Week 6

CS2212

Introduction to Software Engineering

Component-Level Design

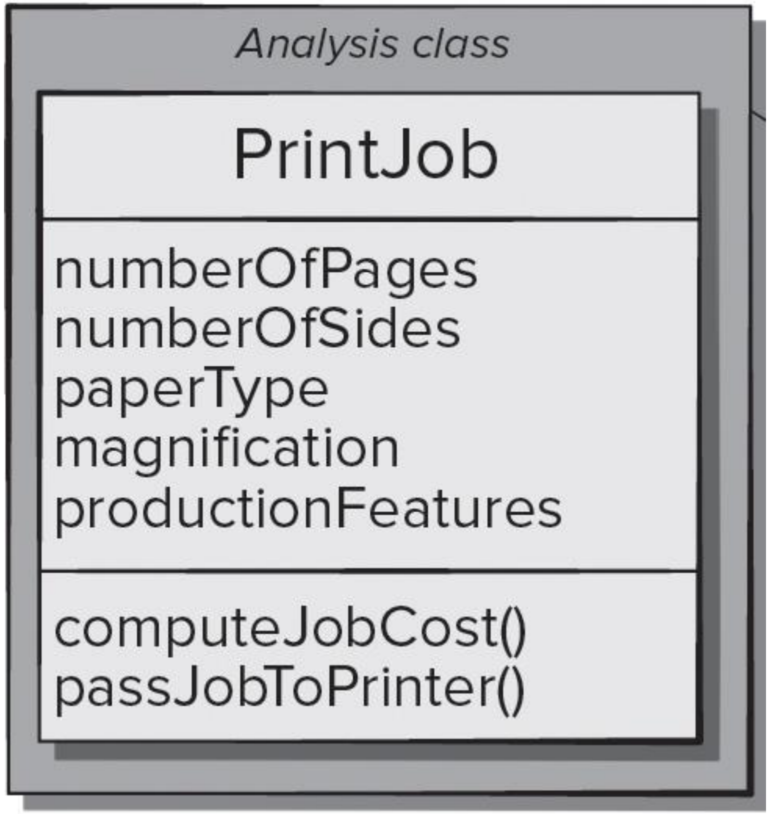
Quick Review: What is a Component?

Software Component:

- *"A **modular**, **deployable**, and **replaceable** part of the system that **encapsulates implementation** and exposes a set of **interfaces**."*
- Parts of a system that **break the complexity into manageable parts**.
- **Hides (encapsulates) implementation details** behind an **interface**.
- Components can be **swapped in and out** so long as they share a common **interface**.

Component Elaboration

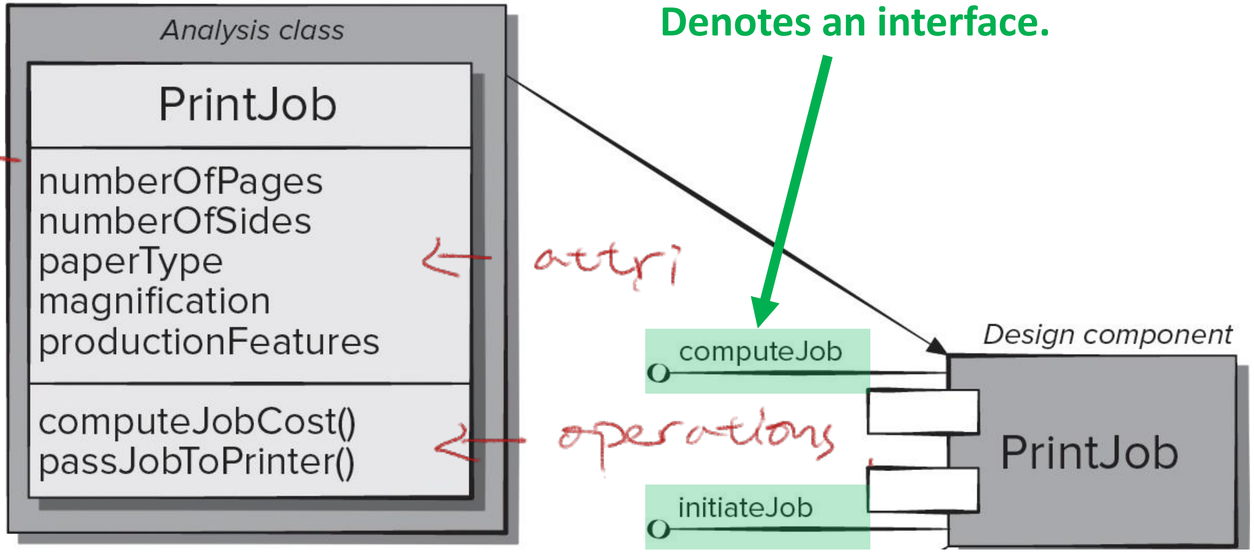
- Begin with the classes from the **analysis model**, divided into components and define **interfaces**.
- **Analysis classes** become design **components**.
- **Interfaces** identified based on **operations** in **analysis classes**.



Component Elaboration

- Must now refine and elaborate on each **analysis class** to create our **design classes**.
- Detail is added for each **attribute**, **operation**, and **interface**.
- **Data structures** for each attribute are specified.
- **Algorithmic detail** for each operation is designed.
- The **mechanisms** required to implement the interface are designed

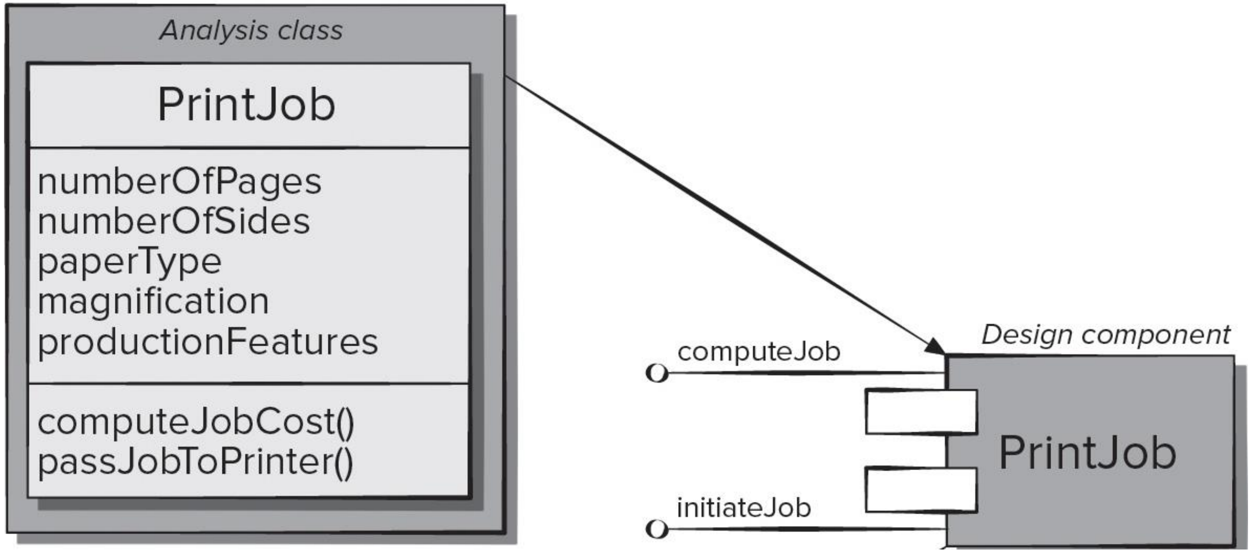
UML "lollipop" notation. Denotes an interface.



interface - mechanism
attribute - data struct
operation - algorithmic detail.

Component Elaboration

- **Infrastructure classes** to support the **design classes** may need to be created.
- Once complete, **all detail necessary for implementation** has been generated and is available to developers.



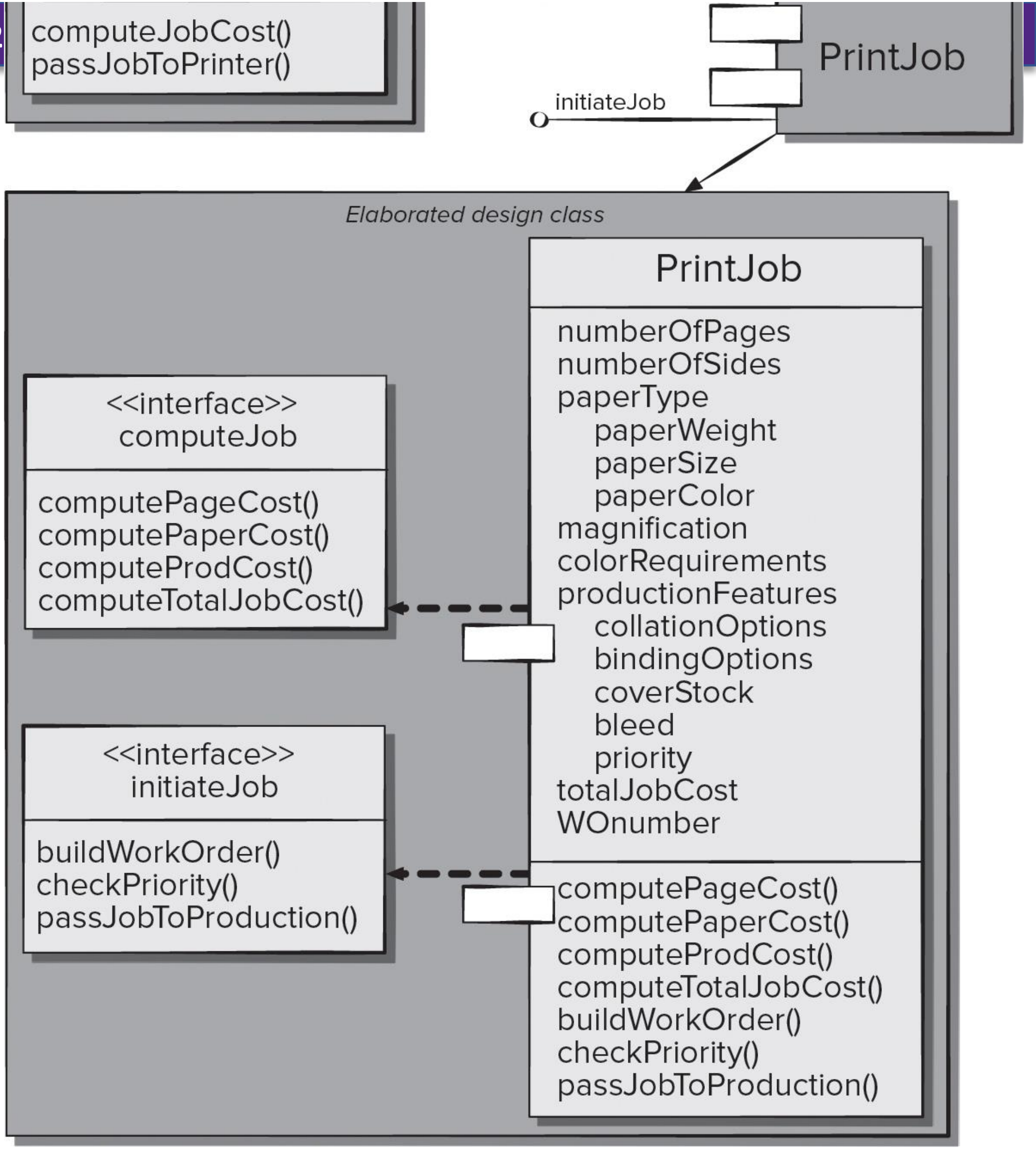
Component Elaboration

PrintJob now a Design Class

- **Interfaces** defined.
- Extra attributes that will be required added.
- Extra operations that will be required added.

Still need to do more:

- Define types and data structures.
- Define operations' algorithms using pseudocode and **stepwise refinement**.
- Consider grouping related attributes and operations into their own class.
- Elaborate on all other components in the software.



Basic Design Principles

- Open-Closed Principle (OCP)
- Liskov Substitution Principle (LSP)
- Dependency Inversion Principle (DIP)
- Interface Segregation Principle (ISP)
- Release Reuse Equivalency Principle (REP)
- Common Closure Principle (CCP)
- Common Reuse Principle (CRP)

Basic Design Principles

- **Open-Closed Principle (OCP)**

Open-Closed Principle (OCP)

*"A module [component] should be **open for extension** but **closed for modification**."*

- Specify the component in a way that allows it to be extended without the need to make internal (code/logic) modifications to the component.

REP)

- Common Closure Principle (CCP)
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Basic Design Principles

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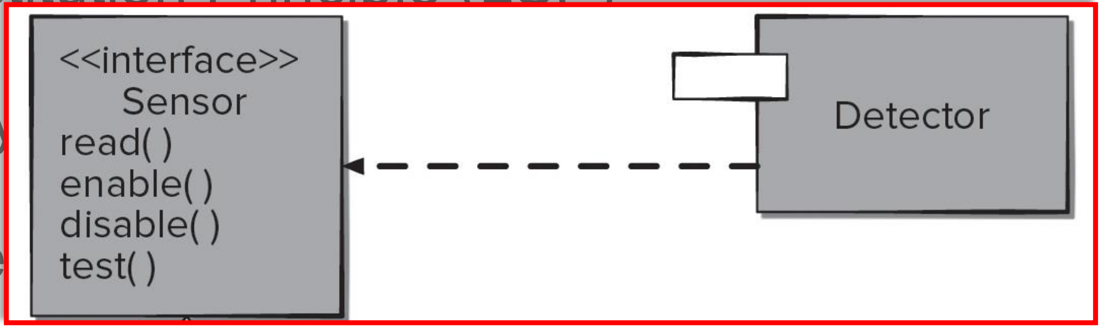
- Dependency
- Interface Se



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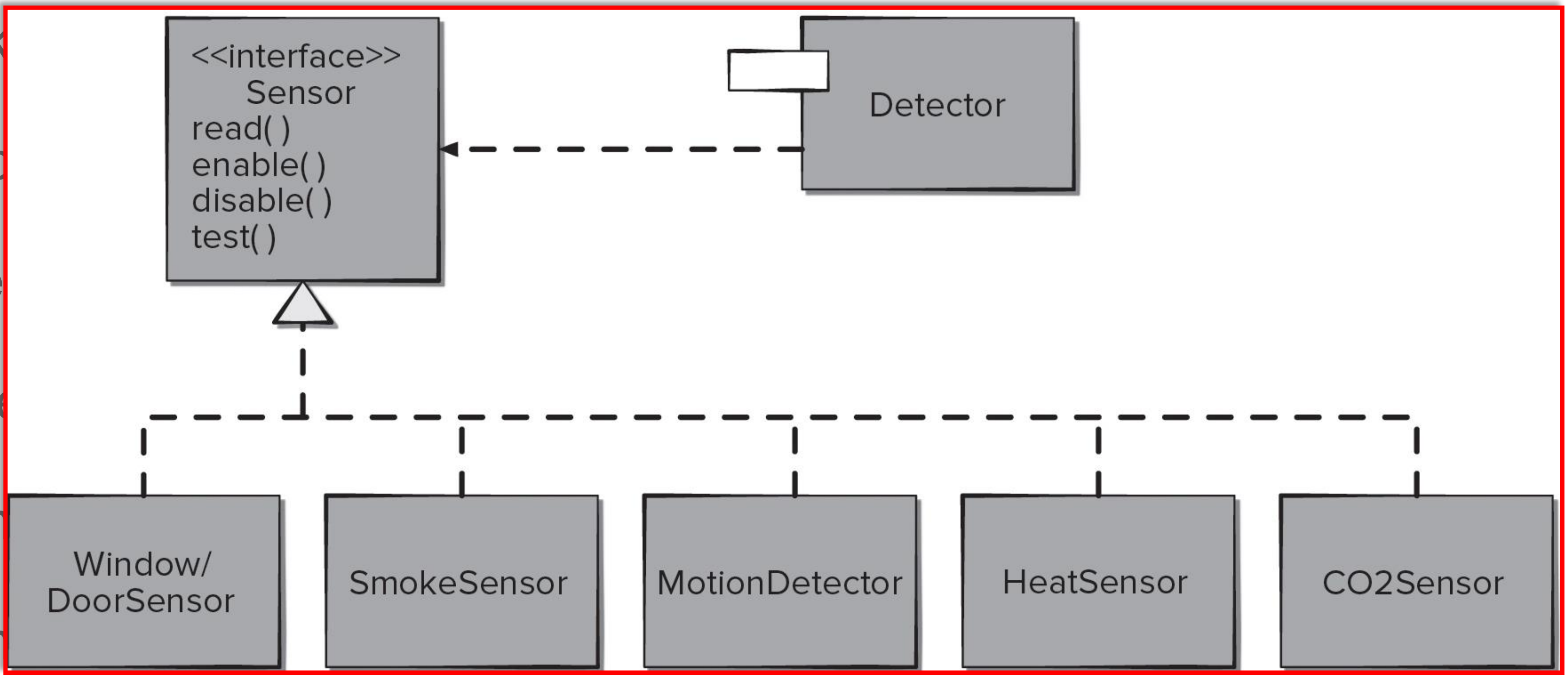

Basic Design Principles

- Open-Closed Principle (OCP)
- **Liskov Substitution Principle (LSP)**
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Liskov Substitution Principle (LSP)

"Subclasses should be substitutable for their base classes."

- A component that uses a base class should continue to function properly if a class derived from the base class is passed to the component instead.

- Common Reuse Principle (CRP)

Basic Design Principles

- Open-Closed Principle (OCP)
- Liskov Substitution Principle (LSP)
- **Dependency Inversion Principle (DIP)**

Dependency Inversion Principle (DIP)

"Depend on abstractions. Do not depend on concretions."

- **Abstractions** are the place where a design can be **extended without great complication**.
- The more components depend concrete components (rather than abstractions such as an interface), the more difficult it will be to extend.

interface makes extension easier

Interface Segregation Principle (ISP)

"Many client-specific interfaces are better than one general purpose interface."

- Only those operations that are relevant to an individual client category should be specified in the interface for that client.
- That is to say, **no code should be forced to depend on operations it does not use**.

- **Interface Segregation Principle (ISP)**
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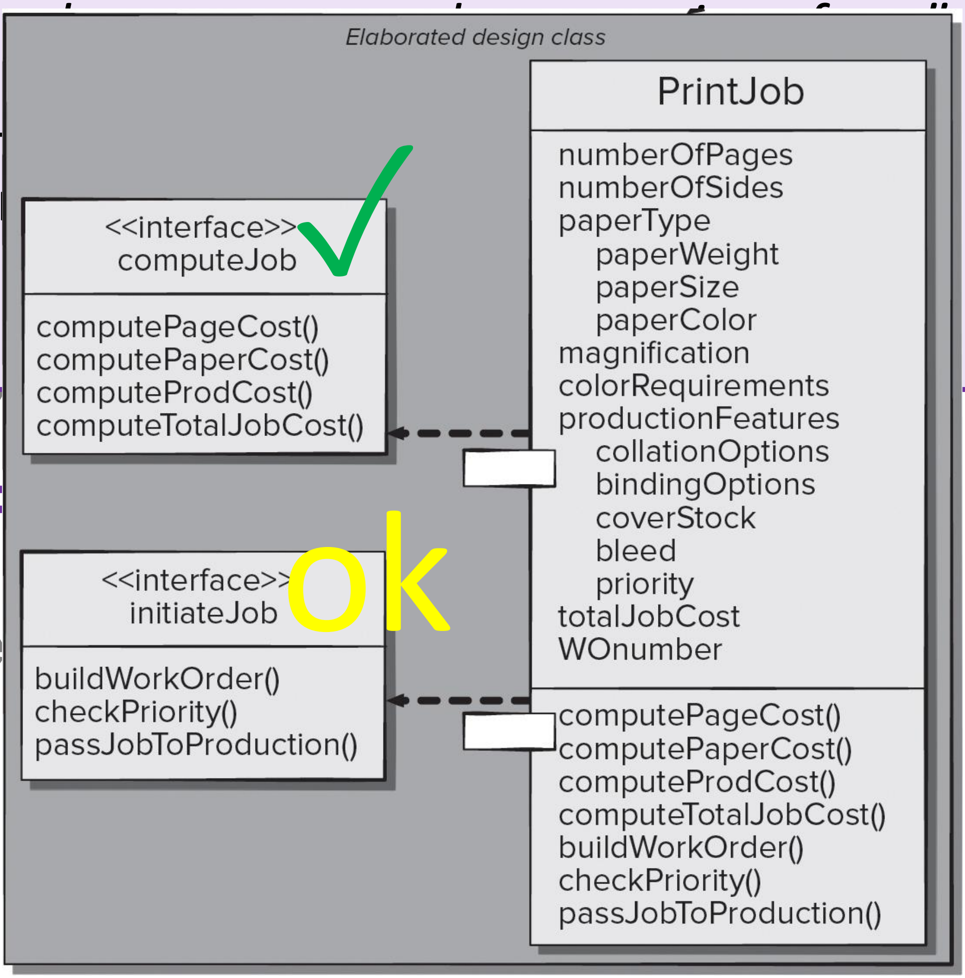

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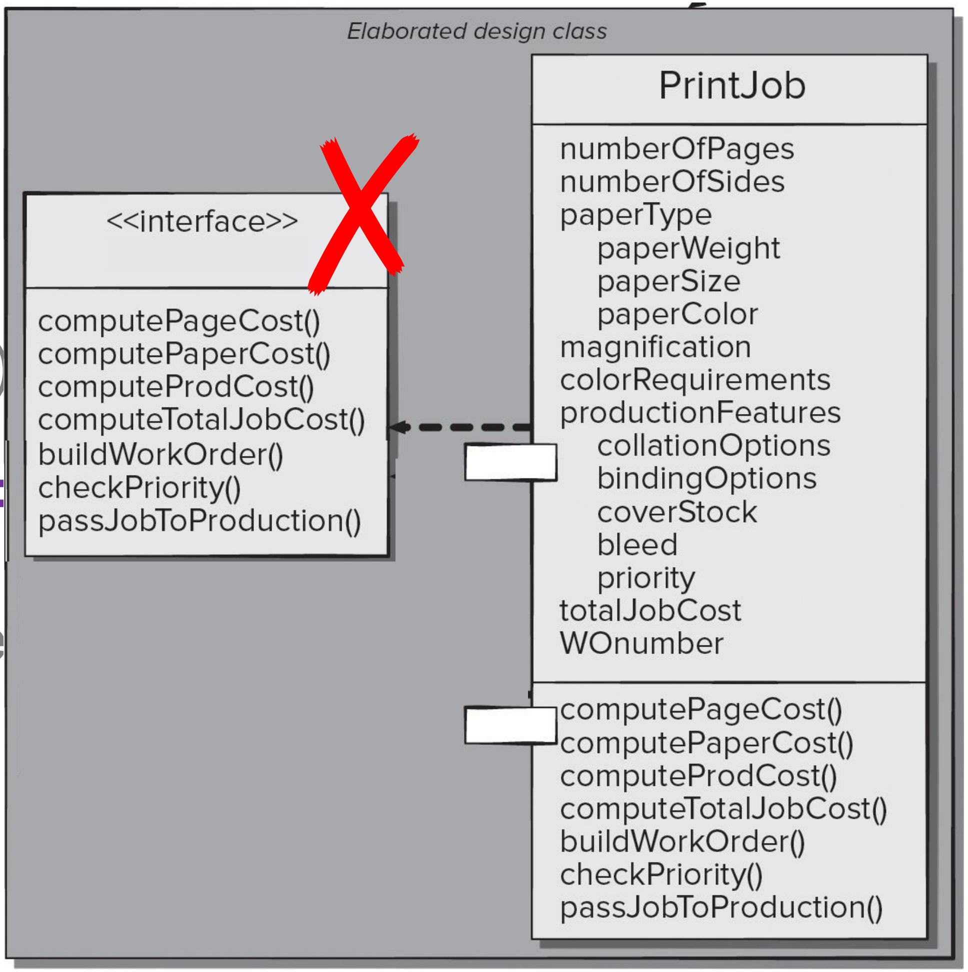

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Component Placing and Packaging Principles

Basic Design Principles

Release Reuse Equivalency Principle (REP)

“The granule of reuse is the granule of release.”

- Effective reuse requires tracking of releases from a change control system. The package is the effective unit of reuse and release.
- When designing for reuse, don’t address classes individually, group them into packages that can be more easily managed.

- Interface Segregation Principle (ISP)
- **Release Reuse Equivalency Principle (REP)**
- Common Closure Principle (CCP)
- Common Reuse Principle (CRP)

Basic Design Principles

Common Closure Principle (CCP)

"Classes that change together belong together."

- Classes should be packaged **cohesively**.
- Classes in the same package should address the same functional or behavioural area.
- When characteristics of that area change, it is likely that only those classes within the package will require modification.

- Release Reuse Equivalency Principle (REP)
- **Common Closure Principle (CCP)**
- Common Reuse Principle (CRP)

Basic Design Principles

- Open-Closed Principle (OCP)

Common Reuse Principle (CRP)

"Classes that aren't reused together should not be grouped together"

- Only classes that are reused together should be included within the same package.
- Unrelated classes lead to extra integration work and testing.
- Also means new releases of the package even if changes have no impact on some systems.

- Common Closure Principle (CCP)
- **Common Reuse Principle (CRP)**

Cohesion

Traditional View: the ***"single-mindedness"*** of a module.

Object-Oriented View: *cohesion* implies that a **component** encapsulates only attributes and operations that are **closely related to one another** and the component itself.

Types of Cohesion:

1. **Functional:** Module performs **one and only one computation**.
2. **Layer:** Occurs when a **higher layer accesses the services of a lower layer**, but **lower layers do not access higher layers**.
3. **Communicational:** All **operations that access the same data** are defined within one class.

Coupling

Traditional View: Degree to which a component is connected to other components and to the external world.

Object-Oriented View: Qualitative measure of the **degree to which classes are connected** to one another.

Types of Coupling:

1. **Content:** Occurs when one component *"surreptitiously"* **modifies data that is internal to another component**.
2. **Control:** Occurs when control flags are passed to components to **request alternate behaviours** when invoked.
3. **External:** Occurs when a component communicates or **collaborates with infrastructure components**.

Coupling

Control Coupling

```
public int doMath(int a, int b, int flag) {
    switch(flag) {
        case ADDITION: return a + b;
        case MULTIPLICATION: return a * b;
        case SUBTRACTION: return a - b;
        default: return 0;
    }
}
```

Traditional View: Degree t
and to the external world.

Object-Oriented View: Qu
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Types of Coupling:

1. **Content:** Occurs when one component *"surreptitiously"* **modifies data that is internal to another component**.

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3. **External:** Occurs when a component communicates or **collaborates with infrastructure components**.

Component-Level Design

- **Step 1:** Identify all **design classes** that correspond to the **problem domain**.

- **Step 2:** Identify all **design classes** that correspond to the **infrastructure domain.**

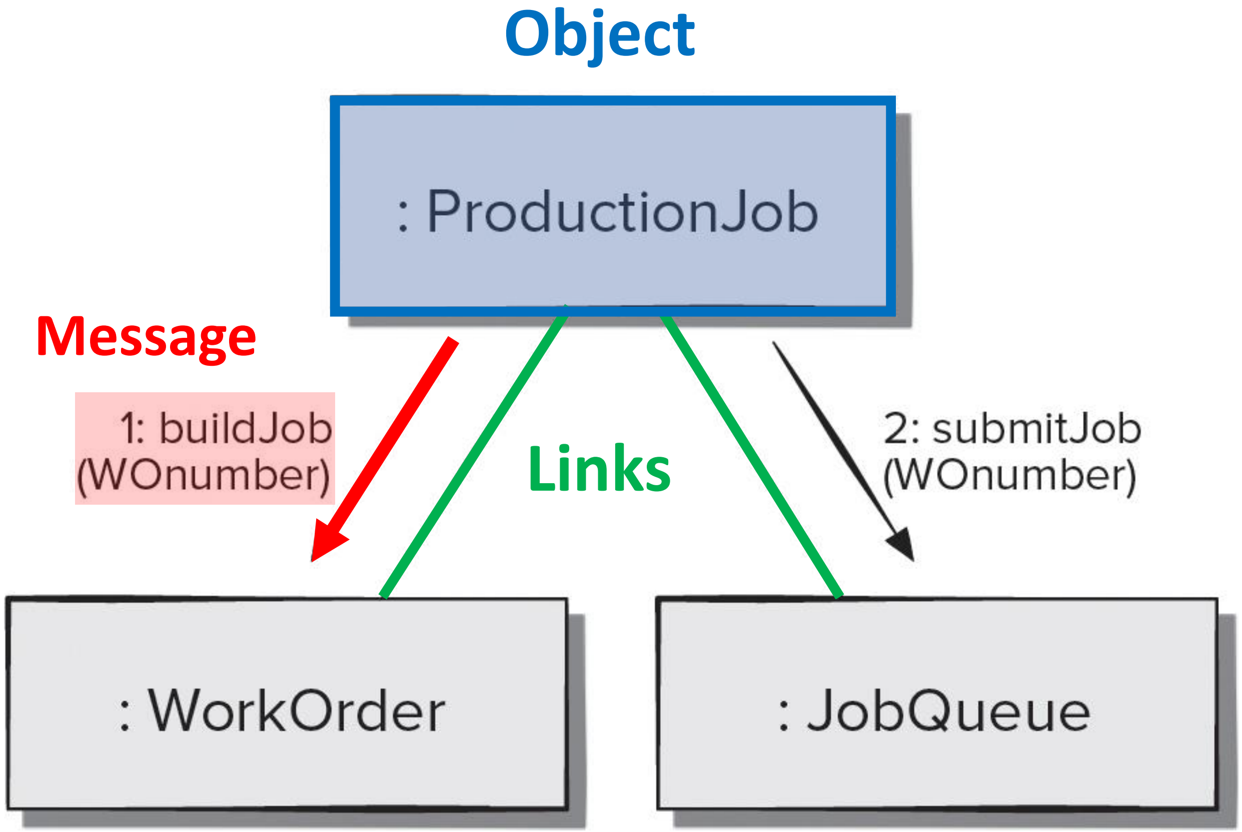
Component-Level Design

- **Step 3: Elaborate** all **design classes** that are not acquired as reusable components.
  - **Step 3a:** Specify **message details** when classes or component collaborate. **Collaboration diagrams** commonly uses.
  - **Step 3b: Identify appropriate interfaces** for each component.
  - **Step 3c: Elaborate attributes**, **define data types,** and **data structures.**
  - **Step 3d: Describe processing flow** within each operation in detail, using **pseudocode**, an **activity diagram**, or a **flowchart**.

Collaboration Diagram

Collaboration diagram from our earlier printing example, with messaging details shown.

- Sequence numbers show the order of messages
- Names of operations are given (buildJob and submitJob)
- Argument list is provided (a WOnumber).



Component-Level Design

- **Step 4: Describe** persistent **data sources** *(databases and files)* and **identify the classes** required to manage them.

- **Step 5:** Develop and **elaborate behavioral representations** for a class or component; **state diagrams** can be useful for this.

- **Step 6: Elaborate deployment diagrams** to provide additional implementation detail.

- **Step 7: Refactor** every component-level design representation and always consider alternatives.