Prototyping

15-413: Introduction to Software Engineering

Jonathan Aldrich

What is a Prototype?

Student answers

- Early rendition of your project
  - Not completely functional
  - Some level of functionality
  - Proof of concept
  - UI – includes mock-ups
- Why?
  - Decide whether to build the real system
    - Lessens risk
  - Get better client specifications

What is a Prototype?

- Initial, partial version of a software system used to learn about the problem, explore designs and solution techniques

Benefits of Prototyping

- Help to elicit and validate requirements
- Explore a UI design
- Explore potential designs and solutions
- Oracle for later testing

Prototyping Guidelines

- Address high risk issues
  - Requirements uncertain
  - User interface unknown
  - Implementation strategy unknown
  - Platform unknown
- Focus only on the issue
  - Build a system that addresses the problem and ignores all other concerns
  - Ok to suspend normal development standards and QA

UI Design

- UIs are hard to design/specify
  - Interactive nature
  - Graphical layout
  - Difficult for users to think abstractly
- Mock-ups
  - Provide direct experience with interface
    - Examples make it easier to identify good, bad characteristics
  - Observe look and feel
  - Work through usage scenarios
  - See if all information, options are accounted for

Paper UI Prototyping

- Good first step for a UI design
- Storyboard
  - Draw versions of system screens
  - Good for group presentation
- Walk through scenario
  - Draw information displayed, options available
  - Good for detailed individual feedback

Live UI Prototyping

- Wizard of Oz
  - Interact with UI program
  - Inputs given to behind-the-scenes programmer who generates responses
- Scripts
  - Create screens
  - Associate script with buttons
  - Script produces next screen
    - Logic may be hard-coded

System Design

- Demonstrate feasibility of system
- Learn about necessary technologies
- Explore design technique
  - Ideally, see limitations of design and do it a different way "for real"

Throw it away

- "Plan to throw one away…you will anyway" – Fred Brooks
- No investment in quality
  - No documentation, testing
    - Example: no unit tests in XP "spike solution"
  - Design may be poor
    - Unmaintainable, poor performance & reliability, insecure…

Risks of Prototyping

Student answers

- Manager doesn't understand – requires you to keep working on it
- Team that comes afterwards may not learn what you learned

Risks of Prototyping

- Client may believe the system is real
  - Unrealistic expectations of progress
  - Delivering or building on the prototype is almost always a mistake
- Implementors make poor choices
  - Justified in prototype, but not in real system
  - Tempting to build the real system the same way
- Prototype is not identical to final system
  - Users may interact differently due to different response characteristics
  - Must interpret prototype experience with care

Prototyping Assignment

- Prototype plan
  - Goals of prototyping (pick one or two)
    - Requirements elicitation/refinement
    - UI mockup
    - Explore a design
    - Prove feasibility
    - Learn a technology
  - What you will build
  - How you will evaluate it
- Prototype results
  - What you did
  - What you learned
    - Updates to requirements and risks
    - Changes to schedule or design
    - Other lessons learned
- Presentation of all of the above in class

Understanding Software Problems

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Problems and quotations taken from *Problem Frames* by Michael Jackson

Problem Vs. Solution

- Requirements: what is the problem?
  - What will the system do
    - Addresses key risk: building the wrong system
  - Important to focus on independently of solution
    - Avoid prejudicing the design
- Design: what is the solution?
  - How the system will do it

Patient Monitoring

A patient monitoring program is required for the ICU (intensive care unit) in a hospital. Each patient is monitored by an analog device which measures factors such as pulse, temperature, blood pressure, and skin resistance. The program reads these factors on a periodic basis (specified for each patient) and stores the factors in a database. For each patient, safe ranges for each factor are also specified by medical staff. If a factor falls outside a patient's safe range, or if an analog device fails, the nurses' station is notified.

- Developing a Solution
  - What SQL statements should be used to write to the database?
  - How should the monitoring be scheduled so that each patient is monitored as often as required?
  - What object classes should there be in the system?
  - Should the list of patients be held in a Java vector?

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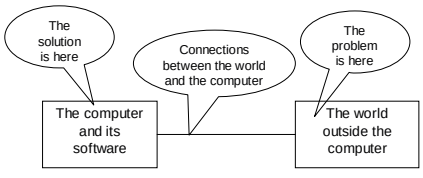
- Focusing on the Problem
  - Are all intensive care patients to be monitored, or only some of them?
  - Are different vital factors to be monitored for different patients, or the same factors for all of them?
  - Do the medical staff specify the periods as well as the ranges, or does someone else specify the periods?
  - In what ways to the analog devices fail? How can these failures be detected and diagnosed?
  - Do a patient's monitoring needs ever change while the patient is being monitored?

The Machine and the World



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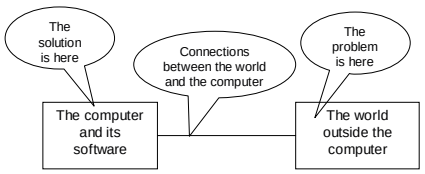


Could the context (the world) be a computer also?

Is the problem at the interface?

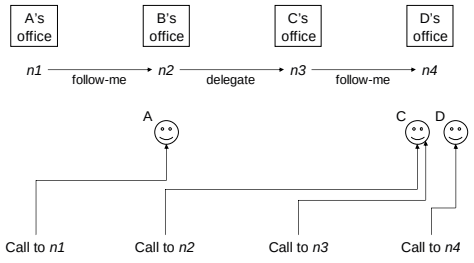
Call Forwarding

- *Call forwarding* is a common feature in telephone systems. It allows a subscriber at one number to arrange to have incoming calls forwarded to another number: the subscriber at *n1* can set up either no call forwarding at all, or forwarding to any specified numer *n2*. The problem is to develop and desribe the detailed requirements for the feature.
- Question: Should call forwarding be transitive?
  - For example, if *n1* forwards to *n2*, which forwards to *n3*, should *n1* then forward to *n3*?

Call Forwarding

- Question: Should call forwarding be transitive?
- Follow me forwarding
  - The forwarder will be in an unusual place and wants to be followed by incoming calls
  - Forwarding to a telephone
- Delegate forwarding
  - The forwarder expects to be unavailable and wants someone else to answer
  - Forwarding to a person
- How should the rules differ in these situations?

Call Forwarding



The problem is not at the interface

- Supporting both kinds of delegation require additions to the interface
- However, understanding the problem is done entirely in terms of the world
  - People
  - Phone numbers
  - Moving offices
  - Delegating responsibility
- These *do not* appear in the interface
- Moral: You have to understand the world to get the software requirements right