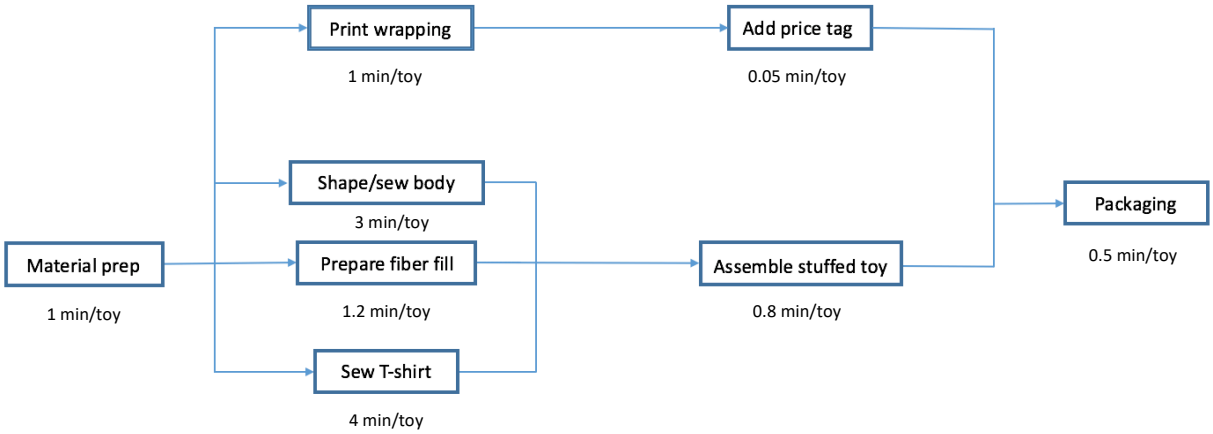
RC TOM SAMPLE QUIZ QUESTIONS FOR PRACTICE

Note: The midterm quiz will contain more questions and will cover additional concepts than the sample questions in this document. The quiz will cover materials up to and including the Toyota case.

Part A: Stuffed Animal Production

Yessica owns and operates a small toy factory in Peru. She has hired you as a consultant to assess a production process that produces stuffed animals. The production process is summarized in the process flow diagram below (with processing time below each step). Each of the eight workstations is staffed by a single, specialized worker dedicated to just that workstation (that is, there are eight workers in total, none of whom are cross-trained). The process begins each day without work-in-progress inventory, and there are no buffers in the process where work-in-process could accumulate.



1. How much time does it take to complete the first unit of the day?

a. 2.55 minutes
b. 4 minutes
c. 6.05 minutes
d. 6.3 minutes
e. 16 minutes

2. When the process is in steady state, what is the capacity of the entire process?

a. 10 toys/hour
b. 15 toys/hour
c. 20 toys/hour
d. 30 toys/hour
e. 60 toys/hour

3. What is the labor content of a finished toy?

a. 4 minutes
b. 10.55 minutes
c. 6.3 minutes
d. 11.05 minutes
e. 11.55 minutes

4. When the process is in steady state, what is the highest labor utilization of any single worker on the production process?

a. 75%
b. 80%
c. 90%
d. 100%
e. Not enough information to determine

5. When the process is in steady state, what is the average labor utilization of all workers on the production process?

a. Approximately 25%
b. Approximately 30%
c. Approximately 34%
d. Approximately 36%
e. Approximately 50%

6. For this question only, assume Yessica is considering sending as many as three different workers to a training program to improve their efficiency. Though expensive, this training would enable them to halve the processing time of their particular processing step. Assuming Yessica's goal in sending workers to the training is to maximize the capacity of the production process, which workers should she send to this training program? Note: A particular worker can be sent to this training only one time.

a. The three workers operating the sew T-shirt, assemble stuffed toy, and packaging tasks.
b. The three workers operating the sew T-shirt, shape/sew body, and prepare fiber fill tasks.
c. The two workers operating the shape/sew body and assemble stuffed toy tasks.
d. The two workers operating the sew T-shirt and shape/sew body tasks.
e. The two workers operating the material prep and packaging tasks.

7. Yessica decided not to send any workers to the training mentioned above. Instead, she is considering introducing a radical new labor policy that would pay workers based only on the time they are working on products (that is, adding labor content to products) as specified in the process flow diagram, but not for idle time. To implement this new wage scheme, she would invest in technology that could detect when workers are working productively and when they are idle. If Yessica implemented this scheme by paying each of her workers 50 Peruvian Soles per hour of labor content they add to products, how much would she pay in total to the eight workers *per hour the factory operates*, assuming steady state?

a. About 50 Soles per hour the factory operates
b. About 121 Soles per hour the factory operates
c. About 144 Soles per hour the factory operates
d. About 189 Soles per hour the factory operates
e. About 280 Soles per hour the factory operates

Part B: Fidget Spinner Production

Sourobh reads an exposé in *Poets and Quants* about the new craze sweeping business schools across the world: fidget spinners. Looking for ways to supplement his doctoral stipend, Sourobh convinces a reluctant fellow doctoral student, Meitong, to enter into business with him to produce and sell fidget spinners to the MBA Class of 2019. Sourobh argues that the spinners are mechanically simple and easy to produce and assemble, yielding the promise of a potentially profitable venture.

Meitong locates an abandoned machine shop in Cambridge to produce the spinners using a three-step production process. First, an injection molding machine creates the spinner's plastic body. Second, high-precision ball bearings are inserted into the plastic body using a "press fit" machine. Third, a machine places stickers on the assembled body. The shop processes each order as a batch. Because the machine shop is small, there is no space for buffers between these three steps. Sourobh and Meitong seek to design the process to maximize its capacity.

The shop employs four full-time workers who set up machines; their training enables them to set up only their own assigned machine. Each machine has to be set up by its worker for each new order, during which time that machine cannot produce units. Once set up, the machines are automated and do not require labor to run.

The Create Body station has one injection molding machine with one worker. There are two identical Insert Bearing stations, each of which has one press fit machine and one worker. There is one Add Stickers station with one worker.

Units are passed between stations as a batch. Once the batch has been processed at the Create Body station, it is passed to the two Insert Bearing stations, where the batch is divided equally between the two stations. Once the batch has completed the Insert Bearing step, the batch is moved to the Add Stickers station, where the units are finished.

The setup and run times of each station are as follows:

	Setup time	Run time
Create Body	45 minutes/batch	0.1 minutes/unit
Insert Bearings (each station)	25 minutes/batch	0.5 minutes/unit
Add Stickers	10 minutes/batch	0.7 minutes/unit

8. If every batch is of the same size, 30 units, what is the bottleneck of the operation?

a. Create Body
b. Insert Bearings
c. Add Stickers
d. None of the above

9. If every batch is of the same size, 30 units, what is the labor content of each batch?

a. 80 minutes
b. 94 minutes
c. 105 minutes
d. 144 minutes
e. 192 minutes

10. Suppose Sourobh is considering increasing the output rate of the overall process by upgrading one of these steps to reduce its cycle time. For which of these steps is investing in an increase in output rate *never* worthwhile, regardless of batch size?

a. Add Stickers
b. Create Body
c. Create Body and Add Stickers
d. Insert Bearings
e. None; investing in upgrading any of these steps would increase the output rate of the overall process

11. Compared to the bottleneck associated with a batch of 30, for which of the following batch sizes will the bottleneck be a different step?

a. 52 units
b. 71 units
c. 82 units
d. 71 units and 82 units
e. None of the above

For the next three questions, please consider the following: Meitong convinced Sourobh that they should trade in their injection molding machine and pay $1,000 to get a 3D printer to perform the Create Body step. This enabled them to produce a fancier spinner they called a whirligig. After conducting some market research, they expected the whirligig to yield an additional $1 in gross profit per unit. The 3D printer has a setup time of four minutes per batch and a run time of 0.8 minutes/unit. Like the other machines, the 3D printer has to be setup by its worker for each new order, during which time the 3D printer cannot produce units. Once set up, the 3D printer is automated and does not require labor to run. To simplify operations, they produce whirligig orders in batches of 20 units of the same design.

12. What is the hourly capacity of the production line with the new 3D printer performing the Create Body step?

a. 30 units per hour
b. 40 units per hour
c. 50 units per hour
d. 60 units per hour

e. 70 units per hour

13. After fulfilling the aforementioned whirligig orders, Meitong and Sourobh begin to consider whether they should reduce the fixed production order size, but they disagree on the operational benefits of the smaller batches that would result. They ask you to help resolve their argument: which of the following would occur if the fixed production order size (and thus batch size) were cut in half from 20 units/batch to 10 units/batch?

a. The production process's capacity in terms of units per hour would increase
b. The direct labor content *per unit* would decrease
c. The labor utilization would decrease
d. The throughput time *per batch* would decrease
e. None of the above

Part C: Edison Motors Assembly

The final assembly process of the Edison Motors Model Y electric car is conducted using a conveyor-paced assembly line that consists of five stations, each of which is five meters long. Each station has one worker. In this process, cars move along the conveyor at equally spaced increments.

As shown in the table below,

- the worker at Station 1 performs Tasks 1–3,
- the worker at Station 2 performs Tasks 4–7,
- the worker at Station 3 performs Tasks 8–11,
- the worker at Station 4 performs Tasks 12–15, and
- the worker at Station 5 performs Tasks 16–19.

Each worker performs his or her tasks sequentially, and an individual worker cannot perform a task in parallel with any of their other tasks. Management sets the speed of the conveyor to maximize the output rate of assembly process while maintaining the task allocations and task times (in seconds) depicted in the table below.

Station (Worker)	Task	Time (seconds)
1	1	80
	2	25
	3	10
2	4	70
	5	75
	6	80
	7	15
3	8	50
	9	15
	10	45
	11	45
4	12	35
	13	30
	14	35
	15	30
5	16	15
	17	5
	18	65
	19	115

14. What is the direct labor content of a car during the final assembly process?

a. 720 seconds
b. 840 seconds

c. 1,080 seconds
d. 1,200 seconds
e. 1,440 seconds

15. What is the throughput time of a car going through the final assembly process?

a. 720 seconds
b. 840 seconds
c. 1,080 seconds
d. 1,200 seconds
e. 1,440 seconds

16. What is the hourly capacity of the final assembly process?

a. 15 cars/hour
b. 18 cars/ hour
c. 20 cars/ hour
d. 24 cars/ hour
e. 30 cars/ hour

17. What is the labor utilization of the final assembly process?

a. 68%
b. 70%
c. 72%
d. 85%
e. Approximately 100%

18. For this question only, you can reallocate one task from one worker to another (adjacent) worker—without changing the sequence of the tasks or the workers—in order to maximize the capacity of the final assembly process. What would the capacity of the final assembly process be after you reallocated that one task?

a. Approximately 4 cars/hour
b. Approximately 16 cars/hour
c. Approximately 18 cars/hour
d. Approximately 19 cars/hour
e. Approximately 21 cars/hour

19. For this question only: Suppose that the plant manager wanted to maximize labor utilization of the final assembly process and discovered that the activities completed in the 19 tasks could be divided into any number of small subtasks, where the total processing time of these subtasks is the same as the total processing time of the original 19 tasks. For example, task 1 (80 seconds) could be divided into a task 1a that required 30 seconds, to be followed by a task 1b that required 50 seconds. Note that the processing times of the subtasks must exactly add up equal the original task's processing time (here, 30 seconds + 50 seconds = 80 seconds).

These subtasks created by dividing up the original tasks would be assigned to five stations, each of which would be staffed by one worker. Each of the 5 workers would continue to work at just one station, and the overall sequence of the activities would be required to remain the same as the sequence in the original configuration.

What would the final assembly process's capacity be if these adjustments were made to maximize labor utilization?

a. Approximately 20 cars/hour
b. Approximately 21 cars/hour
c. Approximately 30 cars/hour
d. Approximately 33 cars/hour
e. Approximately 60 cars/hour

Part D: Airport Security

You have been hired as a consultant to assess Harvard Airport's airline passenger screening. Passengers seeking to enter the gate area of a terminal must pass through entry lines that consist of a four-step security screening process. Each step can process only one passenger at a time. For each entry line in this airport, there is no space in between steps in which a passenger can wait.

In Terminal 1, each passenger goes through the following four steps:

1. The passenger approaches an airport worker who verifies that their ticket's gate is in Terminal 1.
2. The passenger then approaches a security officer who examines their government ID to verify their identity.
3. The passenger proceeds to the Bag Inspection step, where an officer inspects their carry-on luggage.
4. After the Bag Inspection station, the passenger proceeds to the last step, Security Pat Down, where a security guard passes their hands over the passenger's body to search for prohibited items.

These steps occur in this fixed sequence (for example, a passenger's security pat down occurs only after the passenger completes Bag Inspection), and a passenger cannot exit their current step to enter the next step until the passenger at the next step has left it. Assume that there is always a queue of passengers waiting to enter the Ticket/Gate Verification process.

Terminal 1 has two entry lines, Entry Line A and Entry Line B, and passengers can choose to use either one. Each of these entry lines has one worker dedicated exclusively to each step, and thus each entry line has 4 workers. The steps and processing times are provided in the table below. The time required to complete each task at each entry line varies uniformly around the average time noted. For example, at Entry Line A, for Ticket/Gate Verification, the mean processing time is 25 seconds, and any processing time between 20 seconds and 30 seconds is equally likely.

Step	**Terminal 1** **Entry Line A**	**Terminal 1** **Entry Line B**
Ticket/Gate Verification	25 $\pm$ 5 seconds/passenger	25 $\pm$ 3 seconds/passenger
Government ID Check	25 $\pm$ 5 seconds/passenger	25 $\pm$ 3 seconds/passenger
Bag Inspection	25 $\pm$ 5 seconds/passenger	25 $\pm$ 3 seconds/passenger
Security Pat Down	25 $\pm$ 5 seconds/passenger	25 $\pm$ 3 seconds/passenger

20. On average, can Entry Line A or Entry Line B process more passengers per hour?

a. Entry Line A
b. Entry Line B
c. The two entry lines can process the same number of passengers per hour

d. Not enough information to determine

21. Suppose the airport was able to create space in Entry Line A for one passenger to stand after completing the Bag Inspection while the Security Pat Down was still processing the passenger ahead of them. How would this influence the average output rate of Entry Line A?

a. It would increase its average output rate
b. It would decrease its average output rate
c. It would have no effect on its average output rate
d. Not enough information to determine

22. How would adding the standing space to Entry Line A described in the prior question influence the overall labor utilization of Entry Line A?

a. Overall labor utilization would increase
b. Overall labor utilization would decrease
c. Overall labor utilization would not change

Terminal 2 also has two entry lines: Entry Line Q and Entry Line R, and passengers can choose to use either one. These entry lines have the same steps as the entry lines in Terminal 1, but they have different processing times. The time required to complete each task at each entry line in Terminal 2 varies uniformly around the average time noted in the following table.

Step	**Terminal 2 Entry Line Q**	**Terminal 2 Entry Line R**
Ticket/Gate Verification	20 $\pm$ 7 seconds/passenger	22 $\pm$ 11 seconds/passenger
Government ID Check	38 $\pm$ 7 seconds/passenger	38 $\pm$ 7 seconds/passenger
Bag Inspection	27 $\pm$ 3 seconds/passenger	28 $\pm$ 4 seconds/passenger
Security Pat Down	15 $\pm$ 4 seconds/passenger	14 $\pm$ 3 seconds/passenger

23. On average, can Entry Line Q or Entry Line R process more passengers per hour?

a. Entry Line Q
b. Entry Line R
c. The two entry lines can process the same number of passengers/hour
d. Not enough information to determine the answer

The information in this paragraph applies only to the next two questions: The airport has the option to invest in worker training that would eliminate the variability in processing time for that worker's task and thus their step. For example, training Entry Line R's Bag Inspection worker would change that step's processing time from 28 $\pm$ 4 seconds per passenger to exactly 28 seconds per passenger. However, training is costly and justified only if it would increase the average output rate of the trained worker's entry line.

24. For Entry Line Q, how many workers should be trained?

a. None
b. One
c. Two
d. Three
e. Four

25. For Entry Line R, how many workers should be trained?

a. None
b. One
c. Two
d. Three
e. Four

Part E: Apple Picking and Cider Production

It's fall in New England, which means it is peak season for Maciej's family farm to produce apple cider. The farm has a small facility that processes locally-grown apples to produce delicious cider. The process begins with workers unloading apple delivery trucks and depositing the apples into a holding bin that automatically feeds the apples into a pressing machine. The holding bin is large enough so that it is never full. The pressing machine's capacity to convert apples into finished cider is 100 kg of apples per hour. Assume that the pressing machine has no other inputs, and that there is always an ample supply of apples waiting in the delivery trucks.

In the morning from 9:00 am to 12:00 pm (noon), four of Maciej's brothers and sisters ("siblings") deposit apples into the holding bin, and each sibling works at a constant rate of 50 kg per hour. During 12:00 pm to 1:00 pm, all four siblings take a break and no apples are added to the holding bin while the pressing machine continues to run. At 1:00 pm, three of the siblings leave the cider production facility to carry out other work on the farm. Thus, from 1:00 pm to 5:00 pm, only one sibling deposits apples into the holding bin, working at a constant rate of 50 kg per hour. At 5:00 pm, when all of Maciej's siblings go home, the pressing machine continues processing any apples that remain in the holding bin and then automatically shuts off. The holding bin feeding the pressing machine starts empty each morning at 9:00 am, with no WIP from the previous day.

26. How many kilograms of apples are processed per day?

a. 500 kg
b. 600 kg
c. 700 kg
d. 800 kg
e. 900 kg

27. What is the maximum amount (in kg) of apples that the holding bin holds at any particular moment on any given day?

a. 150 kg
b. 200 kg
c. 250 kg
d. 300 kg
e. 350 kg

28. What is the average inventory (in kg) of apples in the holding bin over the course of a day when the pressing machine is operating? Please round to the nearest 10 kg.

a. About 100 kg
b. About 110 kg
c. About 120 kg
d. About 140 kg
e. About 160 kg

29. Maciej worries about the freshness of his cider and wonders whether the apples spend too much time in the holding bin. How long, on average, do the apples spend in the holding bin?

a. about 1 hour
b. about 1.4 hours
c. about 2 hours
d. about 2.2 hours
e. about 2.5 hours

30. In addition to the operations described above, one morning, Maciej allowed visitors to go apple picking at his orchards until noon, as long as they agreed to give half the apples they picked to him. At 1:00 pm, Maciej brought 150 kg of apples from the visitors and dumped them in the holding bin all at once. The siblings continue to staff the operation as described above, with four working in the morning and one working after lunch. The extra activity with visitors had no effect on the siblings' performance of their apple-related tasks as described above. At what time will the pressing machine automatically shut off on this day?

a. 5:00 pm
b. 5:30 pm
c. 6:00 pm
d. 6:30 pm
e. 7:00 pm

31. Maciej decided to not allow visitors to go apple picking on his farm anymore. Instead, he decided to expand his operation by hiring two neighbors to be additional workers. These neighbors work along with the siblings to deposit apples into the holding bin from 9:00 am to 12:00 pm and from 1:00 pm to 5:00 pm. The siblings continue to staff the operation as described above, with four working in the morning and one working after lunch. Each of these neighbors can deposit apples at a rate of 25 kg/hour. With these two neighbors working along with Maciej's siblings, at what time will the pressing machine automatically shut off?

a. 7:00 pm
b. 8:30 pm
c. 9:30 pm
d. 10:15 pm
e. 11:00 pm