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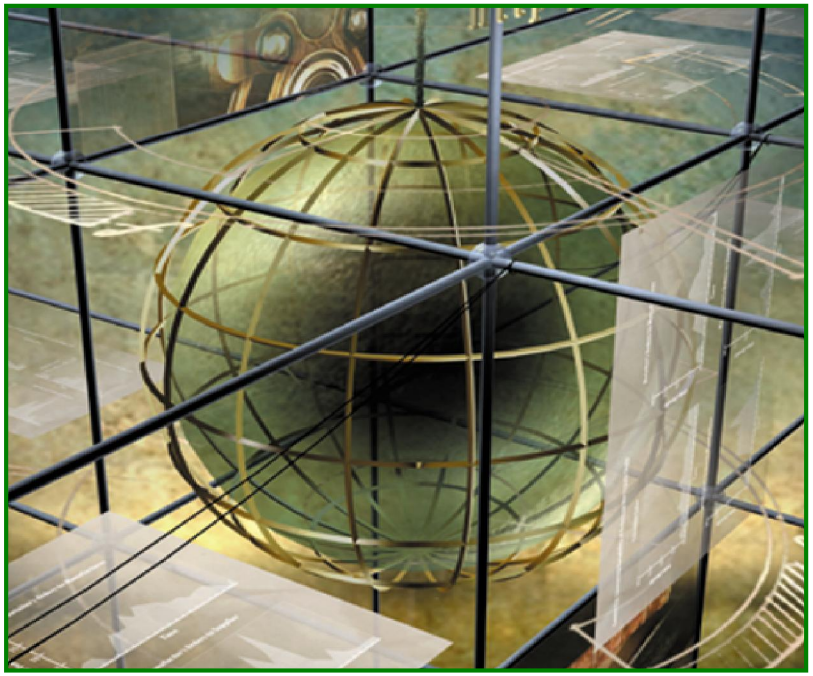
# Operations Management
## For Competitive Advantage

Chapter 15



*Operations Scheduling*

Irwin McGraw-Hill

ninth edition

*Chapter 15*

# Operations Scheduling

- 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 *Defined*

- A work center is an area in a business in which productive resources are organized and work is completed.
- May 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)

# 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 (EDD)
4. Earliest start date first (due date-lead time)
5. Least slack time remaining (STR)

# Priority Rules for Job Sequencing (Continued)

6. Least slack time remaining (per operation as opposed to per job) first
7. Smallest critical ratio (CR) first

   (due date-current date)/(number of days remaining)
8. Smallest queue ratio (QR) first

   (slack time remaining in schedule)/(planned remaining queue time)
9. Last come, first served (LCFS)
10. Random order or whim

# Schedule Performance Measures

- Meeting due dates of customers or downstream operations.
- Minimizing the flow time (the time a job spends in the process).
- Minimizing work-in-process inventory.
- Minimizing idle time of machines or workers.

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

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

What is the FCFS schedule?

Do all the jobs get done on time?

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

## Answer: FCFS Schedule

| Jobs (in order of arrival) | Processing Time (days) | Due Date (days hence) | Flow Time (days) |
|---|---|---|---|
| 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.

What is the SOT schedule?

Do all the jobs get done on time?

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

## Answer: Shortest Operating Time Schedule

| Jobs (in order of arrival) | Processing Time (days) | Due Date (days hence) | Flow Time (days) |
|---|---|---|---|
| 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: Last-Come First-Served

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

What is the LCFS schedule?

Do all the jobs get done on time?

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

## Answer: Last-Come First-Served Schedule

| Jobs (in order of arrival) | Processing Time (days) | Due Date (days hence) | Flow Time (days) |
|---|---|---|---|
| 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: Earliest Due Date First

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

What is the earliest due date first schedule?

Do all the jobs get done on time?

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

## Answer: Earliest Due Date First

| Jobs (in order of arrival) | Processing Time (days) | Due Date (days hence) | Flow Time (days) |
|---|---|---|---|
| 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.

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

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 =(Due date- Processing time)/ Total processing time

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)

What is the CR schedule?

Do all the jobs get done on time?

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

# 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?

| | Time in Hours | |
|---|---|---|
| Jobs | Stage 1 | Stage 2 |
| 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.

| | Time in Hours | |
|---|---|---|
| Jobs | 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.

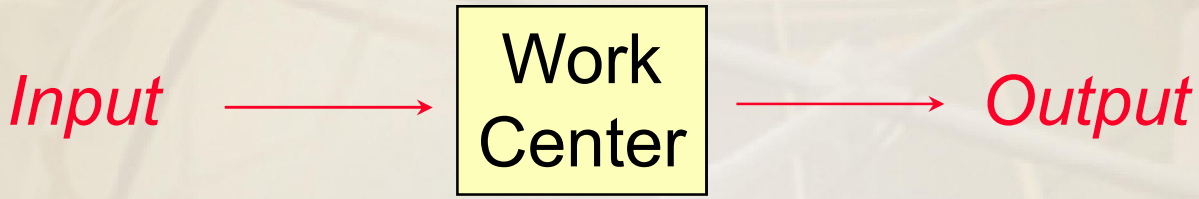
# Shop-Floor Control: Major Functions (Continued)

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

# That's all for now