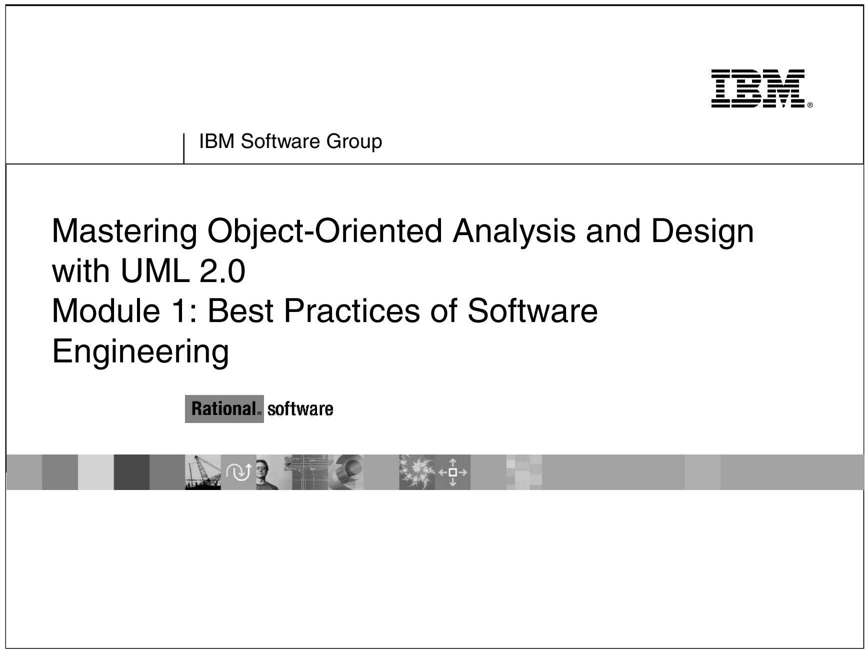
Mastering OOAD w/ UML 2.0 – Instructor Notes

Instructor Notes:



Course materials may not be reproduced in whole or in part without the prior written permission of IBM.

Instructor Notes:

The Best Practices are the key terms and concepts introduced in this module.

Objectives: Best Practices

- Identify symptoms of software development problems.
- Explain the Best Practices.
- Present the Rational Unified Process (RUP) within the context of the Best Practices.

2

In this module, you will learn about recommended software development Best Practices and the reasons for these recommendations. Then you will see how the Rational Unified Process (RUP) is designed to help you implement the Best Practices.

Course materials may not be reproduced in whole or in part without the prior written permission of IBM.

Instructor Notes:

Symptoms of Software Development Problems

- ✓User or business needs not met
- ✓Requirements not addressed
- ✓Modules not integrating
- ✓Difficulties with maintenance
- ✓Late discovery of flaws
- ✓Poor quality of end-user experience
- ✓Poor performance under load
- ✓No coordinated team effort
- ✓Build-and-release issues

3

Course materials may not be reproduced in whole or in part without the prior written permission of IBM.

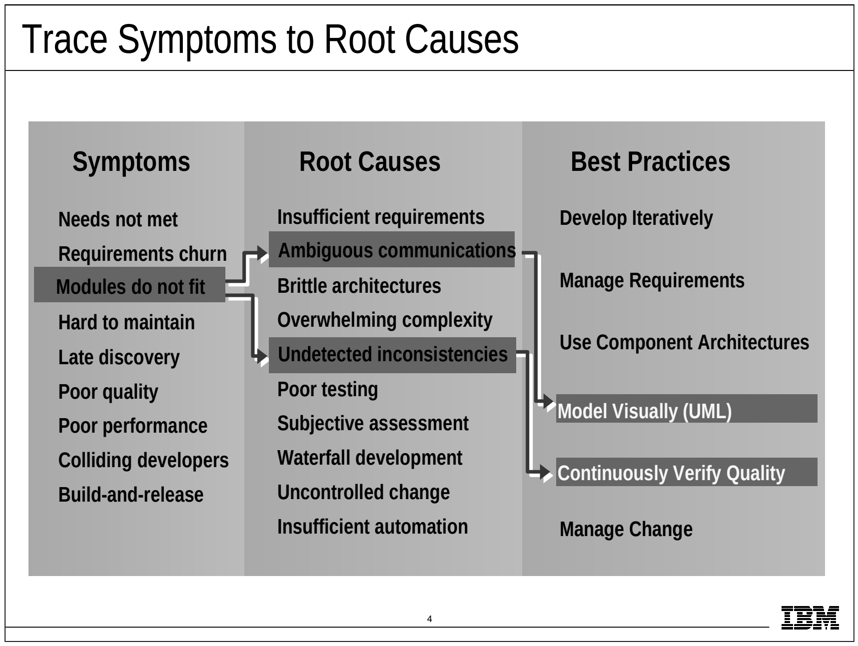
Instructor Notes:

Animation note:

The first mouse click highlights:
-Symptom

The second mouse click highlights:
-Root Causes

The third mouse click highlights:
- Best Practices



By treating these root causes, you will eliminate the symptoms. By eliminating the symptoms, you'll be in a much better position to develop high-quality software in a repeatable and predictable fashion.

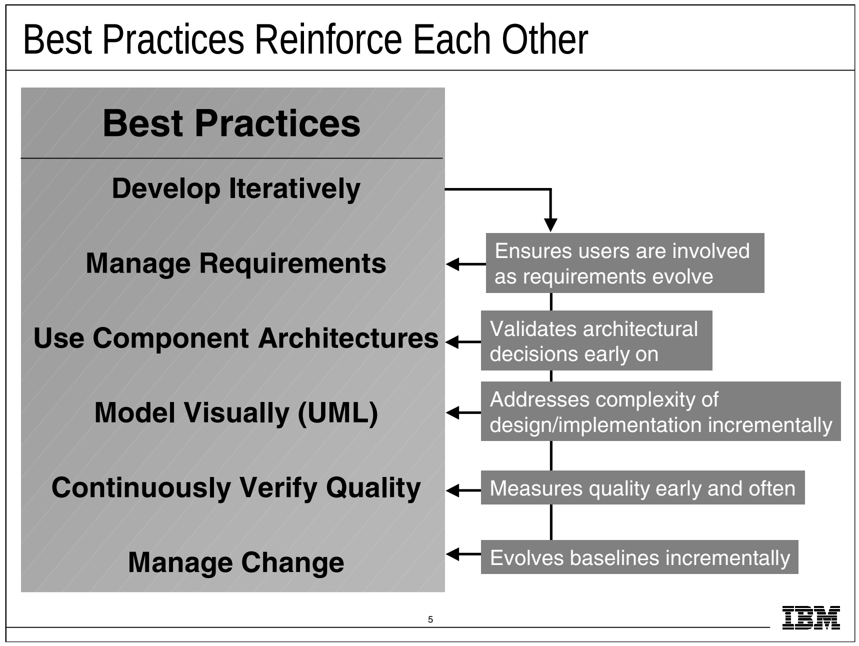
Best Practices are a set of commercially proven approaches to software development, which, when used in combination, strike at the root causes of software development problems. They are called "Best Practices," not because we can precisely quantify their value, but because they have been observed to be commonly used in the industry by successful organizations. The Best Practices have been harvested from thousands of customers on thousands of projects and from industry experts.

Course materials may not be reproduced in whole or in part without the prior written permission of IBM.

Instructor Notes:

This slide may be confusing unless it is explained properly. Use this opportunity to briefly discuss each of the Best Practices. They will be presented more thoroughly in subsequent slides. Ask the students if they can identify some Best Practices of their own.

This slide is intended to illustrate how the Best Practices used together provide much more benefit than each individually. The slide only illustrates how *one* of the Best Practices (Develop Iteratively) supports the others. How others interact might make a good discussion point for the students. For example, how do Manage Change and Continuously Verify Quality relate? The answer is that there is no point in running a test against an unknown configuration and no point in writing a defect against an unknown baseline. Similarly, there is no point in controlling changes until you have reached a stable level of quality in a product. Remind the students that the Best Practices reinforce each other.



In the case of our Best Practices, the whole is much greater than the sum of the parts. Each of the Best Practices reinforces and, in some cases, enables the others. This slide shows just one example: how iterative development supports the other five Best Practices. However, each of the other five practices also enhances iterative development. For example, iterative development done without adequate requirements management can easily fail to converge on a solution. Requirements can change at will, which can cause users not to agree and the iterations to go on forever.

When requirements are managed, this is less likely to happen. Changes to requirements are visible, and the impact on the development process is assessed before the changes are accepted. Convergence on a stable set of requirements is ensured. Similarly, every Best Practices supports each of the other Best Practices. Hence, although it is possible to use one Best Practice without the others, this is not recommended, since the resulting benefits will be significantly decreased.

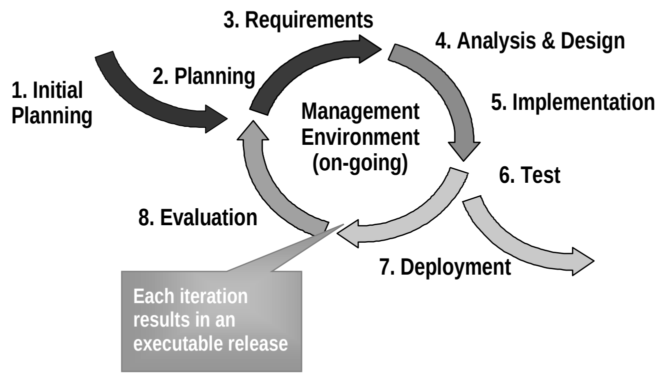
© Copyright IBM Corp. 2004

Course materials may not be reproduced in whole or in part without the prior written permission of IBM.

Instructor Notes:

Develop Iteratively

- Iterative development produces an executable



6

Developing iteratively is a technique that is used to deliver the functionality of a system in a successive series of releases of increasing completeness. Each release is developed in a specific, fixed time period called an **iteration**.

Each iteration is focused on defining, analyzing, designing, building, and testing a set of requirements.

The earliest iterations address the greatest risks. Each iteration includes integration and testing and produces an executable release. Iterations help:

- Resolve major risks before making large investments.
- Enable early user feedback.
- Make testing and integration continuous.
- Define a project's short-term objective milestone.
- Make deployment of partial implementations possible.

Instead of developing the whole system in lock step, an increment (for example, a subset of system functionality) is selected and developed, then another increment, and so on. The selection of the first increment to be developed is based on risk, with the highest priority risks first. To address the selected risk(s), choose a subset of use cases. Develop the *minimal* set of use cases that will allow objective verification (that is, through a set of executable tests) of the risks that you have chosen. Then, select the next increment to address the next-highest risk, and so on.

Course materials may not be reproduced in whole or in part without the prior written permission of IBM.

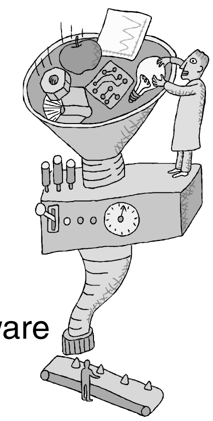
Instructor Notes:

Managing Requirements

Ensures that you
- solve the right problem
- build the right system

by taking a systematic approach to
- eliciting
- organizing
- documenting
- managing

the changing requirements of a software application.



7

A report from the Standish Group confirms that a distinct minority of software development projects is completed on time and on budget. In their report, the success rate was only 16.2%, while challenged projects (operational, but late and over budget) accounted for 52.7%. Impaired (canceled) projects accounted for 31.1%. These failures are attributed to incorrect requirements definition from the start of the project and poor requirements management throughout the development lifecycle. (Source: *Chaos Report*, http://www.standishgroup.com)

Aspects of requirements management:

- Analyze the problem
- Understand user needs
- Define the system
- Manage scope
- Refine the system definition
- Manage changing requirements

Course materials may not be reproduced in whole or in part without the prior written permission of IBM.

Instructor Notes:

You can encourage a brief discussion at this point. A single requirement, such as throughput or fault tolerance, affects almost every design decision made on a system. For example, if a transportation system (such as for trains) is being built, it is likely to have a "no single point of failure" requirement that must be in every developer's mind every step of the way. Many architectural mechanisms will be developed to accommodate that single requirement. If you can get some students to describe their architectural challenges, this point will be driven home more effectively.

Use Component Architectures

Software architecture needs to be:

Component-based	Resilient
▪ Reuse or customize components ▪ Select from commercially available components ▪ Evolve existing software incrementally	▪ Meets current and future requirements ▪ Improves extensibility ▪ Enables reuse ▪ Encapsulates system dependencies

8

Architecture is a part of Design. It is about making decisions on how the system will be built. But it is not all of the design. It stops at the major abstractions, or, in other words, the elements that have some pervasive and long-lasting effect on system performance and ability to evolve.

A software system's architecture is perhaps the most important aspect that can be used to control the iterative and incremental development of a system throughout its lifecycle.

The most important property of an architecture is resilience –flexibility in the face of change. To achieve it, architects must anticipate evolution in both the problem domain and the implementation technologies to produce a design that can gracefully accommodate such changes. Key techniques are abstraction, encapsulation, and object-oriented Analysis and Design. The result is that applications are fundamentally more maintainable and extensible.

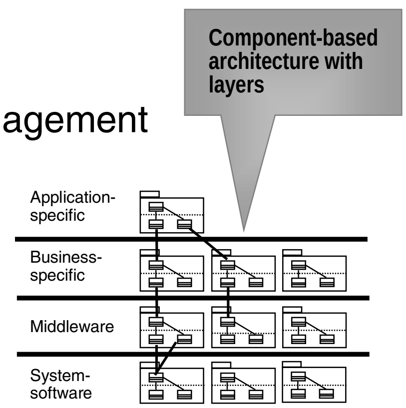
Software architecture is the development product that gives the highest return on investment with respect to quality, schedule, and cost, according to the authors of *Software Architecture in Practice* (Len Bass, Paul Clements, and Rick Kazman [1998] Addison-Wesley). The Software Engineering Institute (SEI) has an effort underway called the Architecture Tradeoff Analysis (ATA) Initiative that focuses on software architecture, a discipline much misunderstood in the software industry. The SEI has been evaluating software architectures for some time and would like to see architecture evaluation in wider use. As a result of performing architecture evaluations, AT&T reported a 10% productivity increase (from news@sei, Vol. 1, No. 2).

© Copyright IBM Corp. 2004

Course materials may not be reproduced in whole or in part without the prior written permission of IBM.

Purpose of a Component-Based Architecture

- Basis for reuse
  - Component reuse
  - Architecture reuse
- Basis for project management
  - Planning
  - Staffing
  - Delivery
- Intellectual control
  - Manage complexity
  - Maintain integrity



9 IBM

Instructor Notes:

Because students vary in their familiarity with the concept of architecture applied to software, it is best to get a sense of their level of understanding before beginning this section. If they are fairly unfamiliar, it helps to use the analogy of buildings or civil engineering. The more complex the building, the more critical a good architecture is. The longer you want the building to be useful, the more effort and expense you will put into the architecture. And in both of these cases, the choice of architect is critical.

Definition of a (software) component:

RUP Definition: A nontrivial, nearly independent, and replaceable part of a system that performs a clear function in the context of a well-defined architecture. A component conforms to and provides the physical realization of a set of interfaces.

UML Definition: A physical, replaceable part of a system that packages implementation and that conforms to and provides the realization of a set of interfaces. A component represents a physical piece of the implementation of a system, including software code (source, binary, or executable) or equivalents such as scripts or command files.

© Copyright IBM Corp. 2004
Course materials may not be reproduced in whole or in part without the prior written permission of IBM.

Instructor Notes:

Visual modeling for software is analogous to blueprints for construction.

Model Visually (UML)

- Captures structure and behavior
- Shows how system elements fit together
- Keeps design and implementation consistent
- Hides or exposes details as appropriate
- Promotes unambiguous communication
  - The UML provides one language for all practitioners.

10

IBM

A **model** is a simplification of reality that provides a complete description of a system from a particular perspective. We build models so that we can better understand the system we are building. We build models of complex systems because we cannot comprehend any such system in its entirety.

Modeling is important because it helps the development team visualize, specify, construct, and document the structure and behavior of system architecture. Using a standard modeling language such as the UML (the Unified Modeling Language), different members of the development team can communicate their decisions unambiguously to one another.

Using visual modeling tools facilitates the management of these models, letting you hide or expose details as necessary. Visual modeling also helps you maintain consistency among system artifacts: its requirements, designs, and implementations. In short, visual modeling helps improve a team's ability to manage software complexity.

© Copyright IBM Corp. 2004

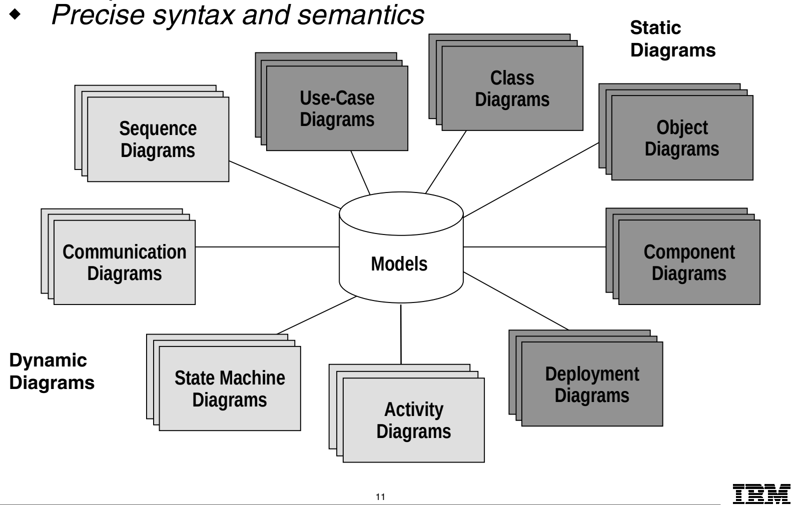
Course materials may not be reproduced in whole or in part without the prior written permission of IBM.

Instructor Notes:

The UML provides a graphical language for representing models but provides little or no guidance on when and how to use these diagrams. This is an area in which the RUP helps. It describes the kinds of project artifacts needed, including diagrams, and puts them in the context of an overall project plan.

Visual Modeling with the Unified Modeling Language

- *Multiple views*
- *Precise syntax and semantics*



In building a visual model of a system, many different diagrams are needed to represent different views of the system. The UML provides a rich notation for visualizing models. This includes the following key diagrams:

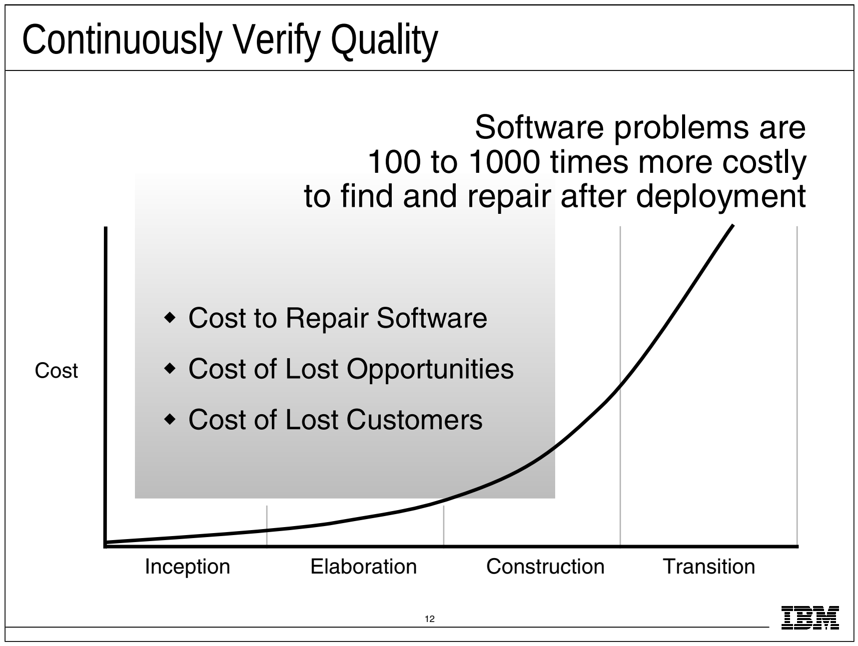
- Use-case diagrams to illustrate user interactions with the system
- Class diagrams to illustrate logical structure
- Object diagrams to illustrate objects and links
- Component diagrams to illustrate physical structure of the software
- Deployment diagrams to show the mapping of software to hardware configurations
- Activity diagrams to illustrate flows of events
- State Machine diagrams to illustrate behavior
- Interaction diagrams (that is, Communication and Sequence diagrams) to illustrate behavior

This is not all of the UML diagrams, just a representative sample.

Course materials may not be reproduced in whole or in part without the prior written permission of IBM.

Instructor Notes:

Many people remember Barry Boehm's groundbreaking work in *Software Economics,* where he quantified the relative expense to fix a bug at different times in the development lifecycle. Be cautious, however, since his work was based on the waterfall model, not an iterative development model.
The iterative model fundamentally changes how and when we test.



Quality, as used within the RUP, is defined as "The characteristic of having demonstrated the achievement of producing a product which meets or exceeds agreed-upon requirements, as measured by agreed-upon measures and criteria, and is produced by an agreed-upon process." Given this definition, achieving quality is not simply "meeting requirements" or producing a product that meets user needs and expectations. Quality also includes identifying the measures and criteria (to demonstrate the achievement of quality) and the implementation of a process to ensure that the resulting product has achieved the desired degree of quality (and can be repeated and managed).

This principle is driven by a fundamental and well-known property of software development: It is a lot less expensive to correct defects during development than to correct them after deployment.

Tests for key scenarios ensure that all requirements are properly implemented.

- Poor application performance hurts as much as poor reliability.
- Verify software reliability by checking for memory leaks and bottlenecks.
- Test every iteration by automating testing.

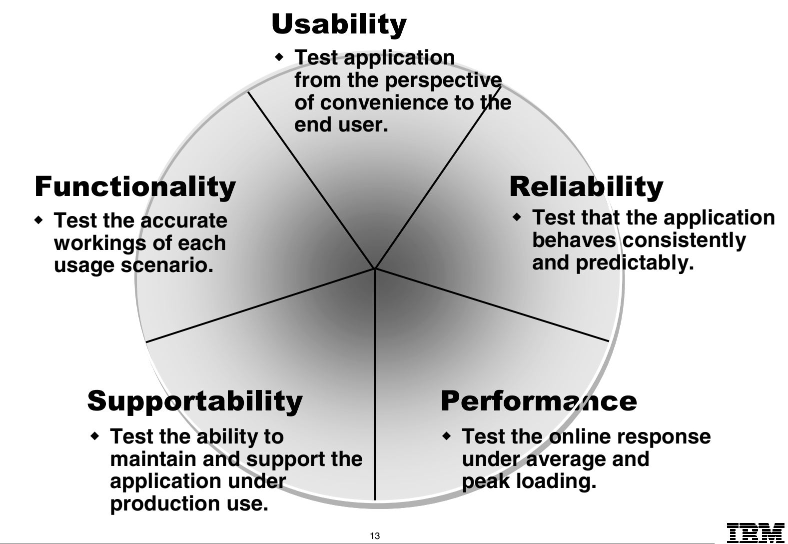
Inception, Elaboration, Construction, and Transition are all RUP terms that will be discussed shortly.

Course materials may not be reproduced in whole or in part without the prior written permission of IBM.

Instructor Notes:

This is the FURPS model of dimensions of quality presented in the RUP. See the RUP for details about all these types of tests. Be prepared to define and discuss all of them.

Testing Dimensions of Quality



Functional testing verifies that a system executes the required use-case scenarios as intended. Functional tests may include the testing of features, usage scenarios, and security.

Usability testing evaluates the application from the user's perspective. Usability tests focus on human factors, aesthetics, consistency in the user interface, online and context-sensitive Help, wizards and agents, user documentation, and training materials.

Reliability testing verifies that the application performs reliably and is not prone to failures during execution (crashes, hangs, and memory leaks). Effective reliability testing requires specialized tools. Reliability tests include tests of integrity, structure, stress, contention, and volume.

Performance testing checks that the target system works functionally and reliably under production load. Performance tests include benchmark tests, load tests, and performance profile tests.

Supportability testing verifies that the application can be deployed as intended. Supportability tests include installation and configuration tests.

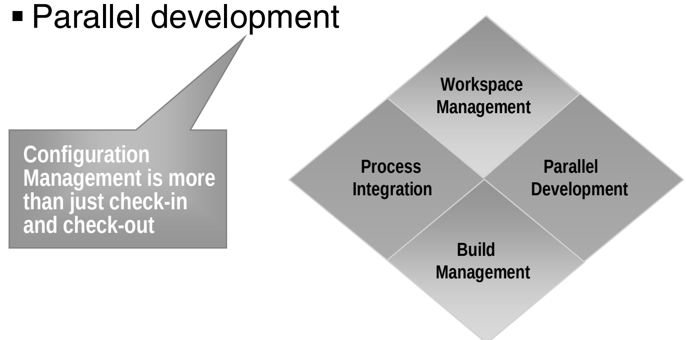
Course materials may not be reproduced in whole or in part without the prior written permission of IBM.

Instructor Notes:

If possible, use examples from your experience to illustrate what can go wrong when doing parallel development without adequate controls. For example, describe two programmers making simultaneous updates to the same component, or a very important test failing in front of a customer because the wrong version of the test case was run.

Manage Change

- To avoid confusion, have:
  - Secure workspaces for each developer
  - Automated integration/build management
  - Parallel development



14

Establishing a secure workspace for each developer provides isolation from changes made in other workspaces and control of all software artifacts — models, code, documents and so forth.

A key challenge to developing software-intensive systems is the need to cope with multiple developers, organized into different teams, possibly at different sites, all working together on multiple iterations, releases, products, and platforms. In the absence of disciplined control, the development process rapidly degrades into chaos. Progress can come to a stop. Three common problems that result are:

- **Simultaneous update**: When two or more roles separately modify the same artifact, the last one to make changes destroys the work of the others.
- **Limited notification**: When a problem is fixed in shared artifacts, some of the developers are not notified of the change.
- **Multiple versions**: With iterative development, it would not be unusual to have multiple versions of an artifact in different stages of development at the same time. For example, one release is in customer use, one is in test, and one is still in development. If a problem is identified in any one of the versions, the fix must be propagated among all of them.

© Copyright IBM Corp. 2004

Course materials may not be reproduced in whole or in part without the prior written permission of IBM.

Instructor Notes:

Regarding support for UCM in the RUP:
The CM concepts described in UCM are covered in the RUP by the following workflow details:
- Create Project CM Environments
- Change and Deliver Configuration Items
- Manage Baselines and Releases

UCM does not cover the RUP activities described in these workflows:
- Monitor and Report Configuration Status
- Manage Change Requests

The activities described in the RUP workflow detail — Plan Project Configuration and Change Control — are at a higher level of abstraction than the notion of a project described in UCM. However, UCM does cover the fact that policies need to be set, and that there is a CM process to be followed to ensure that all project artifacts are maintained under configuration control.

Manage Change (continued)

- Unified Change Management (UCM) involves:
  - Management across the lifecycle
    - System
    - Project management
  - Activity-based management
    - Tasks
    - Defects
    - Enhancements
  - Progress tracking
    - Charts
    - Reports

15

IBM

Unified Change Management (UCM) is “the Rational software approach” to managing change in software system development, from requirements to release. UCM spans the development lifecycle, defining how to manage change to requirements, design models, documentation, components, test cases, and source code.

One of the key aspects of the UCM model is that it unifies the activities used to plan and track project progress and the artifacts undergoing change.

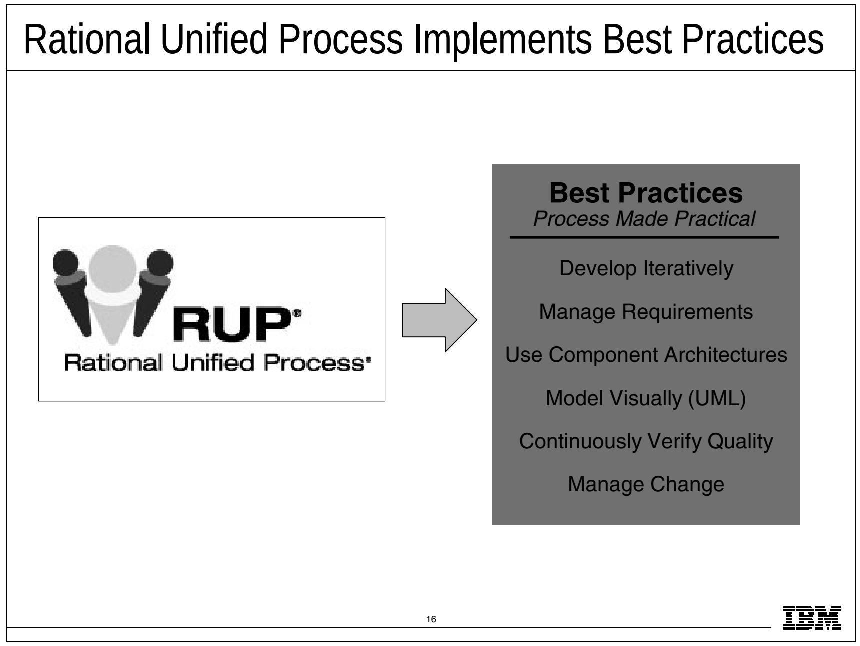
You cannot stop change from being introduced into a project; however, you must control how and when changes are introduced into project artifacts, and who introduces those changes.

You must also synchronize changes across development teams and locations. Unified Change Management (UCM) is the Rational Software approach to managing change in software system development, from requirements to release.

© Copyright IBM Corp. 2004

Course materials may not be reproduced in whole or in part without the prior written permission of IBM.

Instructor Notes:



Why have a process?

- It provides guidelines for efficient development of quality software
- It reduces risk and increases predictability
- It promotes a common vision and culture
- It captures and institutionalizes Best Practices

The Rational Unified Process (RUP) is a generic business process for object-oriented software engineering. It describes a family of related software-engineering processes sharing a common structure and a common process architecture. It provides a disciplined approach to assigning tasks and responsibilities within a development organization. Its goal is to ensure the production of high-quality software that meets the needs of its end users within a predictable schedule and budget. The RUP captures the Best Practices in modern software development in a form that can be adapted for a wide range of projects and organizations.

The UML provides a standard for the artifacts of development (semantic models, syntactic notation, and diagrams): the things that must be controlled and exchanged. But the UML is not a standard for the development *process*. Despite all of the value that a common modeling language brings, you cannot achieve successful development of today’s complex systems solely by the use of the UML. Successful development also requires employing an equally robust development process, which is where the RUP comes in.

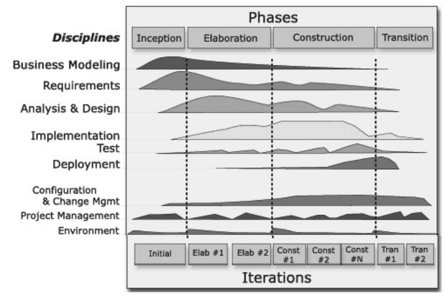
© Copyright IBM Corp. 2004

Course materials may not be reproduced in whole or in part without the prior written permission of IBM.

Instructor Notes:

Achieving Best Practices

- Iterative approach
- Guidance for activities and artifacts
- Process focus on architecture
- Use cases that drive design and implementation
- Models that abstract the system



17

Examples:

- The dynamic structure (phases and iterations) of the Rational Unified Process creates the basis of iterative development.
- The Project Management discipline describes how to set up and execute a project using phases and iterations.
- Within the Requirements discipline, the Use-case model and the risk list determine what functionality you implement in an iteration.
- The workflow details of the Requirements discipline show the activities and artifacts that make requirements management possible.
- The iterative approach allows you to progressively identify components and to decide which one to develop, which one to reuse, and which one to buy.
- The Unified Modeling Language (UML) used in the process represents the basis of visual modeling and has become the de facto modeling language standard.
- The focus on software architecture allows you to articulate the structure: the components, the ways in which they integrate, and the fundamental mechanisms and patterns by which they interact.

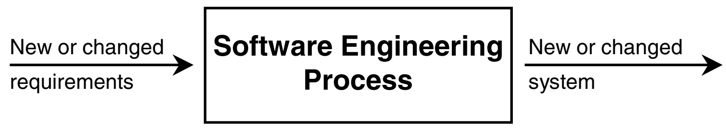
Course materials may not be reproduced in whole or in part without the prior written permission of IBM.

Instructor Notes:

It can be very difficult to explain what a process is, if the students are not already familiar with it. An informal example most people can relate to is the process of balancing a checkbook at the end of the month. Most of us have developed a process we use that includes the same steps every month. It shortens the time required to accomplish the task and ensures that we do not forget any steps. The same applies to a software-engineering process. We want it to be repeatable and to ensure that all required tasks are accomplished when required. Of course, a software-engineering process is much more complex than balancing a checkbook, and there is a tremendous amount of information contained in the RUP.

A Team-Based Definition of Process

A process defines **Who** is doing **What**, **When**, and **How**, in order to reach a certain goal.



18

Course materials may not be reproduced in whole or in part without the prior written permission of IBM.

Instructor Notes:

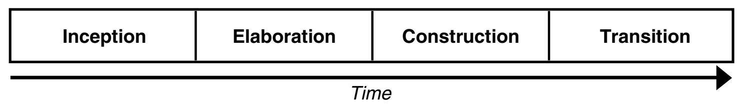
The Student Notes are quite extensive. There is no need to go into that much detail in class. The important thing is to understand how the RUP uses phases to organize the lifecycle. You can also mention that we deliberately chose names that do not match the waterfall names (analysis, design, implementation, and test) to emphasize that they are *not* the same as the waterfall phases. Some ways of describing the phases in common terminology:

- Inception — Bid and proposal
- Elaboration — Building blueprints
- Construction — I think I'm done.
- Transition — How do users react?

Process Structure - Lifecycle Phases

The Rational Unified Process has four phases:

- **Inception** – Define the scope of the project
- **Elaboration** – Plan the project; specify features and baseline architecture
- **Construction** – Build the product
- **Transition** – Transition the product into the end-user community



19

During Inception, we define the scope of the project: what is included and what is not. We do this by identifying all the actors and use cases, and by drafting the most essential use cases (typically 20% of the complete model). A business plan is developed to determine whether resources should be committed to the project.

During Elaboration, we focus on two things: getting a good grasp of the requirements (80% complete) and establishing an architectural baseline. If we have a good grasp of the requirements and the architecture, we can eliminate a lot of the risks, and we will have a good idea of how much work remains to be done. We can make detailed cost and resource estimates at the end of Elaboration.

During Construction, we build the product in several iterations up to a beta release.

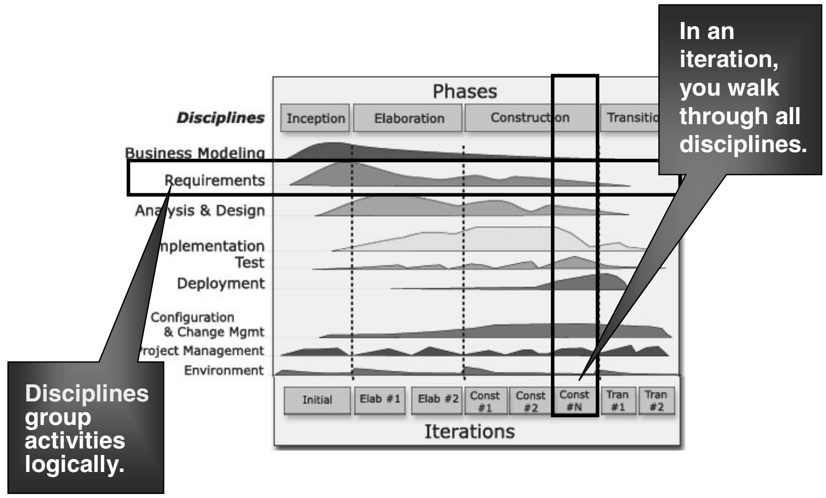
During Transition, we move the product to the end user and focus on end-user training, installation, and support.

The amount of time spent in each phase varies. For a complex project with many technical unknowns and unclear requirements, Elaboration may include three to five iterations. For a simple project, where requirements are known and the architecture is simple, Elaboration may include only a single iteration.

Course materials may not be reproduced in whole or in part without the prior written permission of IBM.

Instructor Notes:

Bringing It All Together: The Iterative Approach



20

This slide illustrates how phases and iterations (the time dimension) relate to the development activities (the discipline dimension). The relative size of each color area in the graph indicates how much of the activity is performed in each phase or iteration.

Each iteration involves activities from all disciplines. The relative amount of work related to the disciplines changes between iterations. For instance, during late Construction, the main work is related to Implementation and Test, and very little work on Requirements is done.

Note that requirements are not necessarily complete by the end of Elaboration. It is acceptable to delay the analysis and design of well-understood portions of the system until Construction because they are low in risk. This is a brief summary of the RUP disciplines:

Business Modeling – Encompasses all modeling techniques you can use to visually model a business.

Requirements – Defines what the system should do.

Analysis & Design – Shows how the system's *use cases* will be realized in implementation.

Implementation – Implements software components that meet quality standards.

Test – Integrates and tests the system.

Deployment - Provides the software product to the end-user.

Configuration & Change Management – Controls and tracks changes to *artifacts*.

Project Management – Ensures tasks are scheduled, allocated and completed in accordance with project schedules, budgets and quality requirements.

Environment – Defines and manages the environment in which the system is being developed.

© Copyright IBM Corp. 2004

Course materials may not be reproduced in whole or in part without the prior written permission of IBM.

Instructor Notes:

Summary

- Best Practices guide software engineering by addressing root causes.
- Best Practices reinforce each other.
- Process guides a team on who does what, when, and how.
- The Rational Unified Process is a means of achieving Best Practices.

21

IBM

Course materials may not be reproduced in whole or in part without the prior written permission of IBM.

Instructor Notes:

22

© Copyright IBM Corp. 2004

Course materials may not be reproduced in whole or in part without the prior written permission of IBM.