And now for something different...

There's another pattern in this chapter.

You've seen how the Adapter Pattern converts the interface of a class into one that a client is expecting. You also know we achieve this in Java by wrapping the object that has an incompatible interface with an object that implements the correct one.

We're going to look at a pattern now that alters an interface, but for a different reason: to simplify the interface. It's aptly named the Facade Pattern because this pattern hides all the complexity of one or more classes behind a clean, well-lit facade.

WHO DOES WHAT?

Match each pattern with its intent:

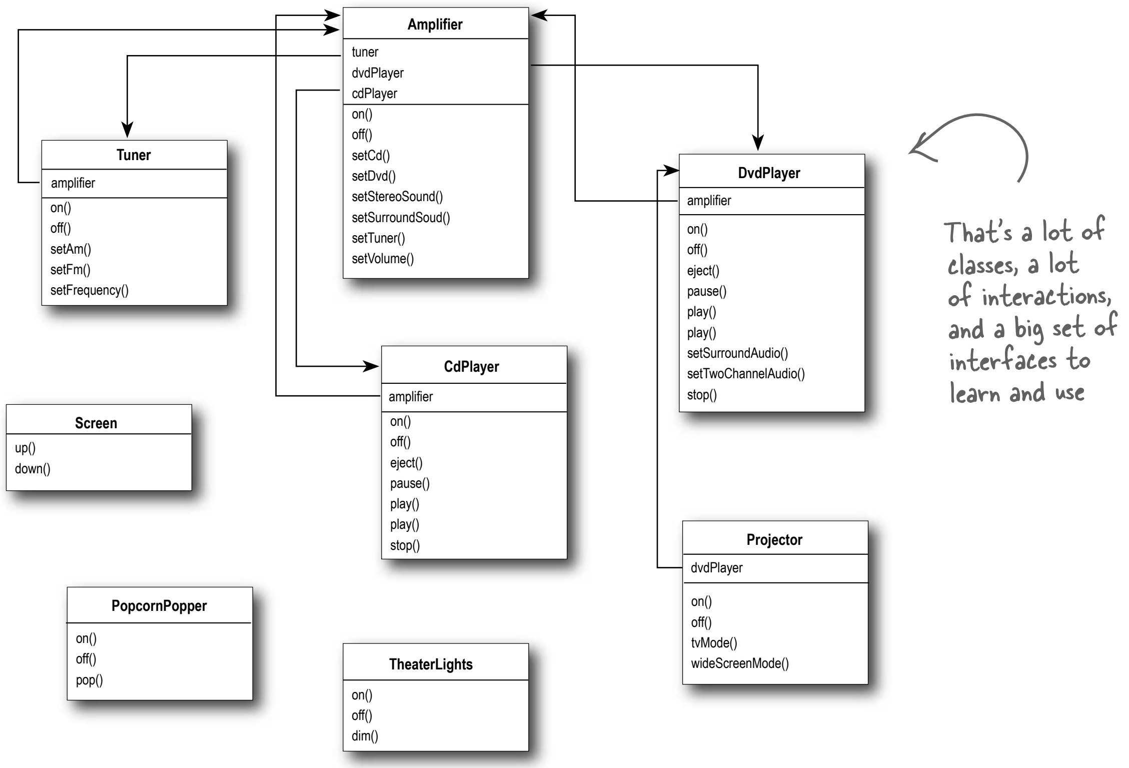
Pattern	Intent
Decorator	Converts one interface to another
Adapter	Doesn't alter the interface, but adds responsibility
Facade	Makes an interface simpler

Home Sweet Home Theater

Before we dive into the details of the Facade Pattern, let's take a look at a growing national obsession: building your own home theater.

You've done your research and you've assembled a killer system complete with a DVD player, a projection video system, an automated screen, surround sound and even a popcorn popper.

Check out all the components you've put together:



You've spent weeks running wire, mounting the projector, making all the connections and fine tuning. Now it's time to put it all in motion and enjoy a movie...

Watching a movie (the hard way)

Pick out a DVD, relax, and get ready for movie magic. Oh, there's just one thing – to watch the movie, you need to perform a few tasks:

1. Turn on the popcorn popper
2. Start the popper popping
3. Dim the lights
4. Put the screen down
5. Turn the projector on
6. Set the projector input to DVD
7. Put the projector on wide-screen mode
8. Turn the sound amplifier on
9. Set the amplifier to DVD input
10. Set the amplifier to surround sound
11. Set the amplifier volume to medium (5)
12. Turn the DVD Player on
13. Start the DVD Player playing

I'm already exhausted and all I've done is turn everything on!

Let's check out those same tasks in terms of the classes and the method calls needed to perform them:

```
popper.on();
popper.pop();

lights.dim(10);

screen.down();

projector.on();
projector.setInput(dvd);
projector.wideScreenMode();

amp.on();
amp.setDvd(dvd);
amp.setSurroundSound();
amp.setVolume(5);

dvd.on();
dvd.play(movie);
```

Six different classes involved!

Turn on the popcorn popper and start popping...

Dim the lights to 10%...

Put the screen down...

Turn on the projector and put it in wide screen mode for the movie...

Turn on the amp, set it to DVD, put it in surround sound mode and set the volume to 5...

Turn on the DVD player... and FINALLY, play the movie!

But there's more...

- When the movie is over, how do you turn everything off? Wouldn't you have to do all of this over again, in reverse?
- Wouldn't it be as complex to listen to a CD or the radio?
- If you decide to upgrade your system, you're probably going to have to learn a slightly different procedure.

So what to do? The complexity of using your home theater is becoming apparent!

Let's see how the Facade Pattern can get us out of this mess so we can enjoy the movie...

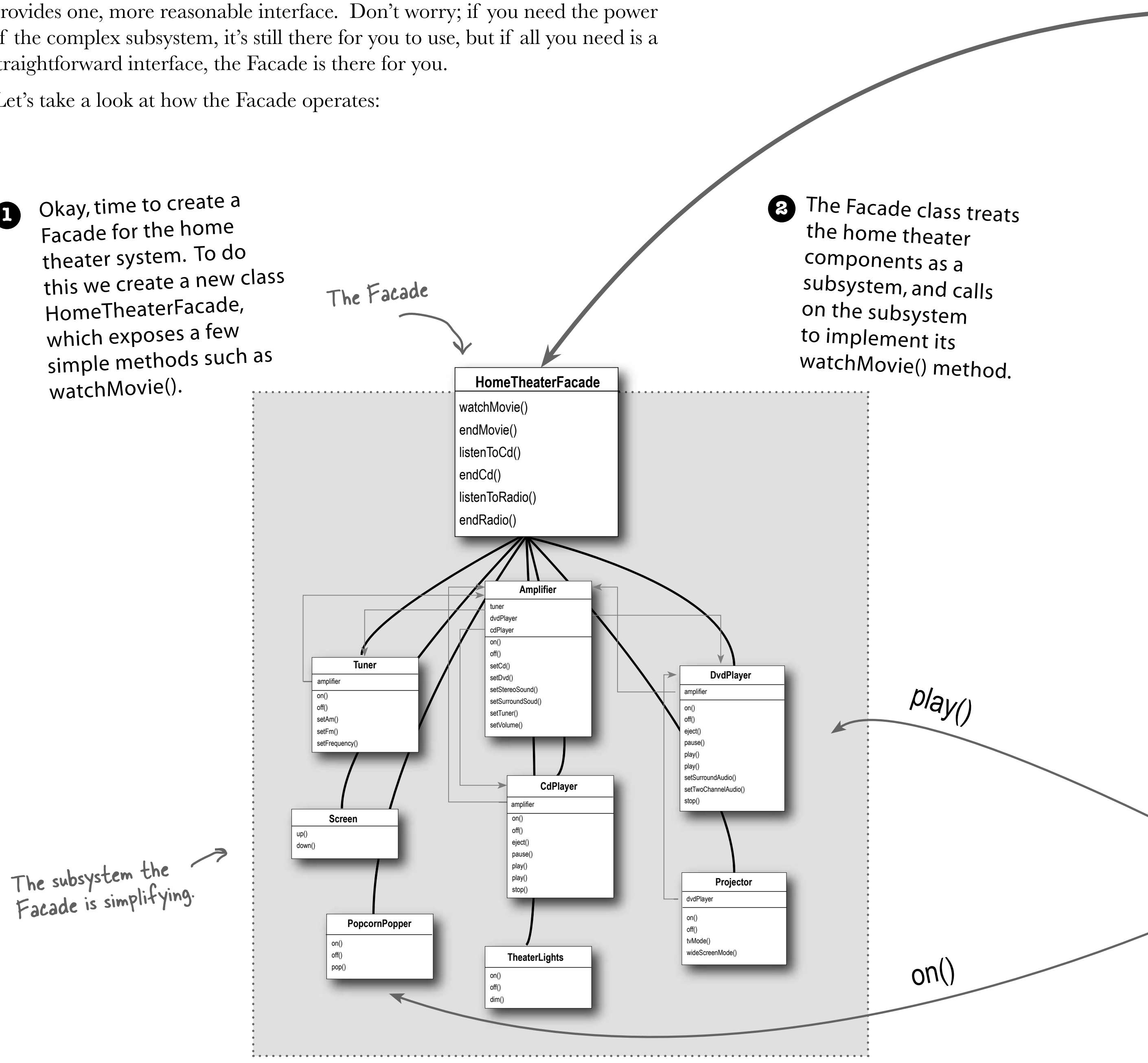
Lights, Camera, Facade!

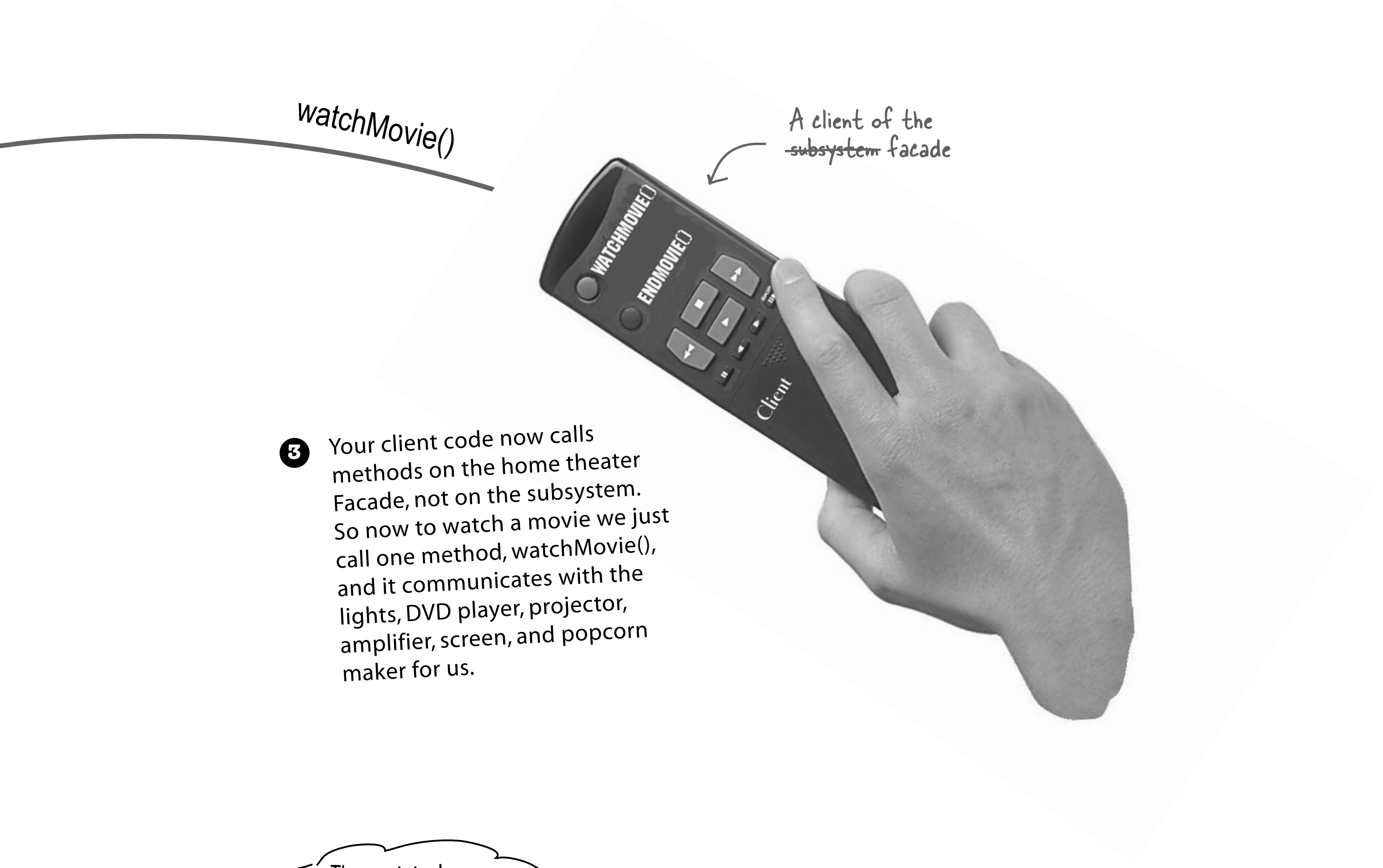
A Facade is just what you need: with the Facade Pattern you can take a complex subsystem and make it easier to use by implementing a Facade class that provides one, more reasonable interface. Don't worry; if you need the power of the complex subsystem, it's still there for you to use, but if all you need is a straightforward interface, the Facade is there for you.

Let's take a look at how the Facade operates:

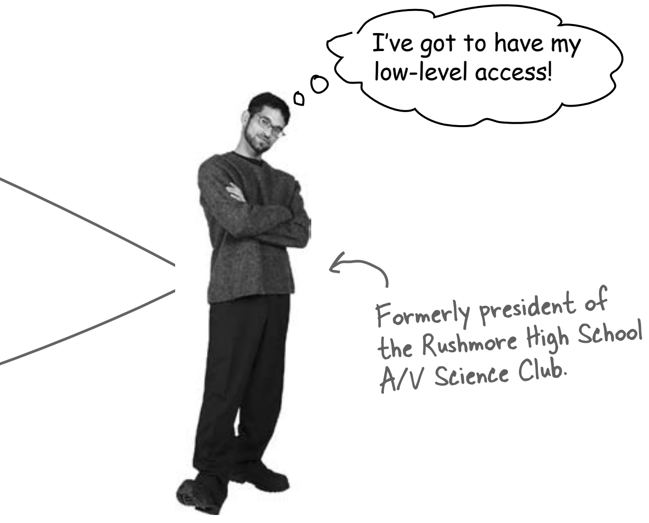
1. Okay, time to create a Facade for the home theater system. To do this we create a new class HomeTheaterFacade, which exposes a few simple methods such as watchMovie().

2. The Facade class treats the home theater components as a subsystem, and calls on the subsystem to implement its watchMovie() method.





❸ Your client code now calls methods on the home theater Facade, not on the subsystem. So now to watch a movie we just call one method, watchMovie(), and it communicates with the lights, DVD player, projector, amplifier, screen, and popcorn maker for us.


I've got to have my low-level access!
Formerly president of the Rushmore High School A/V Science Club.

❹ The Facade still leaves the subsystem accessible to be used directly. If you need the advanced functionality of the subsystem classes, they are available for your use.

there are no Dumb Questions

Q: If the Facade encapsulates the subsystem classes, how does a client that needs lower-level functionality gain access to them?

A: Facades don't "encapsulate" the subsystem classes; they merely provide a simplified interface to their functionality. The subsystem classes still remain available for direct use by clients that need to use more specific interfaces. This is a nice property of the Facade Pattern: it provides a simplified interface while still exposing the full functionality of the system to those who may need it.

Q: Does the facade add any functionality or does it just pass through each request to the subsystem?

A: A facade is free to add its own "smarts" in addition to making use of the subsystem. For instance, while our home theater facade doesn't implement any new behavior, it is smart enough to know that the popcorn popper has to be turned on before it can pop (as well as the details of how to turn on and stage a movie showing).

Q: Does each subsystem have only one facade?

A: Not necessarily. The pattern certainly allows for any number of facades to be created for a given subsystem.

Q: What is the benefit of the facade other than the fact that I now have a simpler interface?

A: The Facade Pattern also allows you to decouple your client implementation from any one subsystem. Let's say for instance that you get a big raise and decide to upgrade your home theater to all new components that have different interfaces. Well, if you coded your client to the facade rather than the subsystem, your client code doesn't need to change, just the facade (and hopefully the manufacturer is supplying that!).

Q: So the way to tell the difference between the Adapter Pattern and the Facade Pattern is that the adapter wraps one class and the facade may represent many classes?

A: No! Remember, the Adapter Pattern changes the interface of one or more classes into one interface that a client is expecting. While most textbook examples show the adapter adapting one class, you may need to adapt many classes to provide the interface a client is coded to. Likewise, a Facade may provide a simplified interface to a single class with a very complex interface.

The difference between the two is not in terms of how many classes they "wrap," it is in their **intent**. The intent of the Adapter Pattern is to **alter** an interface so that it matches one a client is expecting. The intent of the Facade Pattern is to provide a **simplified** interface to a subsystem.

A facade not only simplifies an interface, it decouples a client from a subsystem of components.

Facades and adapters may wrap multiple classes, but a facade's intent is to simplify, while an adapter's is to convert the interface to something different.

Constructing your home theater facade

Let's step through the construction of the HomeTheaterFacade: The first step is to use composition so that the facade has access to all the components of the subsystem:

```
public class HomeTheaterFacade {
    Amplifier amp;
    Tuner tuner;
    DvdPlayer dvd;
    CdPlayer cd;
    Projector projector;
    TheaterLights lights;
    Screen screen;
    PopcornPopper popper;

    public HomeTheaterFacade(Amplifier amp,
                 Tuner tuner,
                 DvdPlayer dvd,
                 CdPlayer cd,
                 Projector projector,
                 Screen screen,
                 TheaterLights lights,
                 PopcornPopper popper) {

        this.amp = amp;
        this.tuner = tuner;
        this.dvd = dvd;
        this.cd = cd;
        this.projector = projector;
        this.screen = screen;
        this.lights = lights;
        this.popper = popper;
    }

        // other methods here

}
```

Here's the composition; these are all the components of the subsystem we are going to use.

The facade is passed a reference to each component of the subsystem in its constructor. The facade then assigns each to the corresponding instance variable.

We're just about to fill these in...

Implementing the simplified interface

Now it's time to bring the components of the subsystem together into a unified interface. Let's implement the watchMovie() and endMovie() methods:

```
public void watchMovie(String movie) {
    System.out.println("Get ready to watch a movie...");
    popper.on();
    popper.pop();
    lights.dim(10);
    screen.down();
    projector.on();
    projector.wideScreenMode();
    amp.on();
    amp.setDvd(dvd);
    amp.setSurroundSound();
    amp.setVolume(5);
    dvd.on();
    dvd.play(movie);
}

public void endMovie() {
    System.out.println("Shutting movie theater down...");
    popper.off();
    lights.on();
    screen.up();
    projector.off();
    amp.off();
    dvd.stop();
    dvd.eject();
    dvd.off();
}
```

watchMovie() follows the same sequence we had to do by hand before, but wraps it up in a handy method that does all the work. Notice that for each task we are delegating the responsibility to the corresponding component in the subsystem.

And endMovie() takes care of shutting everything down for us. Again, each task is delegated to the appropriate component in the subsystem.

BRAIN POWER

Think about the facades you've encountered in the Java API. Where would you like to have a few new ones?

Time to watch a movie (the easy way)

It's SHOWTIME!

```
public class HomeTheaterTestDrive {
    public static void main(String[] args) {
        // instantiate components here

        HomeTheaterFacade homeTheater =
                new HomeTheaterFacade(amp, tuner, dvd, cd,
                        projector, screen, lights, popper);

        homeTheater.watchMovie("Raiders of the Lost Ark");
        homeTheater.endMovie();
    }
}
```

Here we're creating the components right in the test drive. Normally the client is given a facade, it doesn't have to construct one itself.

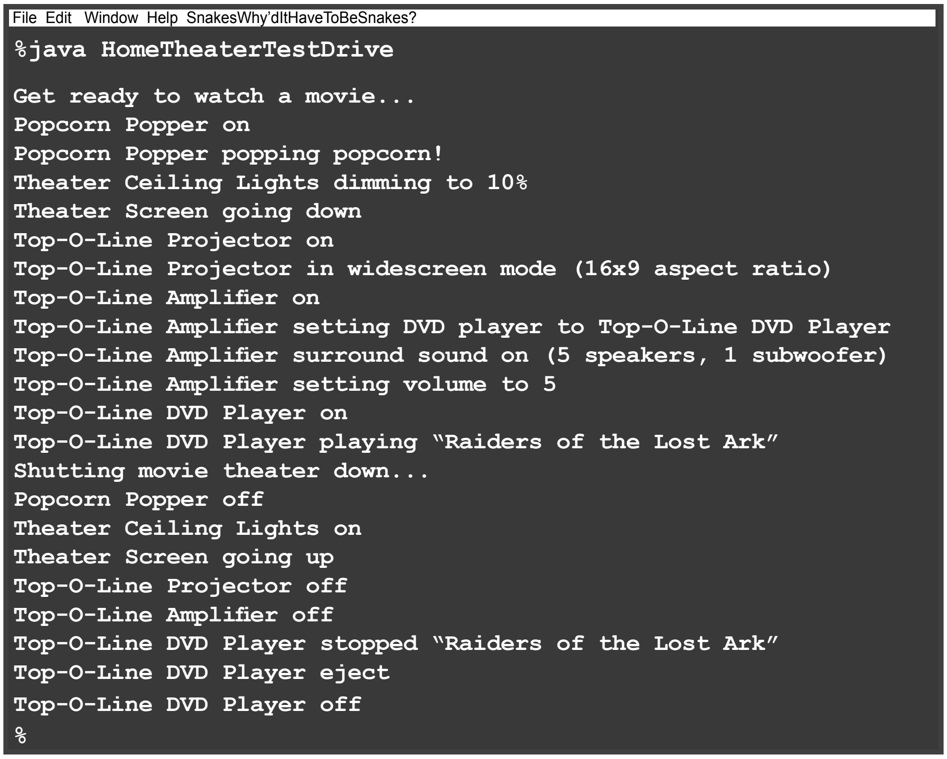
First you instantiate the Facade with all the components in the subsystem.

Use the simplified interface to first start the movie up, and then shut it down.

Here's the output.

Calling the Facade's watchMovie() does all this work for us...

...and here, we're done watching the movie, so calling endMovie() turns everything off.



```
%java HomeTheaterTestDrive

Get ready to watch a movie...
Popcorn Popper on
Popcorn Popper popping popcorn!
Theater Ceiling Lights dimming to 10%
Theater Screen going down
Top-O-Line Projector on
Top-O-Line Projector in widescreen mode (16x9 aspect ratio)
Top-O-Line Amplifier on
Top-O-Line Amplifier setting DVD player to Top-O-Line DVD Player
Top-O-Line Amplifier surround sound on (5 speakers, 1 subwoofer)
Top-O-Line Amplifier setting volume to 5
Top-O-Line DVD Player on
Top-O-Line DVD Player playing "Raiders of the Lost Ark"
Shutting movie theater down...
Popcorn Popper off
Theater Ceiling Lights on
Theater Screen going up
Top-O-Line Projector off
Top-O-Line Amplifier off
Top-O-Line DVD Player stopped "Raiders of the Lost Ark"
Top-O-Line DVD Player eject
Top-O-Line DVD Player off
%
```

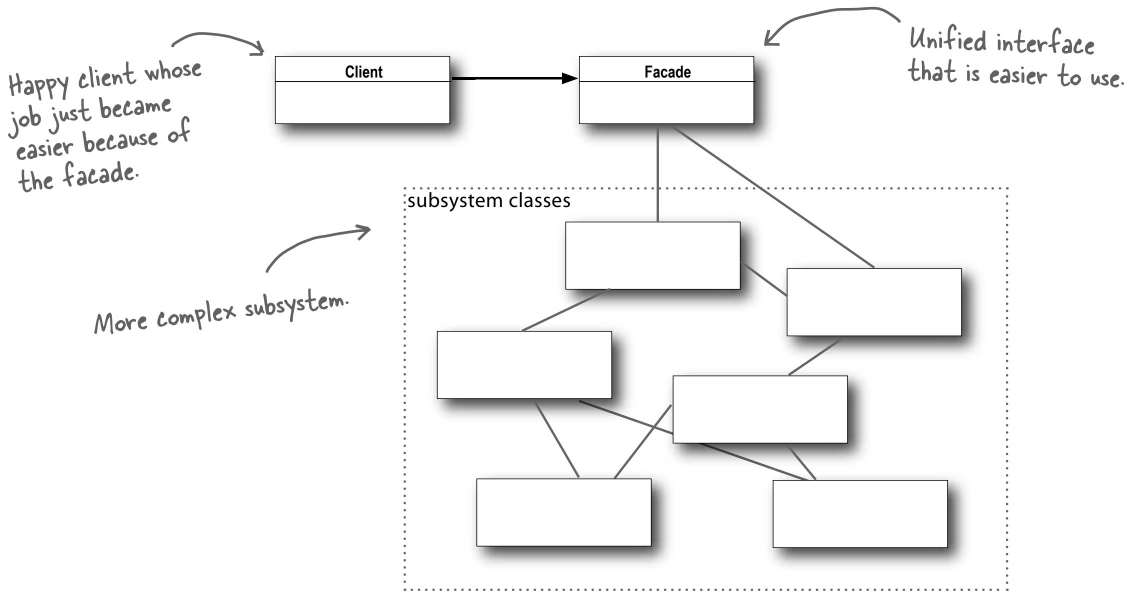
Facade Pattern defined

To use the Facade Pattern, we create a class that simplifies and unifies a set of more complex classes that belong to some subsystem. Unlike a lot of patterns, Facade is fairly straightforward; there are no mind bending abstractions to get your head around. But that doesn't make it any less powerful: the Facade Pattern allows us to avoid tight coupling between clients and subsystems, and, as you will see shortly, also helps us adhere to a new object oriented principle.

Before we introduce that new principle, let's take a look at the official definition of the pattern:

The Facade Pattern provides a unified interface to a set of interfaces in a subsytem. Facade defines a higher-level interface that makes the subsystem easier to use.

There isn't a lot here that you don't already know, but one of the most important things to remember about a pattern is its intent. This definition tells us loud and clear that the purpose of the facade it to make a subsystem easier to use through a simplified interface. You can see this in the pattern's class diagram:


Happy client whose job just became easier because of the facade.
Client
Facade
Unified interface that is easier to use.
subsystem classes
More complex subsystem.

That's it; you've got another pattern under your belt! Now, it's time for that new OO principle. Watch out, this one can challenge some assumptions!

The Principle of Least Knowledge

The Principle of Least Knowledge guides us to reduce the interactions between objects to just a few close "friends." The principle is usually stated as:

Design Principle

Principle of Least Knowledge - talk only to your immediate friends.

But what does this mean in real terms? It means when you are designing a system, for any object, be careful of the number of classes it interacts with and also how it comes to interact with those classes.

This principle prevents us from creating designs that have a large number of classes coupled together so that changes in one part of the system cascade to other parts. When you build a lot of dependencies between many classes, you are building a fragile system that will be costly to maintain and complex for others to understand.

BRAIN POWER

How many classes is this code coupled to?

```
public float getTemp() {
     return station.getThermometer().getTemperature();
}
```

How NOT to Win Friends and Influence Objects

Okay, but how do you keep from doing this? The principle provides some guidelines: take any object; now from any method in that object, the principle tells us that we should only invoke methods that belong to:

- The object itself
- Objects passed in as a parameter to the method
- Any object the method creates or instantiates
- Any components of the object

Notice that these guidelines tell us not to call methods on objects that were returned from calling other methods!!

Think of a "component" as any object that is referenced by an instance variable. In other words think of this as a HAS-A relationship.

This sounds kind of stringent doesn't it? What's the harm in calling the method of an object we get back from another call? Well, if we were to do that, then we'd be making a request of another object's subpart (and increasing the number of objects we directly know). In such cases, the principle forces us to ask the object to make the request for us; that way we don't have to know about its component objects (and we keep our circle of friends small). For example:

Without the Principle

```
public float getTemp() {
    Thermometer thermometer = station.getThermometer();
    return thermometer.getTemperature();
}
```

Here we get the thermometer object from the station and then call the getTemperature() method ourselves.

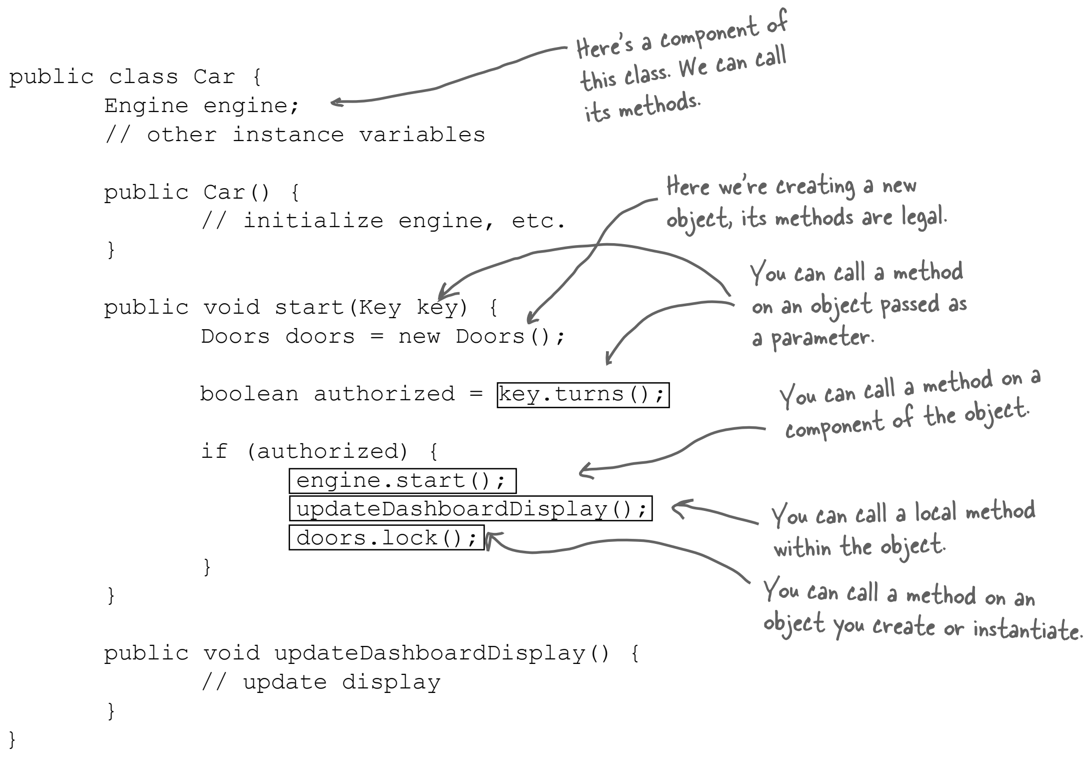
With the Principle

```
public float getTemp() {
    return station.getTemperature();
}
```

When we apply the principle, we add a method to the Station class that makes the request to the thermometer for us. This reduces the number of classes we're dependent on.

Keeping your method calls in bounds...

Here's a Car class that demonstrates all the ways you can call methods and still adhere to the Principle of Least Knowledge:



```
public class Car {
      Engine engine;
      // other instance variables

      public Car() {
            // initialize engine, etc.
      }

      public void start(Key key) {
            Doors doors = new Doors();

            boolean authorized = key.turns();

            if (authorized) {
                  engine.start();
                  updateDashboardDisplay();
                  doors.lock();
            }
      }

      public void updateDashboardDisplay() {
            // update display
      }
}
```

Here's a component of this class. We can call its methods.
Here we're creating a new object, its methods are legal.
You can call a method on an object passed as a parameter.
You can call a method on a component of the object.
You can call a local method within the object.
You can call a method on an object you create or instantiate.

there are no Dumb Questions

Q: There is another principle called the Law of Demeter; how are they related?

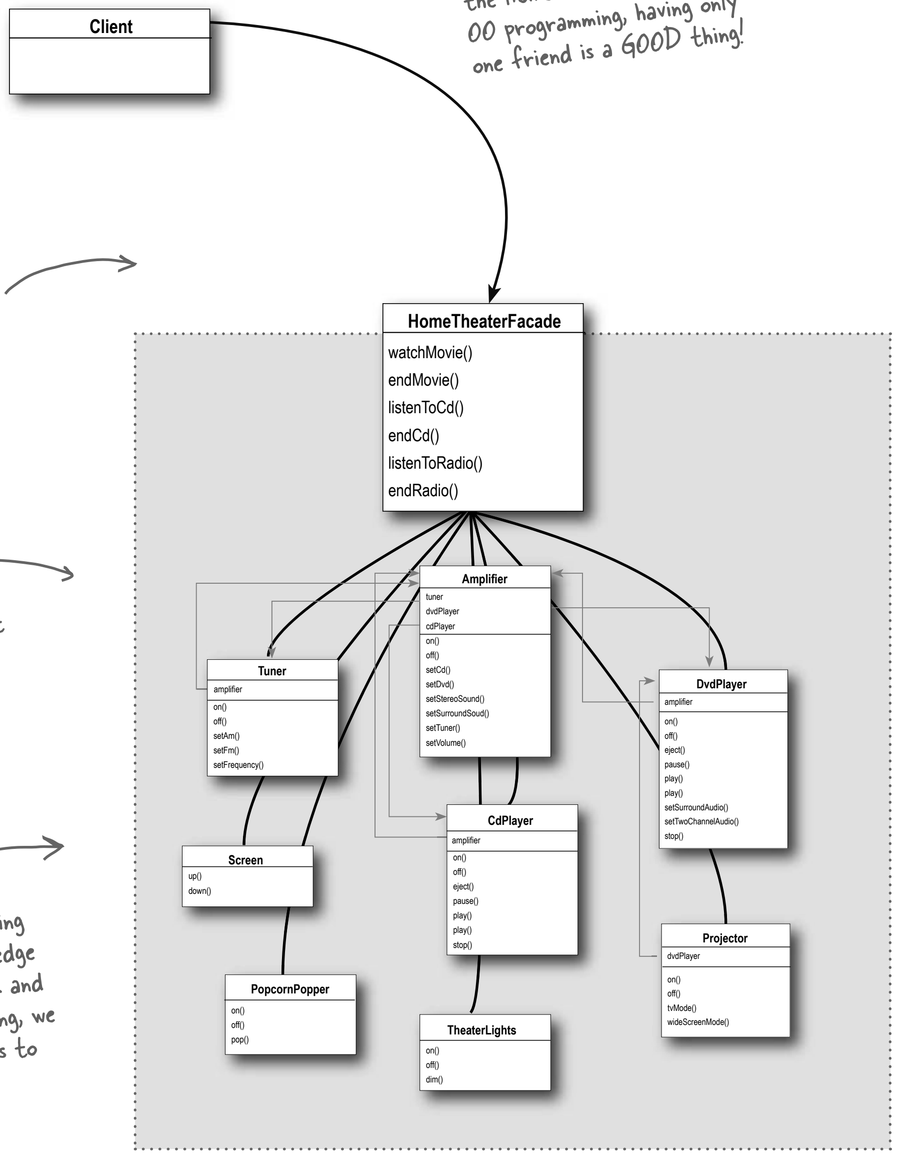
A: The two are one and the same and you'll encounter these terms being intermixed. We prefer to use the Principle of Least Knowledge for a couple of reasons: (1) the name is more intuitive and (2) the use of the word "Law" implies we always have to apply this principle. In fact, no principle is a law, all principles should be used when and where they are helpful. All design involves tradeoffs (abstractions versus speed, space versus time, and so on) and while principles provide guidance, all factors should be taken into account before applying them.

Q: Are there any disadvantages to applying the Principle of Least Knowledge?

A: Yes; while the principle reduces the dependencies between objects and studies have shown this reduces software maintenance, it is also the case that applying this principle results in more "wrapper" classes being written to handle method calls to other components. This can result in increased complexity and development time as well as decreased runtime performance.

The Facade and the Principle of Least Knowledge

This client only has one friend; the HomeTheaterFacade. In OO programming, having only one friend is a GOOD thing!



The HomeTheaterFacade manages all those subsystem components for the client. It keeps the client simple and flexible.

We can upgrade the home theater components without affecting the client .

We try to keep subsystems adhering to the Principle of Least Knowledge as well. If this gets too complex and too many friends are intermingling, we can introduce additional facades to form layers of subsystems.

Tools for your Design Toolbox

Your toolbox is starting to get heavy! In this chapter we've added a couple of patterns that allow us to alter interfaces and reduce coupling between clients and the systems they use.

OO Basics

straction

capsulation

lymorphism

eritance

OO Principles

Encapsulate what varies

Favor composition over inheritance

Program to interfaces, not implementations

Strive for loosely coupled designs between objects that interact

Classes should be open for extension but closed for modification

Depend on abstractions. Do not depend on concretions

Only talk to your friends

We have a new technique for maintaining a low level of coupling in our designs. (remember, talk only to your friends)...

OO Patterns

es a request

ting you

different

...and TWO new patterns. Each changes an interface, the adapter to convert and the facade to unify and simplify

Adapter - Converts the interface of a class into another interface clients expect. Lets classes work together that couldn't otherwise because of incompatible interfaces.

Facade - Provides a unified interface to a set of interfaces in a subsystem. Facade defines a higher-level interface that makes the subsystem easier to use.

BULLET POINTS

- When you need to use an existing class and its interface is not the one you need, use an adapter.
- When you need to simplify and unify a large interface or complex set of interfaces, use a facade.
- An adapter changes an interface into one a client expects.
- A facade decouples a client from a complex subsystem.
- Implementing an adapter may require little work or a great deal of work depending on the size and complexity of the target interface.
- Implementing a facade requires that we compose the facade with its subsystem and use delegation to perform the work of the facade.
- There are two forms of the Adapter Pattern: object and class adapters. Class adapters require multiple inheritance.
- You can implement more than one facade for a subsystem.
- An adapter wraps an object to change its interface, a decorator wraps an object to add new behaviors and responsibilities, and a facade "wraps" a set of objects to simplify.