Introduction to Software Engineering (2/2)

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(slides from CS550 ’06 taught by prof. D. Bae)
Software Development Process

A SW Development Framework for SW with High Assurance

Requirement analysis → System design → Design analysis → Implementation → Testing → Monitoring

Formal requirement Spec. → Formal system modeling → Model analysis/verification → Model-assisted code generation → Model-based testing → Runtime monitoring and checking
Sources of Errors in S/W Developments

- Logic design & Misunderstanding: 20%
- Documentation & Others: 35%
- Coding: 30%
- Functionality & Misunderstanding: 15%
Ex. Requirement on Retail Chain Management Software

- Find ambiguous points in the following requirement
  - If the sales for the current month are below the target sales, then a report is to be printed,
    - unless the difference between target sales and actual sales is less than half of the difference between target sales and actual sales in the previous month
    - or if the difference between target sales and actual sales for the current month is under 5 percent.
Scope of S/W Engineering

- Historical Aspects
- Economic Aspects
- Maintenance Aspects
- Specification & Design Aspects
- Team Programming Aspects
Historical Aspects

- 1967, A NATO group coined the term "Software Engineering"
- 1968, NATO conference concluded that software engineering should use the philosophies and paradigms of established engineering disciplines, to solve the problem of software crisis
Economic Aspects

- Relationship between computer science and software engineering
  - cf: chemistry and chemical engineering

- Software engineer is intended in only those techniques which make sound economic sense, while computer scientists investigate a variety of ways of producing software, some good and some bad
Maintenance Aspects

Maintenance 67%

- Requirements 3%
- Specification 4%
- Planning 2%
- Design 6%
- Module coding 5%
- Module Testing 7%
- Integration 6%
Specification and Design Aspects

Approximate relative cost to detect and correct a fault
Team Programming Aspect

- Parnas, "Multi-person construction of multiversion software."
  - Programming: personal activity
  - S/W engineering: team activity
Team Programming Aspect (Cont.)
(From programming to sw engineering)

- Programming in early days
  - The problem is well understood.
  - Mostly scientific applications.
  - By a person, who is an expert in that area.
  - User = programmer = maintainer

- User and programmer separation
  - User: specify the problem(tasks)
  - Programmer: interpret and translate into code
Team Programming Aspect (Cont.)

- Team project started in late 1960's
  - IBM360 Operating system
  - Software crisis observed
  - "Software Engineering" coined

- Solutions to software crisis
  - Management techniques
  - Team organization
    - Chief programmer team
    - Democratic team
    - Hierarchical team
  - Better languages and tools
  - Standards
  - ==> Applying engineering approach
Team Programming Aspect (Cont.)

- Requirements in the programming-in-the-small
  - Good programming skill
  - Skilled in data structures and algorithms
  - Fluent in programming languages

- Requirements in the programming-in-the-large
  - Needs communication skills and interpersonal skills
  - Be familiar with design approaches
  - Be able to translate vague requirements and desires into precise spec.
  - Be able to build and use a model of the application
  - Needs ability to schedule work
Three Elements of S/W Development
Special Software
Domain: Commercial
Electronics and Embedded System
What’s Different About Embedded Systems

- Embedded systems have different design constraints than general purpose systems
  - Cost may matter more than speed
  - Long life cycle may dominate design decision
  - Reliability/safety may constraint design choice
- Because applications are often unique, software development may wait for hardware to become available
  - Need for simulator/emulators/etc
- Time to market constraints
  - Rapid redesign for changing form factors
  - Rapid redesign for changing control algorithms
Software Characteristics by Domain

- Ordinary IT Software System (e.g. systems developed by SI organizations)
  - Size: Very Large
  - Domain consistency: Low
  - New technology sensitivity: High
  - Hardware dependency: Low
  - Time-to-market pressure: Low
Software Characteristics by Domain

- Commercial Software (e.g. systems developed by software vendors)
  - Size: Large
  - Domain consistency: High
  - New technology sensitivity: High
  - Hardware dependency: Low
  - Time-to-market pressure: Moderate
Software Characteristics by Domain

- Controller Systems/Automation Systems
  - Size: Medium
  - Domain consistency: High
  - New technology sensitivity: Low
  - Hardware dependency: Moderate
  - Time-to-market pressure: Moderate
Software Characteristics by Domain

- Embedded Systems /Commercial Electronics
  - Size: Small
  - Domain consistency: High
  - New technology sensitivity: High
  - Hardware dependency: High
  - Time-to-market pressure: High
Software Engineering Applicability

- In general, Controller Systems/Automation Systems and Embedded Systems /Commercial Electronics can give much higher rewards for software engineering activity
  - Domain consistency is high and new technology sensitivity is low
    - Ease of accumulating empirical data
    - High reusability in accumulated developments assets (e.g. requirements specification, domain model, test cases, modules)
    - Ease of continuous improvement
General Obstacles

- **Hardware dependency is high**
  - Software development may wait for hardware to become available
    - Product line engineering may be helpful
  - Confident testing environment is not supported even until complete hardware is ready
    - May need for effective simulator/emulator for testing

- **Time-to-market pressure is high**
  - High schedule pressure causes difficulties in software engineering activities
    - Overcome the hardware dependency as much as possible
    - Set up process to reduce redundant time consumption
    - Asset reuse