Resistance is Futile – How to Make Your Java Objects Conform with the Adapter Pattern

by Barry A. Burd and Michael P. Redlich

This article, the fourth in a series on design patterns, introduces the Adapter pattern, one of the 23 design patterns defined in the legendary 1995 book *Design Patterns – Elements of Reusable Object-Oriented Software*. (The book’s nickname is the *Gang of Four* (*GoF*) book, because of its four authors, Erich Gamma, Richard Helm, Ralph Johnson, and John Vlissides.)

**Design Patterns**

The GoF book's 23 design patterns fall into three categories:

- A creational pattern abstracts the instantiation process.
- A structural pattern groups objects into larger structures.
- A behavioral pattern defines better communication among objects.

The Adapter design pattern fits into the structural category. Like the Decorator design pattern, the Adapter pattern is also known as a “wrapper.” The Adapter and Decorator design patterns are similar, but they perform slightly different roles.

- A decorator adds responsibilities to an object.
- An adapter connects existing interfaces.

**The Adapter Pattern**

Here's a quotation from the GoF book:

“[An adapter] converts the interface of a class into another interface the client expects. Adapter lets classes work together that couldn’t otherwise because of incompatible interfaces.”

The Adapter design pattern follows two important design principles (both quoted directly from the GoF book):

- “Favor object composition over class inheritance.”
- “Program to interfaces, not implementations.”

**Motivation**

Consider the following situation. You have a nice, useful piece of code, but you can't easily use the code in an existing application. The "useful" code has an interface, but the existing application expects a different interface. Using the Adapter design pattern, you can use the useful code in the existing application.

**Implementation**
Figure 1 shows the official UML diagram for the Adapter pattern.

![UML Diagram](image)

**Figure 1: The official UML diagram for the Adapter design pattern**

Here’s a walk-through of the parts of the UML diagram.

- A **Client** class expects a certain interface (called the **Target** interface).
- An available interface doesn't match the **Target** interface.
- An **Adapter** class bridges the gap between the **Target** interface and the available interface.
- The available interface is called the **Adaptee**.
- The **Adapter** class stores a copy of **adaptee**, an instance of the **Adaptee** class.

What this UML diagram needs is a concrete example. Consider some electronic devices -- Game Boys, cell phones, and other devices. You plug the devices into your car’s cigarette lighter socket or the wall outlet in your house. Both car charging and home charging require adapter cables. The UML diagram for this concrete example is in Figure 2.
The elements in Figure 2 have parallels in Figure 1.

- A Game Boy or cell phone device (the **Client** in Figure 1) expects a certain interface. This interface may be a mini-plug, a USB port, or some other gizmo. The general name for such an interface is the **Target** interface.
- An available **Charger** interface (a power source, such as a wall outlet or cigarette lighter socket) doesn’t match the **Target** interface.
- A **DeviceAdapter** (called an **Adapter** in Figure 1) bridges the gap between the **Target** interface and the **Charger** interface.
- The **Charger** interface is called the **Adaptee**.

Figure 3 shows yet another view of all this terminology.
Figure 3: Visualizing the device charging application

The source code for the UML diagram in Figure 2 is in Listings 1 to 7. A main method to test the code is in Listing 8.

```
public interface Device {
    public void getCharge(String charger);
}

Listing 1: The Device interface

public class GameBoy implements Device {
    public void getCharge(String charger) {
        System.out.println("The Game Boy is being charged by the " + charger + "...");
    }
}

Listing 2. The GameBoy class (a client)

public class CellPhone implements Device {
    public void getCharge(String charger) {
        System.out.println("The Cell Phone is being charged by the " + charger + "...");
    }
}

Listing 3. The CellPhone class (another client)
public interface Charger  
{
    public void chargeDevice(String charger);
    public String getCharger();
}

Listing 4. The Charger interface

public class CigaretteLighter implements Charger  
{
    String charger;

    public CigaretteLighter(String charger)  
    {
        setCharger(charger);
    }

    public void chargeDevice(String charger)  
    {
        System.out.println("The " + charger + " is ready");
    }

    public String getCharger()  
    {
        return charger;
    }

    public void setCharger(String charger)  
    {
        this.charger = charger;
    }
}

Listing 5. The CigaretteLighter class (an adaptee)

public class WallOutlet implements Charger  
{
    String charger;

    public WallOutlet(String charger)  
    {
        setCharger(charger);
    }

    public void chargeDevice(String charger)  
    {
        System.out.println("The " + charger + " is ready");
    }

    public String getCharger()  
    {
        return charger;
    }

    public void setCharger(String charger)  
    {
        this.charger = charger;
    }
}

Listing 6: The WallOutlet class (another adaptee)
The `Device` interface declares a method called `getCharge()` which is the interface that clients (cell phones and Game Boys) use. In the meantime, the `Charger` interface declares a different interface method -- a method named `chargeDevice()`.

The main application (Listing 8) declares `Charger` instances (`CigaretteLighter` and `WallOutlet`) and `Device` instances (`GameBoy` and `CellPhone`). An adapter for each device allows a charger to charge the device. That's where the fun begins. The main method creates an instance of `DeviceAdapter` for each of the devices:
// create the device adapters
Charger device01 = new DeviceAdapter(gameBoy);
Charger device02 = new DeviceAdapter(cellPhone);

Notice two things about the code in DeviceAdapter (Listing 7):

- The code implements the Charger interface, so this code must implement the Charger interface's chargeDevice() method.
- The code's device field stores an instance of a Device type.

The DeviceAdapter uses its stored device object to implement the chargeDevice() method.

```java
public void chargeDevice(String charger)
{
    device.getCharge(charger);
}
```

Each DeviceAdapter instance has a Device instance. Another name for this "has a" relationship is "composition." And the use of composition underlies many design patterns.

Figure 4 displays the output of the ChargeDevices program (Listing 8).

```
-- Device Charging Application --
The Game Boy is being charged by the cigarette lighter...
The Cell Phone is being charged by the cigarette lighter...
The Game Boy is being charged by the wall outlet...
```

Figure 4: The output of the device charging application

Adapting in the Java API

Java has two interfaces for traversing a container -- the older Enumeration interface, and the newer Iterator interface. In the book Head First Design Patterns, written by Eric & Elisabeth Freeman (along with Kathy Sierra and Bert Bates), the authors challenge you to write the following code:

- Adapt an iterator to an enumeration.
- Write a main method that uses this new adapted enumeration to traverse an ArrayList. (Remember, the ArrayList class doesn’t support enumerations.)

Listings 9 and 10 contain a version of the iterator adapter and the main method:

```java
import java.util.Enumeration;
import java.util.Iterator;

public class IteratorAdapter implements Enumeration
{
    Iterator iterator;

    public IteratorAdapter(Iterator iterator)
    {
        this.iterator = iterator;
    }
```
public boolean hasMoreElements()
{
    return iterator.hasNext();
}

class nextElement()
{
    return iterator.next();
}

Listing 9. The IteratorAdapter class

import java.util.ArrayList;
import java.util.Enumeration;
import java.util.Iterator;
import java.util.List;

class IteratorAdapterTest
{
    public static void main(String[] args)
    {
        System.out.println("-- Iterator Adapter Test Application --");
        System.out.println();
        System.out.println("Enumerating Through the JavaBoutique Articles");
        System.out.println("Written by Barry Burd and Michael Redlich");
        System.out.println();

        List<String> list = new ArrayList<String>();
        list.add("James: The Java Apache Mail Enterprise Server, " +
                "September 30, 2005");
        list.add("Avoid Excessive Subclassing with the " +
                "Decorator Design Pattern, " +
                "January 27, 2006");
        list.add("Keeping Your Java Objects Informed with the " +
                "Observer Design Pattern, " +
                "June 19, 2006");
        list.add("Manufacturing Java Objects with the " +
                "Factory Design Pattern, " +
                "August 14, 2006");

        Iterator iterator = list.iterator();
        Enumeration enumeration = new IteratorAdapter(iterator);

        int i = 1;
        while(enumeration.hasMoreElements())
        {
            System.out.println(i + ": " + enumeration.nextElement());
            ++i;
        }
    }

Listing 10: The IteratorAdapterTest class – the client application

Like the DeviceAdapter, the IteratorAdapter implements the adaptee’s interface (the Enumeration interface). The IteratorAdapter stores an instance of Iterator, and uses this instance to call the hasNext() method in the implementation of hasMoreElements(). The main method (Listing 10) creates an ArrayList to
hold some strings. The **ArrayList** class doesn’t support the **Enumeration** interface. Even so, Listing 10 uses an enumeration to traverse an **ArrayList**.

Figure 5 displays the output of the iterator adapter test application.

```plaintext
-- Iterator Adapter Test Application --

Enumerating Through the JavaBoutique Articles
Written by Barry Burd and Michael Redlich

1: James: The Java Apache Mail Enterprise Server, September 30, 2005
2: Avoid Excessive Subclassing with the Decorator Design Pattern, January 27, 2006
3: Keeping Your Java Objects Informed with the Observer Design Pattern, June 19, 2006
4: Manufacturing Java Objects with the Factory Design Pattern, August 14, 2006

Figure 5: The output of the iterator adapter test
```

**Object vs. Class Adapters**

There are actually two ways to implement the Adapter design pattern. The examples in this article demonstrate the use of the Adapter design pattern as an **object** adapter. The object adapter uses composition to accomplish its goal.

The **class** adapter is similar. But the class adapter uses inheritance (more specifically, multiple inheritance) instead of composition. Java doesn't support multiple inheritance, so you can't implement a class adapter in Java. (To implement a class adapter, you must dirty your hands with C++.)

**Resistance is Futile**

For the Borg on Star Trek, and for application software, assimilation is crucial. The adapting of one system to another system’s interface is an important tool in the development process. If the Borg’s computers run Java (and we’re certain that they do) then the computers connect with other species using the Adapter design pattern. The pattern provides an elegant, orderly procedure for making one system’s interface match another system’s expectations.

**Resources**

*Design Patterns – Elements of Reusable Object-Oriented Software*
Erich Gamma, Richard Helm, Ralph Johnson, and John Vlissides

*Head First Design Patterns*
Eric & Elisabeth Freeman
ISBN 0-596-00712-4

*Object-Oriented Software Construction*
Bertrand Meyer
ISBN 0-13-629155-4
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