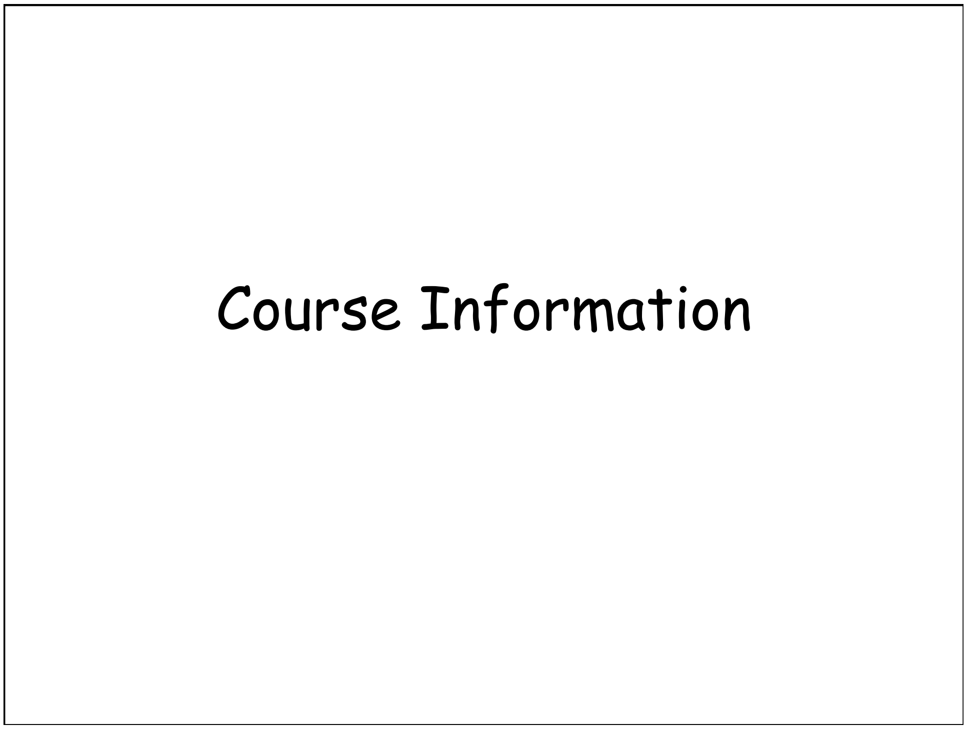
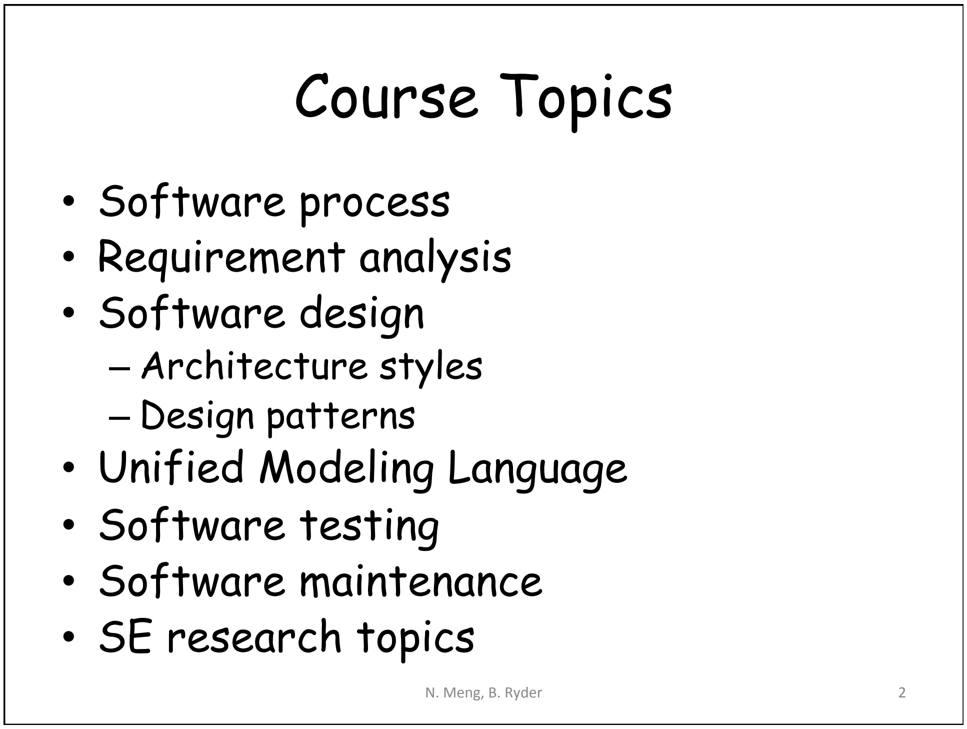
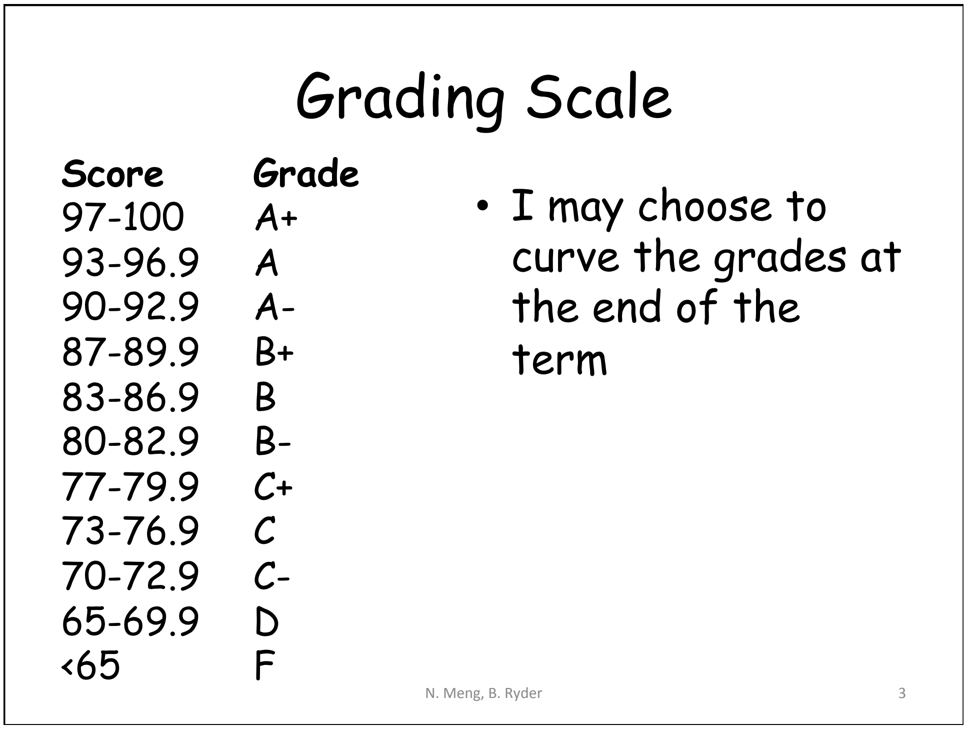


Course Information



Course Topics

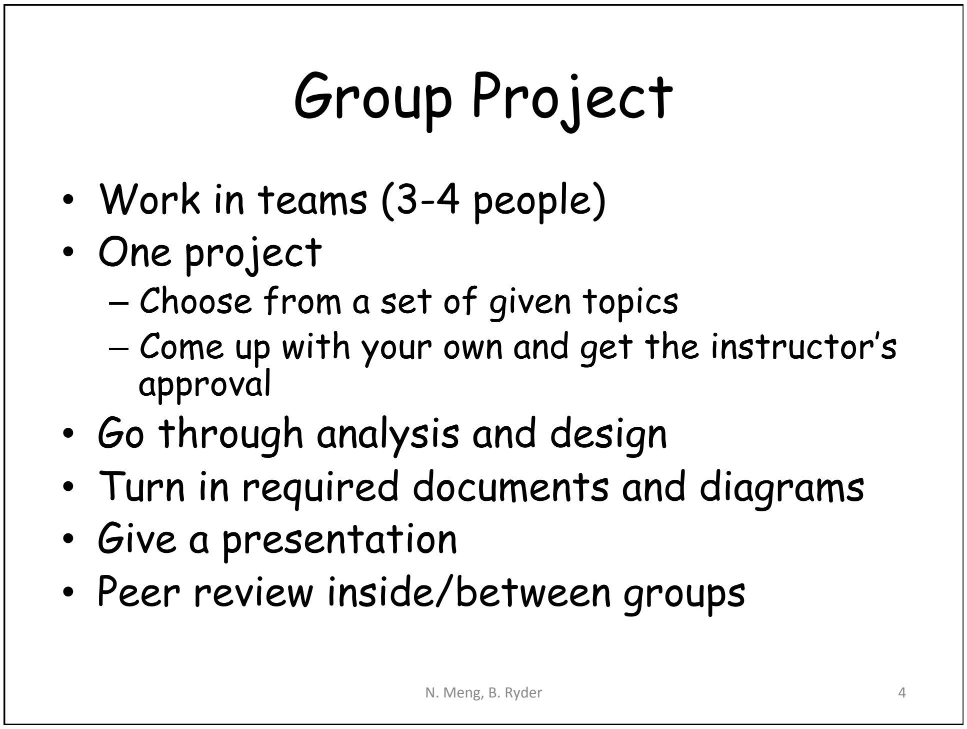
- Software process
- Requirement analysis
- Software design
  - Architecture styles
  - Design patterns
- Unified Modeling Language
- Software testing
- Software maintenance
- SE research topics



Grading Scale

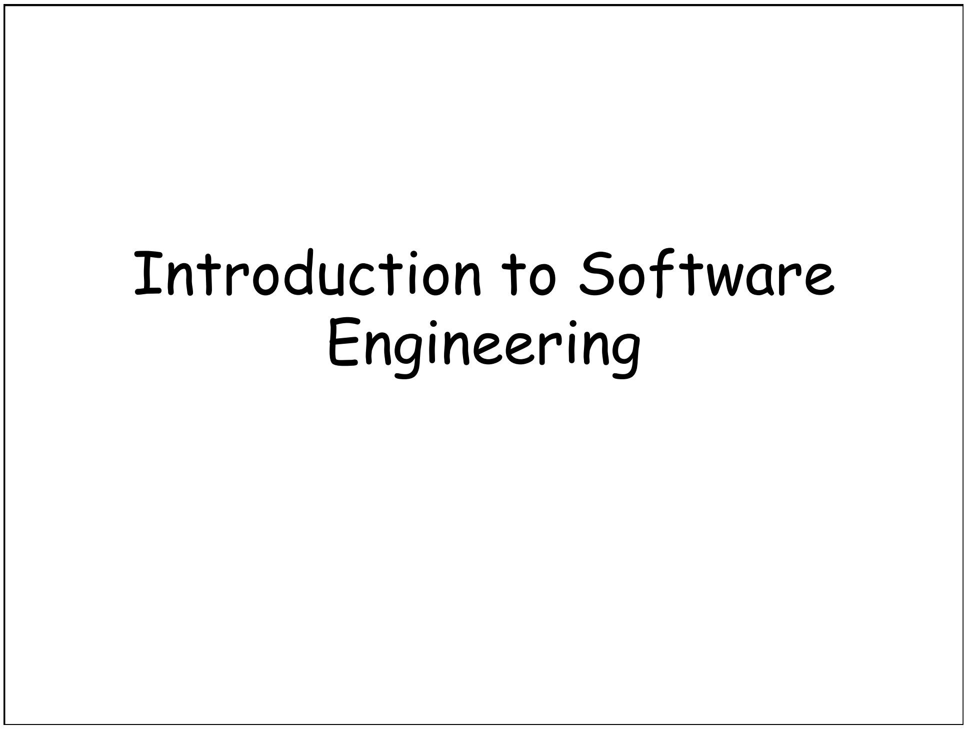
Score	Grade
97-100	A+
93-96.9	A
90-92.9	A-
87-89.9	B+
83-86.9	B
80-82.9	B-
77-79.9	C+
73-76.9	C
70-72.9	C-
65-69.9	D
<65	F

- I may choose to curve the grades at the end of the term

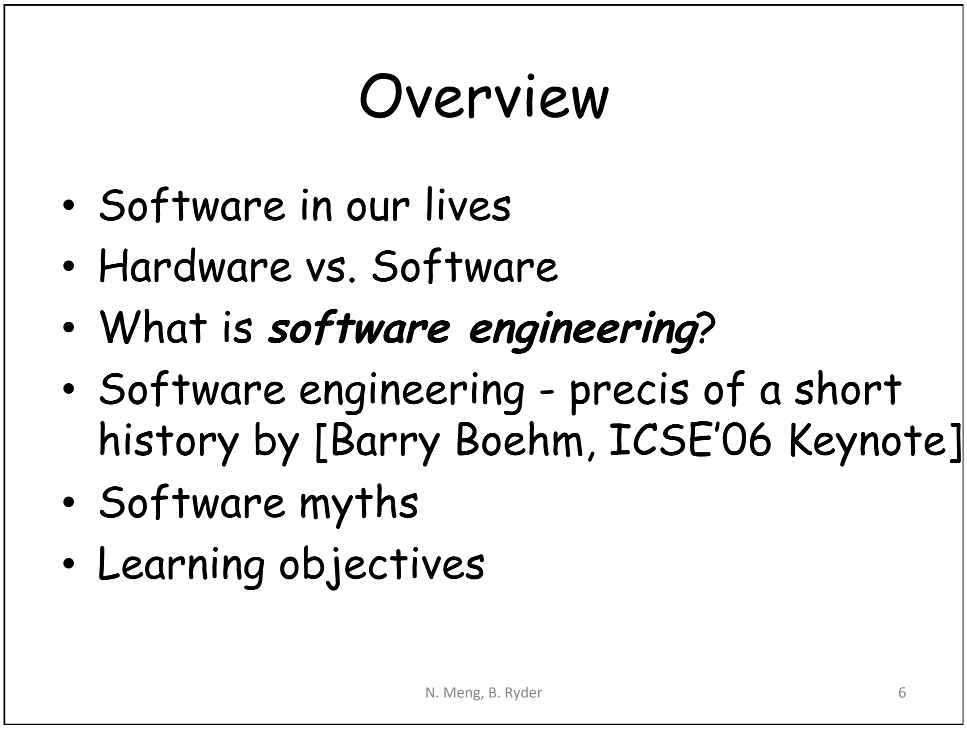


Group Project

- Work in teams (3-4 people)
- One project
  - Choose from a set of given topics
  - Come up with your own and get the instructor's approval
- Go through analysis and design
- Turn in required documents and diagrams
- Give a presentation
- Peer review inside/between groups

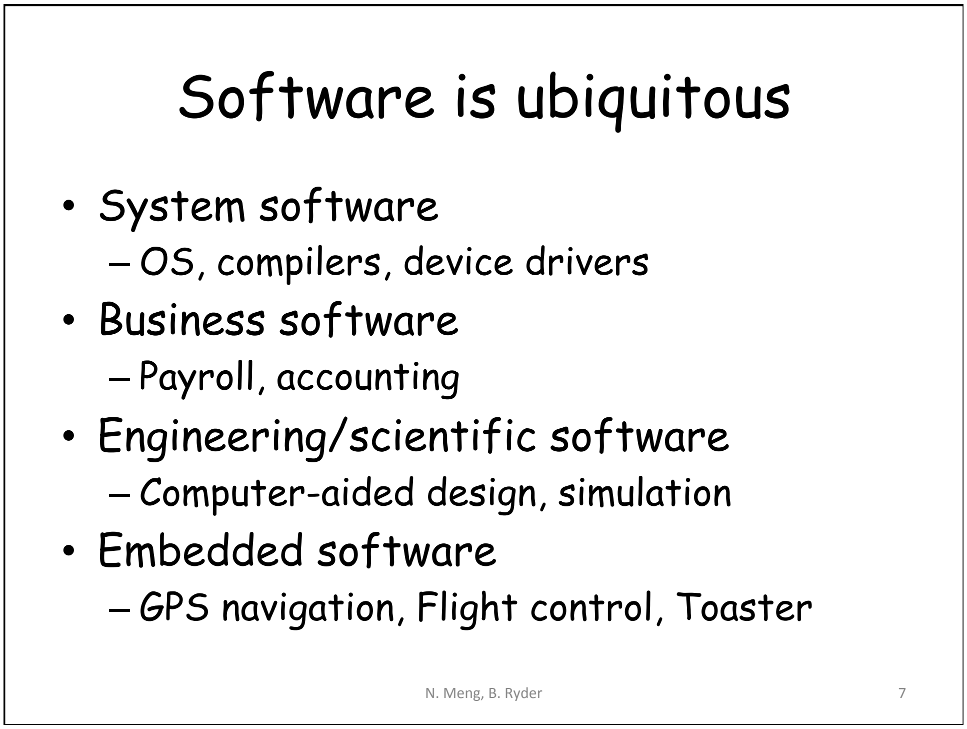


Introduction to Software Engineering



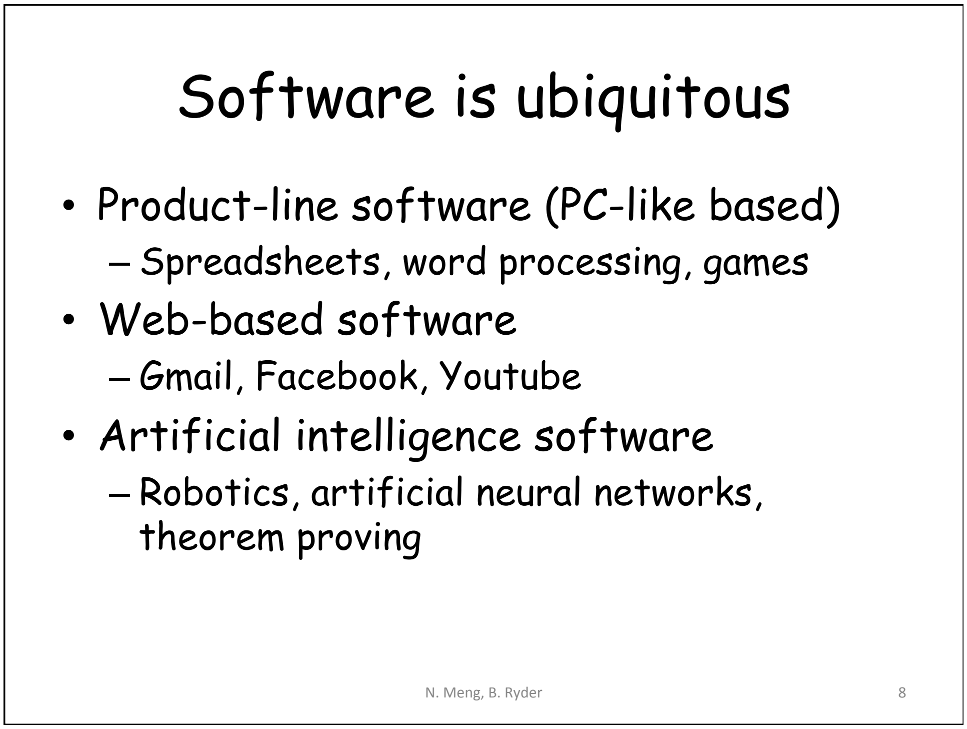
Overview

- Software in our lives
- Hardware vs. Software
- What is ***software engineering***?
- Software engineering - precis of a short history by [Barry Boehm, ICSE'06 Keynote]
- Software myths
- Learning objectives



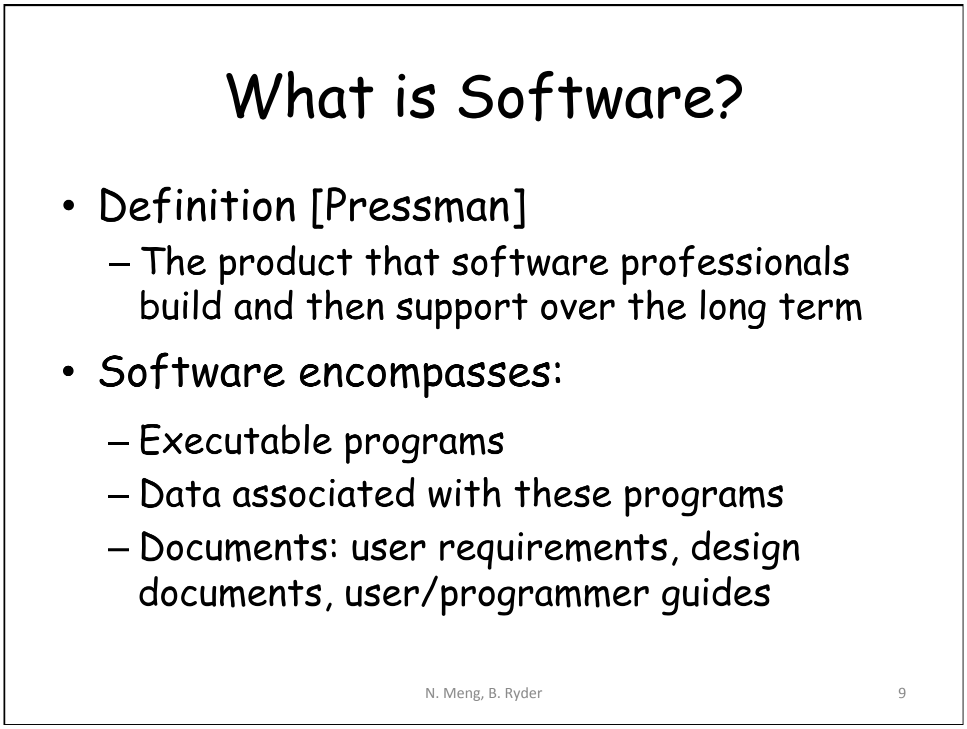
Software is ubiquitous

- System software
  - OS, compilers, device drivers
- Business software
  - Payroll, accounting
- Engineering/scientific software
  - Computer-aided design, simulation
- Embedded software
  - GPS navigation, Flight control, Toaster



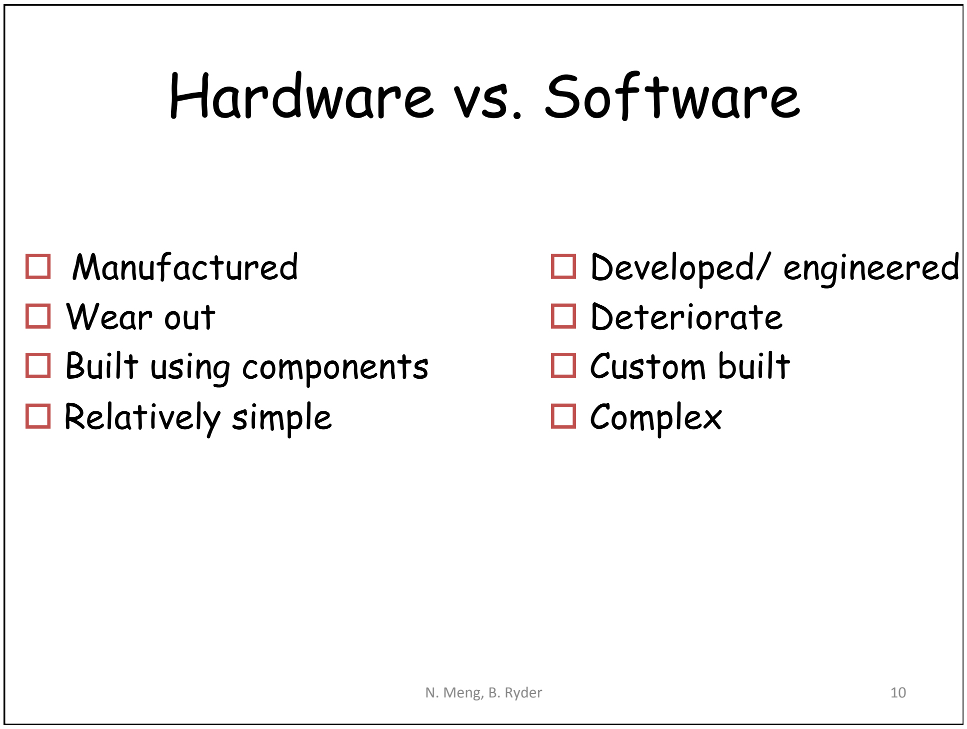
Software is ubiquitous

- Product-line software (PC-like based)
  - Spreadsheets, word processing, games
- Web-based software
  - Gmail, Facebook, Youtube
- Artificial intelligence software
  - Robotics, artificial neural networks, theorem proving



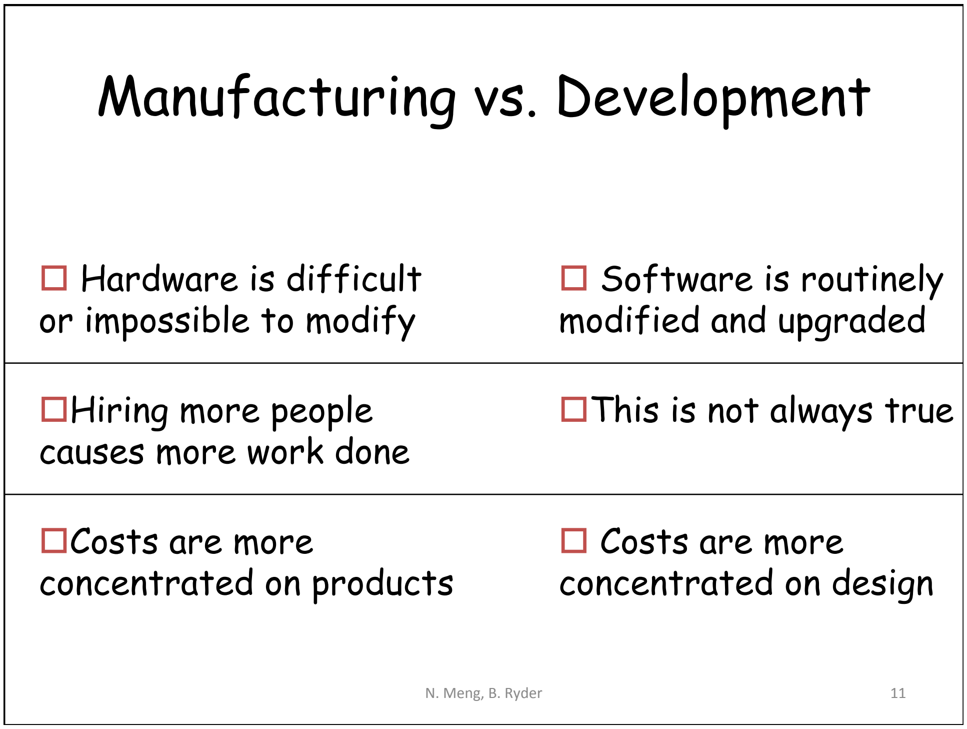
What is Software?

- Definition [Pressman]
  - The product that software professionals build and then support over the long term
- Software encompasses:
  - Executable programs
  - Data associated with these programs
  - Documents: user requirements, design documents, user/programmer guides



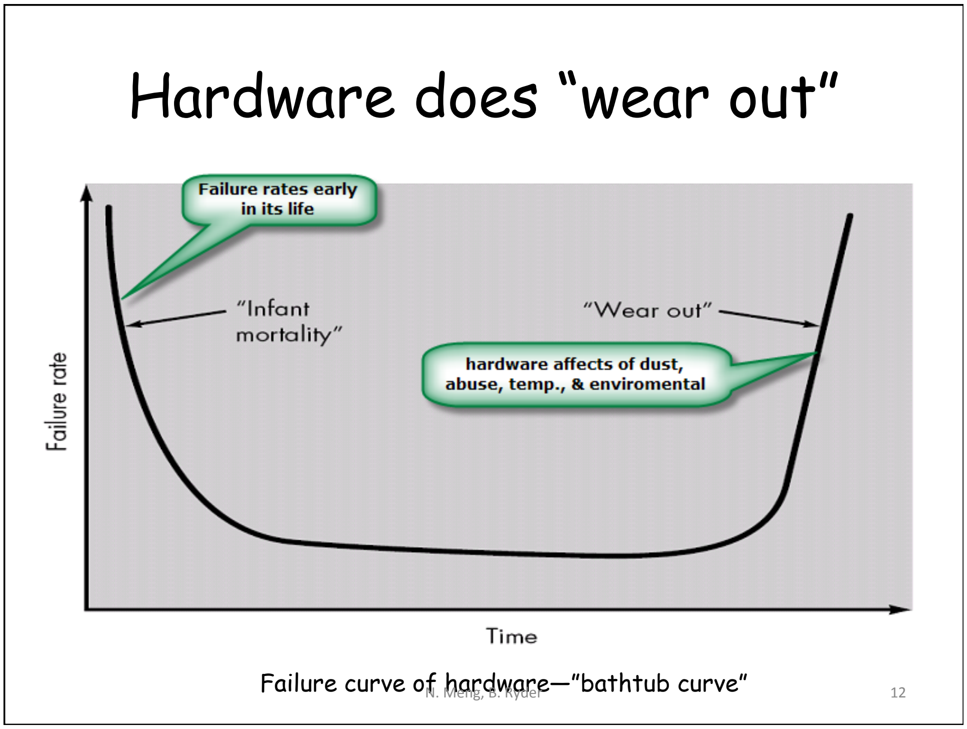
Hardware vs. Software

□ Manufactured	□ Developed/ engineered
□ Wear out	□ Deteriorate
□ Built using components	□ Custom built
□ Relatively simple	□ Complex



Manufacturing vs. Development

□ Hardware is difficult or impossible to modify	□ Software is routinely modified and upgraded
□Hiring more people causes more work done	□This is not always true
□Costs are more concentrated on products	□ Costs are more concentrated on design



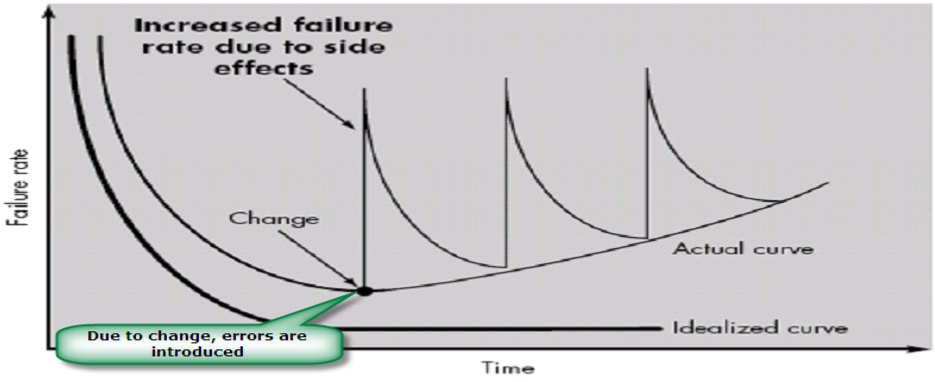
Hardware does "wear out"

Failure rates early in its life

hardware affects of dust, abuse, temp., & enviromental

Failure curve of hardware—"bathtub curve"

Software does "deteriorate"

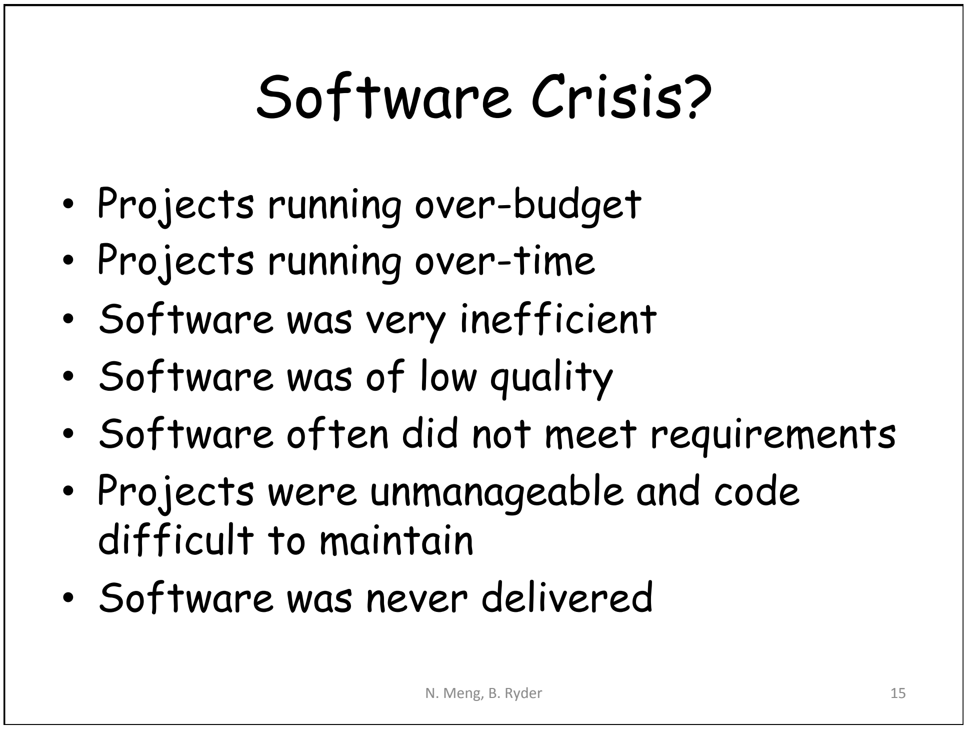


Due to change, errors are introduced

Failure curve of software

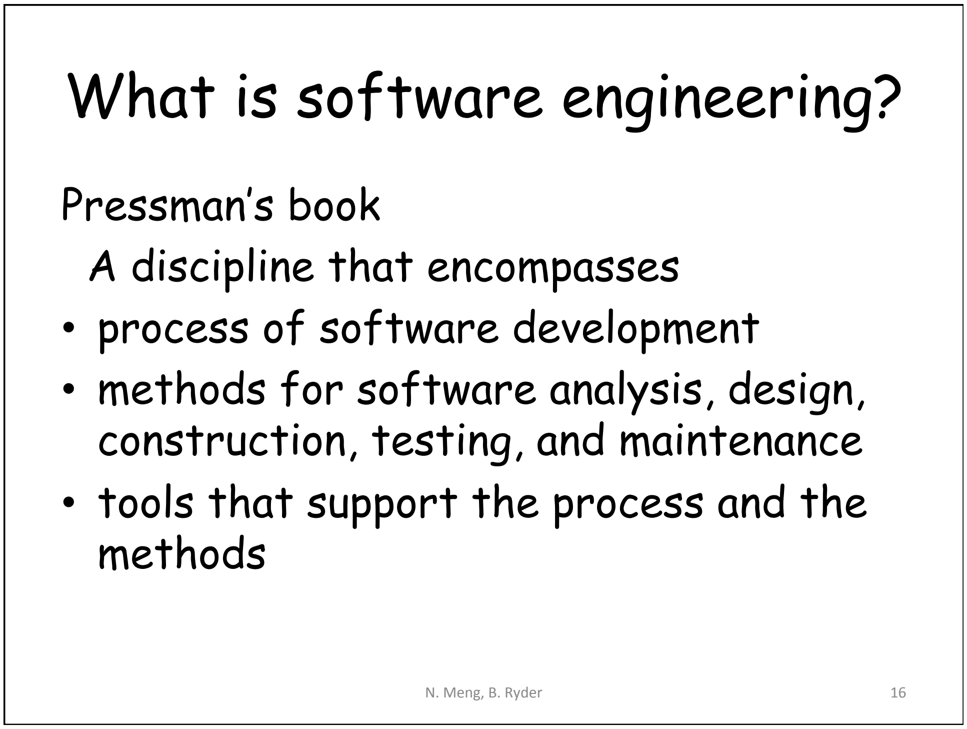
Component based vs. Custom built

- Hardware products employ many standardized design components.
- Most software is always custom built.
- The software industry does seem to be moving (slowly) toward component-based construction.



Software Crisis?

- Projects running over-budget
- Projects running over-time
- Software was very inefficient
- Software was of low quality
- Software often did not meet requirements
- Projects were unmanageable and code difficult to maintain
- Software was never delivered

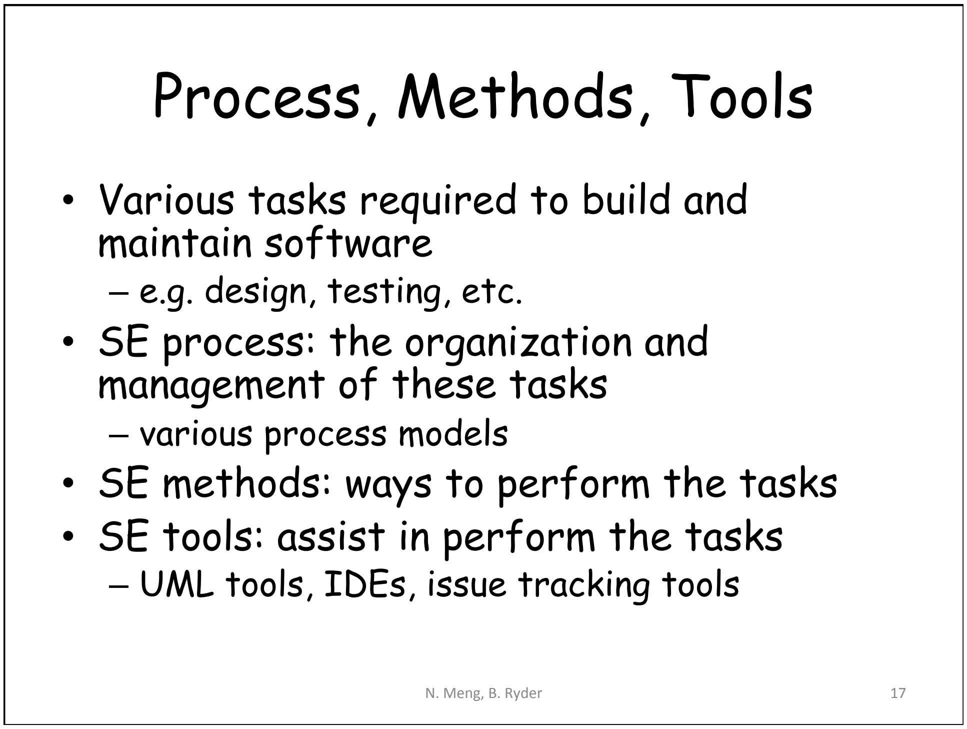


What is software engineering?

Pressman’s book

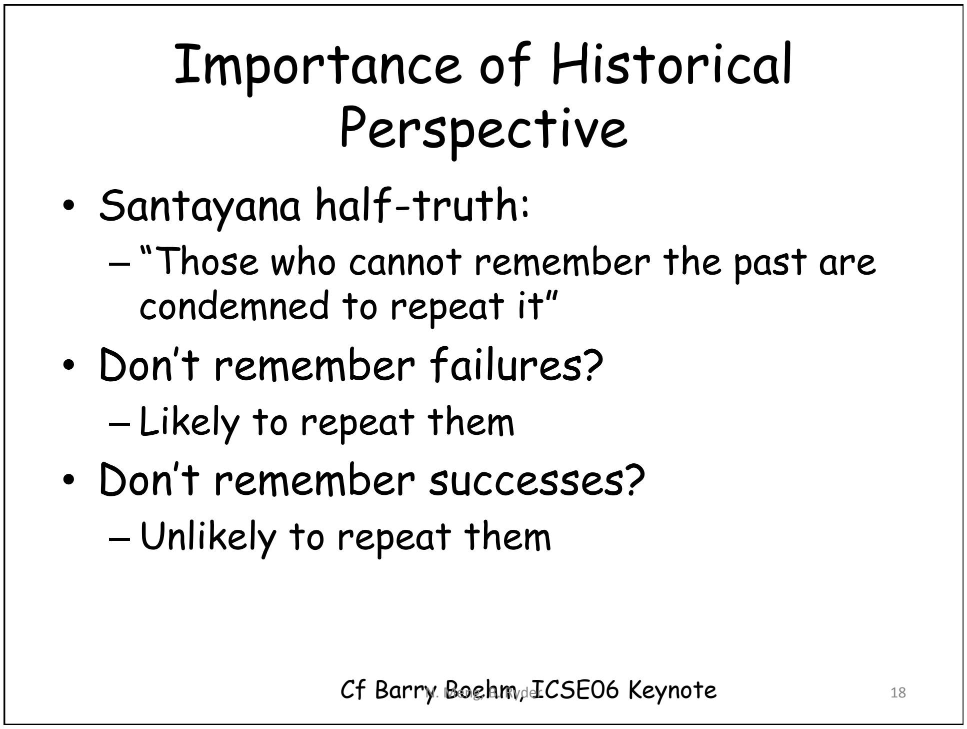
A discipline that encompasses

- process of software development
- methods for software analysis, design, construction, testing, and maintenance
- tools that support the process and the methods



Process, Methods, Tools

- Various tasks required to build and maintain software
  - e.g. design, testing, etc.
- SE process: the organization and management of these tasks
  - various process models
- SE methods: ways to perform the tasks
- SE tools: assist in perform the tasks
  - UML tools, IDEs, issue tracking tools



Importance of Historical Perspective

- Santayana half-truth:
  - "Those who cannot remember the past are condemned to repeat it"
- Don't remember failures?
  - Likely to repeat them
- Don't remember successes?
  - Unlikely to repeat them

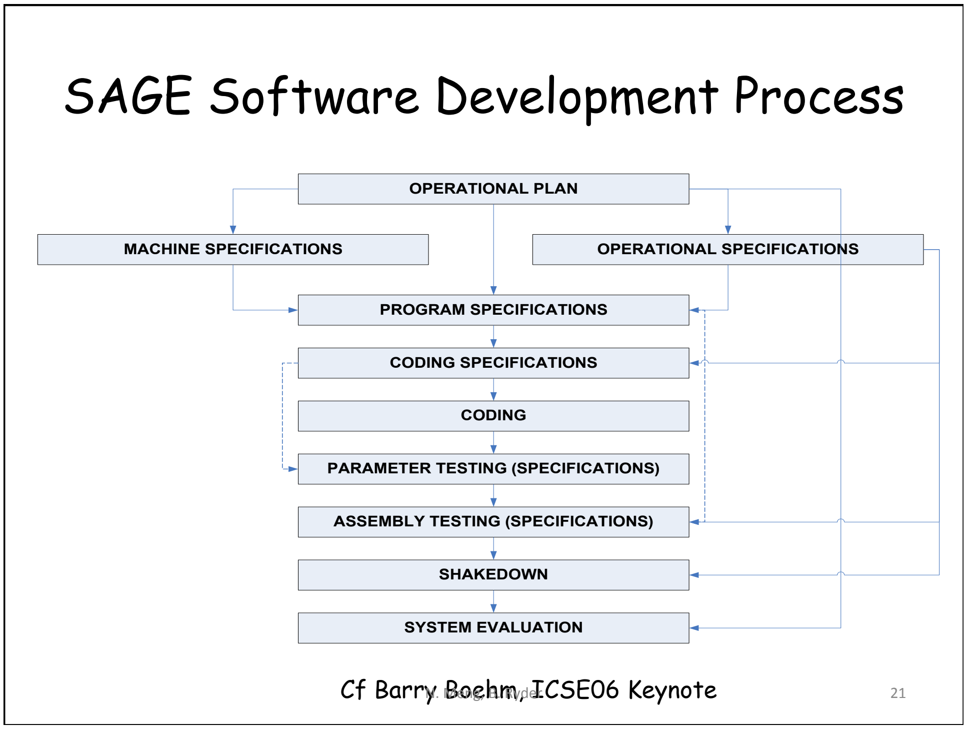
Cf Barry Boehm, ICSE06 Keynote

History of SW Development

1950’s: engineer software like hardware

- Hardware-oriented software applications
  - Airplanes, circuits
- Economics: computer time more valuable than people time
  - Boehm supervisor, 1955: “We’re paying $600/ hour for that computer, and $2/hour for you, and I want you to act accordingly.”

Cf Barry Boehm, ICSE06 Keynote



SAGE Software Development Process

OPERATIONAL PLAN

MACHINE SPECIFICATIONS

OPERATIONAL SPECIFICATIONS

PROGRAM SPECIFICATIONS

CODING SPECIFICATIONS

CODING

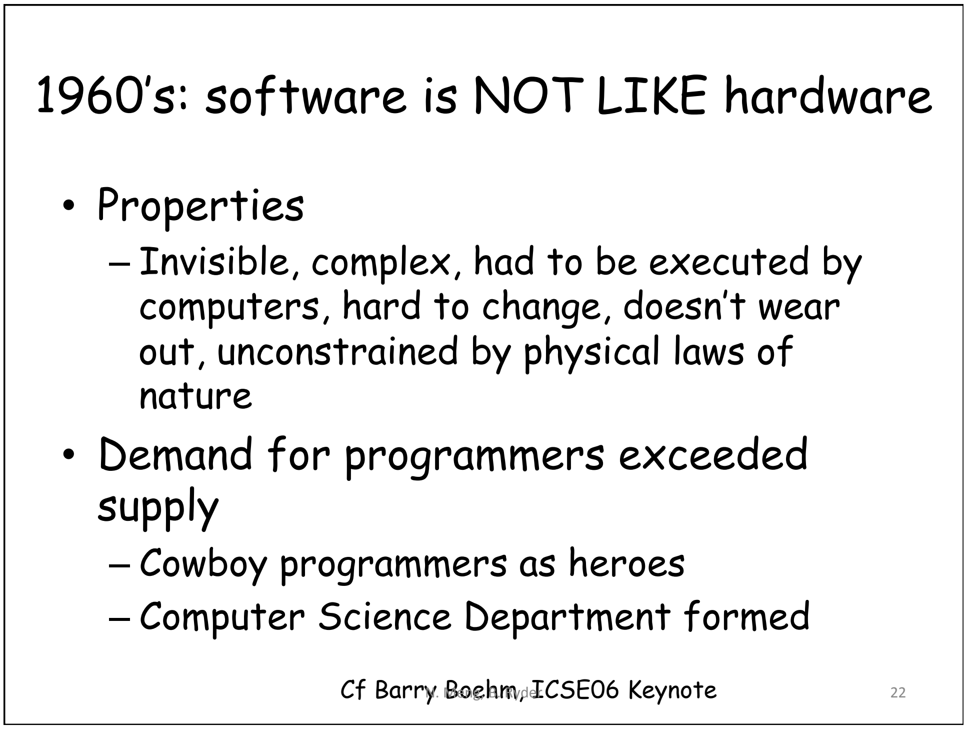
PARAMETER TESTING (SPECIFICATIONS)

ASSEMBLY TESTING (SPECIFICATIONS)

SHAKEDOWN

SYSTEM EVALUATION

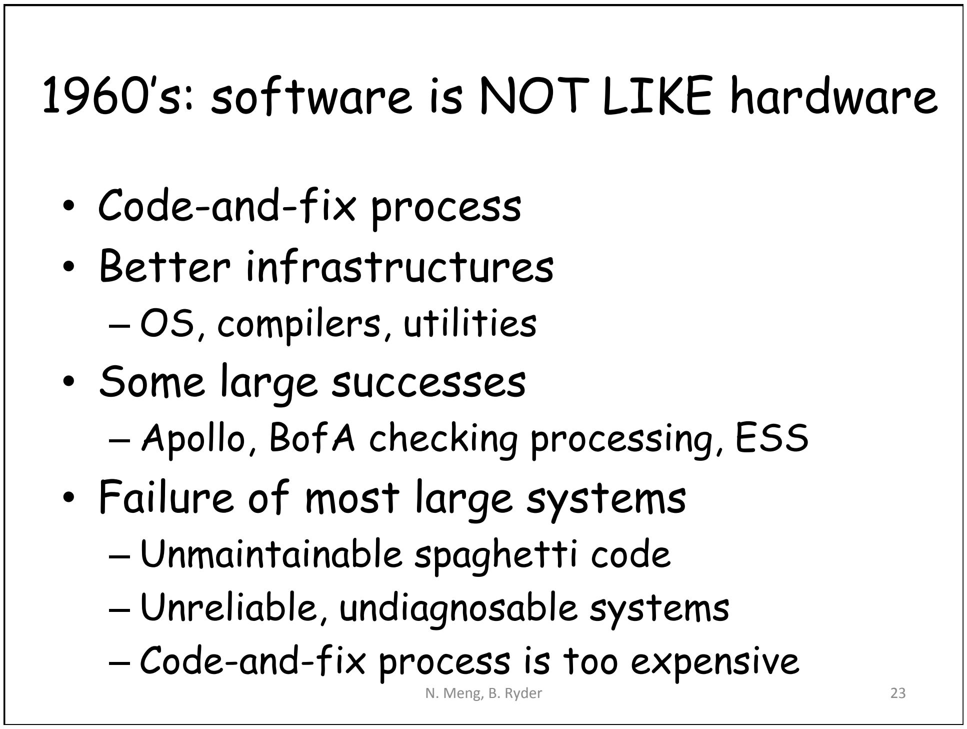
Cf Barry Boehm, ICSE06 Keynote



1960's: software is NOT LIKE hardware

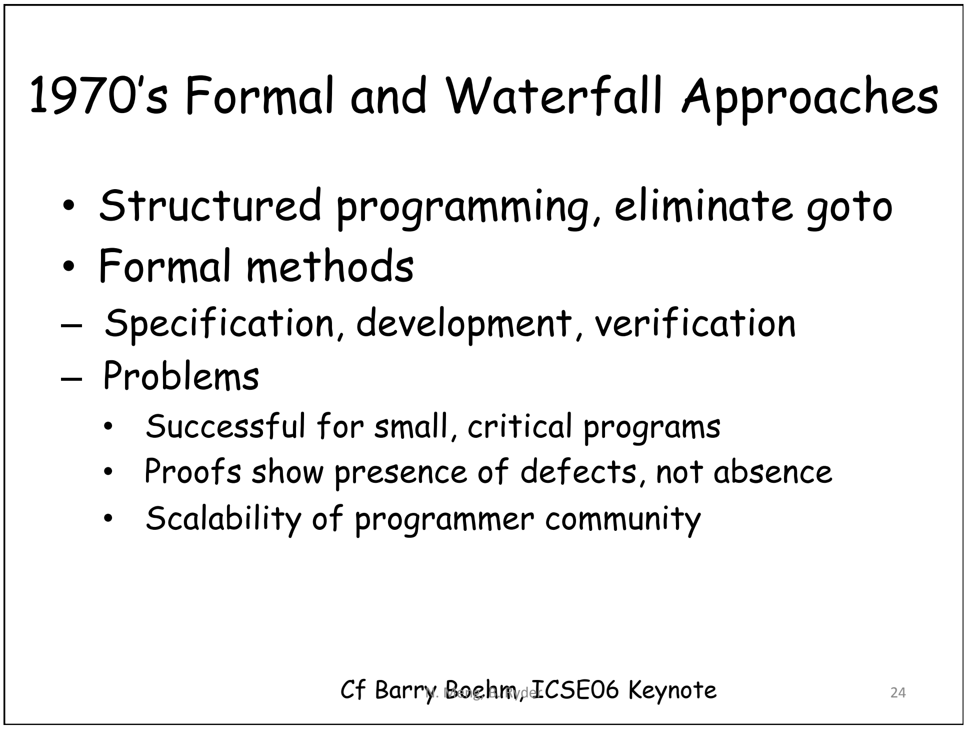
- Properties
  - Invisible, complex, had to be executed by computers, hard to change, doesn't wear out, unconstrained by physical laws of nature
- Demand for programmers exceeded supply
  - Cowboy programmers as heroes
  - Computer Science Department formed

Cf Barry Boehm, ICSE06 Keynote



1960's: software is NOT LIKE hardware

- Code-and-fix process
- Better infrastructures
  - OS, compilers, utilities
- Some large successes
  - Apollo, BofA checking processing, ESS
- Failure of most large systems
  - Unmaintainable spaghetti code
  - Unreliable, undiagnosable systems
  - Code-and-fix process is too expensive



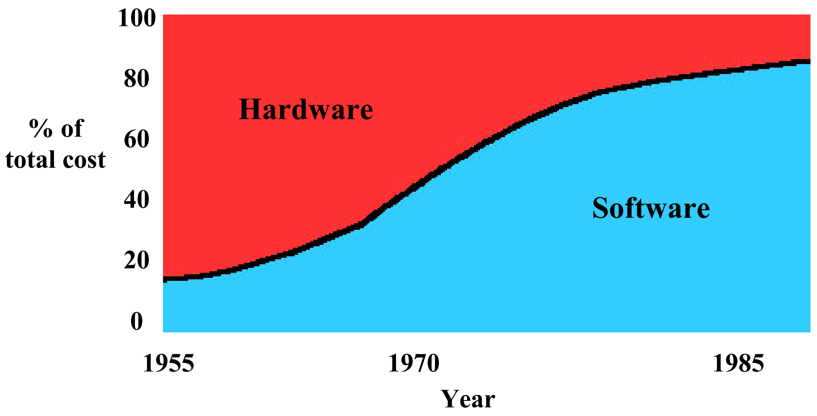
1970's Formal and Waterfall Approaches

- Structured programming, eliminate goto
- Formal methods
- Specification, development, verification
- Problems
  - Successful for small, critical programs
  - Proofs show presence of defects, not absence
  - Scalability of programmer community

Cf Barry Boehm, ICSE06 Keynote

- Waterfall process model
  - Requirements, design, coding, testing, operations (maintenance)
  - Problems
    - Customers' changing requirements destroy distinctions between phases
    - Heavyweight documentation hard to review and maintain
    - Assumption for smooth transition from design and implementation

Large-Organization HW/SW Cost Trends (1973)



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1980's Synthesis: Productivity, Reuse, Objects

- Major SW productivity enhancers
  - Working faster: tools and environments
  - Working smarter: processes and methods
  - Work avoidance: reuse, simplicity, objects
  - Technology silver bullets: AI, Do what I mean, programming by example
- Reuse libraries
- Object orientation
  - Smalltalk, Eiffel, C++

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"No Silver Bullet", Fred Brooks

IEEE Computer, 1987

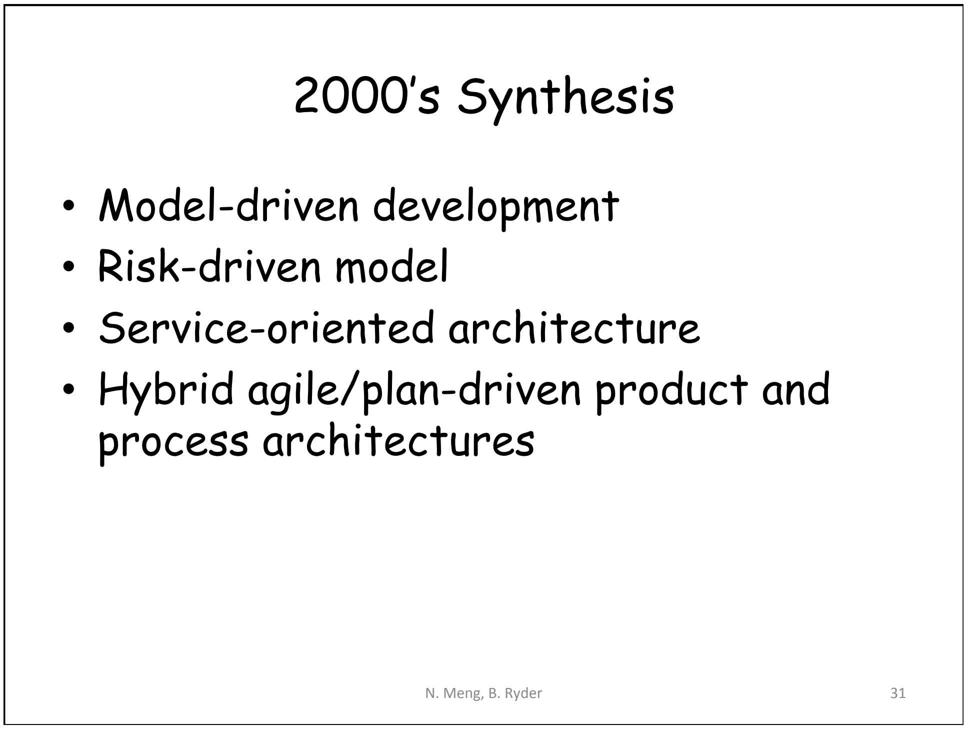
"There is no single development, in either technology or management technique, which by itself promises even one order-of-magnitude improvement within a decade in productivity, in reliability, in simplicity."

- “Essential” difficulties to build software
  - Complexity: no two parts are alike
  - Conformity: conform to existing interfaces
  - Changeability: subject to change
  - Invisibility: has no ready geometric representation
- Closest thing to silver bullet: great designers and communicators

1990’s maturity models and agile methods

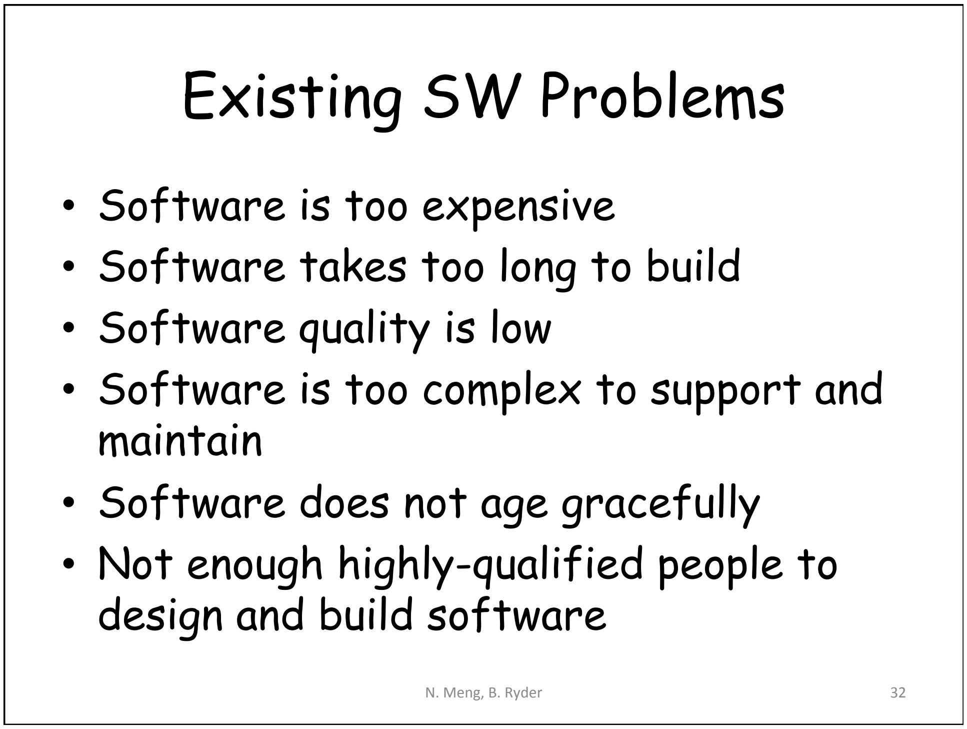
- Capacity Maturity Models (CMM)
  - Reliance on explicit documented knowledge
  - Heavyweight but verifiable, scalable
- Agile Methods
  - Reliance on interpersonal tacit knowledge
  - Lightweight, adaptable, not very scalable
- Other trends
  - reverse engineering, Open Source SW, Spiral process model

Cf Barry Boehm, ICSE06 Keynote



2000's Synthesis

- Model-driven development
- Risk-driven model
- Service-oriented architecture
- Hybrid agile/plan-driven product and process architectures



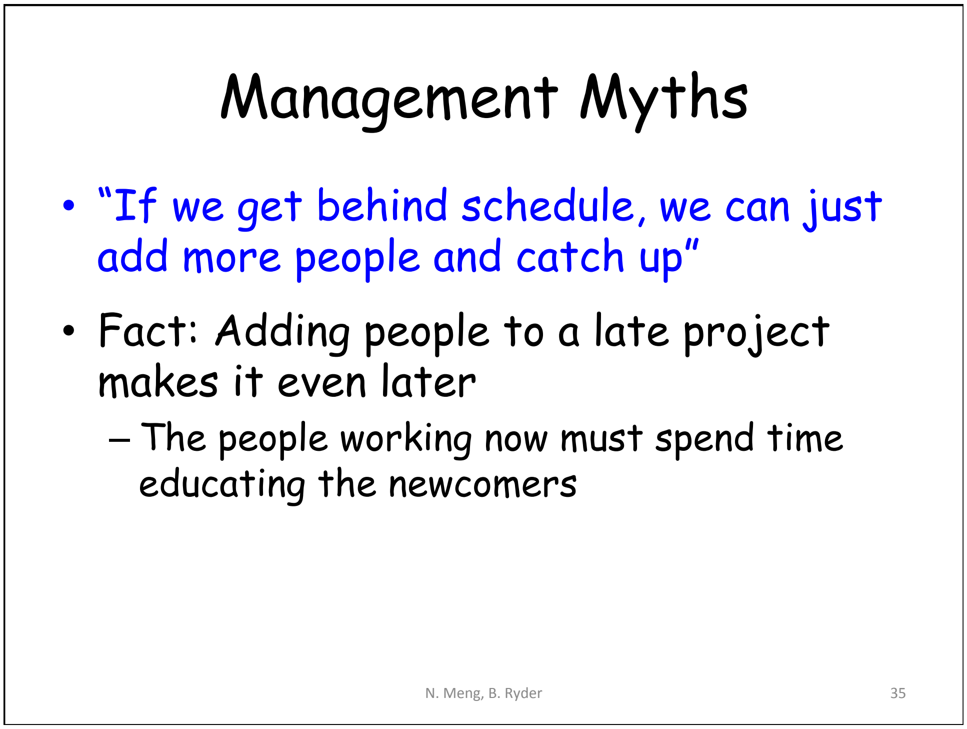
Existing SW Problems

- Software is too expensive
- Software takes too long to build
- Software quality is low
- Software is too complex to support and maintain
- Software does not age gracefully
- Not enough highly-qualified people to design and build software

Data by the Standish Group (1995)

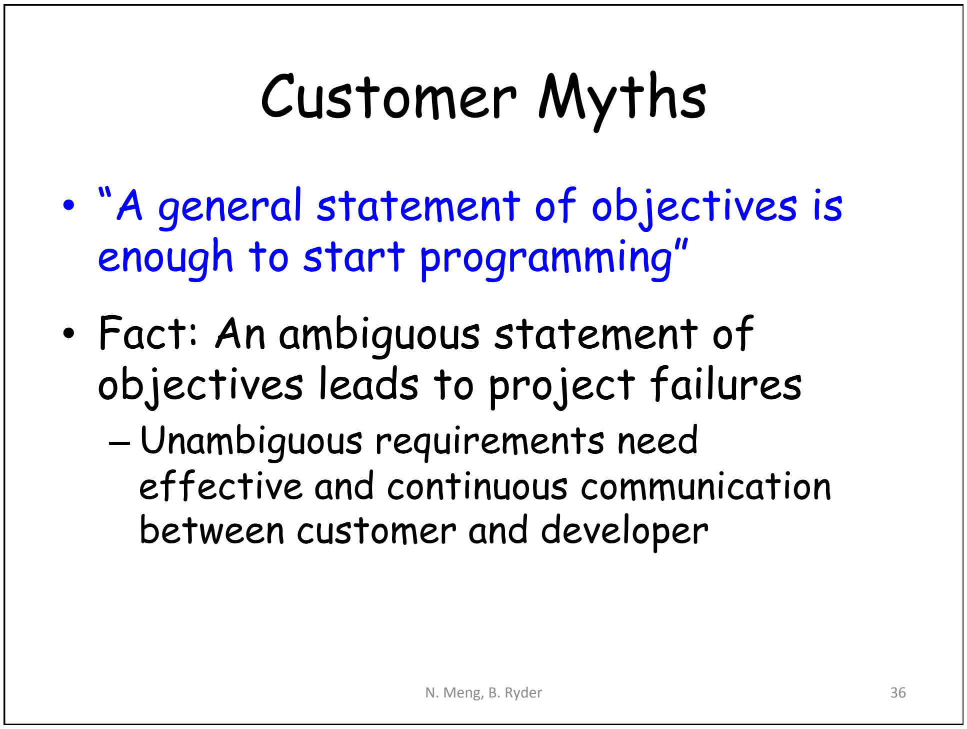
- $81B on canceled software projects
- $59B for budget overruns
- Only 1/6 projects were completed on time and within budget
- Nearly 1/3 projects were canceled
- Over half projects were considered “challenged”
- Among canceled and challenged projects
  - Budget overrun: 189% of original estimate
  - Time overrun: 222% of original estimate
  - Only 61% of the originally specified features

Software Myths



Management Myths

- "If we get behind schedule, we can just add more people and catch up"
- Fact: Adding people to a late project makes it even later
  - The people working now must spend time educating the newcomers

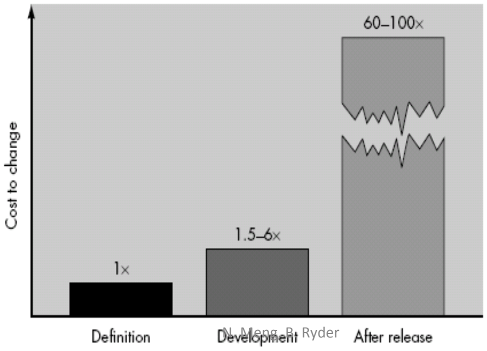


Customer Myths

- "A general statement of objectives is enough to start programming"
- Fact: An ambiguous statement of objectives leads to project failures
  - Unambiguous requirements need effective and continuous communication between customer and developer

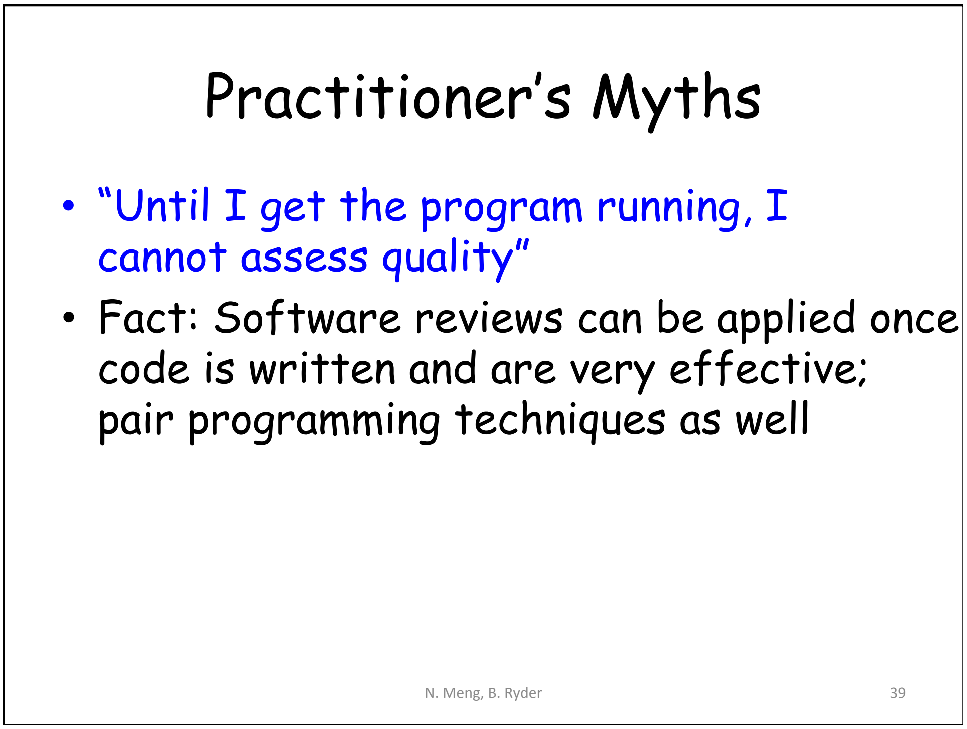
Customer Myths

- "Changes in requirements are easy to deal with because software is flexible"
- Fact: Changes are hard and expensive



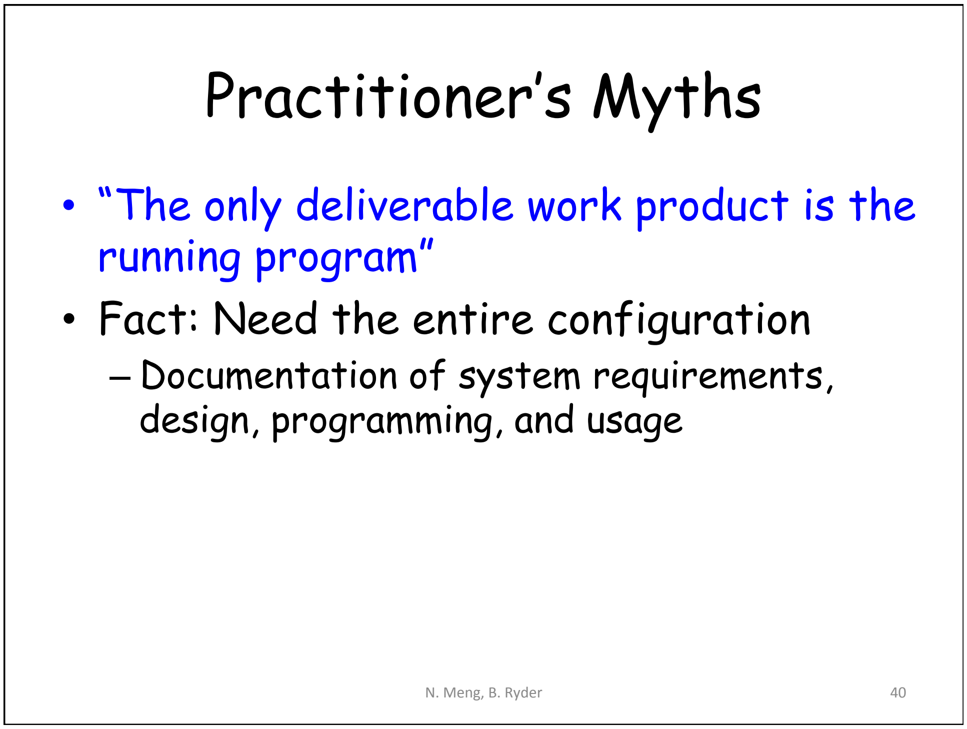
Practitioner's Myths

- "Once we get the program running, we are done"
- Fact: 60-80% effort comes after the software is delivered for the first time
  - Bug fixes, feature enhancements, software reengineering, migration



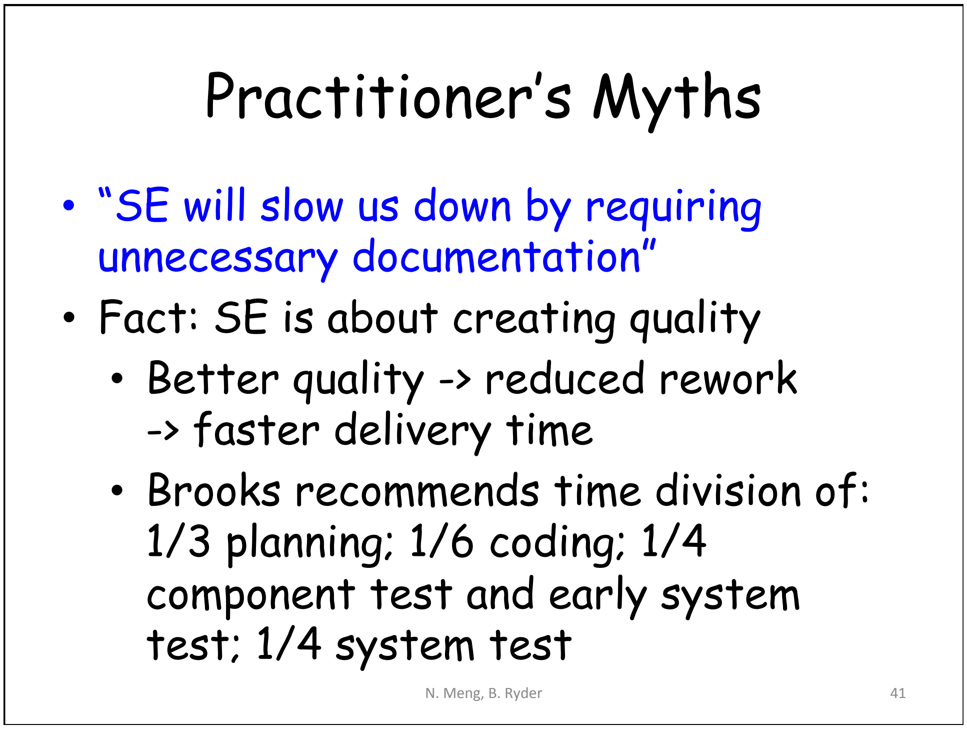
Practitioner's Myths

- "Until I get the program running, I cannot assess quality"
- Fact: Software reviews can be applied once code is written and are very effective; pair programming techniques as well



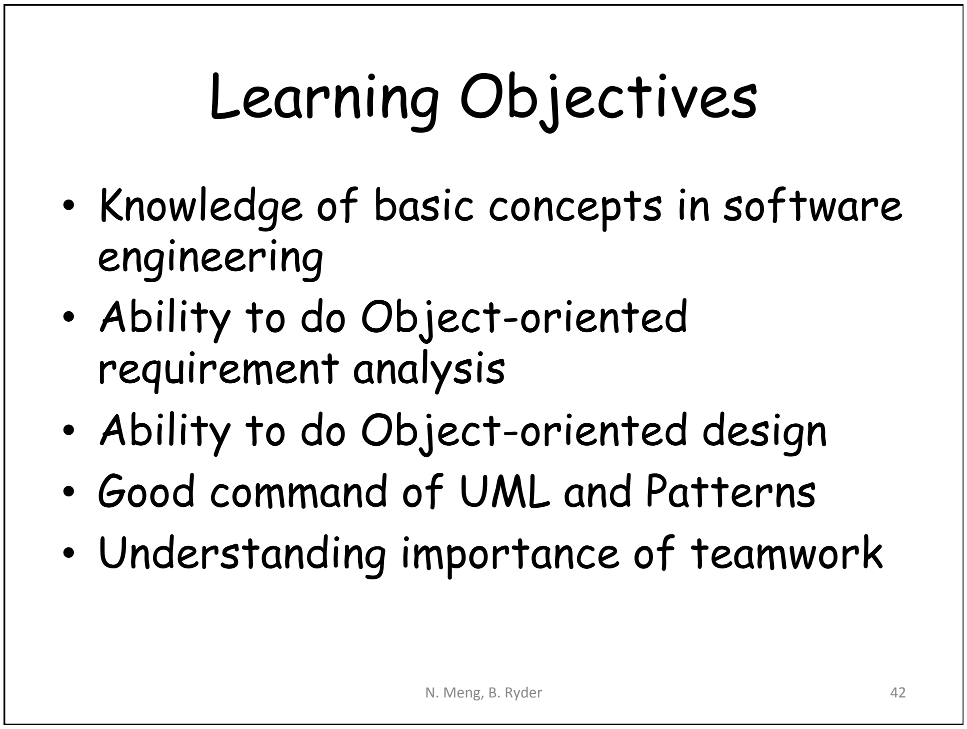
Practitioner's Myths

- "The only deliverable work product is the running program"
- Fact: Need the entire configuration
  - Documentation of system requirements, design, programming, and usage



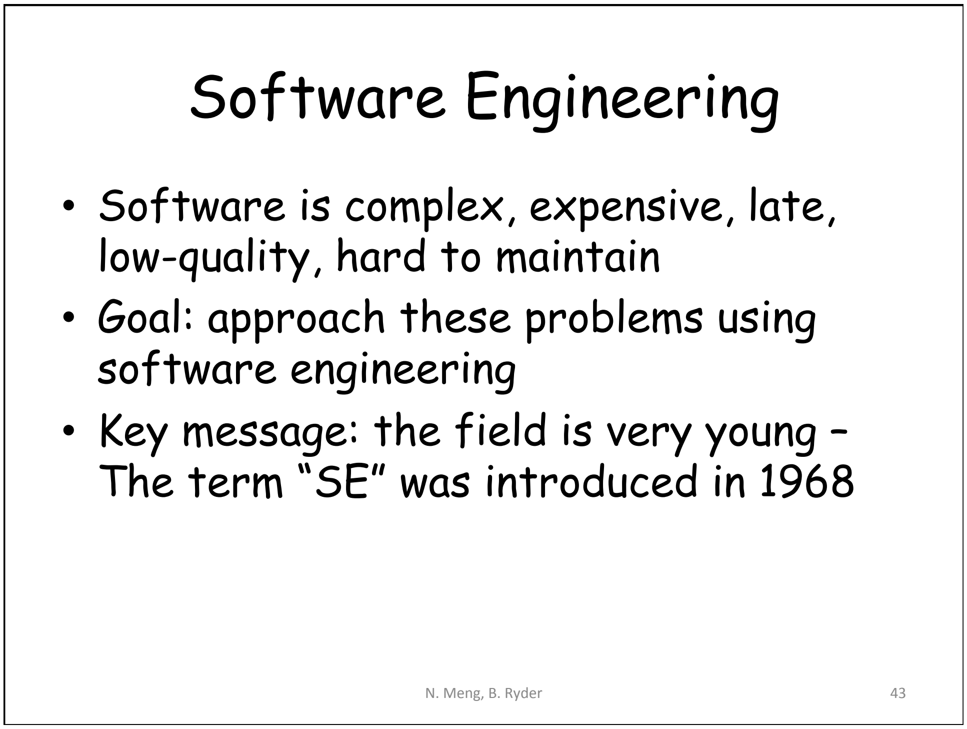
Practitioner's Myths

- "SE will slow us down by requiring unnecessary documentation"
- Fact: SE is about creating quality
  - Better quality -> reduced rework -> faster delivery time
  - Brooks recommends time division of: 1/3 planning; 1/6 coding; 1/4 component test and early system test; 1/4 system test



Learning Objectives

- Knowledge of basic concepts in software engineering
- Ability to do Object-oriented requirement analysis
- Ability to do Object-oriented design
- Good command of UML and Patterns
- Understanding importance of teamwork



Software Engineering

- Software is complex, expensive, late, low-quality, hard to maintain
- Goal: approach these problems using software engineering
- Key message: the field is very young – The term “SE” was introduced in 1968

N. Meng, B. Ryder 43