Project Quality Management

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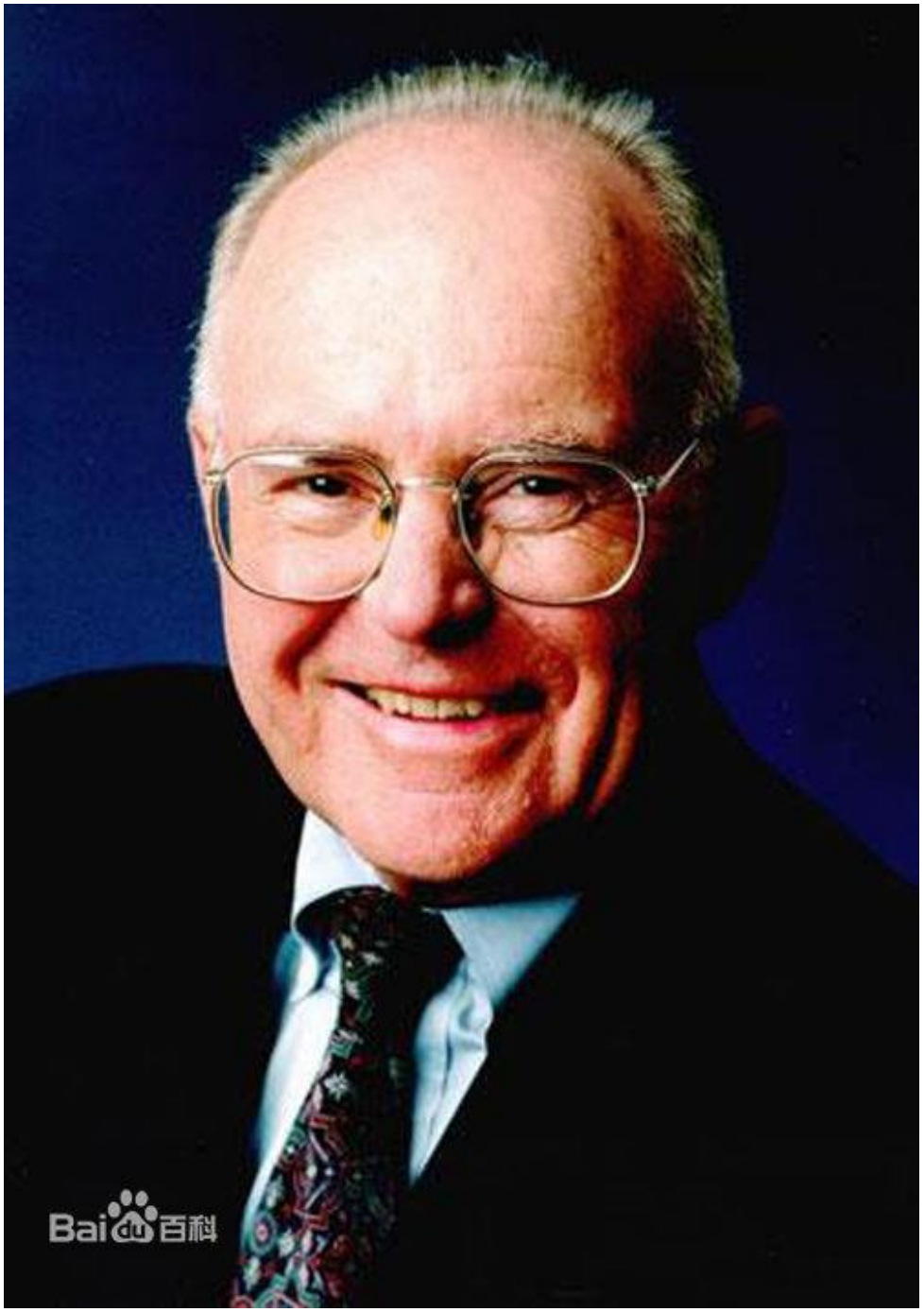
清華大學
Tsinghua University

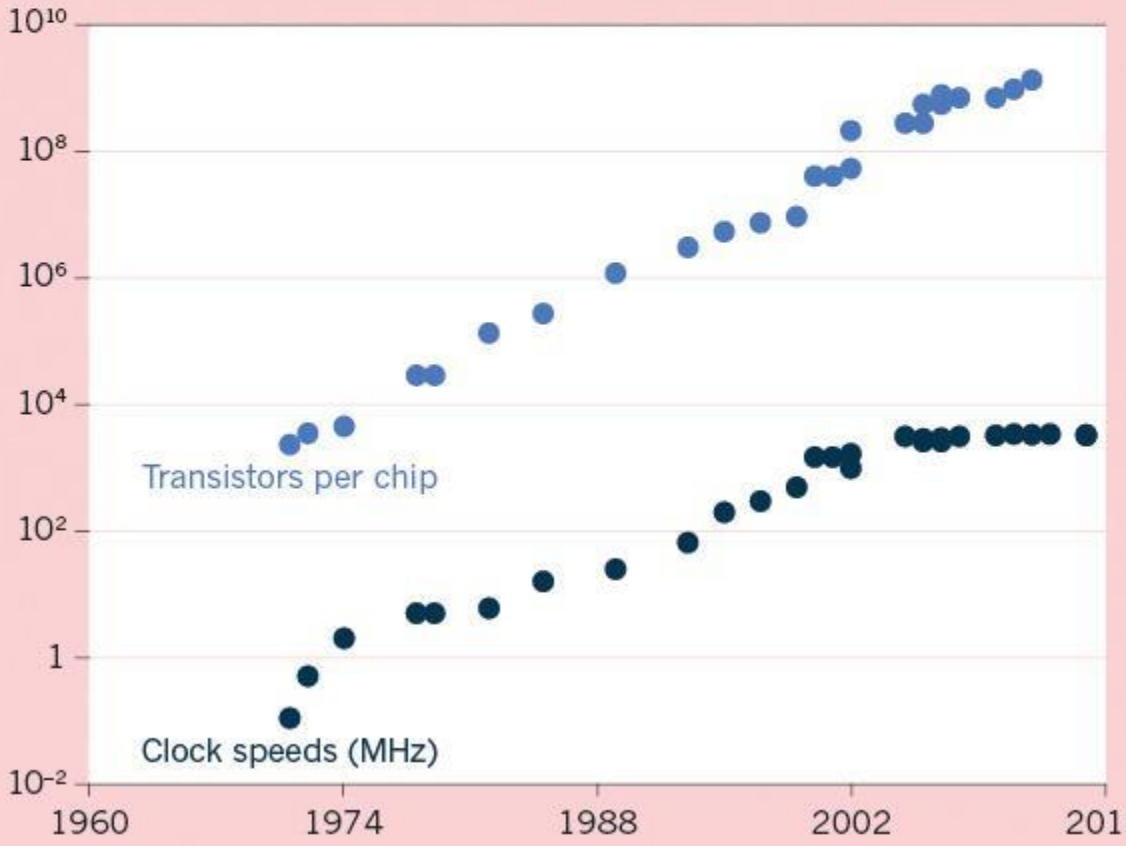
Contents

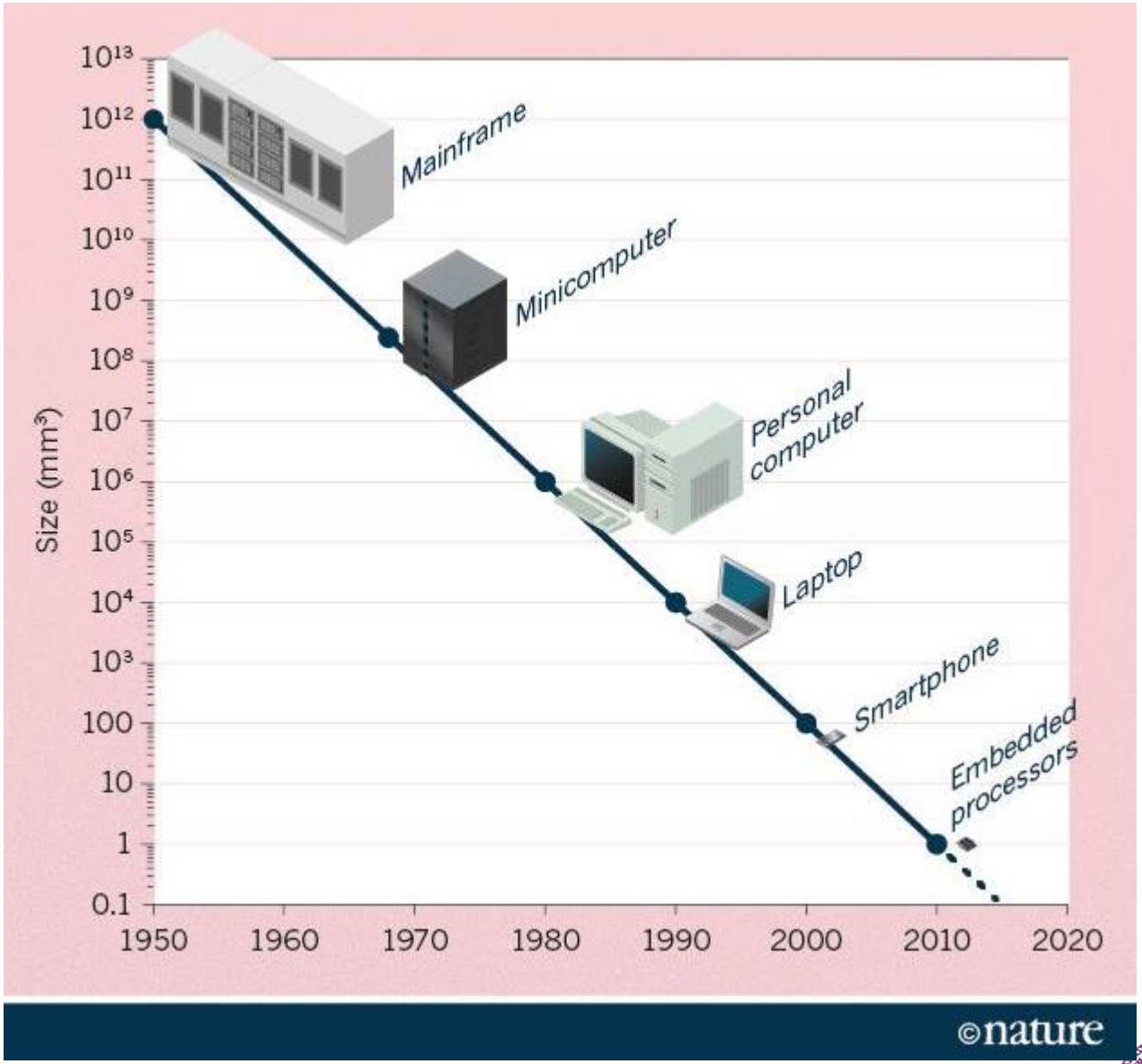
- Importance of PQM
- Plan Quality Management
- Manage Quality
- Control Quality
- Tools and Techniques for Quality Control
- Modern Quality Management
- Improving Information Technology Project Quality
- Software



MOORE'S LORE

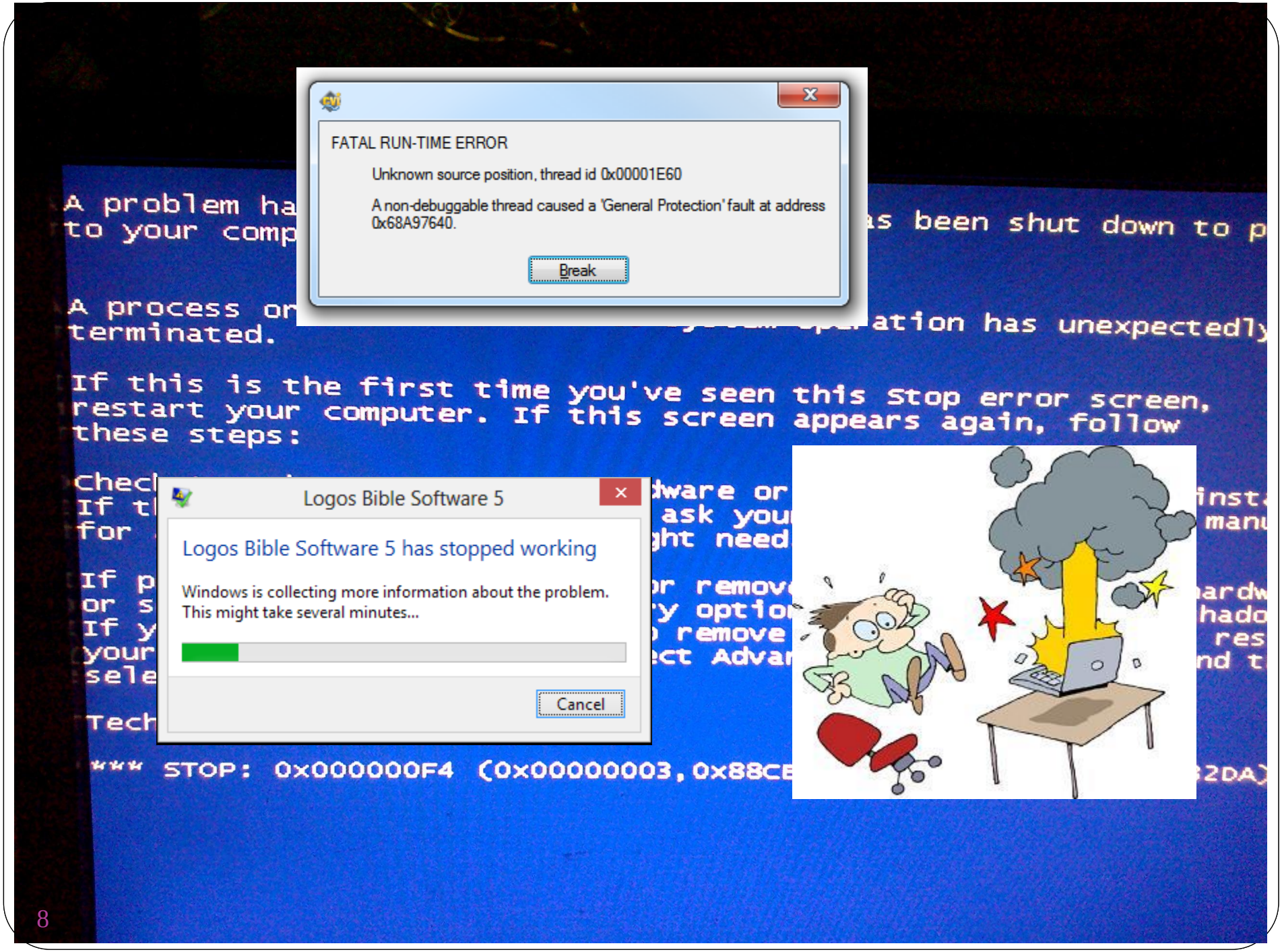
For the past five decades, the number of transistors per microprocessor chip — a rough measure of processing power — has doubled about every two years, in step with Moore's law (top). Chips also increased their 'clock speed', or rate of executing instructions, until 2004, when speeds were capped to limit heat. As computers increase in power and shrink in size, a new class of machines has emerged roughly every ten years (bottom).





If General Motors had kept up with technology like the computer industry has, we would all be driving $25 cars that got 1,000 miles to the gallon

- For no reason whatsoever your car would crash twice a day
- Every time they repainted the lines on the road, you would have to buy a new car
- Macintosh would make a car that was powered by the sun, reliable, five times as fast, and twice as easy to drive, but would run on only five percent of the roads
- New seats would force everyone to have the same size hips
- The airbag system would say “Are you sure?” before going off
- …….


FATAL RUN-TIME ERROR
Unknown source position, thread id 0x00001E60
A non-debuggable thread caused a 'General Protection' fault at address 0x68A97640.
Break
Logos Bible Software 5
Logos Bible Software 5 has stopped working
Windows is collecting more information about the problem.
This might take several minutes...
Cancel
A problem ha
to your comp
A process or
terminated.
If this is the first time you've seen this Stop error screen,
restart your computer. If this screen appears again, follow
these steps:
*** STOP: 0x000000F4 (0x00000003,0x88CE

Poor Quality of IT Products

- Your android APP crashes a couple of times a month
- Cannot login to “11.11” system
- Latest version of your word-processing software was shipped with several known bugs

Is quality a real problem with information technology projects?

Yes

- Food
- Car
- Navigation system on aircraft
- Computer components built into medical equipment
- Financial institutions

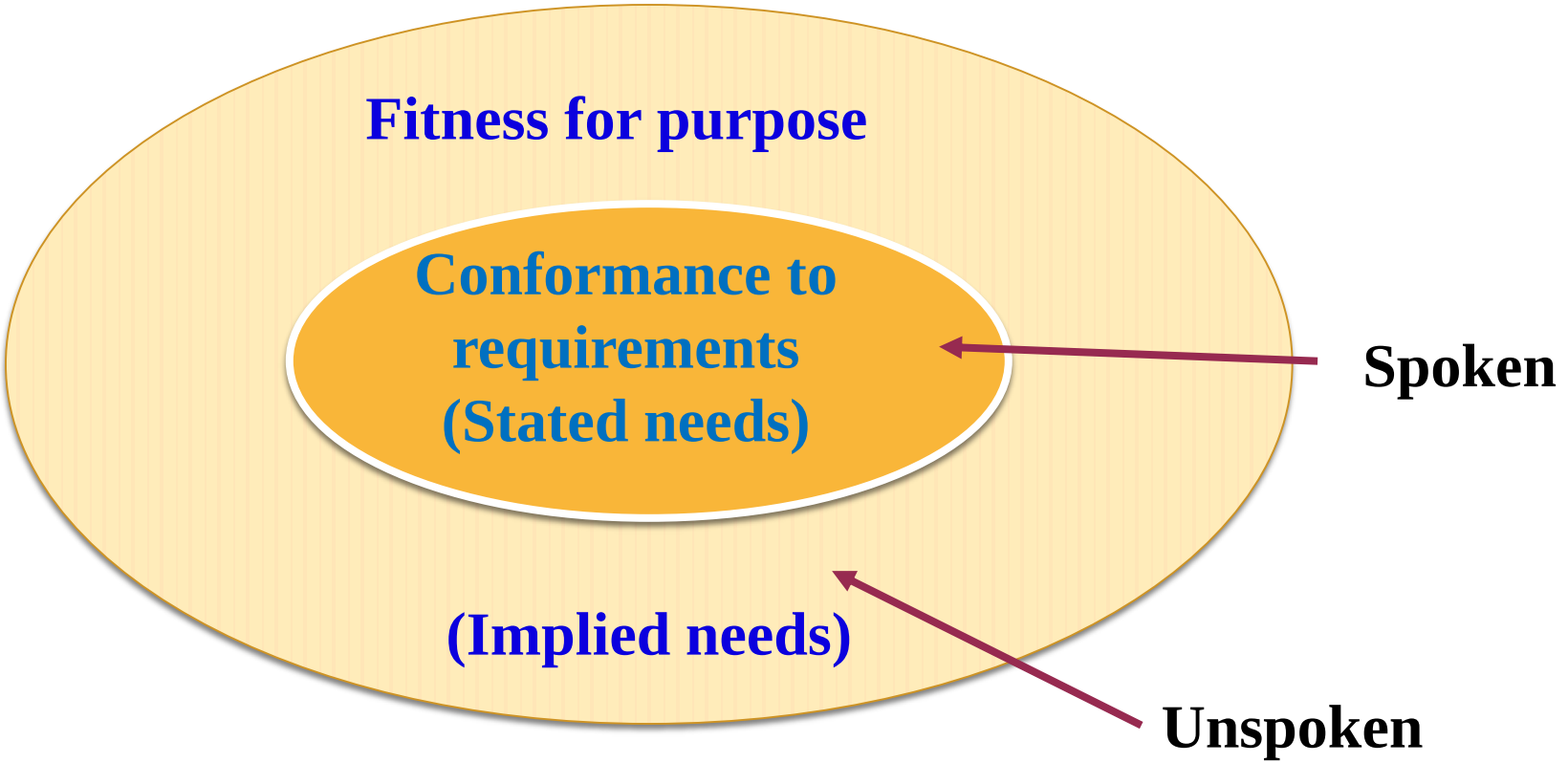
- 1981, a small timing difference caused a launch abort
- 1986, Therac 25 machine killed two patients by emitting fatal doses of radiation because of wrong calibration
- 2018， Mark Zuckerburg

Chemical Bank mistakenly deducted $15 million from more than 100,000 customer accounts

A single line of code in an updated program

Quality

- ISO8042:1994, the totality of characteristics of an entity that bear on its ability to satisfy stated or implied needs
- ISO9000:2000, the degree to which a set of inherent characteristics fulfills requirements
- **Conformance to requirements**: the project's **processes** and **products** meet written specification
- **Fitness for use** means a product can be used as it was intended

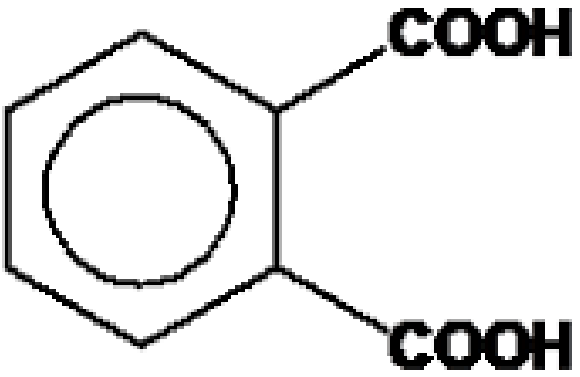


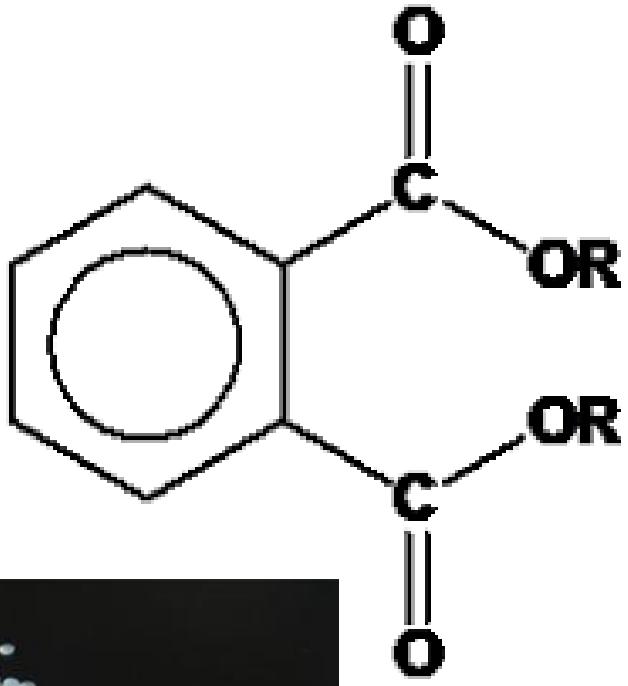
Germany Car vs Japanese Car


www.cfp.cn

Melamine

Plasticizer

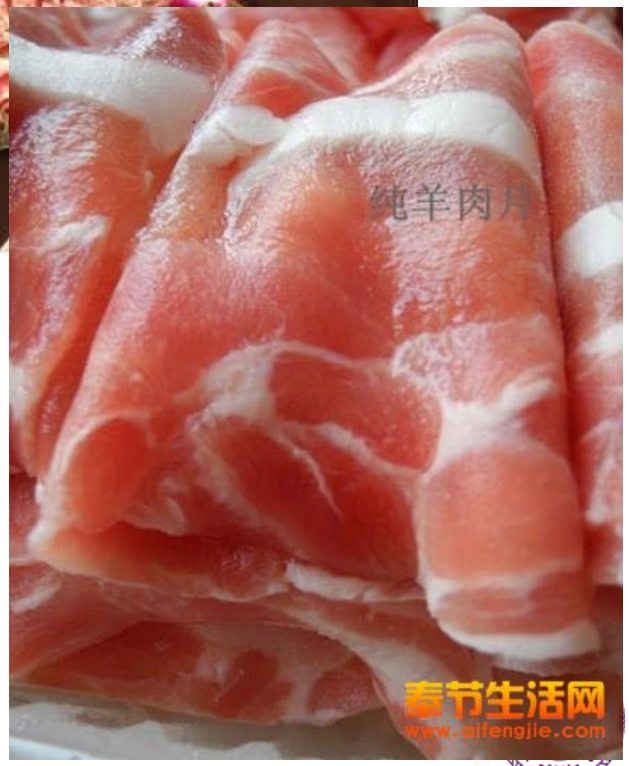




R=烷基


人靠衣衫马靠鞍，馒头也能巧打扮
Gutter oil?
Lean pork powder?


WHAT?? ANOTHER COMPLAINT? WELL, I DON'T KNOW HOW IT'S GETTIN' IN THERE! I BEEN WEARIN' THIS HAIR NET ALL DAY... MUST BE YOU!
Scott Hilburn/Distributed by Universal Uclick via CartoonStock.com
CARTOONSTOCK .com
Search ID: shl100114
1/14



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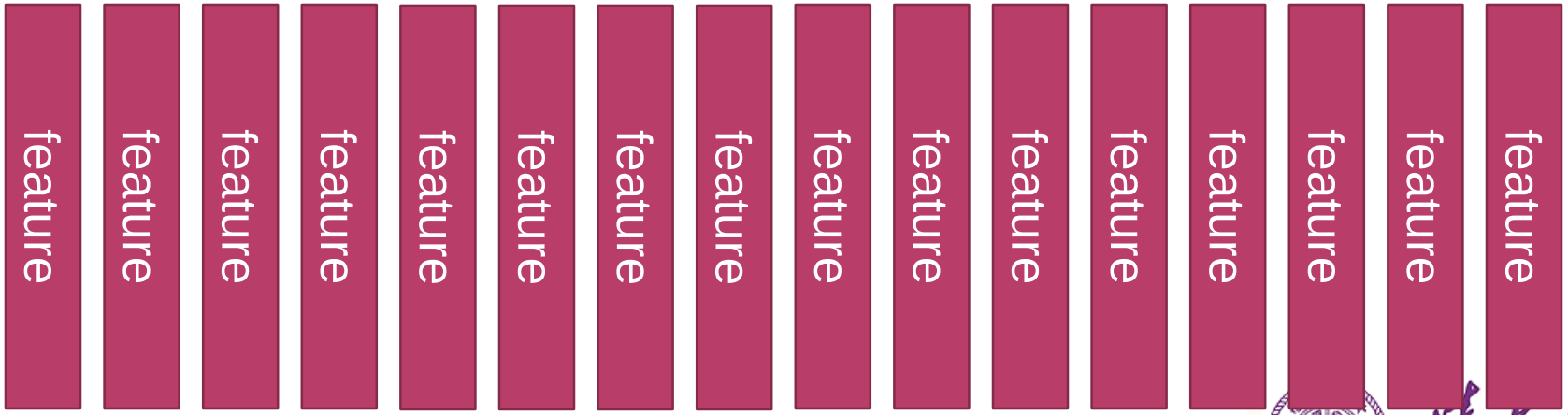
Quality vs Grade

- Quality as a delivered performance or result is “the degree to which a set of inherent characteristics fulfill requirements” (ISO 9000) .
- Grade as a design intent is a category assigned to deliverables having the same functional use but different technical characteristics.



1. Windows 10 Home, which is the most basic PC version.
2. Windows 10 Pro, which has touch features and is meant to work on two-in-one devices like laptop/tablet combinations, as well as some additional features to control how software updates get installed — important in the workplace.
3. Windows 10 Enterprise, which will have extra management features. We have some ideas of pricing here, as Microsoft is touting a $7/month Windows 10 Enterprise subscription for businesses that also includes a bunch of juicy, lucrative cloud services.
4. Windows 10 Mobile for smartphones.
5. Windows 10 Mobile Enterprise, which is like the one above, but with more business management features.
6. Windows 10 Education, which is optimized for schools.
7. Windows 10 IoT Core, which is for robots, smart sensors, and — well, if you need it, you'll know it.

Prevention vs Inspection

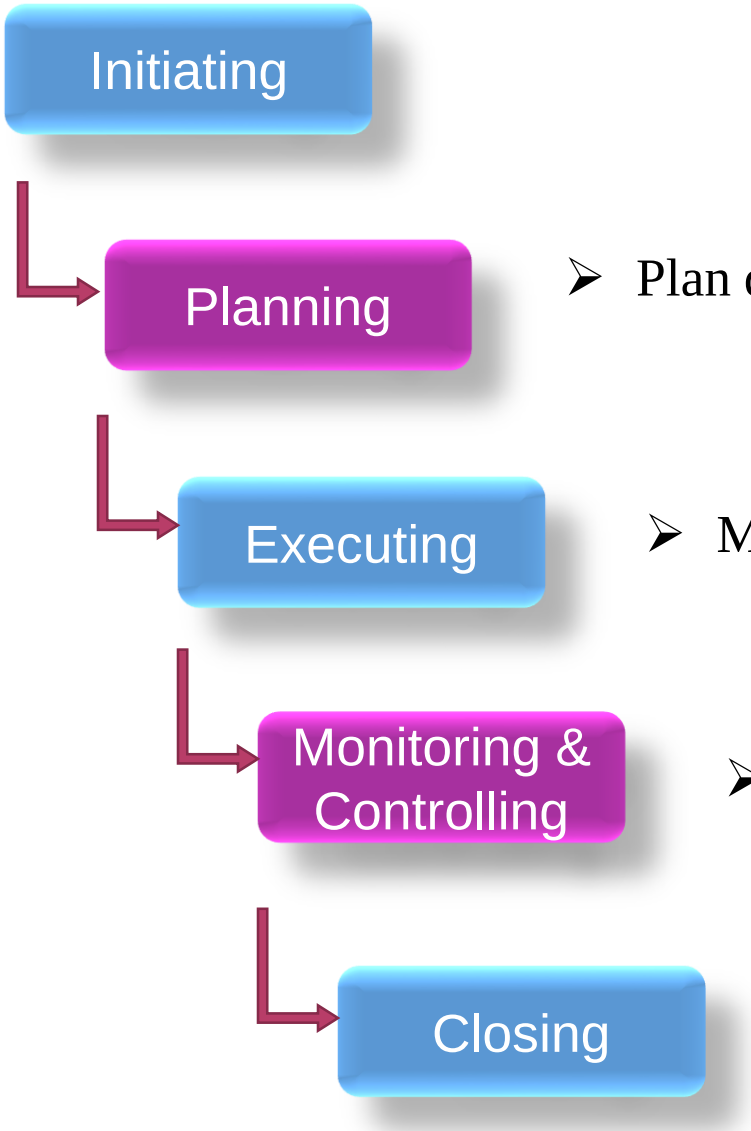
- It is better to design quality into deliverables, rather tan to find quality issues during inspection
- The cost of preventing mistakes is generally much less than the cost of correcting mistakes when they are found by inspection during usage

Five Levels of Quality Management

- Let the customer find the defects
- Detect and correct the defects before the deliverables are sent to the customer
- Use quality assurance to examine and correct the process itself and not just special defects
- Incorporate quality into the planning and designing of the project and product
- Create a culture throughout the organization that is aware and committed to quality in processes and products

Project Quality Management

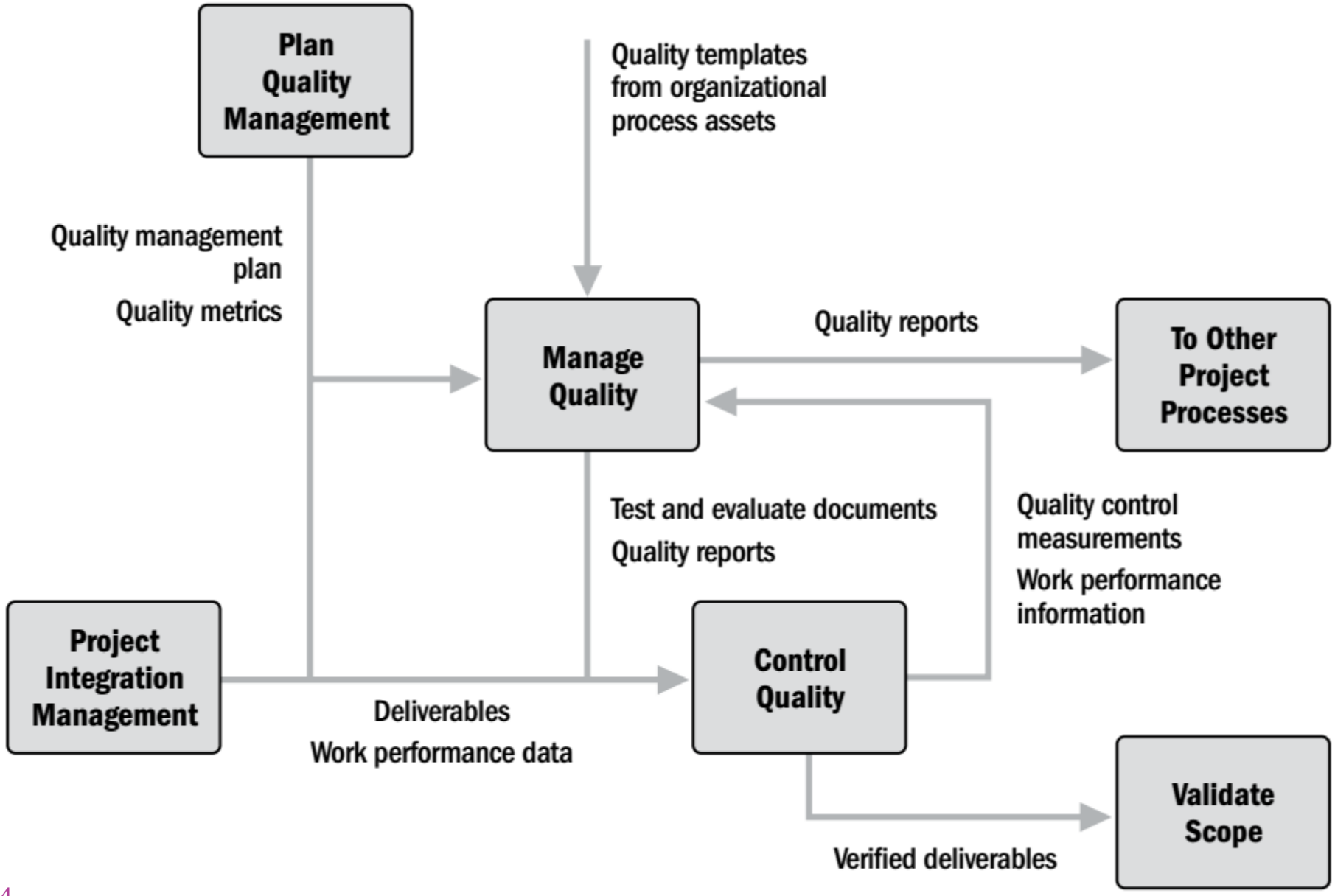
- Includes the processes for incorporating the organization's quality policy regarding planning, managing, and controlling project and product quality requirements in order to meet stakeholders' objectives
- Purpose is to ensure that the project will satisfy the needs for which it was undertaken
- Who will ultimately decides if quality is acceptable?



- Plan quality management
- Manage quality
- Control quality

Trends and Emerging Practices

- Customer satisfaction
- Continual improvement
- Management responsibility
- Mutually beneficial partnership with suppliers


Plan Quality Management
Quality templates from organizational process assets
Quality management plan
Quality metrics
Manage Quality
Quality reports
To Other Project Processes
Test and evaluate documents
Quality reports
Quality control measurements
Work performance information
Project Integration Management
Deliverables
Work performance data
Control Quality
Validate Scope
Verified deliverables

Quality Problems in Project Constrains

- Meeting customer requirements by overworking the project team may result in decreased profits and increased levels of overall project risks, employee attrition, errors, or rework
- Meeting project schedule objectives by rushing planned quality inspections may result in undetected errors, decreased profits, and increased post-implementation risks

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Plan Quality Management

Identify quality requirements and/or standards for the project and its deliverables and documenting how the project will demonstrate compliance with quality requirements and/or standards

Key benefits: It provides guidance and direction on how quality will be managed and verified throughout the project.

Inputs	Tools & Techniques	Outputs
1. Project charter 2. Project management plan 3. Project documents 4. Enterprise environmental factors 5. Organizational process assets	1. Expert judgment 2. Data gathering 3. Data analysis 4. Decision making 5. Data representation 6. Test and inspection planning 7. Meetings	1. Quality management plan 2. Quality metrics 3. Project management plan updates 4. Project documents updates

How to measure the quality of software?

Scope Aspects Affecting Quality

- Functionality – optional / mandatory
- System outputs – screens and reports
- Performance – volumes, transactions, simultaneous users, platform, response time, consistent results, …
- Reliability - IT service management, ITIL
- Maintainability – ease, help desk, …

Quality Management Plan

- The quality management plan is a component of the project management plan that describes how the organization's quality policies will be implemented. It describes how the project management team plans to meet the quality requirements set for the project.
- The quality management plan may be formal or informal, detailed, or broadly framed. The style and detail of the quality management plan are determined by the requirements of the project.

Components of Quality Management Plan

- Quality standards that will be used by the project
- Quality objectives of the project
- Quality roles and responsibilities
- Project deliverables and processes subject to quality review
- Quality control and quality management activities planned for the project (? in the WBS)
- Quality tools that will be used for the project
- Major procedures relevant for the project, such as dealing with nonconformance

Who Is Responsible for Define Quality?

Who Is Responsible for Quality?

Who Is Responsible for Quality Management?

What's the benefit of meeting quality requirements?

- Less rework
- Higher productivity
- Lower costs
- Increased stakeholder satisfaction
- Increased profitability

The higher, the better?

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Manage Quality

- The process of translating the quality management plan into executable quality activities that incorporate the organization's quality policies into the project.

- Key benefits: It increases the probability of meeting the quality objectives as well as identifying ineffective processes and causes of poor quality.

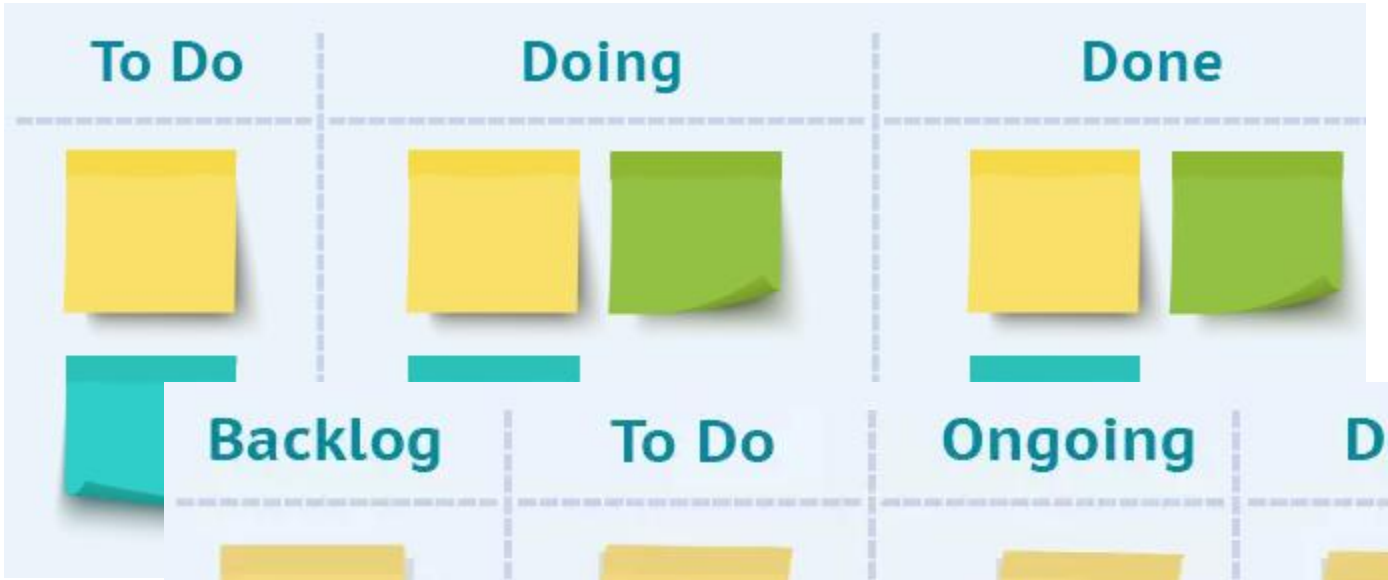
Inputs	Tools & Techniques	Outputs
1. Project management plan 2. Project documents 3. Organizational process assets	1. Data gathering 2. Data analysis 3. Decision making 4. Data representation 5. Audits 6. Design for X 7. Problem Solving 8. Quality improvement methods	1. Quality reports 2. Test and evaluation documents 3. Change requests 4. Project management plan updates 5. Project documents updates

Manage Quality vs Quality Assurance

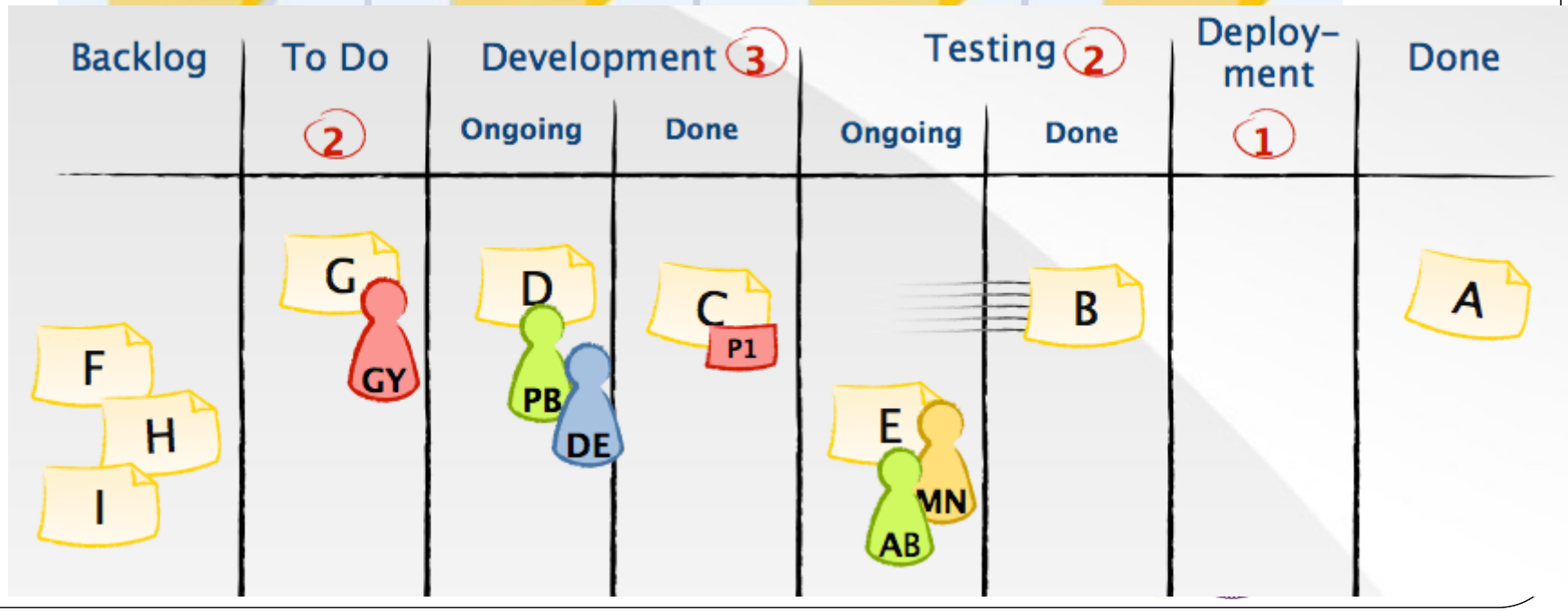
- Quality assurance involves following and meeting standards to assure stakeholders that the final product will meet their needs, expectations, and requirements
- Manage quality includes all the quality assurance activities, and is also concerned with the product design aspects and process improvements.

Tools

- **Experiment design**
- **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 performance organization
- **Quality audit** is a structured review of specific quality management activities that help identify lessons learned and that could improve performance on current and future projects


To Do
Doing
Done

Backlog
To Do
Ongoing
Done
F
D
B
A


Backlog
To Do
2
Development
3
Ongoing
Done
Testing
2
Ongoing
Done
Deploy-ment
1
Done
F
H
I
G
GY
D
PB
DE
C
P1
E
MN
AB
B
A

Kanban

- Visual workflow
- Limit work-in-progress
- Measure and manage flow
- Make process policies explicit
- Use models to recognize improvement opportunities

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Control Quality

- The process of monitoring and recording results of executing the quality management activities in order to assess performance and ensure the project outputs are complete, correct, and meet customer expectations.

- Key benefit: verifying that project deliverables and work meet the requirements specified by key stakeholders for final acceptance.

Inputs	Tools & Techniques	Outputs
1. Project management plan 2. Project documents 3. Approved change requests 4. Deliverables 5. Work performance data 6. Enterprise environmental factors 7. Organizational process assets	1. Data gathering 2. Data analysis 3. Inspection 4. Testing/product evaluations 5. Data representation 6. Meetings	1. Quality control measurements 2. Verified deliverables 3. Work performance information 4. Change requests 5. Project management plan updates 6. Project documents updates

Outcomes of Control Quality

- **Acceptance** decisions determine if the products or services produced as part of the project will be accepted or rejected
- **Rework** is the action taken to bring rejected items into compliance with product requirements, specifications, or other stakeholder expectations
- **Process adjustments** correct or prevent further quality problems based on quality measurements.

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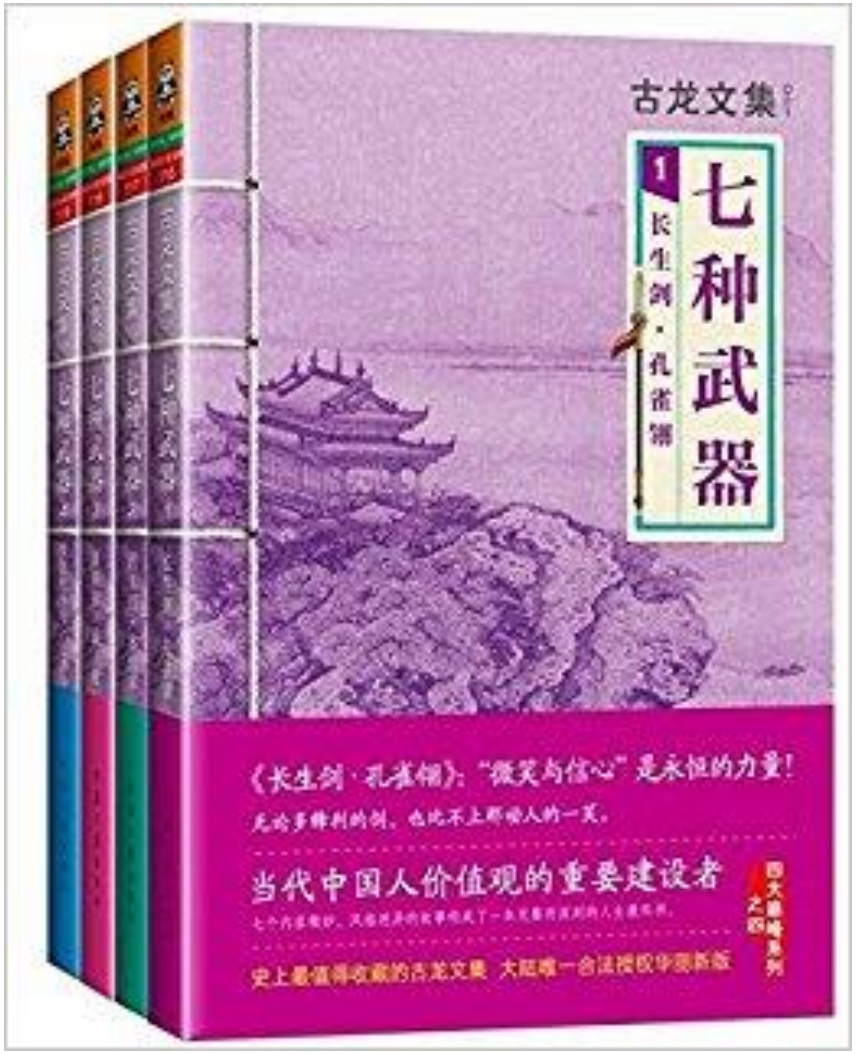


Seven Weapons

Ring

多情環

Knife

碧玉刀

Glove

拳頭

Sword

長生劍

Spear

霸王槍

Hook

離別鉤

Feather

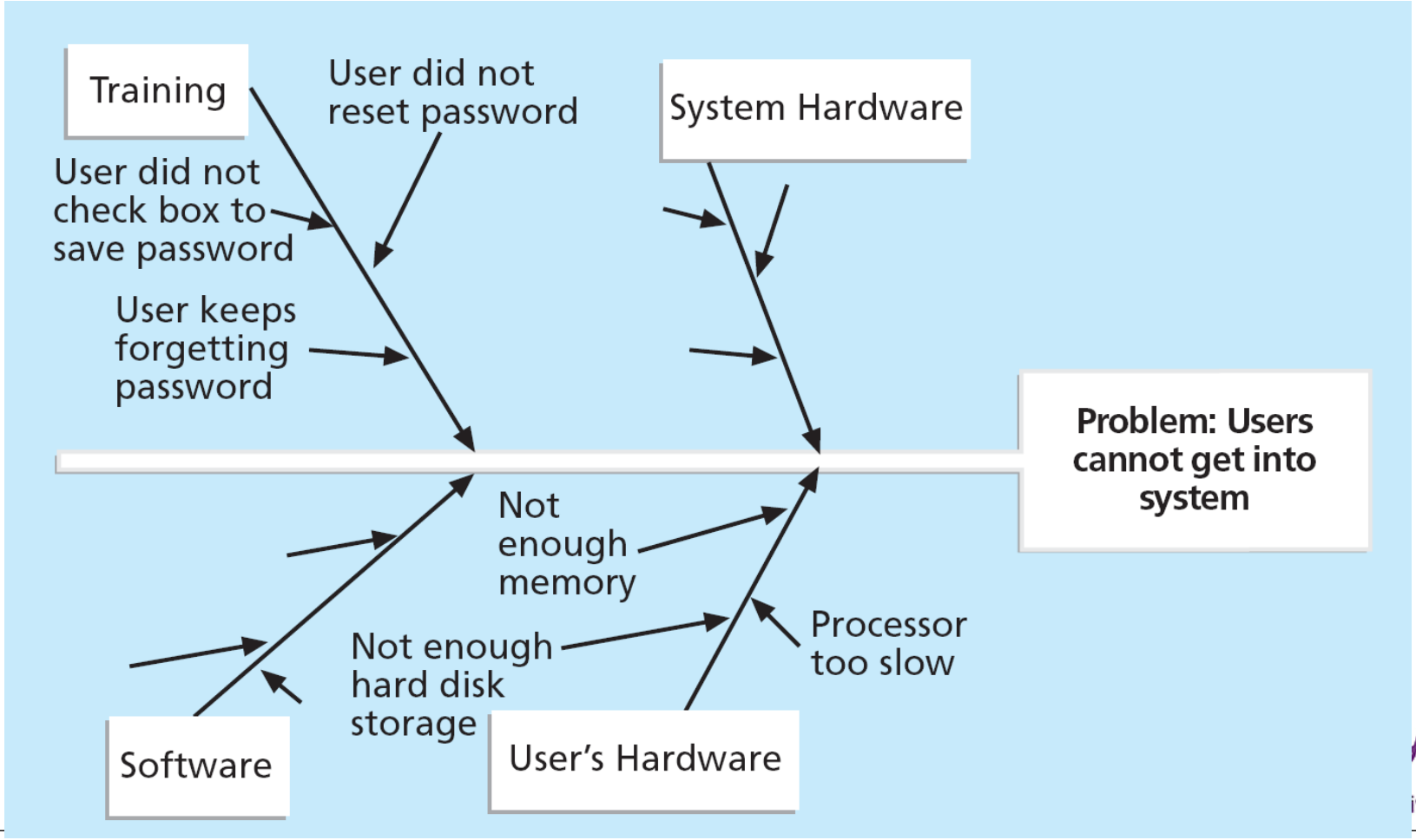
孔雀翎

Seven Basic Tools of Quality

1. Fishbone Diagram/Cause-and-effect diagrams/5 whys/Ishikawa diagram
2. Flowchart
3. Checksheet
4. Control chart / run chart
5. Scatter diagram
6. Histogram
7. Pareto chart

Fishbone Diagrams

- Trace complaints about quality problems back to the responsible production operations.

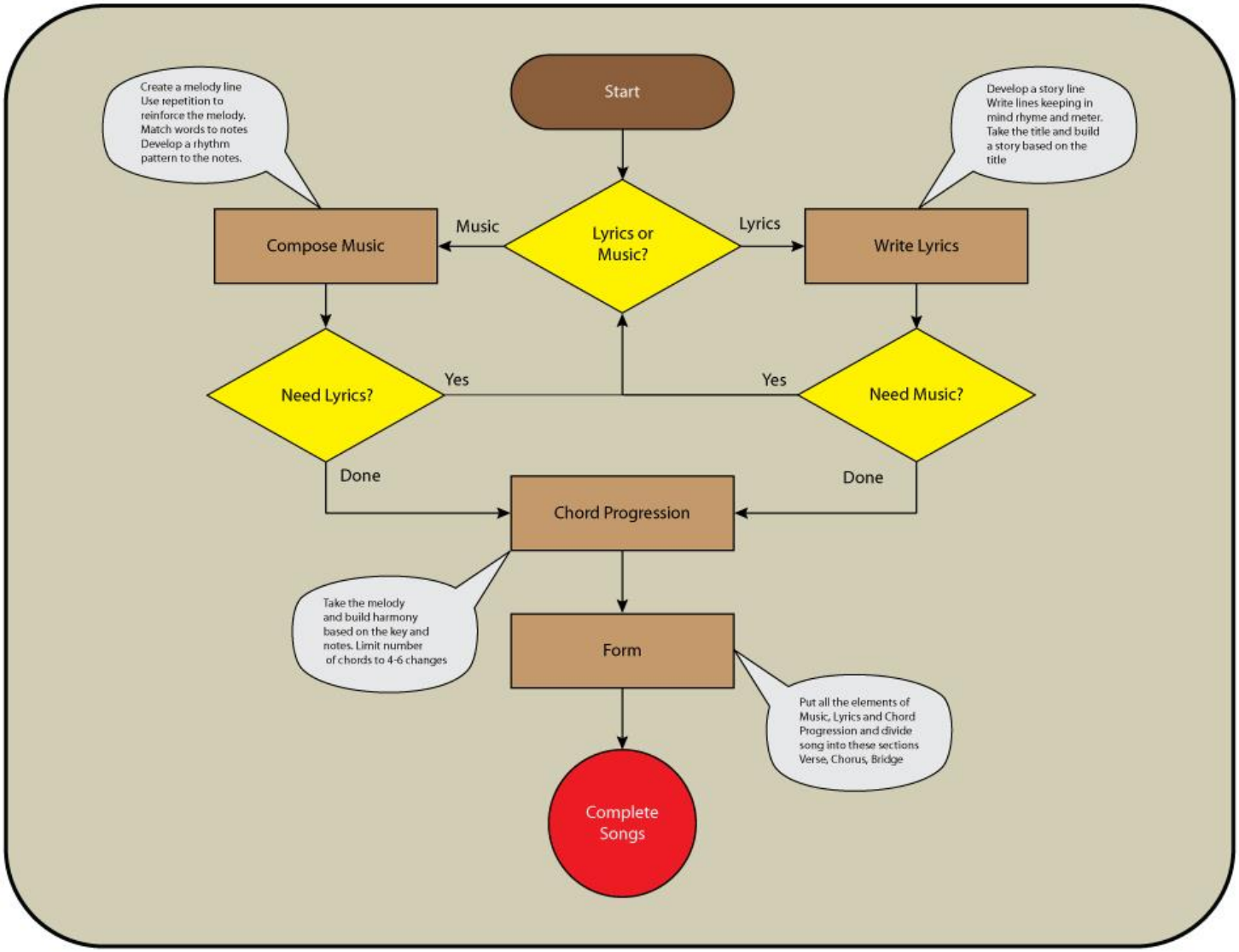


Flowcharts

- 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

Songwriting Flowchart



LearnToWriteSongs.com

Checksheet

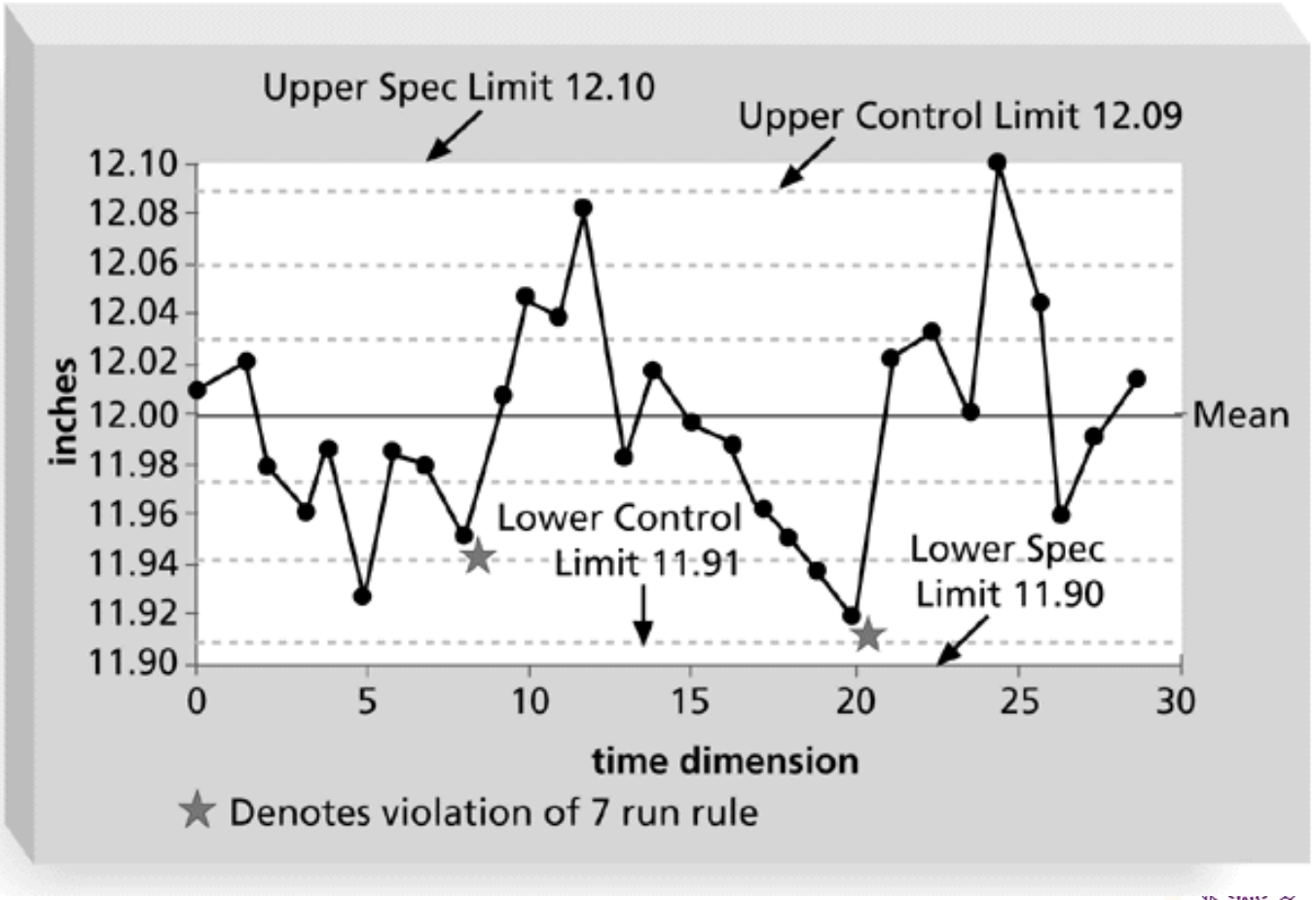
- Collect and analyze data

System Complaints

Source	Day							
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total
Email	𝍸	𝍸	𝍸	𝍸	𝍸		𝍸	12
Text	𝍸 𝍸	𝍸	𝍸 𝍸	𝍸	𝍸	𝍸	𝍸	29
Phone call	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸		8
Total	11	10	8	6	7	3	4	49

Control Chart(1)

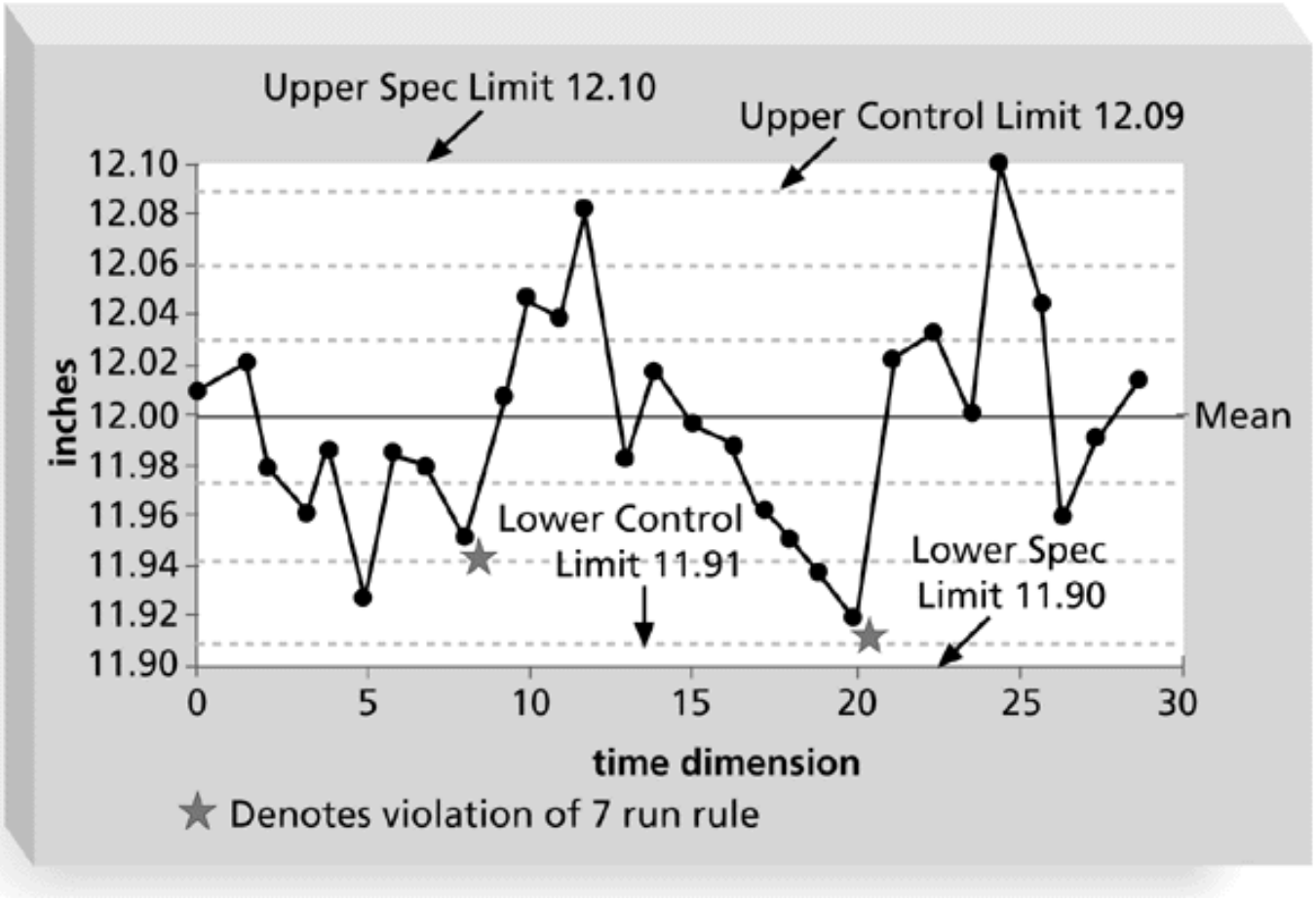
- A graphic display of data that illustrates the results of a process over time



Control Chart(2)

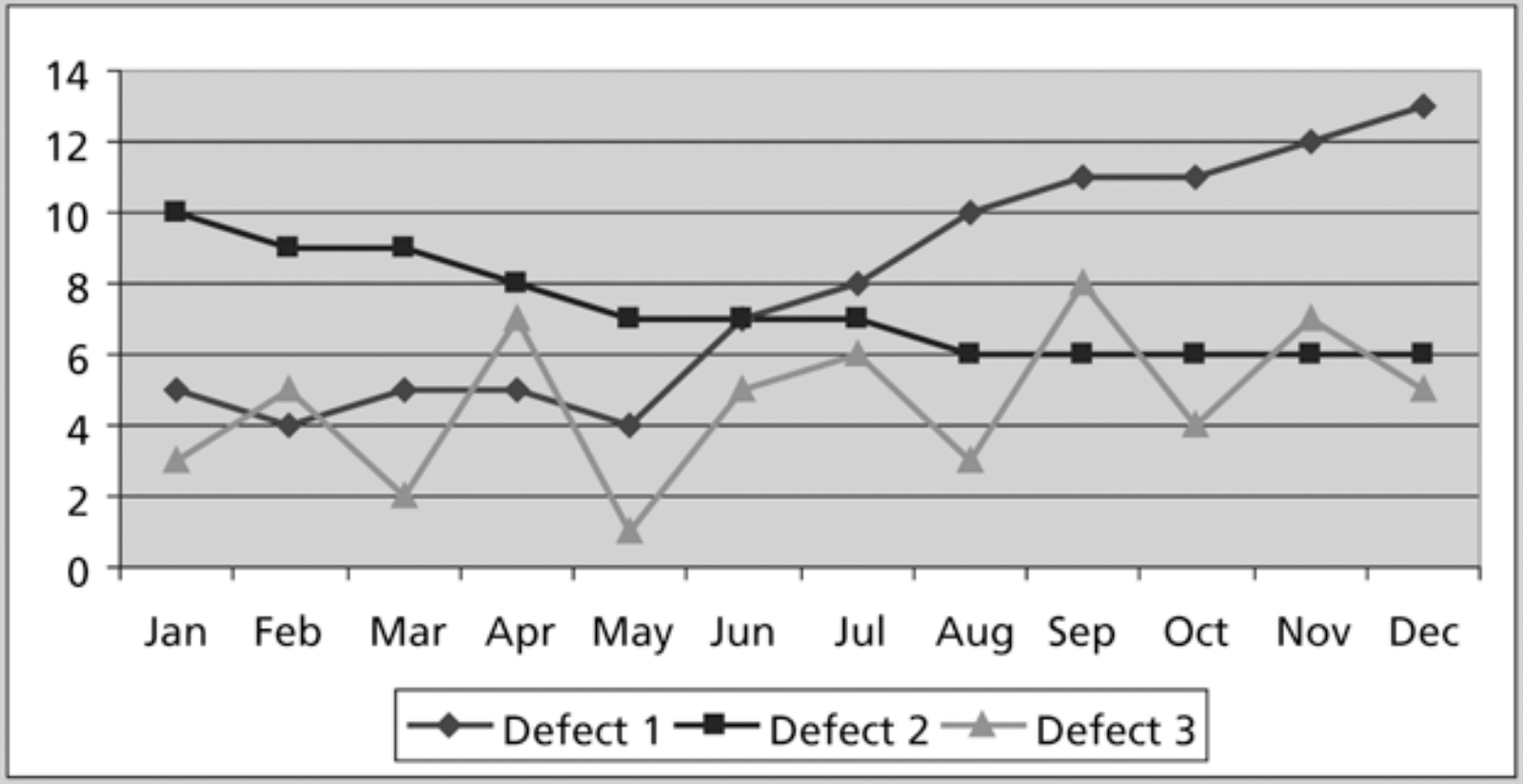
The **seven run** rule states that if seven data points in a row are all below the mean, above the mean, or are all increasing or decreasing, then the process needs to be examined for nonrandom problems

Seven Run Rule



Run Chart

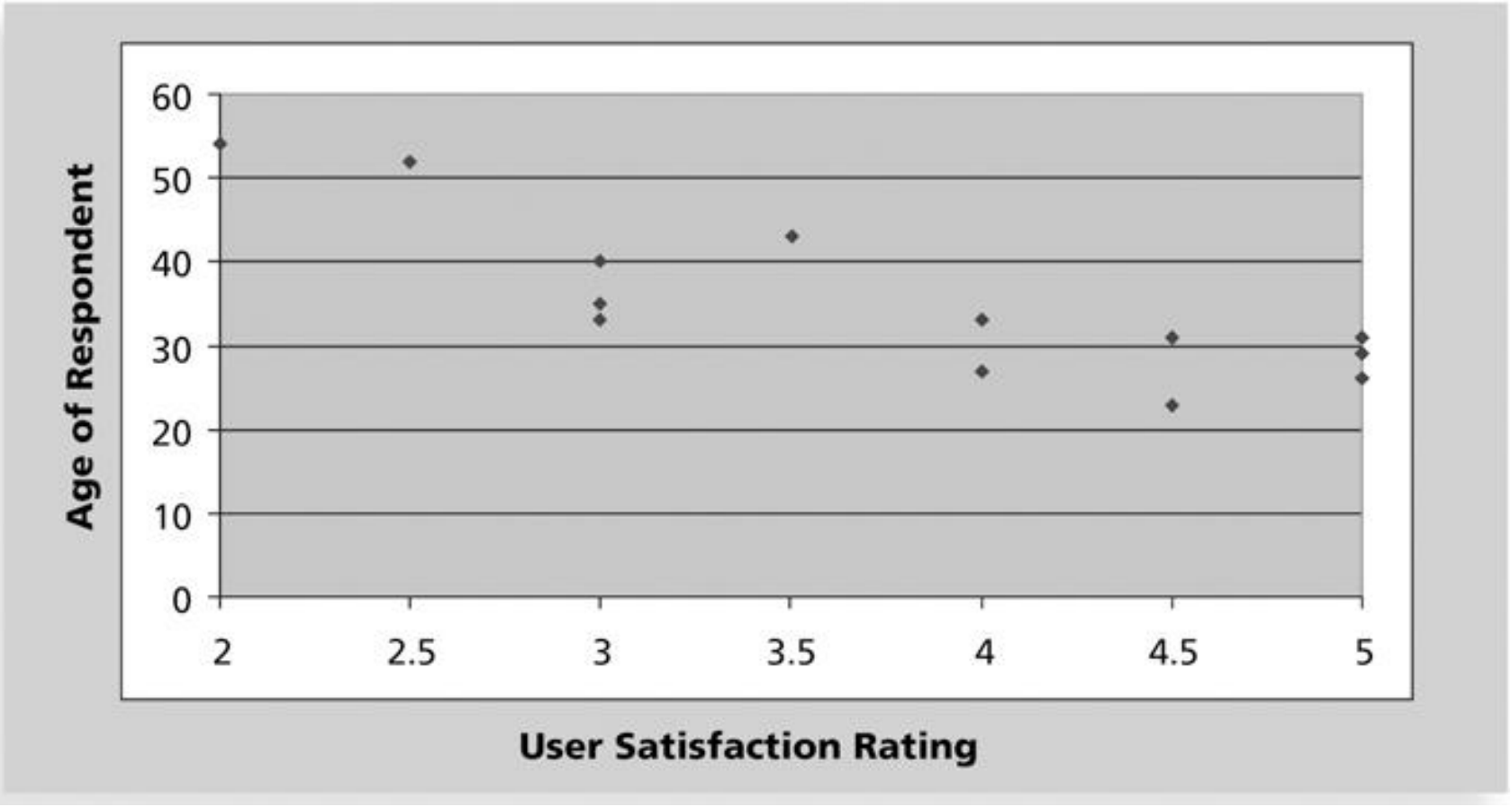
- Display the history and pattern of variation of a process over time
- A line chart that shows data points plotted in the order in which they occur
- It can be used to perform trend analysis to forecast future outcomes based on historical patterns



Scatter Diagram

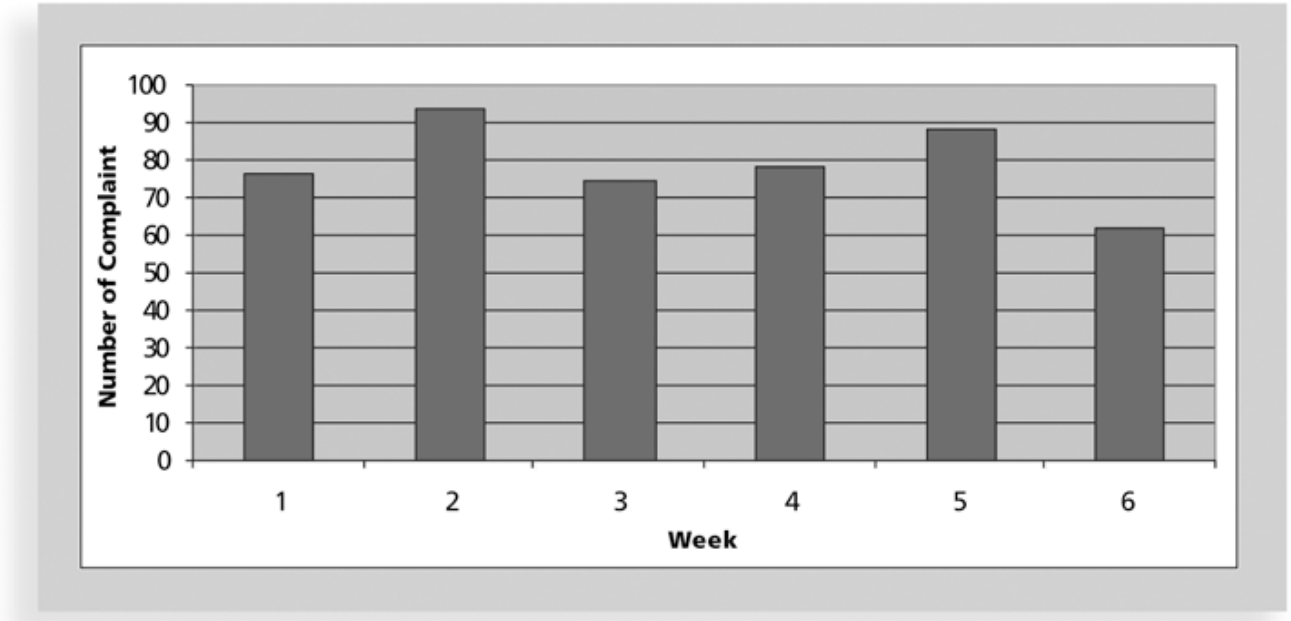
- Helps to show if there is a relationship between two variables

- The closer data points are to a diagonal line, the more closely the two variables are related



Histograms

- 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



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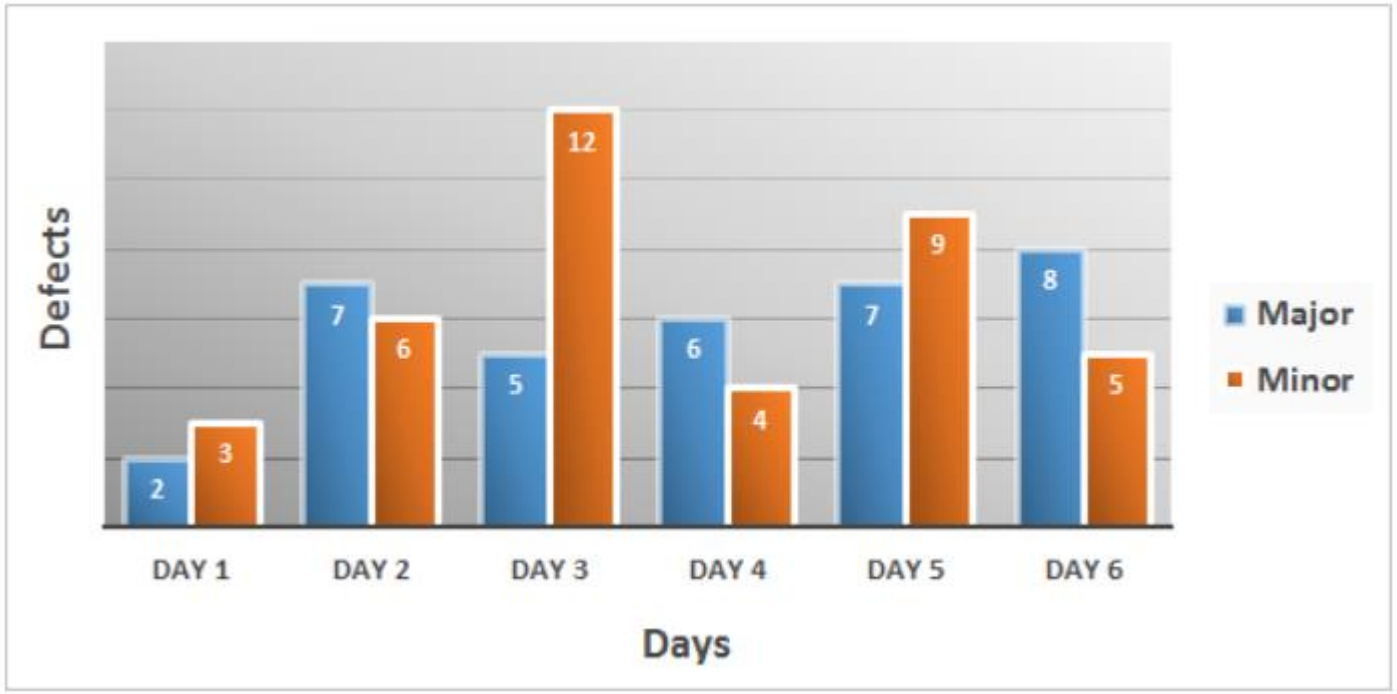
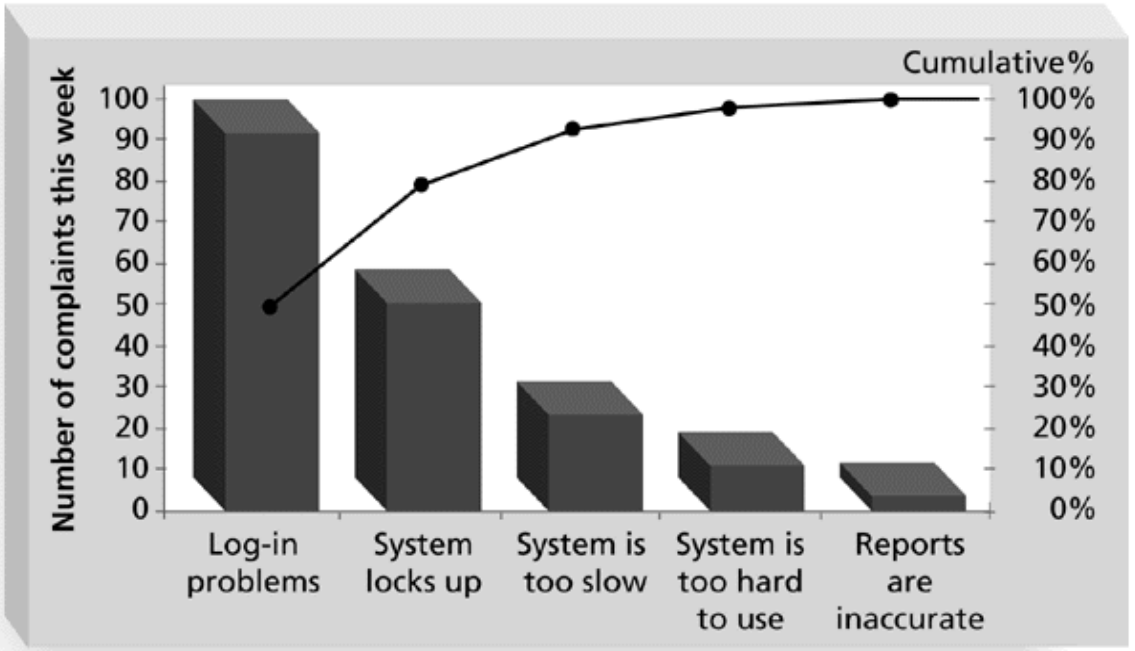


Pareto Chart

- A histogram that can help you identify and prioritize problem areas
- Pareto analysis is sometimes referred to as the 80-20 rule, meaning that 80 percent of problems are often due to 20 percent of the causes.



Other Technologies

- Statistical Sampling
- Six Sigma
- Testing

Statistical Sampling

- Involves choosing part of a population of interest for inspection
- The size of a sample depends on how representative you want the sample to be
- Sample size formula:

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

Commonly Used Certainty Factors

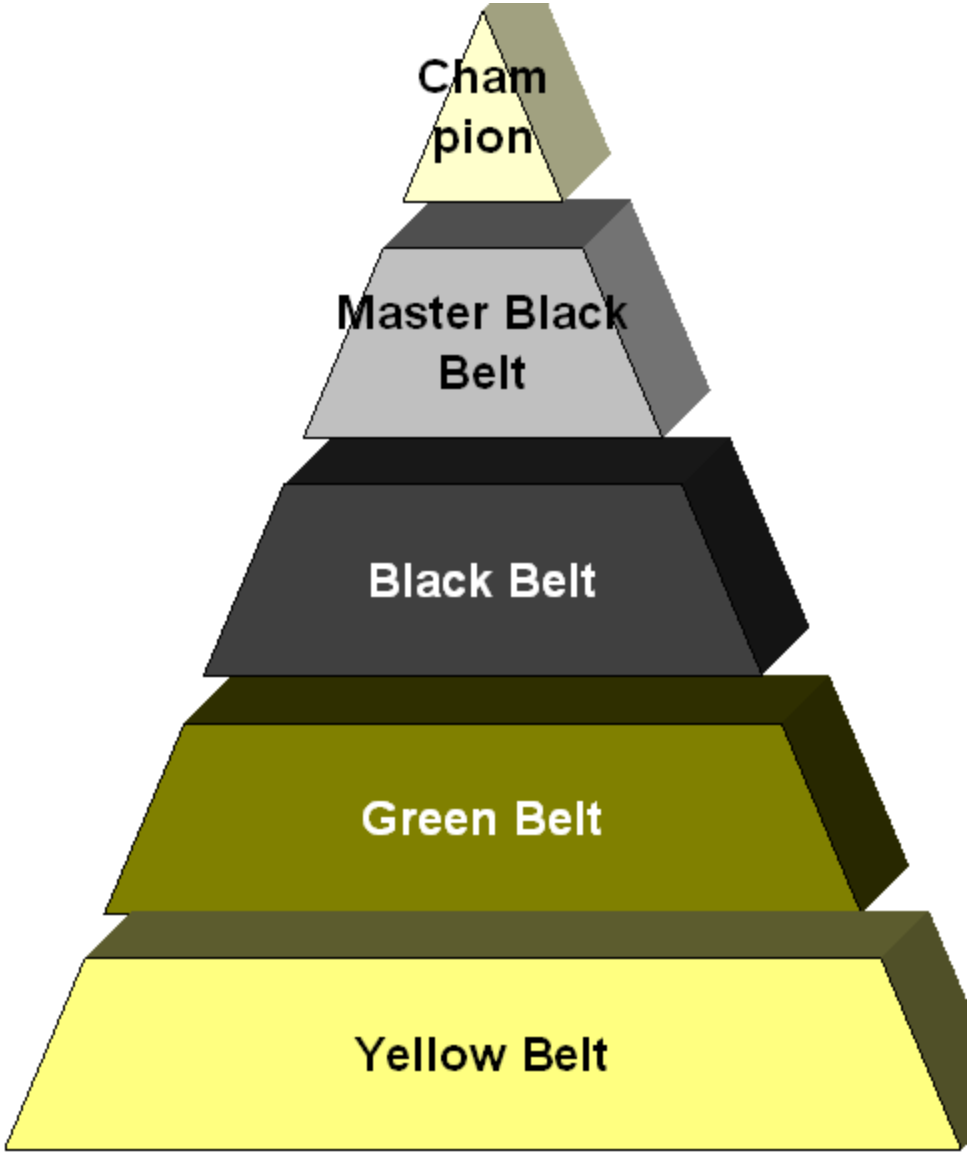
Desired Certainty	Certainty Factor
95%	1.960
90%	1.645
80%	1.281

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.”*

***Pande, Peter S., Robert P. Neuman, and Roland R. Cavanagh, *The Six Sigma Way*, New York: McGraw-Hill, 2000, p. xi.**

Judo?



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
- 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

DMAIC

- **DMAIC** is a systematic, closed-loop process for continued improvement that is scientific and fact based
- DMAIC stands for:
  - **D**efine: Define the problem/opportunity, process, and customer requirements
  - **M**easure: Define measures, then collect, compile, and display data
  - **A**nalyze: Scrutinize process details to find improvement opportunities (? tool)
  - **I**mprove: Generate solutions and ideas for improving the problem
  - **C**ontrol: Track and verify the stability of the improvements and the predictability of the solution (? tool)

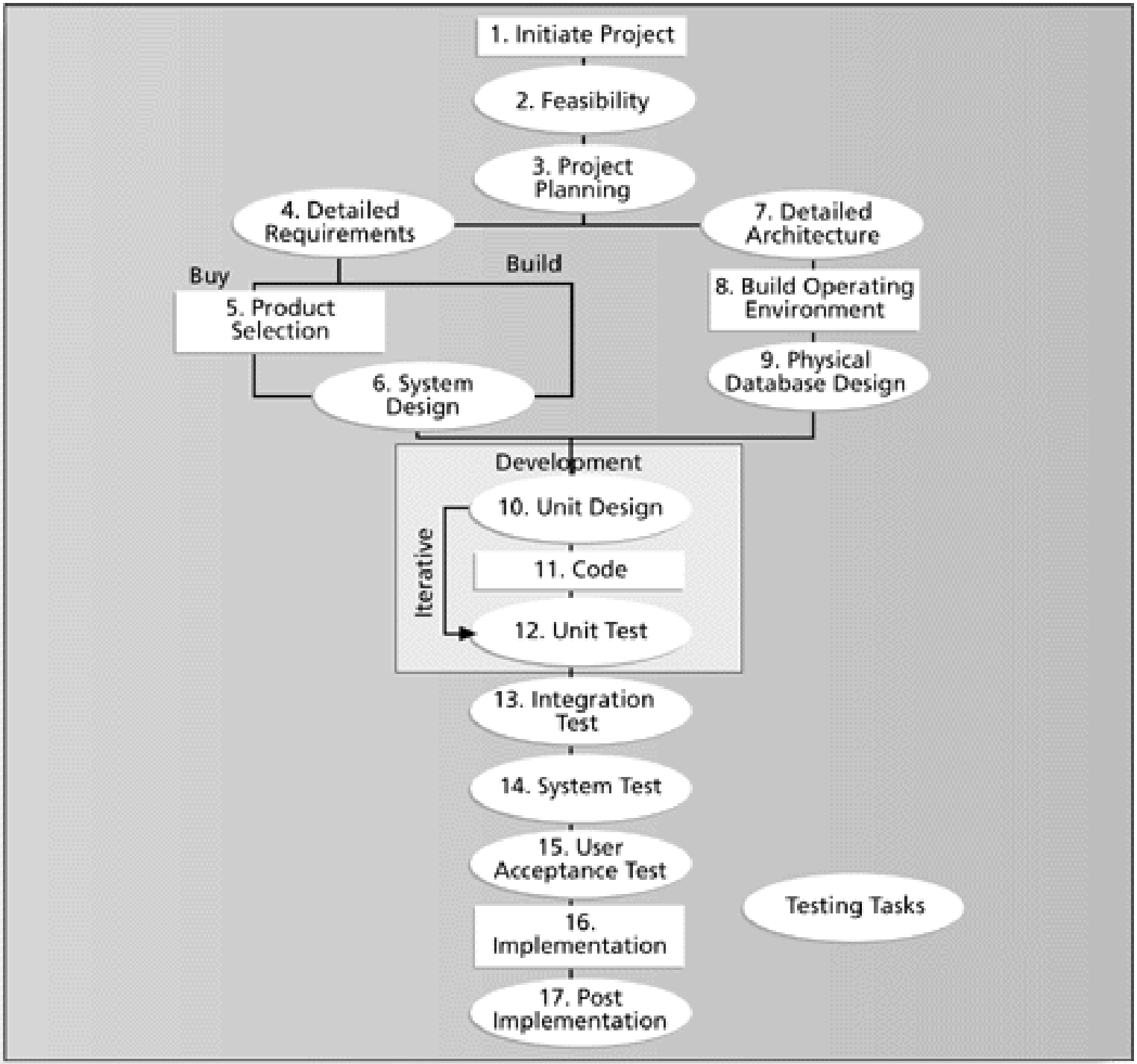
CMMI vs Six Sigma

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


1. Initiate Project
2. Feasibility
3. Project Planning
4. Detailed Requirements
7. Detailed Architecture
Buy
Build
5. Product Selection
8. Build Operating Environment
9. Physical Database Design
6. System Design
Development
10. Unit Design
Iterative
11. Code
12. Unit Test
13. Integration Test
14. System Test
15. User Acceptance Test
16. Implementation
17. Post Implementation
Testing Tasks

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:
  - 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

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Modern Quality Management

- Modern quality management:
  - Requires customer satisfaction
  - Prefers prevention to inspection
  - Recognizes **management** responsibility for quality
- Noteworthy quality experts include Shewhart, Deming, Juran, Crosby, Ishikawa, Taguchi, and Feigenbaum

Quality Time Line

- 1875
  - Taylor
  - Scientific Management
- 1925
  - Shewhart
  - Control charts based on probability distributions
  - Process variation – common cause and special cause
- 1930's
  - Dodge and Romig
  - Acceptance Sampling
- 1950's
  - Deming
  - Top management's responsibility for quality
  - Statistically-based approach to quality
- 1980's
  - Deming and Taguchi and Juran are all influential
  - US industrial leaders begin to embrace quality
  - Beginning to push quality upstream into engineering design
- 2000
  - Institutionalizing quality throughout the organization
  - Global marketplace – international quality standards
  - Six Sigma methods widespread

Quality Experts

- Deming was famous for his work in rebuilding Japan and his 14 Points for Management from *Out of the Crisis*
- Juran wrote the *Quality Control Handbook* and ten steps to quality improvement
- Crosby wrote *Quality is Free* and suggested that organizations strive for zero defects
- Ishikawa developed the concepts of quality circles and fishbone diagrams in *Guide to Quality Control*
- Taguchi – quality is designed into the product and not inspected into it
- Feigenbaum developed the concept of total quality control

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 / healthcare

ISO Standards

- **ISO 9000** is a quality system standard that:
  - 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
- See www.iso.org for more information

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- Importance of PQM
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Improving Information Technology Project Quality

- Suggestions for improving quality for IT projects include:
  1. Establish leadership that promotes quality
  2. Understand the cost of quality
  3. Focus on organizational influences and workplace factors that affect quality
  4. Expectations and Cultural Differences in Quality
  5. Follow maturity models

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

*American Society for Quality (ASQ), *(www.asqc.org/about/history/juran.html*).

Leadership

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 each year and that one-third of the bugs could be eliminated by an improved testing infrastructure

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 quality
- **Internal failure cost**: cost incurred to correct an identified defect before the customer receives the product
- **External failure cost**: cost that relates to all errors not detected and corrected before delivery to the customer
- **Measurement and test equipment costs**: capital cost of equipment used to perform prevention and appraisal activities

Cost of Conformance

Prevention Costs
(Build a quality product)

- Training
- Document processes
- Equipment
- Time to do it right

Appraisal Costs
(Assess the quality)

- Testing
- Destructive testing loss
- Inspections

Money spent during the project **to avoid failures**

Cost of Nonconformance

Internal Failure Costs
(Failures found by the project)

- Rework
- Scrap

External Failure Costs
(Failures found by the customer)

- Liabilities
- Warranty work
- Lost business

Money spent during and after the project **because of failures**

What is Google famous for?

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 organizations, but only by 21 percent 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

Expectations and Cultural Differences in Quality

- Project managers must understand and manage stakeholder expectations
- Expectations also vary by:
  - Organization's culture: dress and stay in their work area
  - Geographic regions: tap water

Maturity Models

- **Maturity models** are frameworks for helping organizations improve their processes and systems
  - The **Software Quality Function Deployment Model** focuses on defining user requirements and planning software projects
  - The Software Engineering Institute's **Capability Maturity Model Integration** is a process improvement approach that provides organizations with the essential elements of effective processes
  - Organizational Project Management Maturity Model - **OPM3** (2003, 2008, 2013)

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Software

- Spreadsheet and charting software helps create Pareto diagrams, fishbone diagrams, and so on
- Statistical software packages help perform statistical analysis
- Specialized software products help manage Six Sigma projects or create quality control charts
- Project management software helps create Gantt charts and other tools to help plan and track work related to quality management

Quality is a Journey, not a Destination

Thanks!

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