

Software Engineering

CS305, Autumn 2020

Week 9

Class Progress...

- Two weeks ago
 - Design patterns, Design principles, Rational Unified Process (RUP)
- Last class
 - Overview of RUP

Class Progress...

- This week:
 - RUP phases, Software Construction, Testing
- Some Topics for Next Assignment (due two weeks from now):
 - Facebook API
 - Ajax, HTML5
 - Google Web Toolkit
 - Google Docs API
 - Webservices: REST API
 - Junit
 - Maven
 - Selenium
 - Android SDK
 - Dart

RUP Contd..

Inception Phase

- **What:** from idea to vision of the end product
 - Identify scope
 - Worth doing? What are the success criteria? Risks? Resources needed?
- **Output:**
 1. Vision document
 2. Simplified initial use-case (who are the actors?)
 3. Draft architecture (what could be the architecture?)
 4. Project Plan and Risks document (How much will it cost? What is the plan?)
 5. Prototype (*optional*)

Inception Phase – Milestone #1

- **When should we stop and consequences:**
 - Stakeholder agrees on scope, cost/schedule estimates
 - Fidelity of the use cases
 - Credibility of cost/schedule estimates, priorities, risks, development process
 - Depth and breadth of prototype if produced

Project may be cancelled or considerably re-thought if it fails to pass this milestone

Elaboration Phase

- **What:** four main activities
 - Analyze problem domain (for better understanding)
 - Establish architectural foundation
 - Eliminate highest risk elements (identify most critical use cases)
 - Refine project plan and estimates
- **Output:**
 - Almost complete use-case model (all actors and use cases identified and most use cases described)
 - Supplementary requirements (functional and non-functional)
 - All those requirements not directly associated with use cases
 - Software Architecture

Elaboration Phase

- Lower-level design model, test cases, *executable prototype*
- Preliminary user manual
- Revised project plan and risk assessment doc
- **When should we stop and consequences (milestone #2):**
 - Are vision and architecture stable?
 - Are major risks addressed and resolved in the prototype?
 - Thoroughness of the plan:
 - Sufficiently accurate / detailed?
 - Stakeholders agree that the vision can be achieved with the current plan?
 - Actual vs. Planned resource expenditure acceptable?

Project may be cancelled or considerably re-thought if it fails to pass this milestone

Construction Phase

- **What:** transition from intellectual property (IP) development to Product
 - All features developed
 - All features thoroughly tested
- **Output:**
 - All use cases realized, with traceability information – which part of design and code realize a particular use case? Which test cases derived from which use case?
 - Software Product integrated on required platforms
 - Complete system test results
 - User manual

Construction Phase

- Beta release: design, code, test cases etc.
- **When should we stop and consequences (milestone #3):**
 - Product stable enough to be deployed?
 - Are stakeholders ready for the transition into the user community?
 - Are actual vs. planned resource expenditures still acceptable?

Transition to post-Beta release may be postponed if it fails to pass this milestone

Transition Phase

- **What:** mostly about deployment and maintenance
 - Users might report bugs, suggest improvements
 - Training customer service and providing help-line assistance
 - Beginning of a new cycle
- **Output:**
 - Complete project
 - Project in use
 - Lessons learnt
 - What should we do in the next cycle?
 - What went well? What did not go well?
 - Plan for the next release

Transition Phase

- **When should we stop and consequences (milestone #4):**
 - Users satisfied?
 - Are actual vs. planned resource expenditures still acceptable?

consequences?

Software Construction

Software Design  Code
and much more..

Software Construction

- Also known as Coding or Implementation Phase
- Overlaps with Design (previous) and Testing (next) phases
- Is a large part of SDLC activity
 - Not just coding. *Involves substantial judgement and creativity*
 - Involves **Reviews, Programming, Refactoring, and Unit Testing**
- **Output:** source code
 - *Should not happen that the source code is the only accurate description of software*

Reviews / Inspections

- Introduced by Fagan in 1976
- **Scope:** applicable to code, design documents, documentation, bug fixes, test plans
- **Goal:**
 - Fault detection (not correction)
 - Detect bugs and defects
 - Check conformance to standards
 - *Not to educate staff*
- **Output:**
 - Inspection defects list (with priority and severity of defects mentioned), outcome.

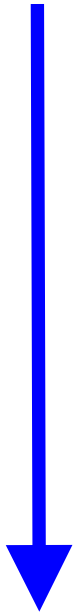
Reviews, Inspections, Walkthroughs

- **Review:** examined by individuals other than the one who produced it
- **Walkthrough:** author describes the artifact and requests for comments from participants
- **Inspections:** more disciplined practice for detecting defects. More like an audit.

Review Methods and Effectiveness

- Review Methods:

- Peer group review
- Informal presentation
- Formal presentation
- Walk through – More formal. But not as formal and comprehensive as an inspection. Well-Structured.
- Inspection – formal audit.



Most effective

Reviews: Roles

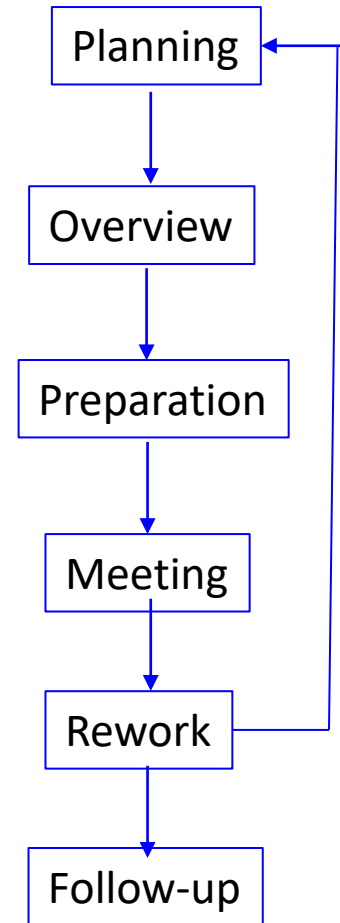
- *Author*: answers questions, clarifies
- *Reader*: reads and paraphrases as needed
- *Recorder*: records defects and issues an *inspection defect list*
- *Inspectors*: analyze and detect defects in the review artifact

Reviews: Roles (contd..)

- *Moderator:*
 - Selects participants
 - Evaluates preparedness of inspection team prior to commencement (aborts inspection if team is not prepared)
 - Verifies that entry criteria is met (actual completion of work to be inspected)
 - Keeps meetings on track and arbitrates differences
 - Is responsible for completion of follow-up

Inspection Process

1. **Planning** – prepare materials
2. **Overview** – Moderator selects and educates participants. ~Time < 5 days.
3. **Preparation** – participants study the material.
~Time = 2 hours
4. **Meeting** - Moderator evaluates preparedness, Reader performs a line-by-line walkthrough of the document, Recorder gives written report to moderator within one day of meeting, *Moderator reviews defect list, determines severity and priority, and decides outcome.* ~Time = max(2 hours or 100LOC per hour)
5. **Rework** – Author confirms and removes defects, team checks if all issues are resolved.
6. **Follow-up** – moderator verifies and validates rework, publishes results, updates process



Reviews: possible outcomes

- *Accept*
 - Some bugs, left to the author's discretion
- *Conditional accept*
 - A few major bugs, to be fixed by the author and verified by the moderator
- *Re-inspect*
 - Many major bugs, to be fixed by the author; the artifact must be re-inspected
- *Reject product outright*

Conducting the Review - Guidelines

- Raise issues don't resolve them
- Review the product and not the producer
- Keep your tone mild by asking questions instead of making accusations
- Stick to the review agenda

Guidelines (I)

- Inspections should not be used for personnel evaluations
- Managers should not attend unless they have participated technically in the production of the document being inspected
- Hold a separate overview meeting to educate staff
- Spread out inspections over time

Guidelines (II)

- Do not allow additional participants (observers)
- Avoid use of “you” and discussion that might raise defensiveness
- Author should not be moderator, recorder, or reader
- Each type of inspection should have its own checklist

Guidelines (III)

- Avoid problem solving during the inspection meeting
- Cost of inspection should be between 10-20% of development effort
- Avoid discussions of style (unless it is in the checklist)

Coding

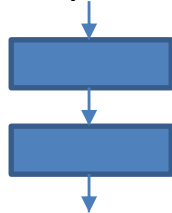
Coding

- Could involve:
 - Writing source code / programming in a chosen language
 - Automatic generation of source code using a design representation of the component to be constructed
 - Automatic generation of executable code using a *fourth-generation* language – program generating language

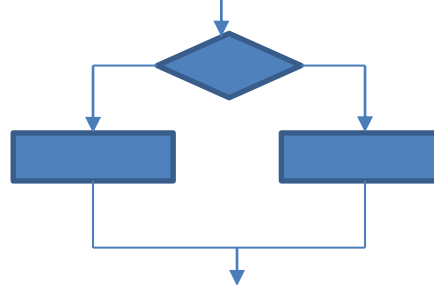
Programming Paradigms

- **Unstructured Programming**
 - Writing a sequence of commands or statements that access ‘Global’ data.
E.g. Assembly lang. programming.
- **Structured Programming** (sometimes used interchangeably with procedural programming)
 - Dijkstra’s advice on using simple logical constructs of:

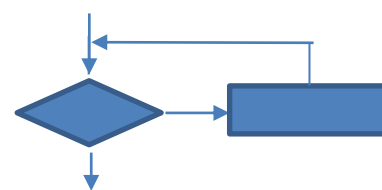
sequence



condition



repetition



- Focus on writing ‘modular’ programs. Have single-entry and single-exit for a procedure / function (control construct). E.g. C, Assembly lang. programming

Programming Paradigms

- Object Oriented Programming
 - Modeling real-world objects. Data is the centerpiece. Combine data and functions, allow code reuse, incremental dev. maintainability, modularity. *(more in Week3 lectures)*. E.g. C++, Java
- Functional Programming
 - Focus on what to do and not how to do. Don't create state that is changeable. E.g. Lisp, Racket
- Concurrent Programming
 - Focus on concurrent execution of a sequence of statements.
 - Parallel programming is a type.
 - E.g. Threads programming (Java threads), Open MP, MPI, CUDA-C.

Human understanding is facilitated by linear sequence of logical statements

Coding Principles

- Ensure that the problem is well-understood before coding (i.e. design is clear, programming language is clear)
- Follow Dijkstra's advice and create modular code that is highly cohesive and loosely coupled
- Select data structures that meet the design objectives
- Create readable code (have indentation, blank lines, and comments)
- Select meaningful names for variables, functions, and follow coding standards and best practices
 - tmp, temp, data are “symptoms of programmer laziness”.
 - (for GCC) <https://gcc.gnu.org/wiki/CppConventions>
- Get code reviewed by peers

Code Review – class exercise

- Review the following Fortran code

```
1  DOUBLE PRECISION FUNCTION SIN(X, E)
2  C      THIS DECLARATION COMPUTES SIN(X) TO ACCURACY E
3      DOUBLE PRECISION E, TERM, SUM
4      REAL X
5      TERM=X
6      DO 20 I=3,100,2
7      TERM=TERM*X**2/(I*(I-1))
8      IF(TERM.LT.E) GO TO 30
9      SUM=SUM+(-1**(I/2))*TERM
10     20 CONTINUE
11     30 SIN=SUM
12     RETURN
13     END
```

Code Review – class exercise

- Review the following Fortran code

- C is comment to end of line
- The `CONTINUE` statement is often used as a place to hang a statement label, usually it is the end of a `DO` loop. If the `CONTINUE` statement is used as the terminal statement of a `DO` loop, the next statement executed depends on the `DO` loop exit condition.
- `.LT.` is less than
- `**` is exponentiation (has higher priority than `*`)
- `DO label var = expr1, expr2, expr3`
 statements
Label `CONTINUE`

var is the loop variable (often called the *loop index*) which must be integer. *expr1* specifies the initial value of *var*, *expr2* is the terminating bound, and *expr3* is the increment (step).

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```


Code Inspection Checklist (excerpt)

1. Data (DA)

- Is each variable correctly typed?
- Is each variable initialized before use?
- Is the initialization appropriate for the type?
- Can global variables be made local?
- Are buffer overflows checked?
- Is dynamically allocated memory freed?

2. Interface (IF)

- Are appropriate values returned from functions?
- Do function calls have correct parameter types/values?
- Are return values tested?

3. Functionality (FN)

- Do loops terminate?
- Do all loops iterate the correct number of times (no off-by-one errors)?

- Is behavior correct if a loop is never entered?
- Is there dead (unreachable) code?
- Do all switch statements have a default case?
- Do all switch arms have break statements? If not, is the "fall through" correct?

4. Input/Output (IO)

- Are files opened before use?
- Are files closed after use?
- Are error conditions checked?

5. Other (OT)

- Any defect discovered that does not fall into one of the above categories.

Further Reading

- Code Reviews:

<http://web.mit.edu/6.005/www/fa16/classes/04-code-review/>

Misc: “The Mess We’re In” - Joe Armstrong

<https://youtu.be/IKXe3HUG2I4>

Pay special attention to the slide on “7 deadly sins” at around 8:00