Analysis, Design and Implementation
Topic 11:
Redesign and Implementation

Scope and Coverage

This topic will cover:

- A redesign of the previous case study
- Assessment of design patterns
- Implementation implications

Learning Outcomes

By the end of this topic students will be able to:

- Follow through the process of applying design patterns.
- Implement a solution from a design.

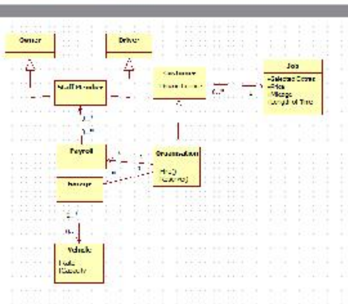
Introduction

- In topic six, we worked through a design case study for a vehicle management service.
- In this topic, we are going to look at issues of implementation that go with the scenario.
- We have a number of new tools in our toolkit.
  - These are our design patterns.
- We should examine each of the things our system will have to do, and identify if we need to adjust our design to accommodate.

Refactoring

- Refactoring is the process of improving things that already exist.
  - We'll talk more about this in the next topic.
- We want to refactor our design so that it is as well engineered as it possibly can be.
  - This is part of the iterative nature of analysis and design.
- This process falls a little between design and implementation.
  - We need to know about our implementation context.

Our Design so Far - Classes



Assessing the Design

- Our first step is to look at where we can refactor our class diagram in light of what we now know about high quality software.
  - Assess for coupling and cohesion
  - Apply design patterns in light of requirements.
- Our system is data coupled for the most part, but not heavily so.
  - That's good, but it perhaps it could be better.
  - That will require some redesign.

Assessing the Design

- Although we do not have methods and attributes defined, we can be reasonably certain cohesion is high.
  - Each class has a narrowly defined responsibility.
  - The existence of classes like Payroll and Garage show that there is a proper separation between 'representing a unit' and 'representing the collection of units'
- We may want to reconsider the class diagram in light of designing for software components.

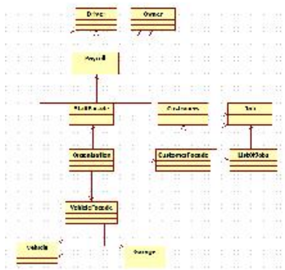
Redesigning

- Redesigning is not a scientific process.
  - There is no **right** answer.
    - Although there are plenty of wrong answers.
- Opinions will vary on how to approach a particular redesign
  - Everything involves trade-offs.
- Even choosing to use a design pattern is a trade off.
  - Extra flexibility versus an increased class count and all that is associated.

Component Design

- Software component design would require us to break this system up into three parts.
  - Vehicle Management
  - Staff management
  - Customer management
- Each of these would be linked into the Organisation class.
  - We could usefully use a Facade here to implement our black box.
- Is this good design?

Component Design



Component design here introduces three new classes, and a large amount of additional coupling. Our three new classes have low cohesion.

Not appropriate for this project.

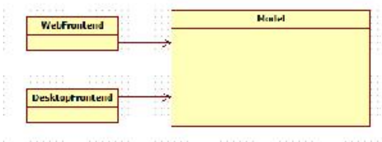
Design Patterns

- Component design introduces more problems than it solves in this example.
  - It comes into its own when discussing much larger projects.
- What about our design patterns?
- Are any appropriate here?
- Starting from our original design, we can start to look at the functionality we have identified and determine where they are appropriate.

The Model View Controller

- The MVC architecture is one that we should always be looking to use.
  - In our case, all we have at the moment is our model.
- However, we have also been told we must implement front-ends in both desktop and web form.
  - Thus, we need to expand our system a bit to include this.
- These new classes will be two separate view/controller classes.
  - They do the same thing, just in different ways.

The Model View Controller



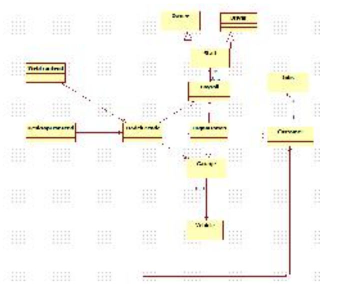
How do the View/Controller classes interact with the model?

We'd want to expose a facade from our model to permit this.

The Facade

- When creating a black box component, we must hide implementation details.
  - Otherwise, parts of the system become structurally dependent.
- We can do this in our model behind a facade.
  - Note that while the Organisation class ties together all of our system, it's not a facade.
  - The roles performed by the classes are different.
    - Organisation ties things together.
    - The Facade simplifies the API and creates an interface.

Modified Design



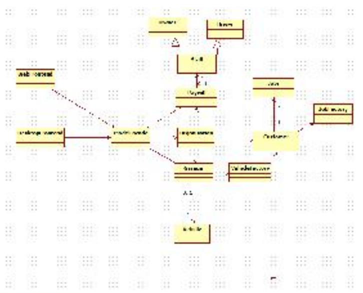
We gain our facade as an entry point and exposed interface to our model.

It's a highly coupled class with low cohesion, but that is the cost we must pay,

The Factory Design Pattern

- We are presumably going to be creating a number of jobs as we go along.
  - We perhaps want to create a job factory that does this.
    - Creates the job based on the data we are given
    - Assigns it to the customer
- Likewise for vehicles.
  - Create vehicle objects using the details we give them.
- We should consider a factory whenever we are creating many instances of an object with complex configuration.

The Factory Design Pattern



There is no need for our factories to be complex.

We can have them as classes with static factory methods if we desire.

The Strategy Pattern

- We don't have a lot of need here for implementing a strategy pattern.
  - Not all patterns are useful everywhere.
- We **could** use a strategy pattern to create a flexible link between the logic for hiring a vehicle and hiring a driver.
  - We must consider what we would really gain from this versus the cost.
- It is perhaps not suitable in this project.

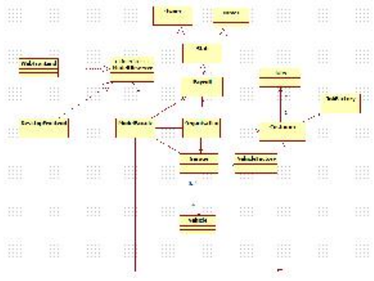
The Flyweight Pattern

- Most of the objects we create have context to go with their state.
  - There is a difference between Vehicle 1 and Vehicle 2, in that they will be assigned to different drivers and jobs.
- Flyweight objects are useful only if they are identical in all respects and free of context.
- The flyweight has no appropriate role in our project.
  - Thus, we don't include it.

The Observer Pattern

- The Observer pattern has a role in most programs.
  - It lets us implement call back coupling.
- However, the benefit gained from this is often not worth the cost of increased object and class complexity.
- We can profitably implement this as the primary mechanism for communication between our model and the facade however.
  - And we should do this to remove structural dependencies.

The Observer Pattern



Here we add in an interface class, and have the front-end classes implement it.

In this way, we have obtained the loosest coupling between the model and the view/controller.

Implementation

- We now have a class diagram that we can convert into code.
  - We know what role each of the classes are going to play.
  - We know where we are using design patterns to their best effect.
- Converting an activity diagram into code is the same process as turning pseudocode into code.
  - We have discussed this process already.
- Our class diagram is a little more complex.

Implementation

- Our class diagram omits attributes and operations.
  - We have already discussed how these should be handled.
  - Fleshing out the diagram with these is left as an exercise for students.
- Our first step in implementing a class diagram is to sketch out the classes in code.
- We start with classes that have no dependencies.
  - So that we can compile as we go along.

Vehicle Implementation

Vehicle
-rate: double -capacity: int
+getRate(): double +setRate(val: double) +getCapacity(): int +setCapacity(val: int)

```
public class Vehicle {
    private double rate;
    private int capacity;

    public void setRate(double val) {
        rate = val;
    }

    public double getRate() {
        return rate;
    }

    public void setCapacity (int val) {
        capacity = val;
    }

    public int getCapacity() {
        return capacity;
    }
}
```

Implementation

- Implementing a base class like this allows us to then implement dependent classes.
  - Such as the VehicleFactory.
- Our factory is going to take in the parts of the vehicle that must be configured, and then spit out a configured object.
  - This will be done as a static method so as to avoid the need to instantiate an object.

Implementation of Factory (1)

VehicleFactory
+getVehicle(type: Int): Vehicle

```
public class VehicleFactory {
    private static final int TYPE_TRANSIT = 0;
    private static final int TYPE_COMBO = 1;
    private static final int TYPE_BOX = 2;

    public static Vehicle getVehicle (int type) {
        return null;
    }
}
```

Implementation of Factory (2)

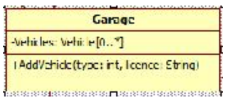
```
public static Vehicle getVehicle (int type) {
        double rate = 0.0;
        int capacity = 0;
        Vehicle v = new Vehicle();

        switch (type) {
            case TYPE_TRANSIT:
                rate = 2.0;
                capacity = 2000;
            break;
            case TYPE_COMBO:
                rate = 1.5;
                capacity = 1000;
            break;
            case TYPE_BOX:
                rate = 3.0;
                capacity = 5000;
            break;
            default:
                return null;
        }
        v.setRate (rate);
        v.setCapacity (capacity);
        return v;
    }
```

Implementation

- Then, we can implement the class that requires the existence of our factory.
  - Our garage
- We need to decide on how the garage is going to store vehicles.
  - We'll use a Dictionary for the this.
- Our Dictionary will store vehicle objects by licence plate.
  - This give us an easy way to query specific vehicles.

Garage Implementation




```
public class Garage {

    Dictionary<String,Vehicle> myVehicles;

    public Garage() {
        myVehicles = new Dictionary<String,Vehicle>();
    }

    public void addVehicle (String licence, int type) {
        Vehicle v = VehicleFactory.getVehicle (type);

        myVehicles.Add (licence, v);
    }

}
```

Implementation

- Implementation progresses like this.
  - Create base classes
    - Implement their logic.
  - Create dependent classes
    - Link them to the base classes.
- You do not need to implement all functionality at once.
  - You can approach the development incrementally.
  - We still need to implement functionality for removing vehicles, for example.

Conclusion

- Analysis and Design is an iterative process.
  - We need to revisit our designs as we learn more about how to implement things.
  - We need to revisit our analysis as we reveal problems with our design.
- Design patterns can be useful.
  - But not in all situations.
- We must always be mindful of the cost of the benefits they give us.

Awarding Great British Qualifications

Topic 11 – Redesign and Implementation

Any Questions?