

Capacity and Constraint Management Exercises

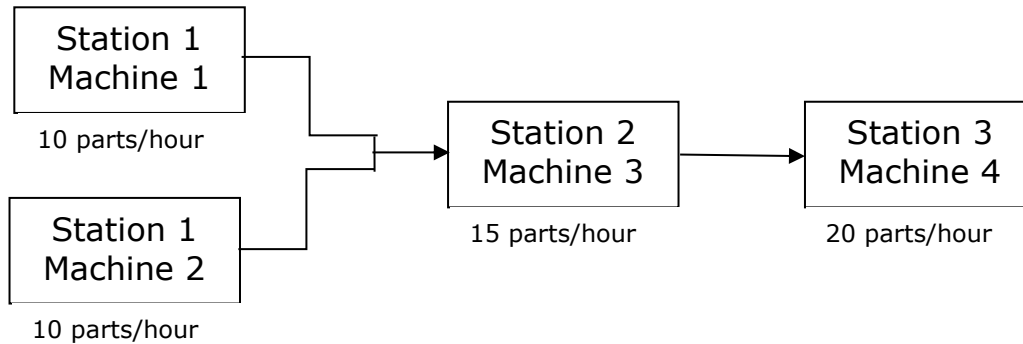
CCM-1. DOCEMEL produces gourmet jams. Currently, the company produces five different kinds of jams that are sold in 250 grams jars. The production process of jam is divided into 4 distinct phases, according with the following table:

	Capacity/machine/Hour	No. of machines
Phase 1	25,000 grams	1
Phase 2	15,000 grams	2
Phase 3	12,000 grams	3
Phase 4	110 jars	1

The company works 8 hours per day. Assume that: the yield in each phase is 100%; there are no stoppages; stock cannot be accumulated between the different phases of the process; there are no losses along the production process; the capacity of the machines is the same for all kind of jam. Currently, the company produces 780 jars per day.

- Which of the phases represents the “bottleneck” operation of the jam production process at DOCEMEL?
- What is the efficiency of the production process of jam?
- What is the effective capacity of Phase 3?
- What is the capacity utilization of the machine installed at Phase 4?
- What is the cycle time of the production process of jam?

CCM-2. METALCAR produces parts for the automotive industry. The following figure shows one of its assembly lines, a 3-station assembly line where the two machines at station 1 are parallel. The product only needs to go through one of the 2 machines before proceeding to Station 2.



- What is the "bottleneck" station of this assembly line?
- What is throughput time?
- If METALCAR operates 8 hours per day, 5 days per week, what is the weekly capacity of this assembly line?

CCM-3. DOUROVINHO has a bottling process that has five distinct operations:

Operation	Description	Yield	Process time for 100 bottles (in seconds)	Number of machines
1	Washing	95%	60	3
2	Bottling	93%	40	1
3	Inspection of bottling (quantity)	99%	20	2
4	Closing	91%	30	4
5	Packaging	95%	60	5

- Identify the bottleneck for the bottling process at DOUROVINHO.
- Assuming that all operations operate at 100%, what is the process time for a lot of 100 bottles?
- Based on the processing of a lot of 10.000 bottles to start with, how many bottles would represent the output at the end of the process?
- Assume that it is now possible to increase the 'yields' of all the operations by 100%. What is the maximum number of bottles per hour that it is possible to process?

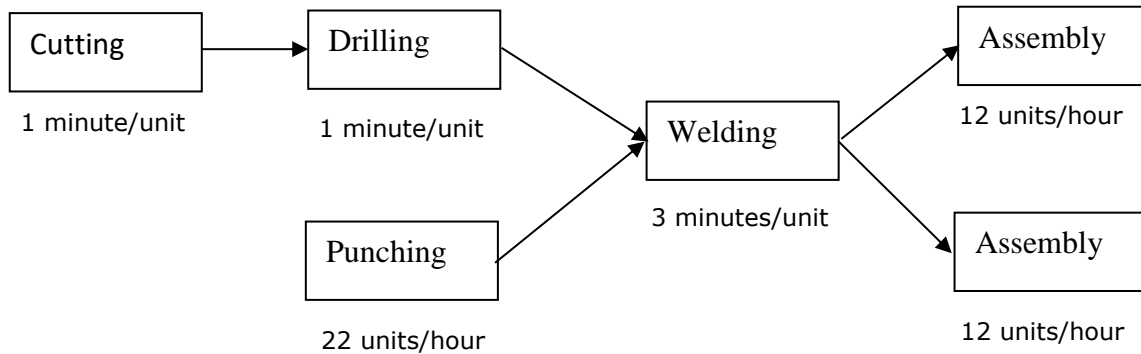
CCM-4. SOFTGILLETTE produces razor blades that are compatible with a large number of razors available on the market. The production line is composed of four distinct stages. The first two stages, which are totally automatic, assure the production of razor blades. Stage 1 has two machines, with the capacity to produce 10,000 units per day each. Stage 2 has one machine, with capacity to produce 10,000 units per day. A quality inspection is made during Stage 3, which is semi-automatic, with each batch of 10 razors takes 15 seconds to inspect. Stage 4 is the packaging process, which uses a machine capable of processing 15,000 units per day (consider an 8 hours/day).

- a) Draw a process flow diagram.
- b) Identify the bottleneck and point out the maximum number of units that SOFTGILLETTE is able to produce in a day.
- c) The capacity utilization of stage 1 is just 45%. The supervisor of this section is concerned about the Production Manager's reaction after receiving the performance indicators for this process.
 - c.1. Considering the capacity utilization of Stage 1, determine the number of units produced each day.
 - c.2. Do you think that the Stage 1 supervisor has reasons to be worried? Justify your answer?
 - c.3. However, the Stage 1 supervisor is happy with the quality indicator for the yield of this stage which was 0.9. The yield for each of the remaining stages was the same. As a Production Manager, how would you react to this information?
- d) In response to an increase in demand, SOFTGILLETTE is considering purchasing a second-hand machine, with 90% capacity of the one currently installed, in order to establish parallel production for Stage 2. The payback study indicates that an increase of daily production of 6,000 units would be necessary to compensate for the investment. In your opinion, should SOFTGILLETTE purchase this machine, or not?

CCM-5. BAC – Biological Agriculture Company, packages biological vegetables and fruit in southern Portugal, mainly corn (maize). The packaging of corn involves four phases before it reaches the retailer. The First Phase is washing, where the corn cobs are washed with a special liquid to make the corn cobs brighter and free of any microorganisms. This phase is performed by two machines, each of which has the capacity to wash 100 corn cobs every 4 minutes. The Second Phase is drying. This phase is performed by one machine only, with a capacity to dry 200 corn cobs per session, each session lasting 4 minutes. The drying machine needs maintenance every 1.5 hours, which takes 6 minutes. Next, the corn cobs are packed by 25 employees in packages of 2 corn cobs each. Each employee takes 1 minute per pack. Finally, the packages are labelled by one special machine, which has the capacity to label 10 packages in 15 seconds. BAC works 8 hours a day. Stock cannot be accumulated between the different phases of the process.

- a) Draw the process flow diagram.
- b) Identify the bottleneck and calculate the number of packages it is possible to produce per day.
- c) Could the capacity be increased if it were possible to accumulate stock between the different phases of the process? Justify.
- d) If BAC produces 11,000 packages of corn cobs per day, what is the capacity utilization for each phase?
- e) The production manager identified a yield of 0.9 for the First Phase, and a yield of 0.85 for all the other phases. BAC rewards all employees when the overall yield of the process is above 0.8. Thus, the production manager wants to reward all the employees involved in this process. Do you agree?

CCM-6. TECNIMETAL is a metalworking company with multiple production lines. The production process at line 1 is shown in the following figure:



The punching operation occurs separately from, and simultaneously with, the cutting and drilling operations. A product need to go through only one of the two assembly operations. Assume that: the company works 8 hours per day (from 8 a.m. to 4 p.m.); the yield in each phase is 100%; there are no stoppages; stock cannot be accumulated between the different phases of the process. Currently, the company produces 144 units/day.

- What operation is the bottleneck?
- What is the daily capacity of this production process?
- What is the throughput time of the overall system?
- What is the capacity utilization of the cutting machine?
- What is the efficiency of this production process?
- Suppose now that: it is only possible to have work-in-process inventory before the Welding machine; the maintenance of the Punching machine takes 60 minutes and starts at 1 p.m.; at the end of the day the level of inventory is equal to zero. What is the new daily capacity of the process?

Multiple choice questions

1. The ORANGE produces natural orange juice. The orange juice is bottled in 0.5 liters bottles. The production process is divided into 4 distinct phases, in accordance with the following table:

	Capacity/Machine/Hour	No. of machines
Phase 1	1,000 liters	2
Phase 2	1,900 liters	1
Phase 3	750 liters	3
Phase 4	4,200 bottles	1

The company works 8 hours a day. Assume that: the yield in each phase is 100%; there are no stoppages; stock cannot be accumulated between the different phases of the process; there are no losses along the production process.

What is the daily production capacity of ORANGE?		
1	<input type="checkbox"/>	6,000 liters
2	<input type="checkbox"/>	15,200 liters
3	<input type="checkbox"/>	16,800 liters
4	<input type="checkbox"/>	18,000 liters

If the company produces 15,000 liters per day, what is the utilization rate of the machine at Phase 4?		
1	<input type="checkbox"/>	98.7%
2	<input type="checkbox"/>	89.3%
3	<input type="checkbox"/>	83.3%
4	<input type="checkbox"/>	100%

Assume that the processing at Phase 1 is interrupted 30 minutes a day to perform preventive maintenance. Which of the phases represents the "bottleneck" operation of the orange juice production process?		
1	<input type="checkbox"/>	Phase 1
2	<input type="checkbox"/>	Phase 2
3	<input type="checkbox"/>	Phase 3
4	<input type="checkbox"/>	Phase 4

2. The production process of DEBULHA is comprised of four distinct phases, in accordance with the following table:

Phase	Capacity/machine/hour	No. of machines
Phase 1	110 units	1
Phase 2	80 units	2
Phase 3	180 units	1
Phase 4	96 units	1

What is the cycle time of the production process of DEBULHA?		
1	<input type="checkbox"/>	22.5 seconds
2	<input type="checkbox"/>	37.5 seconds
3	<input type="checkbox"/>	20 seconds
4	<input type="checkbox"/>	None of the above

Assuming that the company works 8 hours a day, and that the machine used in Phase 1 requires 2 hours of maintenance a day, what is the daily production capacity of DEBULHA?		
1	<input type="checkbox"/>	660 units
2	<input type="checkbox"/>	1,440 units
3	<input type="checkbox"/>	1,280 units
4	<input type="checkbox"/>	None of the above

3. GELI produces iced yoghurts, with three different flavors. Production process is divided into 4 phases, in accordance with the following table:

	Capacity/Machine/Hour	No. of machines	Yield
Phase 1	100 liters	4	95%
Phase 2	150 liters	2	90%
Phase 3	125 liters	4	94%
Phase 4	280 liters	1	90%

The company works 8 hours a day.

Assume that there are no breaks or stoppages:

Which of the phases represents the "bottleneck" operation of the iced yoghurts production process at GELI?		
1	<input type="checkbox"/>	Phase 1
2	<input type="checkbox"/>	Phase 2
3	<input type="checkbox"/>	Phase 3
4	<input type="checkbox"/>	Phase 4

If the company produces 2,100 liters per day, what is the utilization rate of the machine at Phase 4?		
1	<input type="checkbox"/>	87.5%
2	<input type="checkbox"/>	93.8%
3	<input type="checkbox"/>	93.3%
4	<input type="checkbox"/>	100%

What is the yield of the iced yoghurt production process at GELI?		
1	<input type="checkbox"/>	72.33%
2	<input type="checkbox"/>	90.00%
3	<input type="checkbox"/>	95.00%
4	<input type="checkbox"/>	92.25%

Assume that the processing at Phase 2 is interrupted for 30 minutes to clean the machines each time the production of a different flavor is started, and that at the end of the day the machines are left clean for the next day.

What is the daily production capacity of GELI?		
1	<input type="checkbox"/>	2,400 liters
2	<input type="checkbox"/>	800 liters
3	<input type="checkbox"/>	1,950 liters
4	<input type="checkbox"/>	4,000 liters

4. The company BERRIES exports red fruits for several countries. The production process is divided into four phases:

	Capacity/machine
Washing	270 units every 5 minutes
Drying	200 every 5 minutes
Packaging	40 packages of two units every minute
Labeling	30 packages of two units every minute

Assume that the company operates 8 hours/day. Assume that the yield in each phase is 100%; stock cannot be accumulated between the different phases of the process; and that there are no o breaks or stoppages.

Which of the phases represents the “bottleneck” of the production process of BERRIES?		
1	<input type="checkbox"/>	Washing
2	<input type="checkbox"/>	Drying
3	<input type="checkbox"/>	Packaging
4	<input type="checkbox"/>	Labeling

If the company produces 6,000 packages per day, what is the utilization rate of the washing machine?		
1	<input type="checkbox"/>	46.3%
2	<input type="checkbox"/>	28.4%
3	<input type="checkbox"/>	41.7%
4	<input type="checkbox"/>	62.5%

Assuming that the company purchased a new drying machine, how much would increase the capacity of the production process?		
1	<input type="checkbox"/>	There would be no change
2	<input type="checkbox"/>	19,200 packages per day
3	<input type="checkbox"/>	9,600 packages per day
4	<input type="checkbox"/>	3,360 packages per day