

PROCESS ANALYSIS NOTE ANSWERS

1. The copy center has a job order that requires 500 pages of white and 200 pages of pink. The copying rate is 25 pages per minute, the overall setup time is 5 minutes and the color change time is 2 minutes. What is the expected capacity requirement for the copy machine center to do this job?

$$\begin{array}{rcl}
 \text{set-up} & & = 5 \text{ minutes} \\
 \text{run} & = (500 + 200)/25 = & 28 \text{ minutes} \\
 \text{color change} & = & \underline{2 \text{ minutes}} \\
 & & 35 \text{ minutes}
 \end{array}$$

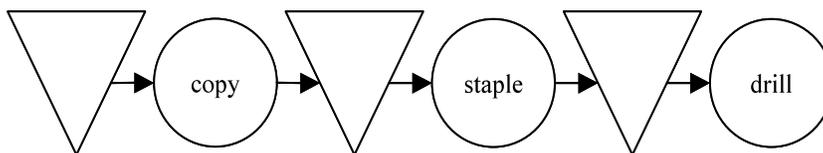
Set-up times may or may not be associated with individual jobs, as here. Some set-ups are general preparation for work for a period (a day or a week).

2. The routing for the job in Problem 1 also calls for stapling and three-hole drilling (in that order). The time standards are 10 minutes and 20 minutes, respectively. If labor cost is charged on the basis of total standard time multiplied by \$6.00 per hour, estimate the cost of this job, including the work in Problem 1.

$$35 + 10 + 20 = 65 \text{ min/job} \times 1 \text{ hour}/60 \text{ min} = 1.083 \text{ hours} \times \$6.00 / \text{hour} = \$6.50/\text{job}$$

Note here that although there are only 65 minutes of actual work time going into this job, workers are typically not only paid for work time, they are also paid for idle time. Each worker has 35 minutes available to work on each unit, but two of the three workers in this process would be idle for part of that time.

3. If the job has to wait in queue at the copy work center for 24 minutes, at the stapling work center for 43 minutes, and at the three-hole drilling work center for 17 minutes, what is the throughput time for this job?



$$24 + 35 + 43 + 10 + 17 + 20 = 149 \text{ min}$$

Remember: If all jobs were copy-staple-drill with the tasks times as given, these waits would not occur. Waits would occur prior to the bottleneck task.

4. Suppose the copy center only did jobs exactly like this one. What would the cycle time be? Assume that different people work in each of the three work centers.

35 minutes.

To illustrate this, let's assume we start with an empty line at 8:00.

Unit	Copy (35)		Staple (10)		Drill (20)	
	Start	Finish	Start	Finish	Start	Finish
1	8:00	8:35	8:35	8:45	8:45	9:05
2	8:35	9:10	9:10	9:20	9:20	9:40
3	9:10	9:45	9:45	9:55	9:55	10:15

} 35 } 35

We can see that the workers at Staple and Drill are idle until work comes to them from the prior workstations and that the interval between completion of successive units at the end of the process is 35 minutes.

5. What is the maximum number of such jobs that can be produced in a 40 hour week?

The answer to this question depends on assumptions about the process.

If it is assumed that the process is in steady state, that jobs can be stopped and restarted at any point, and that the 40 hour week is all available work time (no breaks subtracted), the calculation is:

$$(40 \text{ hours/week} \times 60 \text{ minutes/hour}) / (35 \text{ minutes/job}) = 68.6 \text{ jobs/week}$$

If it is assumed that the first job starts the operation "from scratch," the time required for the first job is 65 minutes, so the calculation would subtract 65 minutes from the total time in the week and divide by the cycle time, then add back the first job (which was subtracted from the total time) to get: $(2400 - 65) / 35 + 1 = 67.7 \text{ jobs/week}$

If it is assumed that breaks are subtracted from the 40 hour work week, total time available is reduced.

If it is assumed that jobs cannot be stopped in the middle, the calculation is more complicated and depends on when breaks are factored in (it is probably not reasonable to assume that the 8 hours are worked without any breaks at all).

When all information is not provided, assumptions must be made. Assumptions must be reasonable (it may be reasonable to assume these copy jobs can be stopped and restarted at any point, but it is certainly not reasonable to assume that surgical procedures can be stopped and restarted at any point, for example), must fit with other available data (40 hour week in this question, not 48, for example), and should be stated explicitly so that there is less chance of miscommunication. Assumptions should also be consistent. For example, if it is assumed that the copy center starts "clean" each morning, then the system also needs to be cleared at the end of the day. If it is assumed that tasks cannot be started and stopped mid-job, then the system probably also needs to be cleared prior to breaks.

6. **What is the capacity utilization of each of the three work centers when the operating unit works at the maximum rate as determined in problem 5?**

$$\text{Copy} = 35/35 = 100\%$$

$$\text{Staple} = 10/35 = 28.6\%$$

$$\text{Drill} = 20/35 = 57.1\%$$

The appropriate capacity utilization for an operation is achieved when the service requirements (effectiveness requirements) are met most efficiently. If rapid service is important and demand arrives unevenly, excess capacity may be required. If customers will tolerate waits, higher capacity utilizations can be achieved. The balance of effectiveness and efficiency depends on the process, the needs of the customer, and competitive priorities.

Capacity utilizations can be balanced by adding a copier (if more capacity is needed) or combining staple and drill tasks (if more capacity is not needed).

High capacity utilizations do not necessarily mean worker exploitation. Standards versus actual times, built-in rests/slack, etc., all need to be considered.

7. **How do the answers to Problems 1-6 change if the batch size is doubled?**

The copy task time becomes 63 minutes ($5 + (1400/25) + 2$); set-up and run for the task are not affected. Assumptions need to be made regarding the effect of the batch size increase on the staple and drill tasks.

8. **If there are 20 jobs on the average in inventory, and the copy center turns out 50 jobs per month, what is the inventory turnover rate?**

$$50/20 = 2.5$$

9. **Suppose that in problem 1, 750 sheets of paper were required in order to complete the job. What is the yield? the scrap rate?**

$$\text{Yield} = 700/750 = 93.3\%$$

$$\text{Scrap} = 1 - \text{yield} = 6.7\%$$

10. As a customer, what criteria might you use to evaluate the quality of the copy center's product and service?

First, who are the customers? Students and faculty are the most direct customers.

The quality characteristics of importance include:

- *On-time delivery*
- *Speed of service*
- *Friendliness of service*
- *Value of packet*
- *Quality of print*
- *Completeness of packet*
- *Comfort of wait in line*
- *Length of wait in line*
- *Completeness of information provided (pre-assignment, required versus suggested readings, etc.)*

These may have different weights for different customer groups and for different individual customers.