

MECH 392 MANUFACTURING PROCESSES

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Do you have the tools and confidence to enter a factory and be able to understand its operations and make suggestions for improvement? Do you know how your everyday use simple items such as, water bottle, cloth hanger, electric power plug, toothbrush, gym dumbbell, coffee cup lid, Gillet razor handle, garbage bags, and so on to more sophisticated items such as your cellphone or laptop enclosure, parts in your bicycle or car, aircraft parts, and many other parts around you are made? Have you heard of additive manufacturing, such as 3D printing or metal laser sintering? MECH 392 is an introduction to a wide range of manufacturing processes. In this course you will learn the fundamentals and applications of many manufacturing processes through lots of examples and video demonstrations. You will also gain a perspective on the future of manufacturing and how it will be shaped by advanced technologies.

Textbook and Materials:

- Core manufacturing Processes (Video links in Section I)
- Quality and Monitoring (Video links in Section II)
- Extra Topics (Self Study) (Video links in Section III)
- Wide Range of Parts and Manufacturing Machine (Video links in Section IV)
- TV Discovery Channel (How It's Made?) (Video links in Section V)
- In class lecture notes (7 Modules)
- Textbook (*Optional*), Groover, M. P., Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, 5th Edition, Wiley, 2013

Note: The main resource for this course will be the video links in this document (Page 5-12) and the lecture notes in the class. The textbook is not required and is optional.

Tentative plan for the course:

You will study chapter 1(an overview of core manufacturing processes) by watching the videos in Section I, on your own before the second class (Monday September 9th). There will be a quiz (*Start Quiz!*) on Monday September 9th.

Chapter 2-7 will be covered in class. Chapter 8 will be introduced briefly (earlier in the term). You need to complete this chapter on your own. You will do a project for this chapter.

Chapter 8-13 are self study topics. (These chapters will not be part of your exam and will not be covered in lectures).

Course Modules:

1. Machining
2. Sheet Metal Forming
3. Injection Molding
4. Thermoforming
5. Casting
6. Additive Manufacturing
7. Quality and Monitoring

Evaluation:

- 1- Fun Quiz (Monday September 9th), 5% (bonus)
 - 2- Midterm (Monday October 8th), 35%
 - 3- Final Exam, 50%
 - 4- Assignments, 5%
 - 5- Projects, 10%
- Total** 105% (100 + 5% bonus)

Projects:

(Guidelines will be provided for each project in the class)

- 1- A short report - Choose 7 different parts (you are free to pick whatever you want) and explain the main manufacturing process or processes for each part.
- 2- A STL and G-Code for a 3D part (TBA)
- 3- Short talk/presentation or just submit a paragraph/slide on “What do you think will be the future of manufacturing?”
 - What do you think is the future of manufacturing? How Virtual Augment Reality, Industry 4.0, AI and Machine learning, and Cyber-physical Production Systems will influence the future of Manufacturing?

Important dates:

Start Quiz: Monday September 9th

Midterm: Monday October 8th

Assignment: TBA

Projects: TBA

Final exam: UBC Exam Schedule

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Office Hours: (Please email for appointment)

Instructor:

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Lectures: Mondays and Wednesdays 14-15

Office Hours: Monday and Wednesdays 16-17 (Please email for appointment)

Course Outline

Ch 1. An overview of core manufacturing processes (video links below in Section I)

Ch 2. Machining

- Turning
- Milling

Ch 3. Sheet Metal Forming

- Cutting
- Bending

Ch 4. Molding (Plastics)

- Injection Molding
- Blow Molding
- Thermoforming

Ch 5. Casting

- Sand Casting
- Die Casting
- Investment Casting

Ch 6. Additive Manufacturing

- Extrusion (FFF/FDM)
- Power Bed Fusion (SLM/SLS)

Ch 7. Production Cost, Variation, Quality, and Monitoring

Self Study Topics

Ch 8. Brief Introduction to 3D Modeling, STL-Files, and G-Code

- Intro to Fusion 360
- G-Code for CNC
- Create STL files for 3D printing

Ch 9. Automation

Ch 10. Sustainable manufacturing

Ch 11. Assembly (Welding, Brazing, Soldering, Adhesive, Fastening)

Ch 12. Metal Forming (Forging, Extrusion, Drawing)

Ch 13. Future of Manufacturing

SECTION I. AN OVERVIEW OF CORE MANUFACTURING PROCESSES



Click on each topic (the video links).

1. Casting

1.1. Sand casting

- [Sand casting concept](#)
- [Actual sand casting in a foundry](#)

1.2. Investment casting:

- [A solid part](#)
- [A Part with hollow core](#)
- [In a factory](#)

1.3. Die casting:

- [Concept](#)
- [Actual process](#)

2. Molding

- 2.1. [Extrusion](#)
- 2.2. [Injection](#)
- 2.3. [Blow](#)

Extra demonstration:

- [Demo 1](#)
- [Demo 2](#)
- [Demo 3](#)
- [LEGO](#)

3. Forming

3.1. Forging

- [Concept](#)
- [Actual process in a factory](#)

3.2. [Rolling](#)

3.3. [Extrusion and Drawing](#)

3.4. [Sheet Metal Forming](#)

3.5. [Operations of shearing and bending sheet metals](#)

4. Machining

4.1. [Drilling](#)

4.2. [Turning\(on a Lathe\)](#)

4.3. [Milling](#)

High speed video face milling:

- [Demo 1](#)
- [Demo 2](#)

A brief intro to milling machine:

- [Crash Course in Milling](#)

4.4. [Grinder](#)

Automated process: [CNC](#)

5. Powder Metallurgy

- [The Process](#)

6. Additive Manufacturing

6.1. [SLA \(Stereolithography\)](#)

6.2. [FDM \(Fused Deposition Modeling\)](#)

6.3. [Metal Laser Sintering, SLM/SLS \(Selective Laser Melting/Sintering\)](#)

[SLM Demo 1](#)

[SLM Demo 2](#)

3D Printing:

- [Why Hollywood loves 3D printing](#)
- [Amazing Parts by 3D Printing](#)
- [How Does 3D Printing Work?](#)
- [The process of 3D Printing](#)

7. Joining

- 7.1. [Welding](#)
- 7.2. [Brazing](#)
- 7.3. [Soldering](#)
- 7.4. [Adhesive Bonding](#)
- 7.5. [Fastening](#)

8. Thermoforming

- [The process](#)
- [Heating source in thermoforming](#)

Examples:

- [Boats](#)
- [Toys](#)
- [Coffee cup lid](#)
- [Plastic cup lid making machine-for paper cup](#)
- [Pharmaceutical Blister Packs](#)

SECTION II. QUALITY AND MONITORING

Examples of quality check and inspection

[Milk cap](#)

[Car body inspection featuring multi-sensor CMM \(Coordinate Measure Machine\)](#)

- **The principles of statistical process control**
 - [Process Capability Index Part 1](#)
 - [Process Capability Index Part 2](#)
 - [Process Capability Index Part 3](#)
- **6 σ**
 - [What is 6 Sigma?](#)
 - [Introduction to Six Sigma](#)

SECTION III. EXTRA TOPICS (SELF-STUDY)

1. Automation

- [Examples of Advanced Automate](#)
- [Glazed Donuts Automation](#)

Main Automation Process:

1. Manipulators
[Spot-welding robots - Automotive industry](#)
2. SCARA (Selective Compliance Assembly Robot Arm)
[Robotic Micro Screw Fastening](#)
[Assembly System with Scara Robots](#)
3. Parallel Robots
[High Speed Pancake stacking with Flex-picker Robots](#)
4. Spherical Parallel Robots
[Concept](#)
5. Grippers
[Vacuum Gripper](#)

2. Sustainable Manufacturing

- [Introduction by Professor Gutowski MIT \(Part 1\)](#)
- [Introduction by Professor Gutowski MIT \(Part 2\)](#)

3. General Tips and Tricks - Manufacturing in China

(It will be covered briefly in the class)

4. Future of Manufacturing

- [What is your vision for future of manufacturing?](#)
- [Virtual and Augmented reality in use for industry 4.0 and building technology](#)
- [Industry 4.0: Augmented reality system for production](#)
- [CPS \(Cyber-Physical Systems\)](#)

5. Quick Introduction to 3D Modeling, STL-file , and G-Code

- [What is Fusion 360?](#)
- [Features of Fusion 360](#)
- [Download Software \(Free for Students\)](#)

Note: Use your UBC email, so the system let you get the full version for free.

6. CNC (Beginners Guide to Manual & CNC Machining)

SECTION IV. WIDE RANGE OF PARTS AND MANUFACTURING MACHINE

(Manufacturing Review and Analysis):

1. [Five machines to start manufacturing at home](#)
2. [iPhone 6 aluminum body](#)
3. [Apple MacBook Pro Aluminum unibody](#)
4. [CNC Machining A Chess Rook](#)
5. [Chicago International Manufacturing Technology Show, IMTS 2018 \(Autodesk Ad.\)](#)
6. [IMTS 2016 \(Hexagon Ad.\)](#)
7. [5-Axis CNC Machined V8 Engine Block!](#)
8. [DATRON M8Cube Milling Mold for Radio Controlled Drone](#)
9. [Toothbrush production](#)
10. [The Panton Chair](#)
11. [How Are Aluminum Cans Recycled? | How Do They Do It?](#)
12. [Progressive die stamping by Scandic \(San Leandro, California USA\)](#)
13. [Turbine Blade Casting](#)
14. [Jewelry Sandcasting \(Gold Ring\)](#)
15. [Aluminum Wheel Die Casting](#)
16. [Investment Casting of Jewelry](#)
17. [Alcoa micro-mill](#)
18. [Kids Injection Molding Machine for Making Toys](#)
19. [Selective Laser Melting for Gas Turbines](#)
20. [Incredible 3D Printed Objects](#)
21. [Arcam EBM's next-generation additive system](#)
22. [PepsiCo Using 3D Printing to Design Bigger, Bolder Potato Chips](#)
23. [BAAM Big Area Additive Manufacturing \(Shelby Cobra\)](#)
24. [3D-printed a large-scale trim tool for a Boeing 777X](#)
25. [The world's first 3D printed metal bike \(Titanium Frame by SLM\)](#)

SECTION V. TV DISCOVERY CHANNEL -HOW IT'S MADE? --

1. [Espresso Machines](#)
2. [PORSCHE Dream Cars](#)
3. [Lego](#)
4. [Bowling balls](#)
5. [Mirrors](#)
6. [Car Tires](#)
7. [Headphones](#)
8. [Aluminum Foil](#)
9. [Surfboards](#)
10. [Welding Electrodes](#)
11. [Pro Hockey Sticks](#)
12. [Ultra-Thin Glass](#)
13. [Shock Absorber](#)
14. [Ice Skates](#)
15. [Vibrating Mining Screens](#)
16. [Snap on Sockets](#)
17. [Tower Cranes](#)
18. [Clarinets](#)
19. [Lithium Ion batteries](#)
20. [Surge Arresters](#)
21. [Wind Turbines](#)
22. [Nuts and Bolts](#)
23. [Plate Glass](#)
24. [Alloy Wheels](#)
25. [Aluminum cans](#)

Other useful links:

- [Cutting Tools Super Slow Motion on High Speed Camera](#)
- [Types of milling cutters](#)
- [5-Axis Vertical Machining Center,](#)
- [Overview - Autodesk Moldflow](#)
- [Injection Molding Overview](#)