Introduction to Design and Information Hiding

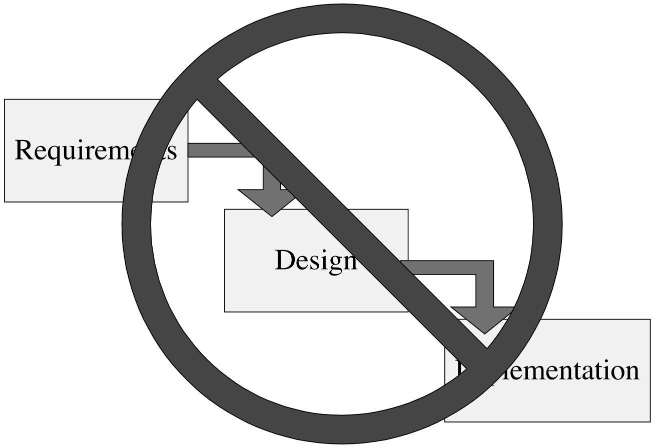
CIS 422, Fall 2007

What is Design?

What is Design? (My answer)

- Reasoned choice
  - Determining alternatives
  - Predicting consequences
  - Balancing tradeoffs

Design is not a phase!



Design Everything

- Design is not a phase
- Everything is design
  - Design the product
    - Its specification, structure, and implementation
  - Design the process
  - Design the organization

Designing Software Structure

- Key Goals
  - Design for change
  - Design to schedule
  - Design for risk control
- Approach
  - Information hiding

Design for Change

Why does software change?

- External environment (e.g., Lira -> Euro)
- User audience - new requirements
- Technical environment
  - XP to Vista; static html to dynamic to ajax; web-enabled office software; ...

Eugene Register Guard, 10 April 1999, Pg. 5B:

Washington Driver's Manual, Test Flawed

> “
> In recent months, the department has used a computerized test that was known to have some answers that conflicted with state law or the state-issued study guide. [...] Some 97,414 tests were administered during the three months, with 36,391 failures reported.
>
> **Some computers used to administer the tests are still marking correct answers as wrong**, said department spokeswoman Suzannne Taylor. **The problem lies in getting updated software for the computers' testing program, she said.** ”

How hard can this be?

- How can it happen that Washington has to wait for updated test software with correct answers?
- How would you design that system? Would your design be vulnerable to this problem?

Information Hiding for Change

- Identify design *secrets*
  - A secret is a potential change that nothing else should depend on
  - A module or subsystem hides a secret
    - Localizes an anticipated change

Hiding and Abstraction

- What is “abstraction”
  - or “an abstraction”
  - or “an abstract interface”?
- Hint:
  - “Abstract” does not mean “vague”
  - “Abstract” does not mean “mathematical”

Abstract

- X is an abstraction if it can be realized (implemented) in multiple, different ways
  - X is "more abstract than" Y if implementations(X) ⊃ implementations(Y)
- An interface can "abstract over" a set of possible implementations
  - the variation is the design secret

Abstract Interface Examples

Interface	*Provides Abstract Service*	*Abstracts over (secret)*
TCP	Reliable communication stream	Routing, transport (ethernet, PPP, ...)
IDE	Addressable block storage	Storage media, device characteristics
SQL	Relational database manipulation	Storage structure, concurrency control
Java Swing	GUI widgets & interaction	Window system, graphics platform (Win32, Cocoa, X, ...)

Hiding is Not Free

- Hiding means pretending not to know
  - Not taking advantage of information that is "hidden" in other modules or subsystems
  - Not using the faster special case (optimizing)
  - Coding for all cases, not just those that can actually occur
- So we hide some things and reveal others

What to Hide?

- Distinguish "likely changes" from "fundamental assumptions"
  - A "fundamental assumption" can be spread throughout system
  - A "likely change" should be isolated (hidden)
- Example
  - SQL databases hide many details
    - index structure, locking or versioning protocol, ...
  - But relational (vs. OODB, etc.) is a "fundamental assumption"

Change Time Scale

- Minutes? Hours? Weeks? Years?
  - Binding mechanism may be different in each case, from table-driven programming to modular organization
- Binding time is a design tradeoff
  - Usually, “more dynamic” is more expensive in complexity and/or performance
    - but not always (e.g., video games, Washington driver test)

Designing Software Structure

- Key Goals
  - Design for change
  - ➢Design to schedule
  - Design for risk control
- Approach
  - Information hiding

Information Hiding and Design to Schedule

- Fixed schedule, flexible feature set
  - Expand or contract as time allows
  - Deliver incremental releases
- Three considerations
  - Independence of optional features
  - Parallel development
  - Staging and replacement

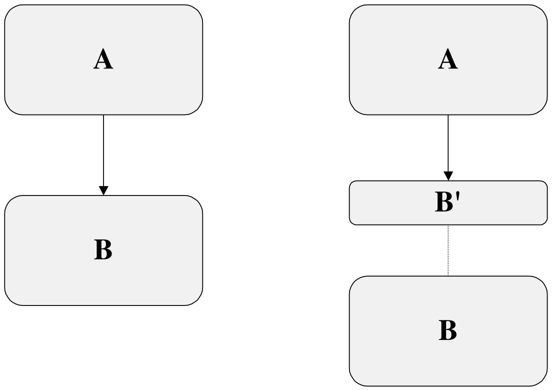
Dependence

- If module A depends on module B
  - B must be developed first
  - A cannot be delivered unless B is delivered
  - Changes to B may require changes to A
- We would like to break (some of) these dependencies

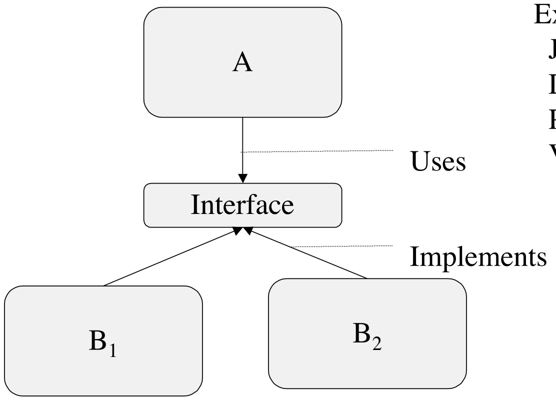
Dependence is Semantic, not (only) syntactic ...

- Dependence may not equal "calls"
- Dependence may not equal "reads from"
- Dependence may not equal "import"

Breaking Dependence



Breaking Dependence with an Interface



Examples:
Java Interface
Device Driver
Protocol
Virtual Machine API

Expand and Contract

- Minimize dependence on optional features
  - Hide presence/absence to the extent possible
- Dependence should be consistent with build order
  - Develop as a series of releases

Design to Control Risk

- Be explicit: What are you worried about?
  - You should have a "risk plan," including technical and non-technical risks
- Risk implies potential change
  - So the design-for-change techniques apply: Information hiding, abstraction

Object-Oriented

- Myth: Object-oriented = information hiding
- Reality:
  - OO is based partly on information hiding principles
  - OO is often good for hiding data structures
  - OO may not help hide other design secrets
    - and can even get in the way, sometimes

Language Support for Information Hiding

- Visibility control
  - Private classes, private methods, packages ...
  - Helpful for information hiding
- "Abstract" interfaces (abstract classes, interfaces, ...)
  - Usually: Encapsulate data structure
  - Possibly allow multiple implementations
    - but only if well designed

Where Language Support Fails

- Hiding memory management policy
  - especially problematic in C++; less in Java
- Hiding concurrency policy
  - although Java has made some progress here
- Factoring information from control
  - what Washington driver test needed
- Large-scale structure
  - Packages are (just) a start

Approaching Design

- Start with explicit consideration of risks, schedule, and likely changes
- Then consider gross organization, with explicit design secrets
- Then (and only then) choose an appropriate design approach
  - OO design, data flow, layered, ...
  - Probably more than one, at different levels

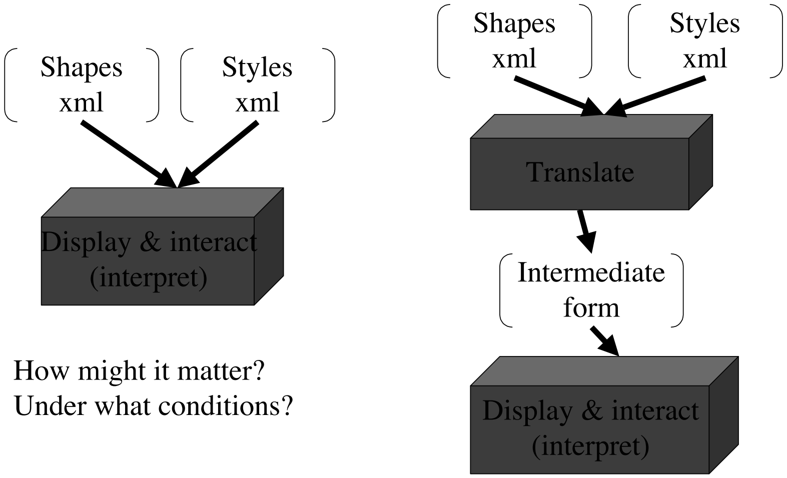
Applied to 07F project ...

- Overall project:
  - Risk identification: Java graphics might be unsuitable for map display/interaction
    - Tracking mouse hits too slow or complex?
    - Jumping mouse unworkable?
  - Separation of concerns / info hiding:
    - Relative independence (?) of GIS style mapping from display & interaction
    - But display & interaction is a big chunk - all interaction will need reimplementing in Java

Applied to 7f Project (cont)

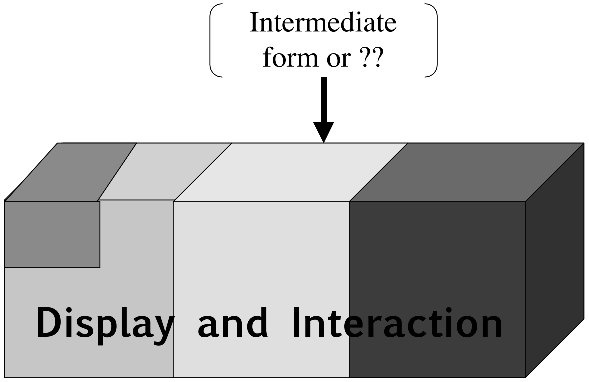
- Design decision: Interpretation/translation approach
  - Directly interpret XML + styles ?
  - Translate XML + Styles to Java code?
  - Translate to data and interpret that?
- A “binding time” issue
  - Very common design dimension, often trading performance and flexibility
  - Different tradeoffs from drivers’ test problem

Product Design & Process



How might it matter?
Under what conditions?

What Else Can You Factor?
(and why?)



Objectives: Parallel work, independent choice, precise interface definition