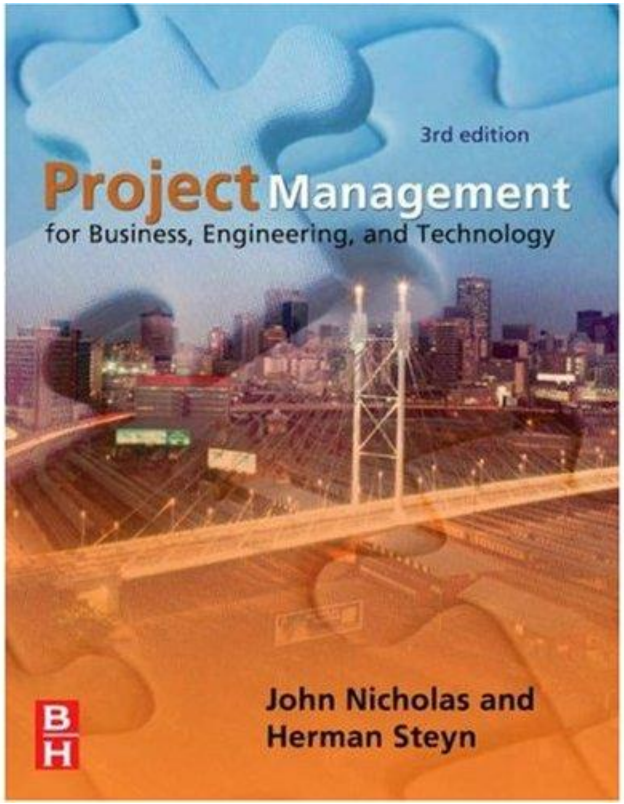
# Chapter 9
# Project Quality Management

Project Management for Business, Engineering, and Technology

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# Project Success

- As beauty is in the eye of the beholder, "*project success*" is in the eye of the stakeholder:

- Many definitions of "*project success*" exist but no universally accepted set of criteria

- The common denominator in all definitions of project success: the "iron triangle" of schedule, cost and *quality*

# The Concept of Quality

1950's

Screening out defects

Inspection

→

Current

Preventing defects & failures

Processes

# Cost, Time & Quality

- Once the Project Manager has made a commitment cost, schedule and quality cannot be compromised without renegotiating

- Think twice before compromising on quality

- Example: The London Tower Bridge

# London Tower Bridge – a Monument for Project Quality

- Opened 4 years late (in 1894)
- Cost escalated from £ 585 000 to over £ 1 000 000

But it withstood the test of time:

- Changed requirements (type of vehicles …)
- Floods, pollution, war, …

# London Tower Bridge – A Monument to Project Quality

# The Concept of Quality

Meeting specifications …

- Prevents being taken to court
- Ensures payment

*But* is not sufficient to ensure:

- Customer satisfaction
- Good reputation
- Repeat business

# The Concept of Quality

Quality implies:

- Fitness for the intended purpose
  - Performance
  - Safety
  - Reliability
  - Ease of handling
  - Logistical support
  - Environmental safety
  - …
- Value for money
- Absence of defects

# The Concept of Quality

Quality implies that everybody:

- Knows what is expected of her
- Is able & willing to meet those expectations
- Knows the extent to which she meets the expectations
- Has the ability & authority to take required corrective actions

# The Concept of Quality

Quality does *not* necessarily imply:

- Most expensive
- Most sophisticated, most features
- Most reliable

Good quality implies cost-effectiveness and fitness for a specific intended purpose

# The Concept of Quality

*Quality* is not the same as *Grade*

*Grade* is a rank or category of type of item e.g. grades of steel include categories such as stainless steels, tool steels, steels for pressure vessels, etc.

# The Concept of Quality
# Class Discussion

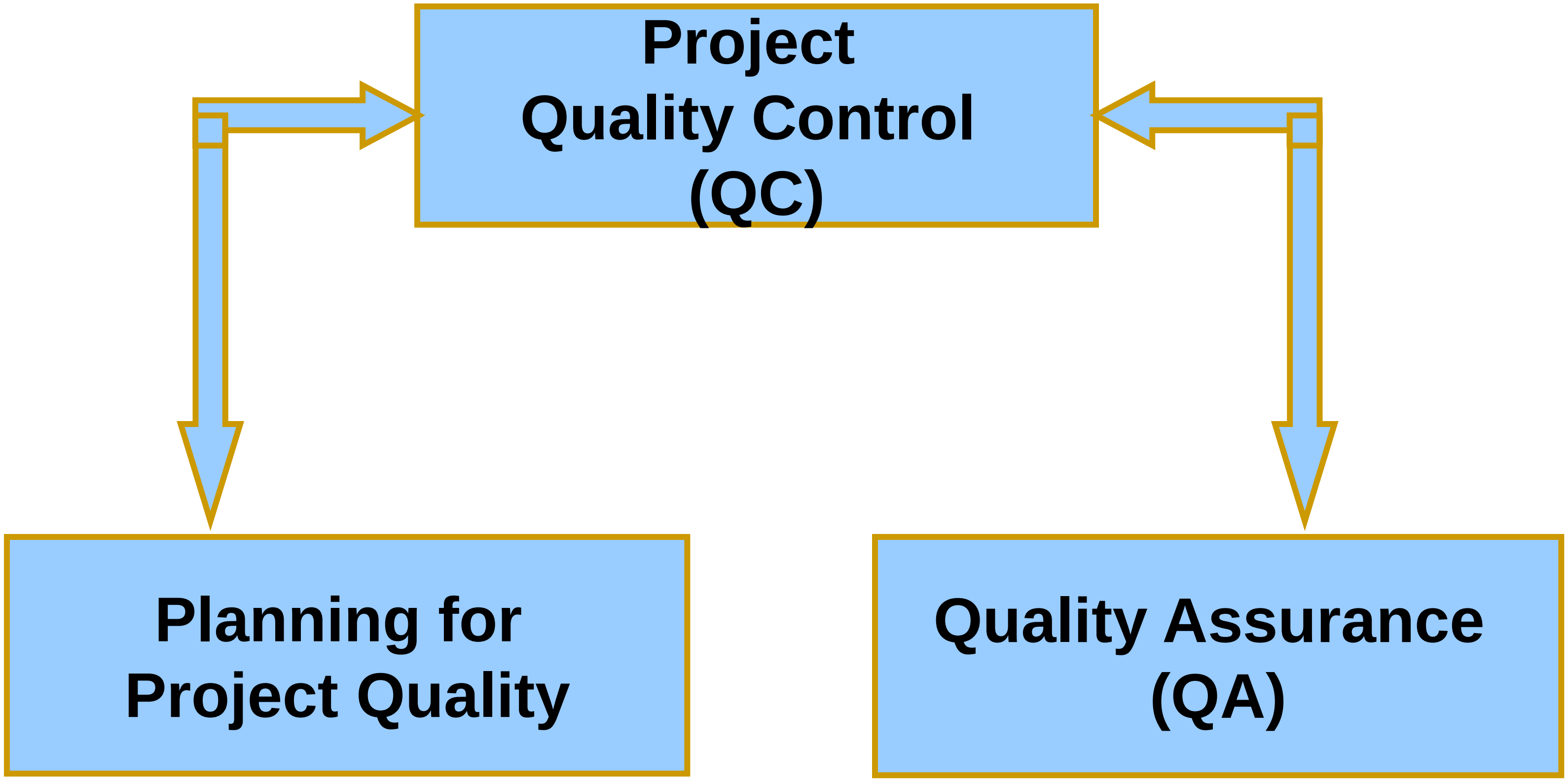
Review Question No 2

Is a Rolls Royce a high-quality vehicle?

# Quality Movements

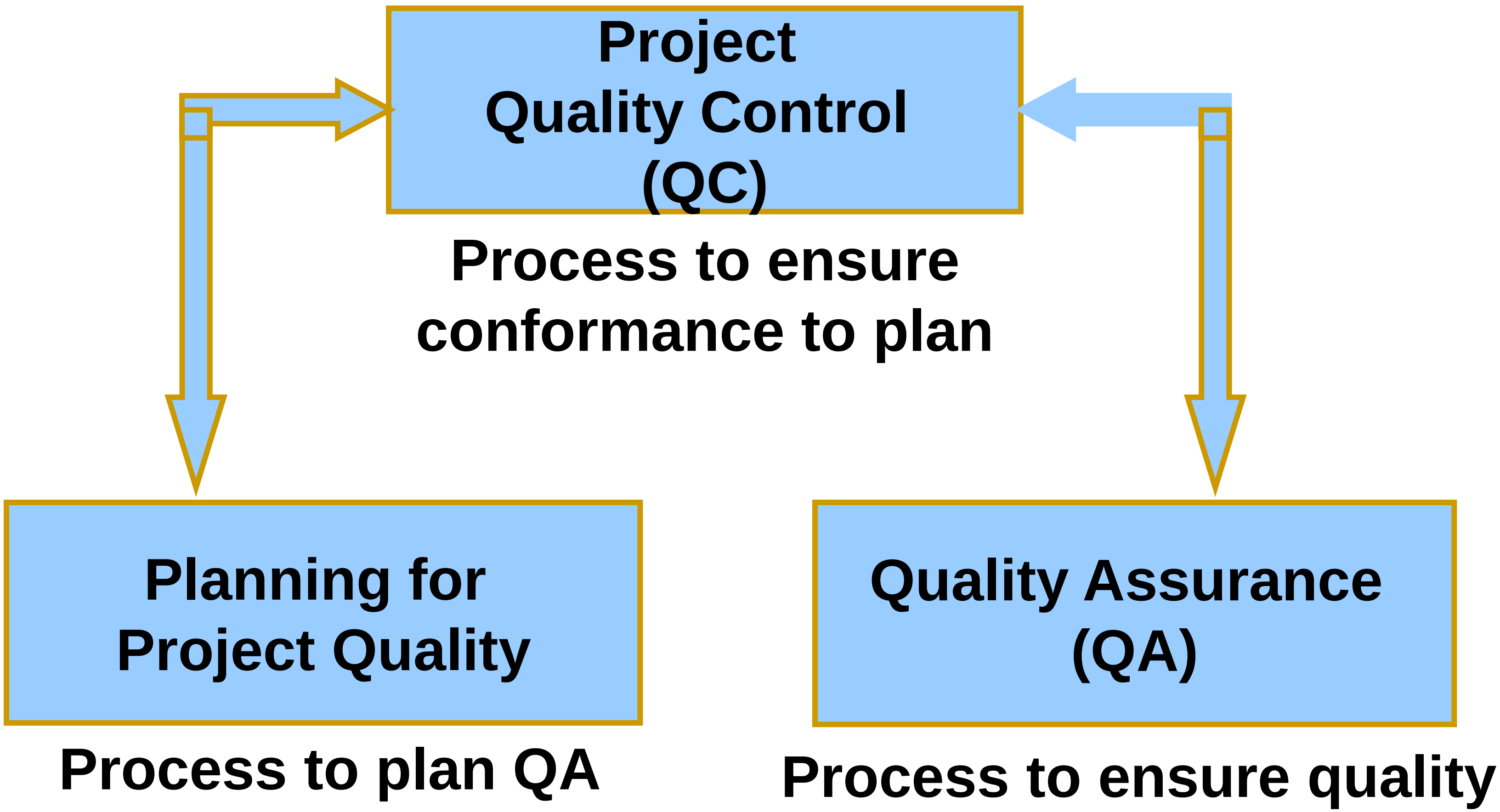
- 1950s Dr Deming in Japan
- Total Quality Management (TQM)
- Just in Time (JIT)
- Six Sigma

# Project Quality Management Process



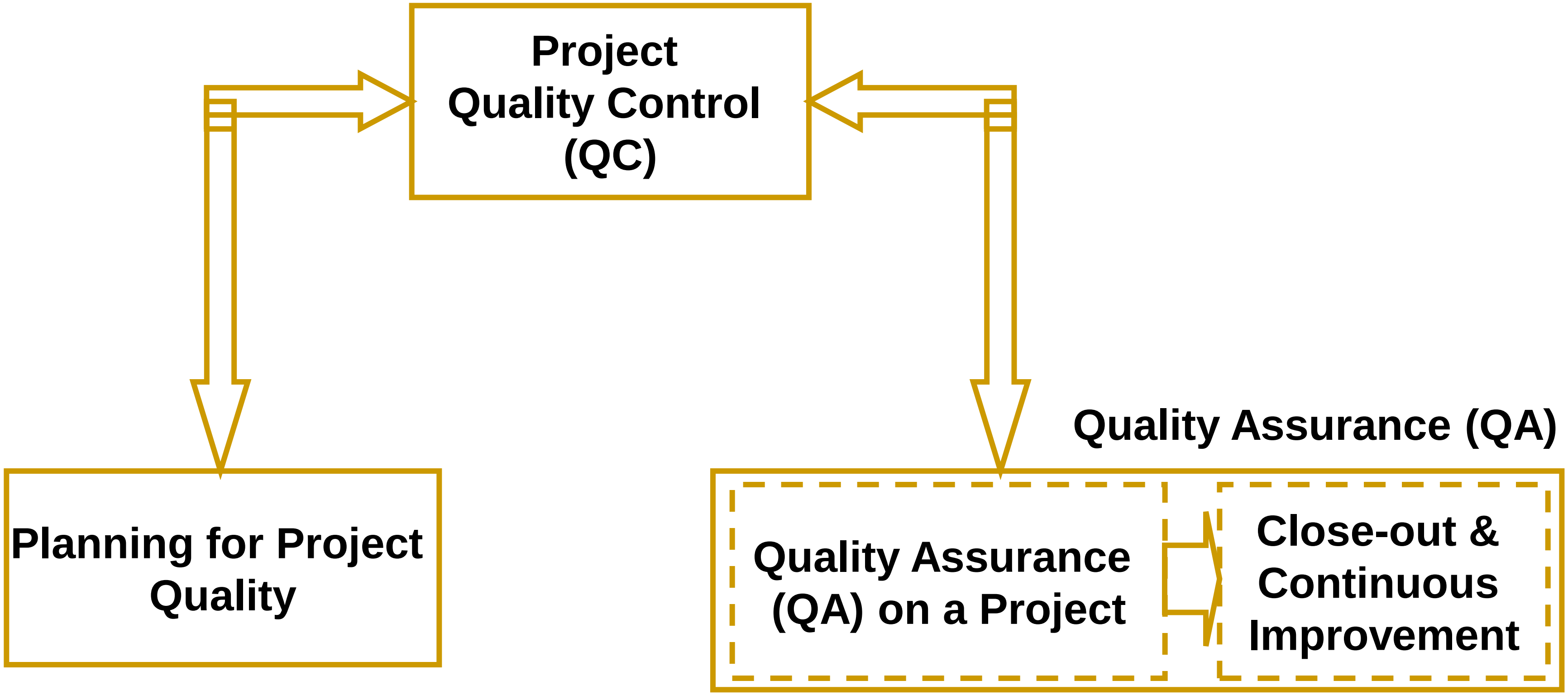

The term “Quality Assurance” is sometimes used to describe all three the above

# Project Quality Management Process

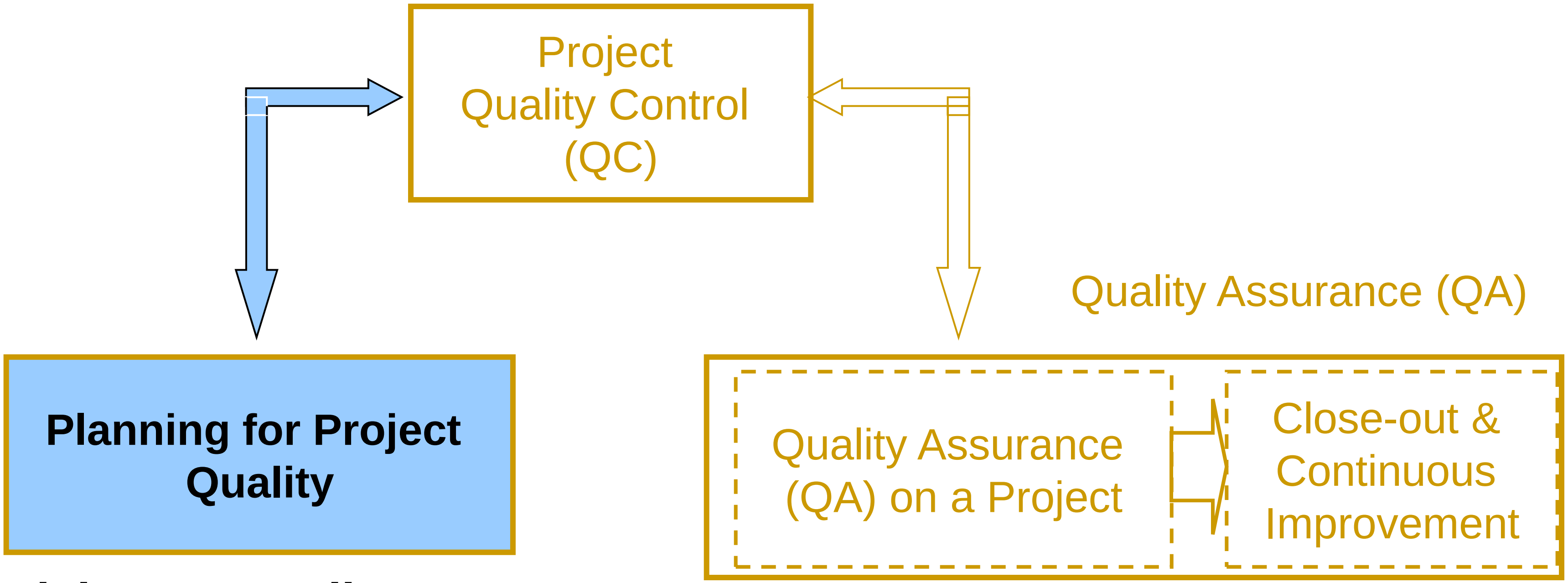



Control: The medicine - QA: The healthy lifestyle

# Project Quality Management Process



# Project Quality Management Process



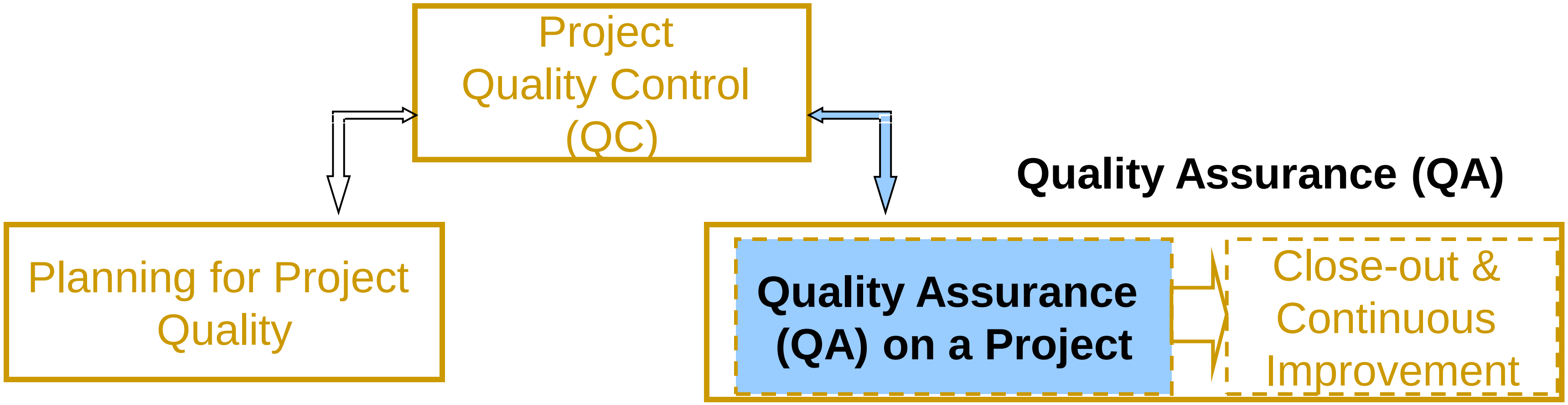

**Decisions regarding:**

- Standards and specifications to meet
- Metrics for meeting specifications/standards
- Criteria for authorizing project phases
- Tools and techniques for QA and QC
- Quality activities in the overall project plan

# Quality Planning

- Company-wide planning of quality systems
  - ISO 9001 specifies requirements for system
- Planning for specific project
  - Integrated with rest of project plan: provided for in schedule & budget
  - Also integrated with risk management plan, safety plan, procurement plan, communications plan, …)

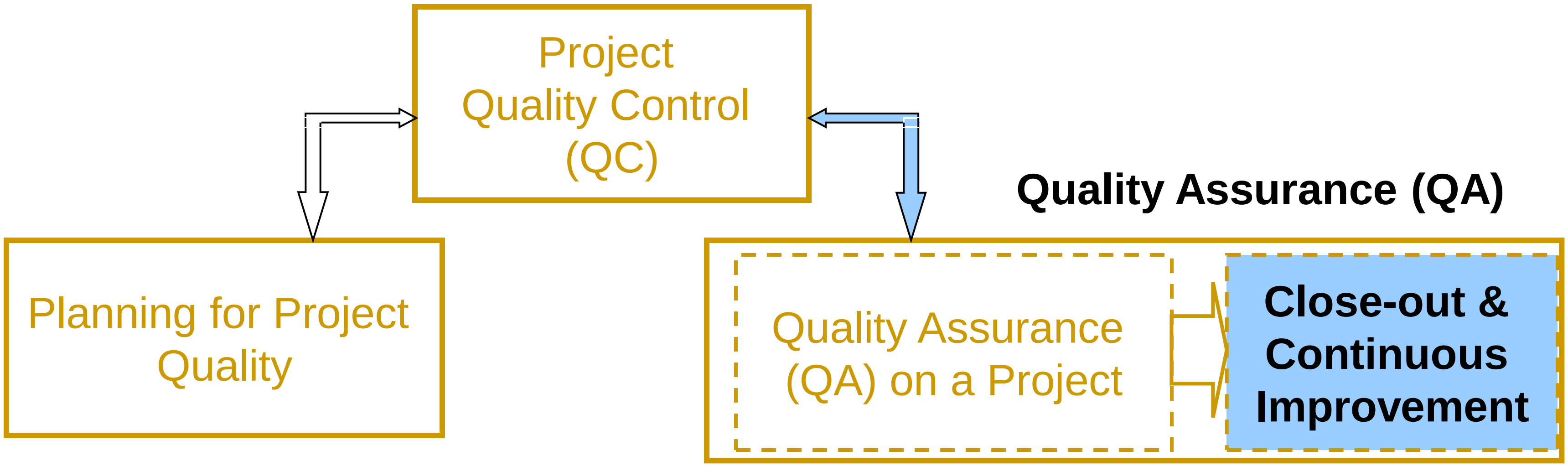
# Project Quality Management Process




**QA toolbox:**

- Training of project team members
- Configuration management system
- Configuration identification
- Design reviews and audits
- Quality function deployment
- Classification of characteristics
- Failure mode and effect analysis
- Modeling and prototyping
- Laboratory tests and other experiments
- Inspection
- Checklists

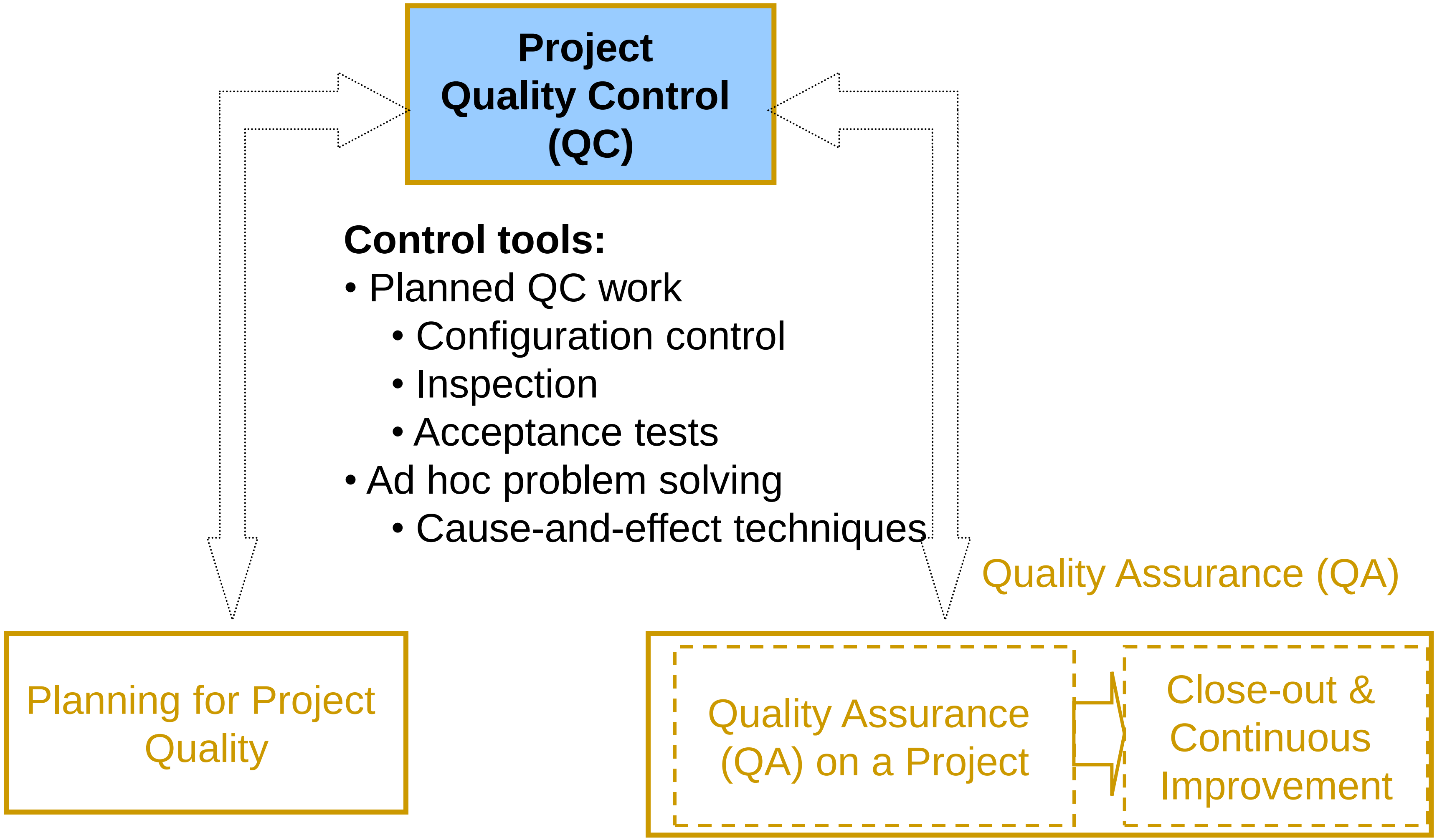
# Project Quality Management Process



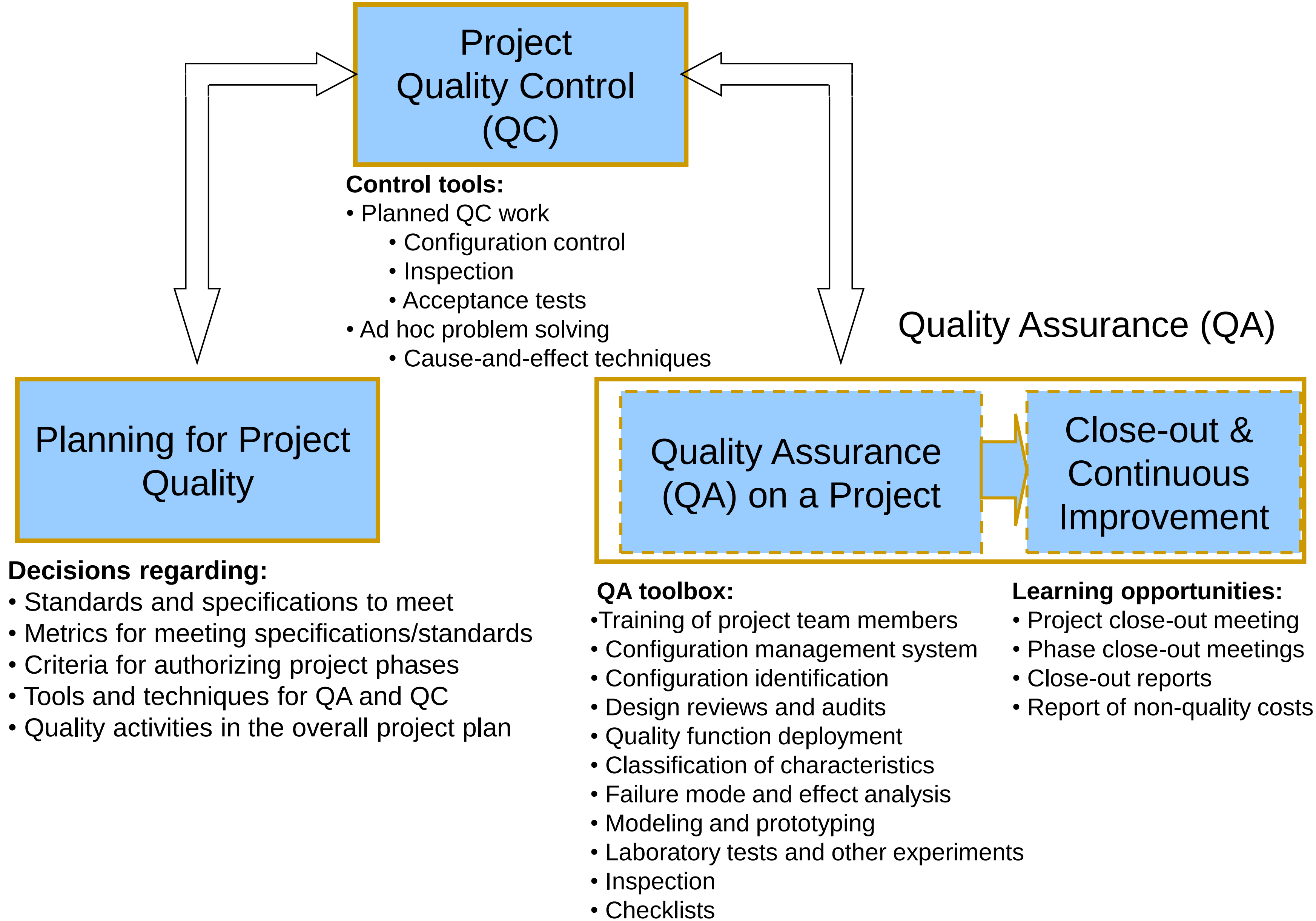

**Learning opportunities:**

- Project close-out meeting
- Phase close-out meetings
- Close-out reports
- Report of non-quality costs

# Project Quality Management Process



# Quality Control


Project
Quality Control
(QC)
Control tools:
• Planned QC work
• Configuration control
• Inspection
• Acceptance tests
• Ad hoc problem solving
• Cause-and-effect techniques
Planning for Project
Quality
Decisions regarding:
• Standards and specifications to meet
• Metrics for meeting specifications/standards
• Criteria for authorizing project phases
• Tools and techniques for QA and QC
• Quality activities in the overall project plan
Quality Assurance (QA)
Quality Assurance
(QA) on a Project
Close-out &
Continuous
Improvement
QA toolbox:
•Training of project team members
• Configuration management system
• Configuration identification
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• Classification of characteristics
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Learning opportunities:
• Project close-out meeting
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# Techniques for QA during System Development

Quality Assurance (QA) on a Project → Close-out & Continuous Improvement

**QA toolbox:**

- Training of project team members
- Configuration management system
- Configuration identification
- Design reviews and audits
- Quality function deployment
- Classification of characteristics
- Failure mode and effect analysis
- Modeling and prototyping
- Laboratory tests and other experiments
- Inspection
- Checklists

**Learning opportunities:**

- Project close-out meeting
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- Report of non-quality costs

# Techniques for QA during System Development

- Configuration Management
- Design Review
- Audit
- Classification of Characteristics
- Failure Mode and Effect Analysis
- Modeling & Prototyping

# Techniques for QA during System Development

## Configuration Management

- Configuration Identification (defining the system)
  - Configuration Item (CI) – an item to be tracked & controlled as individual entity (Also see Chapter 2)
  - Master copies maintained in secure configuration center
- Configuration Control (defining “as built” status)
  - Discussed under “Quality Control”

# Techniques for QA during System Development

## Design Reviews

Insure that design is acceptable in all respects:

- Design assumptions valid
- No omissions or errors
- Cost of ownership
- Safety & product liability
- Reliability
- Availability
- Manufacturability
- Shelf life
- Operability
- Maintainability
- Patentability
- Ergonomics

# Techniques for QA during System Development

## Design Reviews

Attended by representatives form several functions:

- Construction / Manufacturing
- Operations
- Maintenance
- Procurement
- Legal
- Quality
- …

# Techniques for QA during System Development

## Design Reviews

- Formal Design Review
  - Preliminary Design Review: Does concept fit requirements?
  - Critical Design Review: Do details meet specifications?
  - Functional Readiness Review: Is manufacturing process OK?
  - Product Readiness Review: Do products meet requirements when manufactured according to design documentation?
- Informal Design Review

# Techniques for QA during System Development

## Audits

- Verify that management processes comply with requirements
- Verify that technical processes (e.g. welding) comply with specifications
- Determine project status

# Techniques for QA during System Development

## Audits versus Design Reviews

| Design Review | Audit |
| --- | --- |
| Internal or external | Internal or external |
| Design aspects | Variety of aspects |
| Formal or informal | Formal |
| Room for innovation | Strictly verification |

# Techniques for QA during System Development

## Classification of Characteristics

- Large numbers of characteristics
- Pareto principle: small number of characteristics have most serious impact
- Basis for decisions regarding modifications, waivers and deviations
- Classification of characteristics in high-level systems guide designers of lower-level systems
- Not to be confused with classification of defects

# Techniques for QA during System Development

**Classification of Characteristics**

**e.g.**

- Critical
- Major A
- Major B
- Minor

# Techniques for QA during System Development

**FMEA**

(Failure Mode & Effect Analysis)

Determine:

- Ways (modes) in which system may fail
- Effect of identified failure modes

# Techniques for QA during System Development

**FMEA**

1. List relevant components
2. Identify possible ways of failure
3. Describe effects of failure
4. Assess probability of failure
5. Assess seriousness of failure event
6. Rate criticality, based on 4 and 5 above
7. Prepare plan to prevent failure

# Techniques for QA during System Development

## FMEA

**Table 9-1** FMEATable

System ______________ 
Subsystem ______________ 
Component ______________ 
Design Lead ______________ 
Core Team ______________

**Potential**
**Failure Mode and Effect Analysis**
**(Design FMEA)**

Key Date ______________

FMEA Number ______________ 
Prepared By ______________ 
FMEA Date ______________ 
Revision Date ______________ 
Page ______ of ______

| Item/Function | Potention Failure Mode(s) | Potention Effect(s) of Failure | Sev | Potential Cause(s)/ Mechanism(s) of Failure | Prob | Current Design Controls | Det | RPN | Recommended Action(s) | Responsibility & Target Completion Date | Action Results | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Action Taken | New Sev | New Occ | New Det | New RPN |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

# Techniques for QA during System Development

## Modeling & Prototyping

To assess and reduce specific risks – typically linked to specific project phase

- Physical models
  - Full-scale, functioning models
  - Mockups
  - Scale models
- Mathematical & computer models

# Models per Project Phase

**Table 9-2** Phases of equipment development.

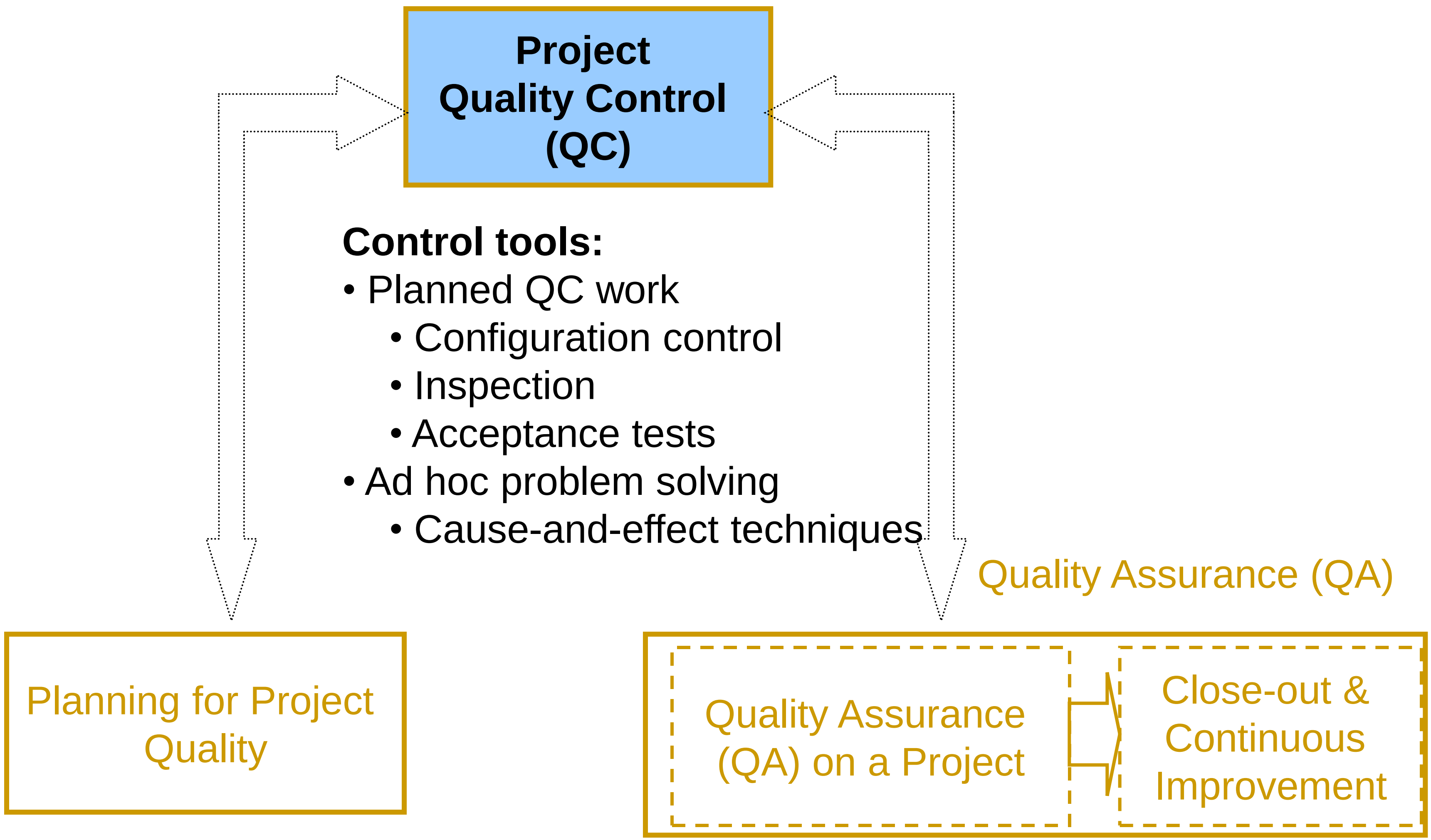
| Project Phase | Model Built and Tested | Objectives Relating to the Elimination of Risks | Risks Eliminated |
|---|---|---|---|
| Concept | Exploratory development model (XDM) (Breadboard models). Such models could be built for the entire system or for specific high-risk subsystems | Proof that any new concept would be feasible | The risk that the concept would not be feasible |
| Validation | Advanced development model (ADM) | Proof that the product would perform according to specifications and interfaces well with other systems (form, fit and function) | The risk that the performance of the system and interfacing with other systems would not be acceptable |
| Development | Engineering development model (EDM) manufactured from the intended final materials | Proof of reliability, availability, and maintainability | The risk of poor operational availability |
| Ramp-up | Pre-production models (PPM) | Proof that the product could be manufactured reliably in the production facility and could be deployed effectively | The risk of unforeseen problems in manufacturing |

# Models per Project Phase

**Table 9-3** Phases for development of a chemical plant

| Project Phase | Objective |
|---|---|
| Laboratory experiments | To prove the basic concept. |
| Pilot plant | To learn how the process works when scaled up. This provides inputs for the design of the final plant. |
| Demonstration plant | To provide a full-scale plant that demonstrates to potential customers the economic feasibility as well as operational aspects. |

# Techniques for Quality Control



# Techniques for Quality Control

## Configuration Management

- Configuration Identification (defining the system)
  - Discussed under “QA”
- Configuration Control
  - Modifications – permanent change of design
  - Waivers – unforeseen nonconformity
  - Deviations – planned, temporary deviation from specification

# Techniques for Quality Control

## Configuration Control – Process

- Anyone may request change
- Change and motivation documented
- Impact evaluated (technical)
- Feasibility evaluated (resources, schedules, …)
- Change accepted or rejected by Configuration Board
- If approved, plan implementation
- Verify

# Class Discussion

Review Question No 7

Differentiate between:

- Modification
- Deviation
- Waiver

# Techniques for Quality Control

## Configuration Control – Process

- Class I requests – approved by contractor
- Class II requests – approved by customer

# Techniques for Quality Control

## Inspection & Testing

- Critical characteristics always 100% inspected
- Sampling
- Destructive testing
- Non-destructive testing

# Basic Tools of Quality Control

1. Check sheet – Data on sheet analyzed using the other 6 tools
2. Flowchart – steps in process e.g. project network diagram
3. Run chart & control chart – observed results plotted versus time
4. Scatter diagram – tracking of repetitive events
5. Pareto diagram – discussion follows
6. Histogram – discussion follows
7. Cause-and-effect diagram – discussion follows

# Pareto Diagram

- 80/20 rule:
- 20% of people own 80% of wealth
- 80% of defects result from 20% of causes
- Separate vital few from trivial many

# Pareto Diagram

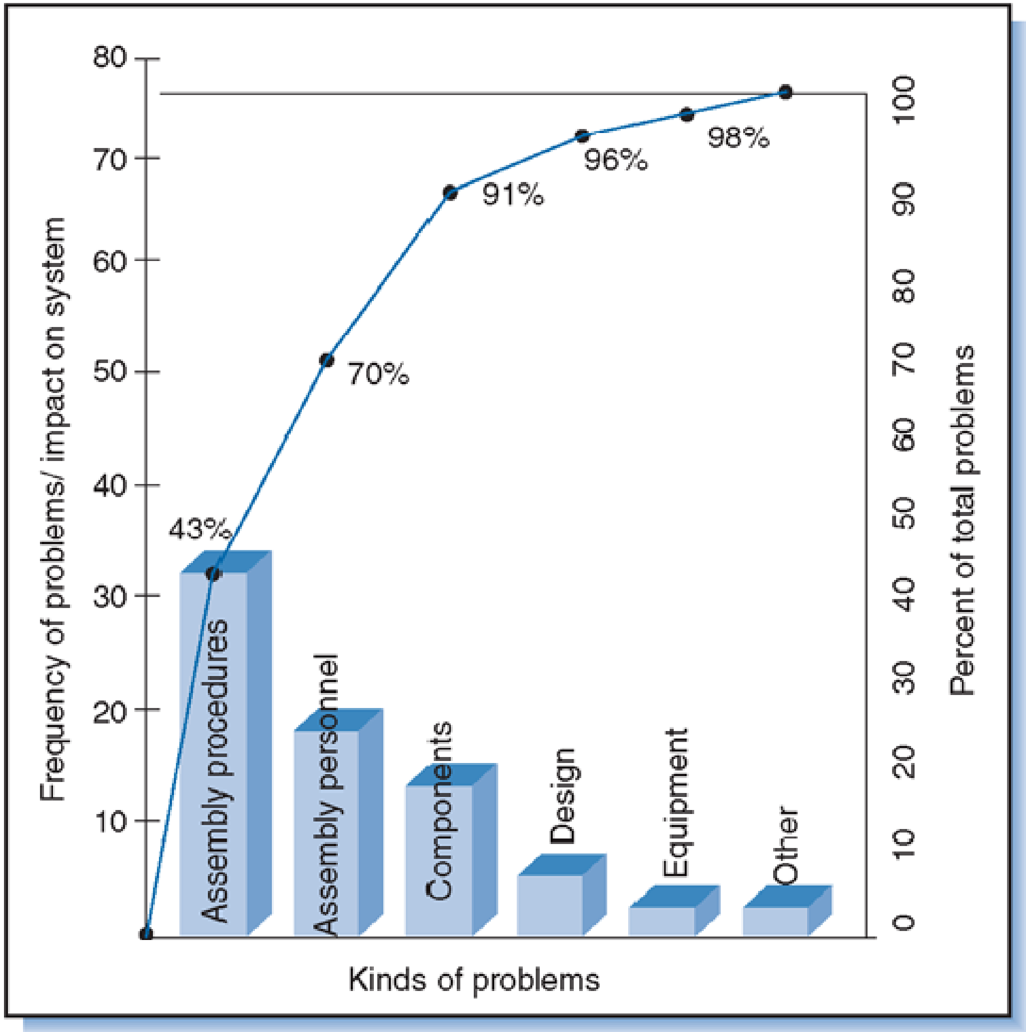



**Figure 9-3**
Pareto diagram.

# Pareto Diagram: Projects versus Operations

- *Repetitive operations*: X-axis is typically a list of defects observed and the Y-axis is the frequency of occurrence of each defect
- *Projects*: X-axis is typically a list of types of problem and the Y-axis the impact on the system

# Histograms

- Pareto Diagram is a specific type of histogram
- Histograms are also used elsewhere e.g. to indicate workload on resources

# Cause-and Effect Diagrams

- Fishbone (Ishikawa) diagrams – simplest
- Causal loop diagrams – illustrate structure of complex system and influences of variables on one another, used for computer modeling of system dynamics
- Current reality trees – rigor of sufficiency of causes to result in effect but laborious

# Fishbone (Ishikawa) Diagram

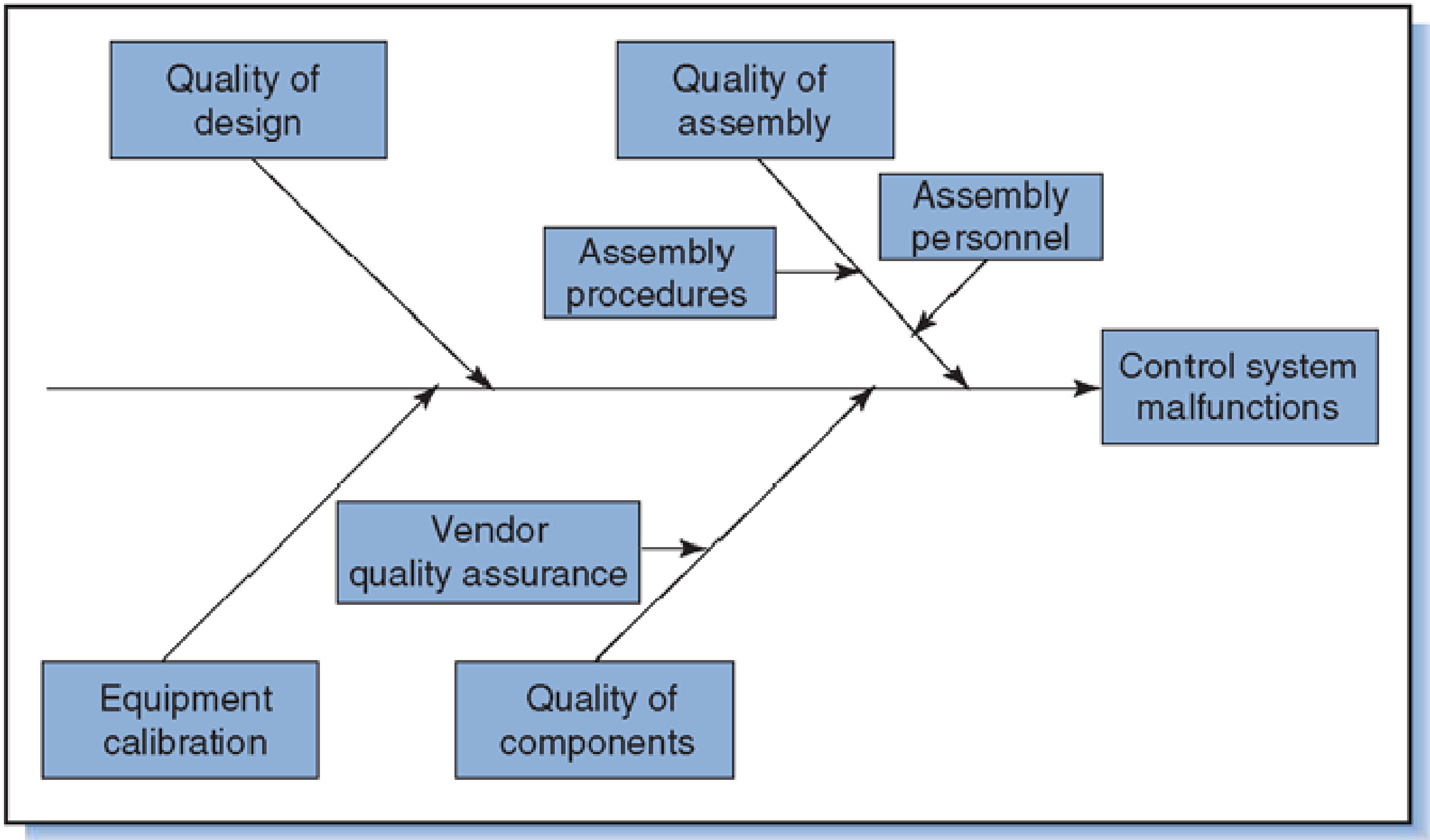



**Figure 9-4**
CE (fishbone or Ishikawa) diagram.

# Causal Loop Diagram

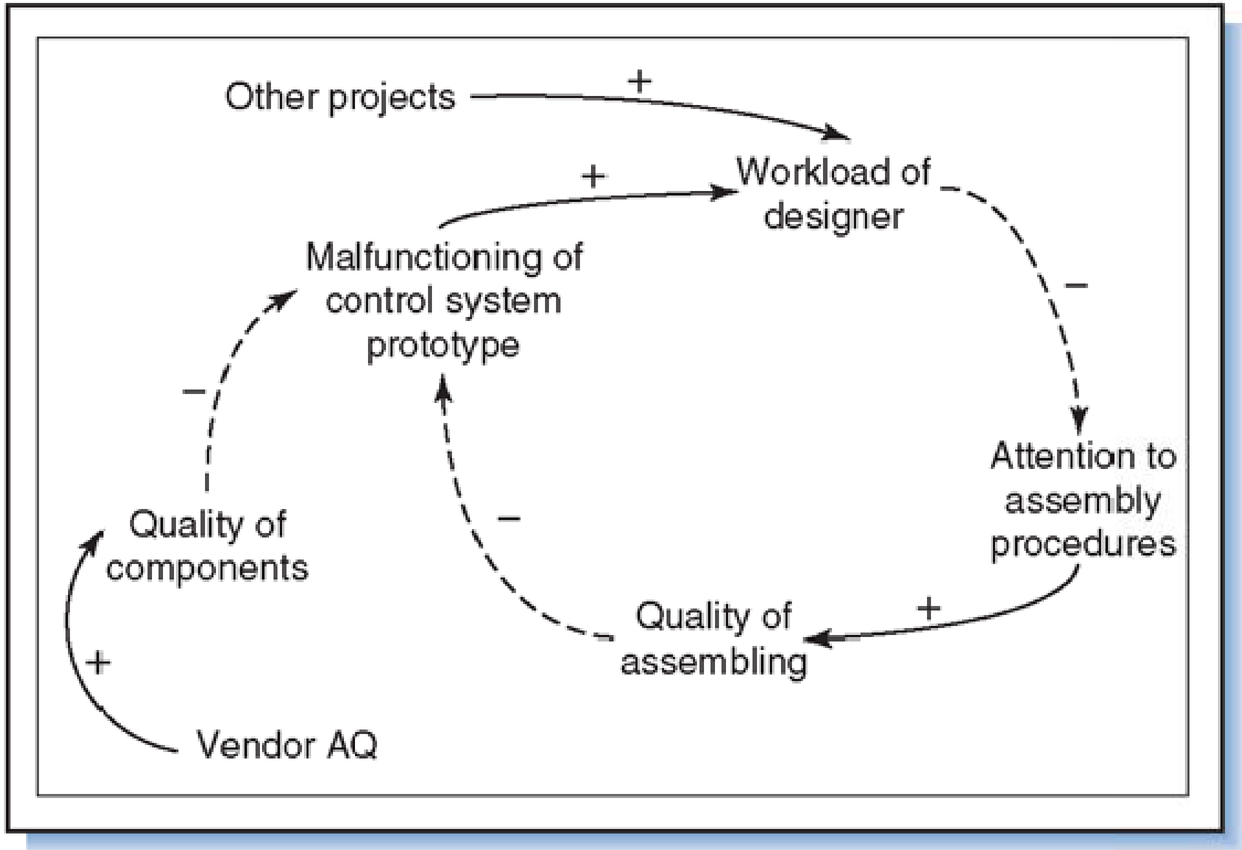



**Figure 9-5**
Casual loop diagram for control system problem.

# Current Reality Tree

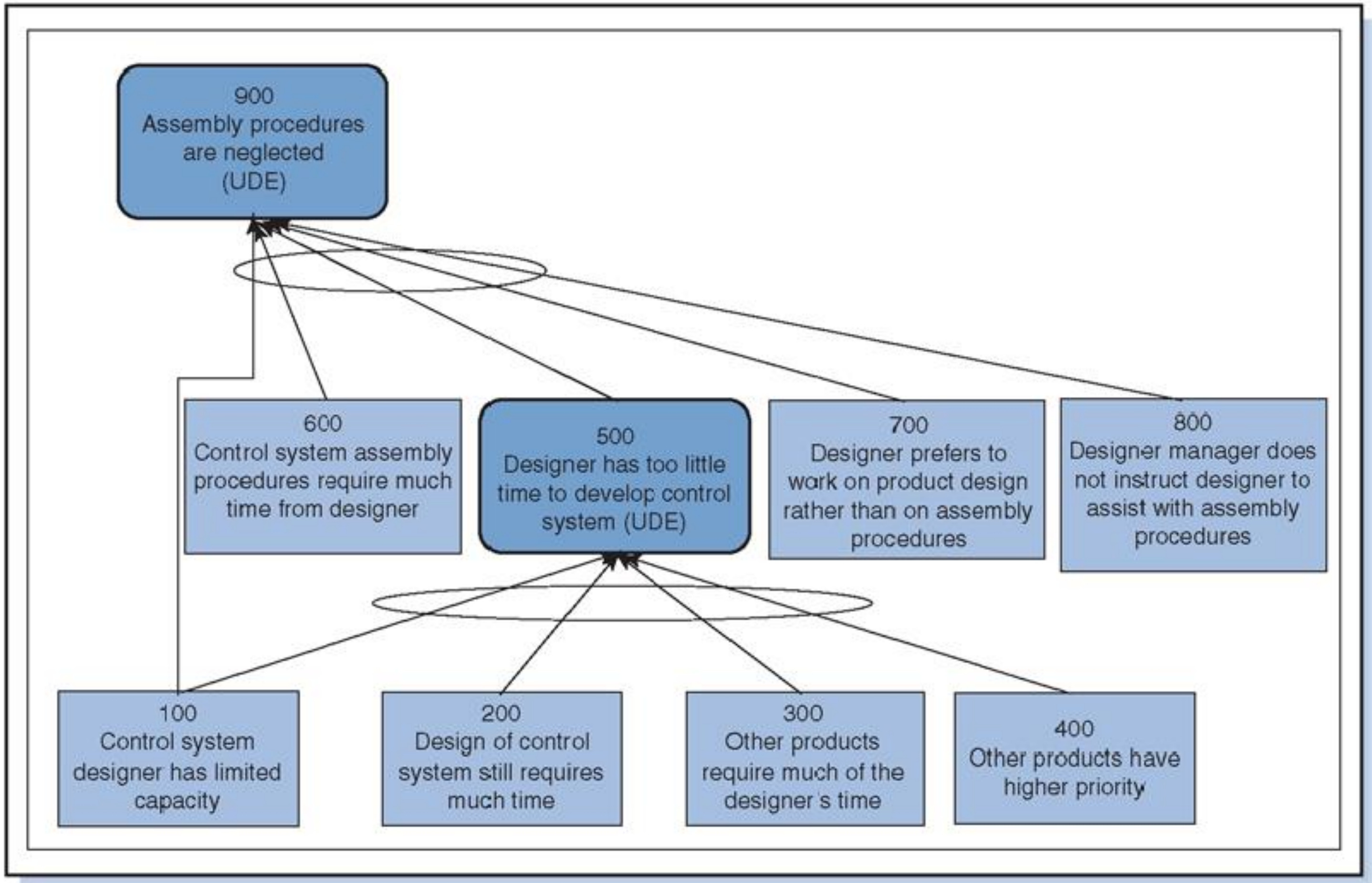



**Figure 9-6**
Example of a CRT.