# Problem 1

Tuesday, January 23, 2024   6:58 PM

A.

1. This regional sortation center in June 2016 at Commercenter Building # 29, Aurora, Colorado, USA, 80011- 8189.
2. 25 and usually just outside of major city centers like Denver Metro Area
3. 2 Delivery Stations near Cherry Hills and connected to C470, 25 and 88; Multiple fullfilment and sorting stations in low income areas that are cut by 470

Gives easy access to the richer neighborhoods of the Denver Metro Area and has two facilities within close proximity of each other. This likely indicates that one of these centers solely service the wealth Area
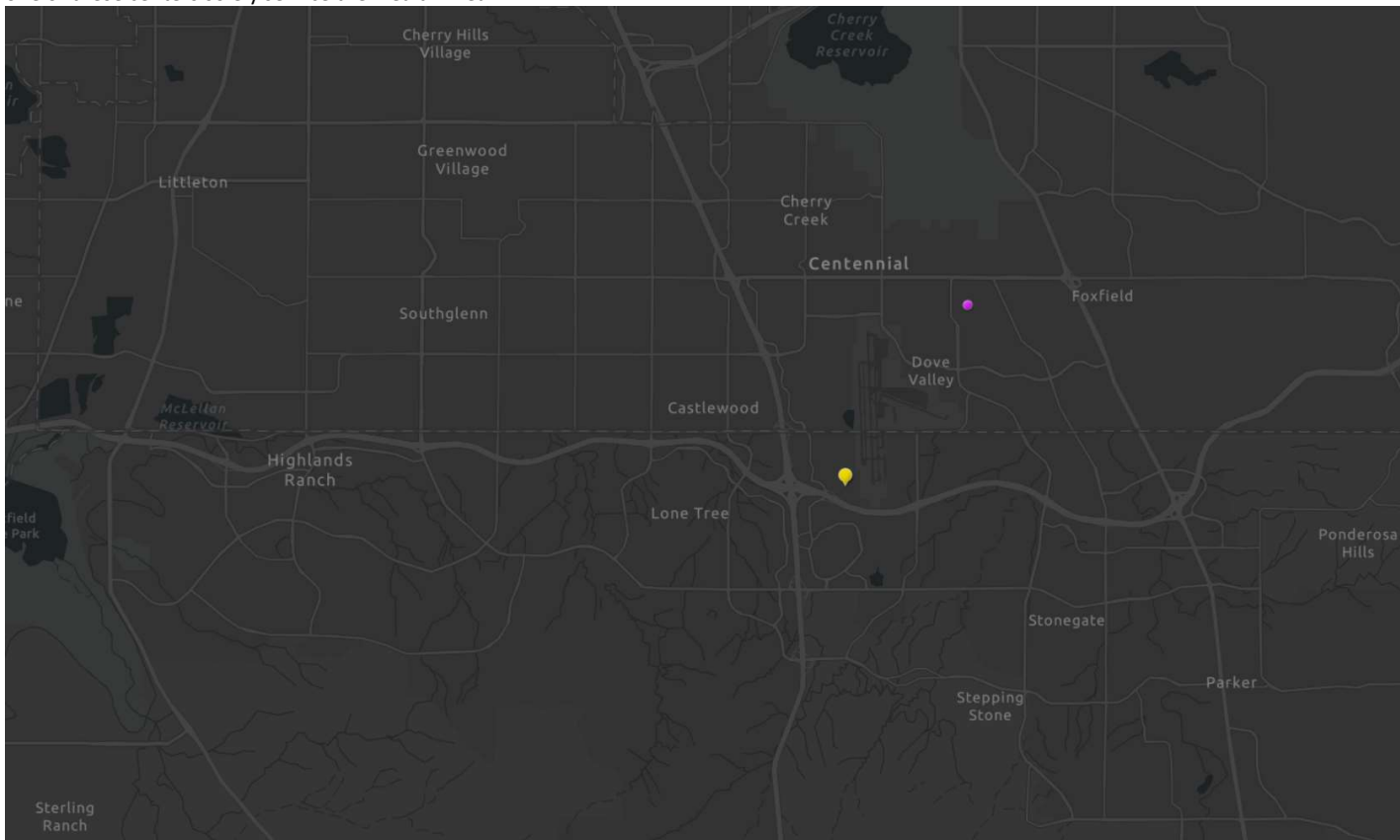
The rich people do not live anywhere near here according to people I know that grew up here. This area has two benefits. 1. easy access to 470 and other Denver metro Areas 2. no rich people to complain about ugly looking buildings.
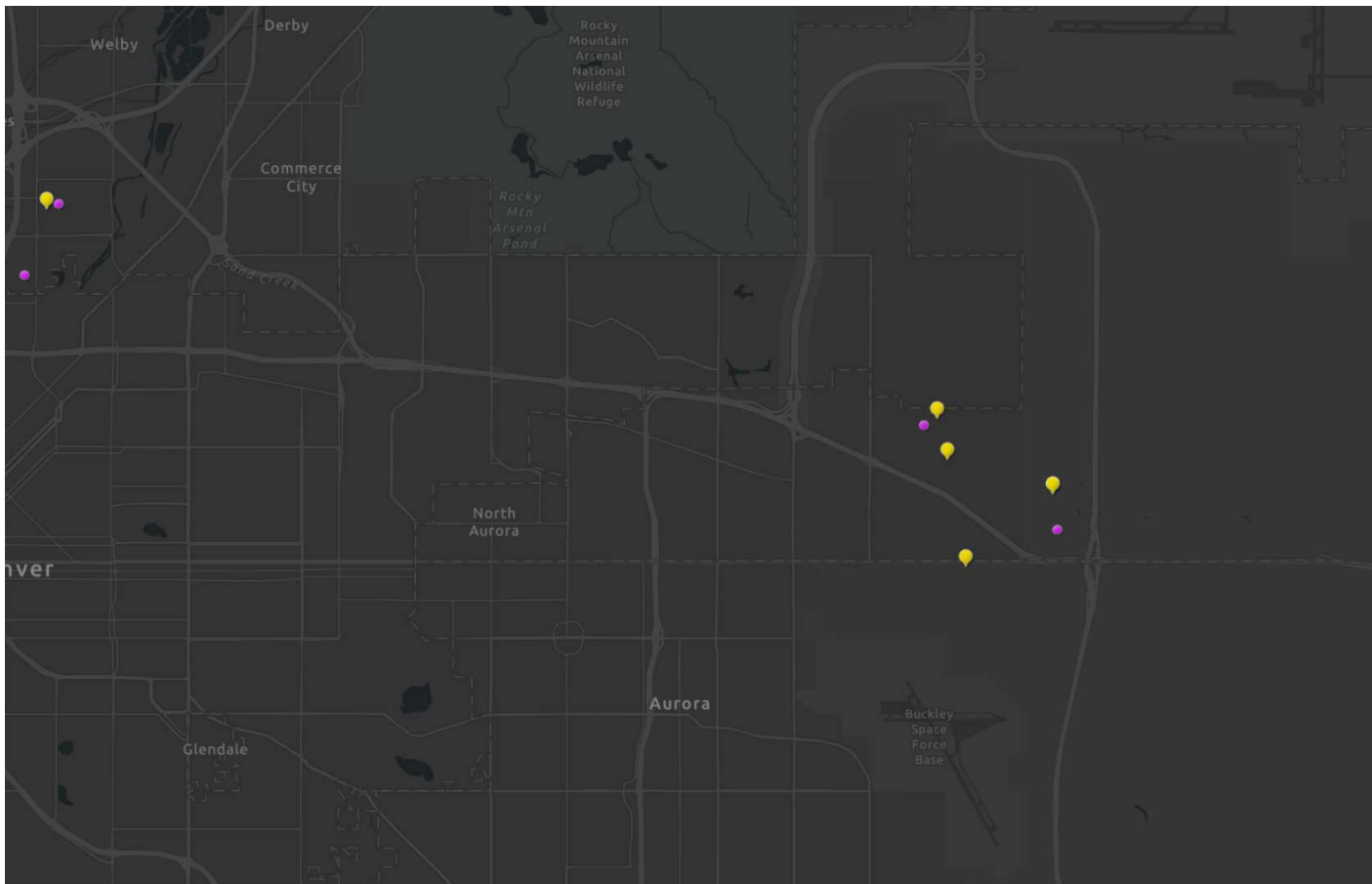
4. Most likely Arvada/Wheat Ridge since it will provide the same mixture of circumstances that the second screenshot provided. 1. No rich people to complain and 2. connected to major highways that can take you north, south, east and west into the mountains.

B. DC = Distribution Center := finished goods are stored and packed until they are picked up; FC = Fulfillment Center := place where 3rd party service processes and ships purchased product; IE := Region in Southern California; LA := Los Angeles; LB := Long Beach; TJ := Tijuana

C. Yea this is capitalism by definition. Amazon is always going to do what is best for their survival, much like any other organism. Although, they are creating situations that will generate a decrease in the average quality of service. Many companies like Amazon only focus on making the profits go boom without any long term planning for the area aroud them. It is unlikely that Amazon will stop on it's own without government intervention, so I do not see how not paying amazon will stop. The company is like a mythical hydra, it is going to regrow the head we just chopped off by boycotting prime.

Problem 2

- Worker Rate = $25.5/hr

- Cost start Part = $.18/hr

$T_o = 26 \sec$

$T_h = 5 \sec$

$T_{h'} = 2 \sec$

$T_C = 33 \sec$

a.) $\quad T_c = T_p \quad$ bc $\quad T_{su} = 0 \, \& \, Q = 1$

$\quad\quad T_p = .55 mn$

So, $\quad R_p = \dfrac{60}{\frac{33}{60}} = \dfrac{60^2}{T_p \, (sec)}$

$\dfrac{\$}{hr} \cdot \dfrac{1 hr}{60 min}$ $\quad\quad \boxed{R_p = 109.091 \dfrac{pc}{hr}}$

$C_{pc} = .18 \dfrac{usd}{pc} + \begin{pmatrix} 25.5 \\ + \\ 16.50 \end{pmatrix} \left(\dfrac{11}{20} \right) + 0$

$\boxed{C_{pc} = .565 \, \$/pc}$

$$\boxed{C_{pc} = .565 \ \$/PC}$$

b.)

$$T_p = 31 \text{ Seconds} \qquad C_t = \$8,000/yr$$
$$C_m = .18 \ \$/pc$$

$$C_L = \frac{1}{5}(25.5) = 5.1 \ \$/hr$$

$$8000 \ \frac{USD}{year} \cdot \frac{1 \ year}{365 \ Days} \cdot \frac{1 \ Day}{24 \ hrs} \cdot \frac{1 \ hr}{60 \ min} = .0152 \ USD/min$$

$$C_{pc} = .18 \ \$/pc + (5.1 + 16.5)\left(\frac{1}{60}\right)\left(\frac{31}{60}\right) +$$

$$\left(.0152\right)\left(\frac{31}{60}\right)$$

$$\boxed{C_{pc} = .3739 \ \$/pc} \qquad\qquad R_p = \underline{60}$$

c.)

$$T_p = \frac{31}{60} \min \cdot \frac{1 \ hr}{60 \ min} \cdot \frac{1 \ Day}{24 \ hrs} = 3.587963e\text{-}4$$
$$\text{Day}/pc$$

$$4 \cdot 10^4 = |C_{mpc} - C_{apc}|(t_?) \qquad R_p \frac{pc}{hr} \cdot \frac{24 \ hrs}{1 \ Day}$$

$$4 \cdot 10 = |C_{mpc} - C_{apc}|(t_?) \quad \cdots \text{hr} \quad 1 \text{Day}$$

$$[\$] = |[\$/pc]|\left[\frac{pc}{hr}\right][hrs]$$

$$4 \cdot 10^4 = \left(.1911467 \, \$/pc\right)\left(\frac{3600}{81}\left[\frac{pc}{hr}\right]\right)\left(t \, [hrs]\right)$$

$$\boxed{t_{BE} = 225.2488 \text{ Days} \quad \text{assuming 8hrs per day}}$$

Problem 3

Tuesday, January 23, 2024   6:58 PM

Engineering Economics: Invent your own product and imagine the surrounding production system. For each of (a-j) below, include visuals, additional external references, and a flowchart as useful for you to envision the hypothetical product being produced and the steps required.

1. How much will you pay your workers per hour? Provide a labor rate and write at least a sentence to justify the rate chosen. (Assume you are manufacturing in Colorado!) (2 pts)
    1. My factories would be fully automated to make a new camping spork.
    2. So I would at most need 1 person to just watch up to ten machines for critical failure. So $20/hr.

1. What do you estimate your labor overhead rate to be? Provide a percentage and explain what costs are included in labor overhead. (2 pts)
    1. $.002778/cycle that produces 10 pieces per cycle that lasts 5 seconds

2. What equipment is needed to create your parts? How many machines are involved in the process? What operations will they complete? For each machine needed, provide the machine's cost and an expected life for the machine, with expected life expressed in the number of parts it can make before wearing out or requiring maintenance. Include a link to a real machine to justify your cost and life estimates. Do you feel this is a conservative or aggressive estimate? Why? (5 pts)
    1. Only a punching machine plus feeding system costs about 30k USD and 1k per 12m belt
    2. https://zjkinglan.en.made-in-china.com/product/ENOQTRxVaokh/China-Jh21-Power-Press-Single-Crank-C-Frame-Sheet-Metal-Punching-Machine-for-Sale.html
    3. https://bifa88.en.made-in-china.com/product/eBsxbXYGnFrU/China-Bifa-12-Meter-Belt-Conveyor-Production-Line-Conveyer-for-Bulk-Material.html
    4. No information given besides warranty so product life is assumed to be 2 years which is double service and about the warranty given.
    5. It is a mix of conservative and aggressive. Most Americans do not look at the wholistic product. Thus the combination allows for companies to aggressively focus on what Americans are looking for so they can skimp on other areas.

3. For each machine/operation listed in part c), estimate the cost rate and the applicable equipment overhead rate. Provide written explanation for what each machine does and how you came up with values for cost rate and equipment overhead rate. *(Note: you can have a very simple product which only requires one operation and machine, or a more complex product with multiple operations/machines.)* (6 pts)
   1. The punching machines take the sheet metal and make the sporks and the conveyers move the products to and from the factory line. Assuming each thing breaks immediately after warranty expiration, the total product cost can range to about 34K USD every two years which reduces to about 17K USD per year in equipment overhead.
4. For each machine and operation listed in part c), describe the steps required to process a part from start to finish. Include loading and unloading parts into the machine as individual steps. For each step, report the time required and provide the sum total (loading, processing, unloading) as the cycle time for each machine/operation. Do you feel this is a conservative or aggressive estimate? Why? (8 pts)
   1. The machines acquired can produce 500 sporks per month which seems extremely conservative. Each day the factory should need about 5 minutes for every ten machines to attain a continuous distribution of metal to the punchers.
5. What material is your product made of? Estimate the cost per piece of starting material, providing a reference link to justify your cost estimate. Is this an over- or under-estimate? Why? (6 pts)
   1. https://www.scrapgators.com/stainless-steel-price-per-pound/ claims that most stainless steels cost less than two dollars per pound. So it costs at most a dollar worth of steel to have enough material for 9 sporks. So this is good!
6. How many days per year and hours per day will your production run? How many hours per day will you pay your workers for? *(Note: consider how many paid breaks your workers will get during an 8-hour shift.)* (3 pts)
   1. There will be about a total of 244 man hours per machine per year including paid hour per person hired. Assuming there is at minimum 1 person always present and 1 person taking a lunch 1 hour per day.
7. Based on parts a-g, calculate:
   1. average production rate (1 pt)
      i. 500 sporks per month according to the vendor
   2. cost per part produced, assuming that you make the quantity of parts identified in part c) as the working life of your most fragile machine (5 pts)
      i. making some assumptions on days in a month and assuming one person can handle ten machines. The cost shakes out to about $3.7

USD per part

3. For your production process, estimate availability (must be less than 100%) and scrap rate (must be greater than zero). Describe the impact on average production rate and cost per part produced (you do not need to recalculate, just describe in words). (3 pts)
    i. I would imagine a scrap rate of about 10-20 percent.
    ii. There will always be machines running but in terms of available max strength, I would say is about 80%
    iii. This will lower the overall number of produced sporks and could endure more overhead cost on equipment if 3rd party services are needed for maintenance.
    iv. The average rate would increase.

4. Comment on your calculations. Is this a realistic cost per part produced? What is not included in your cost breakdown? How could you make this more accurate? (3 pts)
    i. For a single packaged spork this is kind of high, but there are plenty of people who over pay for utensils with the proper marketing.
    ii. Administrative and other non-manufacturing costs are not considered. Electricity and Energy Bills are an example as well as my salary and the book keeper's salary.
    iii. I would need to factor in logistical costs from the supply chain primarily.

Problem 4

Materials Science:

A. There are several variations of Al 6061. What is the difference between Al 6061-O, 6061-T4 and 6061-T6 variations? How were each of these types of aluminum processed? What are each of these materials used for? Use matweb.com to find information on these materials (and use this resource for the rest of class). (1 pt)

   a. T4 Temper - Natural Aging. Used in Aircraft fittings, camera lens mounts, couplings, marines fittings and hardware, electrical fittings and connectors, decorative or misc. hardware, hinge pins, magneto parts, brake pistons, hydraulic pistons, appliance fittings, valves and valve parts.
   b. T6 Temper - Artificial aging for max strength. Used in Aircraft fittings, camera lens mounts, couplings, marines fittings and hardware, electrical fittings and connectors, decorative or misc. hardware, hinge pins, magneto parts, brake pistons, hydraulic pistons, appliance fittings, valves and valve parts; bike frames.
   c. O Annealed - Max Ultimate Tensile strength. Used in Aircraft fittings, camera lens mounts, couplings, marines fittings and hardware, electrical fittings and connectors, decorative or misc. hardware, hinge pins, magneto parts, brake pistons, hydraulic pistons, appliance fittings, valves and valve parts.

A. If a ferrous alloy has been quenched, what is a secondary process that can be used to enhance the toughness of the material? (2 pts)
   a. Tempering

B. What is the difference in melting characteristics between a pure metal element and a metal alloy? (1 pt)
   1. There should exist only one melting point for pure metals. Alloys, have a range of melting points that can better aid in changing the structure of the alloy.

C. Provide an example of when high thermal conductivity is desirable and provide an example of when it is not desirable. Please provide justification

for your responses. (3 pts)
1. High thermal conductivity has good use in heat-sink cooling applications.
2. High thermal conductivity is bad in thermoses, since the idea is to keep the liquid as warm as possible for as long as possible. Bad thermal conductivity will slow down the internal cooling time of the Thermos.

D. What is precipitation hardening? What types of metals can be treated via precipitation hardening? What are the three processing steps in precipitation hardening? What is the difference between natural aging and artificial aging in precipitation hardening? (7 pts)
1. Also known as age Hardening and is a heat treatment technique where it is heated and aged at a higher temperature than other processes
2. Al, Ti, Cu, Stainless and other steels, some alloys that involve nickel
3. 1. Solutionizing- Melt to single phase solid; 2. quench; 3. Aging- then age at a lower temperature than the melting temp used for a long time.
4. Natural aging refers to using the longer cooling time and ambient room or environment temperature used to age a material whereas artificially aging it happens at a high temps like 200 deg Celsius for shorter time