Design ➔ Implementation

Object-Oriented Analysis and Design

CSCI 6448 - Fall 1998

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Goals of the Lecture

- Discuss a variety of implementation issues
  - Iterative Implementation Techniques
  - Translating Associations
  - Scalability Considerations
  - Managing Rapid Prototypes and Beta software

Goal: Begin Implementation

- Situation
  - Constructed
    - Use cases, class diagrams, activity diagrams, state diagrams, etc.
    - Baseline architecture
    - Implementation Plans
- Problem
  - Where to start?

From UML Distilled

- Plan Iterations around Use Cases
  - Each iteration is a mini-project
    - Perform analysis, design, coding, testing, and integration
    - End with user demo and system testing
  - Repeat
- Each iteration is incremental, building on previously constructed functionality

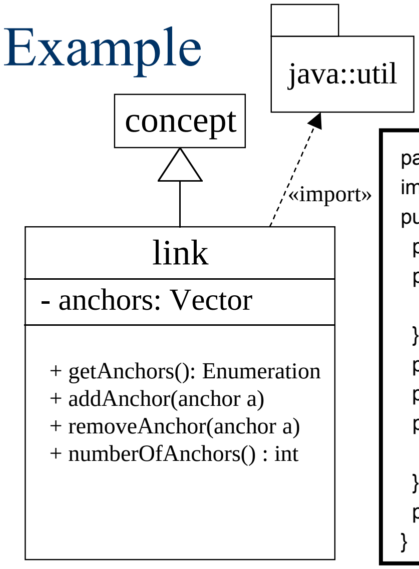
Why more analysis and design?

- Why would A&D occur in each iteration?
  - Moving down levels of abstraction
    - The design should be complete at a logical level, what's left are more practical issues
    - For instance, the details of a user-interface class will eventually need to be specified
      - screen layouts, interaction paradigms, etc.
  - Interactions between use cases may reveal "holes" in the logical design

First Steps

- Identify the collaborations that realize your system's use cases
  - Specify the structural and behavioral aspects of each collaboration
- Create stubs for each class identified in a collaboration
  - Each class is defined in full but with empty bodies for operations

Example



```
package chimera.concepts;
import java.util.*;
public class link extends concept {
  public link() {}
  public Enumeration getAnchors() {
     return null;
  }
  public void addAnchor(anchor a) {}
  public void removeAnchor(anchor a) {}
  public int numberOfAnchors() {
     return 0;
  }
  private Vector anchors;
}
```

Next

- Construct a "start system" class
  - All it does is create the objects needed for your system, start up any required threads, and place the system in its start state
- Compile, link, and execute
  - Nothing should happen, but you'll be surprised at how many problems crop up the first time you do this!

Finally…

- Pick an operation in one of the classes
  - Implement it
  - Compile, link, execute...
- Repeat until Use Case is done
- Repeat until all Use Cases are done
- Pause for redesign and risk management as needed

Don’t forget

- Comments
  - take advantage of tools like JavaDoc
- Testing
  - Kent Beck’s rule of thumb
    - A developer should write at least as much test code as production code
  - Archive the tests and use them for regression testing

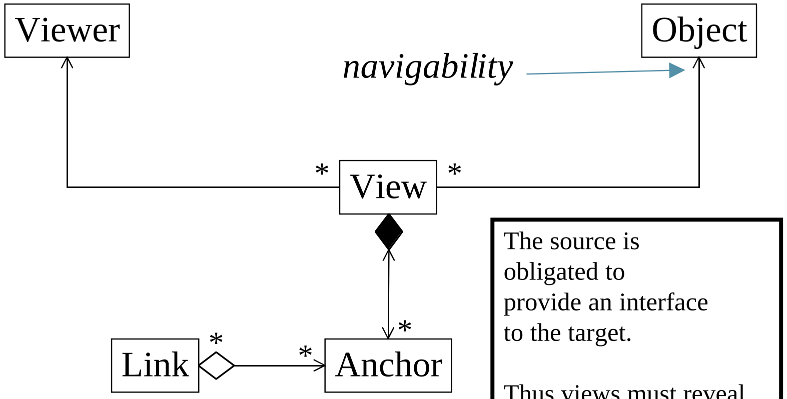
Don’t forget, continued

- Metrics and Planning
  - Record how long it took you to do a task
  - Update the master plan with the team’s accomplishments
  - See <http://psp.colorado.edu/Visitors.html> for links to information on the importance of metrics at an individual level

Mapping Class Diagrams and Associations

- An association implies something about the interface of its classes when implemented
  - In particular, an interface is required that allows the association to be navigated
  - A designer can indicate the navigation responsibilities of a class with arrowheads on associations in UML diagrams

Example



The source is obligated to provide an interface to the target.

Thus views must reveal their viewers, but viewers do not have to reveal their views.

Abbreviated Code Example

```
public class view extends concept {
    public view() {}
    public viewer getViewer() {
        return myViewer;
    }
    …
    private viewer myViewer;
}
```

Discussion

- A multiplicity of one
  - private attribute
- A multiplicity of more than one
  - vector, array, binary tree, etc.
  - As dictated by the system's functional reqs.
- Association Classes point to their members; not the other way around
  - This implies the need of a collection class that points to instances of association classes

Scalability Considerations

- A straightforward OO design process will not necessarily lead to a scalable system
- Most likely lead to primitive operations
  - Scalability requires compound operations
    - especially in the presence of client-server systems

Let me tell you a story...

- Feature request for Chimera:
  - Define an import format that allows anchors and links to be defined outside of Chimera and then imported *en masse*
- Implemented Feature
  - Defined an XML Document Type Definition that allowed Chimera hyperwebs to be imported and exported

Story, continued...

- Tested Feature
  - Created 100KB XML file defining a hyperweb of 1000s of anchors and links
- Released Feature
  - Primary user created six 26MB XML files defining 60,000 anchors and links (roughly half-a-million anchors and links) in total!
- Back to the drawing board!

Should have known...

- Not necessarily true
  - Relationship with user for 3+ years
  - Chimera suited hypermedia needs of their initial evaluation efforts with no problems
- Feature request was motivated by a desire to automate the creation of links for a single (!!) subsystem
  - Scalability reqs. were revealed only then!

Story continued...

- Chimera Server displays the names of all the links of a hyperweb

```
Vector linkIds = hyperweb.getLinks();
for I = 1 to linkIds.size() {
    link L = linkIds.elementAt(I);
    String name = L.getAttribute(“name”);
    -- Add name to scrolling list
}
```

- For 33,000 links, 1/3 complete in 8 hours!

Problem

- OO Design led to creation of
  - concept - manages attributes
  - link - manages anchors
  - hyperweb - collects links
- Natural Algorithm uses primitives
  - What’s needed however is an operation that gets all the links and names at once
  - This implies new operations and classes!

Results

- The new compound operation displayed 33,000 link names in under 5 minutes; 288 times faster!
- Implications on design
  - Identify the need for compound operations via use-cases
  - Add these operations and their associated support classes early!

Managing Prototypes

- During design, a rapid prototype might be needed
  - Purpose
    - Answer specific questions about the design
    - The fewer the better! This reduced focus allows the prototype to concentrate on one aspect only and makes it easier for you to discard it!
    - An end-user should use the prototype
      - Make sure they understand the prototype’s purpose!

Prototypes, continued

- Manager should
  - Assign at most two, preferably one, developer should construct the prototype
    - Design should continue in other areas during this phase
  - Impose a deadline on prototype construction
    - a week or two, no more!
  - Schedule the demonstration with the end-user
  - RAD Tools should be used
    - the tight deadline should encourage their use!

Prototypes, continued

- User's feedback must be recorded
  - "Think-Aloud" while using the prototype
  - Interviews and surveys
  - For user-interfaces, draw alternatives with user still present
- Analyze data / record design decisions
  - Decide if prototype needs to be iterated
- Archive everything for later use!

Beta software, introduction

- Types of software
  - Developmental
    - Internal builds, development team only
  - Alpha
    - Internal builds, select external users allowed
  - Beta
    - External builds, large group of external users
  - Final Candidate, Golden Master, Release
- Beta ≠ Preview Releases
  - Often an excuse to ship buggy software

Purpose of Betas

- Most often all functionality is created during developmental and alpha builds of a system
- Beta software is used to test the software on the widest range of hardware/software configurations
  - functionality is often frozen
  - focus on finding and fixing bugs
    - e.g. system works flawlessly on PowerMac G3, but crashes on PowerMac 6100 with G3 upgrade card

Managing Betas

- Identify a time period for the beta
  - Can be open-ended
  - However better to set a time-limit or a number-of-open bugs threshold
    - e.g. beta is over when all category 1 and 2 bugs are fixed and there are less than 10 category 3 bugs
    - these criteria are **very** context dependent!

Managing Betas, continued

- Private FTP site to distribute betas to external users
- Mailing list or discussion forum for feedback
  - Development team and SQA must participate!
- Bug Database records **all** feedback
  - SQA classifies bugs, managers assign bugs based on priority, developers fix
  - Beta cycles should be short: 1-2 week granularity

Discussion

- A beta-cycle should not greatly impact design
  - Freezing functionality helps to ensure this
- Instead Focus on
  - stability, race-conditions, obscure configurations
- Record for the future
  - Unanticipated ways that users use the software
  - Requests for new functionality
- Note: Sequels are not necessarily good!
  - Word 3000, now records barometric pressure!

Fredrick Brooks, 1975

- ...conceptual integrity is *the* most important consideration in system design. It is better to have a system omit certain anomalous features [and] to reflect one set of design ideas, than to have one that contains many good but independent and uncoordinated ideas

Fredrick Brooks, 20 years later

- A clean, elegant programming product must present… a coherent mental model… [Conceptual] integrity… is the most important factor in ease of use… **Today I am more convinced than ever**. Conceptual integrity *is* central to product quality.