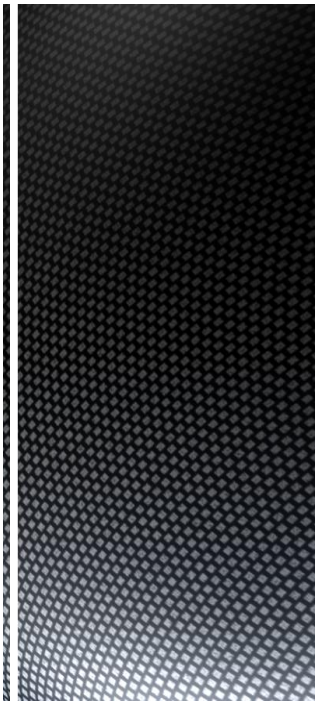


Product Planning & Development (21-423)

Advanced Manufacturing Laboratory
Department of Industrial Engineering
Sharif University of Technology

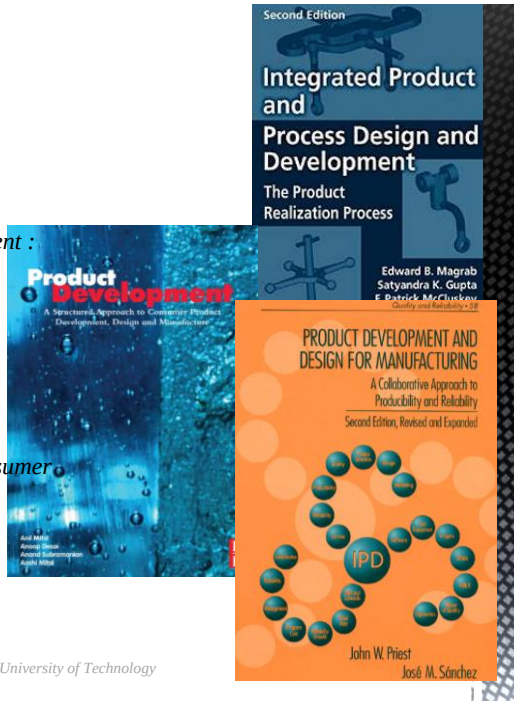
Session #22

Course Description

- *Instructor*
  - *Omid Fatahi Valilai, Ph.D. Industrial Engineering Department, Sharif University of Technology*
  - *Email: FValilai@sharif.edu , Tel: 6616-5706*
  - *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:*
  - *Edward B., "Integrated product and process design and development : the product realization process", CRC Press, 2010*
  - *John Priest, Jose Sanchez; "Product Development and Design for Manufacturing: A Collaborative Approach to Producibility and Reliability, Second Edition", CRC Press, 2001*
  - *Mital et al. , "Product Development A Structured Approach to Consumer Product Development, Design, and Manufacture", Butterworth-Heinemann, 2008*

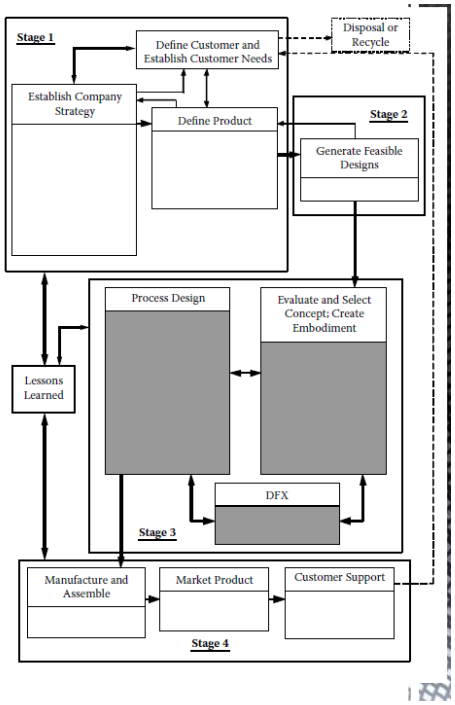


Course Description (Continued..)

- ***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*



Planning and Preparation for Efficient Development

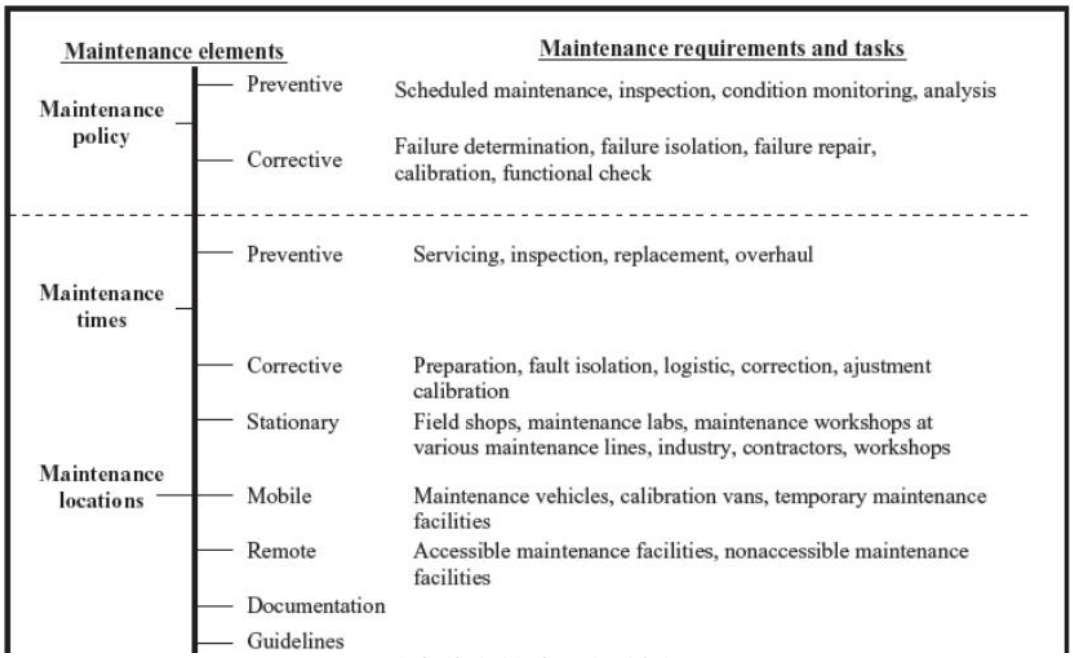
- *Design for x (DFx)*
  - *Designing for Maintenance*
  - *A system or product is said to be maintainable or repairable if, when it fails to perform as required, it can be maintained by a suitable methodology, be it repair, overhaul, or replacement either manually or by an automated action.*
  - *Modern complex systems and products involve a major load on maintenance and support resources, in terms of both personnel and cost.*

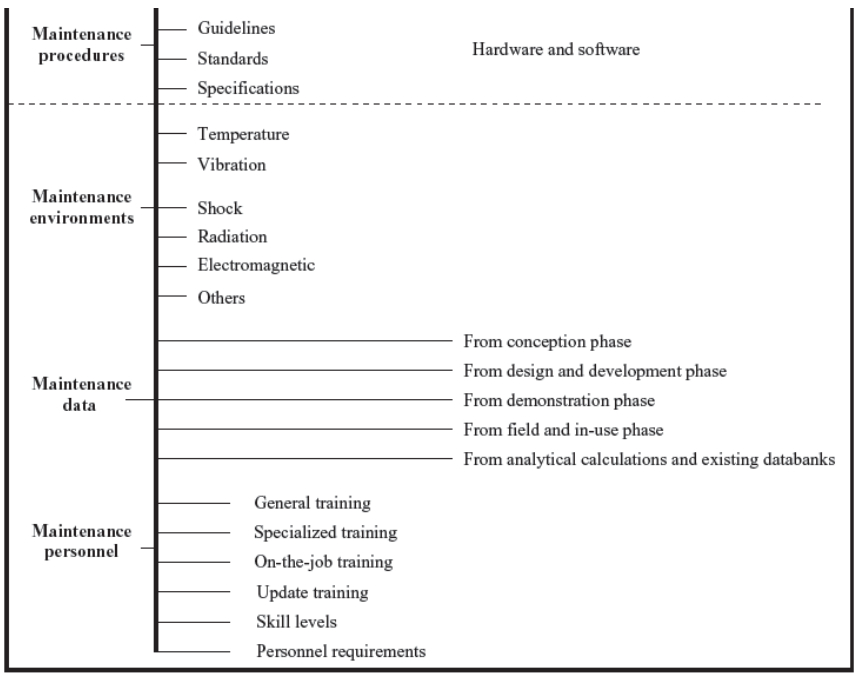
Planning and Preparation for Efficient Development

- *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*


Maintenance elements
Maintenance requirements and tasks
Maintenance policy
Preventive
Scheduled maintenance, inspection, condition monitoring, analysis
Corrective
Failure determination, failure isolation, failure repair, calibration, functional check
Maintenance times
Preventive
Servicing, inspection, replacement, overhaul
Corrective
Preparation, fault isolation, logistic, correction, ajustment calibration
Maintenance locations
Stationary
Field shops, maintenance labs, maintenance workshops at various maintenance lines, industry, contractors, workshops
Mobile
Maintenance vehicles, calibration vans, temporary maintenance facilities
Remote
Accessible maintenance facilities, nonaccessible maintenance facilities
Documentation
Guidelines


Maintenance procedures
Guidelines
Standards
Specifications
Hardware and software
Maintenance environments
Temperature
Vibration
Shock
Radiation
Electromagnetic
Others
Maintenance data
From conception phase
From design and development phase
From demonstration phase
From field and in-use phase
From analytical calculations and existing databanks
Maintenance personnel
General training
Specialized training
On-the-job training
Update training
Skill levels
Personnel requirements

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.*

Planning and Preparation for Efficient Development

- *Design for x (DFx)*
  - *Maintenance Concepts*
    - *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 advantages 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*

Planning and Preparation for Efficient Development

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

Stage and Activity	Purpose	Timing
1. Review of design specifications	To ensure that the significance of all points contained within the design specifications are understood	Prior to the commencement of any design activity
2. Activity systems level review	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	Prior to the start of equipment design
	To comment on the advisability of pursuing projects with a high risk content	
	To examine equipment groups to maximize uniformity and stability	After the completion of the first equipment designs
	To maximize the reliability systems formed by manufacturing and process considerations	
3. Equipment (functional unit) evaluation	To evaluate quantitatively critical items of equipment	After the completion of the first detailed designs
	To undertake qualitative reviews of equipment	
4. Component analysis	To check that certain important sets of components will not give rise to maintainability or reliability problems in service	After the completion of the first detailed design

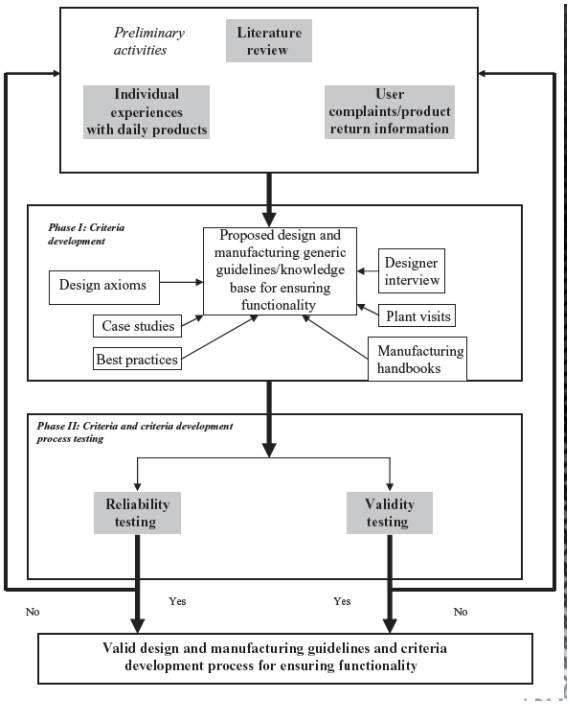
17

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 Dev

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



Planning and Preparation for Efficient Development

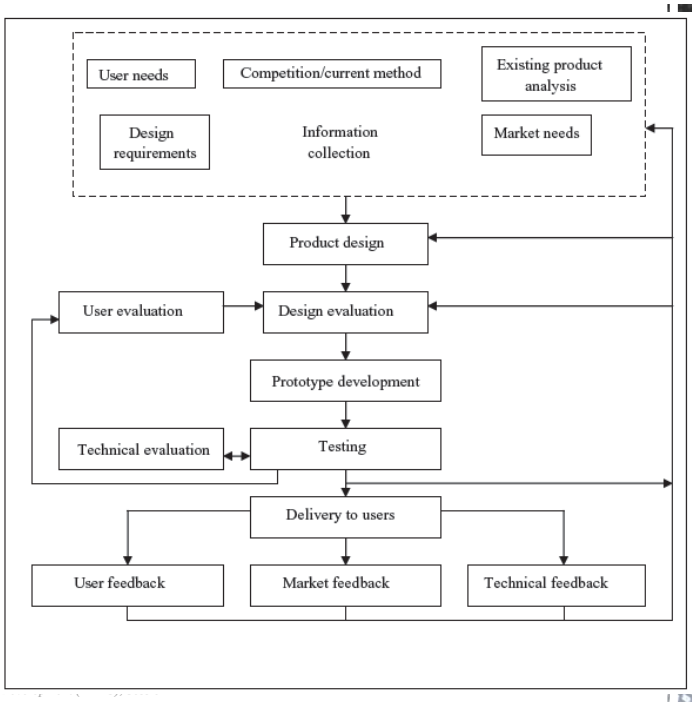
- *Design for x (DFx)*
  - *Design for Usability*
    - *Consumer products are designed to facilitate use by the general public, whereas commercial products are used to produce goods and services.*
    - *Consumer products are different from commercial products in several respects:*
    - *The user generally 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.*

Planning and Preparation for Effi

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



Project

- *Phase 13*
  - *Product DFX Analysis*