## Submarine sandwich and subs

## PROCESS CAPACITY ANALYSIS-SOLVED PROBLEM Daffy Dave’s Sub Shop

 makes custom submarine sandwiches to order. They are analyzing the processes at their shop. The general flow of the process is shown below. There is a separate person working at each of the steps in the process. Slice the Bun and Add the Meat/Cheese Slice the Bun and Add the Meat/Cheese Add the Toppings and Condiments Add the Toppings and Condiments Bag the Order Bag the Order Take the Order Take the Order 1 minute/order 3 minutes/order 4 minutes/order 2 minutes/orderDaffy Dave wants to figure out the following for a typical 8-hour work day. a. What is the current maximum output of the process? b. If we add another person, where would we add him or her and what is the benefit? c. Is there a benefit if we can shift 1 minute from Bun and Meat to Order Taking? Assume we do not make the change in part $b$ above. $d$. Is there a benefit if we shift 1 minute of work from Condiments to Bagging? Assume we do not make the change in parts b and c above. Solution a. Maximum output is 120 subs per day.

OPERATION OUTPUT Take Orders (60 min. per hour/1 min. per order) *8 hours $=480$ subs per day Bun and Meat ( 60 min . per hour/3 min. per order) *8 hours $=160$ subs per day Toppings/Condiments ( 60 min . per hour/4 min. per order) $* 8$ hours $=120$ subs per day Bag the Order ( 60 min. per hour/2 min. per order) $* 8$ hours $=240$ subs per day Output per day is determined by the slowest station; therefore, we can only produce 120 per day because that is the limit of the Toppings/Condiments station (the bottleneck).

NOTE: to be more precise, we should consider the throughput time of the very first sandwich ordered. The total throughput time for anyone sandwich is $1+3+4+2=10$ minutes. In 8 hours, there are 480 minutes. So, from the time that Dave opened, the first sandwich would be " off the line" 10minutes after opening. This would leave 470 minutes to go. $470 \mathrm{~min} / 4 \mathrm{~min}$ per order $=117.5$. Rounding this to 118 , then adding the first sandwich, gives a total of 119 (versus 120). In this case, the difference is negligible.

In other situations, where throughput time is significant relative to the total operating time, the difference in total output could be very significant. b. Dave should add the person to the slowest station (Condiments/Toppings) since it is the bottleneck. OPERATION OUTPUT Take Orders480 subs per day Bun and Meat160 subs per day Toppings/Condiments120 $* 2=240$ subs per day Bag the Order240 subs per day The impact is not a very big one. Even though the Toppings/Condiments station now can do 240 subs per day, the Bun and Meat station can only do 160, so that is the maximum output.

In effect, Dave increased the capacity of step 3, which shifted the bottleneck to step 2. c. Order Taking station will go from 1 minute to 2 minutes, and Bun and Meat goes from 3 minutes to 2 minutes. OPERATION OUTPUT Take Orders (60 min. per hour/2 min. per order) ${ }^{*} 8$ hours $=240$ subs per day Bun and Meat ( 60 min . per hour/2 min. per order) $* 8$ hours $=240$ subs per day Toppings/Condiments (60 min. per hour/4 min. per order) *8 hours $=120$ subs per day Bag the Order ( 60 min . per hour/2 min. per order) $* 8$ hours $=$ 240 subs per day

There is no benefit to this change. Dave can still only make 120 subs per day since we can only produce 120 per day because that is the limit of the Toppings/Condiments station. In other words, if we don't affect the output rate of the bottleneck, the capacity of the process does not change. d . Toppings/Condiments station will go from 4 minutes to 3 minutes, and Bagging goes from 2 minutes to 3 minutes. OPERATION OUTPUT Take Orders (60 min. per hour/1 min. per order) $* 8$ hours $=480$ subs per day Bun and Meat ( 60 min . per hour/3 min. er order) *8 hours $=160$ subs per day Toppings/Condiments (60 min. per hour/3 min. per order) *8 hours $=160$ subs per day Bag the Order (60 min. per hour/3 min. per order) *8 hours = 160 subs per day There is a benefit to this change. Dave can now make 160 subs per day. This will provide the same benefit as hiring another worker. However, if Dave wants to increase output further, he will have to hire some additional staff. In this case, the proposed change does affect the bottleneck so that process capacity does increase.

