

12TH EDITION

# OPERATIONS & SUPPLY MANAGEMENT



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# **Chapter 19**

## **Operations Scheduling**

# OBJECTIVES

- **Work Center Defined**
- **Typical Scheduling and Control Functions**
- **Job-shop Scheduling**
- **Examples of Scheduling Rules**
- **Shop-floor Control**
- **Principles of Work Center Scheduling**
- **Issues in Scheduling Service Personnel**

## Work Center

- A **work center** is an area in a business in which productive resources are organized and work is completed
- Can be a single machine, a group of machines, or an area where a particular type of work is done

## Capacity and Scheduling

- **Infinite loading (Example: MRP)**
- **Finite loading**
- **Forward scheduling**
- **Backward scheduling (Example: MRP)**

## Types of Manufacturing Scheduling Processes and Scheduling Approaches

<u>Type of Process</u>		<u>Typical Scheduling Approach</u>
Continuous process	→	<u>Finite forward</u> of process, machine limited
High-volume manufacturing	→	<u>Finite forward</u> of line, machined limited
Med-volume manufacturing	→	<u>Infinite forward</u> of process, labor and machined limited
Low-volume manufacturing	→	<u>Infinite forward</u> of jobs, labor and some machine limited

## Typical Scheduling and Control Functions

- **Allocating orders, equipment, and personnel**
- **Determining the sequence of order performance**
- **Initiating performance of the scheduled work**
- **Shop-floor control**

## Work-Center Scheduling Objectives

- **Meet due dates**
- **Minimize lead time**
- **Minimize setup time or cost**
- **Minimize work-in-process inventory**
- **Maximize machine utilization**



## Priority Rules for Job Sequencing

- 1. First-come, first-served (FCFS)**
- 2. Shortest operating time (SOT)**
- 3. Earliest due date first (DDate)**
- 4. Slack time remaining (STR) first**
- 5. Slack time remaining per**

## Priority Rules for Job Sequencing (Continued)

### **6. Critical ratio (CR)**

$$CR = \frac{(\text{Due date} - \text{Current date})}{\text{Number of days remaining}}$$

### **7. Last come, first served (LCFS)**

### **8. Random order or whim**

## Example of Job Sequencing: First-Come First-Served

**Suppose you have the four jobs to the right arrive for processing on one machine**

<b>Jobs (in order of arrival)</b>	<b>Processing Time (days)</b>	<b>Due Date (days hence)</b>
A	4	5
B	7	10
C	3	6
D	1	4

**What is the FCFS schedule?**

**Do all the jobs get done on time?**

**Answer: FCFS Schedule**

<b>Jobs (in order of arrival)</b>	<b>Processing Time (days)</b>	<b>Due Date (days hence)</b>	<b>Flow Time (days)</b>
A	4	5	4
B	7	10	11
C	3	6	14
D	1	4	15

**No, Jobs B, C, and D are going to be late**

## Example of Job Sequencing: Shortest Operating Time

**Suppose you have the four jobs to the right arrive for processing on one machine**

<b>Jobs (in order of arrival)</b>	<b>Processing Time (days)</b>	<b>Due Date (days hence)</b>
A	4	5
B	7	10
C	3	6
D	1	4

**What is the SOT schedule?**

**Do all the jobs get done on time?**

**Answer: Shortest Operating Time Schedule**

<b>Jobs (in order of arrival)</b>	<b>Processing Time (days)</b>	<b>Due Date (days hence)</b>	<b>Flow Time (days)</b>
D	1	4	1
C	3	6	4
A	4	5	8
B	7	10	15

**No, Jobs A and B are going to be late**

## Example of Job Sequencing: Earliest Due Date First

**Suppose you have the four jobs to the right arrive for processing on one machine**

<b>Jobs (in order of arrival)</b>	<b>Processing Time (days)</b>	<b>Due Date (days hence)</b>
A	4	5
B	7	10
C	3	6
D	1	4

**What is the earliest due date first schedule?**

**Do all the jobs get done on time?**

**Answer: Earliest Due Date First**

<b>Jobs (in order of arrival)</b>	<b>Processing Time (days)</b>	<b>Due Date (days hence)</b>	<b>Flow Time (days)</b>
D	1	4	1
A	4	5	5
C	3	6	8
B	7	10	15

**No, Jobs C and B are going to be late**

## Example of Job Sequencing: Critical Ratio Method

**Suppose you have the four jobs to the right arrive for processing on one machine**

<b>Jobs (in order of arrival)</b>	<b>Processing Time (days)</b>	<b>Due Date (days hence)</b>
A	4	5
B	7	10
C	3	6
D	1	4

**What is the CR schedule?**

**Do all the jobs get done on time?**

In order to do this schedule the CR's have be calculated for each job. If we let today be Day 1 and allow a total of 15 days to do the work. The resulting CR's and order schedule are:

$CR(A) = (5-4)/15 = 0.06$  (Do this job last)

$CR(B) = (10-7)/15 = 0.20$  (Do this job first, tied with C and D)

$CR(C) = (6-3)/15 = 0.20$  (Do this job first, tied with B and D)

$CR(D) = (4-1)/15 = 0.20$  (Do this job first, tied with B and C)

**No, but since there is three-way tie, only the first job or two will be on time**

## Example of Job Sequencing: Last-Come First-Served

**Suppose you have the four jobs to the right arrive for processing on one machine**

<b>Jobs (in order of arrival)</b>	<b>Processing Time (days)</b>	<b>Due Date (days hence)</b>
A	4	5
B	7	10
C	3	6
D	1	4

**What is the LCFS schedule?**

**Do all the jobs get done on time?**

**Answer: Last-Come First-Served Schedule**

<b>Jobs (in order of arrival)</b>	<b>Processing Time (days)</b>	<b>Due Date (days hence)</b>	<b>Flow Time (days)</b>
D	1	4	1
C	3	6	4
B	7	10	11
A	4	5	15

**No, Jobs B and A are going to be late**

## Example of Job Sequencing: Johnson's Rule (Part 1)

**Suppose you have the following five jobs with time requirements in two stages of production. What is the job sequence using Johnson's Rule?**

<u>Jobs</u>	<u>Time in Hours</u>	
	<u>Stage 1</u>	<u>Stage 2</u>
A	1.50	1.25
B	2.00	3.00
C	2.50	2.00
D	1.00	2.00



## Example of Job Sequencing: Johnson's Rule (Part 2)

First, select the job with the smallest time in either stage.

That is Job D with the smallest time in the first stage. Place that job as early as possible in the unfilled job sequence below.

Jobs	Time in Hours	
	Stage 1	Stage 2
A	1.50	1.25
B	2.00	3.00
C	2.50	2.00
D	1.00	2.00

Drop D out, select the next smallest time (Job A), and place it 4th in the job sequence.

Drop A out, select the next smallest time. There is a tie in two stages for two different jobs. In this case, place the job with the smallest time in the first stage as early as possible in the unfilled job sequence.

Then place the job with the smallest time in the second stage as late as possible in the unfilled sequence.

Job Sequence	1	2	3	4
Job Assigned	D	B	C	A

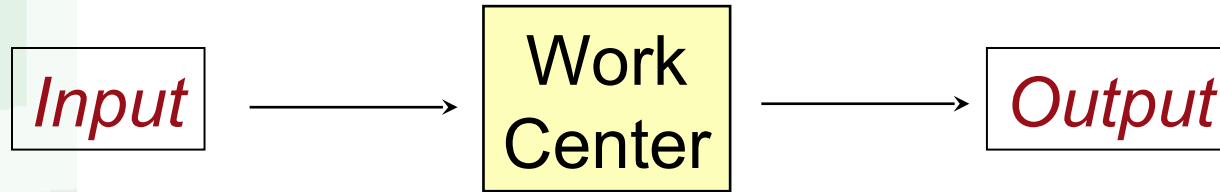
## Shop-Floor Control: Major Functions

- 1. Assigning priority of each shop order**
- 2. Maintaining work-in-process quantity information**
- 3. Conveying shop-order status information to the office**

Shop-Floor Control:  
Major Functions (Continued)

- 4. Providing actual output data for capacity control purposes**
- 5. Providing quantity by location by shop order for WIP inventory and accounting purposes**
- 6. Providing measurement of efficiency, utilization, and productivity of manpower and machines**

## Input/Output Control



- ***Planned input* should never exceed *planned output***
- **Focuses attention on bottleneck work centers**

## Principles of Work Center Scheduling

- 1. There is a direct equivalence between work flow and cash flow**
- 2. The effectiveness of any job shop should be measured by speed of flow through the shop**
- 3. Schedule jobs as a string, with process steps back-to-back**
- 4. A job once started should not be interrupted**

## Principles of Job Shop Scheduling (Continued)

- 5. Speed of flow is most efficiently achieved by focusing on bottleneck work centers and jobs**
- 6. Reschedule every day**
- 7. Obtain feedback each day on jobs that are not completed at each work center**
- 8. Match work center input information to what the worker can actually do**

## Principles of Job Shop Scheduling (Continued)

**9. When seeking improvement in output, look for incompatibility between engineering design and process execution**

**10. Certainty of standards, routings, and so forth is not possible in a job shop, but always work towards achieving it**

## Personnel Scheduling in Services

- **Scheduling consecutive days off**
- **Scheduling daily work times**
- **Scheduling hourly work times**



## Question Bowl

**A Work Center may be which of the following?**

- a. A single machine**
- b. A group of machines**
- c. An area where a particular type of work is performed**
- d. All of the above**
- e. None of the above**

**Answer: d. All of the above**

## Question Bowl

**When work is assigned to a work center simply based on what is needed over time, we would refer to this as which of the following scheduling systems?**

- a. A finite loading of work**
- b. An infinite loading of work**
- c. Forward scheduling**
- d. All of the above**
- e. None of the above**

**Answer: b. An infinite loading of work**

## Question Bowl

**Typical scheduling and controlling of operations include which of the following functions?**

- a. Allocating orders at work centers**
- b. Allocating equipment at work centers**
- c. Allocating personnel at work centers**
- d. All of the above**
- e. None of the above**

**Answer: d. All of the above**

## Question Bowl

**Typical scheduling and controlling of operations include which of the following functions?**

- a. Determining the job sequences**
- b. Dispatching**
- c. Expediting late and critical orders**
- d. All of the above**
- e. None of the above**

**Answer: d. All of the above**

## Question Bowl

**Which of the following are standard measures of schedule performance used to evaluate priority rules?**

- a. Meeting due dates**
- b. Maximizing job flow time**
- c. Maximizing work-in-process inventory**
- d. All of the above**
- e. None of the above**

**Answer: a. Meeting due dates (Correct answer can also include minimizing WIP inventory, idle time, and job flow time.)**

## Question Bowl

**Which priority rule uses the calculation of the difference between the due date and the current date divided by the number of work days remaining?**

- a. STR**
- b. SOT**
- c. DDate**
- d. FCFS**
- e. None of the above**

**Answer: e. None of the above (Correct answer can is CR or critical ratio.)**

## Question Bowl

**The major functions of a shop-floor control are which of the following?**

- a. Conveying shop-order status**
- b. Measuring efficiency**
- c. Assigning priorities**
- d. Maintaining WIP quantity information**
- e. All of the above**

**Answer: e. All of the above (Correct answer can also include providing quantity by location and actual output data.)**

## Question Bowl

**Which of the following are Tools of Shop-Floor Control?**

- a. Daily dispatch lists**
- b. Scrap reports**
- c. Rework reports**
- d. All of the above**
- e. None of the above**

**Answer: d. All of the above (Correct answer can also include all status and exception reports and input/output control reports.)**



## Question Bowl

**Which of the following is a Principle of Work-Center Scheduling?**

- a. There is a direct equivalence between work flow and cash flow**
- b. Certainty of routings are very possible in a shop**
- c. Reschedule only once a week**
- d. All of the above**
- e. None of the above**

**Answer: a. There is a direct equivalence between work flow and cash flow (There are nine other principles.)**

# **End of Chapter 19**