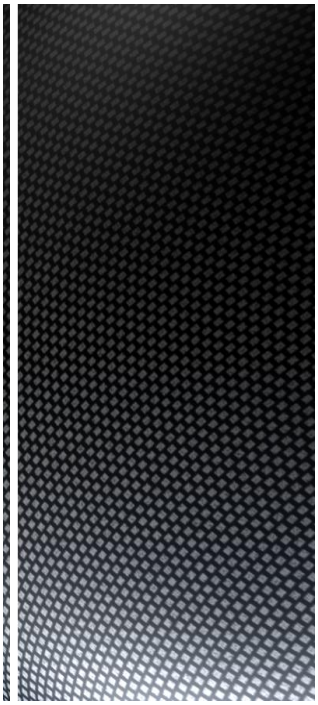
Product Planning & Development (21-423)

Advanced Manufacturing Laboratory
Department of Industrial Engineering
Sharif University of Technology

Session #19

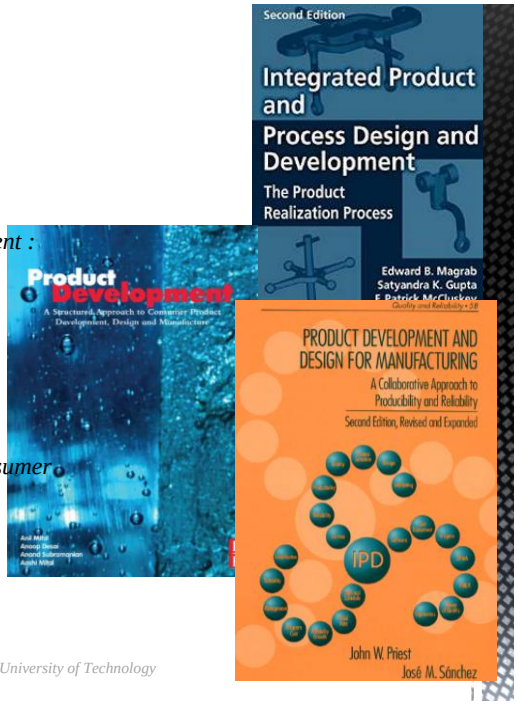


Course Description

- *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*

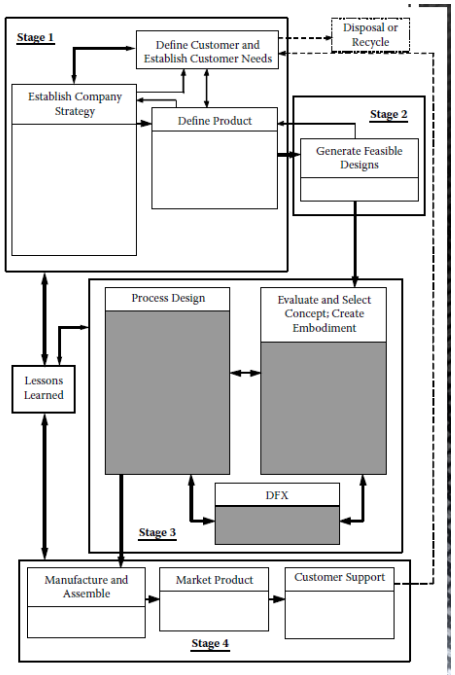


Course Description (Continued..)

- ***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*

Production System; Strategies, planning, and methodologies

- *Material Selection*



Production System; Strategies, planning, and methodologies

- *Material selection*
- *After the conception of a product idea, the question that the research and development (R&D) personnel must ask is,*
  - *What would be the best material for the product?*
  - *Is the material selected easily manufacturable?*
  - *What would be the best material and process combination for developing a product that not only performs the indispensable functions but is also economical to manufacture.*

Production System; Strategies, planning, and methodologies

- *Material selection*
- *It is widely accepted that the final cost of a manufactured product is determined largely at the design stage.*
- *Designers tend to conceive parts in terms of processes and materials with which they are familiar and, as a consequence, may not consider process and material combinations that could prove more economical.*
- *Sometimes, the designers tend to focus only on the cost aspect of materials and manufacturing and select a combination of materials and processes that lead to products of substandard quality and reduced operating life*
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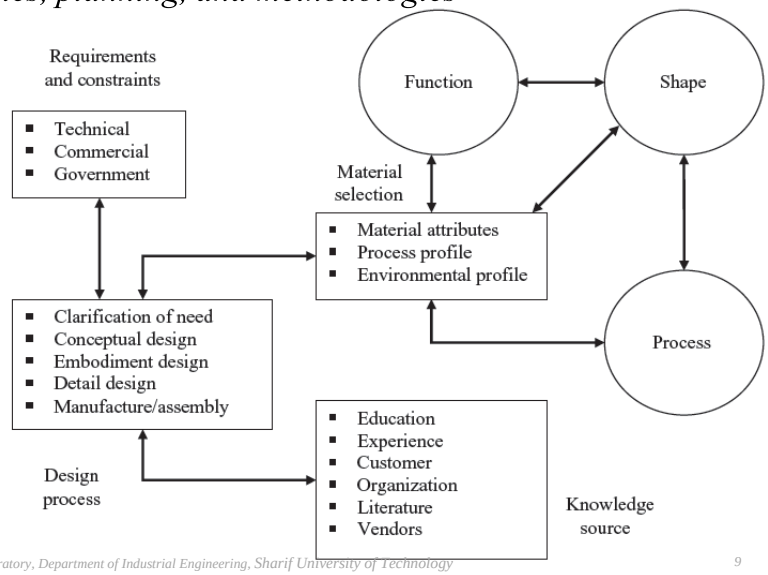
Production System; Strategies, planning, and methodologies

- *Material selection*
- *A vital cog in this product design wheel is the materials engineer.*
- *The optimal selection of material used to construct or make the product should lead to*
  - *optimum properties and*
  - *the least overall cost of materials,*
  - *ease of fabrication or manufacturability of the component or structure, and*
  - *environmentally friendly materials.*

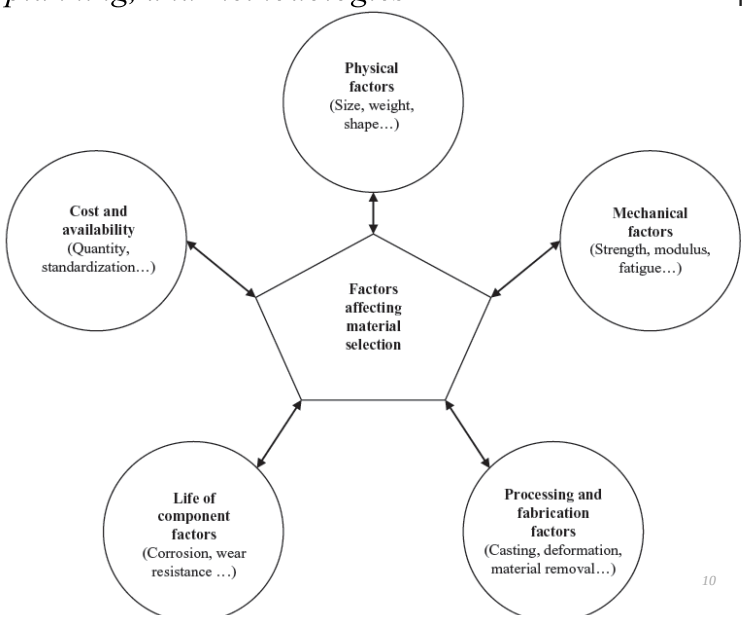
Production System; Strategies, planning, and methodologies

- *Material selection*



Production System; Strategies, planning, and methodologies

- *Material selection*



Production System; Strategies, planning, and methodologies

- *Material selection*
- *Physical factors:*
  - *The factors in this group are the size, shape, and weight of the material needed and the space available for the component.*
  - *Shape considerations greatly influence selection of the method of manufacture.*

  - *Some typical questions considered by a materials designer are*
    - *What is the relative size of the component?*
    - *How complex is its shape? Does it need to be one piece or can it be made by assembling various smaller pieces?*
    - *How many dimensions need to be specified, and what are the tolerances on these dimensions?*
    - *What are the surface characteristic requirements for the product?*

Production System; Strategies, planning, and methodologies

- *Material selection*
- *Mechanical factors:*
  - *The ability to withstand stress and strain is determined by these factors.*
  - *Strength, ductility, modulus, fatigue strength, and creep, are some mechanical properties that influence what material needs to be used.*
  - *The mechanical properties also are affected by the environment to which the materials are exposed.*
- *Some typical questions that designers consider while narrowing down the material to be used are:*
  - *What are the static strength needs of the product?*
  - *What is the most common type of loading to which the product would be subjected during its use (tensile, compressive, bending, cyclic)?*
  - *Is the loading static or dynamic? Would the product be subjected to impact loading?*
  - *Does the product require wear resistance?*
  - *What temperature range must the mechanical properties possess?*

Production System; Strategies, planning, and methodologies

- *Material selection*
- *Processing and fabrication factors:*
  - *The ability to form or shape a material falls under the processing and fabrication factors.*
  - *Casting and deformation processing are commonly used.*

- *Typical questions that arise out of consideration of these factors are*
  - *Has the design addressed the requirements that facilitate ease of manufacture? Machineability? Weldability? Formability? Hardenability? Castability?*
  - *How many components are to be made? What must be the production rate?*
  - *What are the maximum and minimum cross-sectional dimensions?*
  - *What is the desired level of quality for the finished product?*

Production System; Strategies, planning, and methodologies

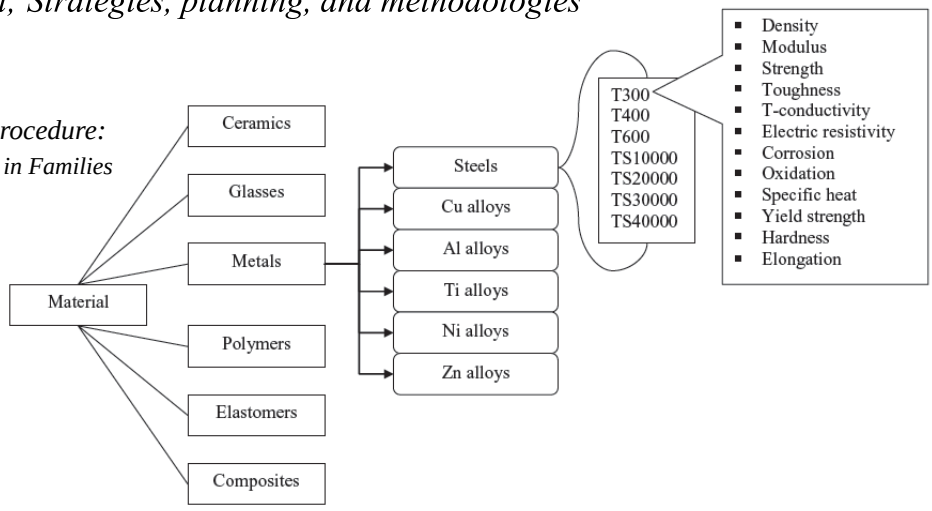
- *Material selection*
- *Life of component factors:*
  - *These factors relate to the life of the materials to which they perform the intended function.*
  - *The properties of this group are the external surface properties like oxidation, corrosion, and wear resistance and some internal properties like fatigue and creep.*
  - *The performance of materials based on these properties is the hardest to predict during the design stages.*

Production System; Strategies, planning, and methodologies

- *Material selection*
- *Cost and availability:*
  - *With reduced lead times from design to market, there is a tendency to jump to the first material that fits the selection profile.*
  - *It is important to note that additional effort determining the correct material helps optimize the manufacturing costs. Also, standardization of parts and materials is related to the cost of the final product.*
  - *Special processing requirements or rare materials with limited availability increase the final cost and affect the timely manufacture of the product*

Production System; Strategies, planning, and methodologies

- *Material selection*
- *Material Selection procedure:*
  - *Grouping Materials in Families*

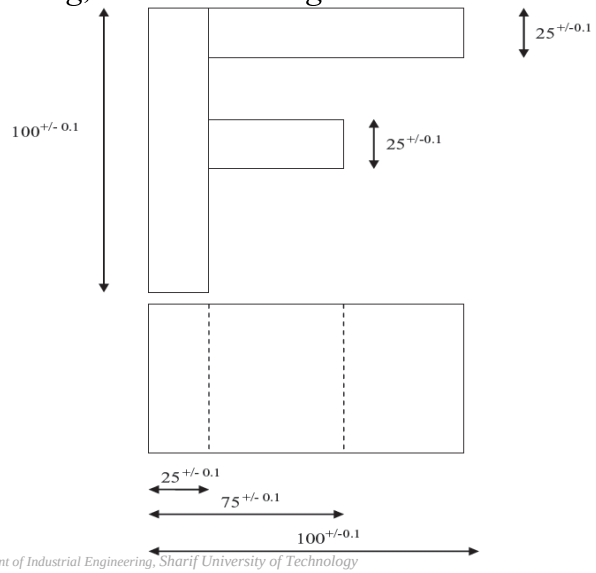


Production System; Strategies, planning, and methodologies

- *Material selection*
- *Material Selection procedure:*
  - *Grouping Materials based on Process capability*
  - *Filtering is required based on the fabrication process and suitability of each prescreened material to each process.*
  - *The shape, geometry, surface finish, detailed specifications, and the like, to a large extent, determine which processes cannot be used to manufacture the product.*
  - *Selecting a material based on processing requirements is a complex task because of the very large number of processing methods and sequence possibilities.*

Production System; Strategies, planning, and methodologies

- *Material selection*
- *Material Selection procedure:*



Production System; Strategies, planning, and methodologies

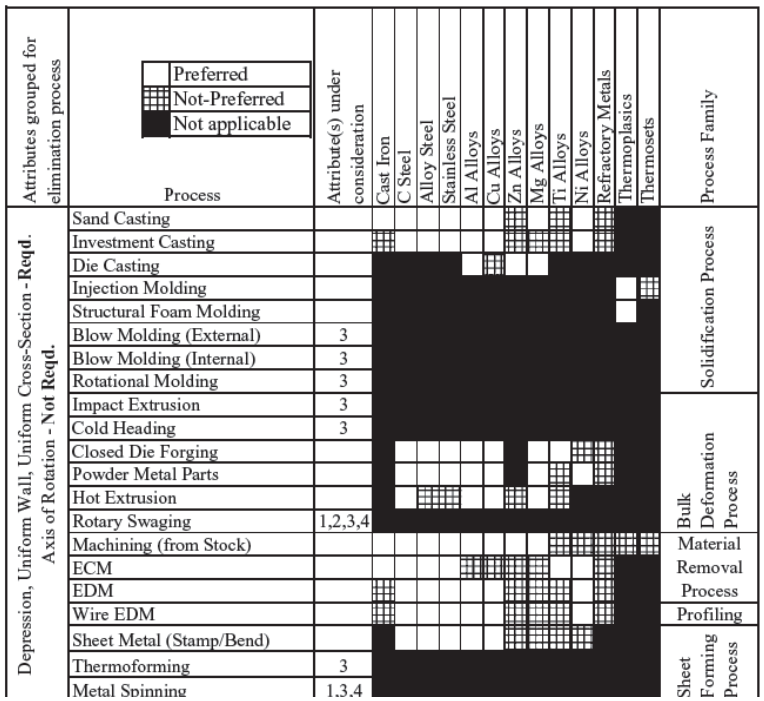
- *Material selection*

Required Attributes (Shape and Material) for the Component to Be Manufactured

Attributes	Condition
Shape	Required
Depression	Required
Uniform wall	Required
Uniform cross section	Required
No draft	Not required
Axis of rotation	Not required
Regular cross-section	Not required
Captured cavity	Not required
Enclosed cavity	Maximum temperature 500°C
Material	Excellent corrosion resistance to weak acids and alkalis

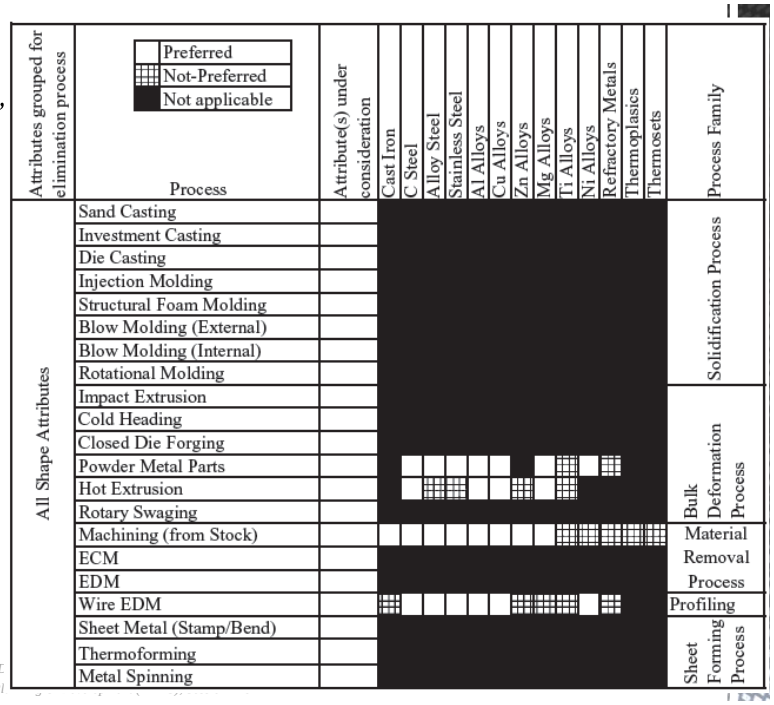
Production System; Strate

- *Material selection*
- *Material Selection procedure:*



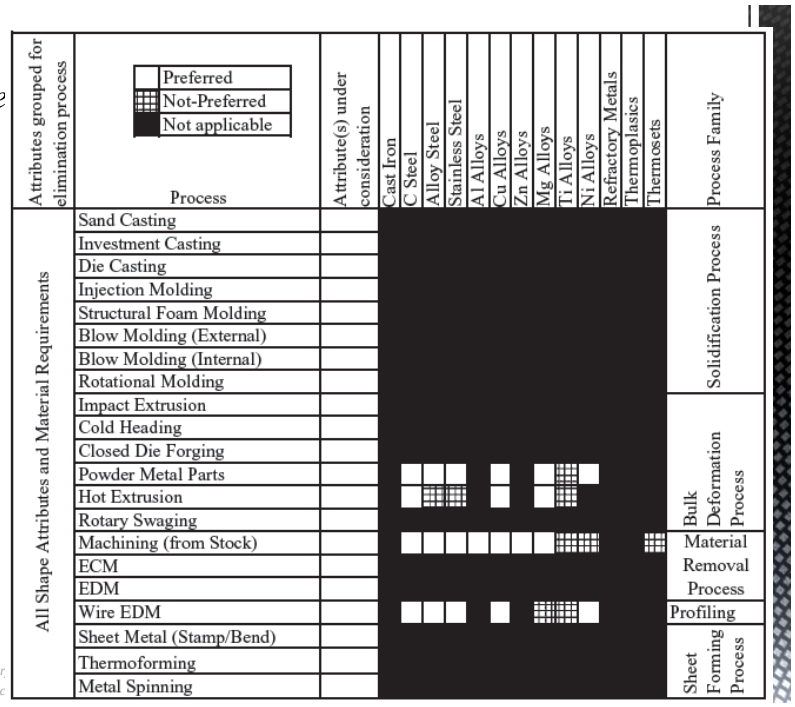
Production System; Strategies,

- *Material selection*
- *Material Selection procedure:*



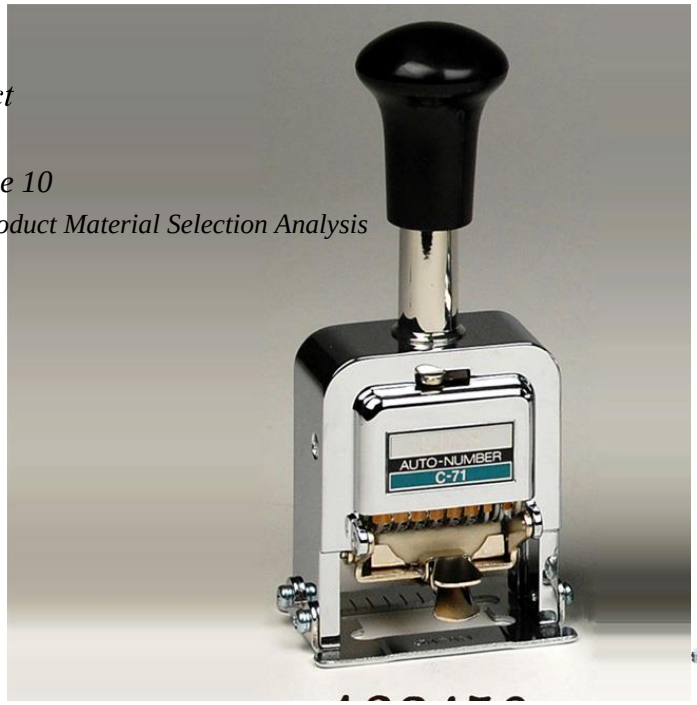
Production System; Strategie

- *Material selection*
- *Material Selection procedure:*



Project

- *Phase 10*
  - *Product Material Selection Analysis*



Production System; Strat

- *Material selection*
- *Material Selection procedure*