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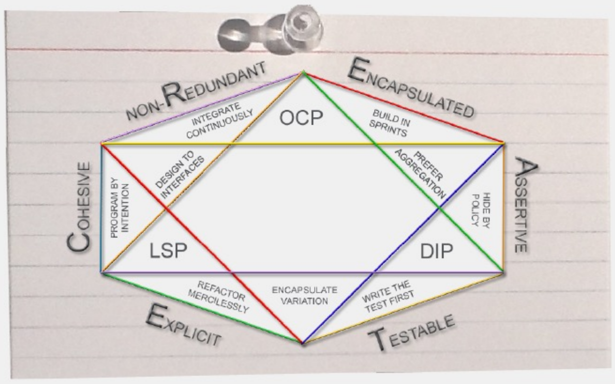
Patterns of Instantiation



Object Lifecycle Management

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David Scott Bernstein

- Software developer since 1980
- Trained 8,000 developers since 1990
- Author of the book *Beyond Legacy Code: Nine Practices to Extend the Life (and Value) of Your Software*

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My Book – Beyond Legacy Code

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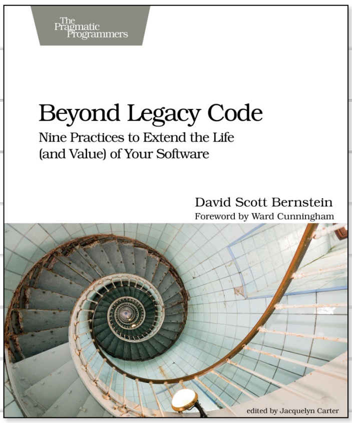
The Pragmatic Programmers
Beyond Legacy Code
Nine Practices to Extend the Life (and Value) of Your Software
David Scott Bernstein
Foreword by Ward Cunningham
edited by Jacquelyn Carter

- Nine practices to design and build healthy code, plus some tips on dealing with legacy code.
- Discusses the value and reasoning behind the technical practices, so both managers and the team can get on the same page as to their value.
- It's not a "How To" book, it's a "Why To" book.

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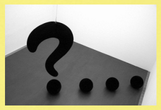
Why this Talk?



- Instantiation is at the very core of object-oriented programming but often misunderstood and under-utilized.
- Failing to leverage instantiation in object-oriented programming creates tightly coupled classes that are difficult to extend.
- This is the biggest technical issue I find in virtually all the code I see from my clients, who are the largest companies in the world.
- When we leverage object instantiation we build software that is straightforward to extend and verify, dropping the cost of ownership.
- In the 1990s, I taught nearly 4,000 professional software developers wrong, everyone did, and I want to make up for that now as best I can.

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Patterns and Anti-Patterns

- Design patterns is a term coined by Christopher Alexander who used it to describe the forces that make a structure “livable.”
- Design patterns were adopted by software developers to describe common intents or way of encapsulating something that is varying.
- We commonly think of patterns as “best practices.”
- If patterns are “best practices” then anti-patterns are “worst practices.”
- In this session, we’ll look at some common anti-patterns, why they should be avoided, and what good patterns can be used instead.

Anti-Pattern: Creating Objects You Use

- Good Intention: Create an object so you can use its services.
- Flaw: Over-encapsulates services that an object uses.
- Result: From the outside, the created object becomes indistinguishable from the object that creates it, making it impossible to independently verify, extend, or reuse.
- Testability: Objects that create the services they use are inseparable from those services so they must be tested together, which can make tests slow and unreliable.
- Contraindications: This only applies to external dependencies or objects you might want to extend in the future.

Why It’s Bad to Create Objects You Use

- When one object instantiates another object and then uses it there’s no way to substitute the object it’s using.
- This creates a dependency between the two pieces of code that makes it impossible to test each piece separately.
- It also means that we can’t extend one without changing the other.
- Following this anti-pattern causes a system to become brittle, intertwined, and nearly impossible to work with.

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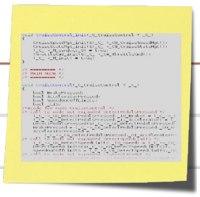
For Example



- A common programming practice is to new up the services you need in an object’s construction. For example:

```
public class MyClass {
      Service myService;
      public MyClass() {
            Service myService = new Service();
       }
      public void doSomething() {
            /* ... */
            myService.process();
            /* ... */
      }
}
```

Instantiates

Uses

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Problems with New

- The “new” keyword is used to create an instance of a class
- It requires that you pass in the class name
- It returns an instance of the class
- Therefore the caller of “new” must know the class it wants to create

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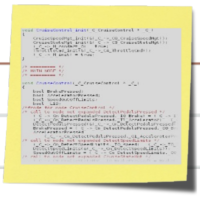
Mixing Perspectives



Here’s some code that I would have written 17 years ago

```
public class Document {
  Sort sortStrategy;
  public Document() {
    Sort sortStrategy = new Sort(); ← Creates
    }
   public void prepareDocument() {
   /* ... */
   sortStrategy.sort(); ← Uses
   /* ... */ }
}
```

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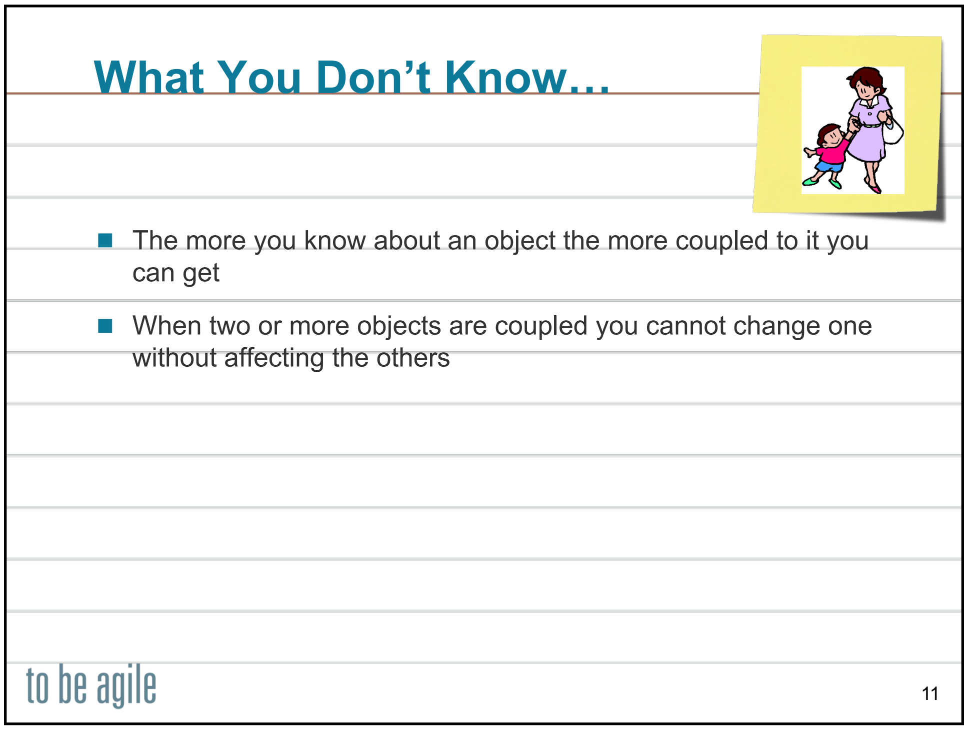

What You Don't Know…

- The more you know about an object the more coupled to it you can get
- When two or more objects are coupled you cannot change one without affecting the others

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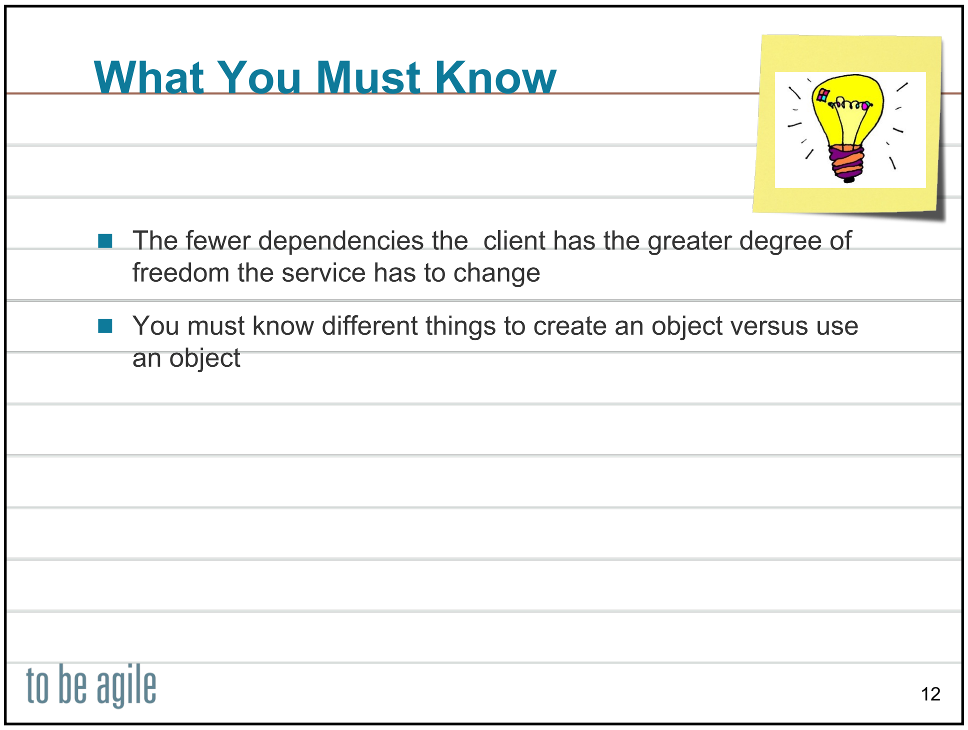

What You Must Know

- The fewer dependencies the client has the greater degree of freedom the service has to change
- You must know different things to create an object versus use an object

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To Create an Object

- To instantiate an object you must know:
  - The object's type
  - Any overloaded constructors

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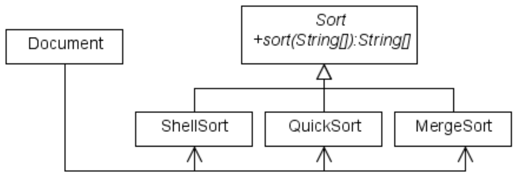
Creating Example

- What can you change without affecting the caller?
  - You can change the method signature
- What can you not change without affecting the caller?
  - You cannot change the specific derivations



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To Use an Object

- To call methods on an object you must know:
  - The object’s type, or
  - The type the object is derived from, or
  - An interface the object implements
- When you call a method you are also coupled to its interface

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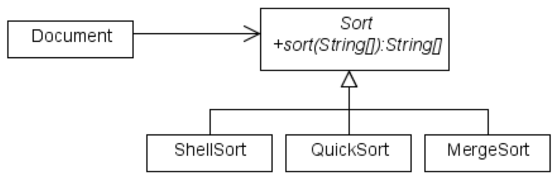
Using Example

- What can you change without affecting the caller?
  - You can add new derivations
- What can you not change without affecting the caller?
  - You cannot change the method signature



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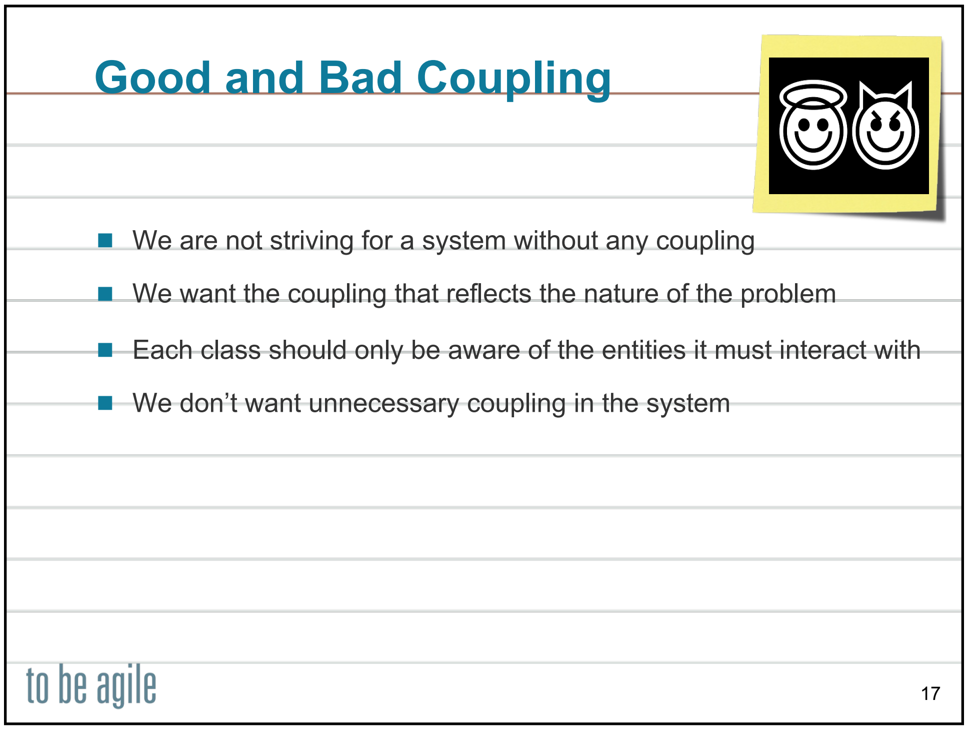

Good and Bad Coupling

- We are not striving for a system without any coupling
- We want the coupling that reflects the nature of the problem
- Each class should only be aware of the entities it must interact with
- We don't want unnecessary coupling in the system

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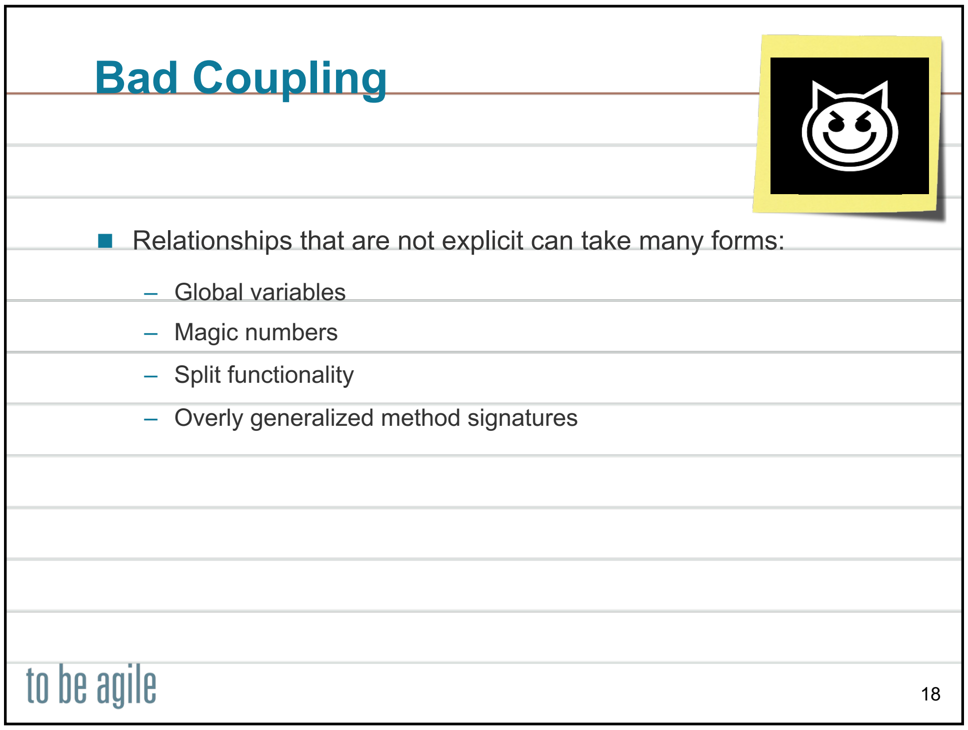

Bad Coupling

- Relationships that are not explicit can take many forms:
  - Global variables
  - Magic numbers
  - Split functionality
  - Overly generalized method signatures

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Kinds of Coupling

Name	Coupled To
Type coupling	The existence of a class
Interface coupling	The method signatures of another class
Abstract coupling	The abstract type only
Concrete coupling	A subtype in a polymorphic set

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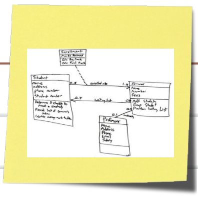
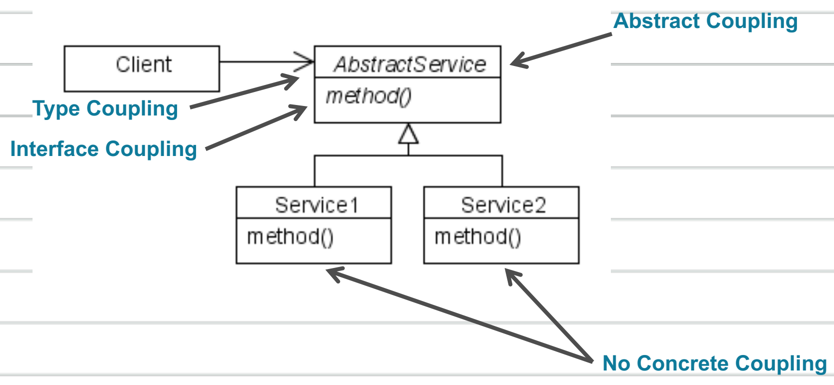
Coupling Example





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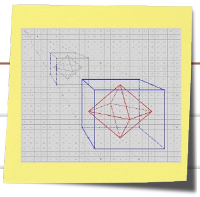
Coupling of Perspectives



Coupling	Creation	Use
Type	Yes	No
Interface	No	Yes
Abstract	Yes	Yes
Concrete	Yes	No

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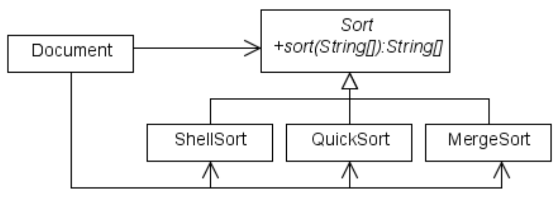
Mixing Perspectives

- When you mix the perspective of creation with the perspective of usage
  - What you can change freely is nothing
  - What you cannot change freely is everything



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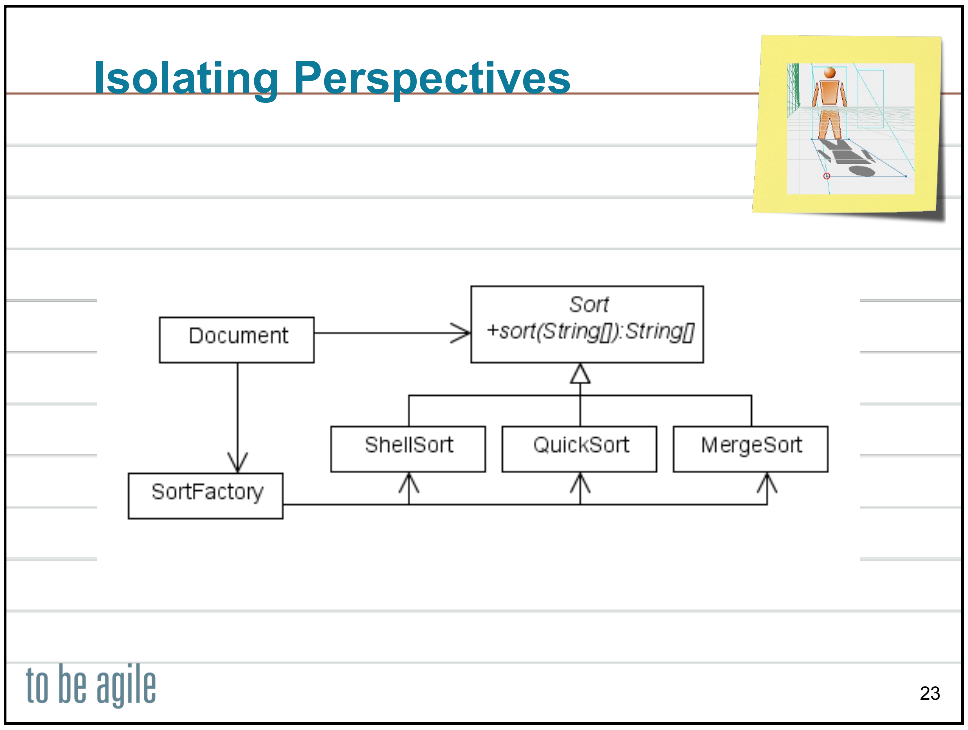
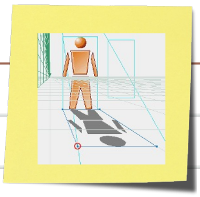
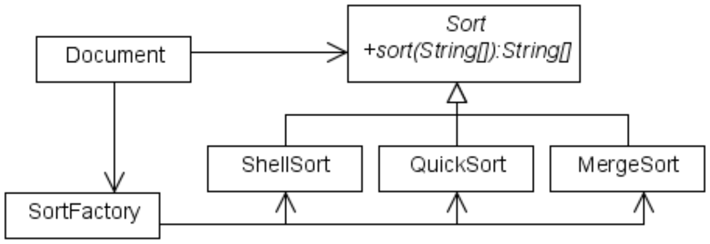


Isolating Perspectives





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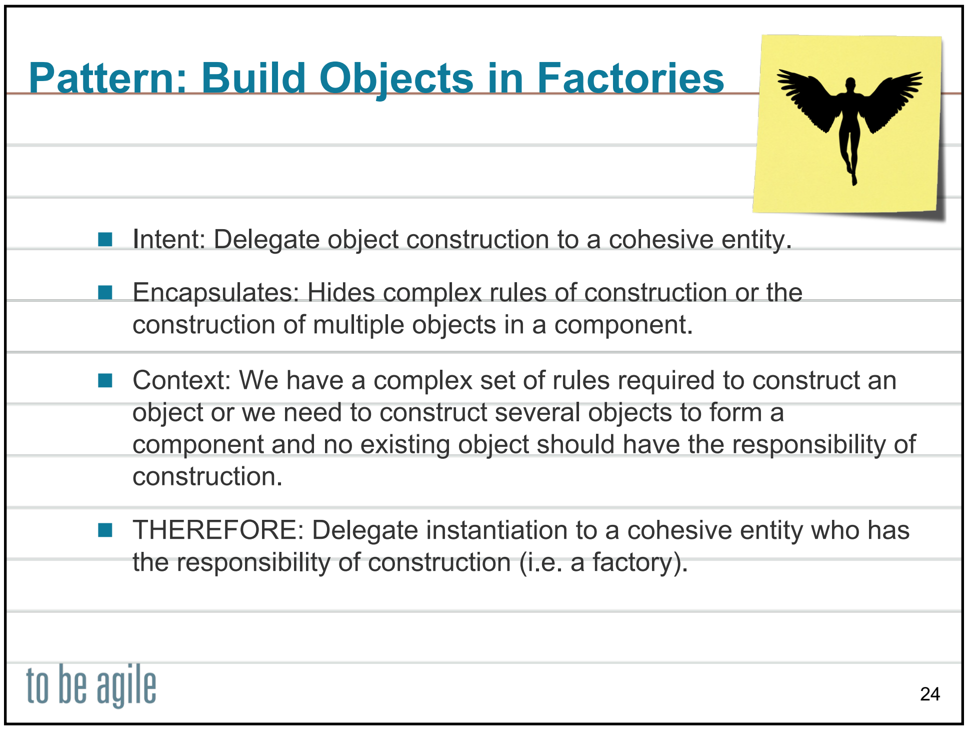

Pattern: Build Objects in Factories

- Intent: Delegate object construction to a cohesive entity.
- Encapsulates: Hides complex rules of construction or the construction of multiple objects in a component.
- Context: We have a complex set of rules required to construct an object or we need to construct several objects to form a component and no existing object should have the responsibility of construction.
- THEREFORE: Delegate instantiation to a cohesive entity who has the responsibility of construction (i.e. a factory).

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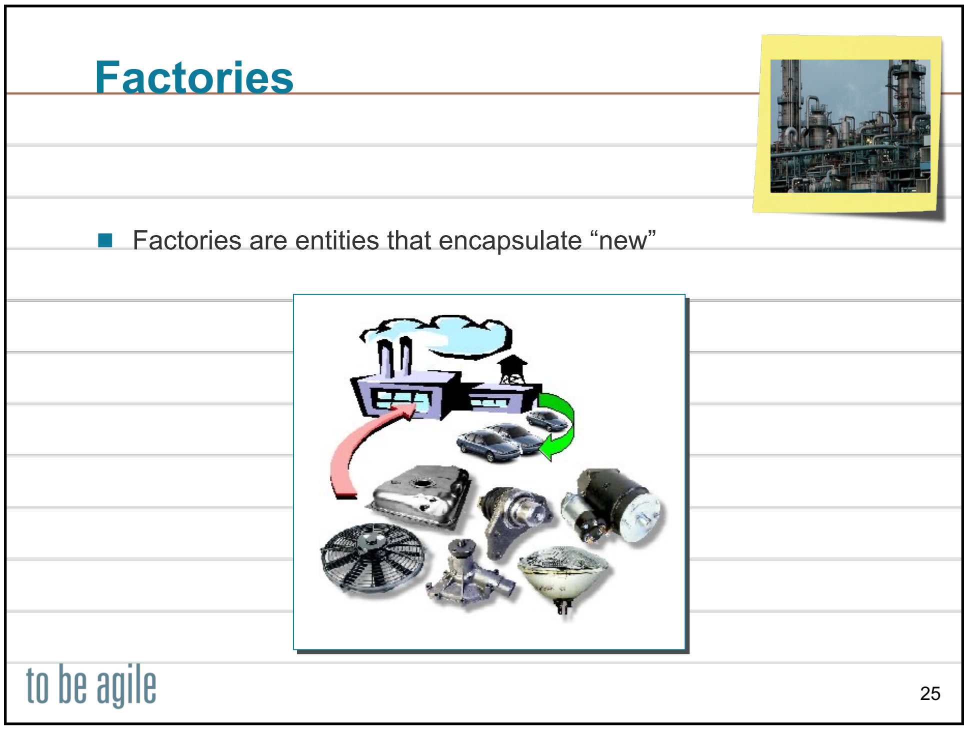

Factories

- Factories are entities that encapsulate "new"

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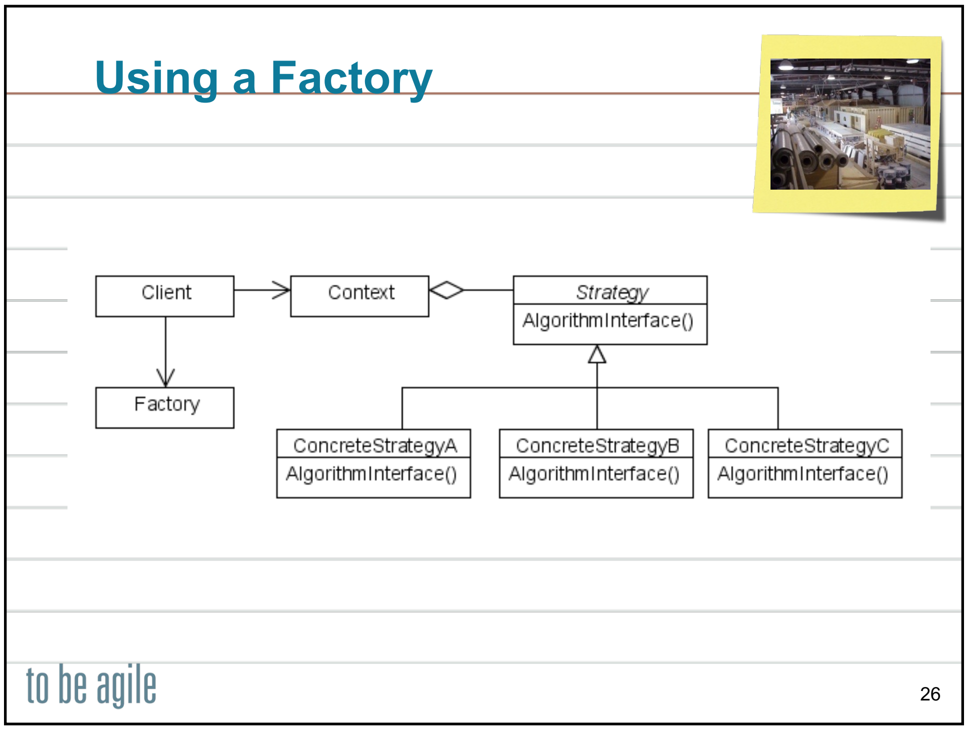
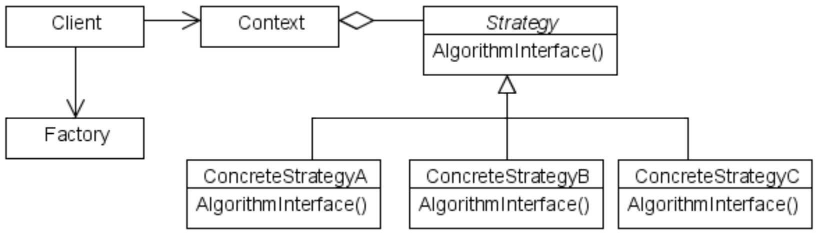


Using a Factory



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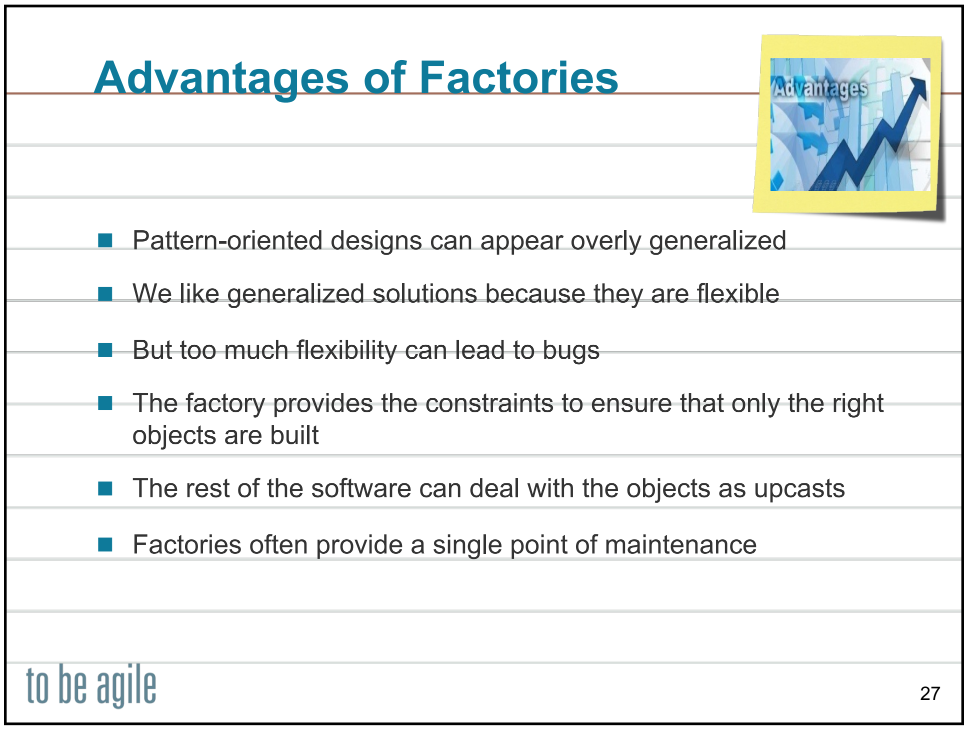

Advantages of Factories

- Pattern-oriented designs can appear overly generalized
- We like generalized solutions because they are flexible
- But too much flexibility can lead to bugs
- The factory provides the constraints to ensure that only the right objects are built
- The rest of the software can deal with the objects as upcasts
- Factories often provide a single point of maintenance

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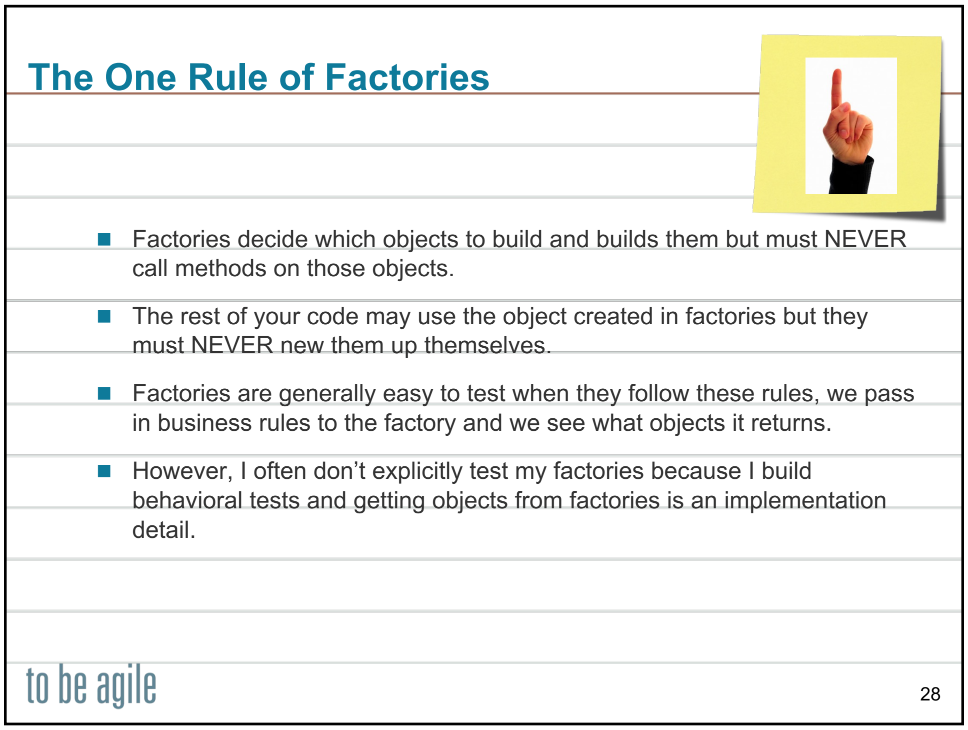

The One Rule of Factories

- Factories decide which objects to build and builds them but must NEVER call methods on those objects.
- The rest of your code may use the object created in factories but they must NEVER new them up themselves.
- Factories are generally easy to test when they follow these rules, we pass in business rules to the factory and we see what objects it returns.
- However, I often don’t explicitly test my factories because I build behavioral tests and getting objects from factories is an implementation detail.

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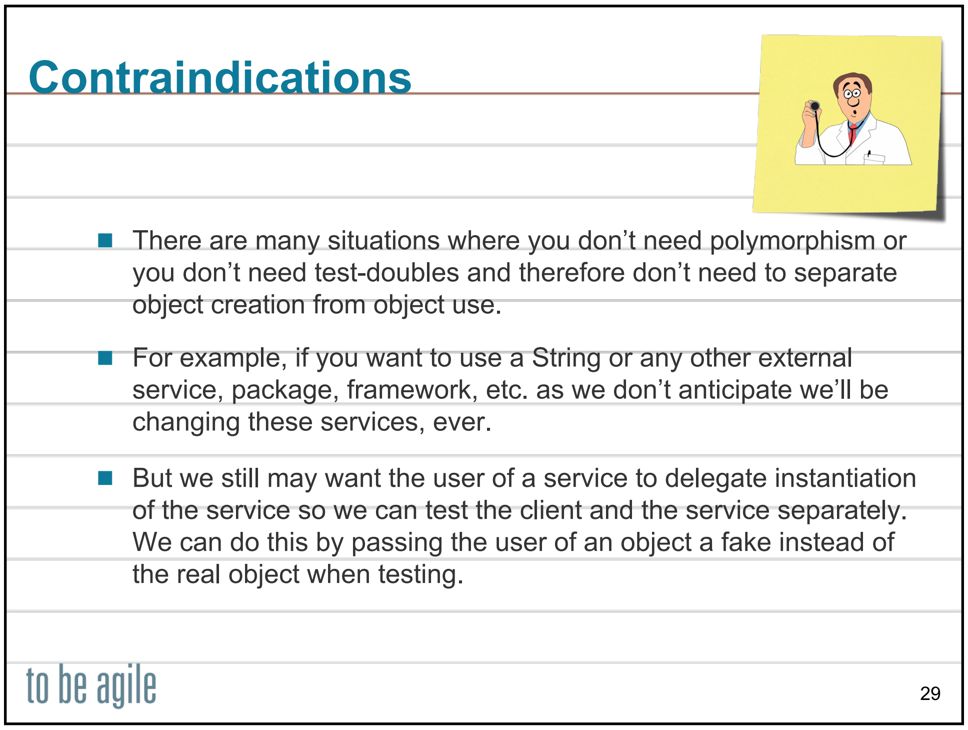

Contraindications

- There are many situations where you don’t need polymorphism or you don’t need test-doubles and therefore don’t need to separate object creation from object use.
- For example, if you want to use a String or any other external service, package, framework, etc. as we don’t anticipate we’ll be changing these services, ever.
- But we still may want the user of a service to delegate instantiation of the service so we can test the client and the service separately. We can do this by passing the user of an object a fake instead of the real object when testing.

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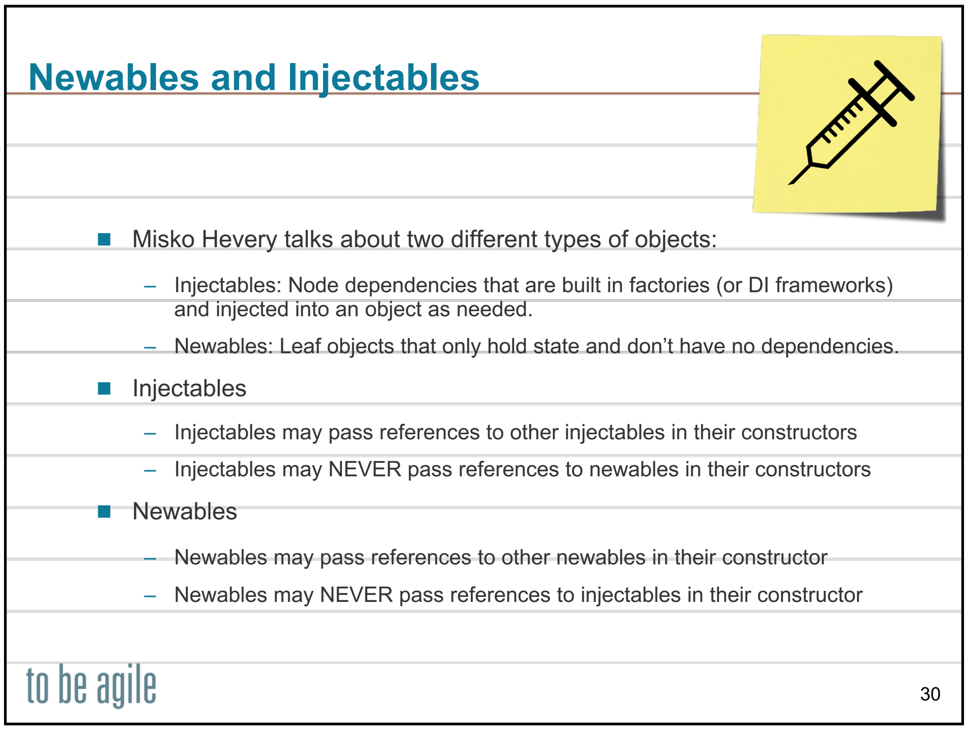

Newables and Injectables

- Misko Hevery talks about two different types of objects:
  - Injectables: Node dependencies that are built in factories (or DI frameworks) and injected into an object as needed.
  - Newables: Leaf objects that only hold state and don’t have no dependencies.
- Injectables
  - Injectables may pass references to other injectables in their constructors
  - Injectables may NEVER pass references to newables in their constructors
- Newables
  - Newables may pass references to other newables in their constructor
  - Newables may NEVER pass references to injectables in their constructor

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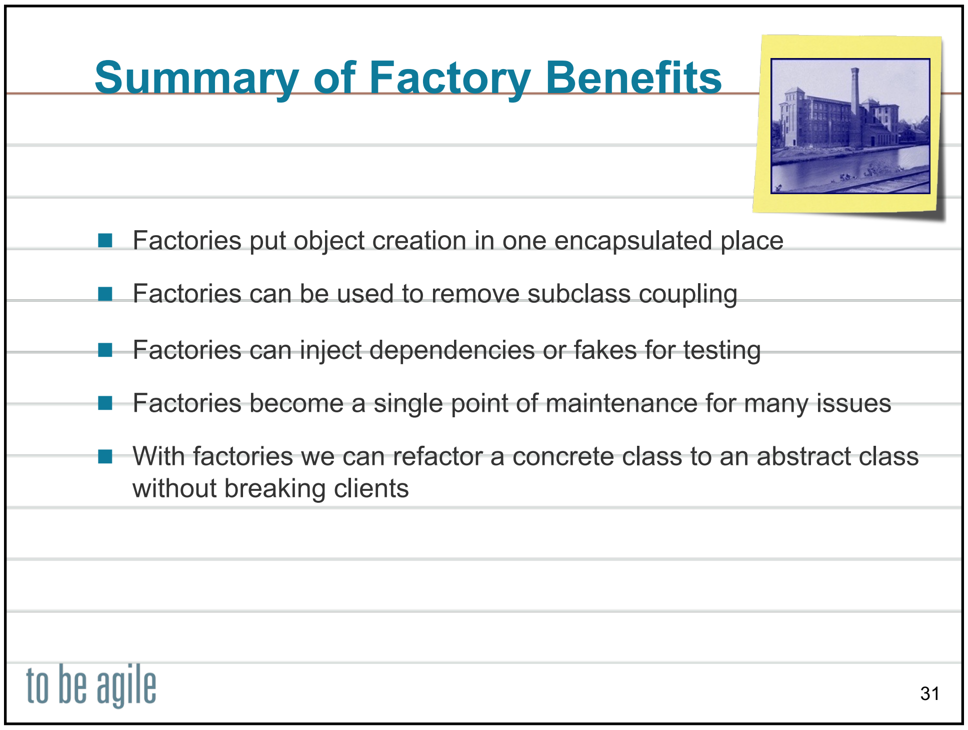
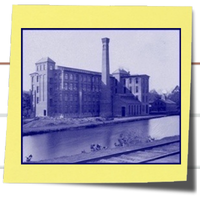


Summary of Factory Benefits



- Factories put object creation in one encapsulated place
- Factories can be used to remove subclass coupling
- Factories can inject dependencies or fakes for testing
- Factories become a single point of maintenance for many issues
- With factories we can refactor a concrete class to an abstract class without breaking clients

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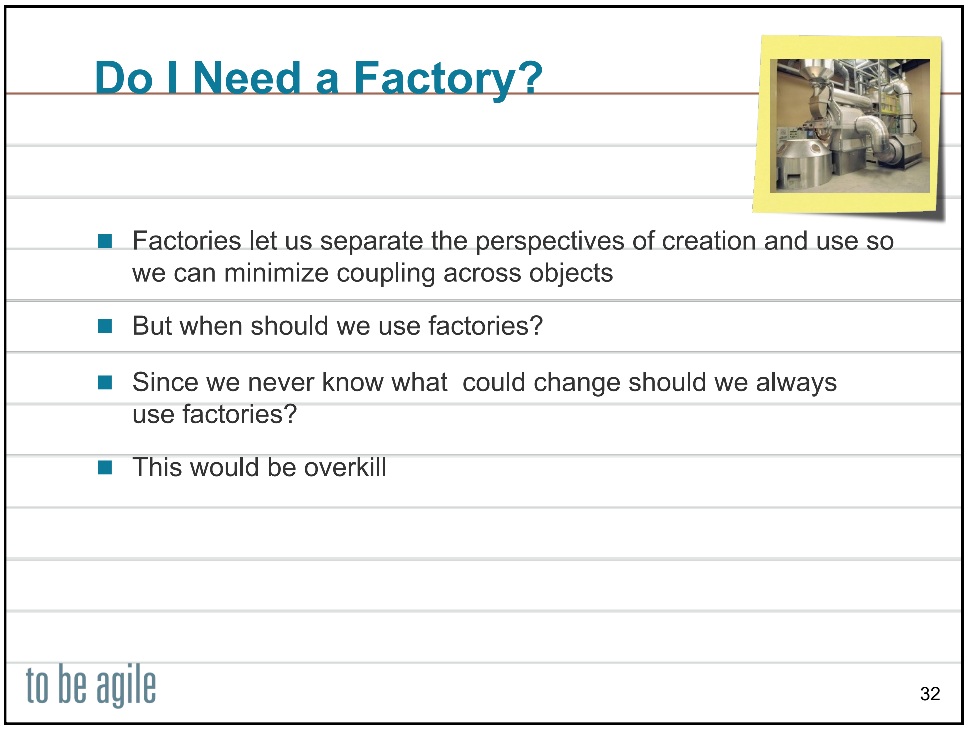

Do I Need a Factory?

- Factories let us separate the perspectives of creation and use so we can minimize coupling across objects
- But when should we use factories?
- Since we never know what could change should we always use factories?
- This would be overkill

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The Question of Construction

- When should we focus on constructing our objects?
- It is often easier to focus on object construction after you have come up with your basic design
- Building objects apart from where they are used will lead to higher code quality

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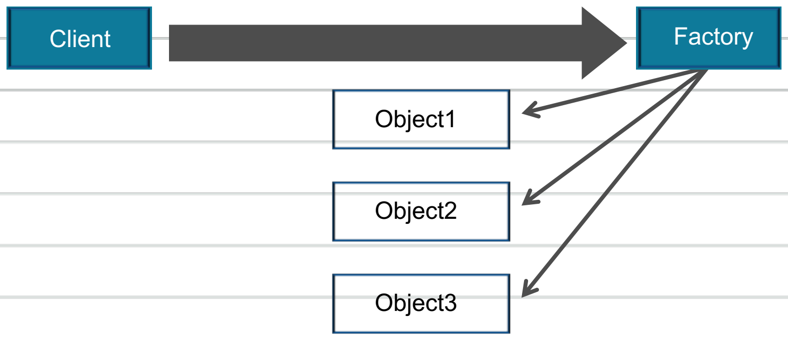
And Then a Miracle Happens



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Problems with Factories

- But when should we use factories? Always?
- That seems like an awfully big burden

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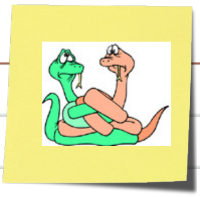
Separate Construction from Use



- Many of the benefits of using factories come from the separation of construction from use
- You must know different things to create an object versus to use it
- Separating out these perspectives means less unintentional coupling for the classes involved

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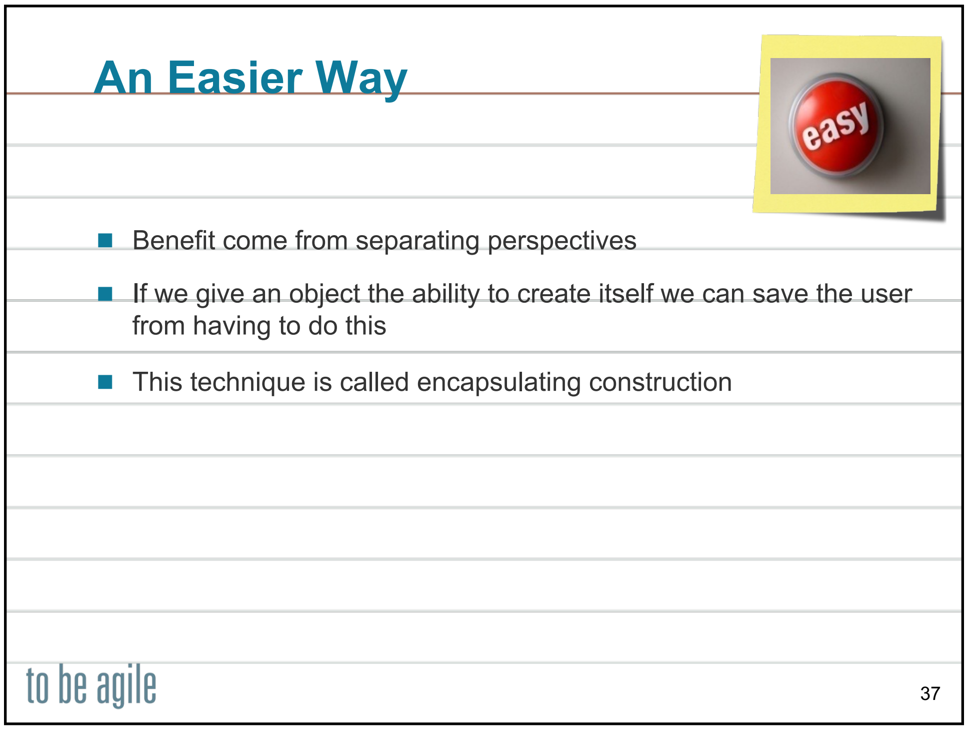

An Easier Way

- Benefit come from separating perspectives
- If we give an object the ability to create itself we can save the user from having to do this
- This technique is called encapsulating construction

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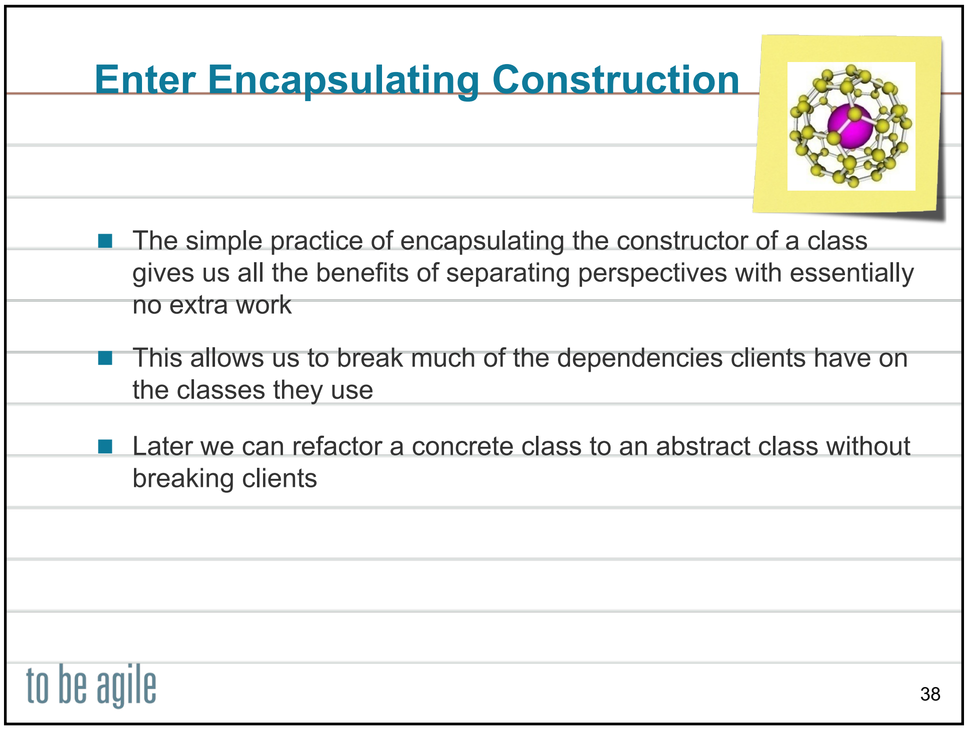
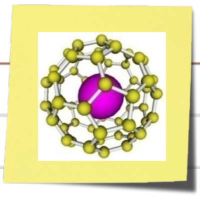


Enter Encapsulating Construction



- The simple practice of encapsulating the constructor of a class gives us all the benefits of separating perspectives with essentially no extra work
- This allows us to break much of the dependencies clients have on the classes they use
- Later we can refactor a concrete class to an abstract class without breaking clients

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Pattern: Encapsulate Construction

- Intent: Give objects the responsibility of creating themselves
- Encapsulates: Hides the object's type from its users.
- Context: We would like users of objects to not have to create those objects themselves.
- THEREFORE: Objects can expose a public static method users can call so the object creates itself.

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Encapsulating Construction

```
public class Sort {
    private Sort() {
        // construction goes here
    }
    public static Sort getInstance() {
        return new Sort();
    }
    // ...
}
public class Document {
    private Sort mySort;
    public void processDocument() {
        // ...
        mySort = Sort.getInstance();
        mySort.sort();
        // ...
    }
}
```

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Refactoring to a Strategy

```
public abstract class Sort {
    private Sort() {
        // construction goes here
    }
    public static Sort getInstance() {
        if (someDecision() == true)) {
            return new ShellSort();
        } else {
            return new QuickSort();
        }
    }
    // ...
}
```

```
public class ShellSort extends Sort {
    // …
}
public class QuickSort extends Sort {
    // …
}
public class Document {
    private Sort mySort;
    public void processDocument() {
        // ...
        mySort = Sort.getInstance();
        mySort.sort();
        // ...
    }
}
```

No change to client!

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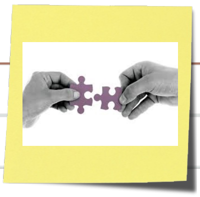
Now Objects are Extensible



- Notice how when we encapsulate construction we can change a concrete class into an abstract class and introduce polymorphism without breaking our callers.
- Encapsulating construction allows us to inject design patterns, which are often based on abstract classes, virtually anywhere in code without breaking callers, allowing us a great deal of freedom to emerge designs.
- This one simple technique enables code to have maximum extensibility as well as independently verifiability.

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Why Encapsulate Construction

- When encapsulating construction we get many of the benefits of using a factory without the extra effort.
- The benefits of encapsulating construction include
  - Takes no extra time to provide
  - Lets us refactor a concrete class into an abstract class without affecting the caller
  - Promotes the Open-Closed Principle
  - Promotes a cohesion of perspectives by separating object creation from use

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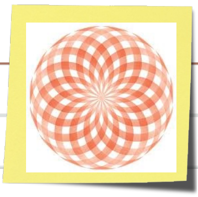
An Object's Responsibility



- The object-oriented programming model is based on created autonomous, assertive objects who are responsible for themselves.
- One of an object's most important responsibilities is to instantiate itself.
- This is true for biological organisms like bacteria and humans as well as solar systems and galaxies.
- If fact, we see many similar patterns in nature for instantiating biological processes that we see good coding practices, including abstract factory and builder patterns.

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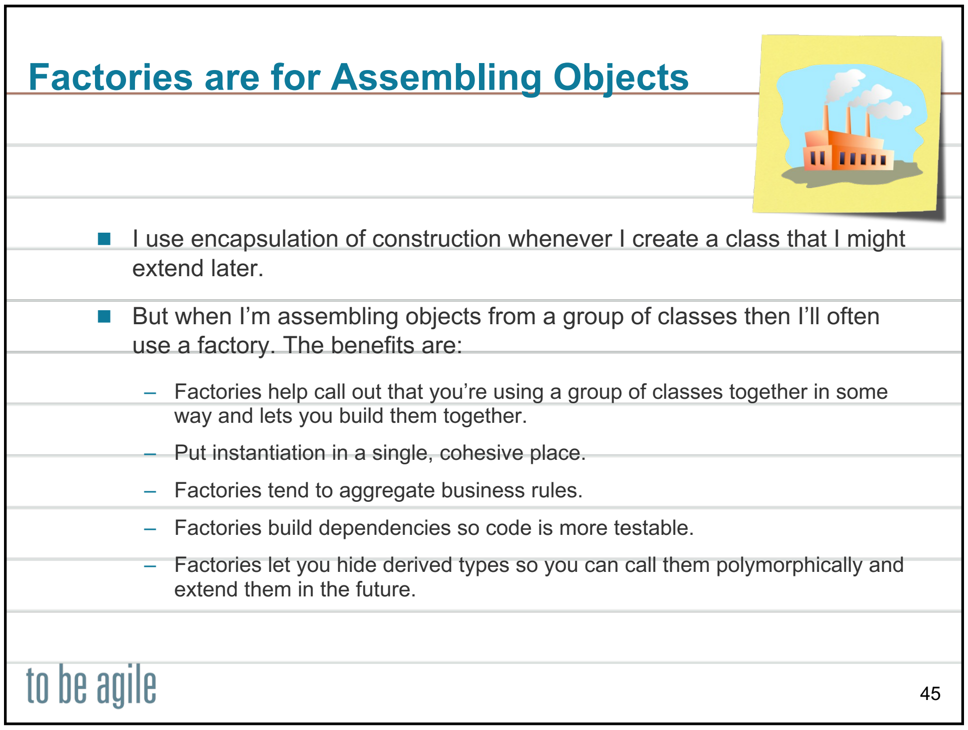

Factories are for Assembling Objects

- I use encapsulation of construction whenever I create a class that I might extend later.
- But when I'm assembling objects from a group of classes then I'll often use a factory. The benefits are:
  - Factories help call out that you're using a group of classes together in some way and lets you build them together.
  - Put instantiation in a single, cohesive place.
  - Factories tend to aggregate business rules.
  - Factories build dependencies so code is more testable.
  - Factories let you hide derived types so you can call them polymorphically and extend them in the future.

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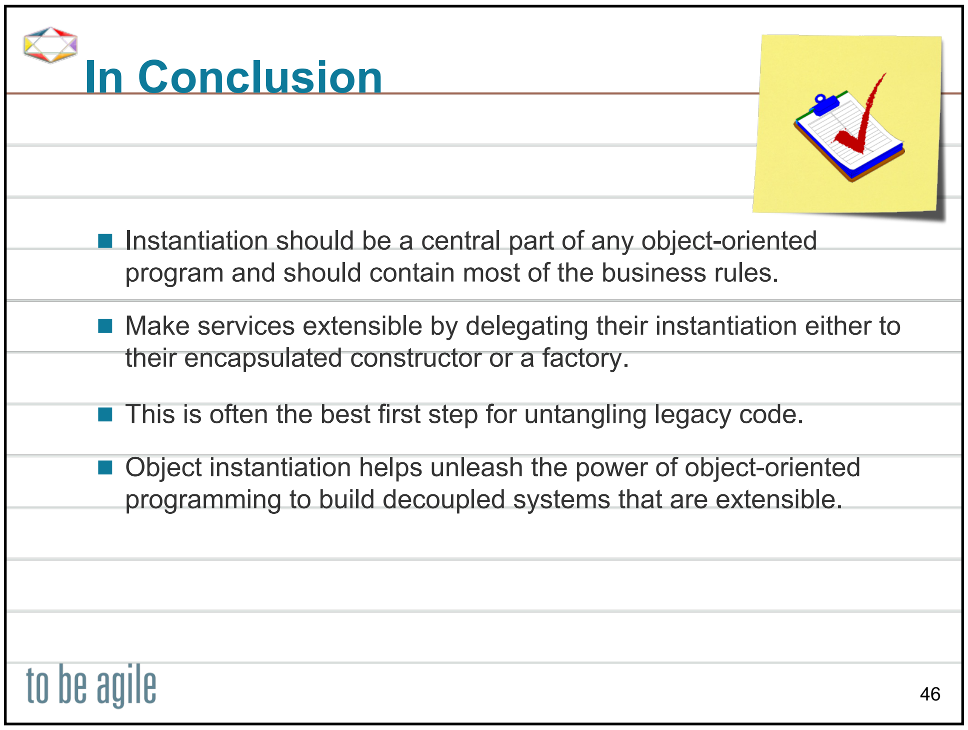

In Conclusion

- Instantiation should be a central part of any object-oriented program and should contain most of the business rules.
- Make services extensible by delegating their instantiation either to their encapsulated constructor or a factory.
- This is often the best first step for untangling legacy code.
- Object instantiation helps unleash the power of object-oriented programming to build decoupled systems that are extensible.

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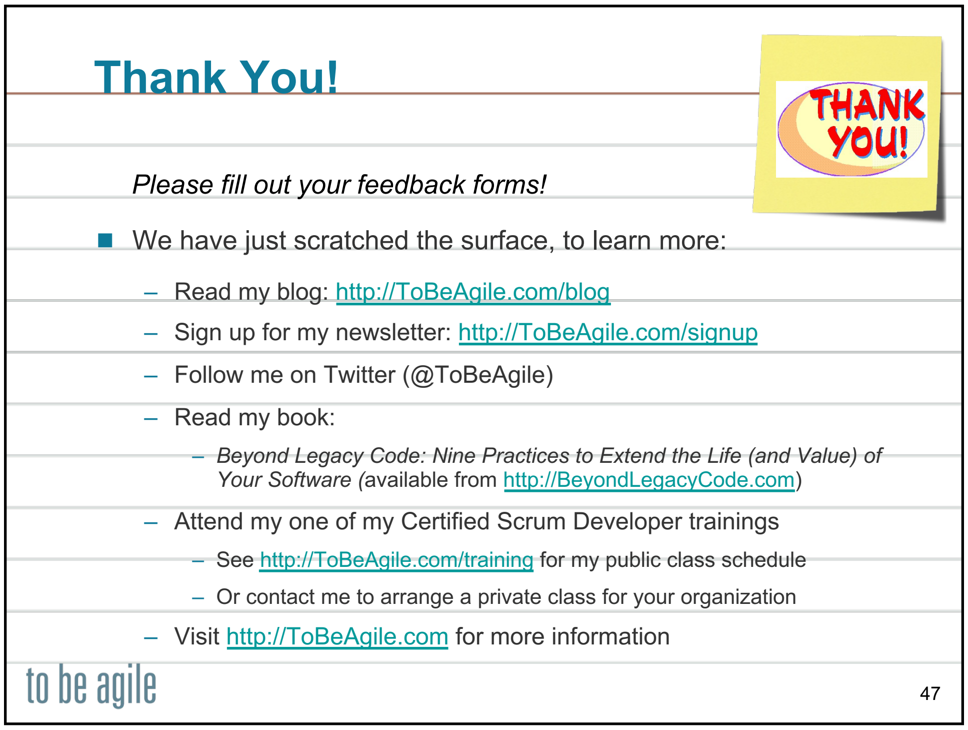

Thank You!

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- We have just scratched the surface, to learn more:
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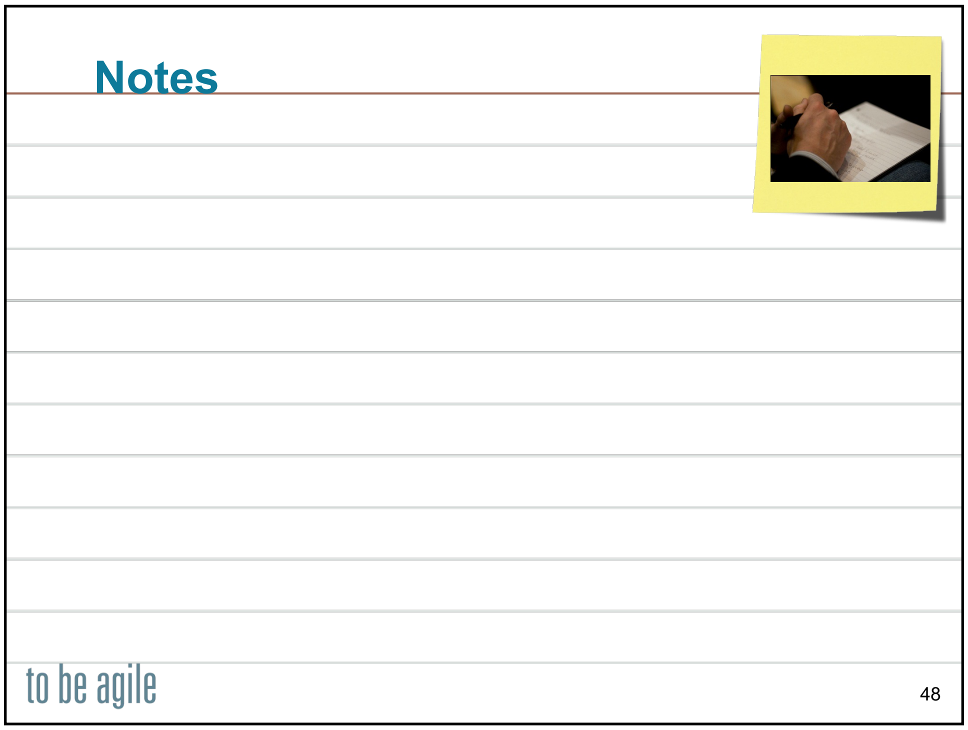

Notes

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