MNE 654-102: Design for Manufacturability

Sanchoy Das

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Online Course Delivery

Due to the extraordinary circumstances caused by the COVID-19 outbreak, NJIT will be offering most graduate classes, including MNE654, under a fully remote learning mode. This course has been revised and updated to be delivered in a full online learning mode. This syllabus integrates several updates that have been made to facilitate the online course delivery.

Classes will be held in a synchronous online session at 6 pm on Mondays.

COURSE DESCRIPTION

Design-Build new products quickly and ensure these products meet cost targets and incorporate proven efficient manufacturing methods and digital design analysis tools. This course focusses on tools and methods for evaluating new and existing product designs with an objective of reducing production costs, improving quality and improving sustainability. Innovation driven design is central to this objective.

Specifically, the course introduces methodologies used in the synthesis and analysis of design specifications and utilizes parametric models to relate them to cost and quality. The role of creativity and innovation on new product development methods and the relationship of design to production processes, product material, material handling, quality costs, and CAD/CAM are presented. Emphasis is primarily on assembled products.

Cost estimation software and other design analysis tools are employed. Lean manufacturing and Six Sigma concepts in the design context are also introduced. The course cornerstone is a project in which teams of students play both management and engineering design analysis to improve an existing commercial product. The course also introduces the ideation process which is being used to foster fast innovation.

GRADING

Based on individual and team performance as follows:

- 15% Homework #1
- 15% Homework #2
- 20% Midterm Exam
- 20% Final Exam
- 15% Team Project
- 15% Ideation Project
**TEXTBOOK AND COURSE READINGS**

*There is no required textbook for the course.* Several articles and papers have been selected to complement the course material and will be distributed through the course website. *The following are suggested textbook readings, other readings are listed by week:*

- *MnE 654 lectures slides by Prof. Sanchoy Das* will be distributed electronically through Canvas
- *Product Design for Manufacture & Assembly* - by Peter Dewhurst, Winston Knight, Geoffrey Boothroyd, Marcel Dekker; 2nd edition, **ISBN:** 082470584X

**CANVAS**

The course will make extensive use of the Canvas system to optimize student-instructor communication. All course materials including lecture slides and homework etc. will be distributed through Canvas. All submission of homework and other assignments will also be through Canvas. To access the system please go to [http://canvas.njit.edu/](http://canvas.njit.edu/), you will need a valid UCID to login.

During the semester we will be have a weekly online class session. During these sessions I will discuss course material, have discussions with students and deliver lectures. These sessions will be conducted through the WEBEX platform which is integrated with Canvas. To enter the WEBEX class click on ONLINE CLASS EVENT at the top of the course Canvas page.

**ONLINE CLASS SESSIONS & WEBEX:** Mondays starting at 6.00 pm.

**VIDEO RECORDING OF LECTURES** – To maximize the online class experience, I have been recording the class lectures. These are integral to the course and made available under the corresponding topic # in Canvas. A key part of the weekly assignment is for all students to review the video recording of the lecture. When a lecture is presented during the online class session, it will be recorded and the corresponding Video lecture in Canvas will be updated. From the course Canvas page you will see the archived WEBEX SESSIONS listed in the corresponding topic box and referenced by lecture number.

**TEAM PROJECTS**

The course will require all students to complete two team projects: (i) Design Ideation Project and (ii) Disruptive Redesign Project. Projects will be done in teams of three. The same team will execute both the projects and will collaborate using available online and mobile technologies. Teams are expected to communicate digitally through email, text message, and skype. You are encouraged to use the Google Drive (part of NJIT WebMail) to share project documents.
Design Ideation Project – Ideate a new product design such that it disrupts the current designs that are dominant in the market and/or provides currently unmet functionalities. These will be assigned in the third week of the semester and will be due immediately after the spring break. Project assignments will be made in Mid-February.

Disruptive Design Project - Each team will extend their Ideation project to full design. The team will take the role of in-house disruptors tasked with transitioning the idea to a design. Team will focus on optimizing the production economics and design innovativeness of the product. The project will use the Pro-DFM software for costing and manufacturability analysis. Design drawings can be done in either ProE, AutoCAD or any other design creation tool. Each team will make a presentation and submit a report.

The team will be required to make a 10 minute Ideation presentation and a 15 minute disruptive presentation. Presentations will be scheduled as noted in the outline below. Each team will also be assigned an Executive Role for another project. That is they will be allocated 5 minutes for Q&A of that project.

# WEEKS TOPIC

Click on the WebEx link at the top of the Canvas page to connect with Online Live lecture

1. 1 Introduction to Design for Assembly and Manufacturability (DFA/DFM)
   - The Design Process: Objectives, Theories, Participants & Plans
   - DFMA Definitions and Objectives
   - What is Industrial Design?
   - Introduction to Design Analysis tools

Class Date: January 25, 2021

Slides: Lecture #1 – Introduction
Video: Tesla Model S Head of Product Design
Reading #1: Smaller Businesses Struggle to Make It in the USA
Reading #2: Sir Jonathan Ive: The iMan cometh
Reading #3: Made in America, Again

2. 2 New Product Design (NPD) & Innovation Process
   - Product Design: Fast ideas, prototypes and analysis
   - Innovation – Swimming in the Shark Tank
   - Innovation value creators
   - Functional requirements (FR), design parameters (DP), and process variables (PV)
   - Stage-Gate Review Process and Innovation

Class Date: February 1 and 8, 2021

Slides: Lecture #2 – New Product Development Process
Video: Shark Tank – QBall Episode
Video: Shark Tank – Ring Doorbell Episode + Amazon Buyout
Reading #4: Perspective: Stage Gate Idea to Launch Process
3. 1  Design for Assembly - Assembly Method Selection
   - Automatic Feeding & Part Orientation
   - Vibratory bowl feeders
   - Selecting the Assembly Method

Class Date: February 15, 2021

Slides: Lecture #3 – Boothroyd-Dewhurst Part A
Video: CouchCoaster - Design, Prototype & Manufacture
Reading #5: Factory of the Future – Proto Labs
Reading #6: NPD Process in High Tech
Boothroyd-Dewhurst DFA Online Tutorials

HW# 1 Assigned

4. 2  Design for Assembly - Boothroyd-Dewhurst Method
   - Orienting and Insertion Efficiency
   - Design Efficiency Calculation

Class Date: February 22 and March 1, 2021

Slides: Lecture #4 – Boothroyd-Dewhurst Part B
Reading #7: Effect of Front-Loading Problem-Solving on Product Develop

MIDTERM EXAM (3/22/2021)

Completed remotely. Time constrained to 2.5 hours. 2 hours to complete the exam plus 0.5 hours to download, scan and upload completed exam.

6:00 pm, Monday March 22 - Exam download link opens
8:30 pm, Monday March 22 – Exam upload link closes

Notes: (i) Preprint the Online exam integrity sheet, sign and upload with your exam, (ii) Arrange your schedule and exam setting so that you can efficiently complete and upload the exam at the scheduled time.

Ideation Project – Assigned on 2/10/2021 – Presentations on 3/8/2021

5. 1 - C  Manufacturing Cost Estimation of New Products
   - Setting Cost Targets
   - Pro-DFM Cost Analyzer
   - Seer-DFM Methodology

Class Date: March 8, 2021

Slides: Lecture #5A – Design to Cost
Slides: Lecture #5B – The Pro-DFM Method
Slides: Lecture #5C – SEER Estimate Method
6. Lean Manufacturing & Design
   - Lean Manufacturing Principles
   - Toyota Production System & the Seven Wastes
   - Design for Environmental Sustainability

   **Class Date: March 29, 2021**

   *Slides: Lecture #10 – Lean Manufacturing*
   *Reading #8: The Cisco Connected Factory*
   *Reading #9: The New Practice of Global Product Development*

7. Design for Six Sigma
   - The Six Sigma Concept
   - DMADV Methodology and IDOV Methodology
   - Monte Carlo Simulation

   **Class Date: April 5 and 12, 2021**

   *Slides: Lecture #6A and #6B – Design for Six Sigma*
   *Reading #10: DFM and Design for X*

8. Design for Quality & Reliability
   - Taguchi Methods & Orthogonal Arrays
   - Failure Modes and Effects Analysis (FMEA)

   **Class Date: April 20 and 27, 2021**

   *Slides: Lecture #7 – Design for Quality*
   *Slides: Lecture #8 – Failure Modes Effects Analysis*
   *Reading #11: Manufacturing the Future*

   **HW# 2 Assigned**

9. 3D Printing Systems & NPD
   - Base technology, materials and capabilities
   - Economics and scalability

   **Class Date: May 3, 2021**

   *Slides: Lecture #9 – 3D Printing Systems*
   *Reading #12: Using 3D Printing to Make Jet Engines*

    All Disruptive Design Projects will require an online presentation using the WebEx Platform. Teams will be assigned for 15-minute presentations on one of the two dates above. Specific instructions on how to make your online presentation will follow.
FINAL EXAM (5/10/2021)

Completed remotely. Time constrained to 2.5 hours. 2 hours to complete the exam plus 0.5 hours to download, scan and upload completed exam.

6:00 pm, Monday May 10 - Exam download link opens
8:30 pm, Monday May 10 - Exam upload link closes