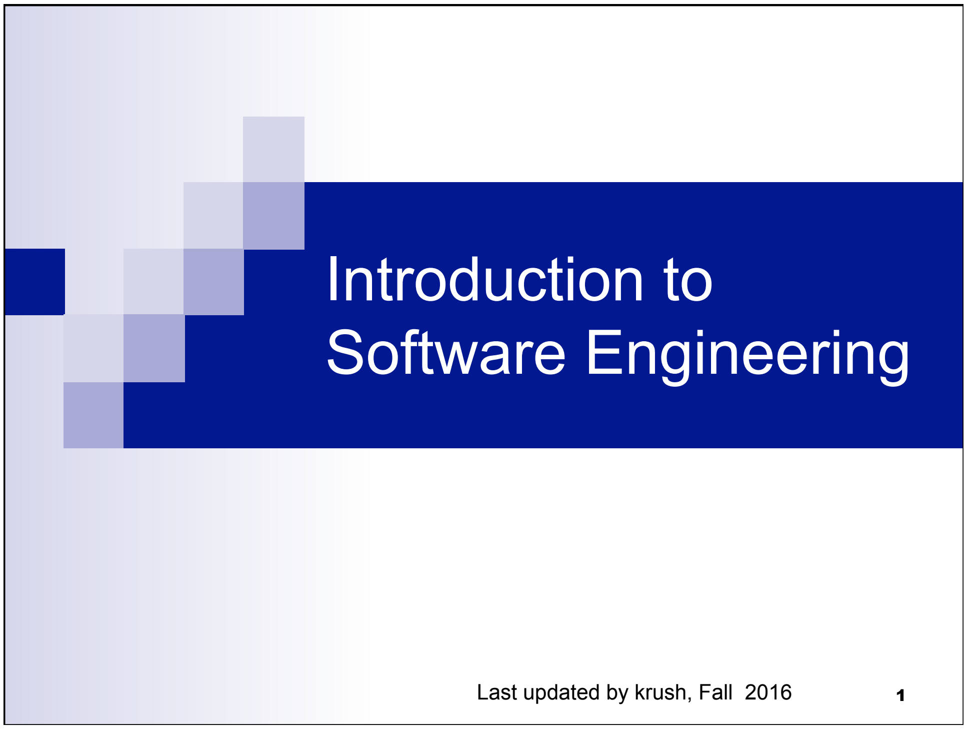

Introduction to Software Engineering

Last updated by krush, Fall 2016

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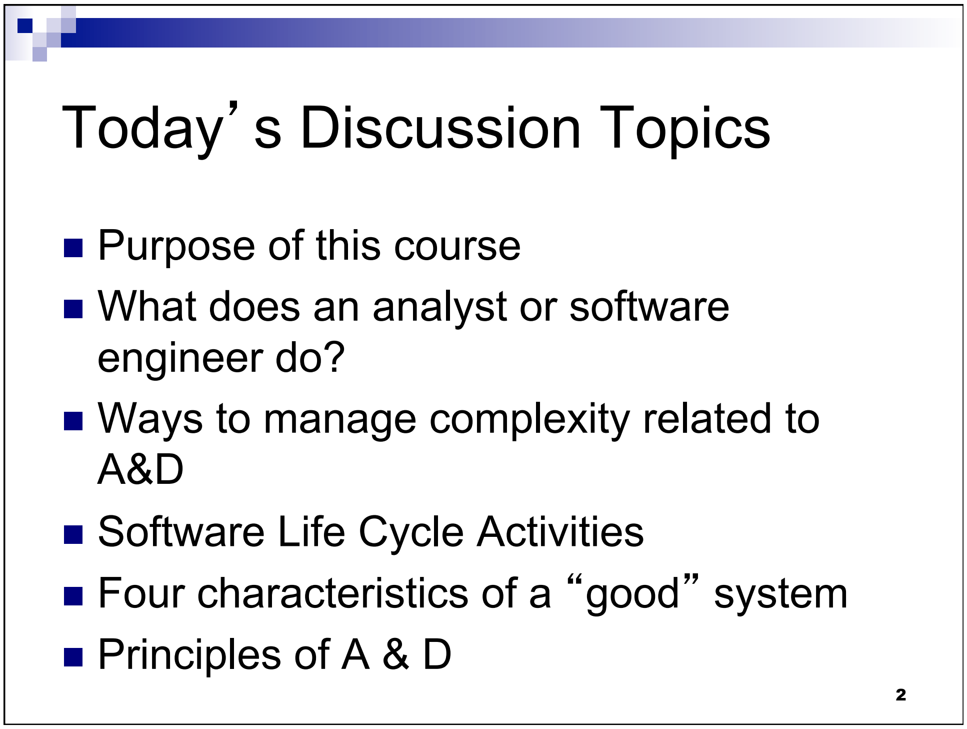

Today’s Discussion Topics

- Purpose of this course
- What does an analyst or software engineer do?
- Ways to manage complexity related to A&D
- Software Life Cycle Activities
- Four characteristics of a “good” system
- Principles of A & D

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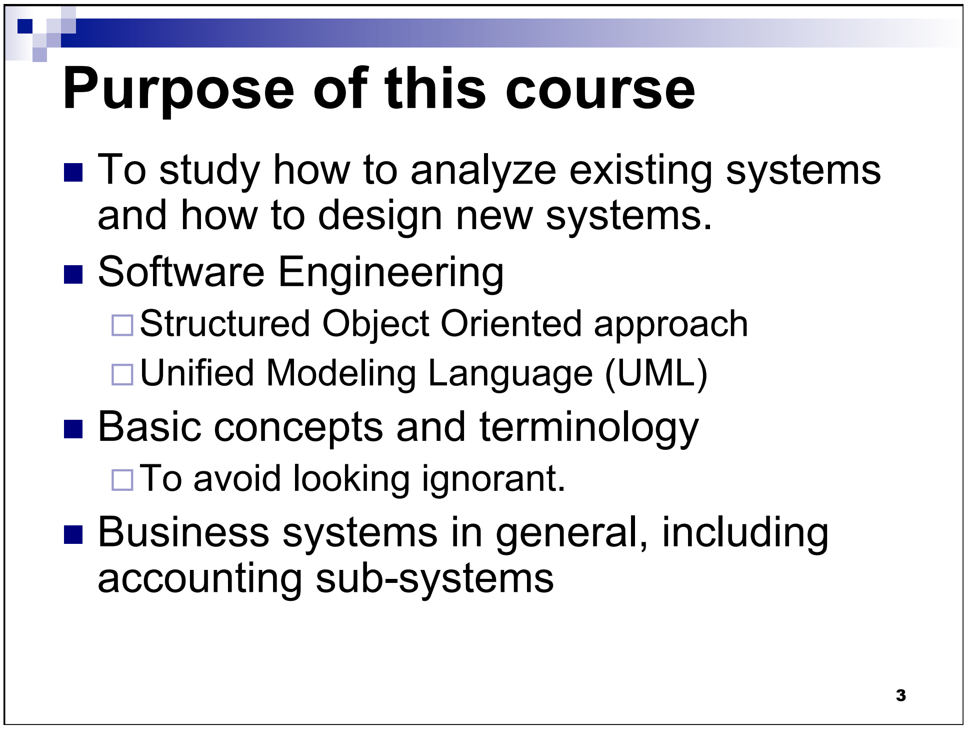
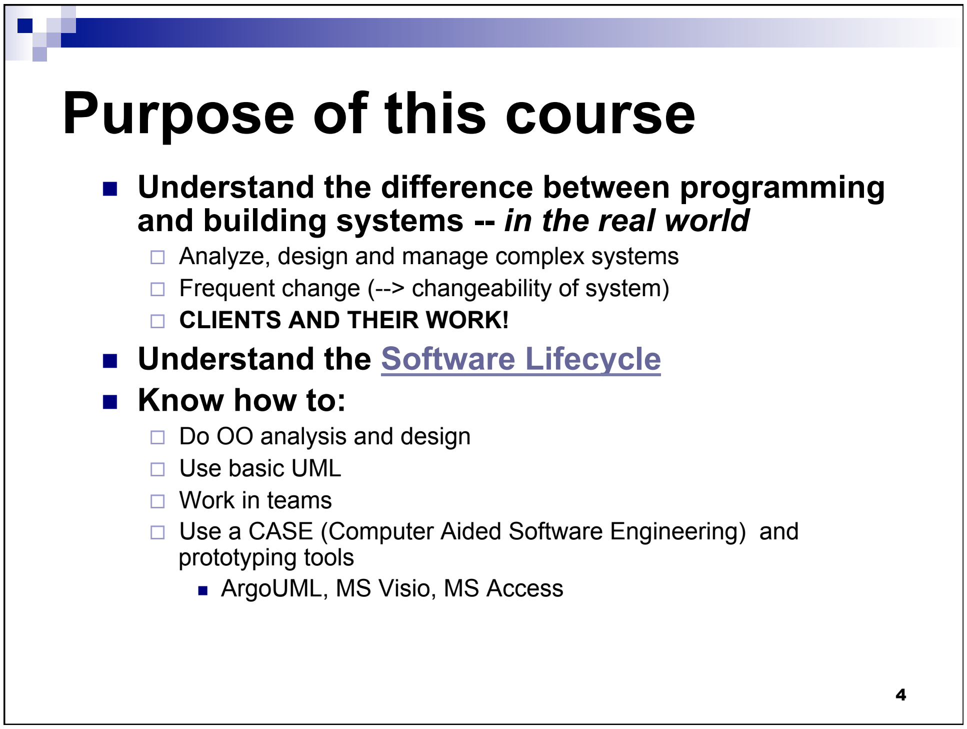


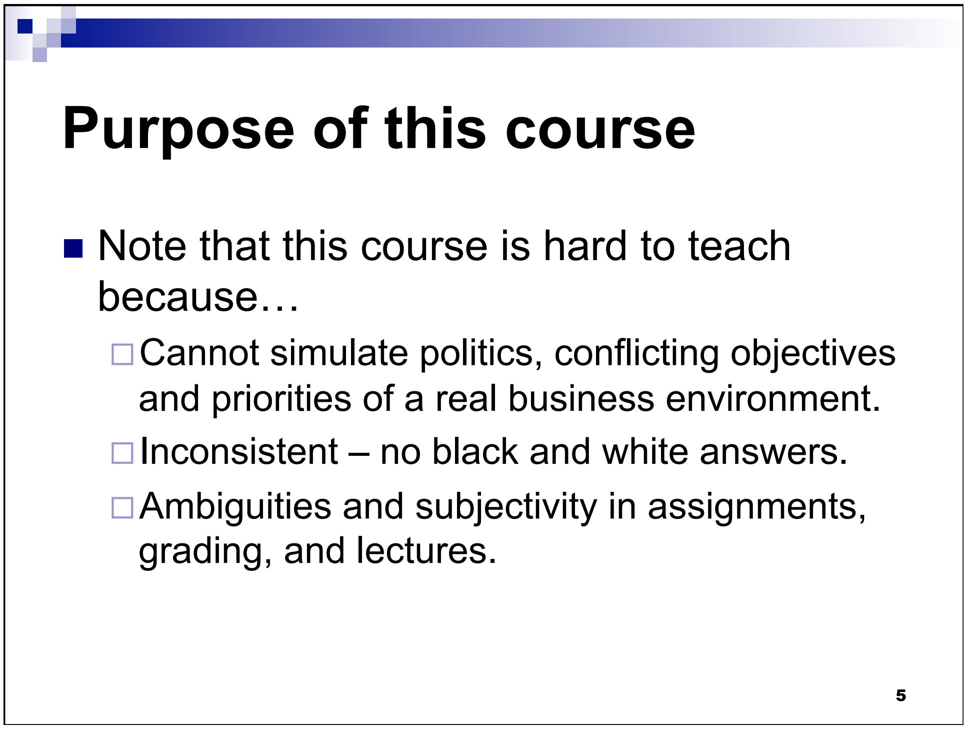
Purpose of this course

- To study how to analyze existing systems and how to design new systems.
- Software Engineering
  - □ Structured Object Oriented approach
  - □ Unified Modeling Language (UML)
- Basic concepts and terminology
  - □ To avoid looking ignorant.
- Business systems in general, including accounting sub-systems



Purpose of this course

- **Understand the difference between programming and building systems -- *in the real world***
  - □ Analyze, design and manage complex systems
  - □ Frequent change (--> changeability of system)
  - □ **CLIENTS AND THEIR WORK!**
- **Understand the Software Lifecycle**
- **Know how to:**
  - □ Do OO analysis and design
  - □ Use basic UML
  - □ Work in teams
  - □ Use a CASE (Computer Aided Software Engineering) and prototyping tools
    - ArgoUML, MS Visio, MS Access



Purpose of this course

- Note that this course is hard to teach because…
  - □ Cannot simulate politics, conflicting objectives and priorities of a real business environment.
  - □ Inconsistent – no black and white answers.
  - □ Ambiguities and subjectivity in assignments, grading, and lectures.

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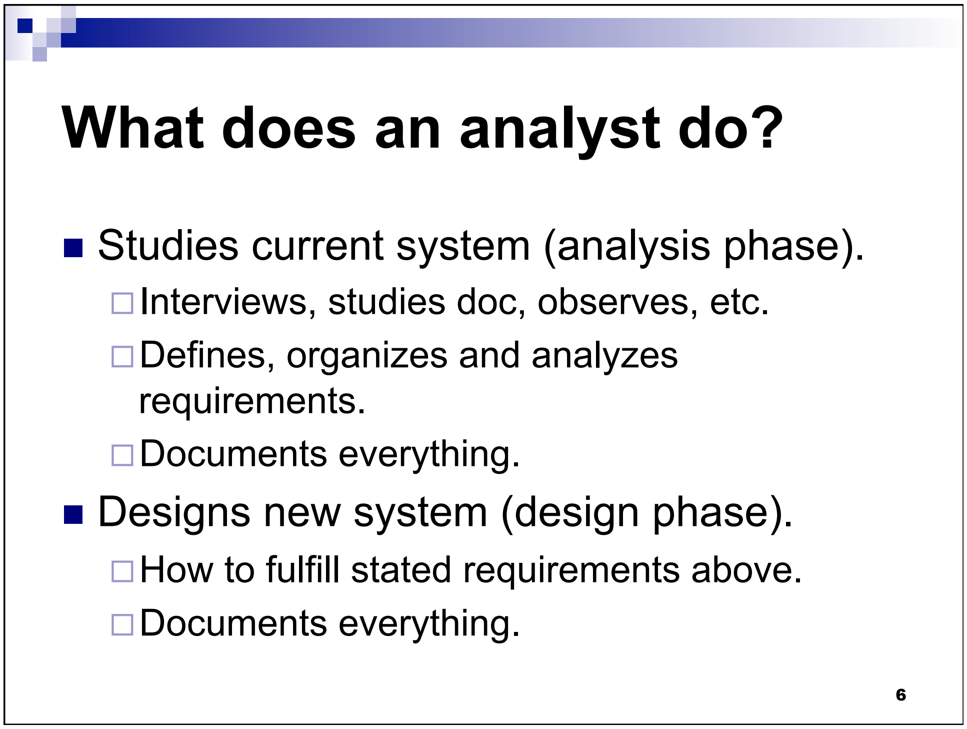

What does an analyst do?

- Studies current system (analysis phase).
  - □ Interviews, studies doc, observes, etc.
  - □ Defines, organizes and analyzes requirements.
  - □ Documents everything.
- Designs new system (design phase).
  - □ How to fulfill stated requirements above.
  - □ Documents everything.

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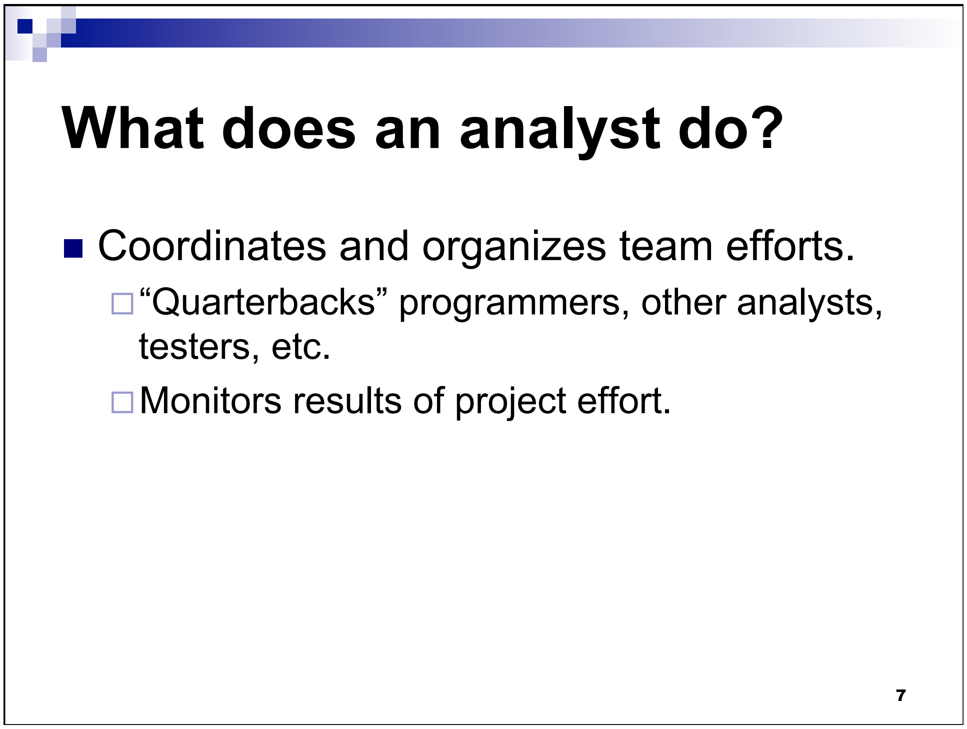

What does an analyst do?

- Coordinates and organizes team efforts.
  - “Quarterbacks” programmers, other analysts, testers, etc.
  - Monitors results of project effort.

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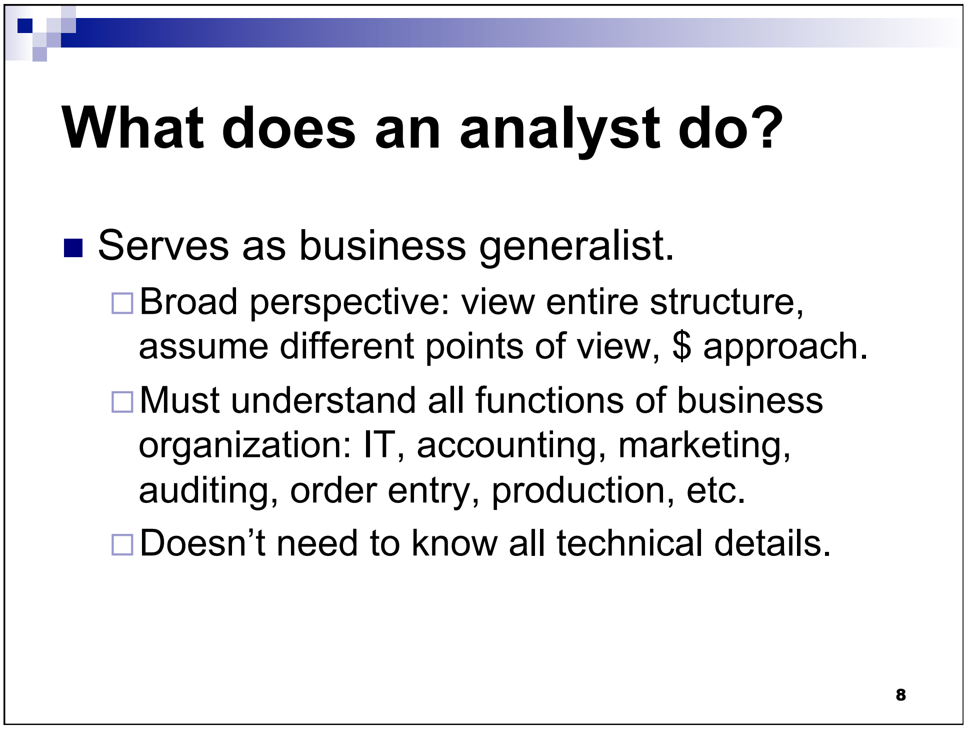

What does an analyst do?

- Serves as business generalist.
  - Broad perspective: view entire structure, assume different points of view, $ approach.
  - Must understand all functions of business organization: IT, accounting, marketing, auditing, order entry, production, etc.
  - Doesn’t need to know all technical details.

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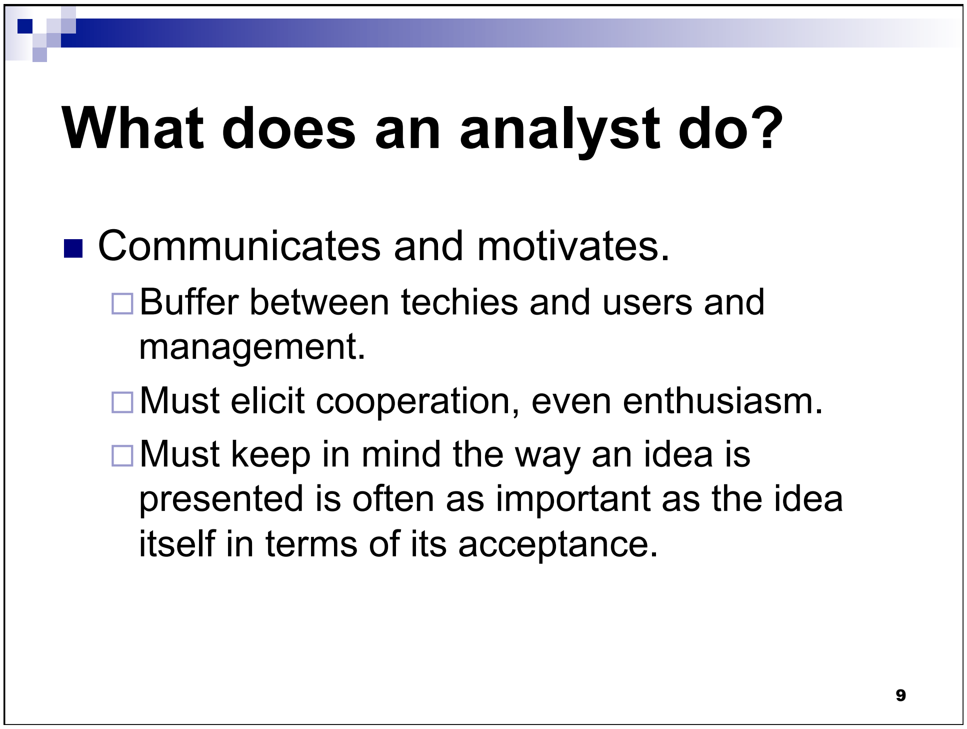

What does an analyst do?

- Communicates and motivates.
  - □ Buffer between techies and users and management.
  - □ Must elicit cooperation, even enthusiasm.
  - □ Must keep in mind the way an idea is presented is often as important as the idea itself in terms of its acceptance.

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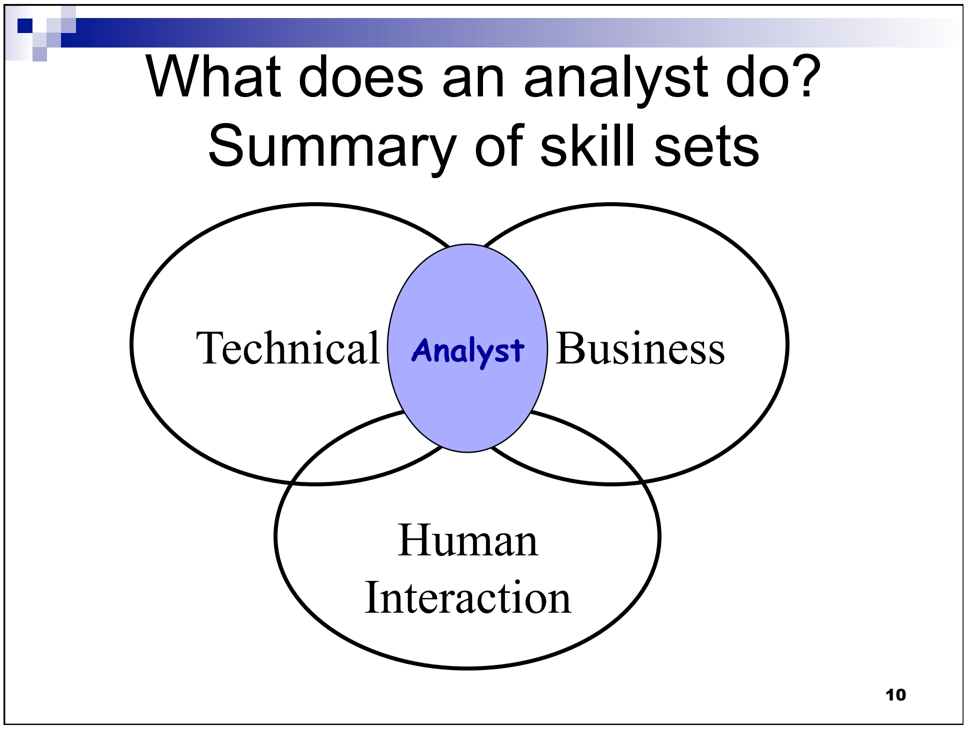

What does an analyst do? Summary of skill sets

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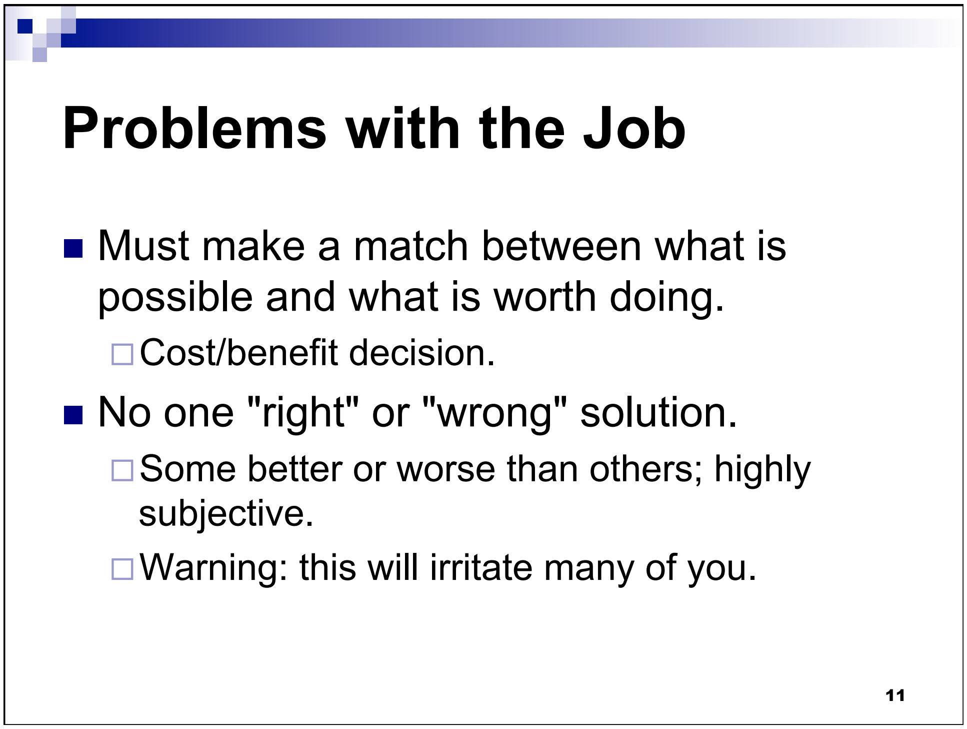
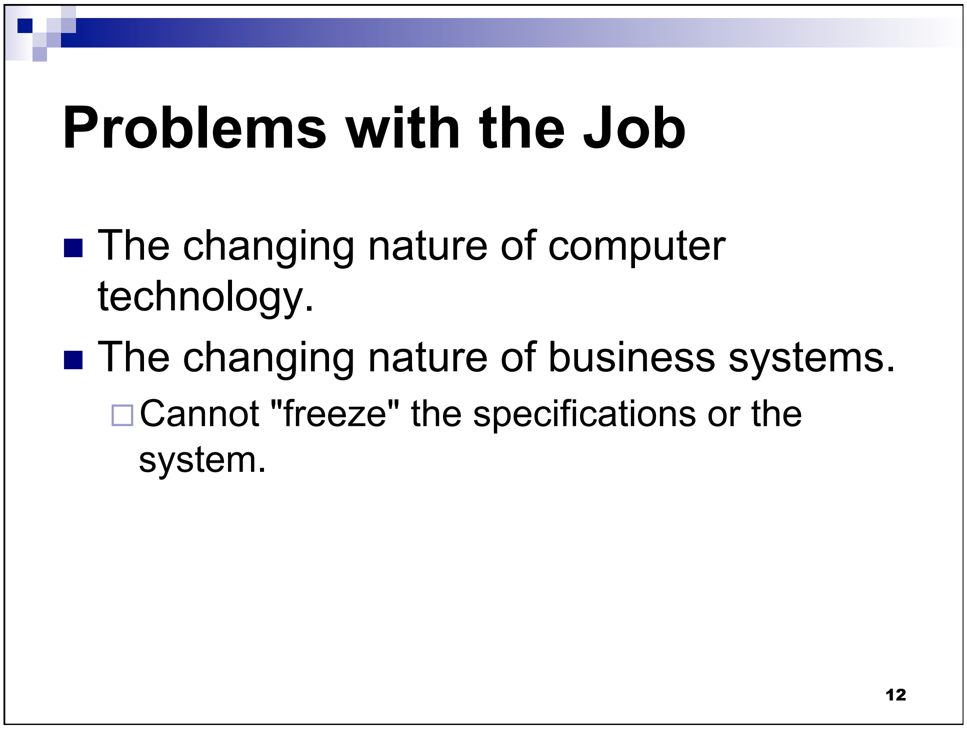


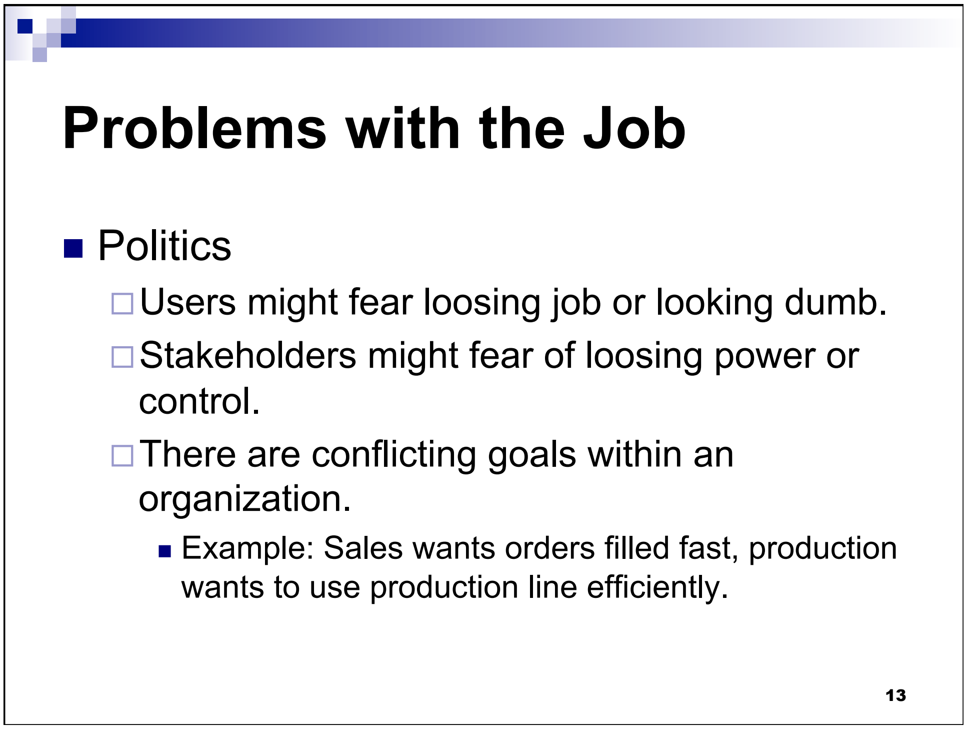
Problems with the Job

- Must make a match between what is possible and what is worth doing.
  - □ Cost/benefit decision.
- No one "right" or "wrong" solution.
  - □ Some better or worse than others; highly subjective.
  - □ Warning: this will irritate many of you.



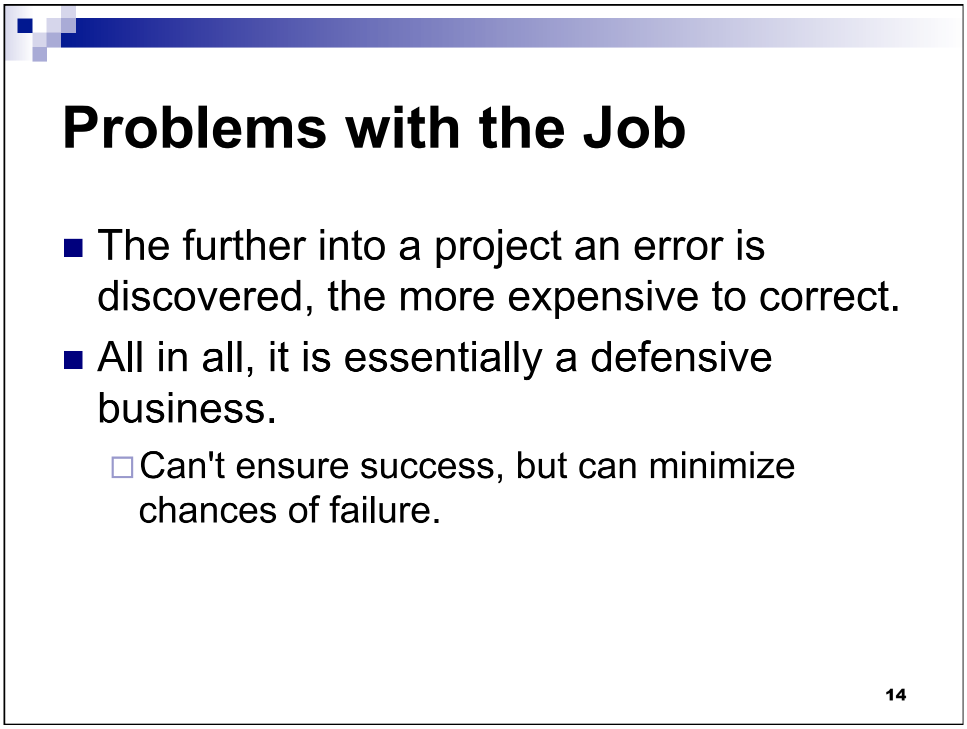
Problems with the Job

- The changing nature of computer technology.
- The changing nature of business systems.
  - □ Cannot "freeze" the specifications or the system.



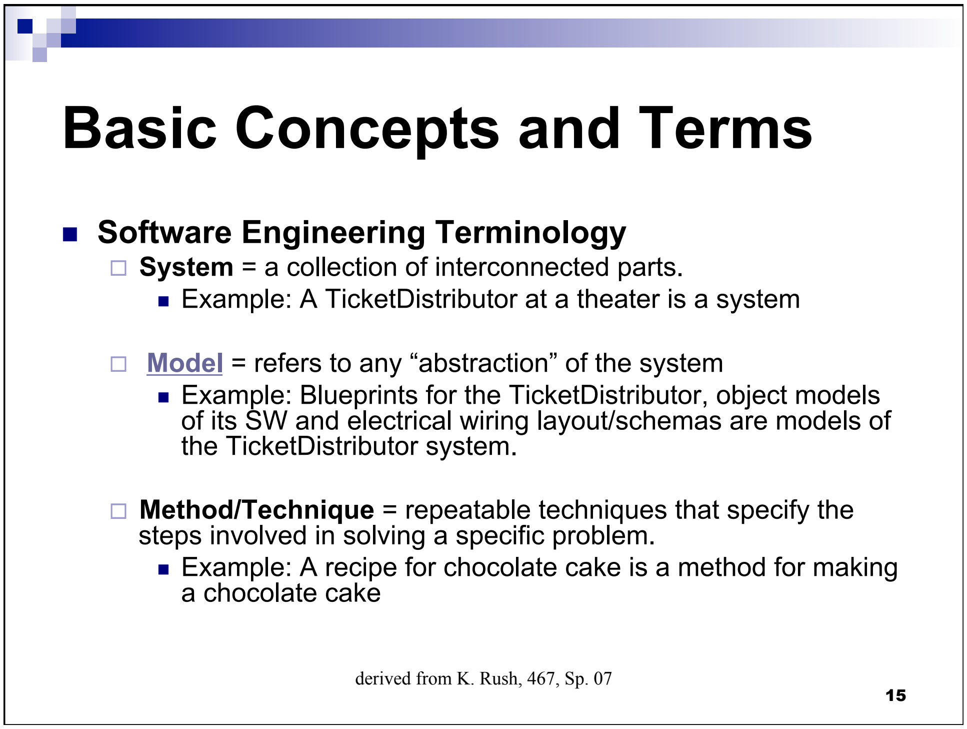
Problems with the Job

- Politics
  - Users might fear loosing job or looking dumb.
  - Stakeholders might fear of loosing power or control.
  - There are conflicting goals within an organization.
    - Example: Sales wants orders filled fast, production wants to use production line efficiently.



Problems with the Job

- The further into a project an error is discovered, the more expensive to correct.
- All in all, it is essentially a defensive business.
  - Can't ensure success, but can minimize chances of failure.



Basic Concepts and Terms

- **Software Engineering Terminology**
  - □ **System** = a collection of interconnected parts.
    - Example: A TicketDistributor at a theater is a system
  - □ Model = refers to any “abstraction” of the system
    - Example: Blueprints for the TicketDistributor, object models of its SW and electrical wiring layout/schemas are models of the TicketDistributor system.
  - □ **Method/Technique** = repeatable techniques that specify the steps involved in solving a specific problem.
    - Example: A recipe for chocolate cake is a method for making a chocolate cake

derived from K. Rush, 467, Sp. 07

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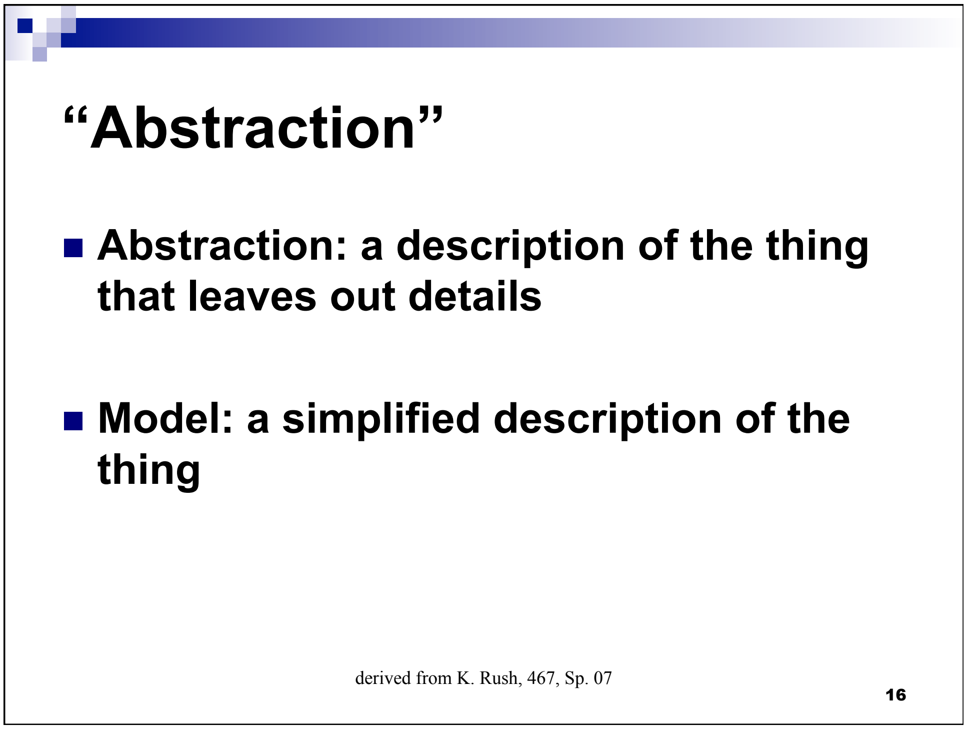

“Abstraction”

- **Abstraction: a description of the thing that leaves out details**
- **Model: a simplified description of the thing**

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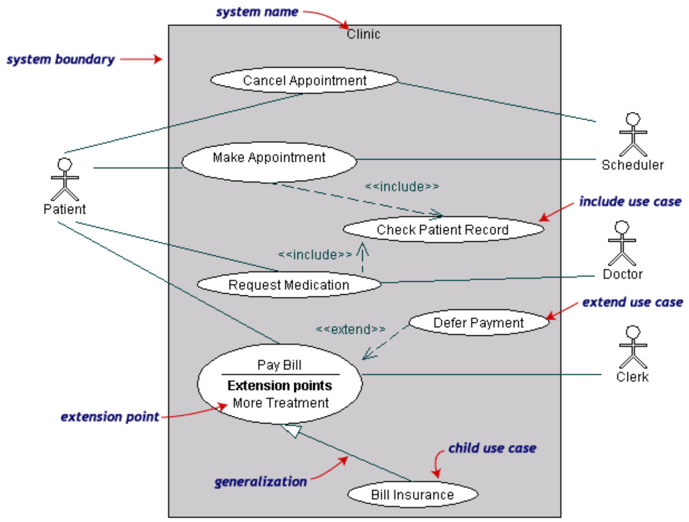
Example: Model



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Basic Concepts and Terms (Cont’d)

- **Functional Requirements** = all the functions the system must do (or allow a user to do)
  - □ Example: A customer shall be able to add an item to a shopping basket.
- **Non-Functional Requirements** = other characteristics or attributes the system must have
  - □ Example: The system must be available 24 - 7.
- **Problem/Application Domain** = All aspects of the user’s problem/ situation
  - □ Physical environment
  - □ The users
  - □ Work processes
- **Solution Domain** = The system: objects, processes, design, implementation

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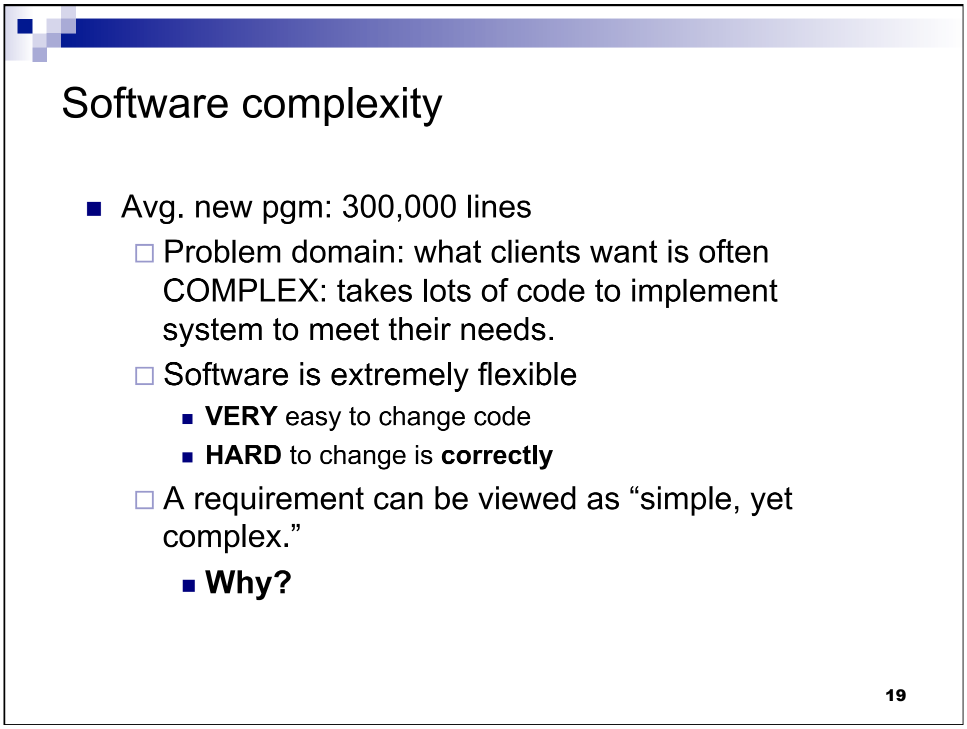
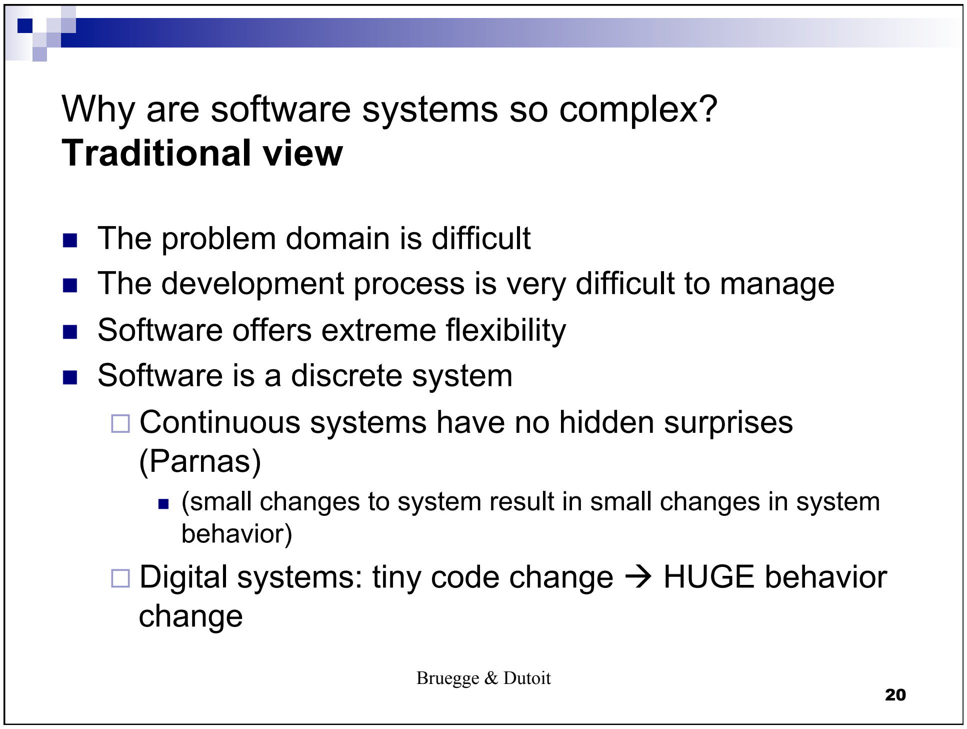


Software complexity

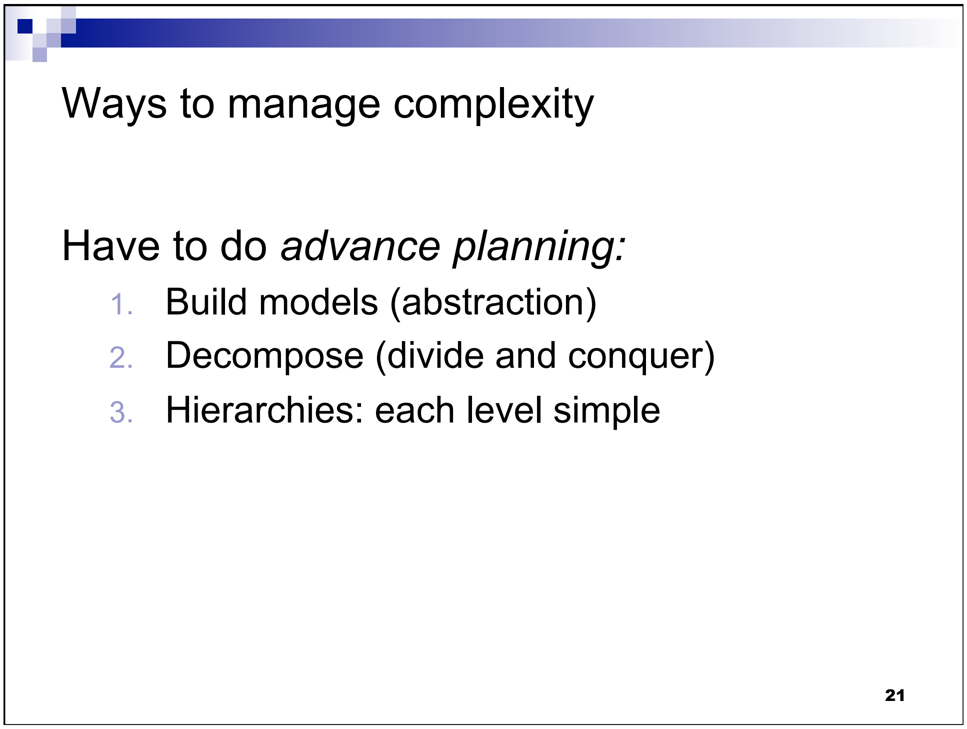
- Avg. new pgm: 300,000 lines
  - □ Problem domain: what clients want is often COMPLEX: takes lots of code to implement system to meet their needs.
  - □ Software is extremely flexible
    - **VERY** easy to change code
    - **HARD** to change is **correctly**
  - □ A requirement can be viewed as “simple, yet complex.”
    - **Why?**



Why are software systems so complex? **Traditional view**

- The problem domain is difficult
- The development process is very difficult to manage
- Software offers extreme flexibility
- Software is a discrete system
  - □ Continuous systems have no hidden surprises (Parnas)
    - (small changes to system result in small changes in system behavior)
  - □ Digital systems: tiny code change → HUGE behavior change

Bruegge & Dutoit



Ways to manage complexity

Have to do *advance planning:*

1. Build models (abstraction)
2. Decompose (divide and conquer)
3. Hierarchies: each level simple

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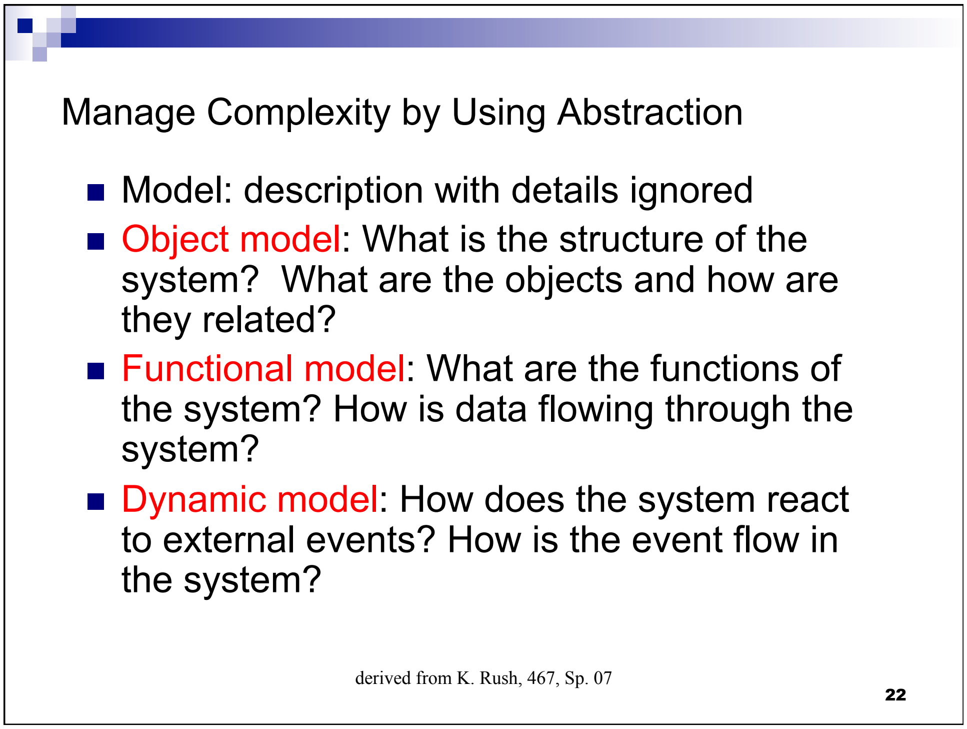

Manage Complexity by Using Abstraction

- Model: description with details ignored
- Object model: What is the structure of the system? What are the objects and how are they related?
- Functional model: What are the functions of the system? How is data flowing through the system?
- Dynamic model: How does the system react to external events? How is the event flow in the system?

derived from K. Rush, 467, Sp. 07

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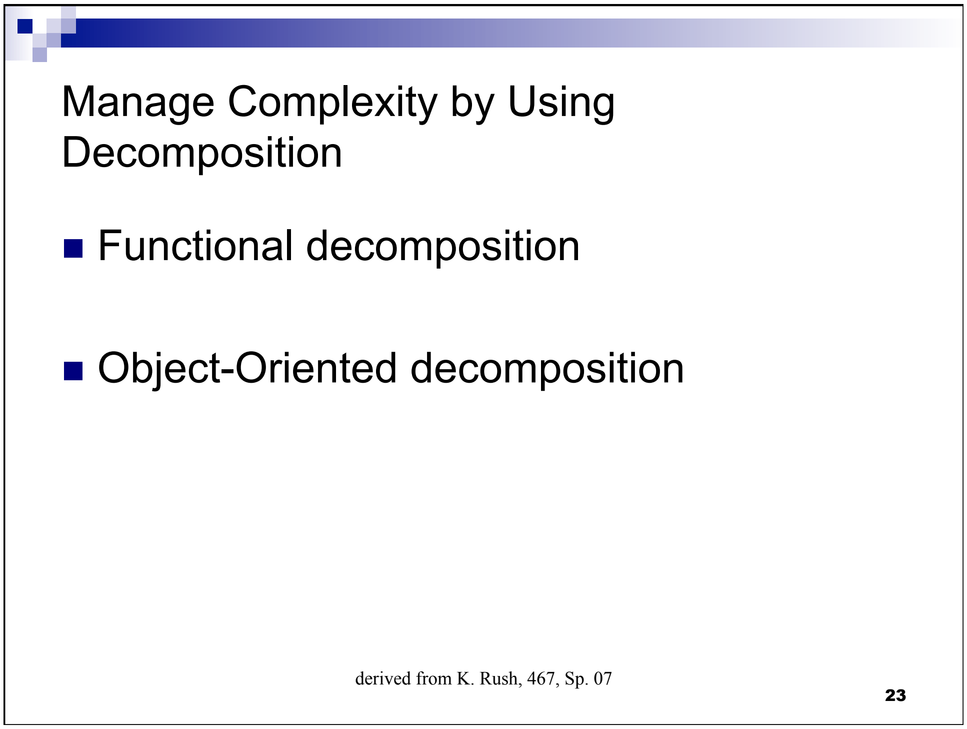

Manage Complexity by Using Decomposition

- Functional decomposition
- Object-Oriented decomposition

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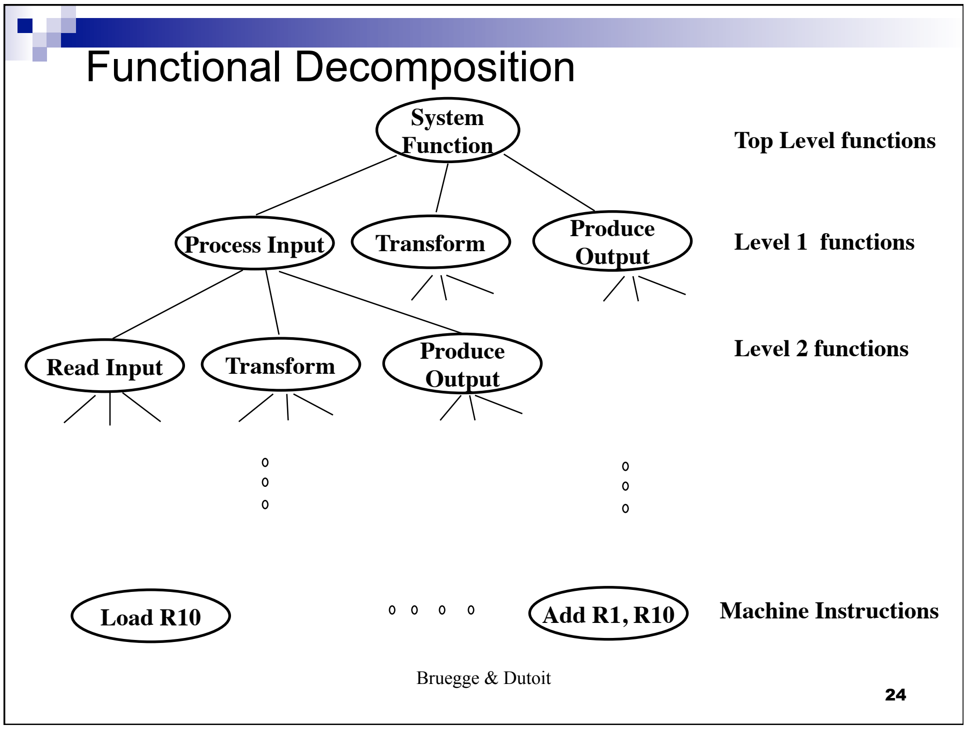

Functional Decomposition

System Function

Process Input

Transform

Produce Output

Read Input

Transform

Produce Output

Load R10

Add R1, R10

Top Level functions

Level 1 functions

Level 2 functions

Machine Instructions

Bruegge & Dutoit

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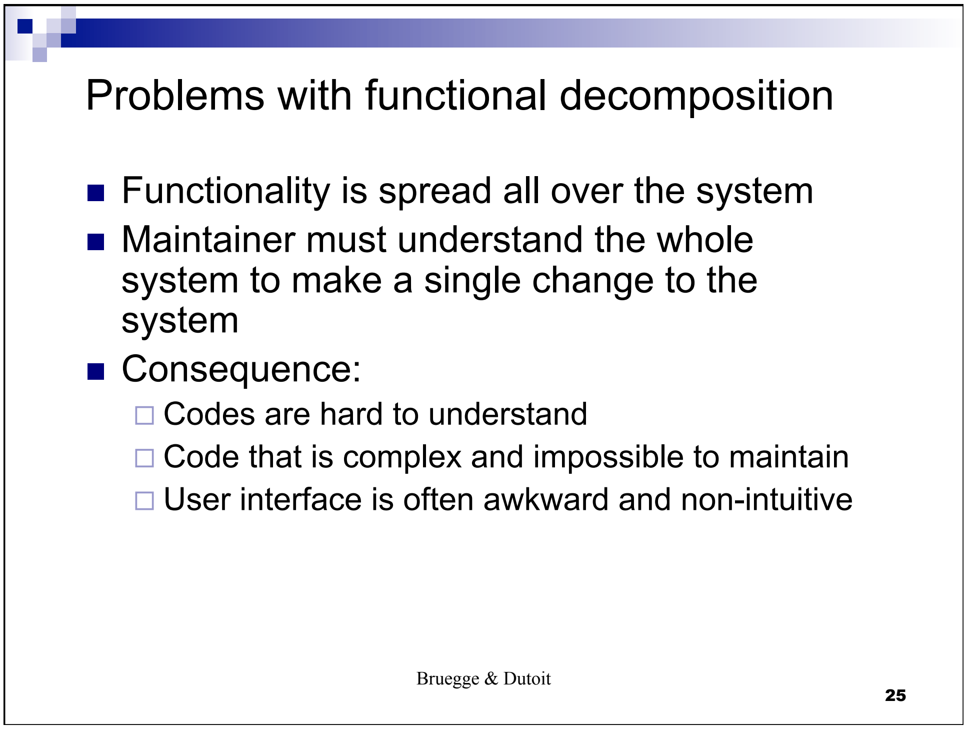
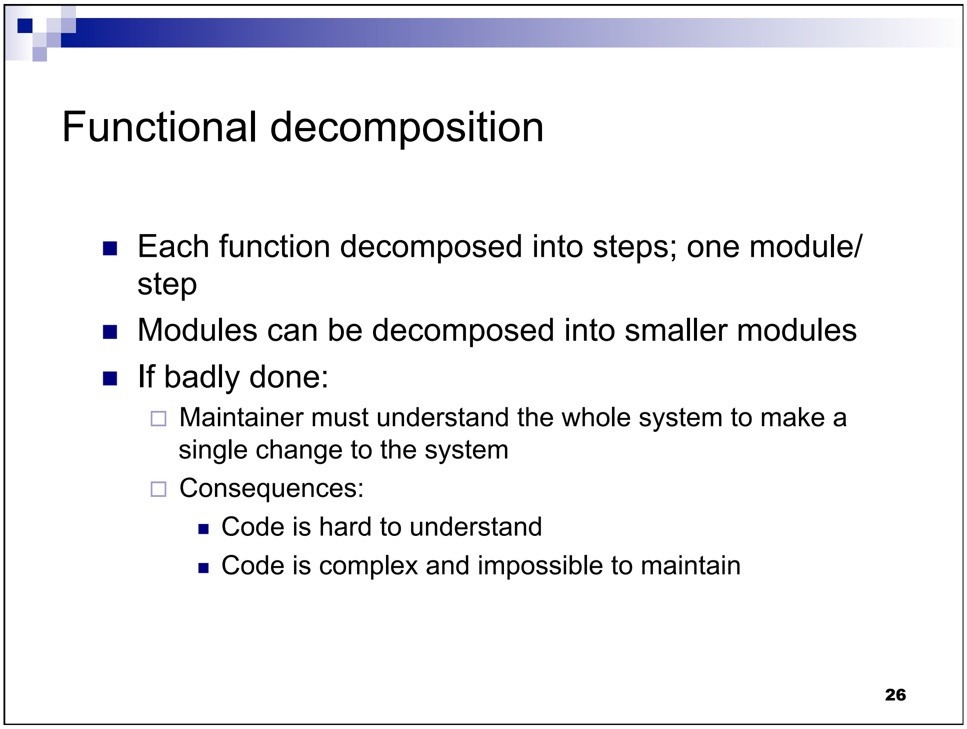


Problems with functional decomposition

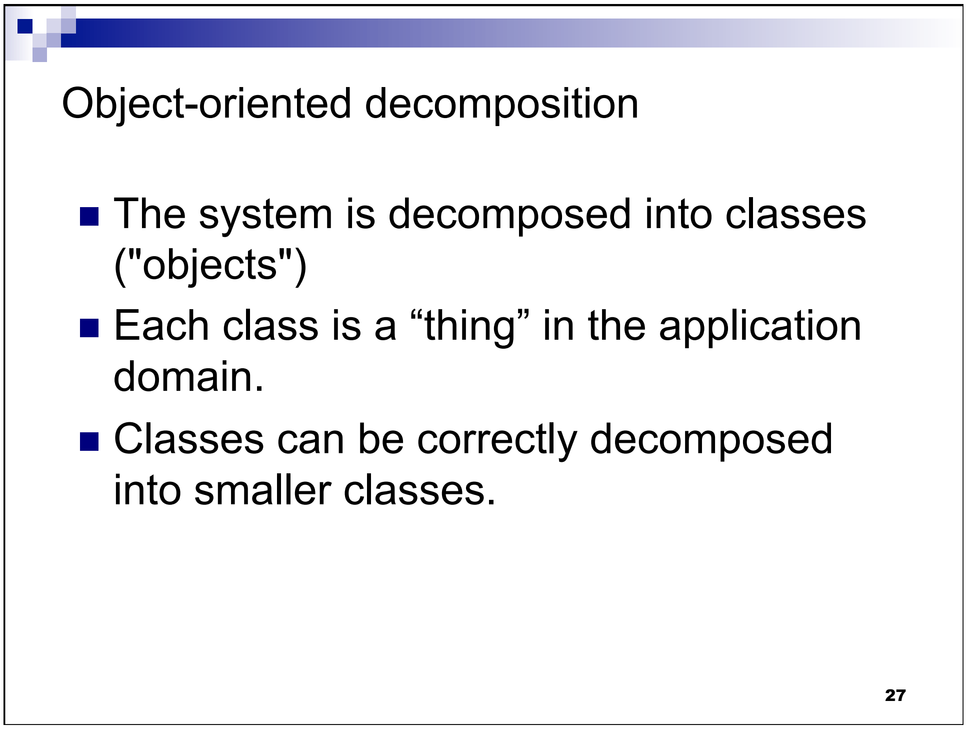
- Functionality is spread all over the system
- Maintainer must understand the whole system to make a single change to the system
- Consequence:
  - □ Codes are hard to understand
  - □ Code that is complex and impossible to maintain
  - □ User interface is often awkward and non-intuitive

Bruegge & Dutoit



Functional decomposition

- Each function decomposed into steps; one module/ step
- Modules can be decomposed into smaller modules
- If badly done:
  - □ Maintainer must understand the whole system to make a single change to the system
  - □ Consequences:
    - Code is hard to understand
    - Code is complex and impossible to maintain



Object-oriented decomposition

- The system is decomposed into classes ("objects")
- Each class is a “thing” in the application domain.
- Classes can be correctly decomposed into smaller classes.

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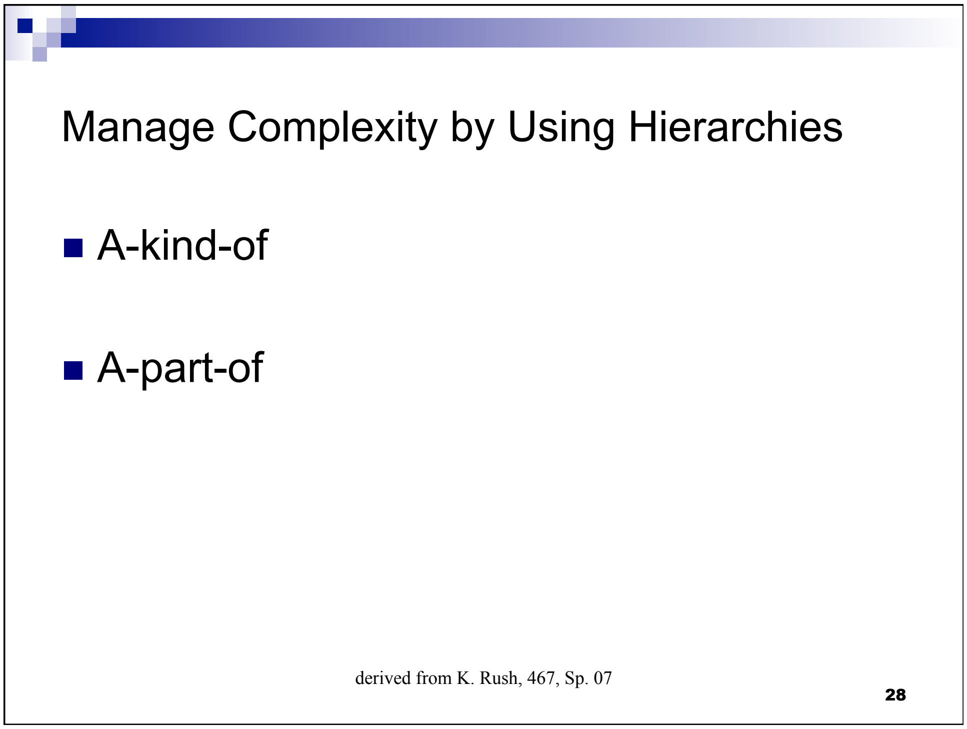

Manage Complexity by Using Hierarchies

- A-kind-of
- A-part-of

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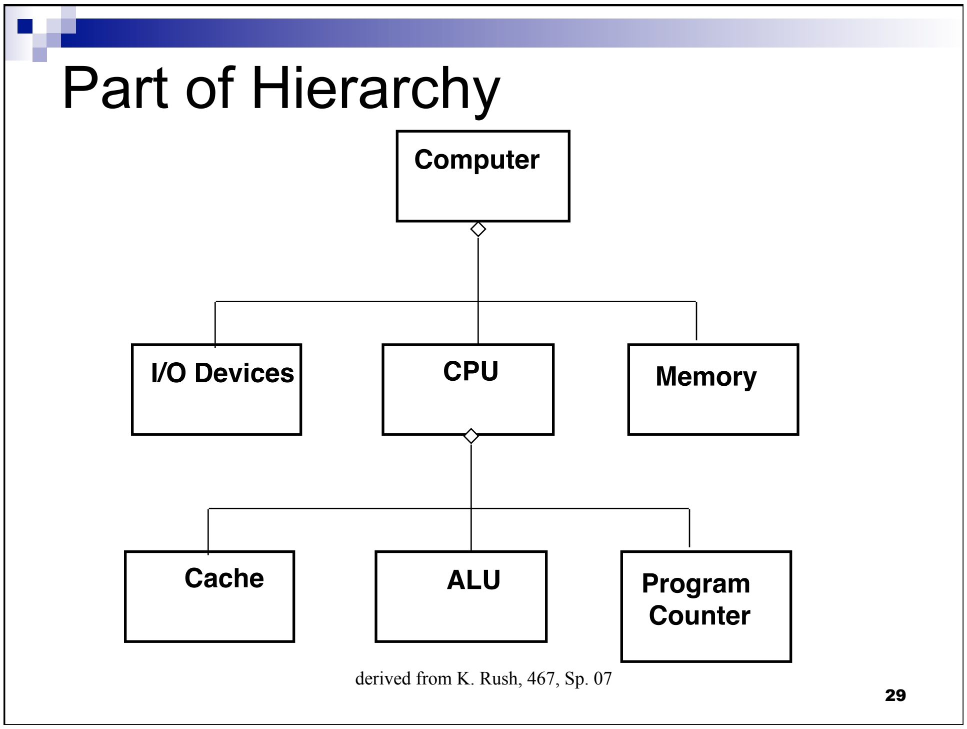

Part of Hierarchy

Computer

I/O Devices

CPU

Memory

Cache

ALU

Program Counter

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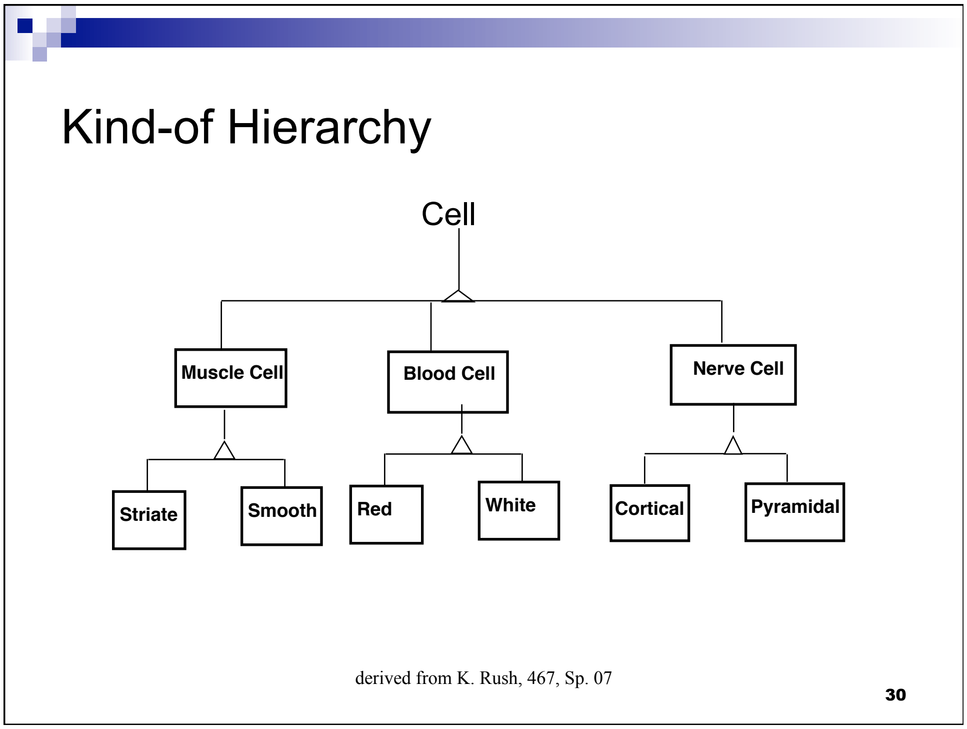

Kind-of Hierarchy

Cell

Muscle Cell

Blood Cell

Nerve Cell

Striate

Smooth

Red

White

Cortical

Pyramidal

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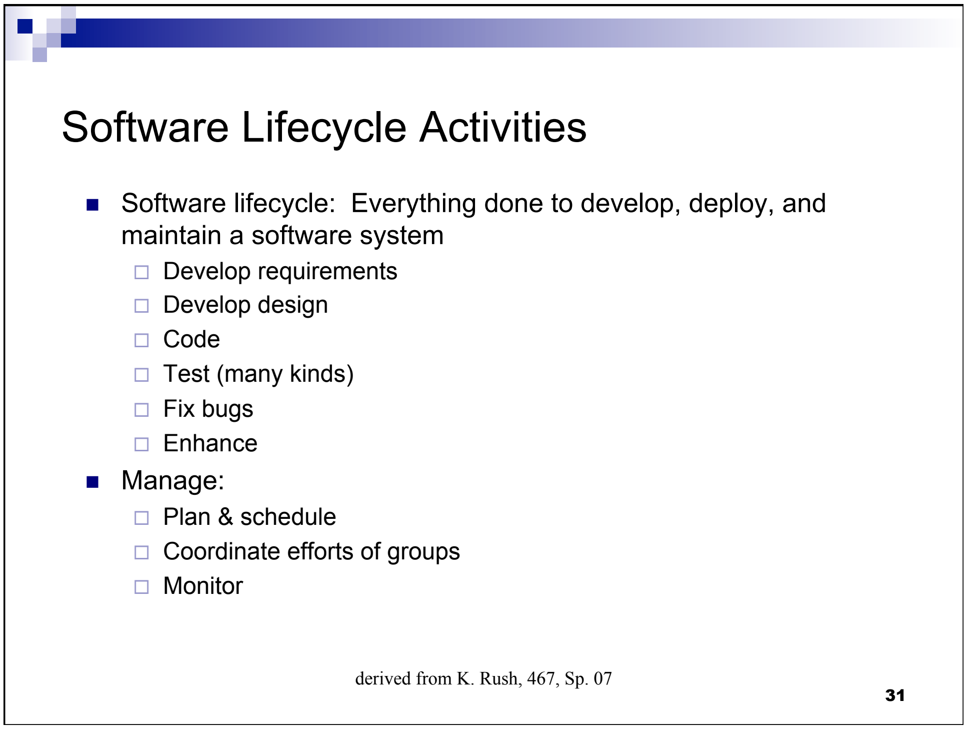

Software Lifecycle Activities

- Software lifecycle: Everything done to develop, deploy, and maintain a software system
  - □ Develop requirements
  - □ Develop design
  - □ Code
  - □ Test (many kinds)
  - □ Fix bugs
  - □ Enhance
- Manage:
  - □ Plan & schedule
  - □ Coordinate efforts of groups
  - □ Monitor

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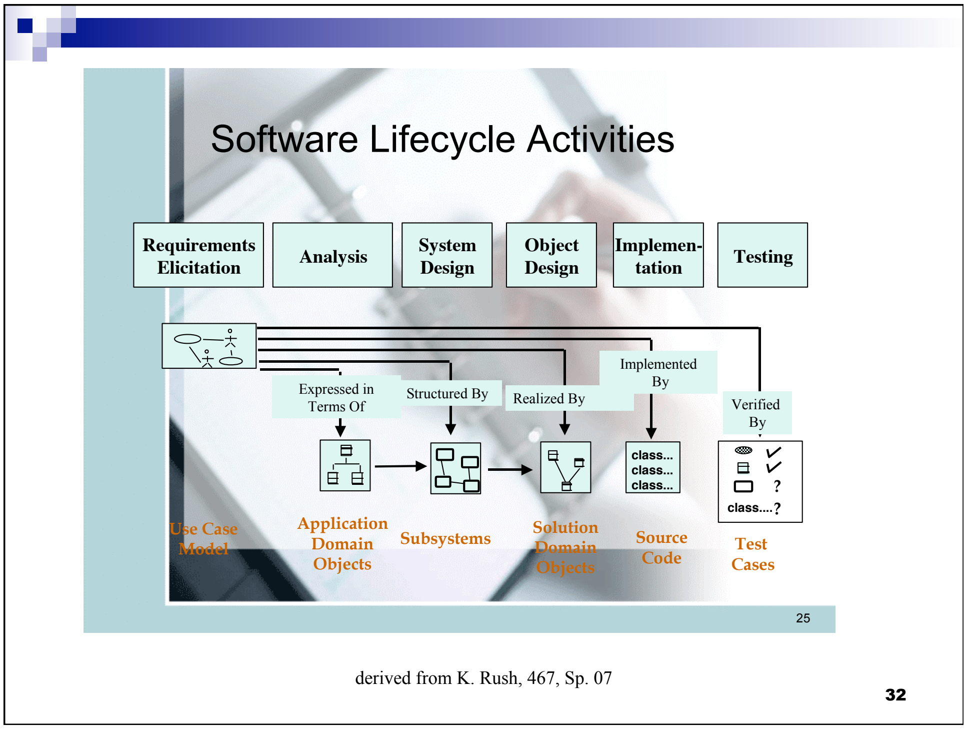

Software Lifecycle Activities

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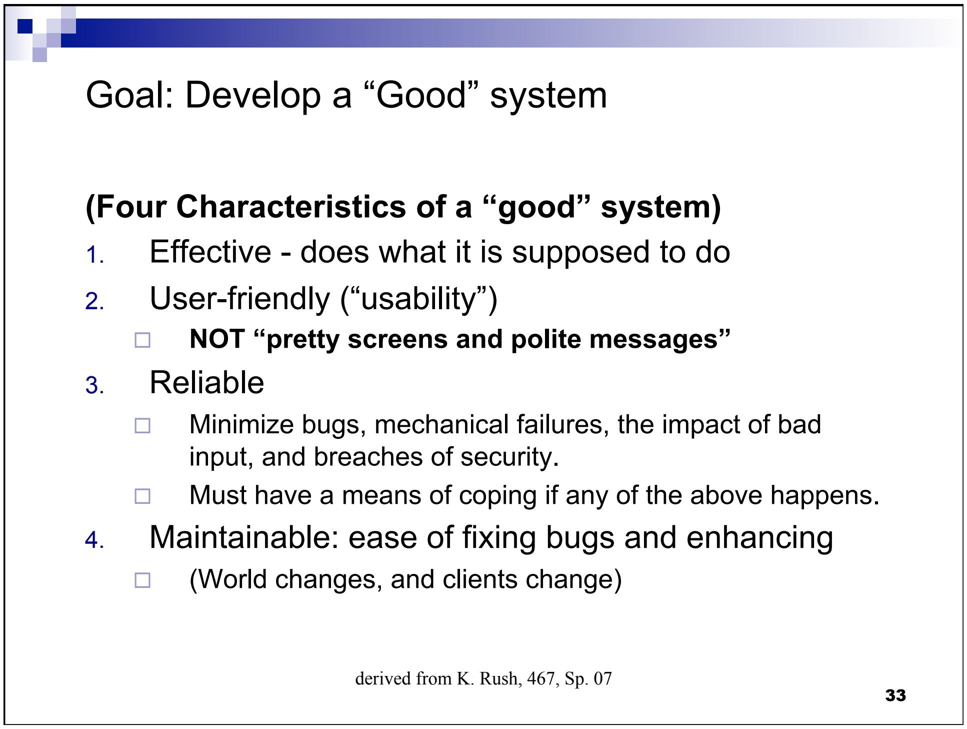

Goal: Develop a “Good” system

(Four Characteristics of a “good” system)

1. Effective - does what it is supposed to do
2. User-friendly (“usability”)
   - □ **NOT “pretty screens and polite messages”**
3. Reliable
   - □ Minimize bugs, mechanical failures, the impact of bad input, and breaches of security.
   - □ Must have a means of coping if any of the above happens.
4. Maintainable: ease of fixing bugs and enhancing
   - □ (World changes, and clients change)

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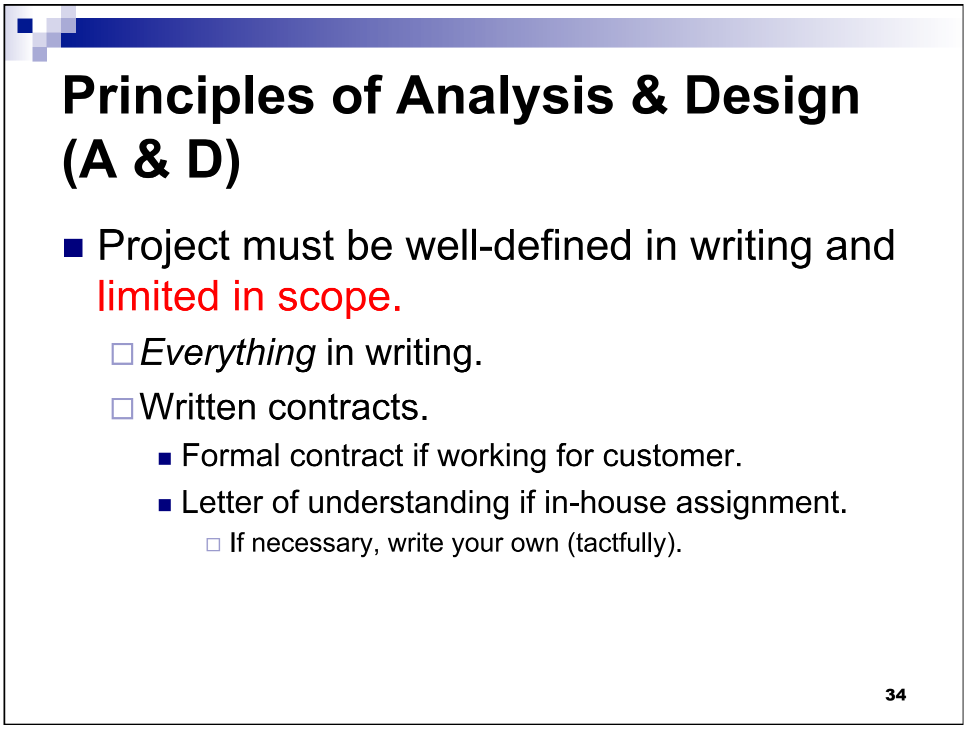

Principles of Analysis & Design (A & D)

- ■ Project must be well-defined in writing and limited in scope.
  - □ *Everything* in writing.
  - □ Written contracts.
    - ■ Formal contract if working for customer.
    - ■ Letter of understanding if in-house assignment.
      - □ If necessary, write your own (tactfully).

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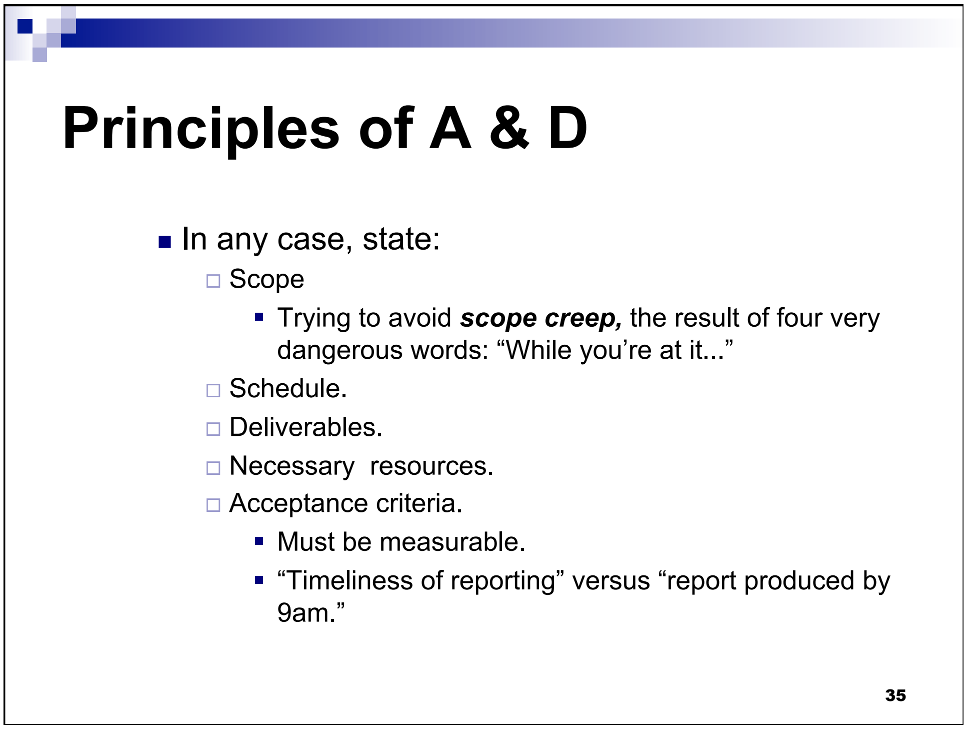
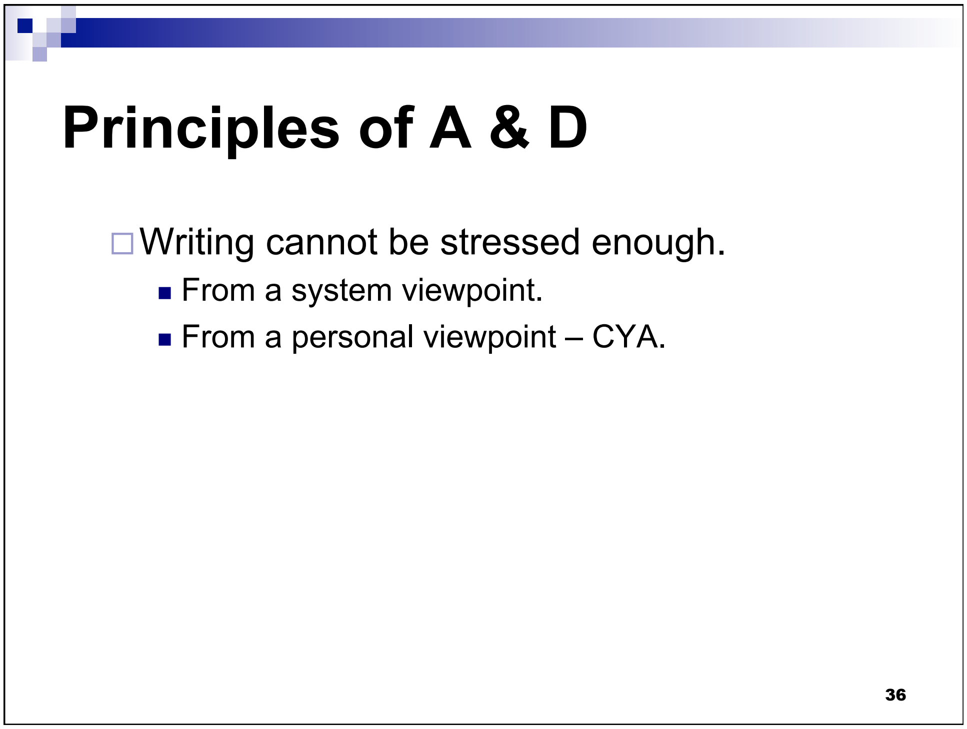


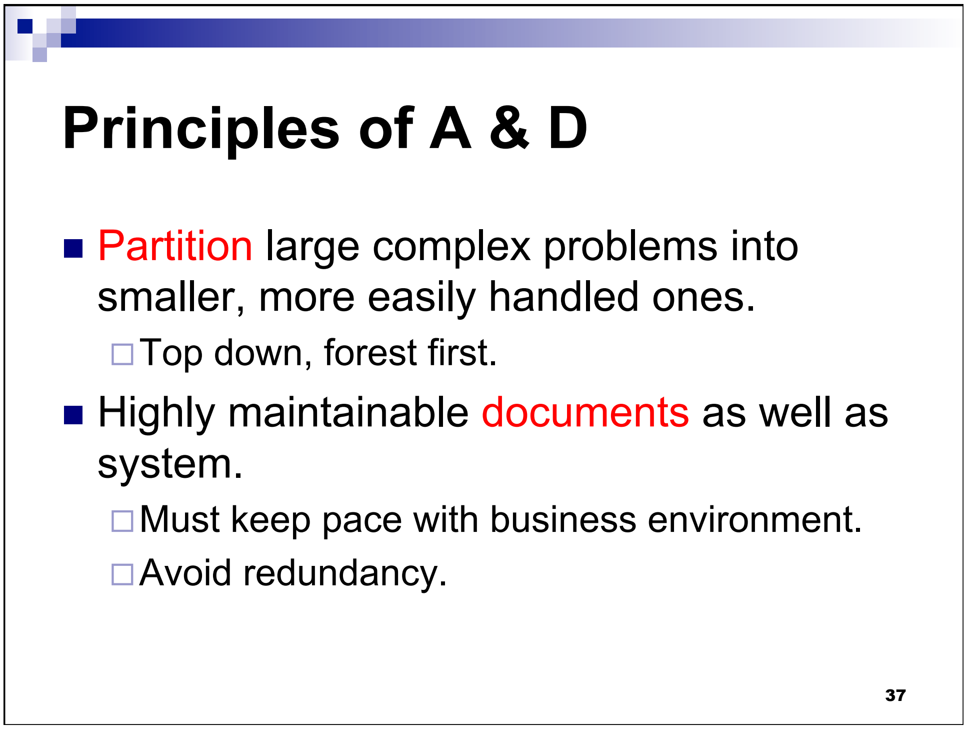
Principles of A & D

- In any case, state:
  - Scope
    - Trying to avoid ***scope creep,*** the result of four very dangerous words: “While you’re at it...”
  - Schedule.
  - Deliverables.
  - Necessary resources.
  - Acceptance criteria.
    - Must be measurable.
    - “Timeliness of reporting” versus “report produced by 9am.”



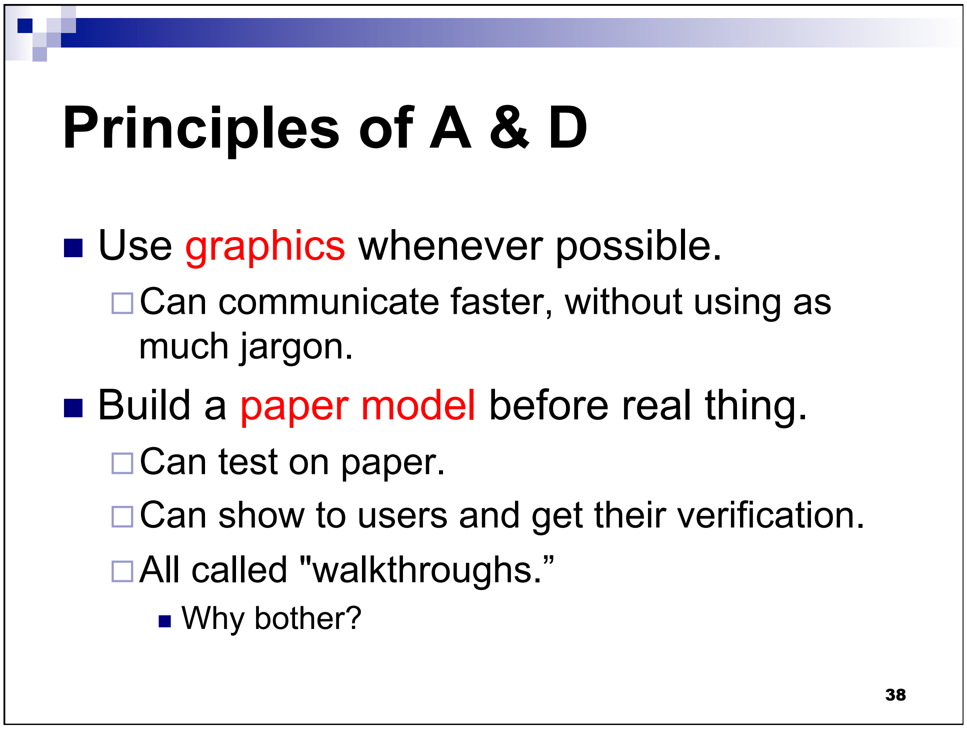
Principles of A & D

- Writing cannot be stressed enough.
  - From a system viewpoint.
  - From a personal viewpoint – CYA.



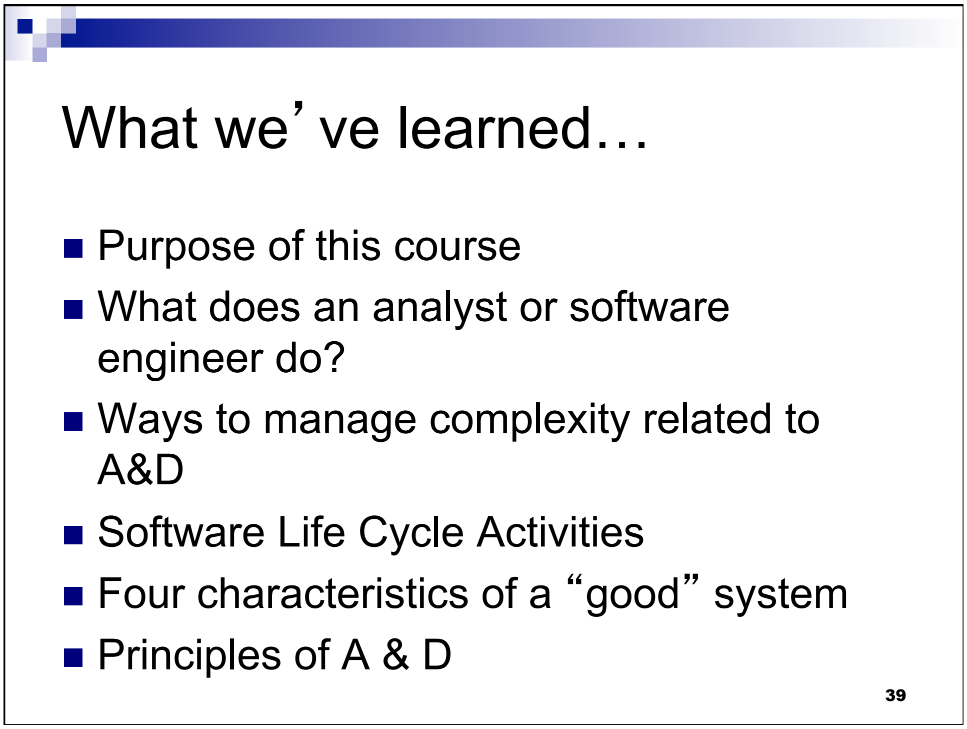
Principles of A & D

- Partition large complex problems into smaller, more easily handled ones.
  - Top down, forest first.
- Highly maintainable documents as well as system.
  - Must keep pace with business environment.
  - Avoid redundancy.



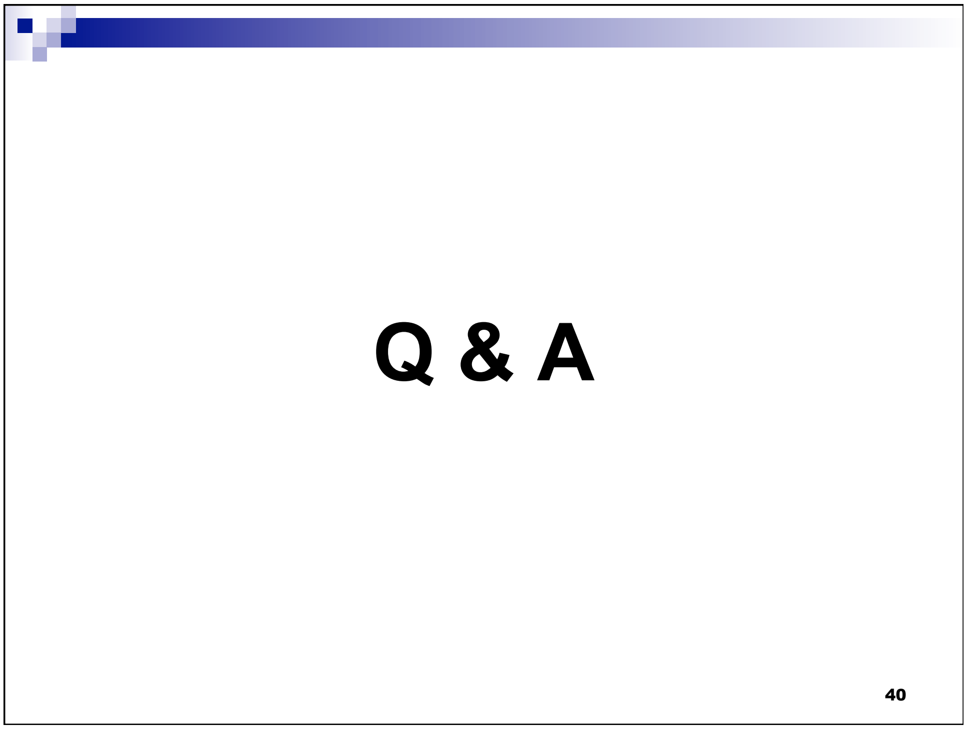
Principles of A & D

- Use graphics whenever possible.
  - Can communicate faster, without using as much jargon.
- Build a paper model before real thing.
  - Can test on paper.
  - Can show to users and get their verification.
  - All called "walkthroughs.”
    - Why bother?



What we’ve learned…

- Purpose of this course
- What does an analyst or software engineer do?
- Ways to manage complexity related to A&D
- Software Life Cycle Activities
- Four characteristics of a “good” system
- Principles of A & D



Q & A