SOFTWARE ARCHITECTURE & DESIGN PATTERNS IN THE REAL WORLD

Zhuowei Zhang
@zhuowei

Never spend 6 minutes doing something by hand when you can spend 6 hours failing to automate it

ABOUT ME

NAME

Courtney Cooksey courtney@thecrossingchurch.com

OCCUPATION

Software Engineer at The Crossing EPC

CURRENTLY BASED IN

Savannah, MO

AGENDA

Terminology & the Origin of Design Patterns

1 | What Qualifies as a Design Pattern

2 | A Few Design Patterns

3 | Why Design Patterns are Useful

Practical Application

4 | Using Design Patterns

5 | Anti-Patterns

Beyond Today

6 | Pattern Catalogs & Categories

7 | Resources

Terminology & the Origin of Design Patterns

WHAT QUALIFIES AS A DESIGN PATTERN

A DESIGN PATTERN IS A SOLUTION TO A PROBLEM IN A CONTEXT.

The problem consists of forces

- **Goal**
  What we are trying to achieve.
- **Constraints**
  Restrictions on achieving our goal.

A solution that properly balances the goal with the constraints is a useful pattern.

PATTERNS PROVIDE BLUEPRINTS, NOT CODE

The origin of patterns began, not with a software developer, but with an architect.

1977, Christopher Alexander and Co.

Coined the term *Pattern Language* to provide a new way of talking about problems in architecture and solutions to those problems.

A PATTERN LANGUAGE EXAMPLE: THE ENTRANCE ROOM (130)

Arriving in a building, or leaving it, you need a room to pass through. This is the entrance room.

The subtleties of saying goodbye. When hosts and guests are saying goodbye, the lack of a clearly marked "goodbye" point can easily lead to an endless "Well, we really must be going now," and then further conversations and lingering on.

At the main entrance to a building, make a light-filled room which marks the entrance and straddles the boundary between indoors and outdoors.

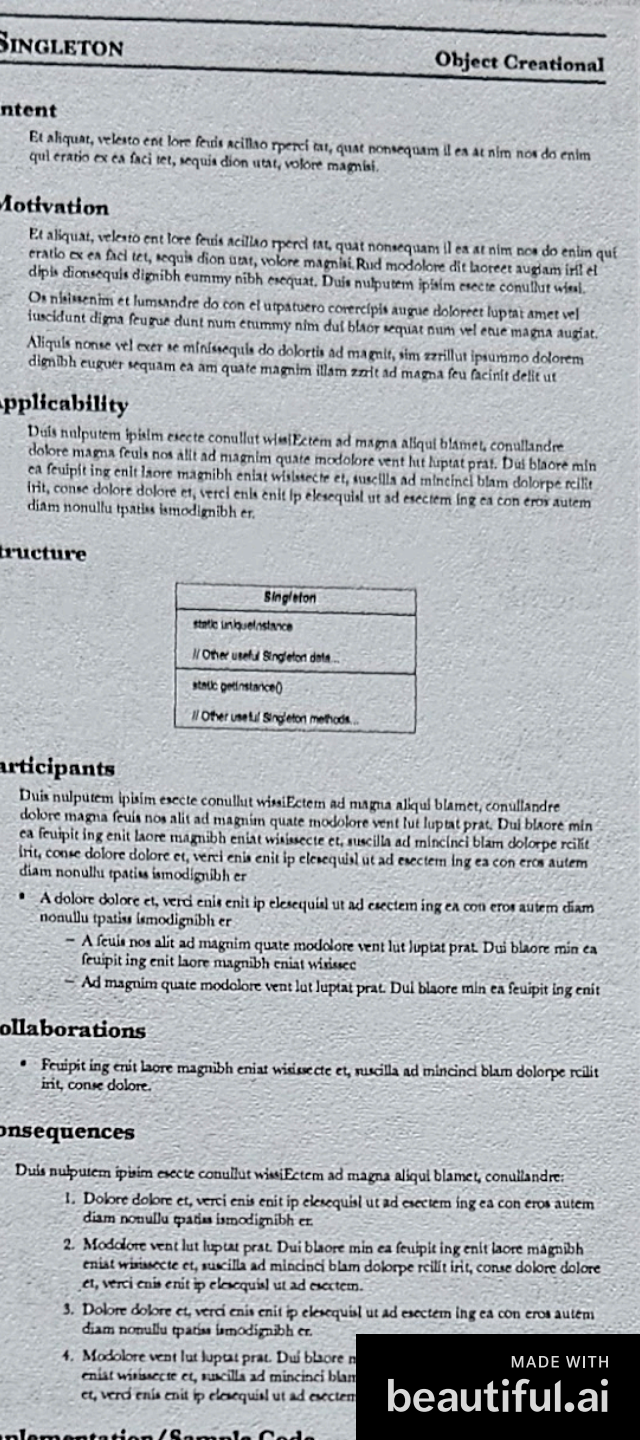
See Also: FAMILY OF ENTRANCES (102), MAIN ENTRANCE (110), ENTRANCE TRANSITION (112), CAR CONNECTION (113), PRIVATE TERRACE ON THE STREET (140).

HOW TO READ A DESIGN PATTERN

Name and description of the pattern

NAME OF PATTERN Classification

- **Intent**
  Description of the pattern.
- **Motivation**
  Describes the problem and how the solution solves the problem.
- **Applicability**
  The situations in which the pattern can be applied.



SINGLETON — **Object Creational**

Intent

Et aliquat, velesto ent lore feuis acillao rperci tat, quat nonsequam il ea at nim nos do enim qui eratio ex ea faci tet, sequis dion utat, volore magnisi.

Motivation

Et aliquat, velesto ent lore feuis acillao rperci tat, quat nonsequam il ea at nim nos do enim qui eratio ex ea faci tet, sequis dion utat, volore magnisi.Rud modolore dit laoreet augiam irit el dipis dionsequis dignibh eummy nibh esequat. Duis nulputem ipisim esecte conullut wissi.

Os nisissenim et lumsandre do con el utpatuero corercipis augue doloreet luptat amet vel iuscidunt digna feugue dunt num enummy nim dui blaor sequat num vel etue magna augiat.

Aliquis nonse vel exer se minissequis do dolortis ad magnit, sim zzrillut ipsummo dolorem dignibh euguer sequam ea am quate magnim illam zzrit ad magna feu facinit delit ut

Applicability

Duis nulputem ipisim esecte conullut wissiEctem ad magna aliqui blamet, conullandre dolore magna feuis nos alit ad magnim quate modolore vent lut luptat prat. Dui blaore min ea feuipit ing enit laore magnibh eniat wisissecte et, suscilla ad mincinci blam dolorpe rcilit irit, conse dolore dolore et, verci enis enit ip elesequisl ut ad esectem ing ea con eros autem diam nonullu tpatiss ismodignibh er.

Structure

Participants

Duis nulputem ipisim esecte conullut wissiEctem ad magna aliqui blamet, conullandre dolore magna feuis nos alit ad magnim quate modolore vent lut luptat prat. Dui blaore min ea feuipit ing enit laore magnibh eniat wisissecte et, suscilla ad mincinci blam dolorpe rcilit irit, conse dolore dolore et, verci enis enit ip elesequisl ut ad esectem ing ea con eros autem diam nonullu tpatiss ismodignibh er

- A dolore dolore et, verci enis enit ip elesequisl ut ad esectem ing ea con eros autem diam nonullu tpatiss ismodignibh er
  - A feuis nos alit ad magnim quate modolore vent lut luptat prat. Dui blaore min ea feuipit ing enit laore magnibh eniat wisissec
  - Ad magnim quate modolore vent lut luptat prat. Dui blaore min ea feuipit ing enit

Collaborations

- Feuipit ing enit laore magnibh eniat wisissecte et, suscilla ad mincinci blam dolorpe rcilit irit, conse dolore.

Consequences

Duis nulputem ipisim esecte conullut wissiEctem ad magna aliqui blamet, conullandre:

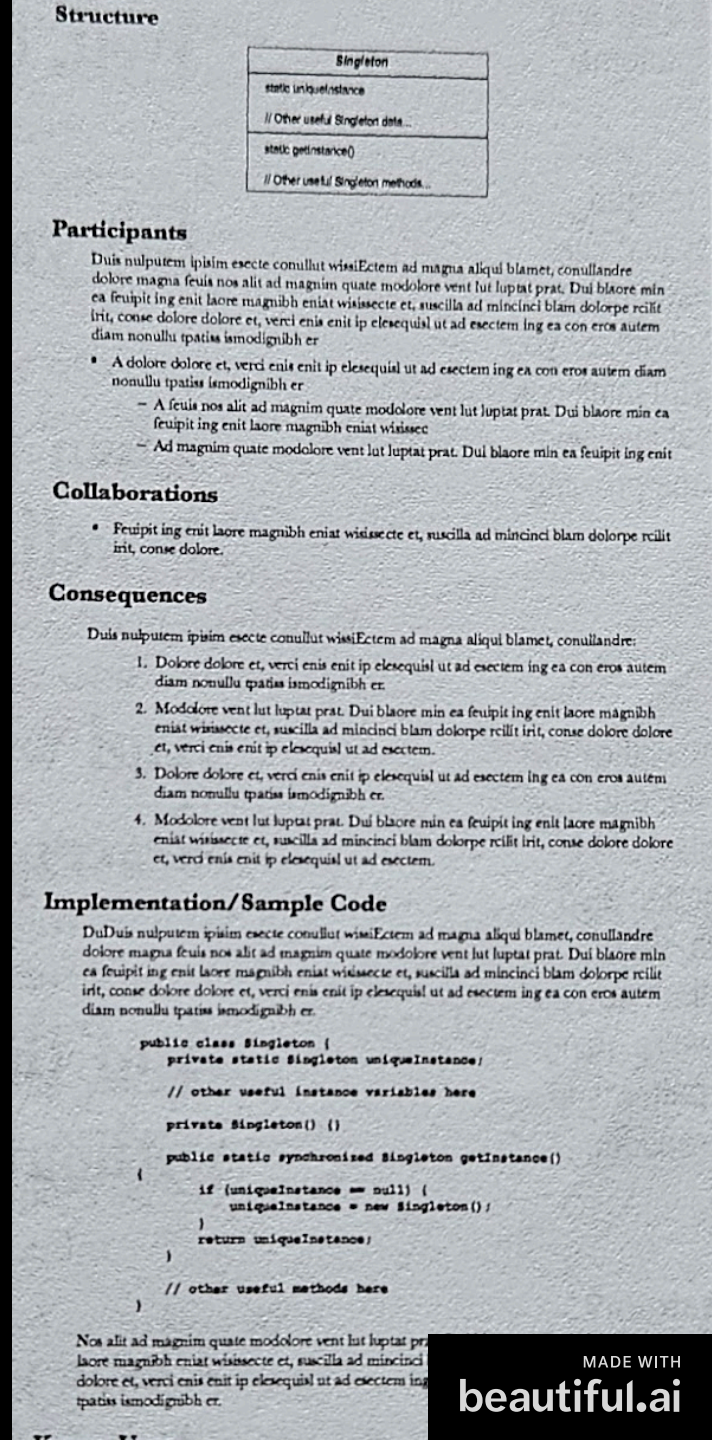
1. Dolore dolore et, verci enis enit ip elesequisl ut ad esectem ing ea con eros autem diam nonullu tpatiss ismodignibh er.
2. Modolore vent lut luptat prat. Dui blaore min ea feuipit ing enit laore magnibh eniat wisissecte et, suscilla ad mincinci blam dolorpe rcilit irit, conse dolore dolore et, verci enis enit ip elesequisl ut ad esectem.
3. Dolore dolore et, verci enis enit ip elesequisl ut ad esectem ing ea con eros autem diam nonullu tpatiss ismodignibh er.
4. Modolore vent lut luptat prat. Dui blaore m
   eniat wisissecte et, suscilla ad mincinci blam
   et, verci enis enit ip elesequisl ut ad esectem

Implementation/Sample Code

HOW TO READ A DESIGN PATTERN

Technical details of the pattern

- **Structure**
  Diagrams illustrating the relationships among the classes that participate in the pattern.
- **Participants**
  The classes and objects in the design, their responsibilities and roles.
- **Collaborations**
  How the participants work together.
- **Consequences**
  Describes the effects that using this pattern may have: good and bad.
- **Implementation/Sample Code**



Structure

Singleton
static uniqueInstance
// Other useful Singleton data...
static getInstance()
// Other useful Singleton methods...

Participants

Duis nulputem ipisim esecte conullut wissiEctem ad magna aliqui blamet, conullandre dolore magna feuis nos alit ad magnim quate modolore vent lut luptat prat. Dui blaore min ea feuipit ing enit laore magnibh eniat wisissecte et, suscilla ad mincinci blam dolorpe rcilit irit, conse dolore dolore et, verci enis enit ip elesequisl ut ad esectem ing ea con eros autem diam nonullu tpatiss ismodignibh er

- A dolore dolore et, verci enis enit ip elesequisl ut ad esectem ing ea con eros autem diam nonullu tpatiss ismodignibh er
  - A feuis nos alit ad magnim quate modolore vent lut luptat prat. Dui blaore min ea feuipit ing enit laore magnibh eniat wisissec
  - Ad magnim quate modolore vent lut luptat prat. Dui blaore min ea feuipit ing enit

Collaborations

- Feuipit ing enit laore magnibh eniat wisissecte et, suscilla ad mincinci blam dolorpe rcilit irit, conse dolore.

Consequences

Duis nulputem ipisim esecte conullut wissiEctem ad magna aliqui blamet, conullandre:

1. Dolore dolore et, verci enis enit ip elesequisl ut ad esectem ing ea con eros autem diam nonullu tpatiss ismodignibh er.
2. Modolore vent lut luptat prat. Dui blaore min ea feuipit ing enit laore magnibh eniat wisissecte et, suscilla ad mincinci blam dolorpe rcilit irit, conse dolore dolore et, verci enis enit ip elesequisl ut ad esectem.
3. Dolore dolore et, verci enis enit ip elesequisl ut ad esectem ing ea con eros autem diam nonullu tpatiss ismodignibh er.
4. Modolore vent lut luptat prat. Dui blaore min ea feuipit ing enit laore magnibh eniat wisissecte et, suscilla ad mincinci blam dolorpe rcilit irit, conse dolore dolore et, verci enis enit ip elesequisl ut ad esectem.

Implementation/Sample Code

DuDuis nulputem ipisim esecte conullut wissiEctem ad magna aliqui blamet, conullandre dolore magna feuis nos alit ad magnim quate modolore vent lut luptat prat. Dui blaore min ea feuipit ing enit laore magnibh eniat wisissecte et, suscilla ad mincinci blam dolorpe rcilit irit, conse dolore dolore et, verci enis enit ip elesequisl ut ad esectem ing ea con eros autem diam nonullu tpatiss ismodignibh er.

```
public class Singleton {
   private static Singleton uniqueInstance;

   // other useful instance variables here

   private Singleton() {}

   public static synchronized Singleton getInstance()
{
       if (uniqueInstance == null) {
           uniqueInstance = new Singleton();
       }
       return uniqueInstance;
   }

   // other useful methods here
}
```

Nos alit ad magnim quate modolore vent lut luptat pr
laore magnibh eniat wisissecte et, suscilla ad mincinci
dolore et, verci enis enit ip elesequisl ut ad esectem in
tpatiss ismodignibh er.

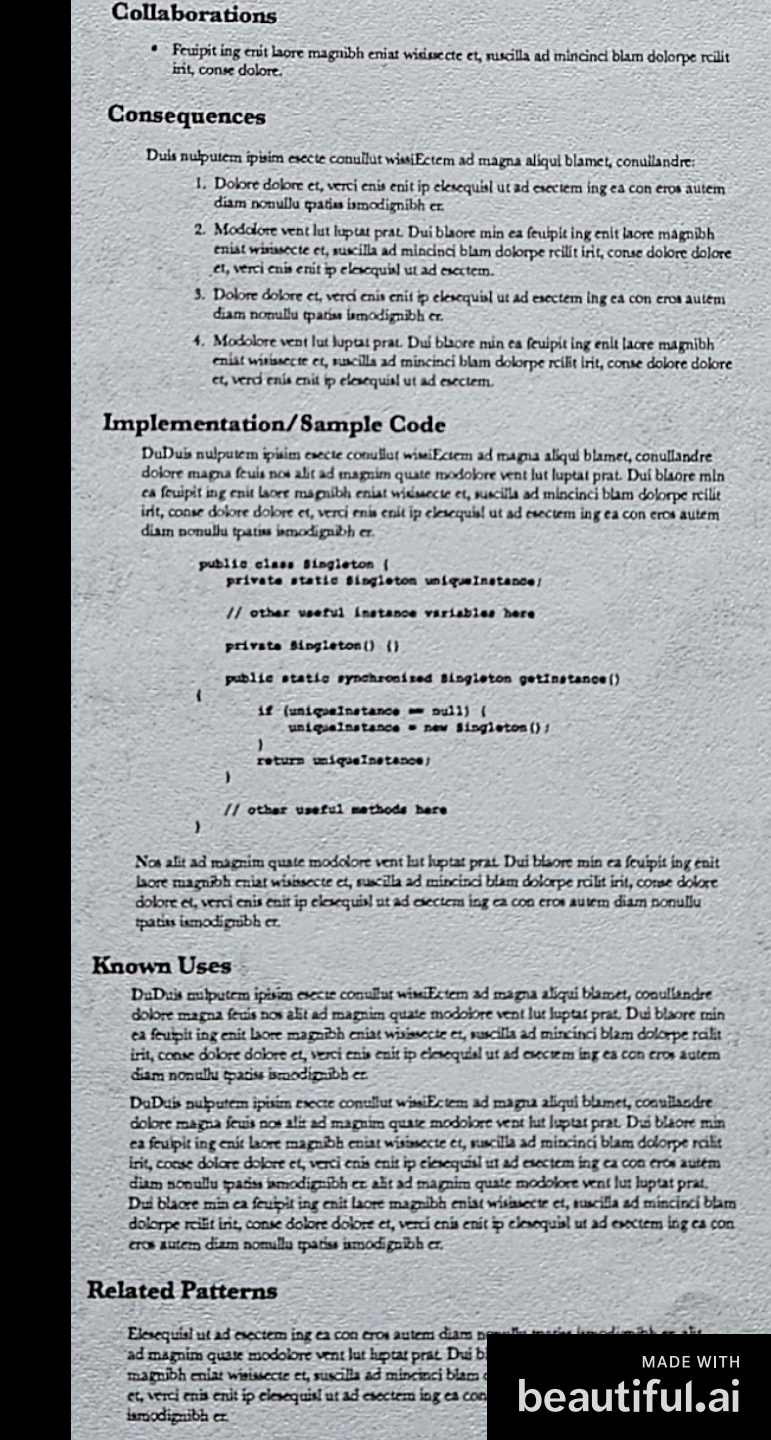
HOW TO READ A DESIGN PATTERN

- **Known Uses**

  Describes examples of this pattern found in real systems.

- **Related Patterns**

  Describes the relationship between this pattern and others.



Collaborations

- Feuipit ing enit laore magnibh eniat wisisecte et, suscilla ad mincinci blam dolorpe rcilit irit, conse dolore.

Consequences

Duis nulputem ipisim esecte conullut wissiEctem ad magna aliqui blamet, conullandre:

1. Dolore dolore et, verci enis enit ip elesequisl ut ad esectem ing ea con eros autem diam nonullu tpatiss ismodignibh er.
2. Modolore vent lut luptat prat. Dui blaore min ea feuipit ing enit laore magnibh eniat wisisecte et, suscilla ad mincinci blam dolorpe rcilit irit, conse dolore dolore et, verci enis enit ip elesequisl ut ad esectem.
3. Dolore dolore et, verci enis enit ip elesequisl ut ad esectem ing ea con eros autem diam nonullu tpatiss ismodignibh er.
4. Modolore vent lut luptat prat. Dui blaore min ea feuipit ing enit laore magnibh eniat wisisecte et, suscilla ad mincinci blam dolorpe rcilit irit, conse dolore dolore et, verci enis enit ip elesequisl ut ad esectem.

Implementation/Sample Code

DuDuis nulputem ipisim esecte conullut wissiEctem ad magna aliqui blamet, conullandre dolore magna feuis nos alit ad magnim quate modolore vent lut luptat prat. Dui blaore min ea feuipit ing enit laore magnibh eniat wisisecte et, suscilla ad mincinci blam dolorpe rcilit irit, conse dolore dolore et, verci enis enit ip elesequisl ut ad esectem ing ea con eros autem diam nonullu tpatiss ismodignibh er.

```
public class Singleton {
   private static Singleton uniqueInstance;

   // other useful instance variables here

   private Singleton() {}

   public static synchronized Singleton getInstance()
{
       if (uniqueInstance == null) {
          uniqueInstance = new Singleton();
       }
       return uniqueInstance;
   }

   // other useful methods here
}
```

Nos alit ad magnim quate modolore vent lut luptat prat. Dui blaore min ea feuipit ing enit laore magnibh eniat wisisecte et, suscilla ad mincinci blam dolorpe rcilit irit, conse dolore dolore et, verci enis enit ip elesequisl ut ad esectem ing ea con eros autem diam nonullu tpatiss ismodignibh er.

Known Uses

DuDuis nulputem ipisim esecte conullut wissiEctem ad magna aliqui blamet, conullandre dolore magna feuis nos alit ad magnim quate modolore vent lut luptat prat. Dui blaore min ea feuipit ing enit laore magnibh eniat wisisecte et, suscilla ad mincinci blam dolorpe rcilit irit, conse dolore dolore et, verci enis enit ip elesequisl ut ad esectem ing ea con eros autem diam nonullu tpatiss ismodignibh er.

DuDuis nulputem ipisim esecte conullut wissiEctem ad magna aliqui blamet, conullandre dolore magna feuis nos alit ad magnim quate modolore vent lut luptat prat. Dui blaore min ea feuipit ing enit laore magnibh eniat wisisecte et, suscilla ad mincinci blam dolorpe rcilit irit, conse dolore dolore et, verci enis enit ip elesequisl ut ad esectem ing ea con eros autem diam nonullu tpatiss ismodignibh er. alit ad magnim quate modolore vent lut luptat prat. Dui blaore min ea feuipit ing enit laore magnibh eniat wisisecte et, suscilla ad mincinci blam dolorpe rcilit irit, conse dolore dolore et, verci enis enit ip elesequisl ut ad esectem ing ea con eros autem diam nonullu tpatiss ismodignibh er.

Related Patterns

Elesequisl ut ad esectem ing ea con eros autem diam
ad magnim quate modolore vent lut luptat prat. Dui b
magnibh eniat wisisecte et, suscilla ad mincinci blam
et, verci enis enit ip elesequisl ut ad esectem ing ea con
ismodignibh er.

DESIGN PATTERNS SHOULD BE REUSABLE

A solution is not truly a design pattern unless it is applicable in multiple situations.

The Rule of Three

A pattern can only be called a pattern if it has been applied in a real-world solution at least three times.

QUALIFICATIONS FOR A DESIGN PATTERN

- **Solution to a Problem in a Context**
  The pattern must balance the goal with the constraints to be considered useful.
- **Reusability and Flexibility**
  A pattern isn't a pattern if it can't be applied to multiple unique situations.
- **Documentation**
  Our pattern needs a name and definition, something we can easily hand to another person so they can implement it for their unique situation.
- **Community Acceptance**
  There needs to be at least three examples of this pattern being used in the real world.

Technical Details & Practical Information

A FEW DESIGN PATTERNS

PIZZAS WITH PIZZAZ

A new pizza shop is opening up and we're going to write their software

REQUIREMENTS

- **Menu**
  Customers need to know what they can order
- **Pizza Prep**
  The chef needs to know how to make each pizza
- **Bake**
  We can't serve a raw pizza

```
public class PizzaStore {
  private Dictionary<string, string> _menu { get; set; }
  public void initializeStore() {
    _menu = new Dictionary<string, string>();
    _menu.Add("Cheese", "Dough, Sauce, Cheese");
  }
  public Dictionary<string, string> getMenu() {
    return _menu;
  }
  public IPizza order(string selection) {
    IPizza _pizza;
    if(selection == "Cheese") {
      _pizza = new CheesePizza();
    } else {
      throw OrderNotFoundException("Sorry, we don't serve " + selection + " pizzas.");
    }
    _pizza.prep(); _pizza.bake(); _pizza.cut();
    return _pizza;
  }
}
```

```
public interface IPizza {
  public string name;
  private List<string> _ingredients;

  public void prep();
  public void bake();
  public void cut() {
    Console.WriteLine("Cutting Pizza...");
  }
}
```

```
public class CheesePizza: IPizza {
  public string name = "Cheese";
  private List<string> _ingredients = new List<string>() { "Dough", "Sauce", "Cheese" };

  public void prep() {
    rollOutDough();
    addSauce();
    addCheese();
  }

  public void bake() {
    int time = 23; int temp = 350;
    while(time > 0) {
      Console.WriteLine("Baking at " + temp.ToString());
      time--;
    }
  }
}
```

NEW REQUIREMENT: INGREDIENT UPDATE

Cheese isn't a great description, we need to specify that our pizza is made with Mozzarella

```
public class CheesePizza: IPizza {
  private List<string> _ingredients = new List<string>() { "Dough", "Sauce", "Mozzarella"
};
 }
```

```
public class PizzaStore {
  public void initialize() {
    _menu.Add("Cheese", "Dough, Sauce, Mozzarella");
  }
}
```

We're also going to introduce a new menu item, Pepperoni Pizza!

```
public class PizzaStore {
  public void initializeStore() {
    _menu = new List<IPizza>(){ new CheesePizza(), new PepperoniPizza() };
  }
  public Dictionary<string, string> getMenu() {
    Dictionary<string, string> menu = new Dictionary<string, string>();
    foreach(var pizza in _menu) { menu.Add(pizza.name, pizza.getInfo()); }
    return menu;
  }
  public IPizza order(string selection) {
    IPizza _pizza;
    if(selection == "Cheese") {
      _pizza = new CheesePizza();
    } else if(selection == "Pepperoni") {
      _pizza = new PepperoniPizza();
    } else {
      throw OrderNotFoundException("Sorry, we don't serve " + selection + " pizzas.");
    }
    _pizza.prep(); _pizza.bake(); _pizza.cut(); return _pizza;
  }
}
```

```
public interface IPizza {
  public string name;
  private List<string> _ingredients;

  public string getInfo() {
    return String.Join(", ", _ingredients);
  }

  public void prep();
  public void bake();
  public void cut() {
    Console.WriteLine("Cutting Pizza...");
  }
}
```

```
public class PepperoniPizza: IPizza {
  public string name = "Pepperoni";
  private List<string> _ingredients = new List<string>() { "Dough", "Sauce", "Cheese", "Pepperoni"
};

  public prep() {
    rollOutDough();
    addSauce();
    addCheese();
    addMeat();
  }

  public bake() {
    int time = 27; int temp = 375;
    while(time > 0) {
      Console.WriteLine("Baking at " + temp.ToString());
      time--;
    }
  }
}
```

NEW REQUIREMENT: CRAZY CUPCAKES

The owner's sister is opening a bakery. She doesn't have enough start up money to build her own software so we're going to use the pizza store software we already have.

```
public interface IStore {
  private List<IProduct> _menu { get; set; }
  public void initializeStore();

  public Dictionary<string, string> getMenu() {
    Dictionary<string, string> menu = new Dictionary<string, string>();
    foreach(IProduct product in _menu) {
      menu.Add(product.name, product.getInfo());
    }
    return menu;
  }

  public IProduct order(string selection) {
    IProduct item;
    item = createMeal(selection);
    item.make();
    item.serve();
    return item;
  }
  private IProduct createMeal(string selection);
}
```

```
public interface IProduct {
  public string name;
  private List<string> _ingredients;

  public string getInfo() {
    return String.Join(", ", _ingredients);
  }

  public void make();
  public void serve();
}
```

```
public class PizzaStore: IStore {
  public void initializeStore() {
    _menu = new List<IProduct>(){ new CheesePizza(), new PepperoniPizza(), new SideSalad() };
  }

  private IProduct createMeal(string selection) {
    IProduct _item;
    if(selection == "Cheese") {
      _item = new CheesePizza();
    } else if(selection == "Pepperoni") {
      _item = new PepperoniPizza();
    } else if(selection == "Salad") {
      _item = new SideSalad();
    } else {
      throw OrderNotFoundException("Sorry, we don't serve " + selection);
    }
    return _item;
  }
}
```

```
public class CupcakeStore: IStore {
  public void initializeStore() {
    _menu = new List<IProduct>(){ new VanillaCupcake(), new MiniCheesecake() };
  }

  private IProduct createMeal(string selection) {
    IProduct _item;

    if(selection == "Vanilla") {
      _item = new VanillaCupcake();
    } else if(selection == "MiniCheesecake") {
      _item = new MiniCheesecake();
    } else {
      throw OrderNotFoundException("Sorry, we don't serve " + selection);
    }

    return _item;
  }
}
```

INTRODUCING THE FACTORY METHOD PATTERN

By encapsulating the creation of our pizza and cupcake objects we've implemented the Factory Method Pattern.

```
public IProduct order(string selection) {
    IProduct item;
    item = createMeal(selection);
    item.make();
    item.serve();
    return item;
}
```

The Factory Method Pattern defines an interface for creating an object, but lets subclasses decide which class to instantiate.

NEW REQUIREMENT: RESTAURANT SEATING

Our pizza store is doing great! The owner is opening a formal dine-in Italian restaurant. With this comes new requirements.

REQUIREMENTS

- **Seating**
  The hostess needs to know what tables are available for seating customers and the waitstaff need a way to bus tables.

```
public class ItalianRestaurant: IStore {
  private Dictionary<string, bool> _tables = new Dictionary<string, bool> {}; //Table Number, Is
Occupied?
  public void initializeStore() {
    _menu = new List<IProduct>(){ new TortelliniAlfredo(), new GarlicBread(), new Risotto() };
    _tables.Add("One", false); _tables.Add("Two", false);
  }
  private IProduct createMeal(string selection) { /*We already know how this method works */ }
  public void seat(string tableNumber) {
    bool tableIsOccupied;
    if( _tables.TryGetValue(tableNumber, out tableIsOccupied) ) {
      if(!tableIsOccupied) {
        _tables[tableNumber] = true; //Our new customer is now occupying the table
      }
      throw TableIsOccupiedException(tableNumber + " is already occupied!");
    }
    throw TableNotFoundException(tableNumber + " is not a valid table.");
  }
  public void bus(string tableNumber) {
    _tables[tableNumber] = false;
  }
}
```

NEW REQUIREMENT: TABLE IS READY NOTIFICATION

Our Italian restaurant is blowing up! The system for seating isn't very efficient though.

To get people seated faster we want to notify all our hosts as soon as a table is ready.

```
public interface IStore {
  private List<ISubscriber> _subscribers;

  public void subscribe(ISubscriber subscriber) {
    _subscribers.Add(subscriber);
  }
  public void unsubscribe(ISubscriber subscriber) {
    _subscribers.Remove(subscriber);
  }
  private void notify(string tableNumber) {
    foreach(ISubscriber subscriber in _subscribers) {
      subscriber.update(tableNumber);
    }
  }
}
```

```
public interface ISubscriber {
  public void update(string tableNumber) {
    Console.Writeline(tableNumber + " is ready!");
  }
}
```

```
public class ItalianRestaurant: IStore {
  public void bus(string tableNumber) {
    _tables[tableNumber] = false;
    notify(tableNumber);
  }
}
```

INTRODUCING THE OBSERVER PATTERN

The Observer Pattern defines a one-to-many dependency between objects so that when one object changes state, all of its dependents are notified and updated automatically.

```
public interface IStore {
  public void subscribe;
  public void unsubscribe;
  private void notify(string tableNumber);
}
```

```
public interface ISubscriber {
  public void update(string tableNumber);
}
```

You may have heard the Observer Pattern referred to as the "Pub/Sub Model" or an "Event Listener"

HOW ARE WE ORDERING OUR INGREDIENTS ANYWAYS?

```
public interface IIngredient {
  public string name;
  public IngredientCategory category;
  private int _quantity;
  private ISupplier _supplier;
  public void useIngredient() { _quantity--; }
  public void stockIngredient(int count) {
    if(_supplier.purchase(name, category, count)) {
      _quantity += count;
    }
  }
  public int getQuantityInStock() { return _quantity; }
}
public enum IngredientCategory { Vegetable, Fruit, Protein, Oil, Dairy, Grain }
```

NEW REQUIREMENT: SWITCHING SUPPLIERS

Our restaurants are doing great but one of our suppliers is going under.

We have to use a new supplier and unfortunately they don't implement the ISupplier interface our other suppliers do.

Their ingredient categories are different than our other suppliers and their purchase method returns an http response instead of a boolean.

OPTIONS TO HANDLE THE NEW SUPPLIER

Add Conditional Checks

We could add some if statements to our code to check for an instance of the new supplier and handle it differently.

Override Purchase

We could add overrides for the purchase method but we'd still need to rewrite our ingredient interface to handle it.

Wrap the New Supplier

This supplier is the odd one out in our experience and they have a reputation for constantly rewriting their API.

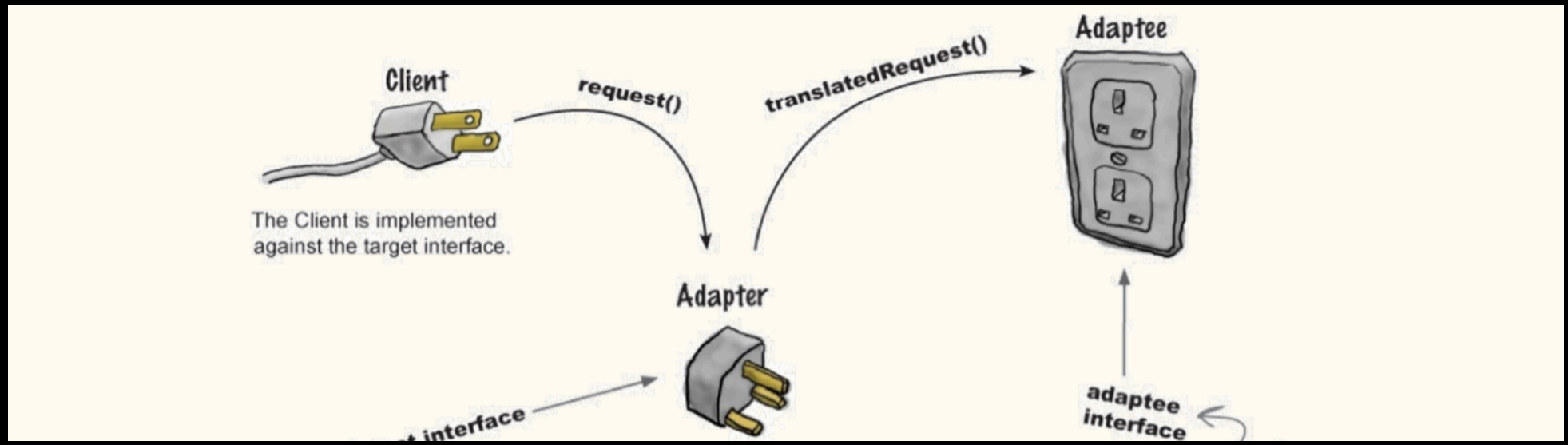
```
public class NewSupplierWrapper: ISupplier {
  private CustomSupplier _supplier;

  public bool purchase(string name, IngredientCategory category, int count) {
    CustomIngredientCategory supplierCategory = findCategory(category);
    HttpResponse response = _supplier.purchase(name, supplierCategory, count);
    if(response.StatusCode == 200) {
      return true;
    }
    return false;
  }
  private CustomIngredientCategory findCategory(IngredientCategory category) {
    //Code to map and convert the categories
  }
}
public enum CustomIngredientCategory { Vegetable, Fruit, Meat, Tofu, Oil, Dairy, VeganDairy, Fat,
```

With this solution we don't have to worry about making changes to our core codebase to support any changes the new supplier makes.

INTRODUCING THE ADAPTER PATTERN

By wrapping the new supplier in a class that allows it to implement our existing supplier interface we have used the Adapter Pattern.

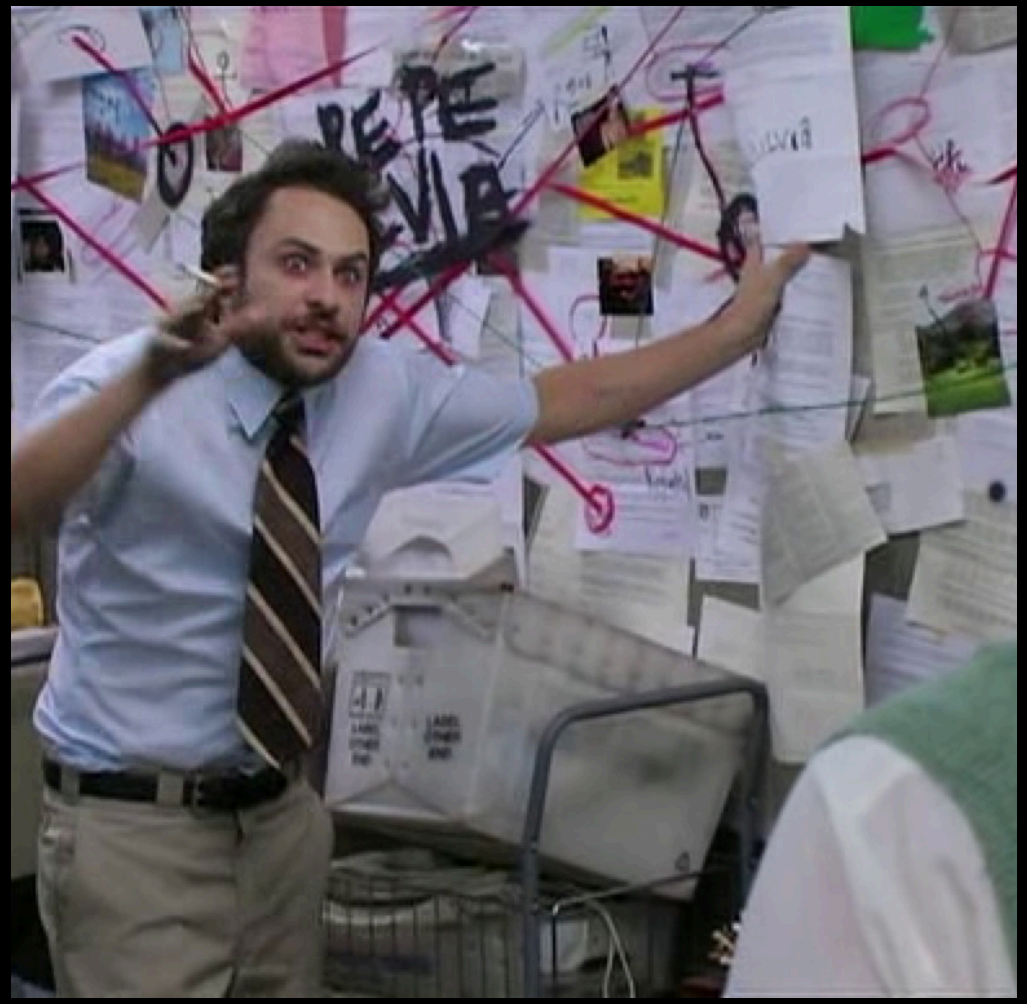


The Adapter Pattern converts the interface of a class into another interface the clients expect. Adapter lets classes work together that couldn't otherwise because of incompatible interfaces. Ever installed a device driver?

Terminology & the Origin of Design Patterns

WHY DESIGN PATTERNS ARE USEFUL

DESIGN PATTERNS PROVIDE A SHARED VOCABULARY



Communication struggles are the biggest time wasters in any project.

PATTERNS ALLOW YOUR TEAM TO KEEP DESIGN DISCUSSIONS AT A CONCEPTUAL LEVEL

When discussing how to design a new system it is easy to get lost in the details of the specific implementation if we don't have common terminology for talking about the overarching design.

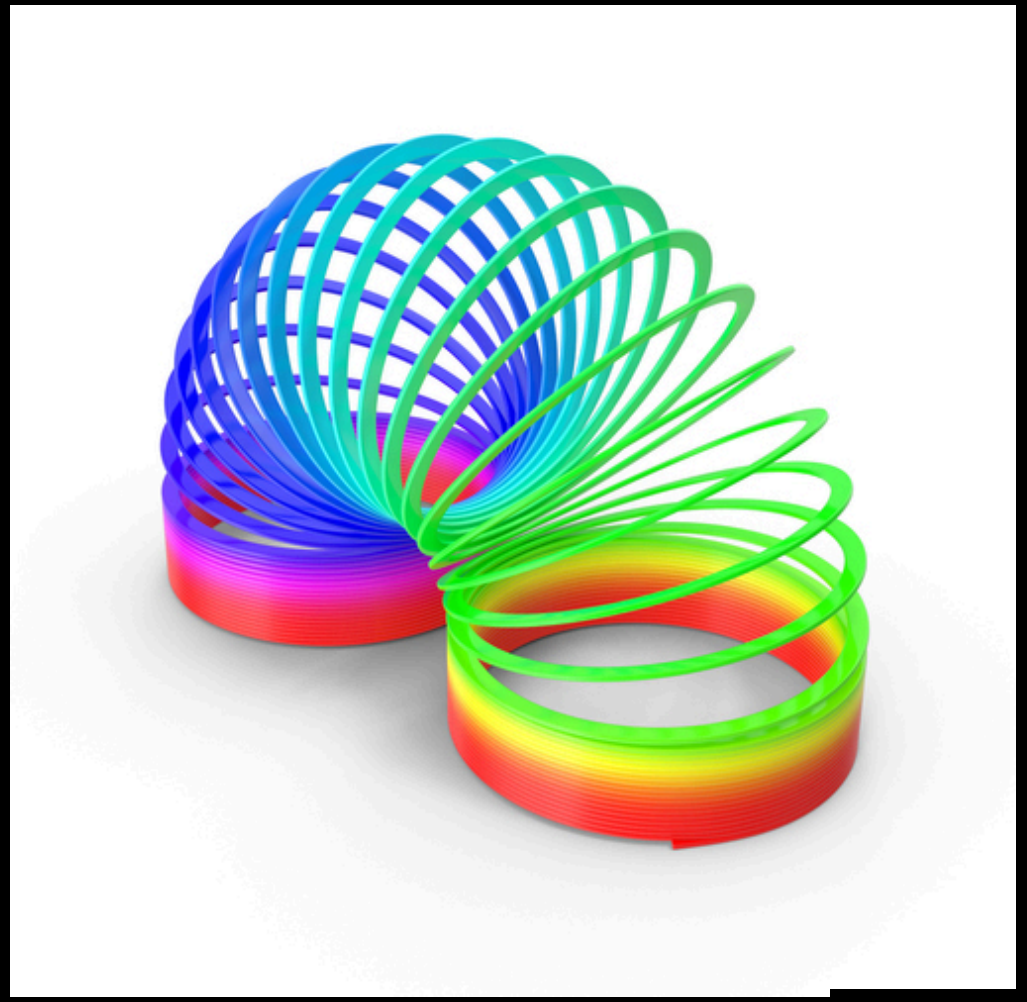
DESIGN PATTERNS MAKE IT EASY TO REUSE OUR EXISTING CODE

Any project we don't have to start from scratch is a good project.

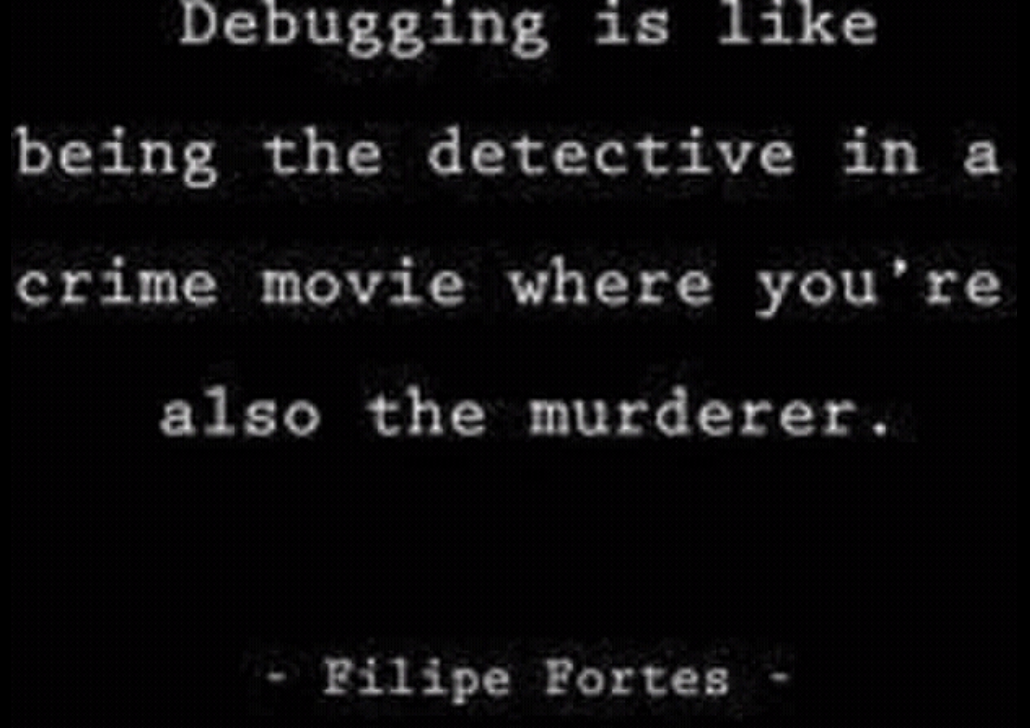
We were able to create new menu items and stores without needing to rewrite the basic store and product operations.

DESIGN PATTERNS KEEP CODE FLEXIBLE

Crazy Cupcakes doesn't prepare their cupcakes the same way Pizzas with Pizzaz prepares their pizzas. Since we encapsulated their product's preparation methods it wasn't a problem to add unique items.



SYSTEMS BUILT USING GOOD DESIGN PATTERNS ARE GENERALLY EASY TO MAINTAIN



Design Patterns make it easier for other developers (or yourself months later) to read and understand your code.

They are also flexible enough that we can extend systems without rewriting them.

DESIGN PATTERNS HAVE THE BENEFIT OF BEING VERIFIED BY THE COMMUNITY

Patterns only become patterns when they have been used in multiple, unique, real-world systems.

SOFTWARE ARCHITECT IS A DISTINCT JOB FOR A REASON

```
public interface IAnimal {
    string _name;
    string _sound;
    void Walk();
    void Fly();
    string MakeSound();
}
```

Knowing object oriented principals doesn't automatically make you a good designer.

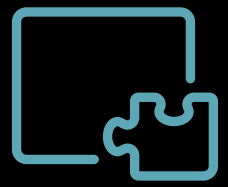
We can use encapsulation and inheritance and still end up with bad code.

Technical Details & Practical Information

USING DESIGN PATTERNS

WHEN TO USE A DESIGN PATTERN

When the need arises...



When it would address a problem in your system

Hosts need to know when a table is ready for new customers.

When you expect aspects of your system to vary

We know all restaurants prepare their products differently. If we expect to reuse our pizza store code we should use a flexible design pattern.

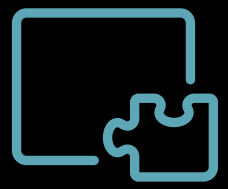
Are we building the first phase of a new enterprise system? Experimenting with a new vendor?

When you find yourself with a massive if statement

Not a catch all, but if you have a function with 25 if/else statements there is a chance it could be refactored.

WHEN NOT TO USE A DESIGN PATTERN

There are a lot of times we don't need a design pattern.



When there isn't a practical reason we need to support change or variation

While we want to design with future variation in mind, we shouldn't add unnecessary complexity based on hypothetical future changes.

Overusing patterns can make code unnecessarily complex and inefficient

If we have to wade through 13 interfaces and create 12 additional objects in memory just to perform one action, our design is probably over-engineered.

When you're writing something for single use

About to migrate ChMS systems? A one-time data conversion from one specific format to another probably doesn't require a design pattern.

THE MOST IMPORTANT PRINCIPAL OF DESIGN IS SIMPLICITY

The goal of our software designs should always be to write the most simple solution that solves the problem.

The simplest solution to a problem often involves a design pattern, but not always.

Don't need a design pattern right now?

Don't write it.

Don't need to support the change you expected?

Remove the design pattern you originally included.

Using design patterns doesn't automatically make you a good developer.

Not using them doesn't make you a bad developer.

FACTORING DESIGN PATTERNS INTO YOUR DEVELOPMENT PROCESS

Natural Recognition Comes With Experience

It will take time to be able to naturally identify when a pattern would fit into your design

Keep it Simple

The simplest solution is always the best, your design should always be focused on simplicity and following good OO practices, not trying to use a pattern

Refactor Time is Pattern Time

Are you making a change to an application?

Could this refactor have been avoided if our system used a design pattern?

Time to evaluate the current design

Look at Patterns When Designing

Brush up on your patterns

Learn about new patterns that might be helpful in your design

Don't force a pattern based solution

Technical Details & Practical Information

ANTI-PATTERNS

DEFINITION OF AN ANTI-PATTERN

An Anti-Pattern is a BAD solution to a problem in a context. An Anti-Pattern has:

- A name we can use to talk about it
- A description of the problem, context, and forces
- The supposed solution
- The refactored solution
- Real-world examples

WHY ANTI-PATTERNS ARE USEFUL

Tell you why a bad solution is attractive

Tell you why a bad solution won't work long-term

Suggest other applicable patterns that may provide good solution

ANTI-PATTERNS IN ACTION: THE GOLDEN HAMMER

- **Problem**

  You need to choose technologies for new development and you believe one technology must dominate the architecture

- **Context**

  The new system/software that needs to be developed doesn't fit well with the technology the team is familiar with

- **Forces**

  The team is committed to the technology they know

  The team is not familiar with other technologies

  Unfamiliar technologies are seen as risky

  It is easy to plan and estimate development with familiar technology

- **Supposed Solution**

  Use the familiar technology anyways, apply it obsessively to many problems, even if it is clearly inappropriate

- **Refactored Solution**

  Expand the knowledge of the team through education, training, and book studies that expose them to new solutions

- **Examples**

  Web companies that use their own internal caching systems instead of an open source alternative

  Ministries with Excel workbooks?

  Software dev learns about observer patterns wants to use it everywhere lol

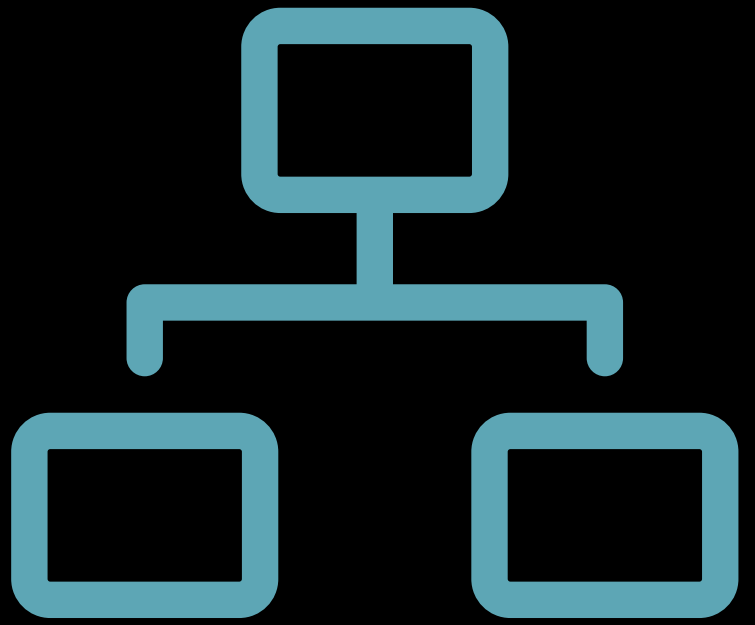
Beyond Today

PATTERN CATALOGS & CATEGORIES

A PATTERN CATALOG IS AN ORGANIZED COLLECTION OF PATTERNS

Pattern Catalogs are useful references for designing software because they provide a definition of a number of patterns and the relationships between them.

Pattern Catalogs organize patterns into categories to help you find the one you need.



PURPOSE-BASED PATTERN CATEGORIES

Creational

Involve object instantiation

Abstract Factory

Factory Method

Singleton

Behavioral

Concerned with how classes and objects interact

Command

Iterator

Observer

State

Strategy

Template Method

Structural

Let you compose classes or objects into larger structures

Adapter

Composite

Decorator

Facade

Proxy

Beyond Today

RESOURCES

SOME BOOKS, PATTERN CATALOGS, AND WEBSITES

Design Patterns
Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides

Head First Design Patterns
Eric Freeman, Elisabeth Robson

Refactoring Guru

A Philosophy of Software Design
John Ousterhout

Fundamentals of Software Architecture
Mark Richards, Neal Ford

The Portland Patterns Repository