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Software Engineering and Architecture

Deriving Abstract Factory

The *dependency injection* pattern

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Prelude

- The Receipt class revisited
  - Add responsibility to print itself

Receipt
• know its value in minutes parking time • print itself

  - Provided by method

```
public void print(PrintStream stream);
```

  - Result:

```
-----------------------------------------------
-------  P A R K I N G   R E C E I P T  -------
                Value 049 minutes.
              Car parked at 08:06
-----------------------------------------------
```

Demo: frsproject/paystation-facade

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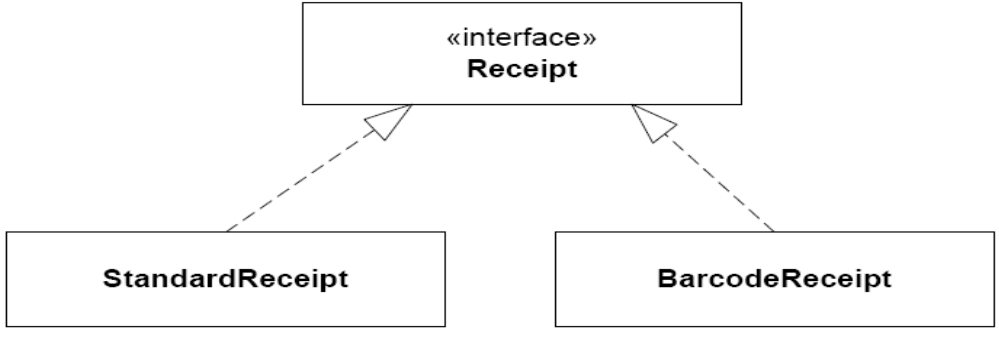
BetaTown

- *Change is the only constant in software dev.*
- Req: Receipts with bar code for easy scanning

```
-----------------------------------------------
-------  P A R K I N G   R E C E I P T  -------
                Value 049 minutes.
              Car parked at 08:06
||  ||||| | || ||| || ||  ||| | || |||| | || ||||
-----------------------------------------------
```



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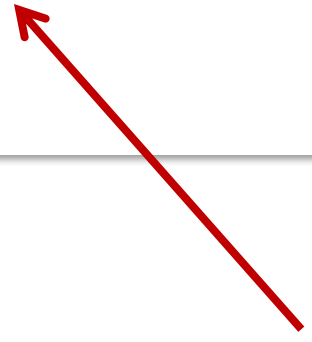
Code View

- Something must be done at:

```
public Receipt buy() {
  Receipt r = new ReceiptImpl(timeBought);
  reset();
  return r;
}
```



A ”new BarCodeReceiptImpl(tb)” in BetaTown

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Yet another Variability

- **New variability point!** Resulting configurations:

Table 13.1: The three different configurations of the pay station.

	Variability points	
Product	**Rate**	**Receipt**
Alphatown	Linear	Standard
Betatown	Progressive	Barcode
Gammatown	Alternating	Standard

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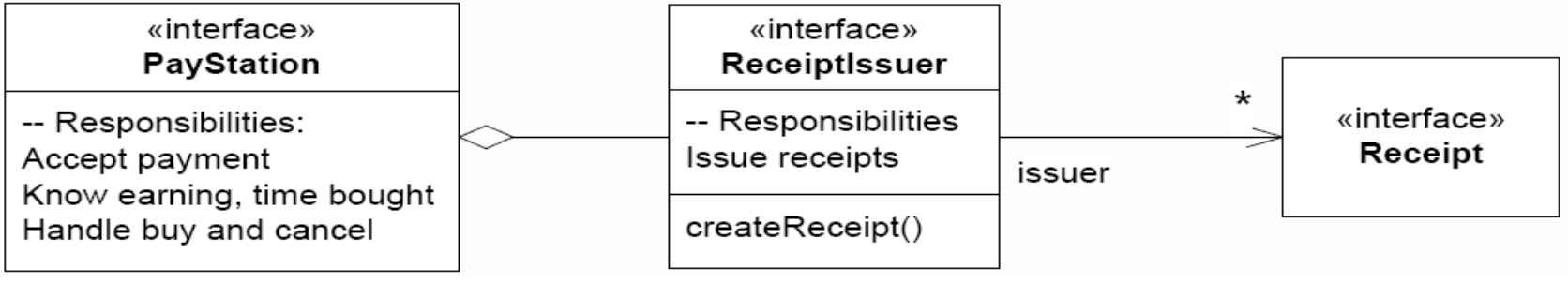
The Compositional Design

3-1-2

- Cranking the 3-1-2 *blindly*
  - 3) Identify what varies: *instantiation of receipts*
  - 1) Interface express responsibility: ReceiptIssuer
  - 2) Compose behavior: delegate to ReceiptIssuer



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Trying it out

- Quickly add a test:

```
@BeforeEach
public void setUp() {
  ps = new PayStationImpl(coinValue -> coinValue,
                          new StandardReceiptIssuer());
}
```

- **Low cohesion**: *object creation in two different objects – why not make one cohesive object???*

TDD Principle: **Do Over**

What do you do when you are feeling lost? Throw away the code and start over.

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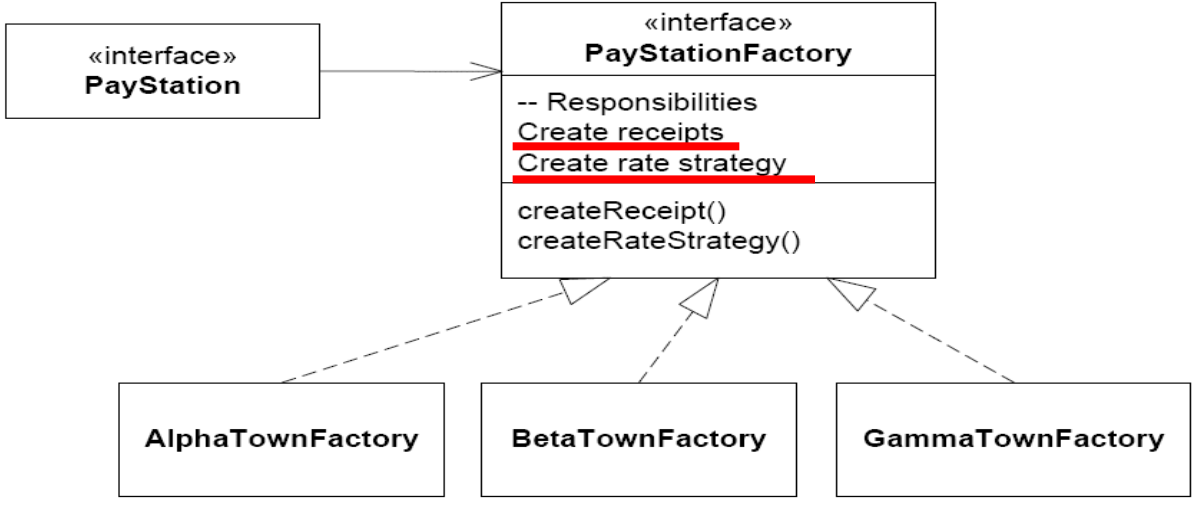
More Cohesive Design

- **One** place to “create delegates”: the **factory**

PayStationFactory

- Create receipts
- Create rate strategies



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Usage

```
public class PayStationImpl implements PayStati
  [...]
  /** the strategy for rate calculations */
  private RateStrategy rateStrategy;
  /** the factory that defines strategies */
  private PayStationFactory factory;

  /** Construct a pay station.
      @param factory the factory to produce strategies
  */
  public PayStationImpl( PayStationFactory factory ) {
    this.factory = factory;
    this.rateStrategy = factory.createRateStrategy();
    reset();
  }
  [...]
  public Receipt buy() {
    Receipt r = factory.createReceipt(timeBought);
    reset();
    return r;
  }
  [...]
}
```

Only one delegate!

Uncle Bob is happy

Listing: chapter/abstract-factory/iteration-1a/src/main/java/paystation/domain/PayStationFactory.java

```
package paystation.domain;
/** The factory for creating the objects that configure
    a pay station for the particular town to operate in.
*/

public interface PayStationFactory {
  /** Create an instance of the rate strategy to use. */
  public RateStrategy createRateStrategy();

  /** Create an instance of the receipt.
   * @param the number of minutes the receipt represents. */
  public Receipt createReceipt(int parkingTime);
}
```

```
class TestTownFactory implements PayStationFactory {
  public RateStrategy createRateStrategy() {
    return coinValue -> coinValue;
  }
  public Receipt createReceipt(int parkingTime) {
    return new StandardReceipt(parkingTime);
  }
}
```

The ‘test town’ which uses the ‘evident test’ rate strategy, for unit testing the PayStation…

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To Configure BetaTown

- The factory for BetaTown

	Variability points	
Product	**Rate**	**Receipt**
Alphatown	Linear	Standard
Betatown	Progressive	Barcode
Gammatown	Alternating	Standard

```
class BetaTownFactory implements PayStationFactory {
  public RateStrategy createRateStrategy() {
    return new ProgressiveRateStrategy();
  }
  public Receipt createReceipt( int parkingTime ) {
    return new StandardReceipt(parkingTime, true);
  }
}
```

Important benefit: *all configuration is contained in one java source file!*

Why? **Cohesion – do the same thing in the same place!**

SideBar

- Huh? No ‘barcode’ receipt subclass? No composition?

```
class BetaTownFactory implements PayStationFactory {
  public RateStrategy createRateStrategy() {
    return new ProgressiveRateStrategy();
  }
  public Receipt createReceipt( int parkingTime ) {
    return new StandardReceipt(parkingTime, true);
  }
}
```

But Uncle Bob again is unhappy ☹

- Only two variants envisioned!
  - **Parametric variability much simpler = the right variability management choice!**

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The Compositional Process

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The Process Again Again

- ③ *I identified some behavior, creating objects, that varies between different products.* So far products vary with regards to the types of receipts and the types of rate calculations.
- ① *I expressed the responsibility of creating objects in an interface.* PayStationFactory expressed this reponsibility.
- ② *I let the pay station delegate all creation of objects it needs to the delegate object, namely the factory.* I can define a factory for each product variant (and particular testing variants), and provide the pay station with the factory. The pay station then delegates object creation to the factory instead of doing it itself.

Or…

Definition: **Dependency inversion principle**

High level modules should not depend upon low level modules. Both should depend upon abstractions. Abstractions should not depend upon details. Details should depend upon abstractions. (Martin 1996)

Who is this Martin guy?

Definition: **Dependency injection**

High-level, common, abstractions should not themselves establish dependencies to low level, implementing, classes, instead the dependencies should be established by injection, that is, by client objects. (Fowler 2004)

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Abstract Factory

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Deriving it…

- 3-1-2 has derived yet another design pattern
  - An object (factory) whose responsibility it is to create objects (products) that the client need.

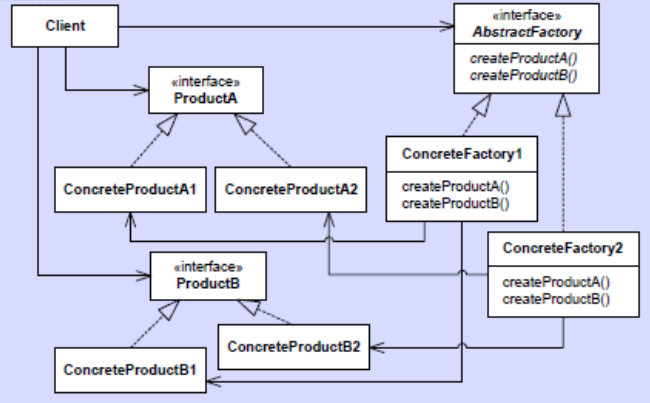
[13.1] Design Pattern: Abstract Factory

Intent Provide an interface for creating families of related or dependent objects without specifying their concrete classes.

Problem Families of related objects need to be instantiated. Product variants need to be consistently configured.

Solution Define an abstraction whose responsibility it is to create families of objects. The client delegates object creation to instances of this abstraction.

Structure:



Roles **Abstract Factory** defines a common interface for object creation. **ProductA** defines the interface of an object, **ConcreteProductA1**, (product A in variant 1) required by the client. **ConcreteFactory1** is responsible for creating **Product**s that belong to the variant 1 family of objects that are consistent with each other.

Cost - Benefit *It lowers coupling between client and products* as there are no `new` statements in the client to create high coupling. *It makes exchanging product families easy* by providing the client with different factories. *It promotes consistency among products* as all instantiation code is within the same class definition that is easy to overview. However, *supporting new kinds of products is difficult*: every new product introduced requires all factories to be changed.

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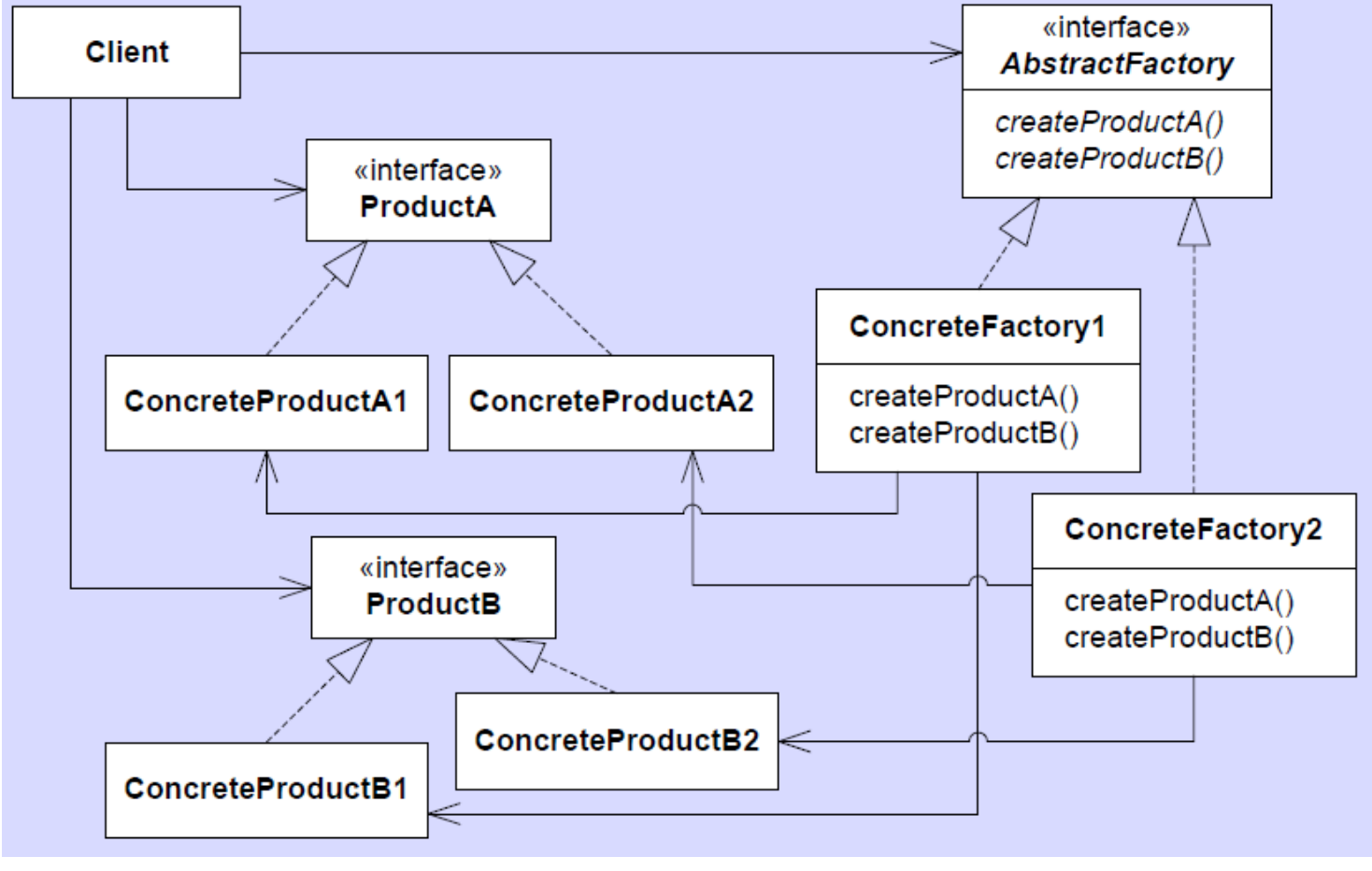
The Structure…



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Mandatory Note

- Abstract Factory is complex
  - Lots of relations
  - Easy to get confused or miss the whole idea
  - Easy to mis-implement a little with BIG consequences

- Morale
  - Do not underestimate it in the Mandatory…