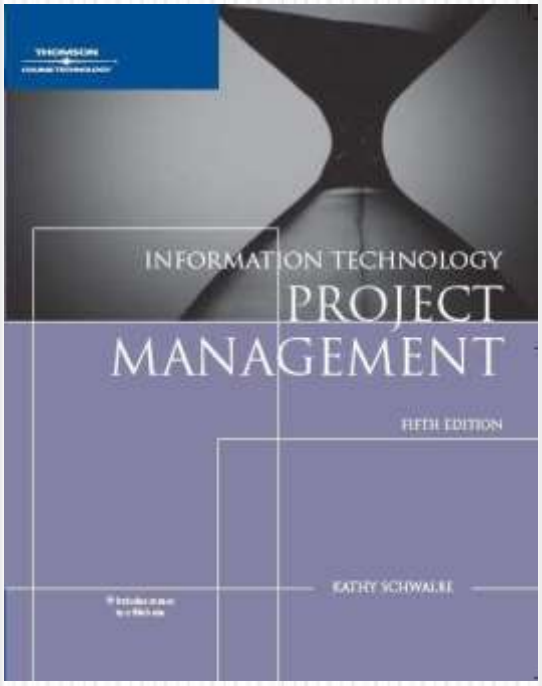
Chapter 8:
Project Quality Management

Information Technology Project Management, Fifth Edition



The Importance of Project Quality Management

- Many people joke about the poor quality of IT products
- People seem to accept systems being down occasionally or needing to reboot their PCs
- But quality is very important in many IT projects

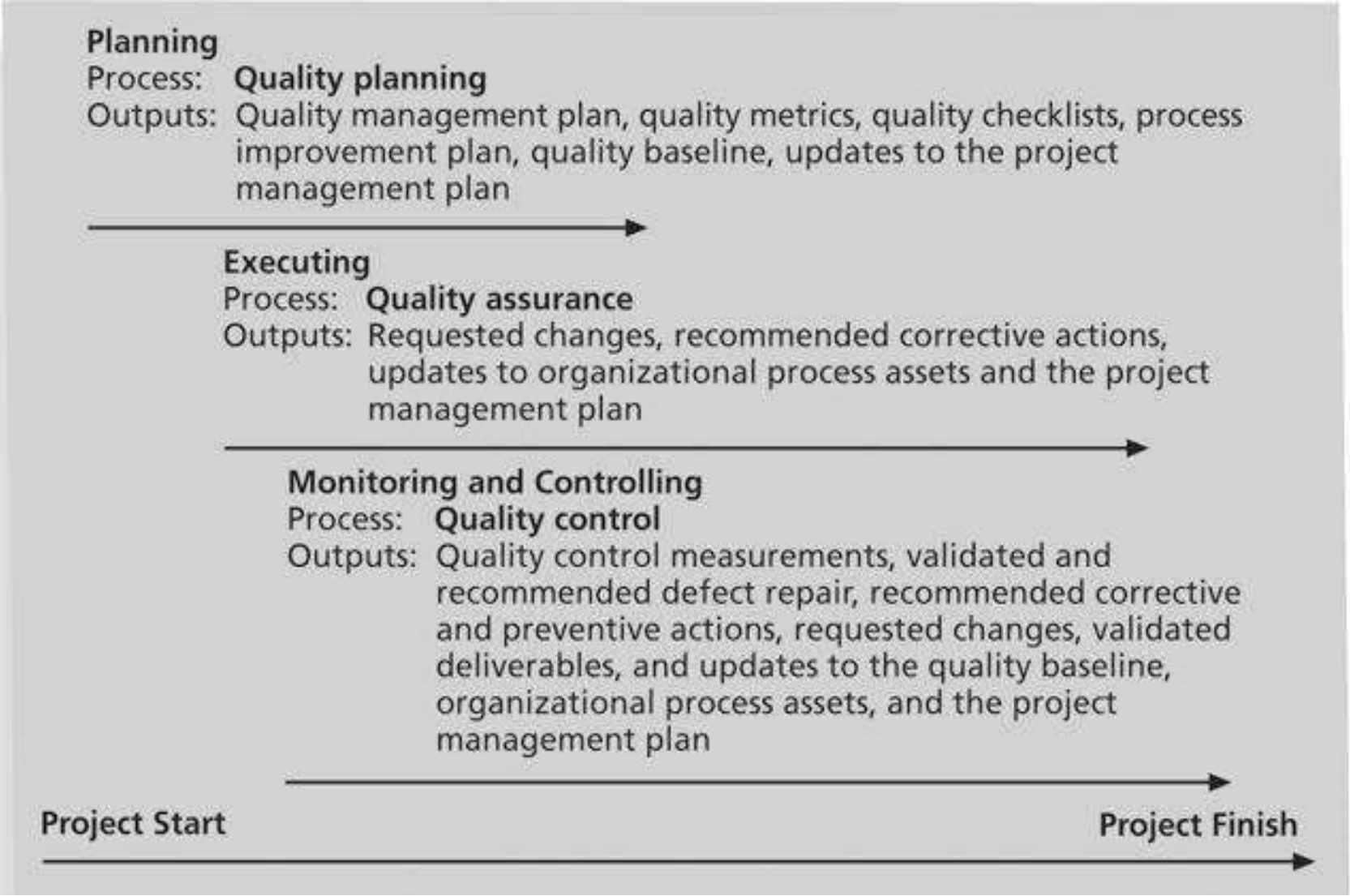
What Is Project Quality?

- The International Organization for Standardization (ISO) defines **quality** as “the degree to which a set of inherent characteristics fulfills requirements” (ISO9000:2000)
- Other experts define quality based on:
  - **Conformance to requirements**: the project’s processes and products meet written specifications
  - **Fitness for use**: a product can be used as it was intended

What Is Project Quality Management?

- **Project quality management** ensures that the project will satisfy the needs for which it was undertaken
- Processes include:
  - **Quality planning**: identifying which quality standards are relevant to the project and how to satisfy them
  - **Quality assurance**: periodically evaluating overall project performance to ensure the project will satisfy the relevant quality standards
  - **Quality control**: monitoring specific project results to ensure that they comply with the relevant quality standards

Project Quality Management Summary



Quality Planning

- Implies the ability to anticipate situations and prepare actions to bring about the desired outcome

- Important to prevent defects by:
  - Selecting proper materials
  - Training and indoctrinating people in quality
  - Planning a process that ensures the appropriate outcome

Design of Experiments

- **Design of experiments** is a quality planning technique that helps identify which variables have the most influence on the overall outcome of a process
  - Computer chip designer would determine what combination of materials and equipment will produce the most reliable chips at a reasonable cost
- Also applies to project management issues, such as cost and schedule trade-offs
  - Junior programmers cost less than senior programmers but will not produce the same level of work in the same amount of time

Design of Experiments

- An appropriately designed experiment to compute` project costs and durations for various combinations of staff can help determine an optimal mix of personnel
- Involves documenting important factors that directly contribute to meeting customer requirements

- It is often difficult for customers to explain exactly what they want in an IT project.
- Important scope aspects of IT projects that affect quality include:
  - **Functionality** is the degree to which a system performs its intended function
    - **Features** are the system's special characteristics that appeal to users. It is important to specify which are required and which are optional
  - **System outputs** are the screens and reports the system generates. Need to define clearly what they look like

Scope Aspects of IT Projects

- **Performance** addresses how well a product or service performs the customer's intended use.
  - Need to know volumes of data and transactions, number of simultaneous users, required response time, etc.
- **Reliability** is the ability of a product or service to perform as expected under normal conditions (customers must define expected level of service)
  - **Maintainability** addresses the ease of performing maintenance on a product

Quality Assurance

- **Quality assurance** includes all the activities related to satisfying the relevant quality standards for a project
  - Another goal of quality assurance is continuous quality improvement
- **Benchmarking** generates ideas for quality improvements by comparing specific project practices or product characteristics to those of other projects or products within or outside the performing organization
- A **quality audit** is a structured review of specific quality management activities that help identify lessons learned that could improve performance on current or future projects
  - Performed by in-house auditors or third parties

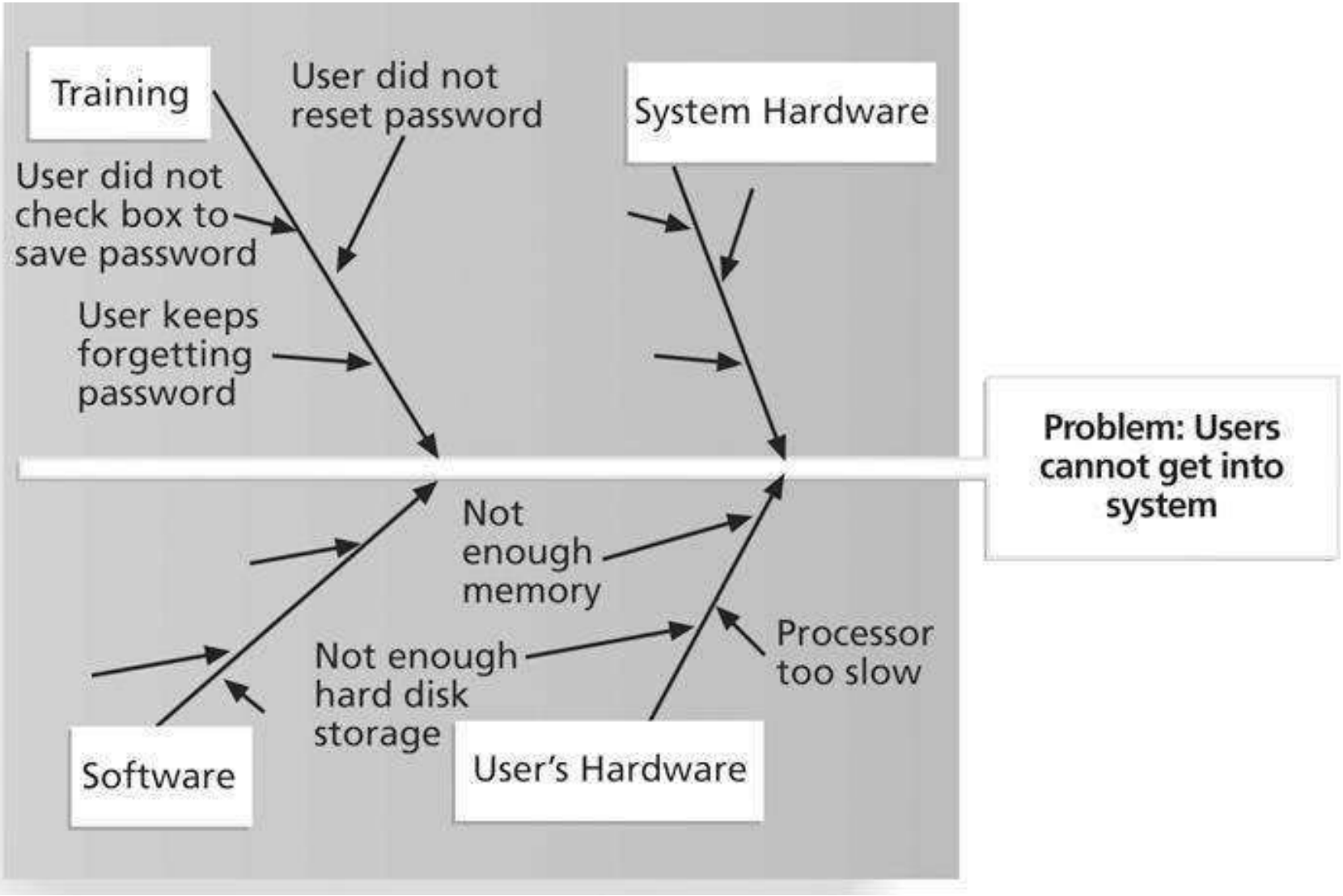
Quality Control

- Although one of the main goals of QC is to improve quality, its main outcomes are:
  - ***Acceptance decisions-*** are the products/services acceptable or should they be rejected and rework is then necessary
  - ***Rework*** – action taken to bring rejected items into compliance with products specs. Can be very expensive
  - ***Process adjustments*** – correct or prevent further quality problems based on quality control measurements (purchase faster server if response time is too slow)

7 Tools & Techniques for Quality Control

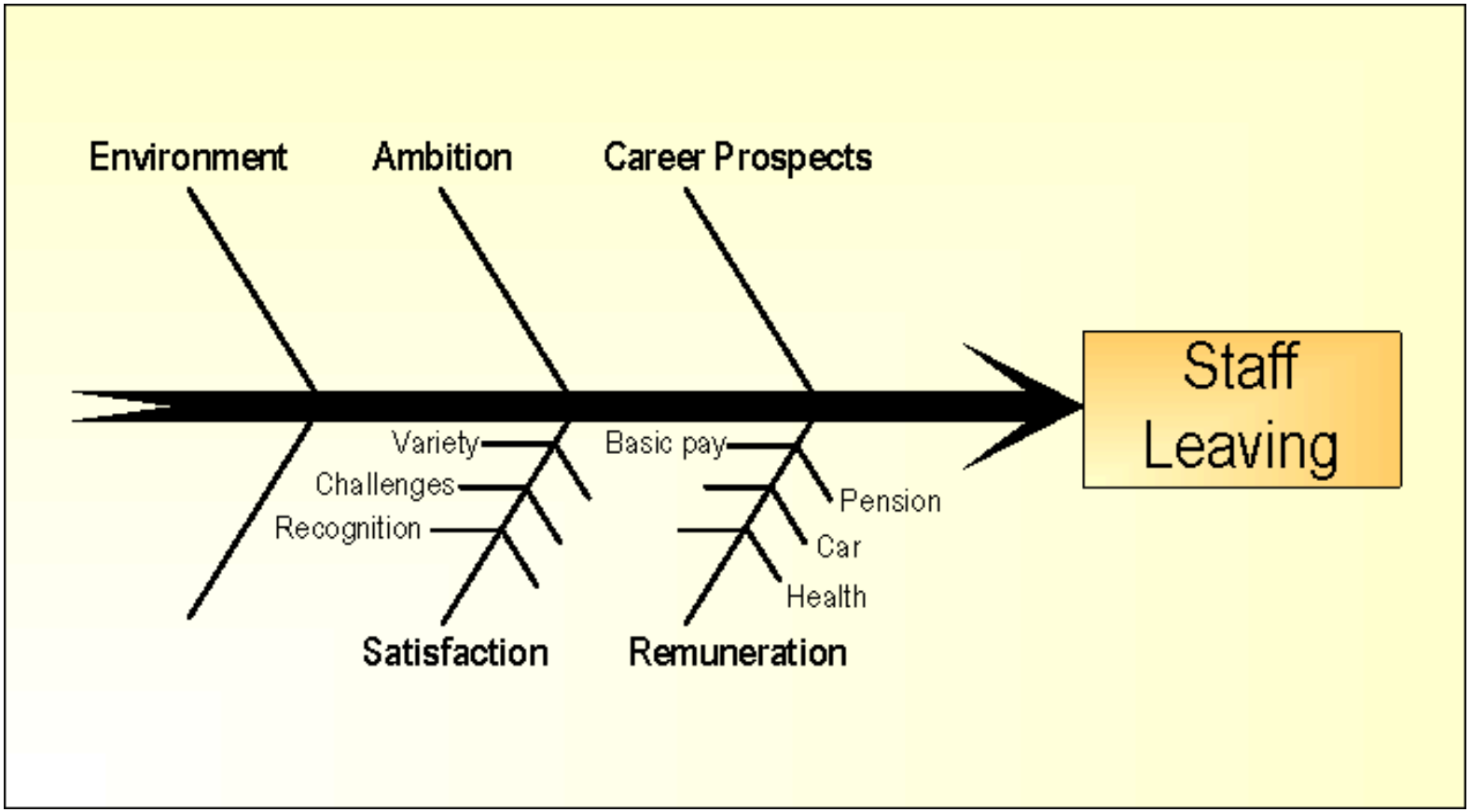
- **1. Cause-and-effect diagrams** trace complaints about quality problems back to the responsible production operations
  - They help you find the root cause of a problem
  - Also known as **fishbone** or **Ishikawa diagrams**
  - Can also use the **5 whys** technique where you repeat the question "Why" (five is a good rule of thumb) to peel away the layers of symptoms that can lead to the root cause
    1. Why the users can not get into the system
    2. Why they keep forgetting passwords
    3. Why didn't they reset their passwords
    4. Why didn't they check the box to save their password, etc.

Sample Cause-and-Effect Diagram



Sample Cause-and-Effect Diagram

- Possible causes of staff leaving before the end of a project
  - They may include environment, ambition, career prospects, satisfaction (variety, challenges, recognition), remuneration (basic pay, benefits - car, health, pension).



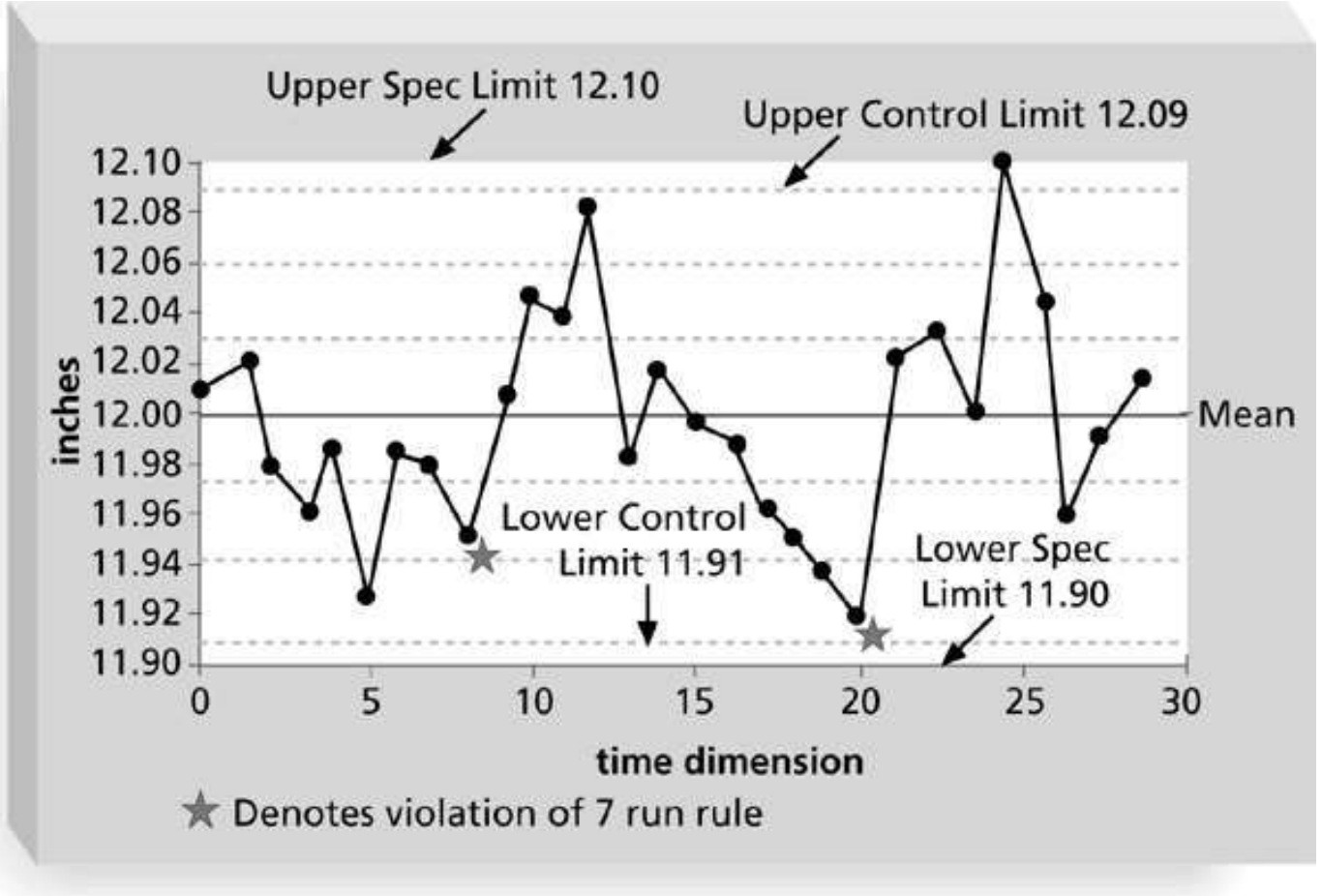
2. Quality Control Charts

- Graphic display of data that illustrates the results of a process over time
- Main use is to prevent defects, rather than to detect or reject them
- Quality control charts allow you to determine whether a process is in control or out of control
  - When a process is in control, any variations in the results of the process are created by random events; processes that are in control do not need to be adjusted
  - When a process is out of control, variations in the results of the process are caused by nonrandom events; you need to identify the causes of those nonrandom events and adjust the process to correct or eliminate them

The Seven Run Rule

- You can use quality control charts and the seven run rule to look for patterns in data
- The **seven run rule** states that if seven data points in a row are all below the mean, above the mean, or are all increasing or decreasing, then the process needs to be examined for nonrandom problems
  - Example: The following slide is a control chart for the manufacture of 12” rulers
    - Upper and lower specifications are 12.10” and 11.9” – this is the range specified as acceptable by the customer for purchase
    - The controls limits of 11.91” and 12.09” mean that the manufacturing process is designed to produce rulers within that range

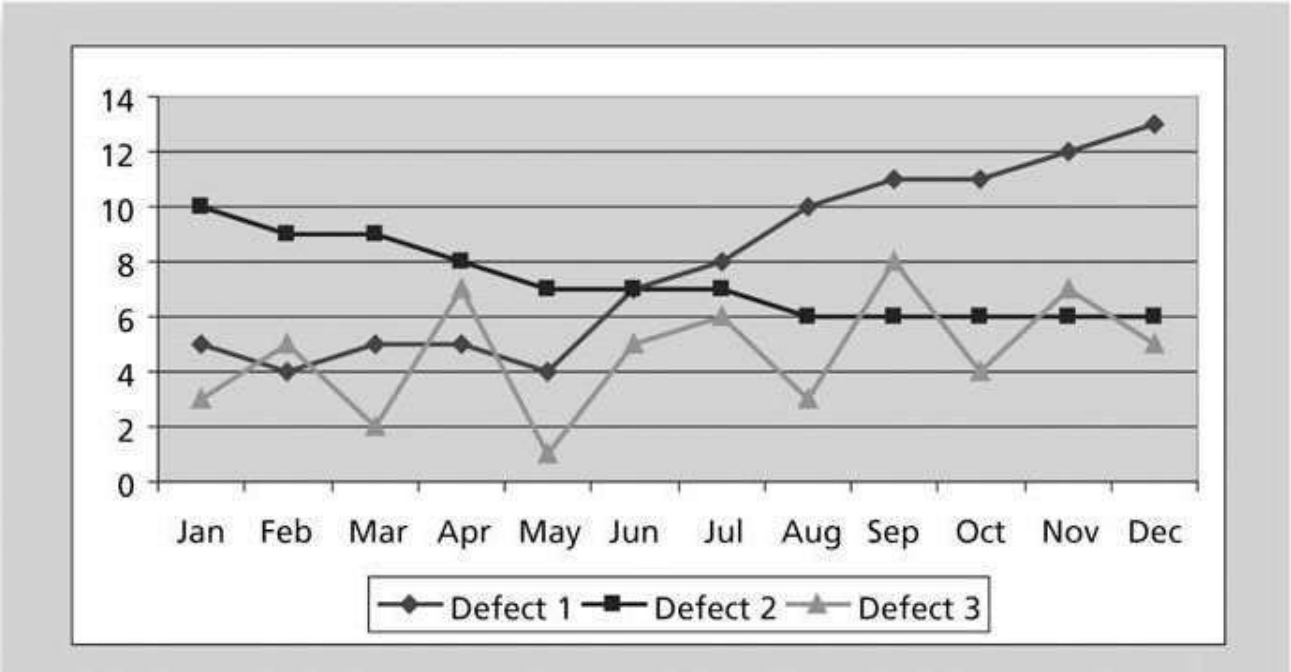
Sample Quality Control Chart



The rule violations indicate that a calibration device may need adjustment

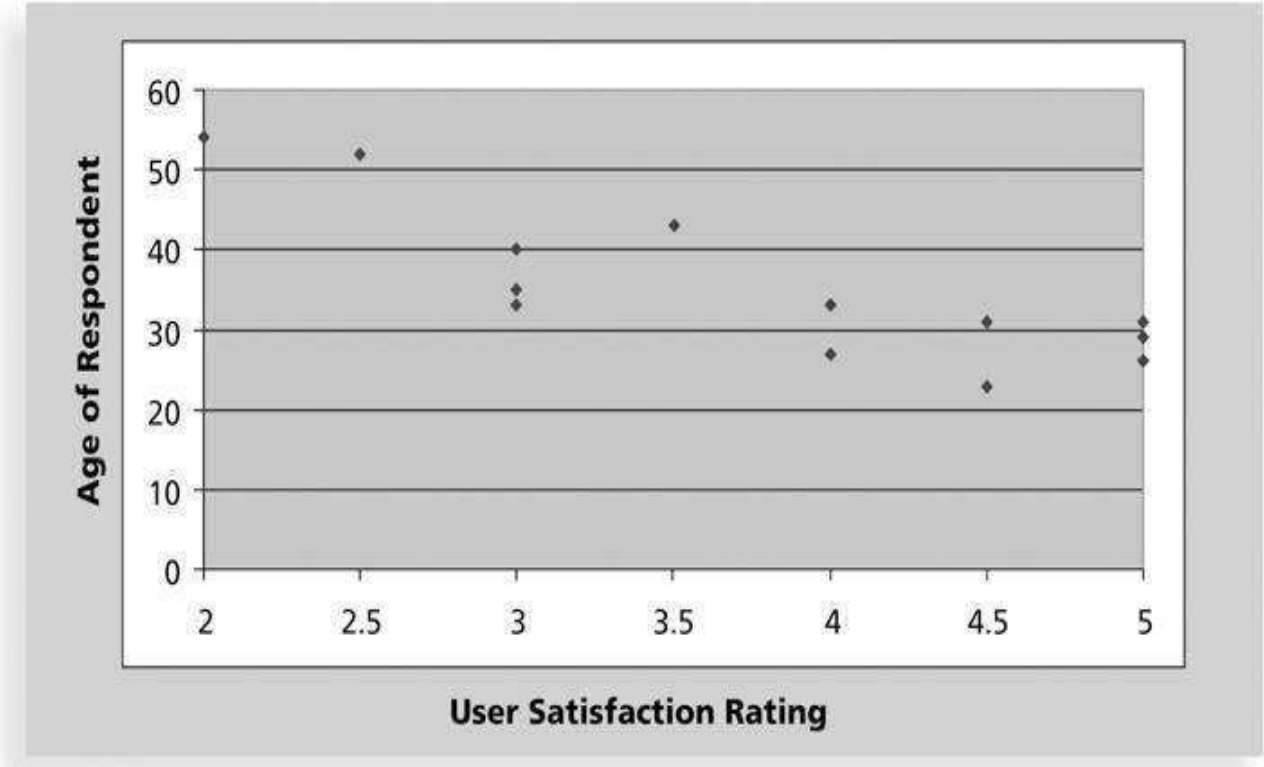
3. Run Chart

- A run chart displays the history and pattern of variation of a process over time
- It is a line chart that shows data points plotted in the order in which they occur
- Can be used to perform trend analysis to forecast future outcomes based on historical patterns e.g., of defects



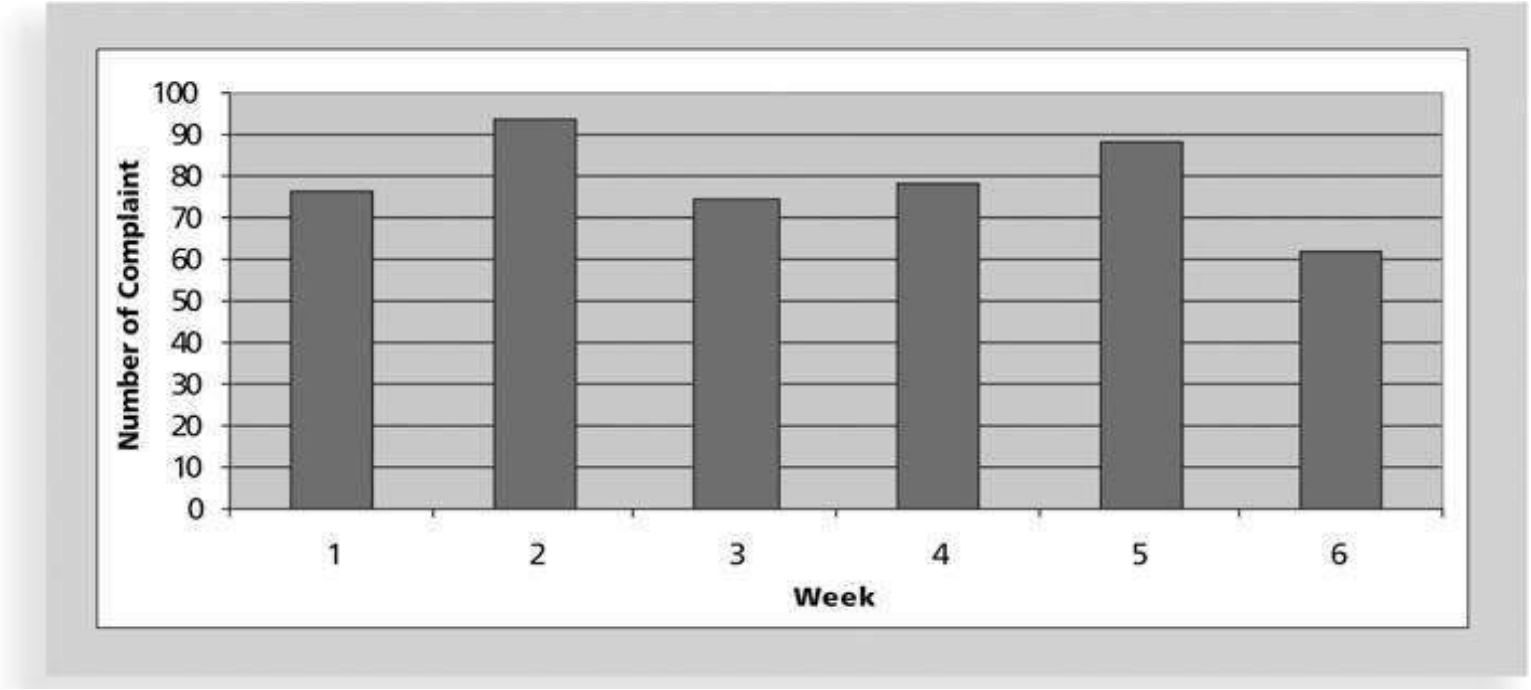
4. Scatter Diagram

- A **scatter diagram** helps to show if there is a relationship between two variables
- The closer data points are to a diagonal line, the more closely the two variables are related



5. Histograms

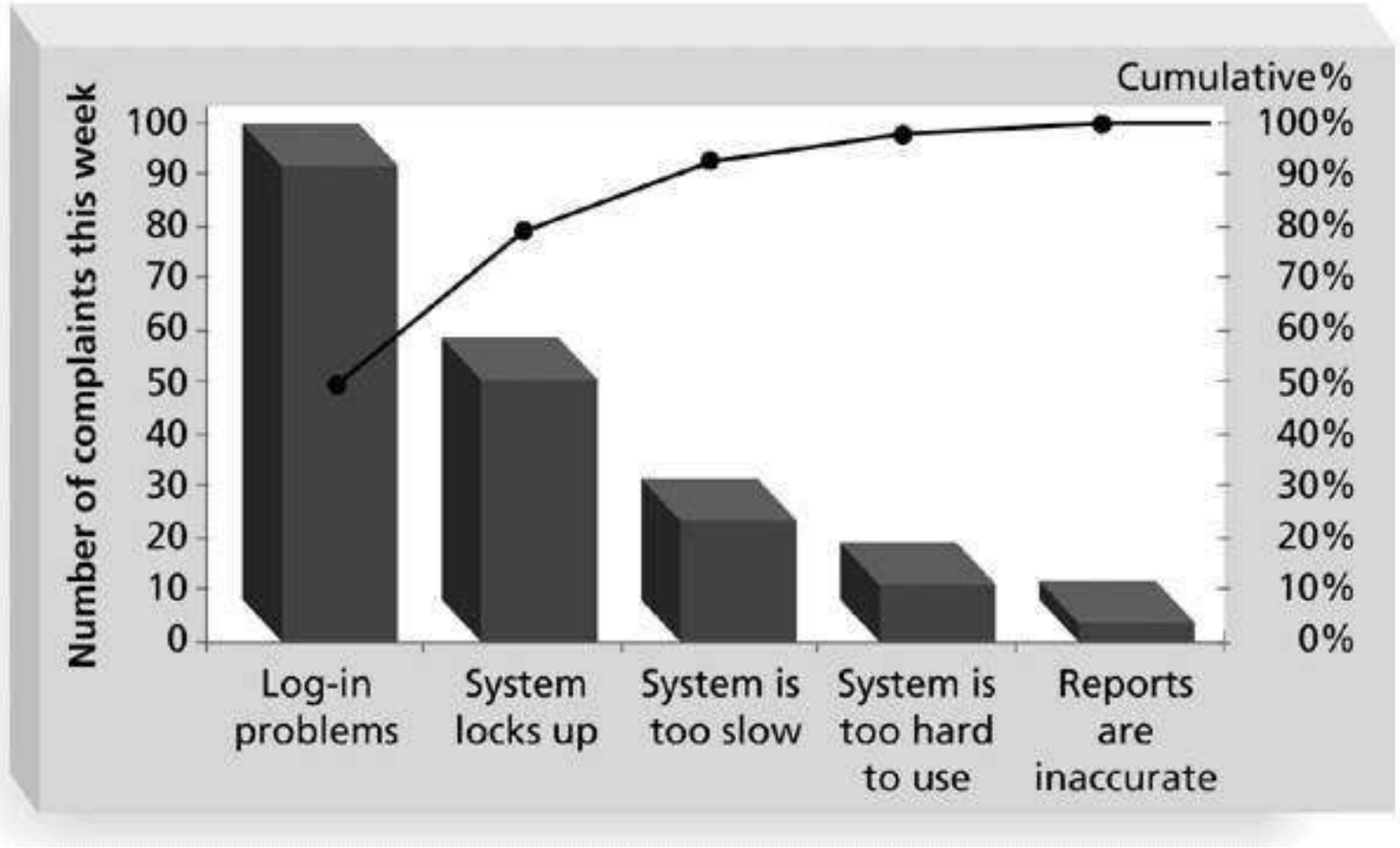
- A **histogram** is a bar graph of a distribution of variables
- Each bar represents an attribute or characteristic of a problem or situation, and the height of the bar represents its frequency



6. Pareto Charts

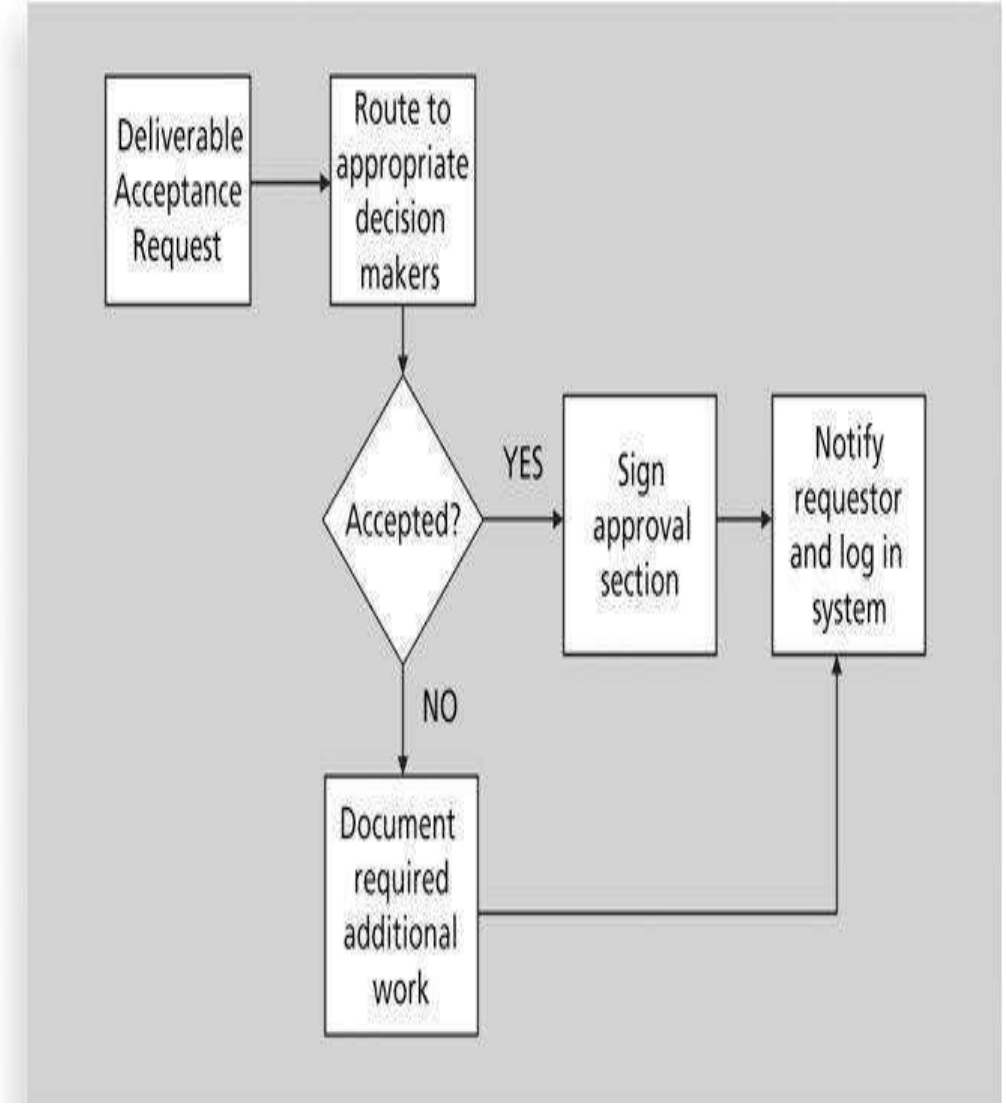
- A histogram that can help you identify and prioritize problem areas
  - The variables are ordered by frequency of occurrence to help identify the key contributors that account for most quality problems (hopefully following the 80-20 rule)
- **Pareto analysis** is also called the 80-20 rule, meaning that 80 percent of problems are often due to 20 percent of the causes
- In the following chart, Log-in Problems account for about 55% of the complaints and together with System lock-ups accounts for about 80%
  - Fixing these two problems can greatly reduce the volume of compalints
  - Small problems should be investigated before addressing them in case the user is in error

Sample Pareto Diagram



7. Flowcharts

- Flowcharts are graphic displays of the logic and flow of processes that help you analyze how problems occur and how processes can be improved
- They show activities, decision points, and the order of how information is processed



Statistical Sampling

- **Statistical sampling** involves choosing part of a population of interest for inspection
  - This is needed when the population is too large be to be completely sampled
- The size of a sample depends on how representative you want the sample to be
- Sample size formula:

Sample size = .25 X (certainty factor/acceptable error)^2

Desired certainty	Certainty factor	Sample size
95%	1.960	384
90%	1.645	68
80%	1.281	10

Six Sigma

- **Six Sigma** is “a comprehensive and flexible system for achieving, sustaining, and maximizing business success.
- Six Sigma is uniquely driven by close understanding of customer needs, disciplined use of facts, data, and statistical analysis, and diligent attention to managing, improving, and reinventing business processes.”

Basic Information on Six Sigma

- The target for perfection is the achievement of no more than **3.4 defects per million opportunities**
- The principles can apply to a wide variety of processes – design and production of a product, a Help Desk or other customer-service process
- Six Sigma projects normally follow a five-phase improvement process called DMAIC

DMAIC

- **DMAIC** is a systematic, closed-loop process for continued improvement that is scientific and fact based
  - **D**efine: Define the problem/opportunity, process, and customer requirements. Tool used include project charter, requirements, Voice of the Customer data.
  - **M**easure: Define measures (in terms of defects per million), then collect, compile, and display data
  - **A**nalyze: Scrutinize process details to find improvement opportunities; seeks root cause of problems
  - **I**mprove: Generate solutions and ideas for improving the problem; pilot test the solution
  - **C**ontrol: Track and verify the stability of the improvements and the predictability of the solution

How Is Six Sigma Quality Control Unique?

- It requires an organization-wide commitment at all levels. Often huge training investements but pay off in higher quality goods and services at lower costs
- Training follows the "Belt" system as in a karate class
- Six Sigma organizations have the ability and willingness to adopt contrary objectives: *reducing errors and getting things done faster; creative and rational; focus on the big picture and minute details; make customers happy and make a lot of money*
- It is an operating philosophy that is customer-focused and strives to drive out waste, raise levels of quality, and improve financial performance at *breakthrough* levels

Six Sigma and Project Management

- Joseph M. Juran stated, “All improvement takes place project by project, and in no other way”
- It’s important to select projects carefully, apply higher quality where it makes sense; companies that use Six Sigma do not always boost their stock values
- Minimizing defects does not matter if an organization is making a product that no one wants to buy. As Mikel Harry puts it, “I could genetically engineer a Six Sigma goat, but if a rodeo is the marketplace, people are still going to buy a Four Sigma horse.”
- Six Sigma projects must focus on a quality problem or gap between the current and desired performance, not have a clearly understood problem, the solution should not be predetermined and an optimal solution should not be apparent

Six Sigma Projects Use Project Management

- The training for Six Sigma includes many project management concepts, tools, and techniques
- For example, Six Sigma projects often use business cases, project charters, schedules, budgets, and so on
- Six Sigma projects are done in teams;
  - the project manager is often called the team leader, and the sponsor is called the champion
- Six Sigma projects are projects that focus on supporting the Six Sigma philosophy by being customer-focused and striving to drive out waste, raise levels of quality and improve financial performance at breakthrough levels

Six Sigma and Statistics

- The term *sigma* means standard deviation
- **Standard deviation** measures how much variation exists in a distribution of data
- Standard deviation is a key factor in determining the acceptable number of defective units found in a population.
  - A small s.d. means the data clusters closely around the middle of a distribution and there is little variability in the data.
- Six Sigma projects strive for no more than 3.4 defects per million opportunities, yet this number is confusing to many statisticians

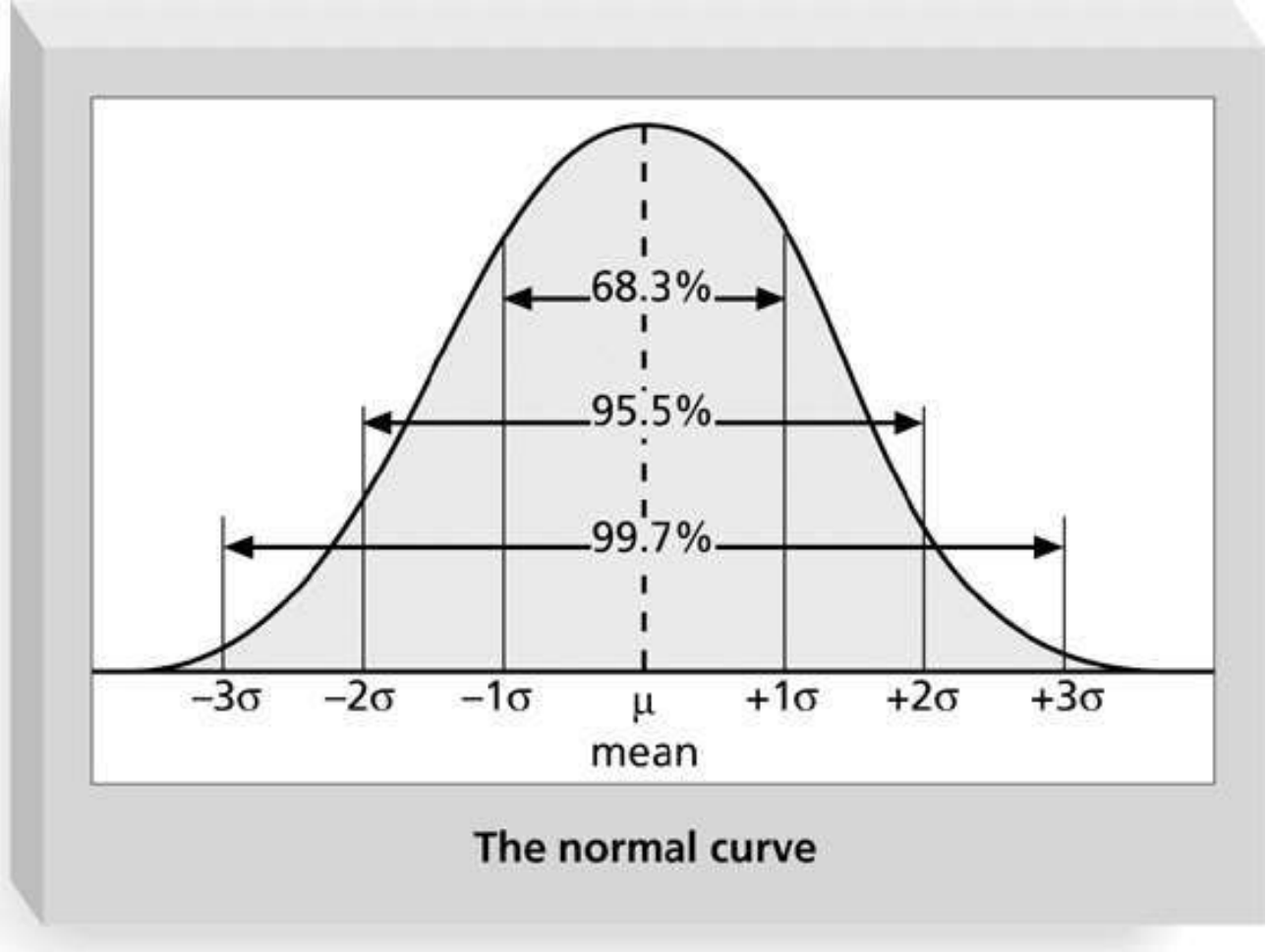
Six Sigma Uses a Conversion Table

- Using a normal curve, if a process is at six sigma, there would be no more than two defective units per billion produced
- Six Sigma uses a scoring system that accounts for time, an important factor in determining process variations
  - **Yield** represents the number of units handled correctly through the process steps

Six Sigma Uses a Conversion Table

- A **defect** is any instance where the product or service fails to meet customer requirements
  - Because most products or services have multiple customer requirements, there can be several opportunities to have a defect
  - Ex: a company is trying to reduce errors on their bills. There could be several errors – misspelled name, wrong address, calculation error, etc.
    - Instead of measuring the number of defects per billing statement, Six Sigma measures the number of defects based on the number of opportunities

Normal Distribution and Standard Deviation



The normal curve

Normal Distribution and Standard Deviation

Specification Range (in +/- Sigmas)	*% of population within range*	*Defective units per billion*
1	68.27	317,300,000
2	95.45	45,400,000
3	99.73	2,700,000
4	99.9937	63,000
5	99.999943	57
6	99.9999998	2

Sigma Conversion Table

Sigma	*Yield*	*Defects per Million Opportunities*
1	**31.0%**	**690,000**
2	**69.2%**	**308,000**
3	**93.3%**	**66,800**
4	**99.4%**	**6,210**
5	**99.97%**	**230**
6	**99.99966%**	**3.4**

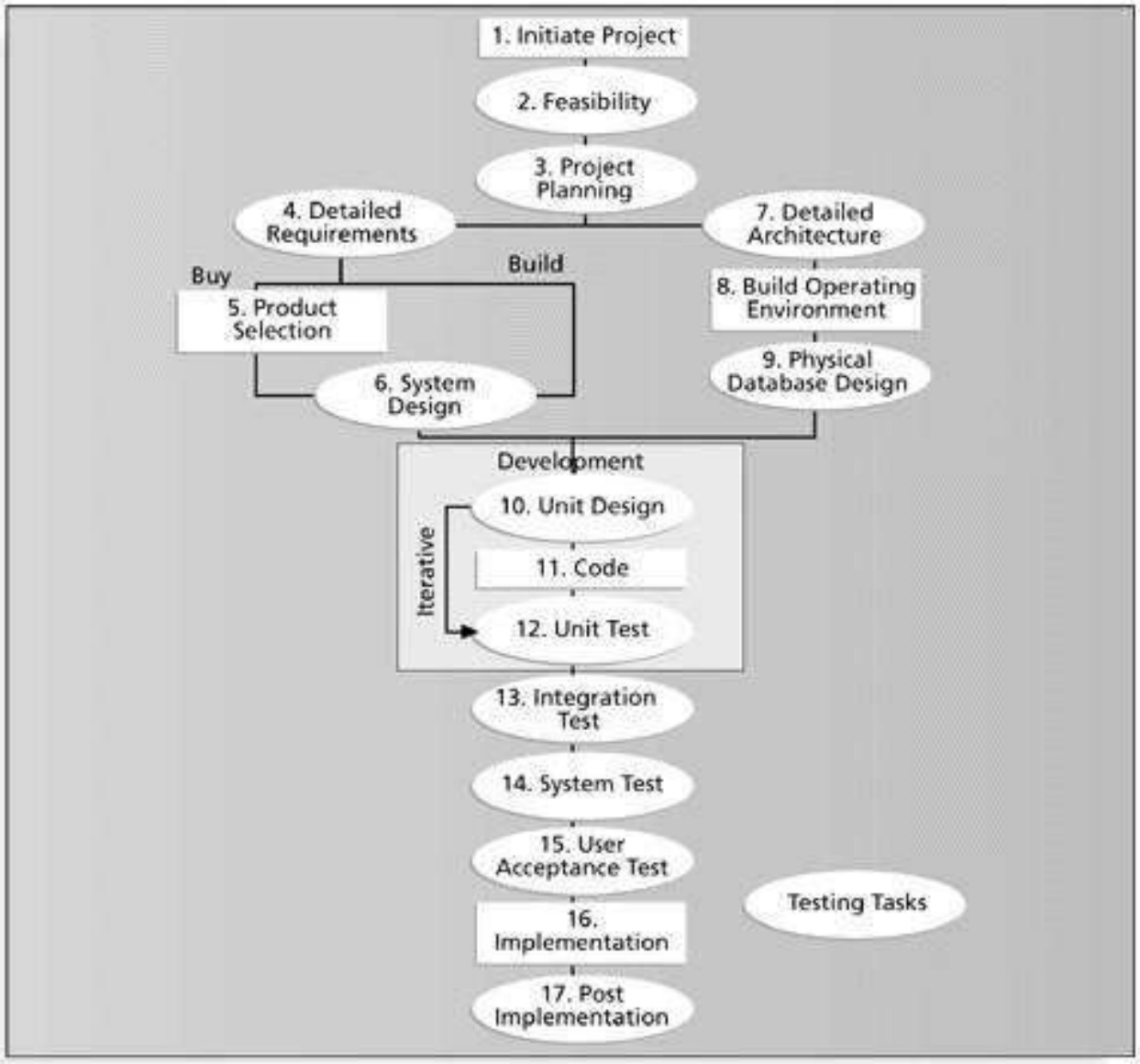
Six 9s of Quality

- **Six 9s of quality** is a measure of quality control equal to 1 fault in 1 million opportunities
- In the telecommunications industry, it means 99.9999 percent service availability or *30 seconds of down time a year*
- This level of quality has also been stated as the target goal for the number of errors in a communications circuit, system failures, or errors in lines of code
- To achieve six 9s of quality requires continual testing to find and eliminate errors or enough redundancy and back-up equipment to reduce the overall system failure to that low a level

Testing

- Many IT professionals think of testing as a stage that comes near the end of IT product development
- Testing should be done during almost every phase of the IT product development life cycle
- **Types of Tests:**
  - **Unit testing** tests each individual component (often a program) to ensure it is as defect-free as possible
  - **Integration testing** occurs between unit and system testing to test functionally grouped components
  - **System testing** tests the entire system as one entity
  - **User acceptance testing** is an independent test performed by end users prior to accepting the delivered system

Testing Tasks in the Software Development Life Cycle



- One way of portraying the systems life cycle
- Shows 17 main tasks involved in a s/w development project and shows their realtionship to each other

Testing Alone Is Not Enough

- Watts S. Humphrey, a renowned expert on software quality, defines a **software defect** as anything that must be changed before delivery of the program
- Testing does not sufficiently prevent software defects because:
  - As code gets more complex, the number of defects missed by testing increases and becomes the problem of not just the testers but also of the paying customers
    - He estimates that finished code, after all testing, contains 5-6 defects per thousand lines of code
  - The number of ways to test a complex system is huge
  - Users will continue to invent new ways to use a system that its developers never considered
- Humphrey suggests that people rethink the software development process to provide *no* potential defects when you enter system testing; developers must be responsible for providing error-free code at each stage of testing

Modern Quality Management

- Modern quality management:
  - Requires customer satisfaction
  - Prefers prevention to inspection
  - Recognizes management responsibility for quality

- Noteworthy quality experts include Deming, Juran, Crosby, Ishikawa, Taguchi, and Feigenbaum

Quality Experts

- Deming was famous for his work in rebuilding Japan after WWII and his 14 Points for Management
  - His ideas were not accepted by US industry until Japan started producing products that seriously challenged American products, particularly in the auto industry
- Juran wrote the *Quality Control Handbook* and ten steps to quality improvement
  - Stressed the difference between manufacturer's view of quality focus on conformance to quality) and the customer's view (fitness for use).
- Crosby wrote *Quality is Free* and suggested that organizations strive for zero defects
  - He suggested that the cost of poor quality is so understated that companies can profitably spend unlimited amounts of money on improving quality

Quality Experts

- Ishikawa developed the concepts of quality circles and fishbone diagrams
  - Quality circles are groups of non-supervisors and work leaders in a single company department who volunteer to conduct group studies on how to improve the effectiveness of work in their department
    - In Japan quality is a company wide commitment while in the US it is delegated to a few staff members

Quality Experts

- Taguchi developed methods for optimizing the process of engineering experimentation
  - Quality should be designed into the product and not inspected into it
  - Quality is best achieved by minimizing deviation from the target value
  - **Robust design methods** – focus on eliminating defects by substituting scientific inquiry for trial-and-error methods
- Feigenbaum developed the concept of total quality control
  - Responsibility for quality should rest with the people who do the work
  - Product quality is more important that production rates and workers are allowed to stop production whenever a quality problem occurs

Malcolm Baldrige Award

- The **Malcolm Baldrige National Quality Award** originated in 1987 to recognize companies that have achieved a level of world-class competition through quality management
- Given by the President of the United States to U.S. businesses
- Three awards each year in different categories
  - Manufacturing
  - Service
  - Small business
  - Education and health care

ISO Standards

- **ISO 9000** is a quality system standard that:
  - Is a three-part, continuous cycle of planning, controlling, and documenting quality in an organization
  - Provides minimum requirements needed for an organization to meet its quality certification standards
  - Helps organizations around the world reduce costs and improve customer satisfaction

Improving Information Technology Project Quality

- Several suggestions for improving quality for IT projects include:
  - Establish leadership that promotes quality
  - Understand the cost of quality
  - Focus on organizational influences and workplace factors that affect quality
  - Improving the organization's overall maturity level in software development and project management

Leadership

- As Joseph M. Juran said in 1945, “It is most important that top management be quality-minded. In the absence of sincere manifestation of interest at the top, little will happen below.”
- A large percentage of quality problems are associated with management, not technical issues

Leadership

- As globalization increases and customers become more demanding, creating quality products quickly at a reasonable price is essential for staying in business
  - In 1988, Motorola Corp. became one of the first companies to receive the Malcolm Baldrige National Quality Award.
  - One of Motorola's innovations that attracted a great deal of attention was its Six Sigma program.
  - Top management stressed the need to develop and use quality standards and provided resources (training, staff, customer input) to help improve quality

The Cost of Quality

- The **cost of quality** is the cost of conformance plus the cost of nonconformance
  - **Conformance** means delivering products that meet requirements and fitness for use
  - **Cost of nonconformance** means taking responsibility for failures or not meeting quality expectations
- A 2002 study reported that software bugs cost the U.S. economy $59.6 billion (6% of GDP) each year and that one-third of the bugs could be eliminated by an improved testing infrastructure
- Gartner Research estimated that the cost of downtime for computer networks is about $42,000/hour.
  - A worse than average system with a downtime of 30 minutes per day can cost more than $7 million per year.

Five Cost Categories Related to Quality

- **Prevention cost**: cost of planning and executing a project so it is error-free or within an acceptable error range
- **Appraisal cost**: cost of evaluating processes and their outputs to ensure that a project is either error-free or within an acceptable error range
- **Internal failure cost**: cost incurred to correct an identified defect before the customer receives the product (rework, inventory costs due to defects, premature failure of products)
- **External failure cost**: cost that relates to all errors not detected and corrected before delivery to the customer (warranty costs, product liability suits, future business losses)
- **Measurement and test equipment costs**: capital cost of equipment used to perform prevention and appraisal activities

Five Cost Categories Related to Quality

- Demarco found that the average large company devoted more than 60% of its s/w development efforts to maintenance
- Around 50% of development costs are typically spent on testing and debugging software
- Top management is primarily responsible for the high cost of nonconformance in IT
  - Top managers often rush their organizations to develop new systems and do not give project teams enough time ot resources to do a project right the first time
  - Top management must create a culture that embraces quality

Organizational Influences, Workplace Factors, and Quality

- Study by DeMarco and Lister showed that organizational issues had a much greater influence on programmer productivity than the technical environment or programming languages
  - Programmer productivity varied by a factor of one to ten across all participants across all organizations, but only by 21% within the same organization
  - Study found no correlation between productivity and programming language, years of experience, or salary
  - A dedicated workspace and a quiet work environment were key factors to improving programmer productivity

Organizational Influences, Workplace Factors, and Quality

- Major problems in with work performance and project failures are sociological, not technological, in nature
  - They suggest minimizing office politics and giving smart people physical space, intellectual responsibility and strategic direction and then just letting them work
  - Manager should not ***make*** people work, but make it possible for people to work by removing political roadblocks

Expectations and Cultural Differences in Quality

- Project managers must understand and manage stakeholder expectations

- Expectations also vary by:
  - Organization's culture – even within the organization
  - Geographic regions

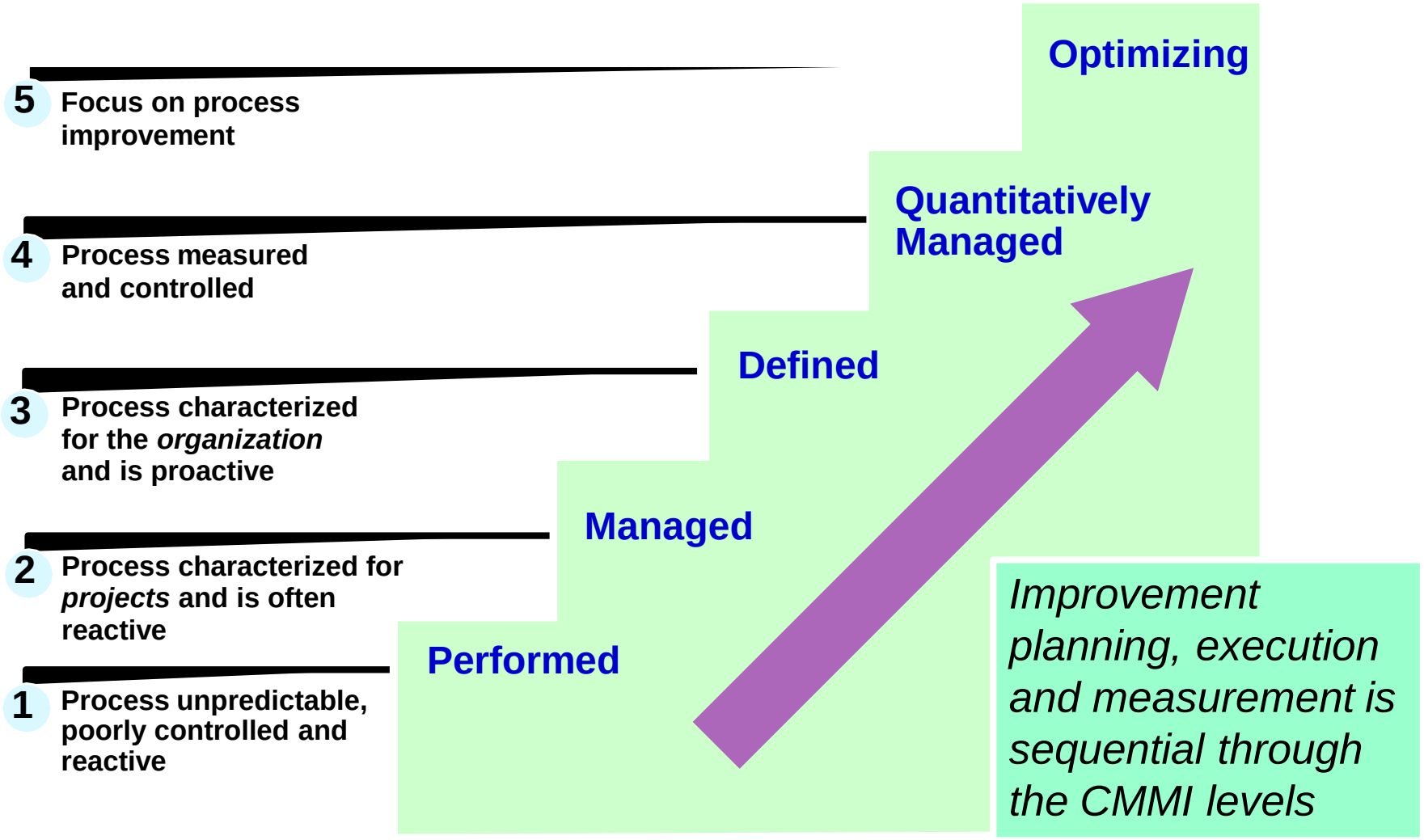
Maturity Models

- **Maturity models** are frameworks for helping organizations improve their processes and systems
  - An evolutionary path of increasingly organized and systematically more mature processes
  - The **Software Quality Function Deployment Model** focuses on defining user requirements and planning software projects resulting in a set of measurable technical product specifications and their priorities
    - Clearer requirements can lead to fewer design changes, increased productivity and ultimately s/w products that are more likely to satisfy stakeholder requirements

Maturity Models

- The Software Engineering Institute's **Capability Maturity Model Integration** is a process improvement approach that provides organizations with the essential elements of effective processes
  - Companies may not get to bid on government projects unless they have a CMMI Level 3

CMMI Staged Representation



PMI's Maturity Model

- PMI released the Organizational Project Management Maturity Model (OPM3) in December 2003

- Model is based on market research surveys sent to more than 30,000 project management professionals, and incorporates 180 best practices and more than 2,400 capabilities, outcomes, and key performance indicators

- Addresses standards for excellence in project, program, and portfolio management best practices and explains the capabilities necessary to achieve those best practices