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GLOSSARY OF BASIC DEFINITIONS IN PROCESS ANALYSIS

In this session, we have studied several basic definitions used in process analysis. The purpose of this note is to summarize these definitions and recap their application to the Kristen cookies case. We strongly recommend you read and reread this short note several times during this course.

When applying these measures remember:

These are steady state measures: They are always calculated once the process has started up or after the production of the first unit is complete. The effects of startup and shutdown are not considered.

1. CYCLE TIME

Time Between Completion Of Successive Units

In the Kristen Cookies case, the unit is a dozen cookies. From the attached Gantt chart, we observe units are completed at 26, 36, 46.... minutes, continuing in this sequence. The time between completion of successive units is 10 minutes.

2. CAPACITY

Production Per Unit Time, Expressed As Units Of Output/Units Of Time

From the attached process flow diagram of Kristen cookies, we observe the following capacities:

Spoon and Mix: We can spoon and mix one dozen cookies in 8 minutes. This means in one hour, we can spoon and mix 60/**8** = 7.5 dozens. Consequently, capacity is 7.5 dozens/hr.

Bake: 60/**10** = 6 dozen per hour

Cool: It takes 5 minutes to cool, but we assume no restriction on the number of trays that can be cooled. Hence, we do not consider this in our capacity calculations, as, from the definition of capacity, this would never restrict capacity. We also do not consider stages like storage: buffers where the processing times are 0 and consequently will never restrict capacity.

Pack: 60/2 = 30 dozen per hour

Receive Payment: 60/1 = 60 dozen per hour

3. BOTTLENECK

Stage With The Lowest Capacity Or Stage That Limits The Flow

Capacity of Bottleneck = **Capacity of Process** = 1/Cycletime of process

Cycle time of process = Processing time at bottleneck

In Kristen cookies, from our previous calculations we observe that the oven is the bottleneck of the process. The **capacity of the process**, which is equal to the capacity of the bottleneck, is six-dozen cookies per hour.

4. BALANCE/IMBALANCE

A Process Is Balanced If All Stages Have Equal Capacity. It Is Imbalanced Otherwise

The process at Kristen cookies is unbalanced since the capacity between stages is unequal.

5. IDLE TIME

Time Spent Per Cycle Not Doing Useful Work Like Waiting To Deliver Or Receive Product.

This Can Be Present For Both Equipment And The Operator

Idle time of equipment = Processing time at bottleneck - Processing time at equipment

Idle time of operator = Processing time at bottleneck - total time spent per unit of product by operator

In Kristen cookies,

Your idle time = 10 - 8 = 2 minutes

Your roommate's idle time = 10 - 4 = 6 minutes

Total operator idle time = 8 minutes

Oven's (Equipment) idle time = 10-10 =0

6. DIRECT LABOR CONTENT

Total Operator Time Spent Per Unit Of Product.

In Kristen cookies: You spend 8 minutes and your roommate spends 4, therefore the total direct labor content is 12 minutes

7. DIRECT LABOR UTILIZATION

Percentage Of Operator Time Spent Doing Useful Work

Direct Labor Utilization = 100*Direct Labor Content/(Direct Labor Content + Total Operator Idle time)

In Kristen cookies = 100*12/(12+8) = 60%

8. THROUGHPUT TIME (OR MANUFACTURING LEAD TIME)

Throughput Time (or MLT) = Sum of all processing times + Wait Time

In Kristen cookies, assume that all three orders came at the same time. The first batch will be produced in 8 + 10 + 5 + 2 + 1 minutes which is the sum of all processing times. Note that since it is the first batch, the wait time is zero. The MLT for the second batch is 36 minutes, which is the sum of the throughput time and the wait time for 10 minutes when the oven is being used for the first batch. The MLT for the third batch is 46 minutes, which is the sum of the throughput time and the time it has to wait time of 20 minutes while the oven is baking the previous two batches. As this is dependent when the order is placed, it is a random variable and is usually expressed in terms of an average. We will discuss how to calculate average MLT in Session 9.

9. LOT (BATCH) SIZE

Number Of Units Of The Same Product Produced Together Before The Production Of Another Product.

In Kristen Cookies: Lot size = 1 dozen

10. SETUP/RUN TIME

Setup Time: Preparation Time Before Batch Is Produced.

This could include arranging tools at the machine, changing dies, setting machine speeds, cleaning etc. This is independent of batch size.

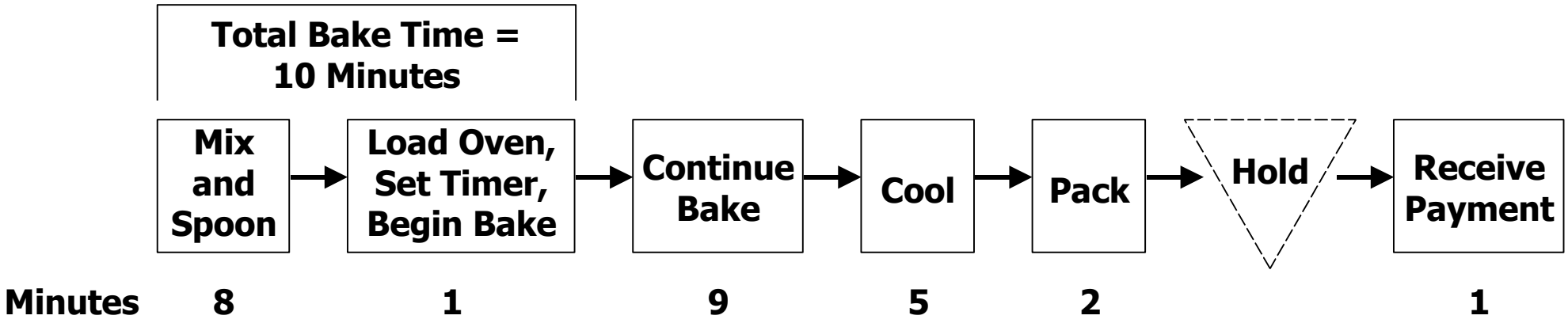
Run Time: Actual Time To Produce The Batch Excluding The Setup Time.

This is the product of the total number of units in the batch and the processing time per unit.

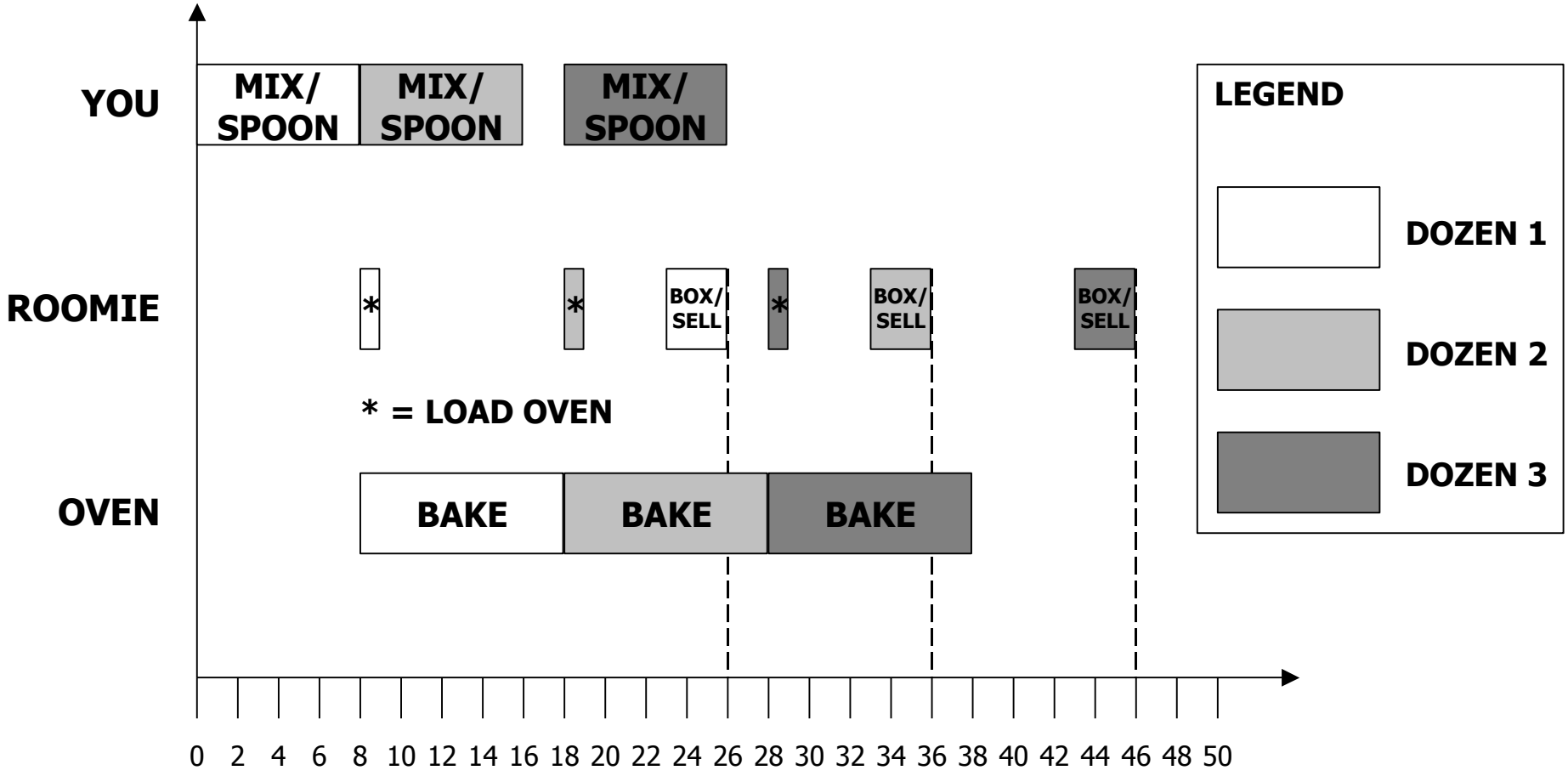
In Kristen Cookies, spooning is a setup and takes six minutes independent of the batch size.

Note: when talking about an entire batch, we will define the total processing time of that batch as the setup time for the batch plus the run time for the batch.

PROCESS FLOW DIAGRAM: ONE ORDER FOR ONE DOZEN IDENTICAL COOKIES



GANTT CHART FOR KRISTEN'S COOKIES
BATCH SIZE = 1 DOZEN COOKIES



CYCLE TIME = 10 MINUTES
THROUGHPUT TIME FOR FIRST BATCH = 26 MINUTES
OVEN IS BOTTLENECK. STEADY STATE CAPACITY = 6 DOZEN/HOUR

HOW MANY DOZEN COOKIES CAN BE MADE IN A 4-HOUR PERIOD?

26, 36, 46, 56, 66, 76, … 116
126, --- 216
226, 236

Count above: 22 complete dozen batches

OR…

Throughput Time for First Batch + (# of Batches) * (Cycle Time) = Total Available Time

$26+(n-1)*10 = 240$

n = 22 one-dozen batches

THE ECONOMICS OF COOKIE PRODUCTION

Assume Price: $4.00

Costs (Given): $0.60 Ingredients
$0.10 Packaging
$0.70

Margin: $4.00 – $0.70 = $3.30

$/hour Earned: ($3.30*22)/(4*2) = $9.075 per hour

IMPROVEMENT OPPORTUNITIES

1. Fire Roommate

You take over tasks: Your time is:

8+4 = 12 minutes

You become the bottleneck!

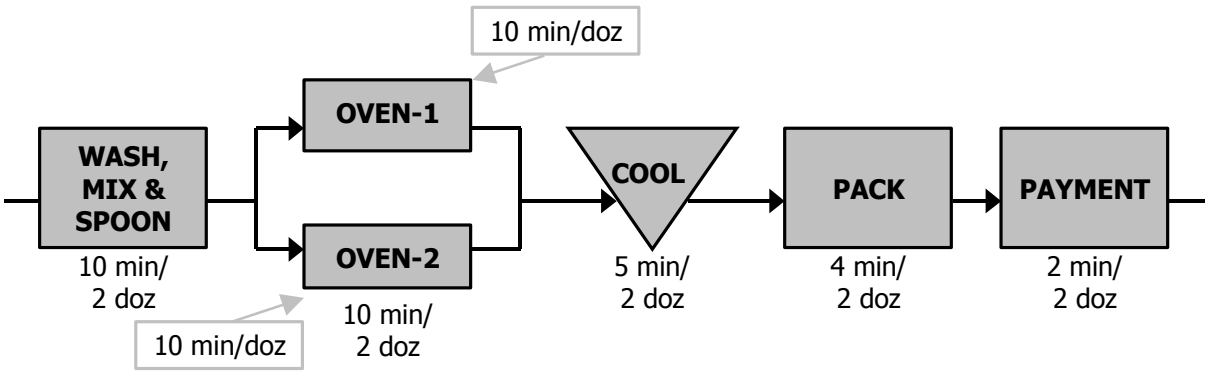
$26+(n-1)*12 = 240$

→ n = 18 one-dozen batches

$/hour Earned: (18*$3.30)/4 = $14.85 (or 63.6% increase from original case).

2. Keep Roommate & Rent Another Oven For $20 Per Night

Process flow diagram for batches of two-dozen cookies:



$31+(n-1)*10 = 240$

n = 21 two-dozen batches

$/hour Earned: ($3.30*21*2–$20)/(2*4) = $14.825 (or 63.36% increase from original case).