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**Name: (please print)      SOLUTION**

**Quiz 1**  
**Process Analysis, Capacity Management, and Little's Law**  
**BUAD311 – Operations Management**  
**Fall 2014**

Time: 20 minutes

There are three pages, including this page. All together the quiz has a maximum of 40 points.

This is a closed-book closed-notes quiz.

You are allowed to use one double-sided crib sheet (8.5x11).

You may use a simple calculator.

No laptops. No PDAs. No cell phones.

You may receive partial credit unless otherwise noted. Show your work and write legibly.

Do not be tempted to seek "inspiration" from a neighbor's quiz. Poor scores can be overcome, but cheating will be dealt with harshly!

Please sign here to indicate that you have adhered to university policies regarding ethical behavior in preparing for and completing this quiz.

"I hereby certify that I have adhered to the university policies regarding ethical behavior in preparing for and completing this quiz."

1. Kristen's cousin Casey started a small local make-to-order orange juice company with 4 employees. Assume that the oranges have been pre-washed and pre-peeled and there are many electric juicers and juice boxes. The orange juice making process has the following steps:

**[Wash & Load]** It takes Employee #1 1.5 minutes to wash and load the electric juicer, which can hold up to 100 oz of oranges.

**[Extract]** Each electric juicer, operated by Employee #2, extracts 100 oz of oranges into 50 oz of juice in 30 seconds.

**[Filter]** Employee #3 then filters the orange juice into a large container. This takes 1 minute.

**[Package]** Employee #4 pours the juices into juice boxes. She then seals the juice boxes. Each juice box contains 50 oz of orange juice. It takes Employee #4 2.5 minutes to pack and seal every juice box.

**[Payment]** Casey accepts the payment and delivers the order at the counter. This takes 1 minute.

- (a) (5 points) Draw the process flow chart for Casey's orange juice business.



- (a) (5 points) Suppose each customer orders 1 juice box. Calculate the flow time of the entire process in minutes.

$$\text{Flow time} = 1.5 + 0.5 + 1 + 2.5 + 1 = 6.5 \text{ min}$$

- (b) (10 points) Which step is the bottleneck, and why?

Each order (50 oz of juice) requires 100 oz of oranges.

Cycle time of Washing & Loading =  $(1 \text{ min} / 100 \text{ oz}) * (100 \text{ oz} / \text{order}) = 1.5 \text{ min/order}$

→  $\text{Cap} = (1/1.5) * 60 = 40 \text{ orders/hr}$

Cycle time of Juicer = 0.5 min/order

→  $\text{Cap} = (1/0.5) * 60 = 120 \text{ orders/hr}$

Cycle time of Filtering = 1 min/order

→  $\text{Cap} = (1/1) * 60 = 60 \text{ orders/hr}$

Cycle time of Packaging = 2.5 min/order

→  $\text{Cap} = (1/2.5) * 60 = 24 \text{ orders/hr}$

Cycle time of Payment = 1 min / order

→  $\text{Cap} = (1/1) * 60 = 60 \text{ orders/hr}$

Packaging (employee #4) is the bottleneck because it has the longest cycle time or the lowest capacity.

- (c) (5 points) What is the capacity of Casey's orange juice business in orders per hour?

From (b) above, Casey's capacity or System capacity = B' neck capacity = 24 orders/hr

Alternately,

Capacity =  $1 / \text{cycle time of bottleneck} = 1 / 2.5 = 0.4 \text{ order/min} = 24 \text{ orders/hr}$

- (d) (5 points) If Casey only opens her business for 5 hours every day, how many orders can she fulfill daily? (You may allow for a fractional order.)

5 hours = 300 minutes

Cycle time of the entire process is determined by the bottleneck – packaging. So it is 2.5 min.

Total number of orders =  $(300 - 6.5) / 2.5 + 1 = 118.4 \approx 118$

- (e) (5 points) If Casey cross-trains all her employees (including herself), what is the capacity of Casey's orange juice business in orders per hour?

The average cycle time is now  $6.5 / 5 = 1.3 \text{ min}$

The capacity is  $60 / 1.3 = 46.15 \text{ orders per hour}$

Alternately, CT of one person = 6.5 mins  $\rightarrow$  cap =  $(1 / 6.5) * 60 \text{ orders/hr}$

Cap of firm = 5 workers \*  $(1 / 6.5) * 60 = 46.15 \text{ orders/hr}$

2. A local fast food restaurant offers both dine-in service and drive-through service. 60% of its customers are dine-in customers, the other 40% are drive-through customers.

- (a) (5 points) Suppose on average, it takes a drive-through customer 3 minutes to get his/her order, and there are on average 6 drive-through customers at any point of time waiting in the drive-through lane. What is the arrival rate of the drive-through customers in customers per minute?

FT = 3 min

WIP = 6

FR =  $WIP / FT = 6 / 3 = 2 \text{ customers/min}$

- (b) (5 points) There are 30 customers in the dining area any point in time. How many minutes, on average, does each dine-in customer spend in the restaurant?

FR = Arrival rate of the dine-in customers =  $(\text{FR of drive-through customers} / 40\%) * 60\% = 3 \text{ customers/min}$

WIP = 30 customers

FT =  $WIP / FR = 30 / 3 = 10 \text{ min}$