The globalization and technology explosion has thrown new challenges to the most successful organizations. Barriers to competition have fallen precipitously as regulations have eased and markets have become more global. The tools and methods which were useful in the past are not enough to solve complex problems faced by these organizations due to unpredictability and dynamic global environment. A Company’s innovation capabilities will determine its future growth potential. Design thinking has been making waves in the business world. This new approach promises to foster potential 21st Century competencies. Design thinking is now known as a creative-problem solving approach designers use to create new values that are different and create positive impact. Design thinking has gained popularity as the approach to innovate.

There is an urgent need to adopt integrated innovative product development strategies to meet the ever-changing customer expectations. This course, through theory and practical classes, aims to look at these issues and create an awareness of innovative product development process and various design methods to achieve success. We attempt to strike a balance between theory and practice through our emphasis on methods. The methods we present are typically step-by-step procedures for completing tasks, but rarely embody a clean and concise theory. In some cases, the methods are supported in part by a long tradition of research and practice, as in the chapter on product development economics. In other cases, the methods are a distillation of relatively recent and ad hoc techniques, as in the chapter on design for environment. In all cases, the methods provide a concrete approach to solving a product development problem. In our experience, product development is best learned by applying structured methods to ongoing project work in either industrial or academic settings. Therefore, we intend this course to be used as a guide to completing development tasks either in the context of a course project or in industrial practice.
IDENTIFYING CUSTOMER NEEDS

The process of identifying customer needs is an integral part of the larger product development process and is most closely related to concept generation, concept selection, competitive benchmarking, and the establishment of product specifications.

PRODUCT DESIGN SPECIFICATION (PDS)

A Product Design Specification (PDS) is a statement of how a design is made, what it is intended to do, and how far it complies with the requirements Product Design Specification is one of the elements of Product Lifecycle Management.

CONCEPT GENERATION

Idea generation refers to the systematic search for new-product ideas. Typically, a company generates hundreds of ideas, maybe even thousands, to find a handful of good ones in the end.

CONCEPT SELECTION METHODS

<table>
<thead>
<tr>
<th>CONCEPT SELECTION MATRIX</th>
<th>GENERATED CONCEPTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selection Criteria</td>
<td>A Master Cylinder</td>
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<tr>
<td>Ease of handling</td>
<td>0</td>
</tr>
<tr>
<td>Ease of use</td>
<td>0</td>
</tr>
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<td>Readability of settings</td>
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<tr>
<td>Durability</td>
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<td>Ease of manufacturing</td>
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<td>Portability</td>
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<tr>
<td>Sum X</td>
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</tr>
<tr>
<td>Net Score</td>
<td>2</td>
</tr>
<tr>
<td>Rank</td>
<td>2</td>
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</tbody>
</table>

Concept selection is the process of evaluating concepts with respect to customer needs and other criteria, comparing the relative strengths and weaknesses of the concepts, and selecting one or more concepts for further investigation, testing, or development.
The Industrial Designers Society of America (IDSA) defines industrial design as “the professional service of creating and developing concepts and specifications that optimize the function, value, and appearance of products and systems for the mutual benefit of both user and manufacturer.”

Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design to optimize human well-being and overall system performance.

**DESIGN FOR MANUFACTURING AND ASSEMBLY - DFX**

Design for Manufacturing and Assembly (DFX) is the process of designing parts, components or products for ease of manufacturing with an end goal of making a better product at a lower cost. This is done by simplifying, optimizing and refining the product design.

**PROTOTYPING / 3D PRINTING**

Prototypes can be usefully classified along two dimensions. The first dimension is the degree to which a prototype is physical as opposed to analytical. Physical prototypes are tangible artifacts created to approximate the product. Aspects of the product of interest to the development team are actually built into an artifact for testing and experimentation. Analytical prototypes include computer simulations, systems of equations encoded within a spreadsheet, and computer models of three-dimensional geometry.

**FINITE ELEMENT ANALYSIS**

Finite Element Analysis (FEA) is a computerized simulation for predicting how a product reacts to real-world forces, vibration, heat, fluid flow and other physical effects. Finite element analysis shows whether a product will break, wear out or work the way it was designed.
IP RATINGS FOR ENCLOSURE DESIGN: The IP (or “Ingress Protection”) is a rating international standard, EN 60529 (British BS EN 60529:1992, European IEC 60509:1989) are used to define levels of sealing effectiveness of enclosures against intrusion from foreign bodies (Solids, Dust, Dirt etc.) and moisture.

Good metal casting design means creating the simplest mold that will produce a desired shape. This process requires expert knowledge of metals and casting methods to find the best value in a quality casting.

Injection molding has been one of the most popular ways for fabricating plastic parts for a very long time. They are used in automotive interior parts, electronic housings, housewares, medical equipment.

The process of duplicating an existing component, subassembly, or product, without the aid of drawings, documentation, or computer model is known as reverse engineering.
MANUFACTURING DRAWINGS

Manufacturing drawings show numerous features of a part that a 3D model doesn’t. For instance, drawings show the material type, the finish, dimensions, hardware, company information, and other specific requirements. The sole purpose of a drawing is to show all the details of a part.

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>GEOMETRIC CHARACTERISTIC</th>
<th>TOLERANCE TYPE</th>
<th>CONTROL SUMMARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>□</td>
<td>FLATNESS</td>
<td>FORM</td>
<td>CONTROLS FORM (SHAPE) OF SURFACES AND CAN ALSO CONTROL FORM OF AN AXIS OR MEDIAN PLANE</td>
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<td>STRAIGHTNESS</td>
<td>(NO RELATION BETWEEN FEATURES)</td>
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<tr>
<td>□</td>
<td>CYLINDRICITY</td>
<td>ORIENTATION</td>
<td>CONTROLS ORIENTATION (TILT) OF SURFACES, AXES, OR MEDIAN PLANES FOR SIZE AND NON-SIZE FEATURES</td>
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<tr>
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<td>LOCATION</td>
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<td></td>
<td></td>
<td></td>
<td>PARALLELISM</td>
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<tr>
<td>⊥</td>
<td>ANGULARITY</td>
<td></td>
<td>ALSO CONTROLS ORIENTATION</td>
</tr>
<tr>
<td>○</td>
<td>POSITION</td>
<td>LOCATION</td>
<td>LOCATES CENTER POINTS, AXES, AND MEDIAN PLANES FOR SIZE FEATURES ALSO CONTROLS ORIENTATION</td>
</tr>
<tr>
<td>⊙</td>
<td>PROFILE OF A SURFACE</td>
<td>LOCATION</td>
<td>LOCATES PLANES</td>
</tr>
<tr>
<td>□</td>
<td>PROFILE OF A LINE</td>
<td>LOCATION</td>
<td>LOCATES PLANES</td>
</tr>
<tr>
<td>⊙</td>
<td>TOTAL RUNOUT</td>
<td>RUNOUT</td>
<td>CONTROLS SURFACE COAXIALITY ALSO CONTROLS FORM AND ORIENTATION OF SURFACES</td>
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<tr>
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<td>CIRCULAR RUNOUT</td>
<td>LOCATION</td>
<td>LOCATES DERIVED MEDIAN POINTS OF A FEATURE</td>
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<tr>
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<td>CONCENTRICITY</td>
<td>LOCATION</td>
<td>NOT COMMON...CONSIDER USING POSITION, RUNOUT, OR PROFILE</td>
</tr>
<tr>
<td>□</td>
<td>SYMMETRY</td>
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</tbody>
</table>

Geometric Dimensioning and Tolerancing (GD&T) is a system for defining and communicating engineering tolerances. It uses a symbolic language on engineering drawings and computer-generated three-dimensional solid models that explicitly describe nominal geometry and its allowable variation. It tells the manufacturing staff and machines what degree of accuracy and precision is needed on each controlled feature of the part.
PRODUCT DESIGN AND DEVELOPMENT
FOR MECHANICAL ENGINEERS

- Identifying Customer Needs
- Product Specifications
- Concept Generation Methods
- Concept Selection Methods
- Industrial Design
- Design for Manufacturing and Assembly
- Prototyping / 3D Printing
- Patent and Intellectual Property
- Machine Design and Mechanisms
- Material Selection and Manufacturing
- Sheet Metal Enclosure Design
- Plastic & Casting Components Design
- Reverse Engineering Techniques
- Geometric Dimensioning and Tolerancing
- Design for Six Sigma
- Tear-Down and Benchmarking Process
- Failure Mode Effect Analysis
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PACKAGED COURSES

**AEC**
- Product Design Associate
  One 2D + one 3D tool
- Product Design Professional
  One 2D + Two 3D tool
- Product Design Master
  One 2D + One 3D + One Analysis tool

**MFG**
- AEC Associate
  One 2D + one 3D tool
- AEC Professional
  One 2D + Two 3D tool
- AEC Master
  One 2D + One 3D + One Analysis tool

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