Product Planning & Development
(21-423)
Advanced Manufacturing Laboratory
Department of Industrial Engineering
Sharif University of Technology

Session #22

Course Description

- Instructor
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  - Website: Sharif.edu/~fvalilai

- Recommended prerequisite
  - Manufacturing process I (21-418)

- Class time
  - Sunday-Tuesday 18:00-19:30

- Course evaluation
  - Mid-term (25%)
  - Final exam (40%)
  - Quiz (5%)
  - Exercise (Manufacturing Lab.) (30%)
Session reference

- Reference:

Course Description (Continued.)

- Contents:
  - Product development in the changing Global world
  - Stages of Product Development
  - The Structure of the Product Design Process
  - Early design: Requirement definition and conceptual Design
  - Trade-off analyses: Optimization using cost and utility Metrics
  - Detailed design: Analysis and Modeling
  - Design Review: Designing to Ensure Quality
  - Production System: Strategies, planning, and methodologies
  - Production System Development
  - Planning and Preparation for Efficient Development
  - Supply chain: Logistics, packaging, supply chain, and the environment
Planning and Preparation for Efficient Development

- **Design for X**

![Diagram](image)

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A system or product is said to be maintainable or repairable if, when it fails to perform as required, it can be maintained by a suitable methodology, be it repair, overhaul, or replacement either manually or by an automated action.

Modern complex systems and products involve a major load on maintenance and support resources, in terms of both personnel and cost.
Planning and Preparation for Efficient Development

▪ Design for x (DFx)
  ▪ Designing for Maintenance

▪ The ability of a product to work successfully over a prolonged period of time is referred to as reliability.

▪ Achieving 100% reliability all the time is nothing more than an imagined fallacy.
  ▪ However, maintaining products periodically by adhering to a strict maintenance regimen cannot only help prolong the life of equipment but also ensure that it works smoothly in the future without breakdown.

Planning and Preparation for Efficient Development

▪ Design for x (DFx)
  ▪ Designing for Maintenance

▪ Maintainability can be defined as the degree of facility with which an equipment or system is capable of being retained in, or restored to, serviceable operation.

▪ It is a function of parts accessibility, interval configuration, use and repair environment and the time, tools and training required to effect maintenance.
<table>
<thead>
<tr>
<th>Maintenance elements</th>
<th>Maintenance requirements and tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maintenance policy</strong></td>
<td></td>
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<tr>
<td>Preventive</td>
<td>Scheduled maintenance, inspection, condition monitoring, analysis</td>
</tr>
<tr>
<td>Corrective</td>
<td>Failure determination, failure isolation, failure repair, calibration, functional check</td>
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<tr>
<td><strong>Maintenance times</strong></td>
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<tr>
<td>Preventive</td>
<td>Servicing, inspection, replacement, overhaul</td>
</tr>
<tr>
<td>Corrective</td>
<td>Preparation, fault isolation, logistic, correction, adjustment calibration</td>
</tr>
<tr>
<td>Stationary</td>
<td>Field shops, maintenance labs, maintenance workshops at various maintenance lines, industry, contractors, workshops</td>
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<tr>
<td><strong>Maintenance locations</strong></td>
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<tr>
<td>Mobile</td>
<td>Maintenance vehicles, calibration vans, temporary maintenance facilities</td>
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<tr>
<td>Remote</td>
<td>Accessible maintenance facilities, non-accessible maintenance facilities</td>
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<tr>
<td>Documentation</td>
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<tr>
<td>Guidelines</td>
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</tbody>
</table>

Product Planning & Development (21423), Session #22

<table>
<thead>
<tr>
<th>Maintenance procedures</th>
<th>Hardware and software</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guidelines</td>
<td></td>
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<tr>
<td>Standards</td>
<td></td>
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<tr>
<td>Specifications</td>
<td></td>
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<tr>
<td>Temperature</td>
<td>From conception phase</td>
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<tr>
<td>Vibration</td>
<td>From design and development phase</td>
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<tr>
<td>Shock</td>
<td>From demonstration phase</td>
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<td>Radiation</td>
<td>From field and in-use phase</td>
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<tr>
<td>Electromagnetic</td>
<td>From analytical calculations and existing databanks</td>
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</table>

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<thead>
<tr>
<th>Maintenance data</th>
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<tbody>
<tr>
<td>General training</td>
<td></td>
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<tr>
<td>Specialized training</td>
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<tr>
<td>On-the-job training</td>
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<td>Update training</td>
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<tr>
<td>Skill levels</td>
<td></td>
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<tr>
<td>Personnel requirements</td>
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<th>Maintenance personnel</th>
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5/28/2015
Planning and Preparation for Efficient Development

- **Design for x (DFx)**
  - **Maintenance Concepts**
    - **Corrective (Reactive) Maintenance**
    - Corrective maintenance is reactive in nature.
  - **Every time a product or system fails, repair or restoration must follow to restore its operability**
  - The chief disadvantage of this maintenance procedure is the inherent amount of uncertainty associated with it.

- **Preventive (and Predictive) Maintenance**
  - As its name implies, preventive maintenance is carried out to minimize the probability of a failure.
  - Preventive maintenance often is referred to as use-based maintenance
  - Due to its inherent nature, preventive maintenance must follow maintenance schedules to be fully effective
  - Primary or periodic maintenance inspections may have to be planned to carry out preventive maintenance effectively
Planning and Preparation for Efficient Development

- Design for x (DFx)
  - Maintenance Concepts
    - Preventive (and Predictive) Maintenance
  - To prepare a preventive maintenance plan, the objectives of the plan should be clear.

- Examples of such objectives include the following:
  - Attempting to maintain system design reliability and availability,
  - Reducing corrective maintenance actions,
  - Increasing planned maintenance work, and
  - Improving the effectiveness of maintenance.

Planning and Preparation for Efficient Development

- Design for x (DFx)
  - Maintenance Concepts
    - Preventive (and Predictive) Maintenance
  - To effect preventive maintenance, equipment has to be taken off-line. The resulting downtime is one of the chief disadvantages of this maintenance philosophy.

- Predictive maintenance is an adaptation of the preventive maintenance procedure.
  - It is based on essentially the same principles, except it employs a different criteria to determine the need for specific maintenance actions.

- Diagnostic equipment measures the physical condition of equipment for such conditions as abnormal temperature, vibration, noise, corrosion, and need for lubrication
Planning and Preparation for Efficient Development

- Design for x (DFx)
  - Maintenance Concepts
  - Preventive (and Predictive) Maintenance
  - A chief advantage of predictive maintenance over preventive maintenance is that equipment is taken off-line only when the need to do so is imminent, not after a passage of time, as is the case with preventive maintenance.

- Design for Maintenance
  - Preventive (and Predictive) Maintenance
  - Maintainability is an integral part of the product design process.

- The design review is one of the most important means of achieving good maintainability and reliability.

- It may be defined as “the quantitative and qualitative examination of a proposed design to ensure that it is safe and has optimal performance with respect to maintainability, reliability and performance variables needed to specify the equipment.”
<table>
<thead>
<tr>
<th>Stage and Activity</th>
<th>Purpose</th>
<th>Timing</th>
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<tbody>
<tr>
<td>1. Review of design specifications</td>
<td>To ensure that the significance of all points contained within the design specifications are understood</td>
<td>Prior to the commencement of any design activity</td>
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<tr>
<td>2. Activity systems level review</td>
<td>To identify critical areas of the design that may affect plant availability and communicate to the detail design teams the necessity to pay particular attention to these areas. To comment on the advisability of pursuing projects with a high risk content. To examine equipment groups to maximize uniformity and stability. To maximize the reliability systems formed by manufacturing and process considerations.</td>
<td>Prior to the start of equipment design. After the completion of the first equipment designs.</td>
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<tr>
<td>3. Equipment (functional unit) evaluation</td>
<td>To evaluate quantitatively critical items of equipment. To undertake qualitative reviews of equipment.</td>
<td>After the completion of the first detailed designs.</td>
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<tr>
<td>4. Component analysis</td>
<td>To check that certain important sets of components will not give rise to maintainability or reliability problems in service.</td>
<td>After the completion of the first detailed design.</td>
</tr>
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Planning and Preparation for Efficient Development

- Design for x (DFx)
  - Design for Functionality
    - It is well recognized that functional design plays a central role in ensuring design quality and product innovation;

- Products with problems in their main functions do not sell well, no matter how sophisticated their details.
Planning and Preparation for Efficient Development

- **Design for x (DFx)**
  - **Design for Functionality**

- **Design for Usability**
  - Consumer products are designed to facilitate use by the general public, whereas commercial products are used to produce goods and services.
  - Consumer products are different from commercial products in several respects:
    - The user generally is untrained.
    - The user often works unsupervised.
    - The user is a part of a diverse population.
Planning and Preparation for Efficient Development

- **Design for x (DFx)**
  - Design for Usability
    - The following may be regarded as the criteria for designing and manufacturing usable consumer products:
      - Functionality.
      - Ease of operation.
      - Aesthetics
      - Reliability.
      - Maintainability/serviceability.
      - Environmental friendliness.
      - Recyclability/disposability.
      - Safety.
      - Customizability.
Project

- Phase 13
  - Product DFX Analysis