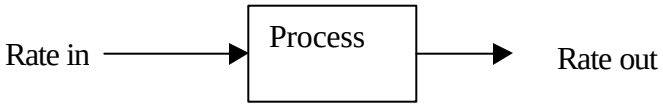
Basic Process Analysis Concepts

{**sources**: Kristen Cookie Company, HBS 9-686-093; Process Fundamentals HBS 9-696-023; Anupindi, et al, Managing Business Process Flows, Prentice Hall.}



Three operational measures of process performance:

Flow time T (hours)
Throughput rate R (units/hour)
Inventory I (units)

Definitions:

Flow rate is the number of units that flow through a specific point of the process per unit time.
Flow time is the total time spent within process boundaries.
Inventory is the number of units present within process boundaries at time t.

Little's Law: Inventory = Throughput * Flow Time

Example (customer flow):

A restaurant processes, on average, 1500 customers per 15-hour work day. At any point in time, there are, on average, 75 customers in the restaurant.

Given:
Throughput rate = R = 1500/day or 100 customers / hour
Average inventory = I = 75 customers

Derived:
Time = I/R = 75/100 or average customer spends ¾ hour in the restaurant.

Another example (job flow):

A branch office of an insurance company processes 10,000 claims per year. Average processing time is 3 weeks. Assume that the office works 50 weeks per year. The process is a branch of the insurance company and the flow unit is a claim.

Given:
Throughput rate R = 10,000 claims/year.
Average flow time T = 3/50 year.

Derived:
Inventory (average) I = R * T = 10,000 * 3/50 = 600 claims.

Flow time measurement, T:
Direct measurement:

1. Observe the process over a specified, extended period of time.
2. Take a random sample of flow units over the specified period.
3. For each flow unit in the sample, measure its flow time from entry to exit.
4. Compute the average of flow times measured.

Indirect measurement: T = I/R.

Key managerial levers for flow time:

1. Decrease waiting time (to be covered later).
2. Decrease theoretical flow time
    a. Reduce the work content of critical path activities
        i. Eliminate non-value-adding aspects of the activity (work smarter).
        ii. Increase the speed at which the activity is performed (work harder).
        iii. Reduce the number of repeat activities (do it right the first time).
        iv. Change the product mix.
    b. Move some work content off the critical path.

Flow rate measurement, R:
Direct measurement:

1. Identify a particular entry and exit point in the process.
2. Observe the process over a given, extended period of time.
3. Measure the number of flow units that pass through a selected point over the selected period of time.
4. Compute the average number of flow units per unit of time.

Definitions:

Capacity = the maximum rate of output of a process, measured in units of output per unit of time.

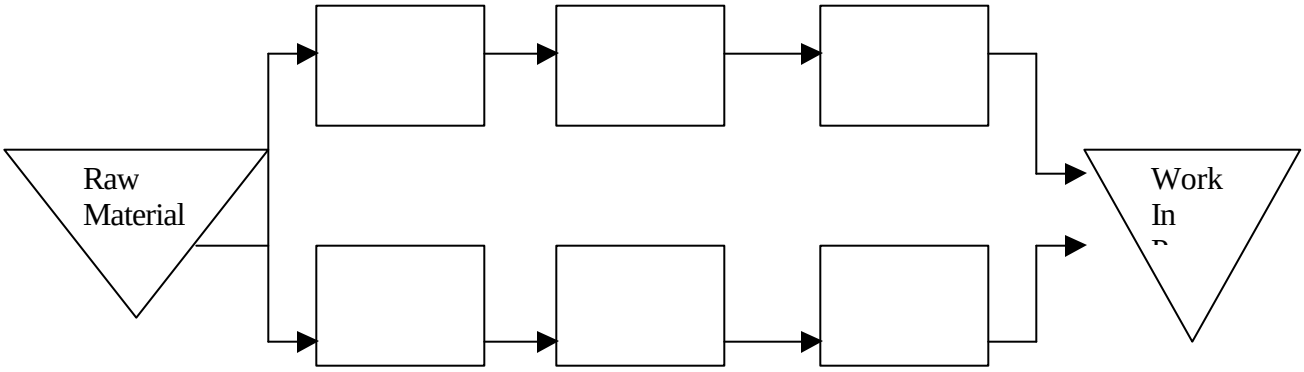
Bottleneck = the production resources that limits the capacity of the overall process (this is the step with the lowest capacity or longest cycle time).

Cycle time = average time between completion of successive units. It is directly related to output rate. (An output rate of 4 units per hour has a cycle time of 15 minutes.)

PROBLEMS: (HBS 9-696-058. Capacity Analysis: Sample Problems.)

Example 1. Bread making on two lines.

The bakery operates two parallel lines, each equipped with a mixer, a proofer, and an oven. In addition, the bakery operates a single packaging line which is shared by the two bread making lines. A process flow diagram is shown below for the bakery.



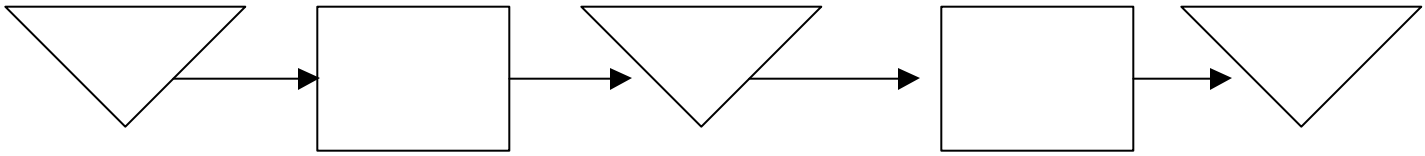
Note: Mix CT = ¾ hour / 100 loaves
Proof CT = ¾ hour / 100 loaves
Bake CT = 1 hour / 100 loaves

Batch = number of units of a particular product type that is produced before beginning production of another product type.

1. Looking just at the bread making process, what is the bottleneck?

2. What is the CT of the system?

Look at the entire process:



Raw Matls | Baking | Work in Process | Pack | FG

CT= ½ hour per 100 loaves

CT= ¾ hour per 100 loaves

3. Now what is the bottleneck? CT for the system?

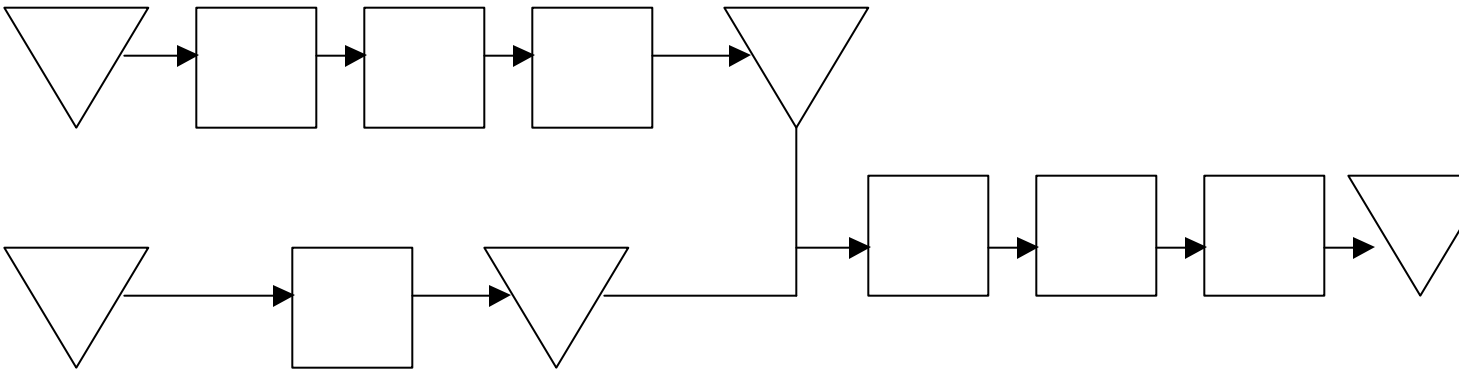
4. In an 8 hour day, what is the overall daily capacity?

5. Consider the following options (choose A or B?) (impact of C?):
   A. Purchase two new ovens capable of 100 loaves in ¾ hour.
   B. Purchase new packaging line capable of 100 loaves in ½ hour.
   C. Adding a new product line – wheat bread.

Example 2. Croissant Manufacturing.

The dough and filling for the croissants are prepared separately. The parallel processes of making dough and mixing filling are dependent, both must be completed before the croissants can be filled, folded and baked.

Mixing the filling for a batch of 50 croissants is relatively quick, taking only 10 minutes. However, preparing the dough involves three steps: mixing, proofing and rolling & cutting. Proofing, with a cycle time of 15 minutes per 50 croissants, is the slowest step in the process of preparing dough, with mix and roll & cut taking 5 minutes per 50 croissants. Although a new batch of filling could be prepared every 10 minutes, the batch of dough necessary to begin the fill & fold task can only be available at 15 minute intervals. The fill & fold task takes 5 minutes per 50 croissants, the bake task takes 20 minutes per 50 croissants and the pack task takes 10 minutes per 50 croissants.



1. Complete the process flow diagram and label CTs for each step.

2. What is the CT of the dough and mixing the filling process?

3. What is the CT of the entire process?

4. What is the 8 hour daily capacity of croissants?

Key Managerial Levers for Managing Flow Rate:

1. Manage supply and demand to increase the throughput.
    a. Have reliable suppliers; produce better forecasts of demand.
2. Decrease resource idleness to increase process capacity.
    a. Synchronize flows within the process to reduce starvation.
    b. Set appropriate size buffers to reduce blockage.
3. Increase the net availability of resources to increase process capacity.
    a. Improve maintenance policies, perform preventative maintenance outside periods of scheduled availability, institute effective problem solving measures that reduce frequency and duration of breakdowns.
    b. Institute motivational programs and incentives to reduce absenteeism, increase employee morale.
    c. Reduce the frequency of or time required for setups or changeovers for a given product mix or change the product mix.
4. Increase the theoretical capacity.
    a. Decrease unit load on the bottleneck resource pool.
        i. Work faster, work smarter, do it right the first time, change product mix.
        ii. Subcontract or outsource.
        iii. Invest in flexible resources.
    b. Increase the load batch of resources in the bottleneck resource pool (increase scale of resource).
    c. Increase the number of units in the bottleneck resource pool (increase scale of process).
    d. Increase scheduled availability of the bottleneck resource pool (work longer).