2.008 Quiz 2 Review

Quiz Scope & Logistics

- Quiz 2 will cover HW 5 - 7 and through Lecture 15 - 24. Even if content was not explicitly asked about in a HW, if it was discussed in class, it is fair game for the quiz
- Quiz 2 will have **Part A (~ 80 mins in class on 5/8)**
  - You are allowed one double sided, handwritten 8.5” x 11” notes sheet. This is for equations and any other pertinent information
  - We will supply you with calculators for the exam
  - Show your work, box your answers
- Quiz 2 will have **Part B**
  - Take home exam. (Open Book/internet, etc but **no collaboration.)**
  - **Will be released same time as Part A but due through Canvas 48 hours later.**

Cumulative Score Correction

Part A, In-Class Component		
Problem 1		Out of 15 points
Problem 2		Out of 31 points
Problem 3		Out of 24 points
Part B, Take-Home Component		
Problem 4		Out of 30 points
Total		**100 points**

Concepts to know

Casting *(Part A)*

1) Understand the advantages/disadvantages of different types of casting processes.
2) Understanding principles of various casting methods and being able to apply theory of heat transfer and fluid mechanics to perform basic sizing calculations related to casting.
3) Understand how to apply cooling time relations to estimate cooling times for sand casting and die casting
4) Understand the implications of the value of flow rate/heat transfer ratio in terms of defects, runner diameter sizing, etc.
5) Understand the implications of having laminar vs turbulent flow.

Forming *(Part A)*

1) Understanding material structure, grain size and parameters that dominate metal forming.
2) Have understanding of bending, stretching and drawing.
3) Understand springback relation and general sheet metal bending process.
4) Understand sheet metal Design For Manufacturing (Boothroyd Reading)
5) Understand stress/strain relations for ductile materials.
6) Have general understanding of rolling, forging, extrusion and drawing.

Additive - 3D printing (*Part A)*

1) Understand the workflow for additive manufacturing.
2) Understand the different types of common AM methods that were covered and tradeoffs.
3) Know what limits the rate of each process
4) Understand the feature resolution possible with each, as well as common defects
5) Know which materials match which process as well.
6) Understand 3D printing in the context of rate, flexibility, cost and quality relative to other manufacturing processes

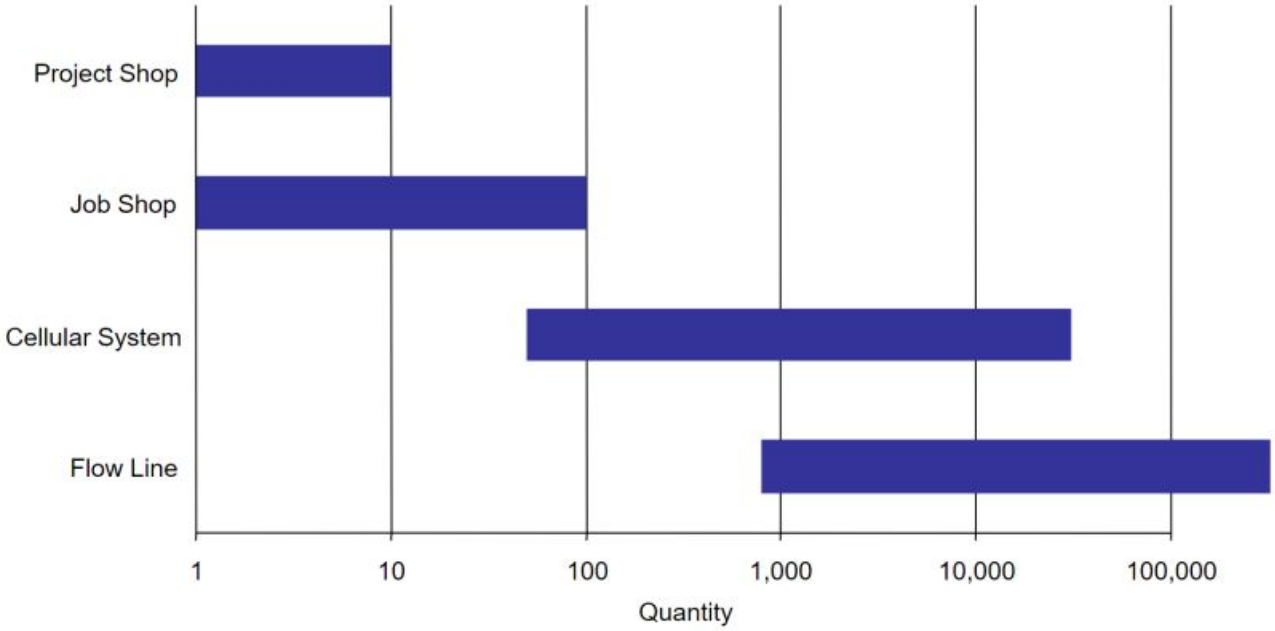
Additive - Electronics + Composites Manufacturing (*Part A)*

1) Understand the Generic Flow Diagram.
2) Understand which processes are subtractive and which are additive.
3) Understand process of photolithography/ soft lithography and purpose of photoresist.
4) Understand CVD/PVD
5) Understand Etching. (isotropic vs anisotropic)
6) Understand purpose of Ion Implantation.
7) Understand manufacturing attributes.
8) Understand the process and benefits of using polymer matrix composites.

Manufacturing Systems (*Part A* + *Part B)*

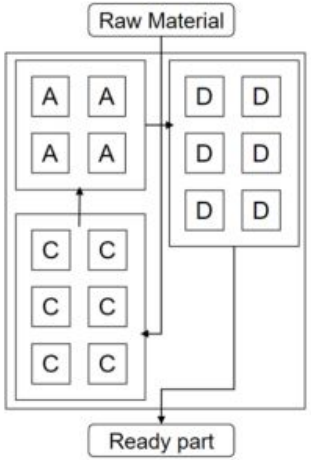
1) Know the difference between a job shop, manufacturing cells, and transfer line, and what sorts of task/quantities are expected at each.
2) Review the Beer Game and Lean Game Activities, what were the key challenges in each game, how did round 2 play address them
3) Understand the role buffers play in manufacturing lines and where they can be placed for maximum efficiency
4) Know how to calculate the production rate of zero and infinite buffer lines, be familiar with little's law, equations for zero and infinite buffer lines and when to use them
5) Understand the difference between the MATLAB Scripts and which is appropriate to use when.
6) How to draw and interpret block diagrams.

Manufacturing System and Quantity

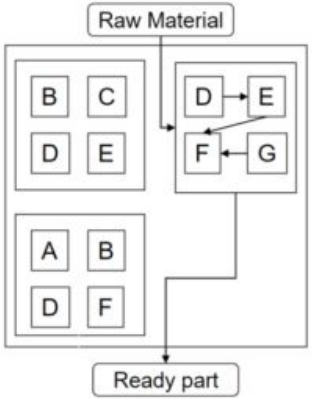


Types of Factory Layouts

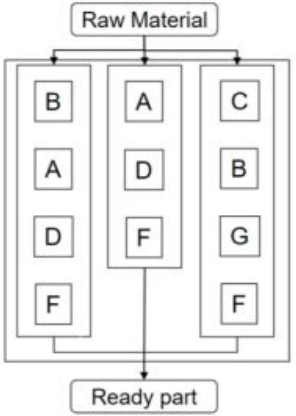
Job Shop:
Machines/Resources are grouped according to the process they perform



Cellular System:
Machines/Resources are grouped according to the processes required for part families



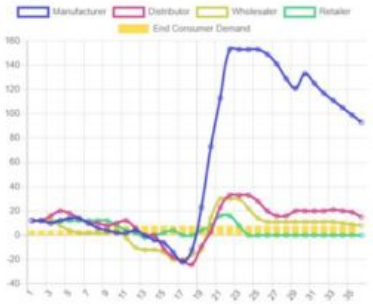
Flow/Transfer Line:
Machines/Resources are Grouped in lines according to the processes sequence of part(s)



Beer Game and Lean Game

Lean Game:
Q7

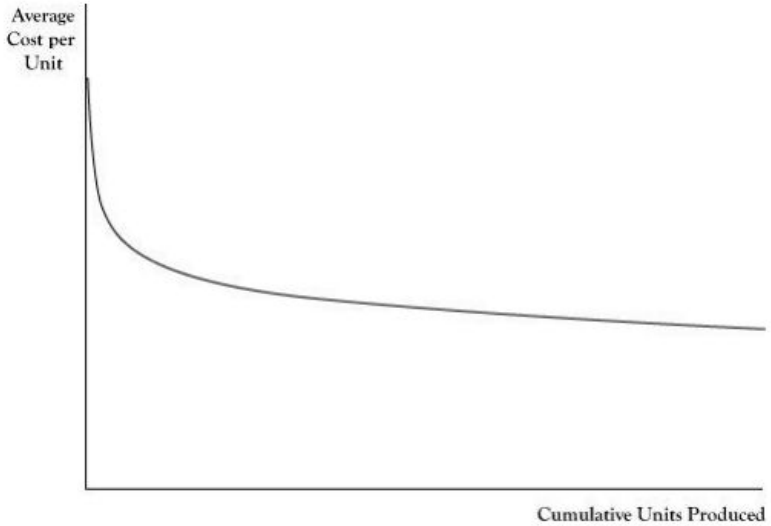
Beer Game:
Q5



- Move stations
- Reduce batch size
- Auto-inspect work - Jidoka (be able to remove dots)
- Balance workload (make all stations 100% flexible)
- Level production plan (Heijunka)
- Add click-guides to reduce defects - poka-yoke / error-proofing
- Kanban (pull-system)
- Reduce tool-changeover time (SMED)

Cost

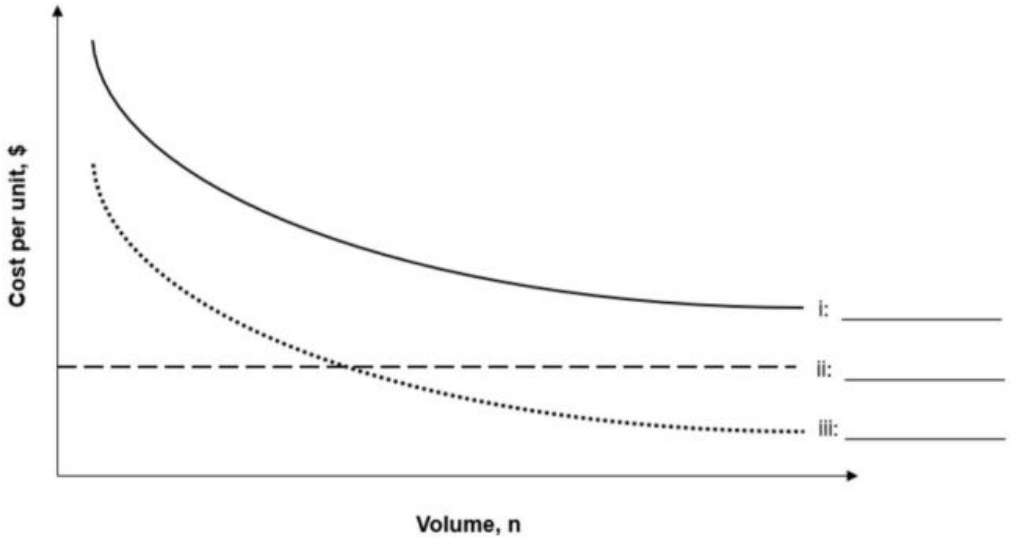
1) Know what the unit cost vs n plot looks like and why it gets its shape
2) Understand how to identify a fixed vs a variable cost for the manufacturing processes you've learned about



Short Answers to Review

Cost

a. A plot of cost per unit vs. volume for a typical part is shown below. The plot features 3 curves, label each curve with the correct title.



$$\frac{Total\ Cost}{n} = \frac{Fixed\ Cost}{n} + variable\ cost$$

- ☐ Total cost
- ☐ Variable cost
- ☐ Fixed cost

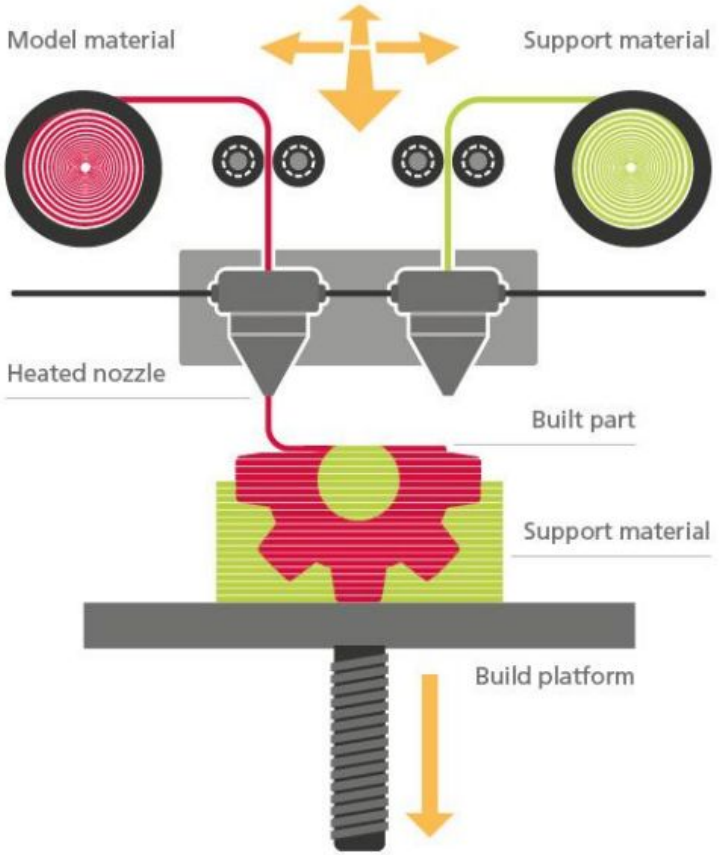
Manufacturing Systems

Consider a transfer line with a bottleneck machine and non-zero buffers. Given a choice of sequencing the machines differently, do you prefer the bottleneck to be the first machine or the last machine

1. First
2. Last
3. Doesn’t Matter

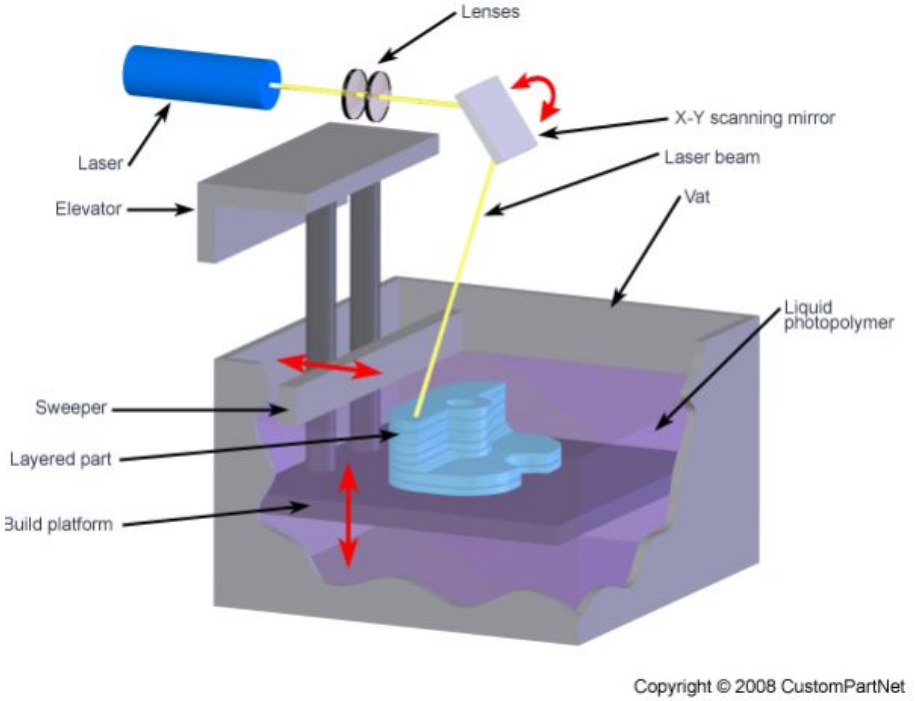
Additive Manufacturing

The layer thickness in a **Fused Deposition Modeling (FDM)** machine is determined by the extruder-die's [height / diameter / feed rate]



Additive Manufacturing

For **Stereolithography (SLA)**, a [ultraviolet / infrared / microwave] laser beam is focused on a selected surface area of the photopolymer and then moved around in the x-y plane to [melt / solidify] that cross-section of the part.



Bending

$$\frac{R_i}{R_f} = 4 \cdot \left(\frac{R_i}{t} \cdot \frac{Y}{E} \right)^3 - 3 \cdot \left(\frac{R_i}{t} \cdot \frac{Y}{E} \right) + 1$$

Y = Yield stress

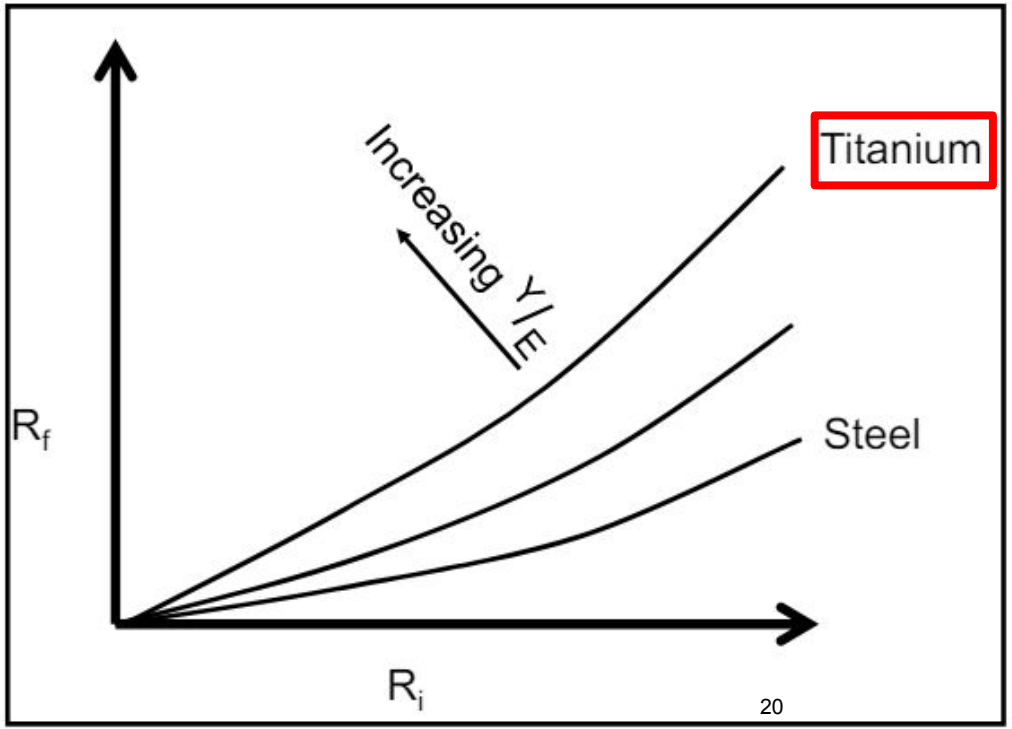
E = Young's Modulus

t = thickness

Springback Increases with:

1. Increasing Y
2. Increasing Ri/t
3. Increasing E
4. Increasing Y/E

Bending



Which material has more springback ?

$$\frac{R_i}{R_f} = 4 \cdot \left(\frac{R_i}{t} \cdot \frac{Y}{E} \right)^3 - 3 \cdot \left(\frac{R_i}{t} \cdot \frac{Y}{E} \right) + 1$$

2.008 Design and Manufacturing II

Spring 2025