Quality Management

- Managing the quality of the design process and final product
Objectives

- To introduce the quality management process and key quality management activities
- To explain the role of standards in quality management
- To explain the concept of a design metric
- To explain how measurement may be used in assessing design quality
Topics covered

- Quality assurance and standards
- Quality planning
- Quality control
- Design measurement and metrics
Quality management

- Concerned with ensuring that the required level of quality is achieved in a product
- Involves defining appropriate quality standards and procedures and ensuring that these are followed
- Should aim to develop a ‘quality culture’ where quality is seen as everyone’s responsibility
What is quality?

- Quality, simplistically, means that a product should meet its specification.
- This is problematical for engineering systems:
  - Contradictions between customer quality requirements e.g. A trade off may exist between efficiency and reusability, etc.
  - Engineering requirements are difficult to specify in an unambiguous way.
  - Product specifications are often inconsistent among different manufacturers.
Quality management activities

- **Quality assurance**
  - Establish organizational procedures and standards for quality

- **Quality planning**
  - Select applicable procedures and standards for a *particular* project and modify these as required

- **Quality control**
  - Ensure that procedures and standards are followed by the design team

- **Quality management should be separate from project management to ensure independence**
ISO 9000

- International set of standards for quality management
- Applicable to a range of organizations from manufacturing to service industries
- ISO 9001 applicable to organizations which design, develop and maintain products
- ISO 9001 is a generic model of the quality process. Must be instantiated for each organization
ISO 9000 certification

- Quality standards and procedures should be documented in an organizational quality manual
- External body may certify that an organisation’s quality manual conforms to ISO 9000 standards
- Customers are, increasingly, demanding that suppliers are ISO 9000 certified
ISO 9000 and quality management

ISO 9000 quality models

Organization quality manual

Project 1 quality plan
Project 2 quality plan
Project 3 quality plan

Organization quality process

Supports
Quality assurance and standards

- Standards are the key to effective quality management
- They may be international, national, organizational or project standards
- *Product standards* define characteristics that all components should exhibit
- *Process standards* define how the product should be used, assembled, or manufactured
Importance of standards

- Encapsulation of best practice - avoids repetition of past mistakes
- Framework for quality assurance process - it involves checking standard compliance
- Provides continuity - new staff can understand the organisation by understanding the standards applied
Problems with standards

- Not seen as relevant and up-to-date by engineers
- Involve too much bureaucratic form filling
- Unsupported by software tools so tedious manual work is involved to maintain standards
Standards development

- Involve practitioners in development. Engineers should understand the rationale underlying a standard.
- Detailed standards should have associated tool support. Excessive clerical work is the most significant complaint against standards.

Review standards and their usage regularly. Standards can quickly become outdated and this reduces their credibility amongst practitioners.
Documentation standards

- process
- product (defined by organizations and company itself)
- Interchange
- Identification
- Structure
- Presentation
- Updates
Process and product quality

- The quality of a developed product is influenced by the quality of the production process
Practical process quality

- Define process standards such as how reviews should be conducted, configuration management, etc.
- Monitor the development process to ensure that standards are being followed
- Report on the process to project management
Quality planning

- A quality plan sets out the desired product qualities and how these are assessed and define the most significant quality attributes
- It should define the quality assessment process
- It should set out which organisational standards should be applied and, if necessary, define new standards
Quality plan structure

- Product introduction
- Product plans
- Process descriptions
- Quality goals
- Risks and risk management
- Quality plans should be short, succinct documents
  - If they are too long, no-one will read them
## Engineering quality attributes

<table>
<thead>
<tr>
<th>Safety</th>
<th>Understandability</th>
<th>Portability</th>
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<tbody>
<tr>
<td>Security</td>
<td>Testability</td>
<td>Usability</td>
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<tr>
<td>Reliability</td>
<td>Adaptability</td>
<td>Reusability</td>
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<tr>
<td>Resilience</td>
<td>Modularity</td>
<td>Efficiency</td>
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<td>Robustness</td>
<td>Complexity</td>
<td>Learnability</td>
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Quality control

- Checking the product development process to ensure that procedures and standards are being followed
- Quality reviews
Quality reviews

- The principal method of validating the quality of a process or of a product
- Group examined part or all of a process or system and its documentation to find potential problems
- There are different types of review with different objectives
  - Inspections for defect removal (product)
  - Reviews for progress assessment (product and process)
  - Quality reviews (product and standards)
Types of review

<table>
<thead>
<tr>
<th>Review type</th>
<th>Principal purpose</th>
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<tbody>
<tr>
<td>Design or program inspections</td>
<td>To detect detailed errors in the design or code and to check whether standards have been followed. The review should be driven by a checklist of possible errors.</td>
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<tr>
<td>Progress reviews</td>
<td>To provide information for management about the overall progress of the project. This is both a process and a product review and is concerned with costs, plans and schedules.</td>
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<tr>
<td>Quality reviews</td>
<td>To carry out a technical analysis of product components or documentation to find faults or mismatches between the specification and the design, code or documentation. It may also be concerned with broader quality issues such as adherence to standards and other quality attributes.</td>
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Quality reviews

- A group of people carefully examine part or all of a system and its associated documentation.
- Code, designs, specifications, test plans, standards, etc. can all be reviewed.
- Documents may be 'signed off' at a review which signifies that progress to the next development stage has been approved by management.
Review functions

- Quality function - they are part of the general quality management process
- Project management function - they provide information for project managers
- Training and communication function - product knowledge is passed between development team members
Quality reviews

- Objective is the discovery of system defects and inconsistencies
- Any documents produced in the process may be reviewed
- Review teams should be relatively small and reviews should be fairly short
- Review should be recorded and records maintained
Engineering measurement and metrics

- Engineering measurement is concerned with deriving a numeric value for an attribute/property of a product or process

- Example
  - Robustness:-sensitivity analysis
  - Reliability-statistical analysis of samples (Weibull analysis)
Metrics assumptions

- The relationship exists between what we can measure and what we want to know
- This relationship has been formalized and validated
- It may be difficult to relate what can be measured to desirable quality attributes
- Theoretical assumptions
- Simulation model assumptions
The measurement process

- A measurement process may be part of a quality control process
- Data collected during this process should be maintained as an organizational resource
- Once a measurement database has been established, comparisons across projects become possible
Product measurement process

1. Choose measurements to be made
2. Select components to be assessed
3. Measure component characteristics
4. Identify anomalous measurements
5. Analyse anomalous components
6. Identify anomalous components
Data collection

- A metrics programme should be based on a set of product and process data
- Data should be collected immediately (not in retrospect) and, if possible, automatically
Data accuracy

- Don’t collect unnecessary data
  - The questions to be answered should be decided in advance and the required data identified

- Tell people why the data is being collected
  - It should not be part of personnel evaluation

- Don’t rely on memory
  - Collect data when it is generated not after a project has finished
Measurement analysis

- It is not always obvious what data means
- Professional statisticians should be consulted if available
- Data analysis must take local circumstances into account
Key points

- Quality assurance procedures should be documented in an organizational quality manual.
- Engineering standards are an encapsulation of best practice.
- Reviews are the most widely used approach for assessing product quality.
Key points

- Measurement gathers information about both the process and the product
- Product quality metrics should be used to identify potentially problematical components