

# IME 100 Interdisciplinary Design and Manufacturing

## Introduction to Manufacturing Processes

### Toy Project

### 3D Printing with Fusion 360 and CURA

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Kettering University



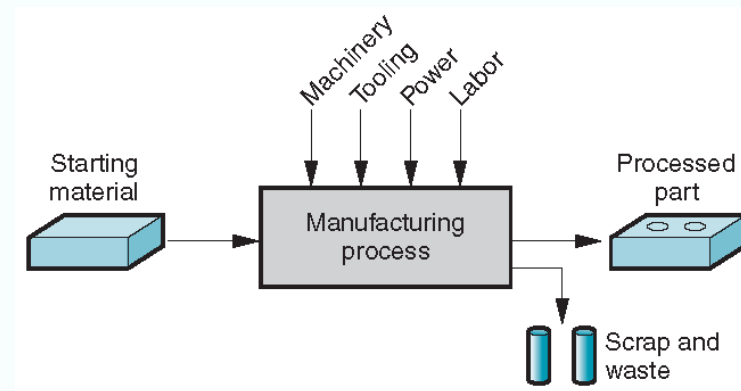
# Agenda

- What is Manufacturing?
- Intro to CNC and G-Code
- Cura Slicer Demonstration (Download)
- Toy Project Introduction and Team Formation



# What is Manufacturing?

- The word manufacture is derived from two Latin words *manus* (hand) and *factus* (make); the combination means “made by hand”
- Application of physical and chemical processes to alter the geometry, properties, and/or appearance of a starting material to make parts or products



[John Wiley & Sons, Inc. M P Groover, *Principles of Modern Manufacturing*]



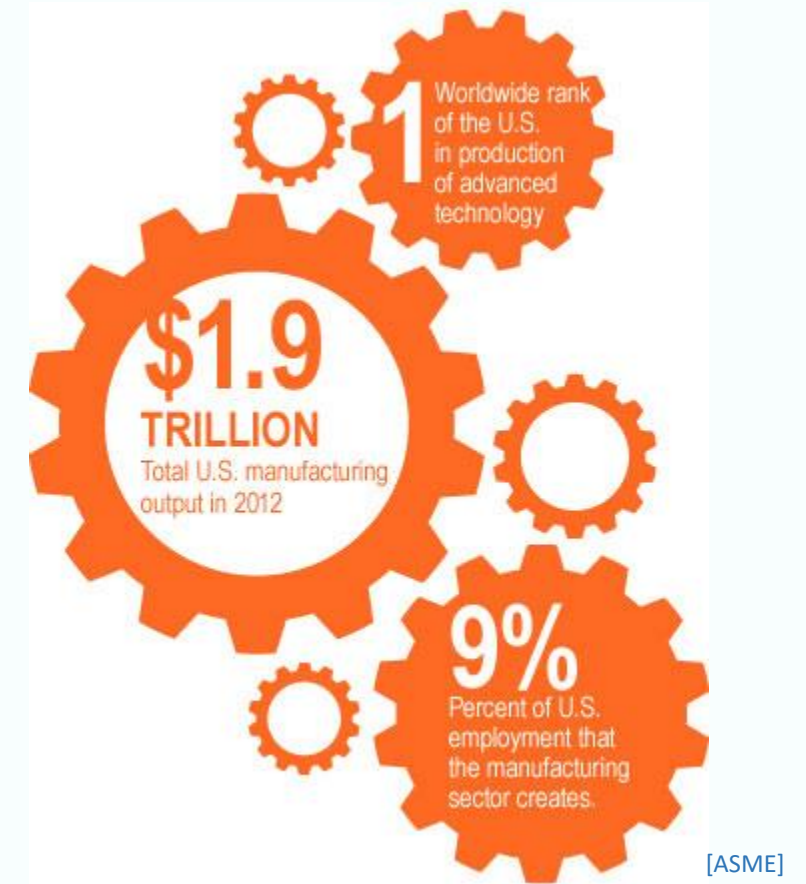
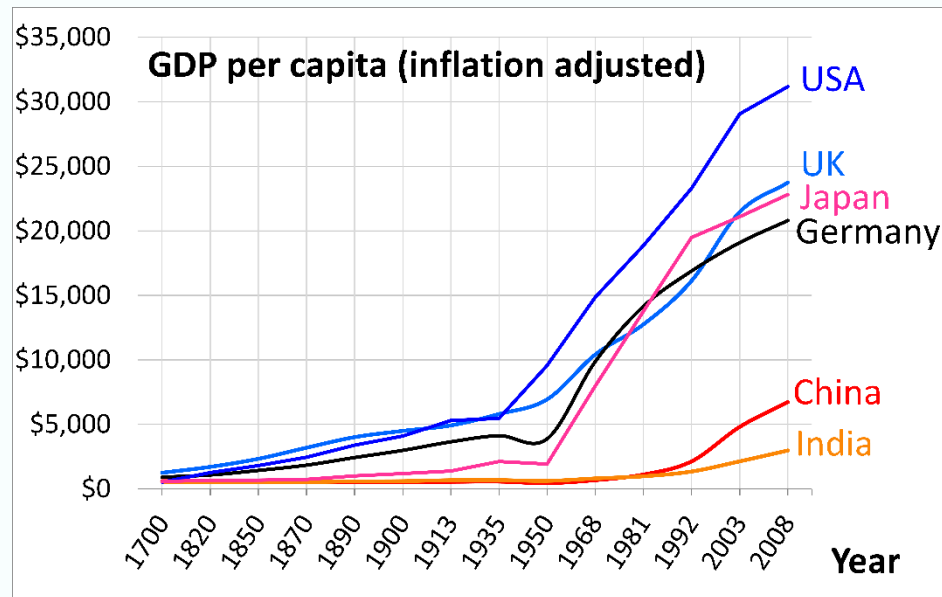
# Some examples of manufacturing methods are:

1. **Casting**
2. **Forming and shaping**
3. **Machining**
4. **Joining and Assembly**
5. **Finishing**
6. **Additive Manufacturing**
7. **Microfabrication and nanofabrication**

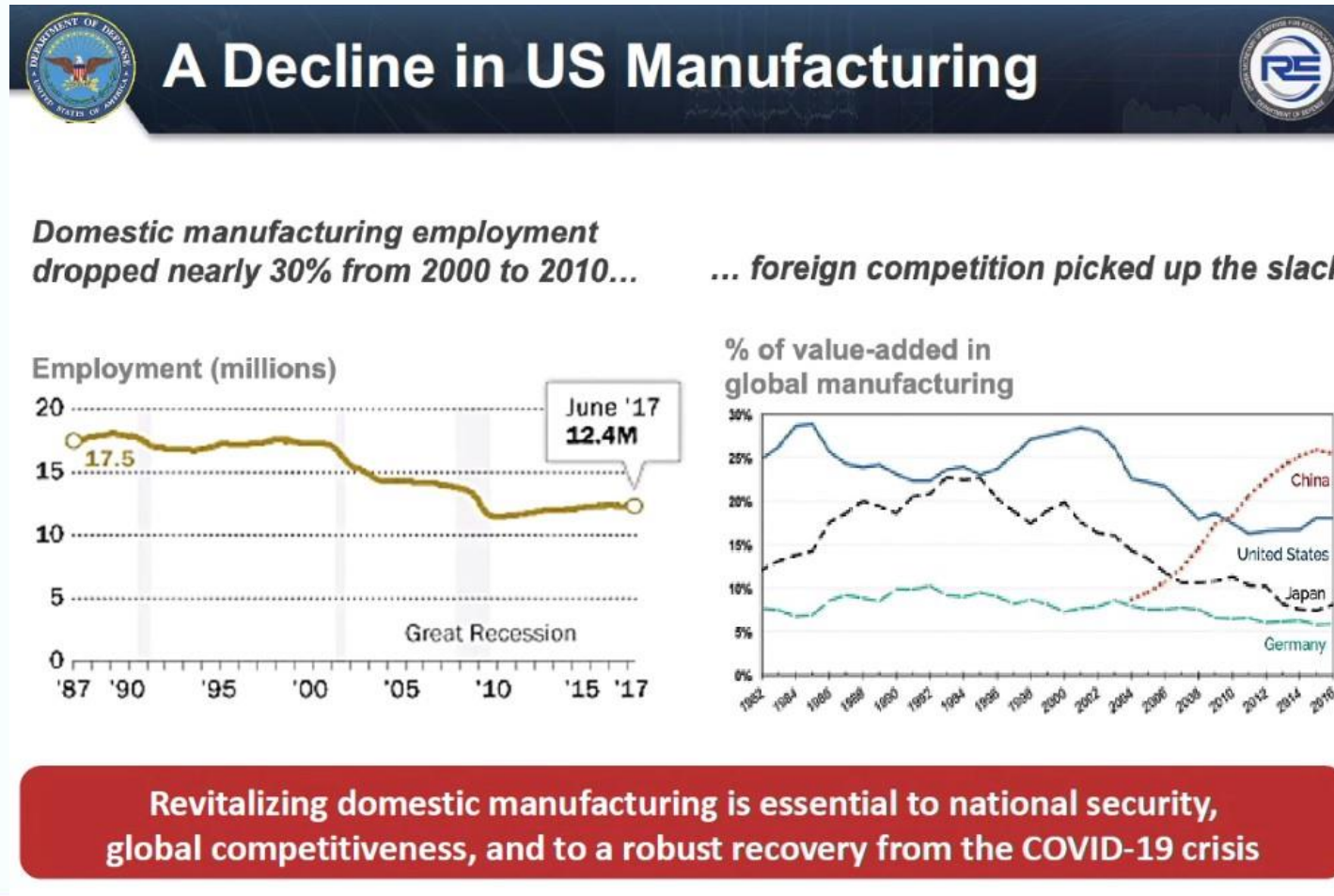


# Why does Manufacturing Matter?

- Economic Growth
- Global leadership



# Comments from the Department of Defense



# Industry 4.0



[Founder Institute]





## Industry 4.0 framework and contributing digital technologies



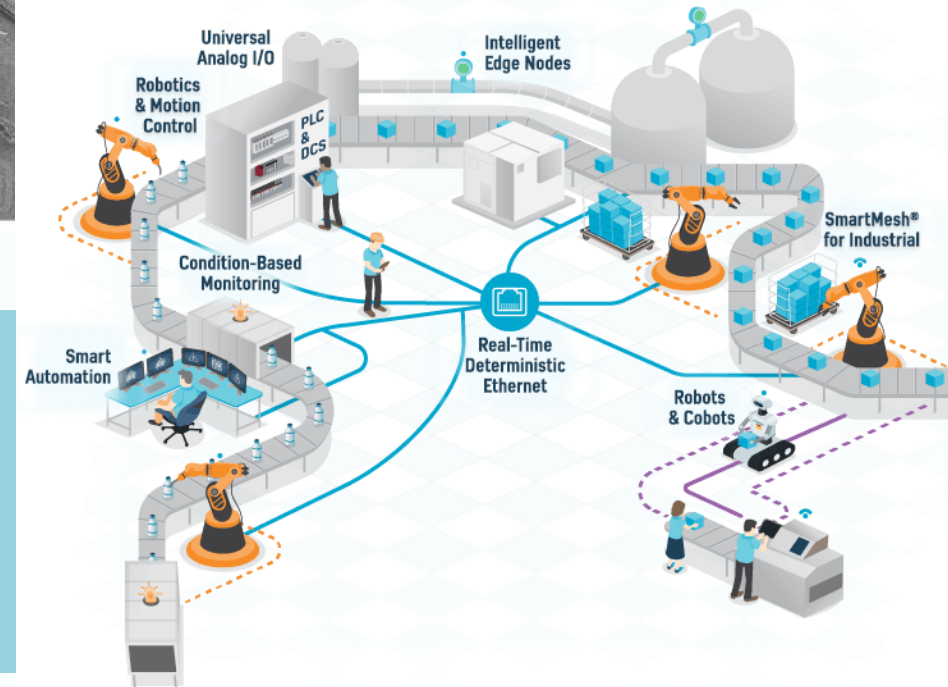
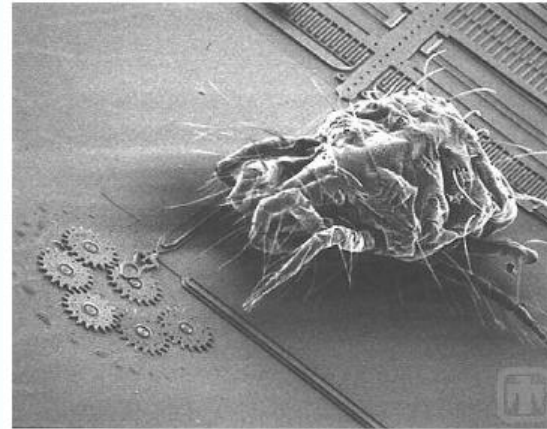
Source: Industry 4.0: Building the digital enterprise, 2016 Global Industry 4.0 Survey, PwC, Engineering & Construction, 2016





# New Trends in Manufacturing

- Energy Beam Based Manufacturing
- Micro and Nano Manufacturing
- Automation and Robotics
- Additive Manufacturing
- Bio-Manufacturing
- Sustainable Manufacturing
- Smart manufacturing

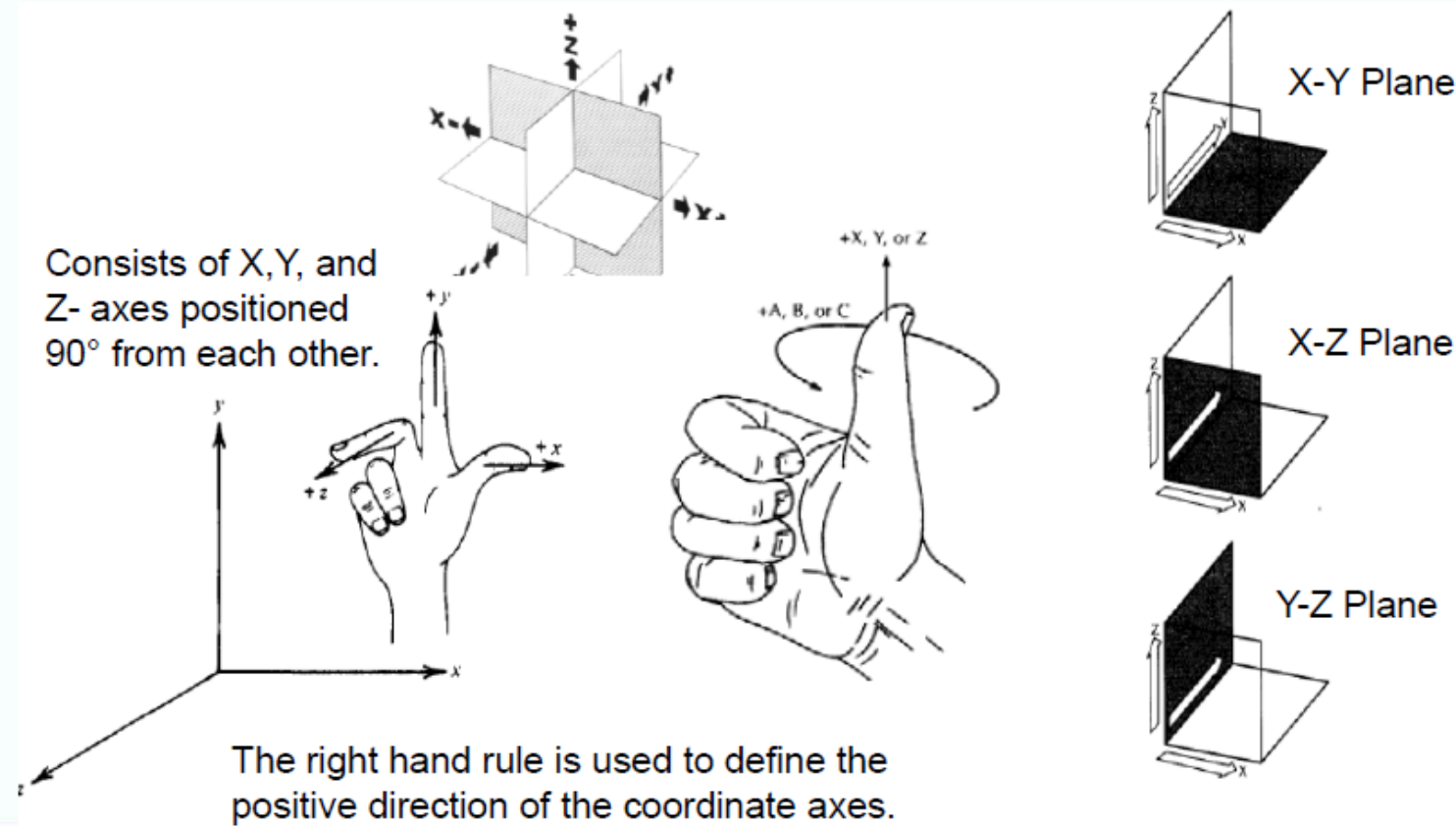


# Computer Numerical Control (CNC)

- A form of programmable automation in which the mechanical actions of a piece of equipment are controlled by a program containing coded alphanumeric data (G-Codes)
- NC operating principle is to control the motion of the workhead (tool) relative to the workpart and to control the sequence of motions
- **CNC Coordinate System**
  - Consists of three linear axes (x, y, z) of Cartesian coordinate system, plus three rotational axes (a, b, c)
  - Rotational axes are used to orient workpart or workhead to access different surfaces for machining
  - Most NC systems do not require all six axes

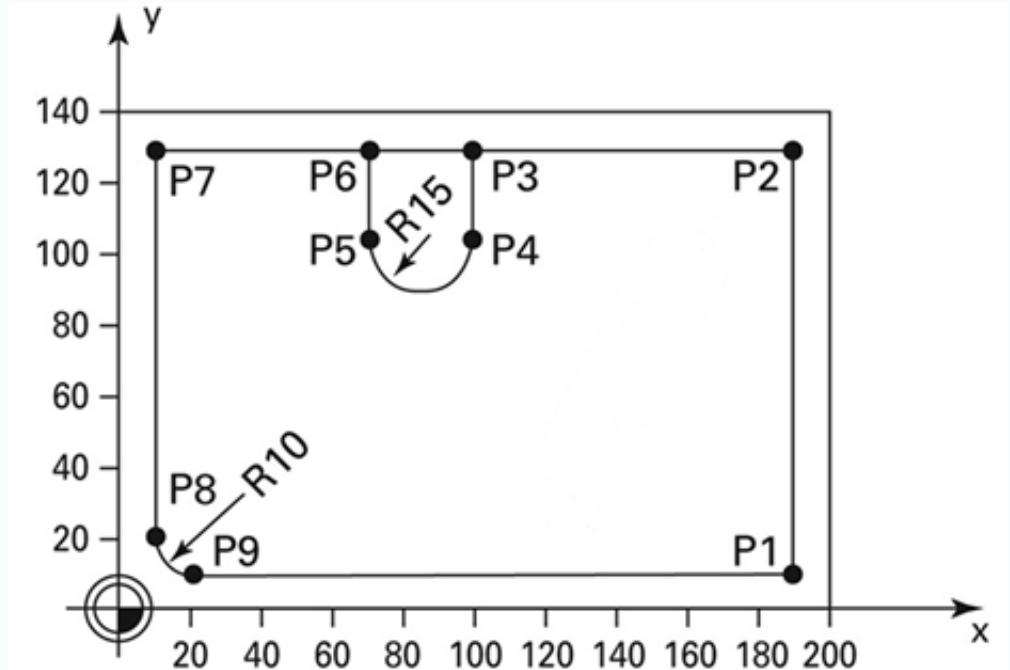


# CNC Coordinate System



# Part Programming Example

- |                             |   |
|-----------------------------|---|
| • N080 G01 Y130 F200        | Straight line from starting point to P2     |
| • N090 G01 X100             | Straight line from P2 to P3                 |
| • N100 G01 Y105 F150        | Straight line from P3 to P4                 |
| • N110 G02 X70 Y105 R15     | Radial arc, clockwise, with 15 radius       |
| • N120 G01 Y130 F200        | Straight line from P5 to P6                 |
| • N130 G01 X10              | Straight line from P6 to P7                 |
| • N140 G01 Y20              | Straight line from P7 to P8                 |
| • N150 G03 X20 Y10 R10 F150 | Radial arc, counterclockwise with 10 radius |
| • N160 G01 X190 F200        | Straight line from P9 to P1                 |
| • N170 G01 Z35 F200         | Retraction from workpiece                   |
| • N180 G00 X300 Y300        | Rapid traverse away from workpiece          |



# Common CNC Words

**TABLE 26-2** Definitions of Common NC Words

NC Word	Use
N	<i>Sequence number:</i> identifies the block of information
G	<i>Preparatory function:</i> requests different control functions, including preprogrammed machining routines
X, Y, Z, B	<i>Dimensional coordinate data:</i> linear and angular motion commands for the axis of the machine
F	<i>Feed function:</i> sets feed rate for this operation
S	<i>Speed function:</i> sets cutting speed for this operation
T	<i>Tool function:</i> tells the machine the location of the tool in the tool holder or tool turret
M	<i>Miscellaneous function:</i> turns coolant on or off, opens spindle, reverses spindle, tool change, etc.
EOB	<i>End of block:</i> indicates to the MCU that a full block of information has been transmitted and the block can be executed

(From DeGarmo)





# Selected G codes and M codes

- G00 Rapid positioning
- G01 Linear interpolation
- G02 CW circular interpolation
- G03 CCW circular interpolation
- G20 Programming in inches
- G21 Programming in mm
- G40 Tool radius compensation off
- G41 Tool radius compensation left
- G42 Tool radius compensation right
- G90 Absolute programming
- G91 Incremental programming
- M00=Program Stop (non-optional)
- M02=End of Program
- M03=Spindle on (CW rotation)
- M04=Spindle on (CCW rotation)
- M05=Spindle Stop
- M06=Tool Change
- M07=Coolant on (flood)
- M08=Coolant on (mist)
- M09=Coolant off
- M30=End of program/rewind tape





# G-Code

- Open your MMG file to see the g-codes!



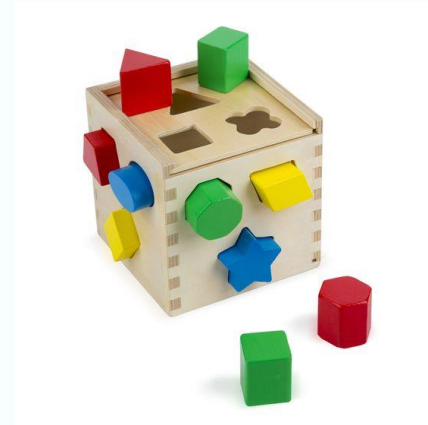
# Project Progress

- Grades
- Coaster
  - Deliverables
  - Figures
  - Drawing
    - Units
    - Depth of cut
- Robot
  - Redesign
  - Manufacturing requirements
  - Technical Writing
  - 3D Printing



# Manufacturing Projects

- Toy Project



**Join your Toy Group on Blackboard Week 3 Page**



# Cura demonstrations

- Install The software Ultimaker Cura
- <https://ultimaker.com/software/ultimaker-cura>



# 3D Printing Demonstration on Fusion 360 and CURA



# Next class on Thursday

Robotics Lab

Time to submit Part 1 including the VR challenges

Kettering University

