CHAPTER 2

INTRODUCTION TO PROCESSES

CONCEPTUAL QUESTIONS

1.

Answer: **C. Number of customers.**

Feedback: The number of workers, cash registers, and suppliers are unlikely to change much over the course of a month and do not "flow" through the process of the hardware store.

2.

Answer: **D. The number of patients.**

Feedback: Physicians, beds, and square footage are unlikely to change much over the course of a month and do not "flow" through the process of a hospital.

3.

Answer: **The flow rate is 1,000 passengers per day and the flow time is 5 days.**

4.

Answer: **The inventory is 15 voters.**

Feedback: The flow rate is 1,800 / 10 = 180 per hour, or 180 / 60 = 3 per minute. The flow time is 5 minutes.

5.

Answer: **B.**

Feedback: The flow rate into a process must equal the flow rate out of a process.

6.

Answer: **False.**

Feedback: Little's Law applies even if there are fluctuations in inventory, flow rates, and flow times.

PROBLEMS AND APPLICATIONS

1.

Answer: **D.**

Feedback: The number of customers is the appropriate flow unit for process analysis. The employees are resources, and the other two measures are unlikely to change from week to week.

2.

Answer: **B.**

Feedback: The number of tax returns completed each week reflects the main operation of the accounting firm during tax season. The accountants are resources; the customers with past-due invoices reflect the accounts receivable process and not the main operation; and the reams of paper received are a result of the firm's purchasing policies and not necessarily the main operation.

3.

Answer: **A and D are correct**

Feedback: The gasoline pumps and employees are resources, not flow units.

4.

Answer: **0.4 callers per minute**

Feedback: 8 calls divided by 20 minutes = 0.4 calls per minute.

5.

Answer: **4 minutes**

Feedback: To calculate the flow time of the callers, subtract the callers departure time from his or her arrival time. 32 total minutes divided by 8 callers = 4 minutes.

6.

Answer: **0.1667 customers per minute**

Feedback: Flow rate = 10 customers divided by 60 minutes = 0.1167.

7.

Answer: **8.6 minutes**

Feedback: To calculate the flow time of the customers, subtract the customers departure time from his or her arrival time. 86 total minutes divided by 10 customers = 8.6 minutes.

8.

*Answer:***4 minutes**

Feedback: To solve this problem, use Little's Law. Inventory = Flow rate × Flow time.
10 people in line (average inventory) = 2.5 flow rate x flow time
Flow time = 4 minutes
The flow rate is 300 customers divided by 120 minutes = 2.5

9.

*Answer:***90,000 wafers**

Feedback: 100 per second x 60 seconds per minute x 15 minutes = 90,000

10.

*Answer:***360 skiers**

Feedback: 1,800 skiers divided by 60 minutes per hour (flow rate) x 12 minutes (flow time) = 360 skiers

11.

*Answer:***8,539 visitors**

Feedback: Flow rate = 3,400,000 visitors divided by 365 days = 9,315.07 visitors per day

Flow Rate = 22 hours/ 24 hours per day = .9167 day

Inventory = 9,315.07 (flow rate) x 0.9167 (flow time) = 8539.12 visitors per day

12.

*Answer:***900,000 patients**

Feedback: 6 months (flow time) x 150,000 new patients per month = 900,000 patients

13.

*Answer:***20 chat sessions**

Feedback: Flow rate = 240 chats divided by 30 employees = 8

Flow time = 5 minutes divided by 60 minutes = 0.833 hour

Inventory = Flow Rate x Flow Time, 8 x 0.833= 0.6667 x 30 employees = 20 chats

14.

Answer: **840 units**

Feedback: 4,200 units divided by (12 minutes/60 minutes) = 840 units

15.

Answer: **120 skiers**

Feedback: 1,200 beds divided by 10 days = 120 new skiers per day.

16.

Answer: **7.5 minutes**

Feedback: To solve this problem, use Little's Law. Inventory = Flow rate × Flow time. 30 people in line (average inventory) = 240 customers/ 60 minutes (flow rate) x flow time. Flow time = 7.5 minutes

17.

Answer: **8 years**

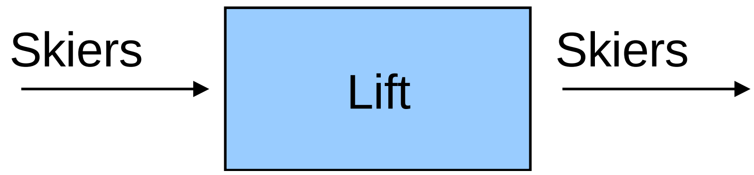
Feedback: 120 associates = 15 new employees x flow time. Flow time = 8

CASE

Although the analysis of the case is relatively simple, the intuition is not always easy to grasp – many students will intuitively believe that the capacity of the faster lift should be greater than the capacity of the slower lift. The main lesson in this case is to get students to understand why that intuition is not correct.

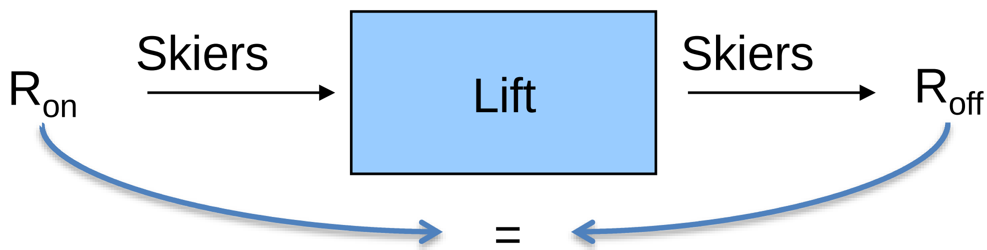
To begin the case discussion, ask the students their opinion as to who is correct, Mark (unloading capacity should be twice as high on the detachable lift) or Doug (the unloading capacity should be the same on the two lifts). Hopefully there are students who support each opinion.

To resolve the question, begin with the simple process flow diagram:

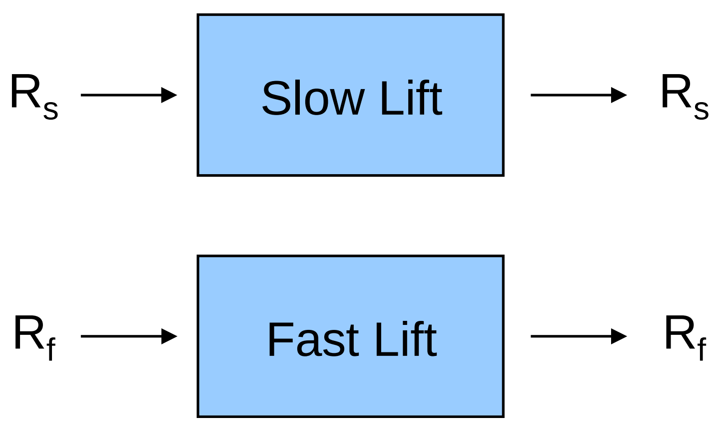


Ask the question "Do all of the skiers that get on the lift at the bottom get off the lift at the top?" Of course, the answer is "We would hope so!". So "What does that mean about how the rate of skiers getting on the lift, R_{on}, is related to the rate of skiers getting off the lift, R_{off}?" And the answer there must be that they are equal! If the rate on where faster than the rate off, the number of people on the lift would grow and grow and grow. We know that can't happen. Similarly, if the rate off exceeded the rate on, then the number of people on the lift would shrink and shrink and shrink, leaving the lift eventually with nobody. Which also doesn't happen.

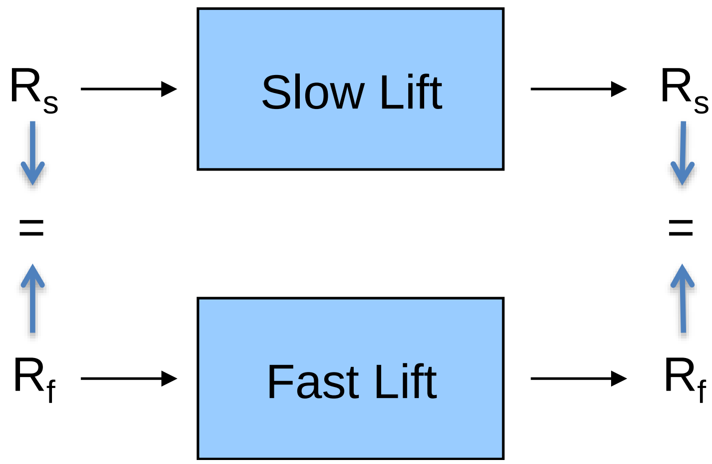
So we can add to our process flow diagram:



Now it is time to compare the two lifts. We can draw the process flow for each of them, emphasizing that the rate on for each must equal the rate off:



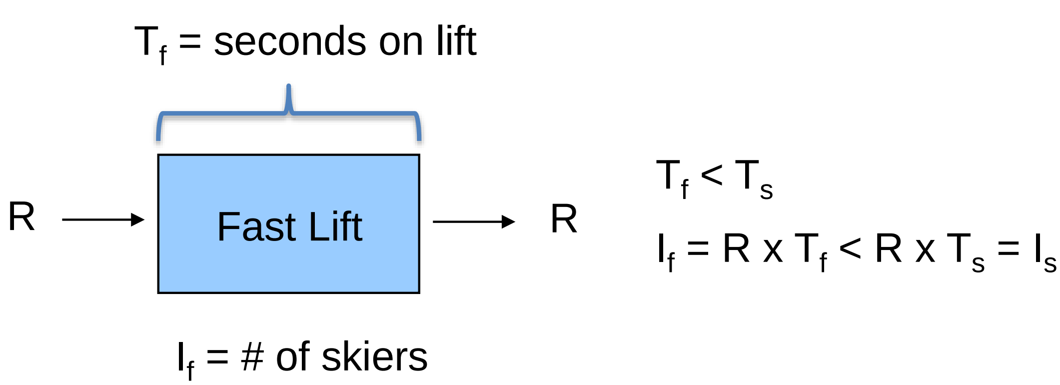
Now ask students "How can we compare the rates across the two types of lifts?" The answer is given in the case – we are told that the rate skiers load onto the slow (fixed grip) lift is the same as the rate they load onto the fast (detachable) lift. That means that $R_s = R_f$. And that means that the rates that they onload skiers at the top must be the same!



Thus, Doug is correct – both lifts have the same capacity to unload skiers at the top even though one is faster than the other.

And this brings us to Jessica's question – so what is the difference between the two lifts? If you ask students this question, the likely first response is that skiers spend less time on the faster lift. And that is correct. But are there other differences? Actually, there are two additional differences worth mentioning. The first comes from Little's Law and the 2nd one requires a deeper understanding of this process.

The first obvious difference is the number of skiers on the lift. According to Little's Law, I = R x T. So if the two lifts have the same R, but the faster lift has a smaller T, then the faster lift must have a smaller I as well:



So fewer people are on the faster lift and they spend less time on the lift but the faster lift and the slower lift bring skiers to the top at the same rate.

If students can't get the next difference between the two lifts, then you can prompt them with the following question "If the faster lift has fewer skiers than the slower lift, then where are the additional skiers?" Or put another way: "If the ski area attracts a certain number of skiers but the faster lift has fewer skiers on it, then where are the other skiers?" The answer is that they are on the slopes! That means that adding a faster lift takes skiers off the lift but they don't disappear. Instead, they are on the only other place they can be, the slopes. Which means, somewhat counter-intuitively, that adding a faster lift makes the slopes more crowded (holding the total number of skiers fixed).