfaces

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## Editorial Review

From the Back Cover

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About the Author

**Martin Fowler** is an independent consultant who has applied objects to pressing business problems for more than a decade. He has consulted on systems in fields such as health care, financial trading, and corporate finance. His clients include Chrysler, Citibank, UK National Health Service, Andersen Consulting, and Netscape Communications. In addition, Fowler is a regular speaker on objects, the Unified Modeling Language, and patterns.

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In the spring of 1999 I flew to Chicago to consult on a project being done by ThoughtWorks, a small but rapidly growing application development company. The project was one of those ambitious enterprise application projects: a back-end leasing system. Essentially it deals with everything that happens to a lease after you've signed on the dotted line: sending out bills, handling someone upgrading one of the assets on the lease, chasing people who don't pay their bills on time, and figuring out what happens when someone returns the assets early. That doesn't sound too bad until you realize that leasing agreements are infinitely varied and horrendously complicated. The business "logic" rarely fits any logical pattern, because, after all, it's written by business people to capture business, where odd small variations can make all the difference in winning a deal. Each of those little victories adds yet more complexity to the system.

That's the kind of thing that gets me excited: how to take all that complexity and come up with a system of objects that can make the problem more tractable. Indeed, I believe that the primary benefit of objects is in making complex logic tractable. Developing a good *Domain Model (116)* for a complex business problem is difficult but wonderfully satisfying.

Yet that's not the end of the problem. Our domain model had to be persisted to a database, and, like many projects, we were using a relational database. We also had to connect this model to a user interface, provide support to allow remote applications to use our software, and integrate our software with third-party packages. All of this on a new technology called J2EE, which nobody in the world had any real experience in using.

Even though this technology was new, we did have the benefit of experience. I'd been doing this kind of thing for ages with C++, Smalltalk, and CORBA. Many of the ThoughtWorkers had a lot of experience with Forte. We already had the key architectural ideas in our heads, and we just had to figure out how to apply them to J2EE. Looking back on it three years later, the design is not perfect but it has stood the test of time pretty damn well.

That's the kind of situation this book was written for. Over the years I've seen many enterprise application projects. These projects often contain similar design ideas that have proven effective in dealing with the inevitable complexity that enterprise applications possess. This book is a starting point to capture these design ideas as patterns.

The book is organized in two parts, with the first part a set of narrative chapters on a number of important topics in the design of enterprise applications. These chapters introduce various problems in the architecture of enterprise applications and their solutions. However, they don't go into much detail on these solutions. The details of the solutions are in the second part, organized as patterns. These patterns are a reference, and I don't expect you to read them cover to cover. My intention is that you read the narrative chapters in Part 1 from start to finish to get a broad picture of what the book covers; then you dip into the patterns chapters of Part 2 as your interest and needs drive you. Thus, the book is a short narrative book and a longer reference book combined into one.

This is a book on enterprise application design. Enterprise applications are about the display, manipulation, and storage of large amounts of often complex data and the support or automation of business processes with that data. Examples include reservation systems, financial systems, supply chain systems, and many others that run modern business. Enterprise applications have their own particular challenges and solutions, and they are different from embedded systems, control systems, telecoms, or desktop productivity software. Thus, if you work in these other fields, there's nothing really in this book for you (unless you want to get a feel for what enterprise applications are like.)

There are many architectural issues in building enterprise applications. I'm afraid this book can't be a comprehensive guide to them. In building software I'm a great believer in iterative development. At the heart

of iterative development is the notion that you should deliver software as soon as you have something useful to the user, even if it's not complete. Although there are many differences between writing a book and writing software, this notion is one that I think the two share. That said, this book is an incomplete but (I trust) useful compendium of advice on enterprise application architecture. The primary topics I talk about are

7. Layering of enterprise applications
8. Structuring domain (business) logic
9. Structuring a Web user interface
10. Linking in-memory modules (particularly objects) to a relational database
11. Handling session state in stateless environments
12. Principles of distribution

The list of things I don't talk about is rather longer. I really fancied writing about organizing validation, incorporating messaging and asynchronous communication, security, error handling, clustering, application integration, architectural refactoring, structuring rich-client user interfaces, among other topics. However, because of space and time constraints and lack of cogitation, you won't find them in this book. I can only hope to see some patterns for this work in the near future. Perhaps I'll do a second volume someday and get into these topics, or maybe someone else will fill these and other gaps.

Of these, message-based communication is a particularly big issue. People who are integrating multiple applications are increasingly making use of asynchronous message-based communication approaches. There's much to be said for using them within an application as well. This book is not intended to be specific for any particular software platform. I first came across these patterns while working with Smalltalk, C++, and CORBA in the late '80s and early '90s. In the late '90s I started to do extensive work in Java and found that these patterns applied well to both early Java/CORBA systems and later J2EE-based work. More recently I've been doing some initial work with Microsoft's .NET platform and find the patterns apply again. My ThoughtWorks colleagues have also introduced their experiences, particularly with Forte. I can't claim generality across all platforms that have ever been or will be used for enterprise applications, but so far these patterns have shown enough recurrence to be useful.

I have provided code examples for most of the patterns. My choice of language for them is based on what I think most readers are likely to be able to read and understand. Java is a good choice here. Anyone who can read C or C++ can read Java, yet Java is much less complex than C++. Essentially most C++ programmers can read Java but not vice versa. I'm an object bigot, so I inevitably lean to an OO language. As a result, most of the code examples are in Java. As I was working on the book, Microsoft started stabilizing its .NET environment, and its C# language has most of the same properties as Java for an author. So I did some of the code examples in C# as well, although that introduced some risk since developers don't have much experience with .NET and so the idioms for using it well are less mature. Both are C-based languages, so if you can read one you should be able to read both, even if you aren't deeply into that language or platform. My aim was to use a language that the largest amount of software developers can read, even if it's not their primary or preferred language. (My apologies to those who like Smalltalk, Delphi, Visual Basic, Perl, Python, Ruby, COBOL, or any other language. I know you think you know a better language than Java or C#. All I can say is I do, too!)

The examples are there for inspiration and explanation of the ideas in the patterns. They aren't canned solutions; in all cases you'll need to do a fair bit of work to fit them into your application. Patterns are useful starting points, but they are not destinations.

## **Who This Book Is For**

I've written this book for programmers, designers, and architects who are building enterprise applications and who want to improve either their understanding of architectural issues or their communication about them.

I'm assuming that most of my readers will fall into two groups: those with modest needs who are looking to build their own software and readers with more demanding needs who will be using a tool. For those of modest needs, my intention is that these patterns should get you started. In many areas you'll need more than the patterns will give you, but I'll provide you more of a headstart in this field than I got. For tool users I hope this book will give you some idea of what's happening under the hood and also help you choose which of the tool-supported patterns to use. Using, say, an object-relational mapping tool still means that you have to make decisions about how to map certain situations. Reading the patterns should give you some guidance in making the choices.

There is a third category; those with demanding needs who want to build their own software. The first thing I'd say here is to look carefully at using tools. I've seen more than one project get sucked into a long exercise at building frameworks, which wasn't what the project was really about. If you're still convinced, go ahead. Remember in this case that many of the code examples in this book are deliberately simplified to help understanding, and you'll find you'll need to do a lot tweaking to handle the greater demands you face.

Since patterns are common solutions to recurring problems, there's a good chance that you have already come across some of them. If you've been working in enterprise applications for a while, you may well know most of them. I'm not claiming to present anything new in this book. Indeed, I claim the opposite--this is a book of (for our industry) old ideas. If you're new to this field, I hope the book will help you learn about these techniques. If you're familiar with the techniques, I hope the book will help you communicate and teach them to others. An important part of patterns is trying to build a common vocabulary, so you can say that this class is a *Remote Facade* (388) and other designers will know what you mean.

Martin Fowler, Melrose, Massachusetts, August 2002

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## **Users Review**

### **From reader reviews:**

#### **Joshua Orvis:**

Why don't make it to be your habit? Right now, try to prepare your time to do the important act, like looking for your favorite reserve and reading a reserve. Beside you can solve your condition; you can add your knowledge by the reserve entitled Patterns of Enterprise Application Architecture. Try to the actual book Patterns of Enterprise Application Architecture as your good friend. It means that it can to get your friend when you feel alone and beside associated with course make you smarter than in the past. Yeah, it is very fortunated for you. The book makes you more confidence because you can know anything by the book. So , let us make new experience as well as knowledge with this book.

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**Donald Oakes:**

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