Introduction to Software Engineering (2/2)

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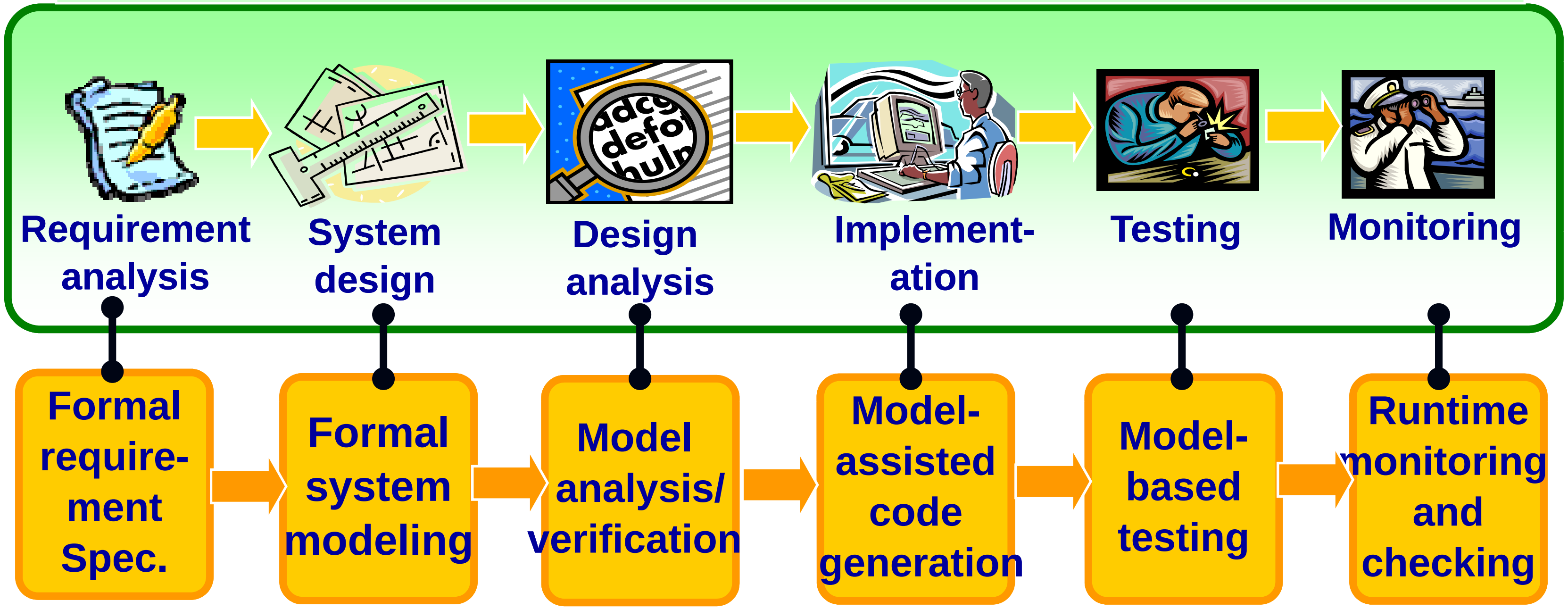
(slides from CS550 ‘06 taught by prof. D. Bae)

Software Development Process

A SW Development Framework for SW with High Assurance



Requirement analysis

System design

Design analysis

Implement-ation

Testing

Monitoring

Formal require-ment Spec.

Formal system modeling

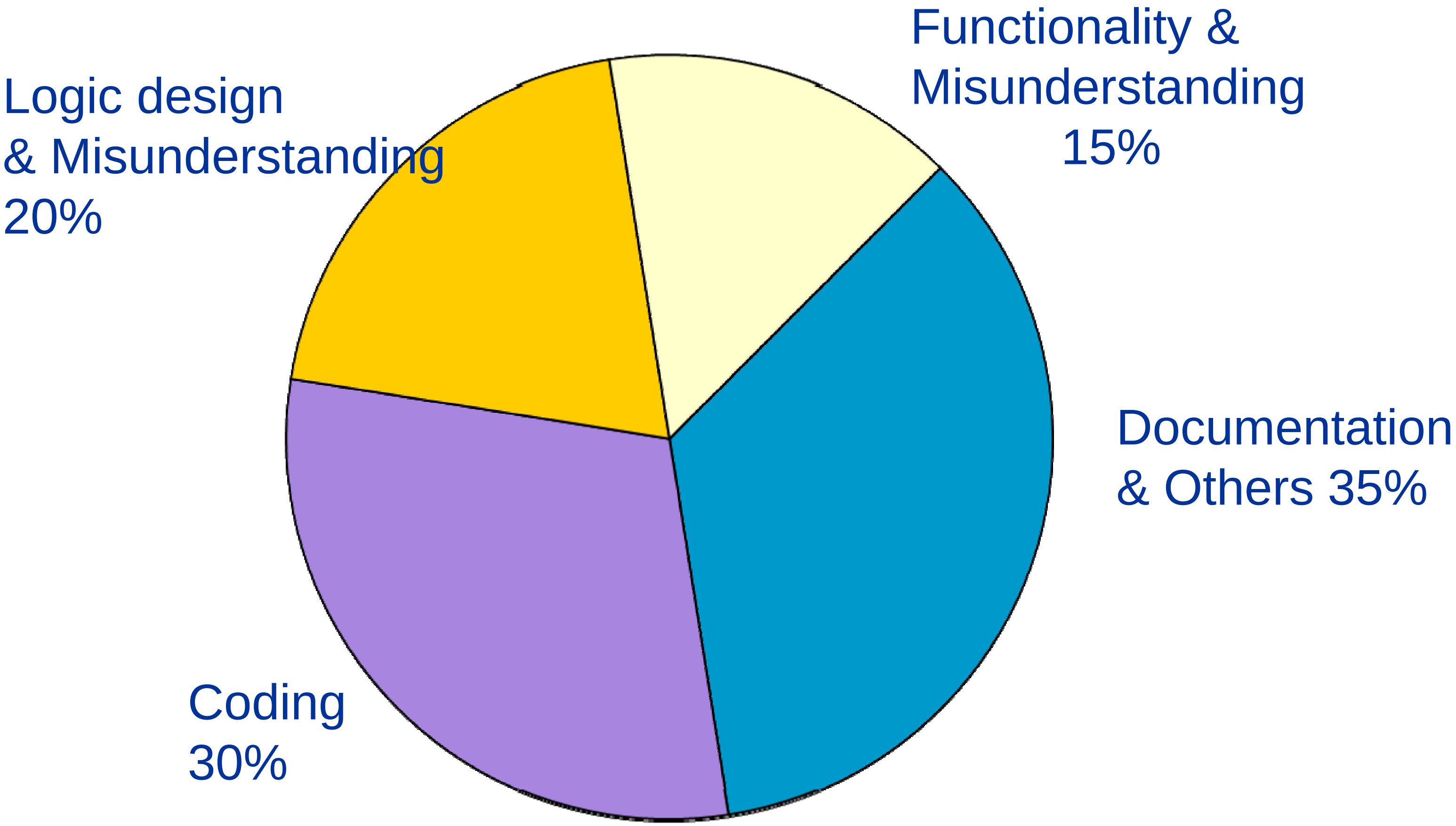
Model analysis/ verification

Model-assisted code generation

Model-based testing

Runtime monitoring and checking

Sources of Errors in S/W Developments



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

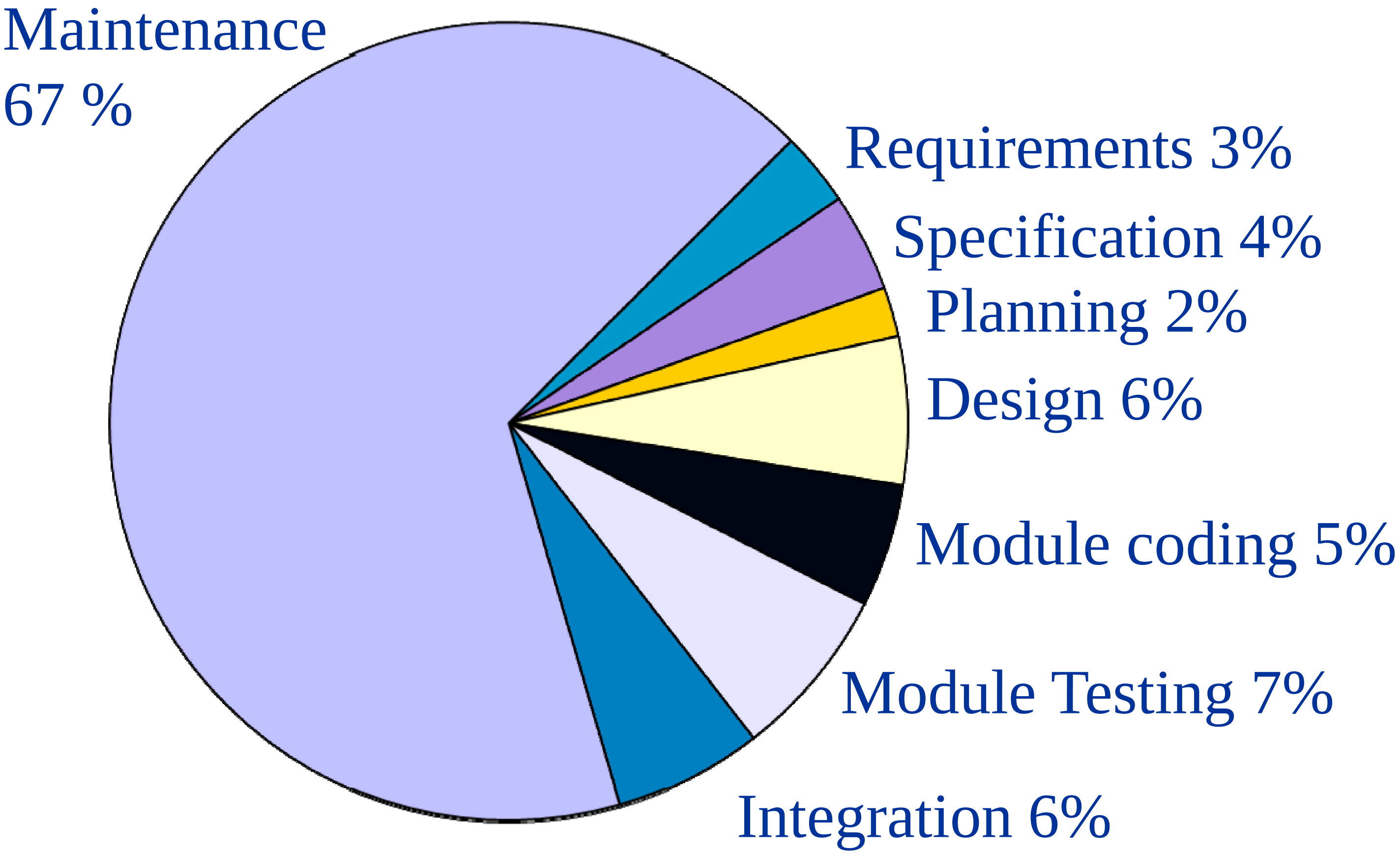
- 1967, A NATO group coined the term " Software Engineering"
- 1968, NATO conference concluded that software engineering should use the philosophies and paradigms of established engineering disciplines, to solve the problem of software crisis

Economic Aspects

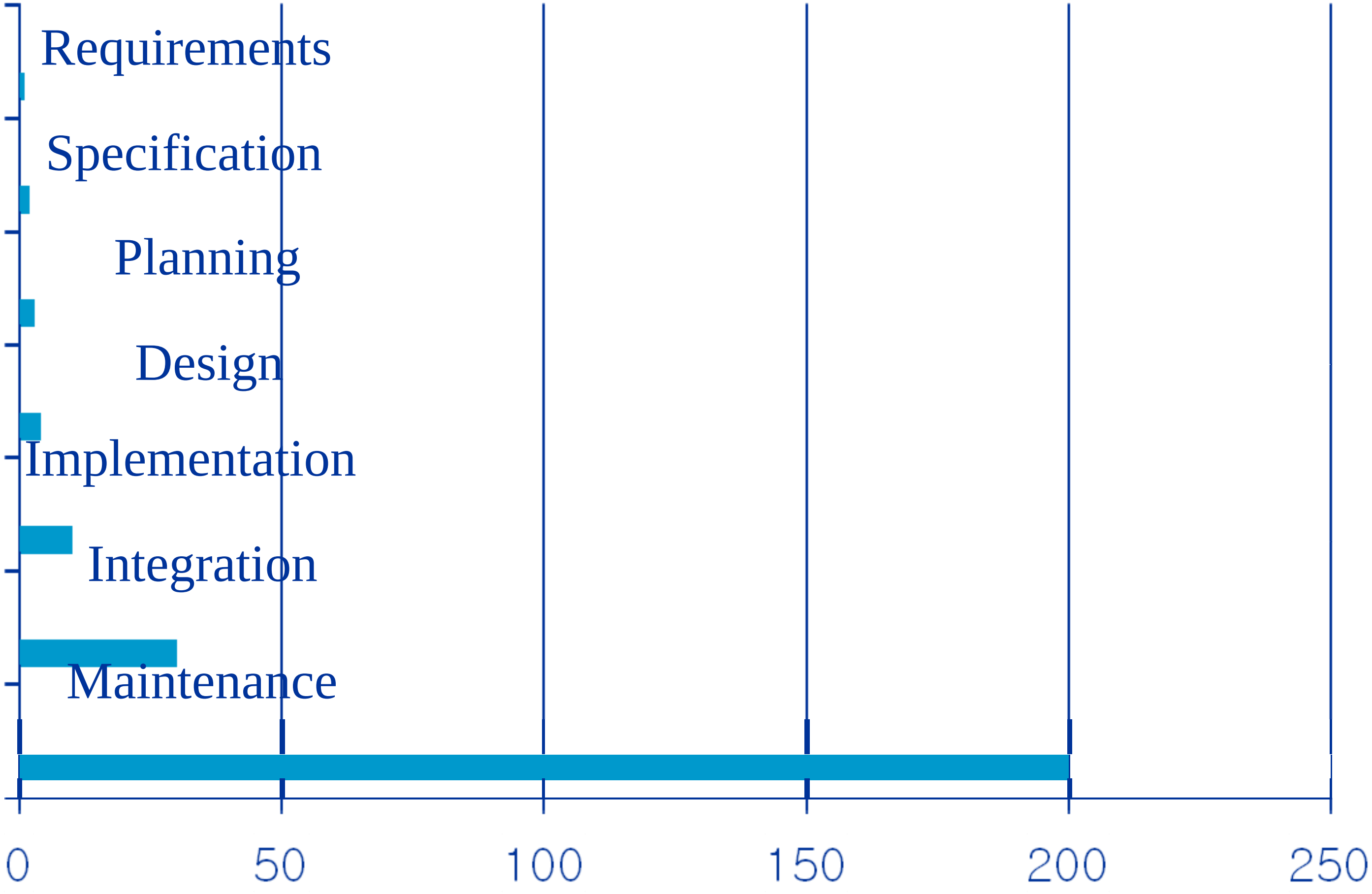
- Relationship between computer science and software engineering
  - cf: chemistry and chemical engineering

- 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



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

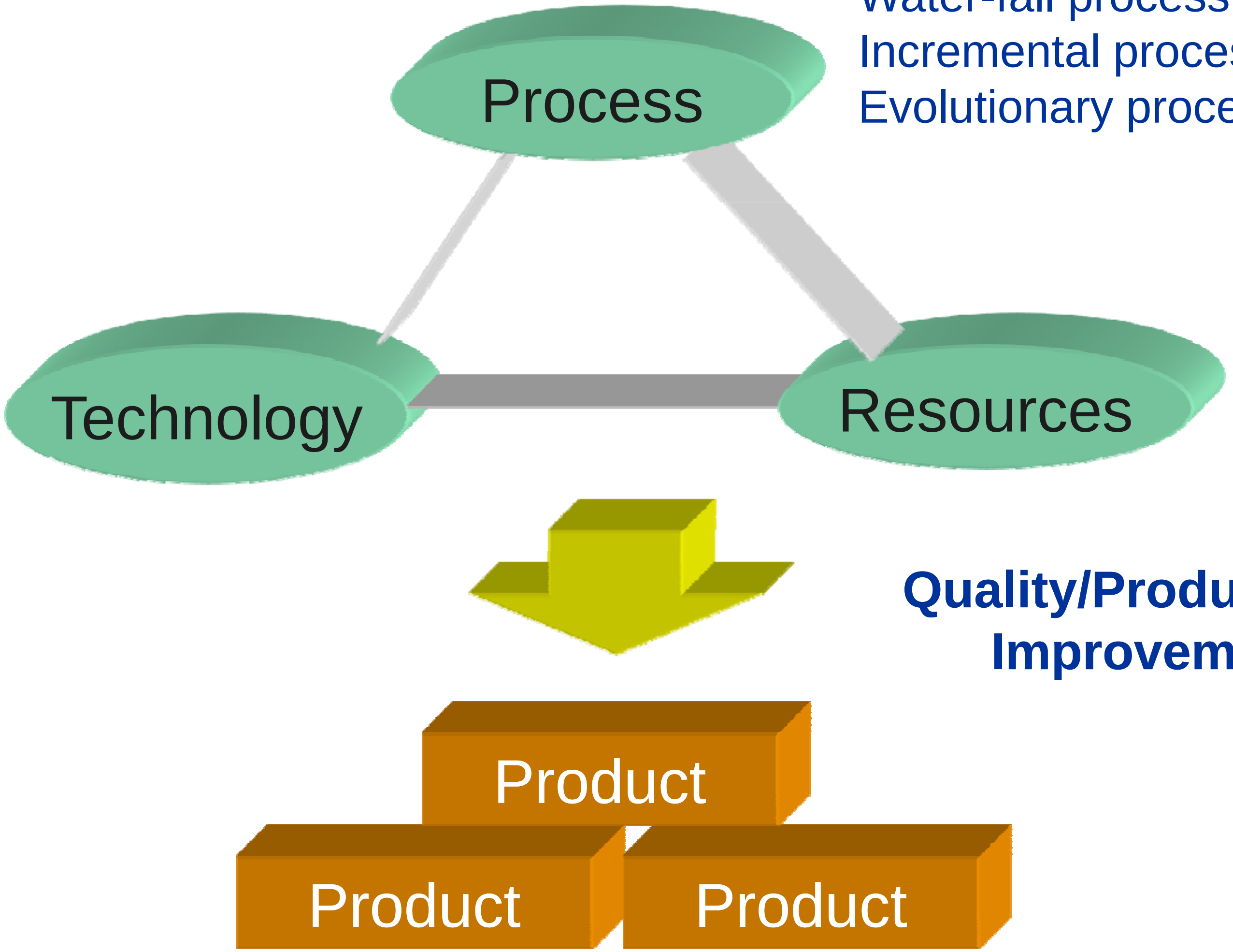
Team Programming Aspect (Cont.)

- 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 (i.e. system abstraction)
    - Top-down design
    - Divide and conquer paradigm
    - Component based integration
  - 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



Process

Technology

Resources

Product

Product

Product

Water-fall process
Incremental process
Evolutionary process

OOP
Model based testing

Facilities
Staff
Budget

Quality/Productivity Improvement

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
    - Since ubiquitous computing paradigm occurred, this aspect is changing
  - 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 (-> Moderate)
  - 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
  - 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

Statistics on Embedded Software

- World-wide unit shipments of embedded devices reached 4.4 billion in 2007 and expected to grow 12.5% through 2009, reaching 6.3 billion
- Total # of worldwide embedded SW and HW developers will grow from 471,500 in 2006 to 504,900 in 2009
  - 2.3 % annual growth rate
  - # of software developers is projected to grow from 312,000 in 2006 to 348,300 in 2009

VDC 2007 Volume4:
Embedded Systems Market Statistics

Statistics on Embedded SW Developers

- Survey of embedded engineers
  - Mean age: 41.7
  - 47% had a higher degree above a bachelor's degree
  - 13 years experience on average, working on over 32 projects
  - C continues to be the dominant programming language
  - 66% produced less than 1000 lines of code per month

- Design methodologies vary widely
  - 33.4% employing an object-oriented methodology
  - 22% using a component-based design methodology
  - 30% using no formal methodology

VDC 2007 Volume4:
Embedded Systems Market Statistics