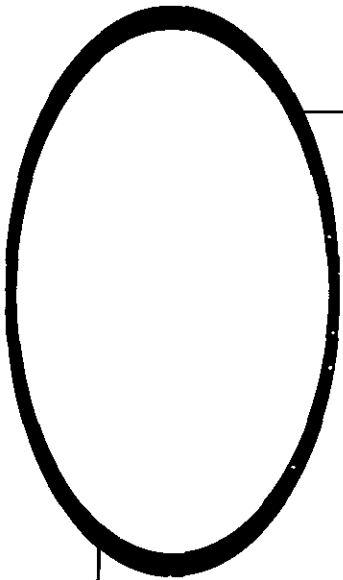

DEPT. OF NUCLEAR TECHNOLOGY

CHULALONGKORN UNIVERSITY

Presentation - 5

" QUALITY in DESIGN '

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Operations Quality Corp.

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OBJECTIVES of PRESENTATION

This presentation will discuss the following topics :

- **Product development**
- **Fitness for use**
  - **reliability**
  - **maintainability**
  - **safety**
  - **ergonomics**
  - **cost effectiveness**
- **Review and validation of design**
- **Quality program as applied to design**

PRODUCT DEVELOPMENT - KEY MANAGEMENT DECISIONS

- Scope of product development process
- Desired level of Quality vs competition
- Intended use vs actual use
- Relative priorities of reliability and maintainability
- Quantification of "fitness for use" parameters
- Who controls product specification ?
  - marketing
  - designers
  - manufacturing
  - a team

PHASE CONCEPT of DESIGN

- **Concept and feasibility phase**
  - marketing specification
- **Detailed design phase**
  - product requirement specification
- **Prototype phase**
  - confirming basic capability
- **Demonstration phase**
  - performance
  - manufacturing (productability)
- **Production and operation phase**
  - performance improvement
  - minimize failures

PRODUCT DEVELOPMENT - TYPICAL DESIGN INPUTS

- Performance requirements
- Codes, standards and regulatory requirements
- Design conditions and loads
- Material requirements
- Operational requirements
- Engineering requirements and limits
- Instrumentation and control
- Fitness for use considerations
- Transportability limitations

PRODUCT DEVELOPMENT - TESTING

- **Problems in testing arise from :**
- **Intended use versus actual use**
- **Prototype construction versus production model**
- **Variability due to small numbers**
- **Validity of test conditions**
- **Evaluation and interpretation of results**

PRODUCT DEVELOPMENT - CANADIAN NUCLEAR PROGRAM

- **Experimental Reactors at Chalk River, from late 40's :**
  - **exploring feasibility**

- **Nuclear Power Demonstration Reactor (20 MW), from early 60's :**
  - **validate fuel channels, heavy water, fuelling and safety concepts**

- **Douglas Point prototype Reactor (200 MW) from late 60's :**
  - **develop and advance design concepts**

- **Pickering commercial production Reactors, (540 MW), from early 70's**
  - **produce economical, environmentally friendly , commercial electrical power**

FITNESS for USE CONSIDERATIONS :

- **Reliability**
- **Maintainability**
- **Safety**
- **Human factors**
- **Manufacturing (productability)**
- **Cost effectiveness**

RELIABILITY DEFINITIONS of MERIT

- Mean time between failures (MTBF)
- Failure rate
- Mean time to failure (MTTF)
- Mean time to first failure (MTFF)
- Mean time between maintenance (MTBM)
- Longevity
- Availability
- System effectiveness
- Probability of success

MAINTAINABILITY - DESIGN CONSIDERATIONS

- The need to balance following criteria
- Reliability versus maintainability
- Modular versus non-modular construction
- Repair versus throw-away
- Person versus machine

MAINTAINABILITY -

EXAMPLES of IMPROVEMENTS

- **Aluminium siding**
- **Maintenance - free batteries**
- **Self- lubricating and sealed bearings**
- **Fewer hours to change aircraft engines**
- **Fiberglass boats and dacron sails**
- **Introduction of "on condition" maintenance**

IMPROVING SAFETY through DESIGN

- **Elimination of hazards and minimizing risk**
- **Limiting the level of hazard**
- **Lock-outs, lock-ins and interlocks**
- **Fail-safe design**
- **Monitors and warnings**
- **Escape, rescue and survival**
- **Isolation of hazards**

FITNESS for USE - MANUFACTURING

- **Relationship of process variables to product results (minimize rejects)**

- **Value and cost of precision :**
  - **tolerancing**
    - standardization
    - by precedent
  - **interchangeability**
    - interfacing dimensions
    - position tolerance
    - tolerance build-up

- **Non-quantifiable characteristics**

- **Rating of designs for ease of manufacture**

FITNESS for USE -

LIFE CYCLE COST ANALYSIS

- Identify life - cycle phases
- Identify cost structure
- Acquire cost data
- Analyze relationships
- Formulate criteria for decision making

SUCCESS FACTORS for DESIGN REVIEWS

- Management support, structure and directive
- Emphasis on constructive input to designers, rather than criticism
- Elimination of perception that others are trying to design the product
- Realistic schedules and resources
- Adequate planning for Design Reviews
- Focusing on unproven and untried features of design
- Resolution mechanism for inter-departmental conflicts, if any

QUALITY PROGRAM - TYPICAL PROCEDURES

- Responsibilities and interfaces between organizations
- Organization and responsibilities within Design
- Technical information exchange
- Maintenance and retention of documents
- Design input requirements
- Verification methods
- Control of computer software
- Control of design changes
- Implementation of corrective actions

SOFTWARE CONFIGURATION - QUALITY MANAGEMENT ISSUE

Attributes :

Correctness
Performance
Traceability

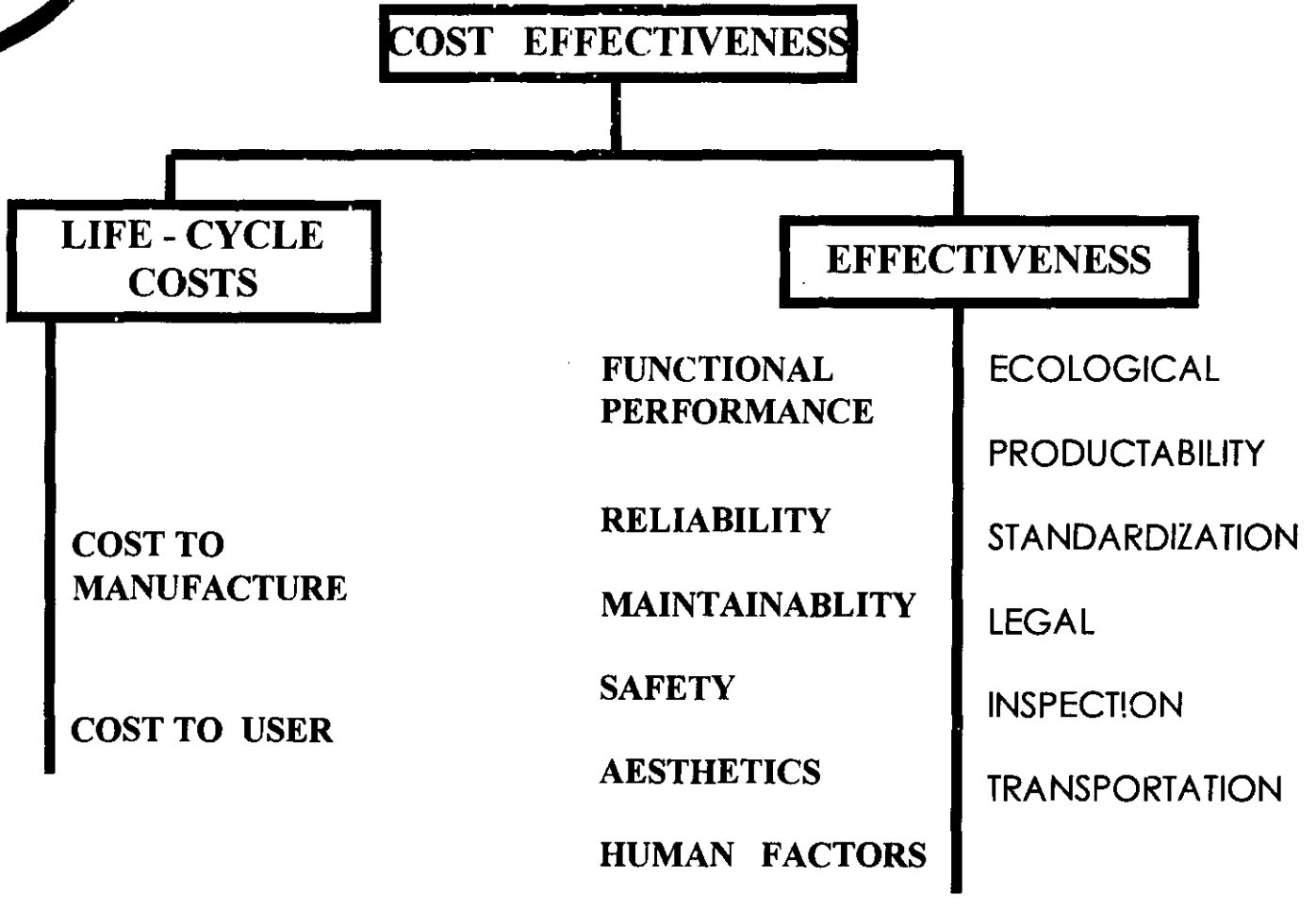
System configuration management plan:

- **Change management :**
  - **control procedure**
  - **software library**
  - **classification and certification**
  - **routine validation**

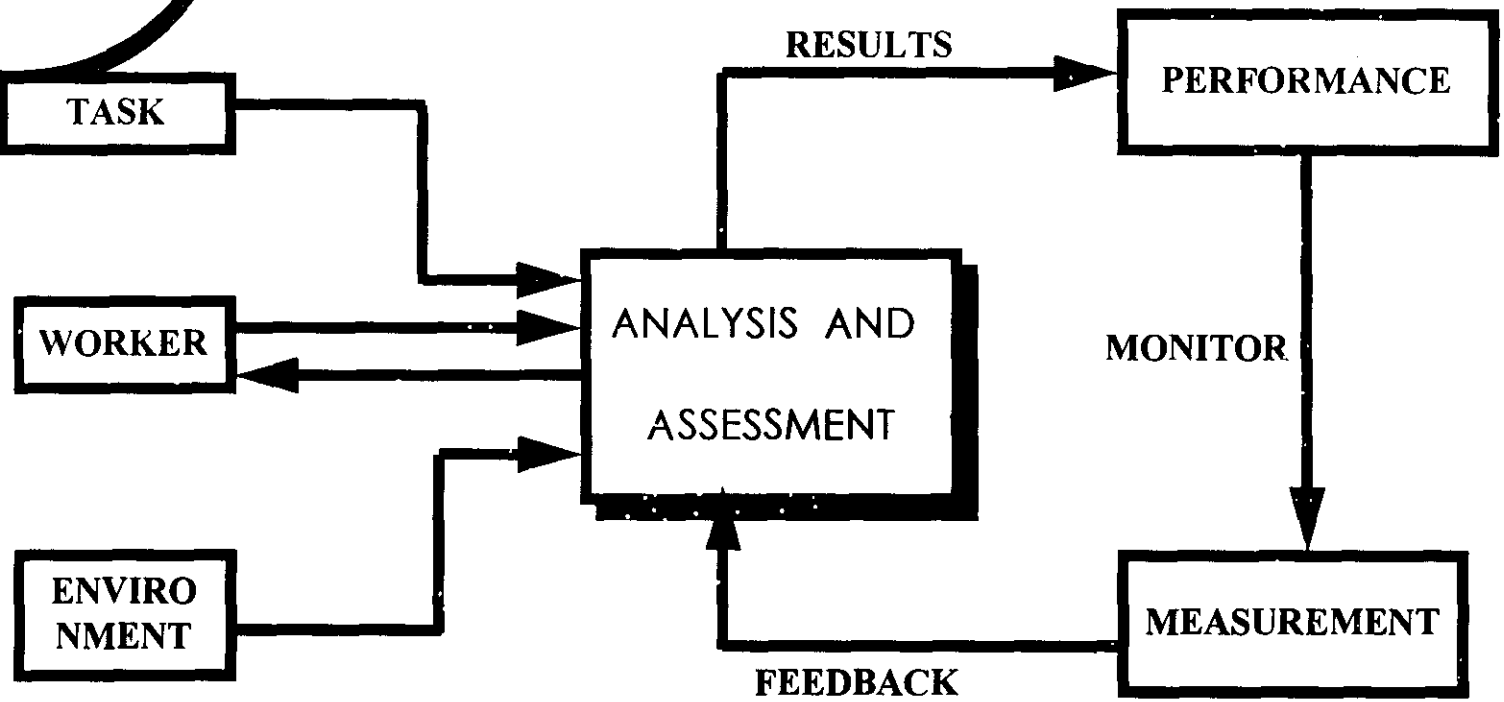
- **Change procedure :**
  - **proposal**
  - **development**
  - **validation/testing/approval**
  - **installation**

- **Documentation**
  - **clear definition of programs**
  - **user manuals**
  - **details of code changes**

FITNESS FOR USE - COST EFFECTIVENESS



FITNESS for USE - ANALYSIS of HUMAN FACTORS



ADDRESS the CAUSE, not SYMPTOMS