Head First Design Patterns

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ch07-02. Facade Pattern

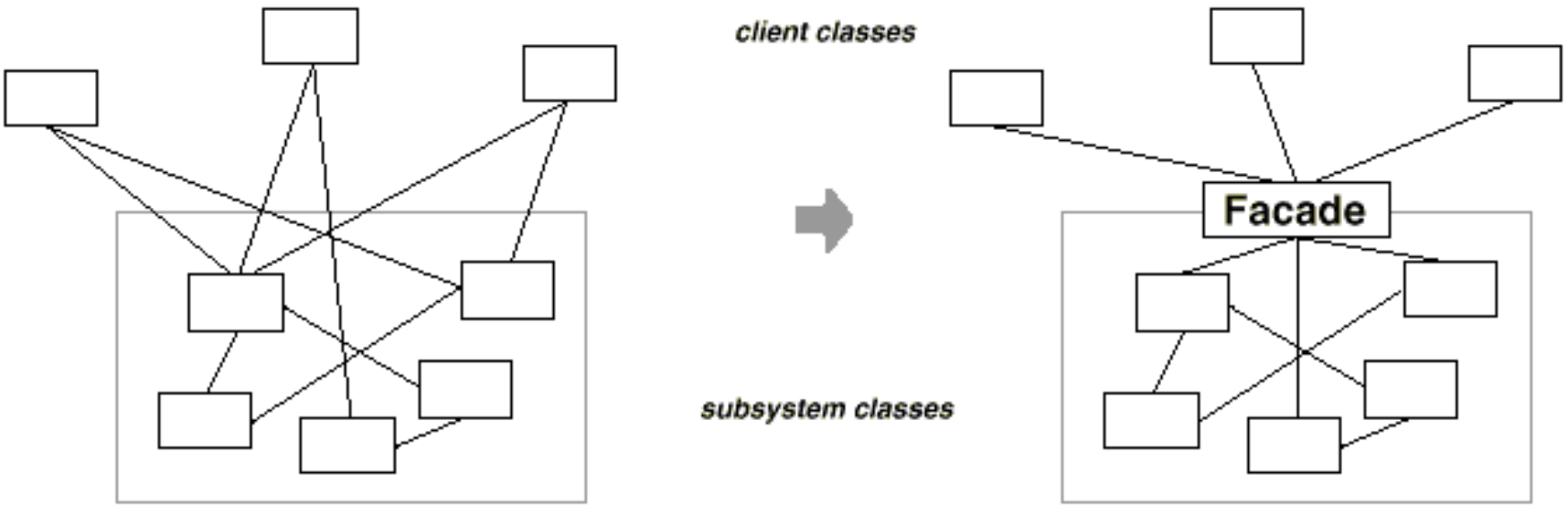
Façade Pattern

- **Purpose**
  - Supplies a single interface to a set of interfaces within a system.

- **Use When**
  - A simple interface is needed to provide access to a complex system.
  - There are many dependencies between system implementations and clients.
  - Systems and subsystems should be layered.

The Facade Pattern

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



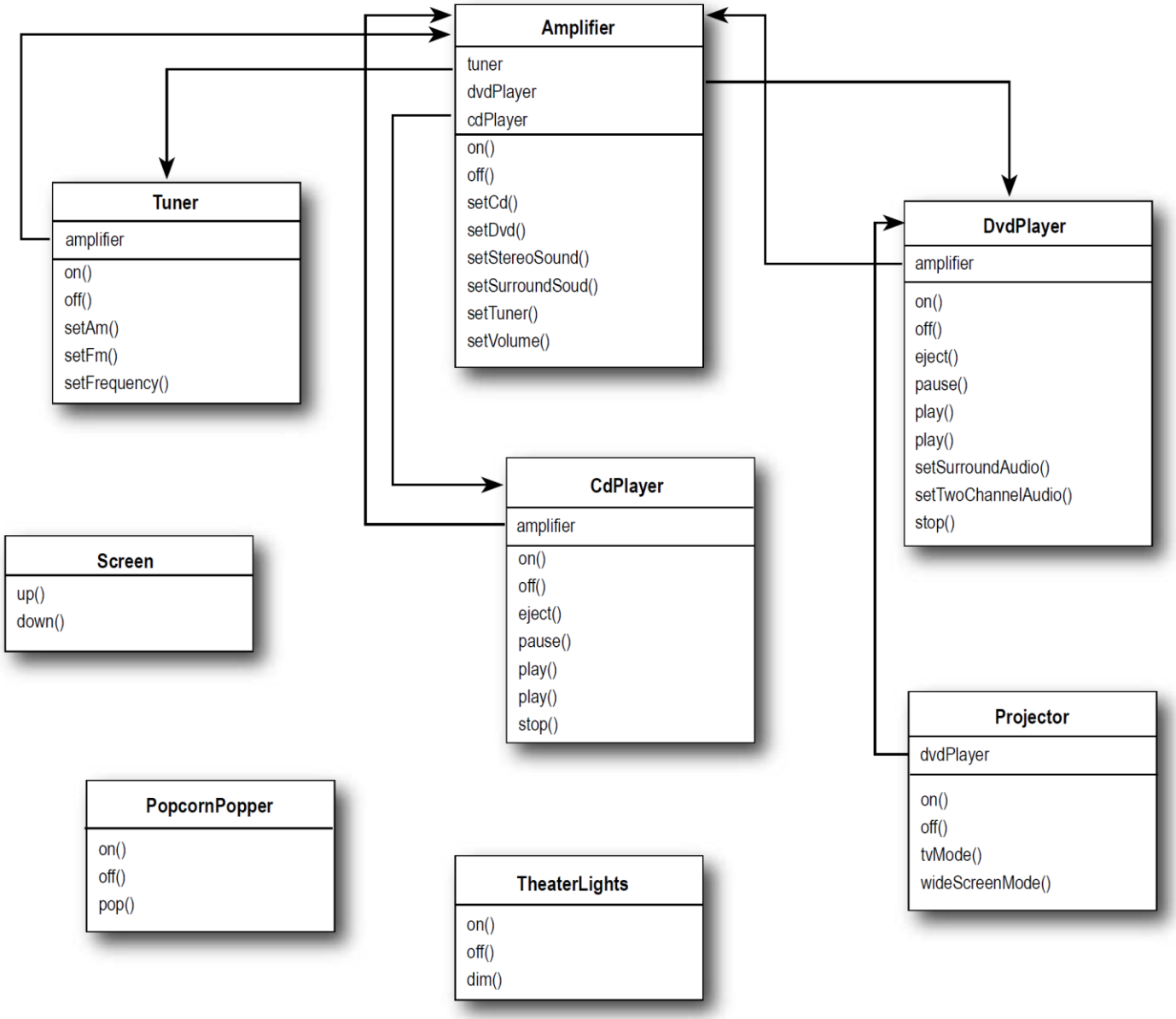
Motivation

- In typical OO Design,
  - Structuring a system into subsystems helps reduce complexity
  - Subsystems are groups of classes, or groups of classes and other subsystems
  - May produces many minimal classes
- Problems
  - Class/Subsystem interface can become quite complex
    - Too many options to use!
  - A new-comer cannot figure out where to begin
- Solution
  - Facade object provides a single, simplified interface to the more general facilities of a subsystem

Benefits

- Hides the implementation of the subsystem from clients
  - makes the subsystem easier to use
- Promotes weak coupling between the subsystem and its clients
  - Allows changing the classes comprising the subsystem without affecting the clients
- **Does not prevent sophisticated clients from accessing the underlying classes**
- Notice: Facade does not add any functionality, it just simplifies interfaces

Example: Home Sweet Home Theater



That's a lot of classes, a lot of interactions, and a big set of interfaces to learn and use

Watching a movie (the hard way)

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

```
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);
```

Turn on the popcorn popper and start popping...

Dim the lights to 10%...

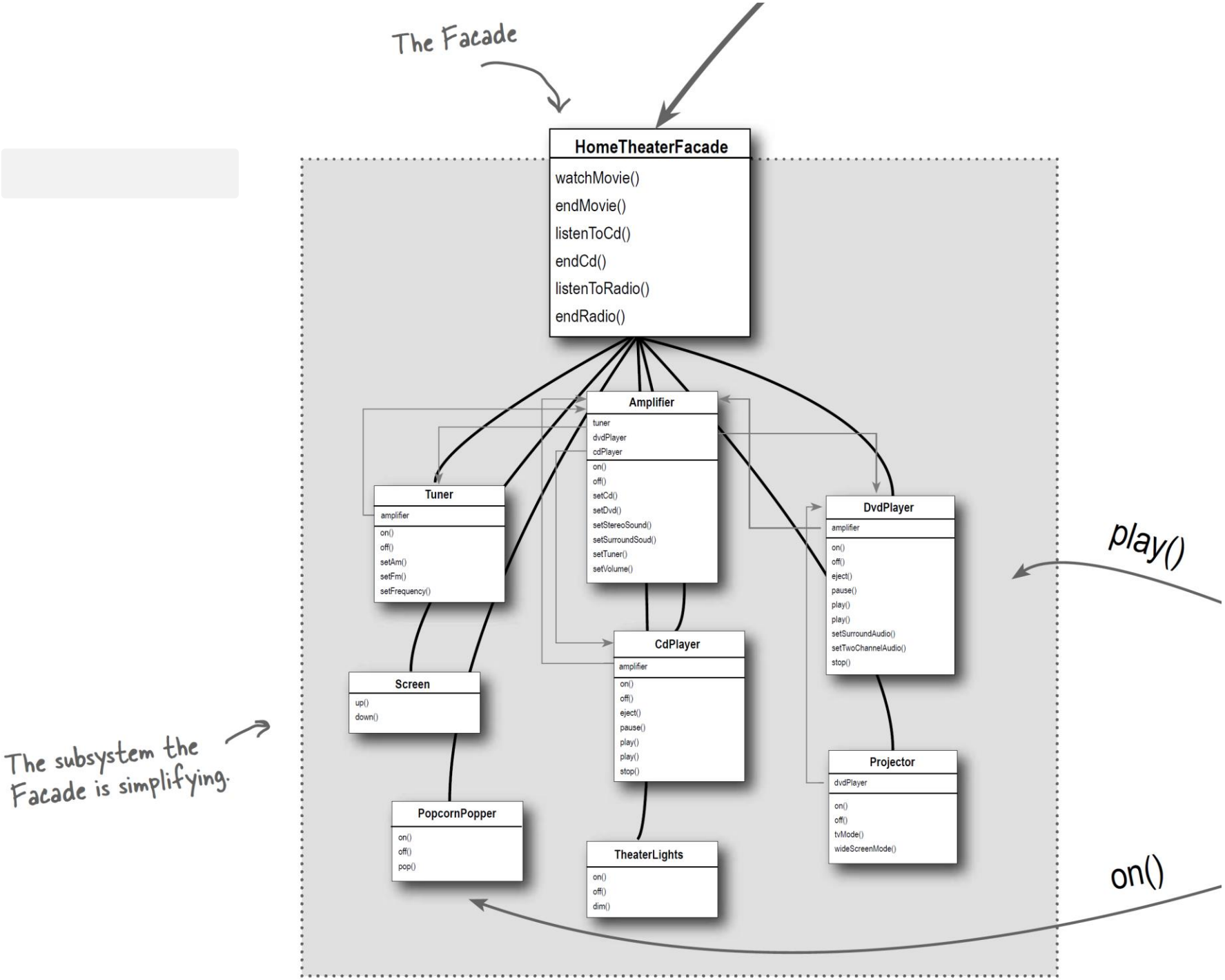
Put the screen down...

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!

Six different classes involved!


The Facade
HomeTheaterFacade
watchMovie()
endMovie()
listenToCd()
endCd()
listenToRadio()
endRadio()
Amplifier
tuner
dvdPlayer
cdPlayer
on()
off()
setCd()
setDvd()
setStereoSound()
setSurroundSoud()
setTuner()
setVolume()
Tuner
amplifier
on()
off()
setAm()
setFm()
setFrequency()
DvdPlayer
amplifier
on()
off()
eject()
pause()
play()
play()
setSurroundAudio()
setTwoChannelAudio()
stop()
CdPlayer
amplifier
on()
off()
eject()
pause()
play()
play()
stop()
Screen
up()
down()
Projector
dvdPlayer
on()
off()
tvMode()
wideScreenMode()
PopcornPopper
on()
off()
pop()
TheaterLights
on()
off()
dim()
play()
on()
The subsystem the Facade is simplifying.

Constructing facade

```
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...

```
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);
}
```

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.

```
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();
}
```

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

Time to watch a movie (the easy way)

```
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...

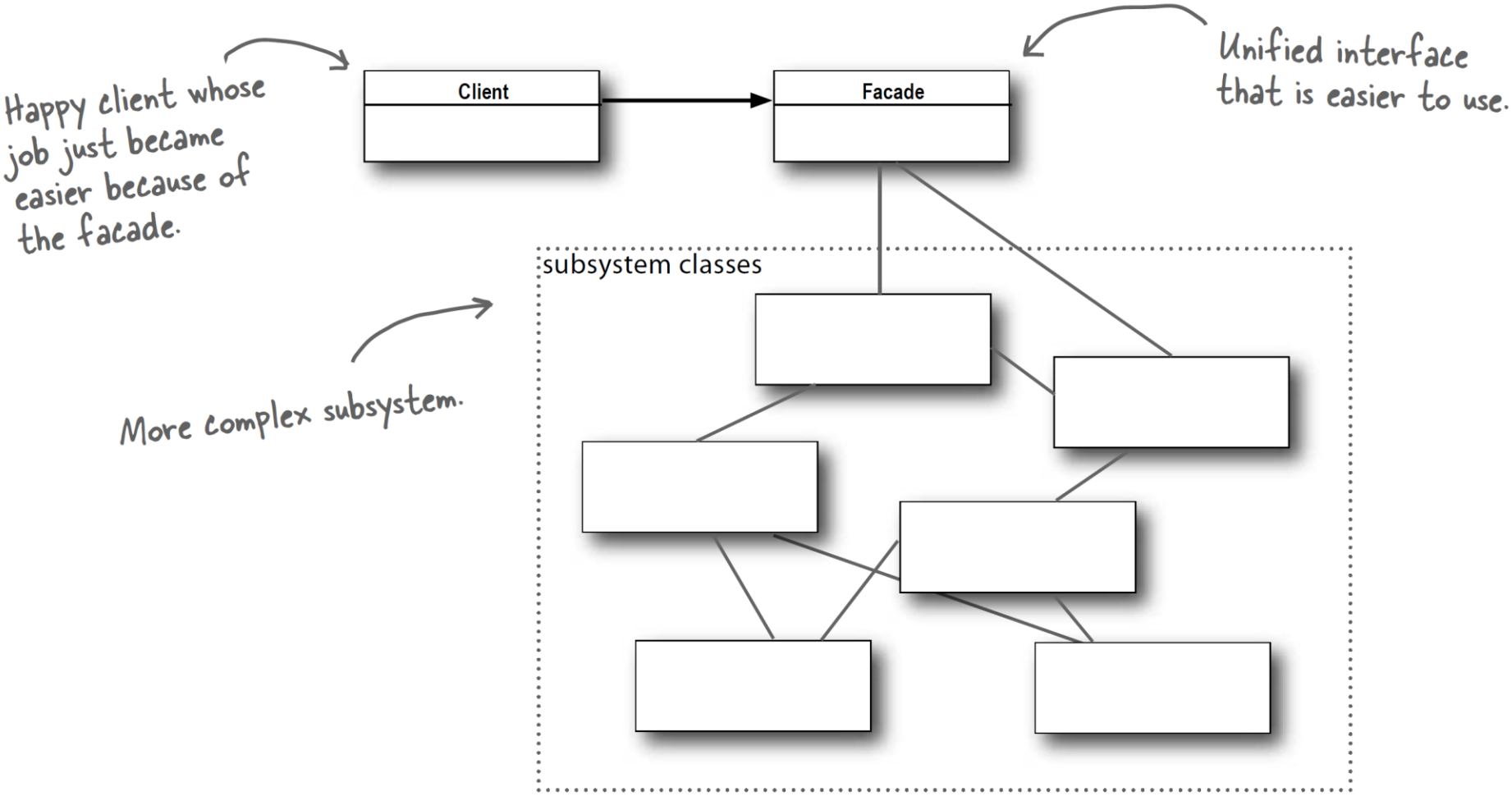
...and here, we're done watching the movie, so calling endMovie() turns everything off.

```
File Edit Window Help SnakesWhy'dItHaveToBeSnakes?
%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

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.


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.

The Principle of Least Knowledge

Design Principle

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

The Principle of Least Knowledge (Law of Demeter)

- Talk only to your immediate friends
  - When you design a system, you should be careful of the number of classes it interacts with and also how it comes to interact with those classes
  - A method m of an object o may only invoke the methods of the following kinds of objects
    - o itself
    - m's parameters
    - any objects created/instantiated within m
    - o's direct component objects
    - a global variable, accessible by o, in the scope of m
  - i.e., "use only one dot"
    - a.b.Method() breaks the law where a.Method() does not

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.

```
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.

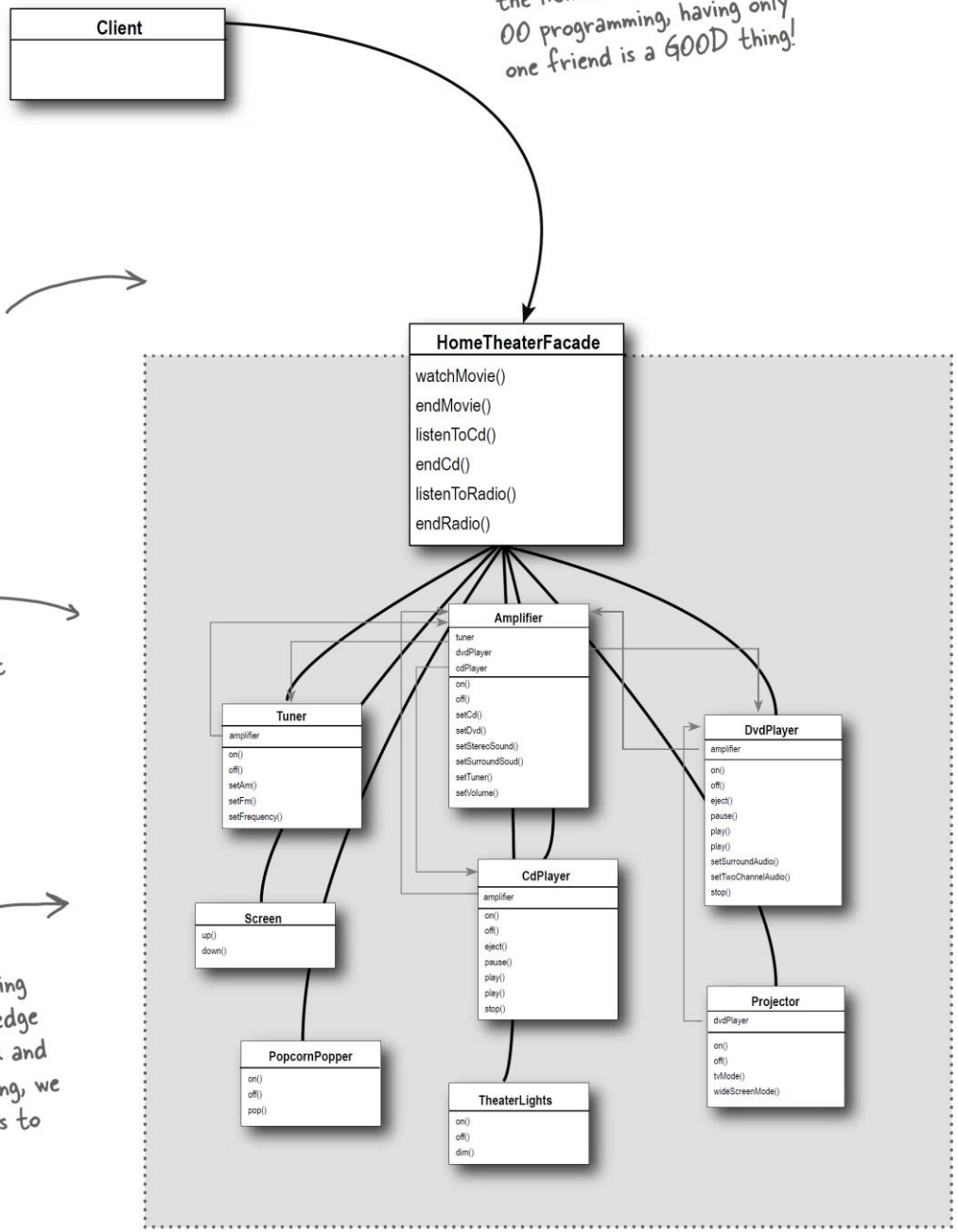
Façade and Principle of Least Knowledge

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.

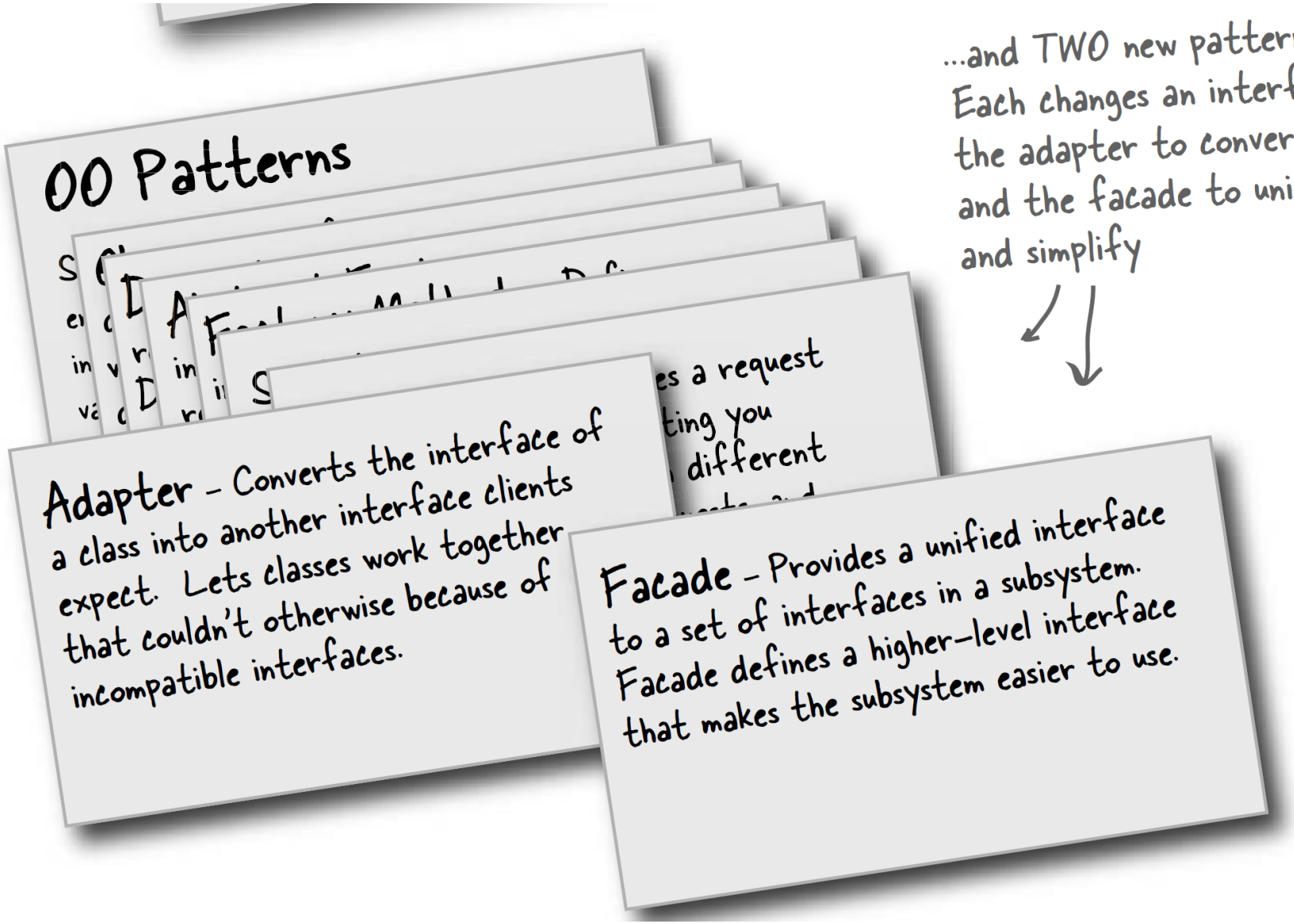


Facade Review

- 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

Related Patterns

- Mediator
  - Mediator's colleagues are aware of Mediator
- Facade
  - Unidirectional rather than cooperative interactions between object and subsystem
  - The subsystem doesn't know about the Facade
  - Facade doesn't add functionality, Mediator does



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