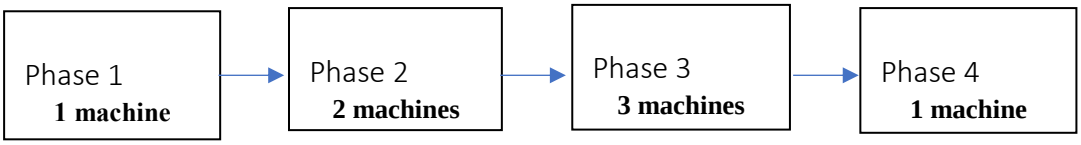
Capacity and Constraint Management Exercises Solutions

CCM1.



Phase 1: 25,000 grams/machine/hour

100 jars/hour ⇒ 800 jars/day

Phase 2: 15,000 grams/machine/hour*2 machines = 30,000 grams/hour

120 jars/hour ⇒ 960 jars/day

Phase 3: 12,000 grams/machine/hour*3 machines = 36,000 grams/hour

144 jars/hour ⇒ 1152 jars/day

Phase 4: 110 jars/hour ⇒ 880 jars/day

a) The "bottleneck" operation is operation 1 (phase 1).

b) Actual output = 780 jars/day

Efficiency of the process = Actual output/ effective capacity of the bottleneck =780/800 = 0.975

c) Effective capacity of phase 3 is 800 jars/hour.

d) Capacity utilization of the machine installed at Phase 4 is given by:

Actual output/ design capacity of phase 4 = 780/880 = 0.8864

e) Cycle time of the process = 1/(capacity of the process) = 1/800 * (8*60*60) = 36 seconds

CCM2.

a)
Station 1: 20 parts/hour
Station 2: 15 parts/hour
Station 3: 20 parts/hour
The bottleneck is station 2.

b) The throughput time is ➔ 6 + 4 + 3 = 13 minutes

c) The weekly capacity is 8 hours/day × 5 days/week × 15 parts/hour = 600 parts/week

CCM3.

a) The process bottleneck corresponds to the task with the longest cycle time. The cycle time for each operation (work station) is given by:

Operation	Process time for 100 bottles (in seconds)	Number of machines	Cycle time
1	60	3	(60/3) = 20 sec
2	40	1	(40/1) = 40 sec
3	20	2	(20/2) = 10 sec
4	30	4	(30/4) = 7.5 sec
5	60	5	(60/5) = 12 sec

The process bottleneck is operation 2 (Bottling).

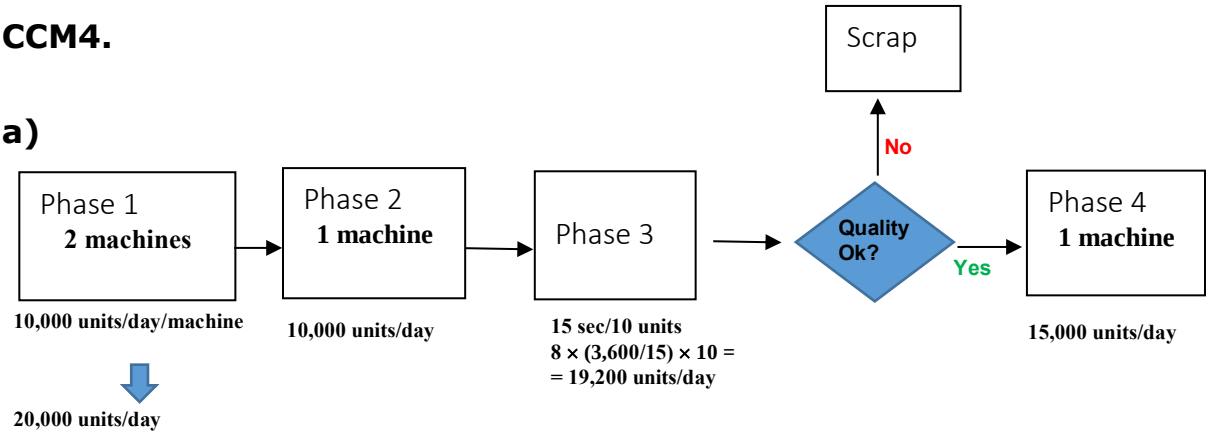
b) The throughput time of a lot of 100 bottles is equal to (60 sec+ 40 sec+ 20 sec + 30 sec + 60 sec) = 210 seconds

c) Global yield = (0.95 × 0.93 × 0.99 × 0.91 × 0.95) = 0.7561. Thus, the output at the end of the process is equal to: 10,000 × 0.7561 = 7,561 bottles.

d) The capacity of the bottleneck defines the capacity of the entire process. Thus, the maximum number of bottles per hour that it is possible to process is equal to: (100 × (3,600/40)) = 9,000 bottles.

CCM4.

a)



b) The bottleneck of the process is the stage 2. Thus, the maximum number of units that SOFTGILLETTE is able to produce in a day 10,000 units.

c)

c1) The capacity utilization is given by (actual output /design capacity) $\Rightarrow$ actual output = (0,45$\times$ 20,000) = 9,000 units.

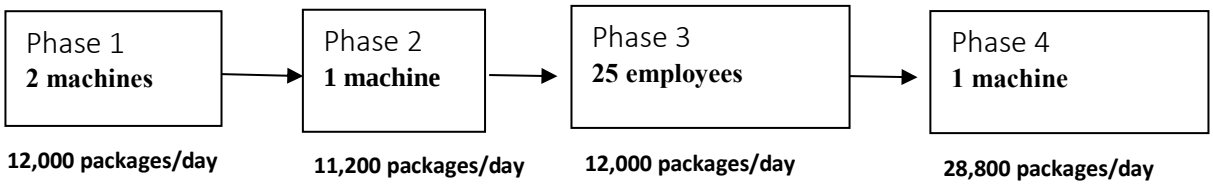
c2) No, because the maximum number of units that SOFTGILLETTE is able to produce in a day is 10,000 units. Consequently, the capacity utilization of stage 1 could only increase to 50%.

c3) As Production Manager you would be dissatisfied since the global yield is only 0,6561 ($0,9^4$).

d) The company should not acquire the new machine. The acquisition of the new machine does not allow an increase in daily production of 6,000 units. The new bottleneck is stage 4.

CCM5.

a)



Phase 1: 100 corn cobs/4 min/machine ⇒ 100*(60/4)*2 = 3,000 corn cobs /hour ⇒ 3,000 corn cobs/hora*8 hours = 24,000 corn cobs /day = 12,000 packages/day

Phase 2: 200 corn cobs/4 min/machine ⇒ 480 min [8h*60m]/(90+6) = 5 cycles ⇒ Available time = 480 – (5 cycles*6 minutes) = 450 minutes ⇒ 450/4 = 112.5 cycles ⇒ 112*200 = 22,400 corn cobs/day =11,200 packages/day

Phase 3: 1min/package/employee ⇒ (60/1)*25*8 = 12,000 packages/day

Phase 4: 15 sec/15 packages ⇒ (3,600/15)*15*8 = 28,800 packages/day

b) The process bottleneck is phase 2(drying). The daily capacity is 11,200 packages.

c)

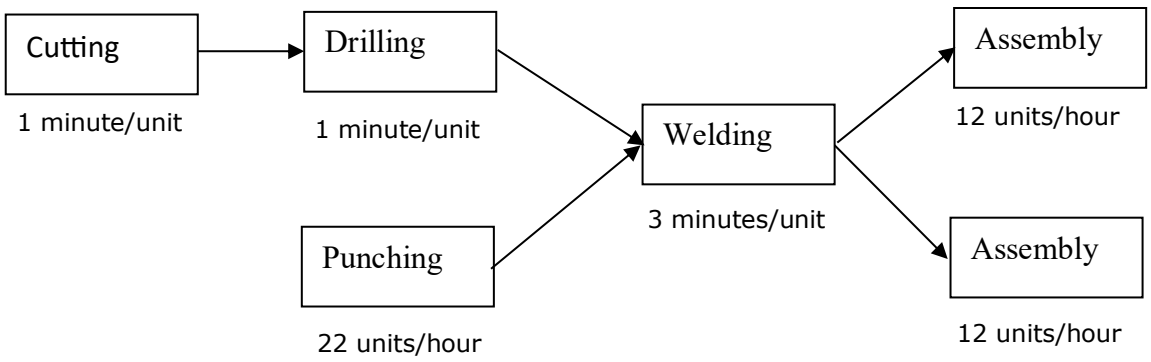
Every 1.5 hours each phase produces:
Phase 1: 4,500 corn cobs
Phase 2: 4,500 corn cobs
Phase 3: 2,250 packages = 4,500 corn cobs
Phase 4: 5,400 packages = 10,800 corn cobs

The process bottleneck are phases 1, 2 and 3. Thus, it is not possible to accumulate stock between the different phases.

d) Utilization = Actual output/design capacity
Phase 1: 11,000/12,000 = 0.917
Phase 2: 11,000/ 12,000 = 0.917 design capacity = 12,000 packages/day, effective capacity = 11,200 packages/day
Phase 3: 11,000/12,000 = 0.917
Phase 4: 11,000/28,800 = 0.382

e) Global yield = $0.9 * 0.85^3 = 0.553 < 0.80$ ⇒ I do not agree with the decision of the production manager.

CCM6.



a) Cutting: 1 minute/unit or 60 units/hour
Drilling: 1 minute/unit or 60 units/hour
Punching: 22 units/ hour or 2,7 minutes/unit
Welding: 3 minutes/unit or 20 units/hour
Assembly: each assembly 5 minutes/unit or 12 units/hour.
But the cycle time in overall Assembly = 5 / 2 = 2.5 min/unit
Therefore, the bottleneck is the slowest operation, which is Welding, at 3 min/unit.

b) The daily capacity is 8*20 = 160 units/day.

c) Throughput time (time for a unit to go through the system) =
Maximum of (1 + 1 + 3 + 5, or 2.72 + 3 + 5) ➔
Maximum of (10 or 10.72) = 10.72 min

d) Capacity utilization of the cutting machine is given by: Actual output/design capacity of cutting machine = 144/480 = 0.3
e) Efficiency of the process = Actual output/ effective capacity of the bottleneck =144/160 = 0.9
f)
Stock: (22 units/hour - 20 units/hour) * 5 hours = 10 units

Daily capacity: 20*5+10+2*20 = 150 units/day

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.

	Capacity/Machine/Hour	Capacity/day
Phase 1	1,000 liters	16,000 liters
Phase 2	**1,900 liters**	**15,200 liters**
Phase 3	750 liters	18,000 liters
Phase 4	4,200 bottles	16,800 liters

What is the daily production capacity of ORANGE?		
1		6,000 liters
2	x	15,200 liters
3		16,800 liters
4		18,000 liters

If the company produces 15,000 liters per day, what is the utilization rate of the machine at Phase 4?		
1		98.7%
2	x	89.3%
3		83.3%
4		100%

(15,000/16,800) =0.8929

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	X	Phase 1
2		Phase 2
3		Phase 3
4		Phase 4

	Capacity/day
Phase 1	16,000 liters
Phase 2	15,200 liters
Phase 3	18,000 liters
Phase 4	16,800 bottles

New capacity of phase 1: 7.5 × 2,000 liters/hour =15,000 liters/day

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

Phase	Capacity/hour	Capacity/day
Phase 1	110	880 units
Phase 2	160	1,280 units
Phase 3	180	1,440 units
Phase 4	**96**	**768 units**

What is the cycle time of the production process of DEBULHA?		
1		22.5 seconds
2	x	37.5 seconds
3		20 seconds
4		None of the above

(1/96) ×3600 = 37.5 seconds

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	x	660 units
2		1,440 units
3		1,280 units
4		None of the above

New capacity of Phase 1: 110 ×6 = 660 units/day

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:

	Capacity/ Hour	Capacity/ day
Phase 1	400 liters	3,200 liters
Phase 2	300 liters	2,400 liters
Phase 3	500 liters	4,000 liters
Phase 4	280 liters	**2,240 liters**

Which of the phases represents the "bottleneck" operation of the iced yoghurts production process at GELI?		
1		Phase 1
2		Phase 2
3		Phase 3
4	X	Phase 4

If the company produces 2,100 litres per day, what is the utilization rate of the machine at Phase 4?		
1		87.5%
2	X	93.8%
3		93.3%
4		100%

(2,100/2,240) =0.9375

What is the yield of the iced yoghurt production process at GELI?		
1	X	72.33%
2		90.00%
3		95.00%
4		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		2,400 liters
2		800 liters
3	X	1,950 liters
4		4,000 liters

Daily capacity of phase = (8-3× 0.5) ×300= 1,950 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		Washing
2	x	Drying
3		Packaging
4		Labeling

	Capacity/hour
Washing	3,240 units
Drying	**2,400 units**
Packaging	4,800 units
Labeling	3,600 units

If the company produces 6,000 packages per day, what is the utilization rate of the washing machine?		
1	x	46,3%
2		28,4%
3		41,7%
4		62,5%

6,000/[(3,240/2) × 8] =0.463

Assuming that the company purchased a new drying machine, how much would increase the capacity of the production process?		
1		There would be no change
2		19,200 packages per day
3		9,600 packages per day
4	x	3,360 packages per day

	Capacity/hour
Washing	**3,240 units**
Drying	4,800 units
Packaging	4,800 units
Labeling	3,600 units

(3,240-2,400) = 840 units/hour ⇒ 6,720 units/day⇒ 3,360 packages per day