Module 11
Operations Scheduling

Chapter 16 (pp 618-634)

- Work Center and definitions
  - Objectives of scheduling
  - Job sequence
- Priority Rules and Techniques
  - Scheduling n jobs on ONE machine
  - Scheduling n jobs on TWO machines
- Shop Floor Control
  - Tools for shop floor control
  - Principles

Work Center

- Work Center is an area in a business in which productive resources are organized and work is completed.
- Work Center may be a single machine, a group of machines, or an area where a particular type of work is done
  - Job shop (*by function*)
  - Flow (*by product*)

Capacity and Scheduling

Capacity Consideration

- Infinite loading *(no consideration to capacity)*
- Finite loading

Type of Scheduling

- Backward scheduling (MRP) *(latest starting date)*
- Forward scheduling *(earliest completion date)*

Resources to Schedule

- Machine –limited
- Labor -Limited

Refer to Exhibit 16.1

Typical Scheduling and Control Functions

- Allocating orders, equipment, and personnel to work centers *(short run capacity planning)*
- Determining the sequence of orders to be done *(job priority)*
- Initiating work of the scheduled orders *(dispatching)*
- Shop-floor control *(Review Status and Expedite)*

Objectives of Work-Center Scheduling

- Meet due dates
- Minimize lead time
- Minimize setup time or cost
- Minimize work-in-process inventory
- Maximize machine *and/or* labor utilization *(w/o affecting flow?)*

Priority Rules for Job Sequencing

Job sequencing is to determine the order of which jobs to be done on a work center

1. First-come, first-served *(FCFS)*
2. Shortest operating time *(SOT)*
3. Earliest due date first
4. Earliest start date first (due date minus lead time)
5. Least Slack Time Remaining (STR) first

Priority Rules for Job Sequencing

6. Least slack time remaining (per operation as opposed to per job-STR/OP) first
7. Smallest critical ratio first

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

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

Performance Measures of Priorities

- 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.

Job Sequencing Example
First-Come First-Served

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

Orders submitted
at beginning of week

n-jobs on one machine

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

Late?
On-Time?

Total completion time= 15 Average=15/4=3.75 Average lateness= ?

Job Sequencing Example
Shortest Operating 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

Orders submitted
at beginning of week

n-jobs on one machine

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

Late?
On-Time?

Total completion time= 15 Average=15/4=3.75 Average lateness= ?

In-Class Exercise

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

Orders submitted
at beginning of week

n-jobs on one machine

Develop LCFS and earliest Due Date schedules?

Job Sequencing Example
Last-Come First-Served

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

Orders submitted
at beginning of week

n-jobs on one machine

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

Jobs Late? 2

Average lateness = (1+10)/4 = 2.75 days

Job Sequencing Example
Earliest Due Date First

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

Orders submitted
at beginning of week

n-jobs on one machine

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

Jobs Late?
Jobs On-Time?

Average Lateness = (2+5)/4 = 1.75 days

Job Sequencing
n Jobs on 2 Machines (Johnson's Rule)

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

1. Select the shortest time
2. If the shortest time is on first machine *schedule* it first; if it is not, *schedule* it last
3. Repeat 1 & 2 until completion of sequence on the first machine

Jobs	M/c 1 (Min)	M/c 2 (Min)
A	3	2
B	6	8
C	5	6
D	7	4

4. Develop machine 2 schedule based on machine 1 schedule. (*End time from machine1 will be start time for machine 2)*

Example of Job Sequencing
Johnson's Rule

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.

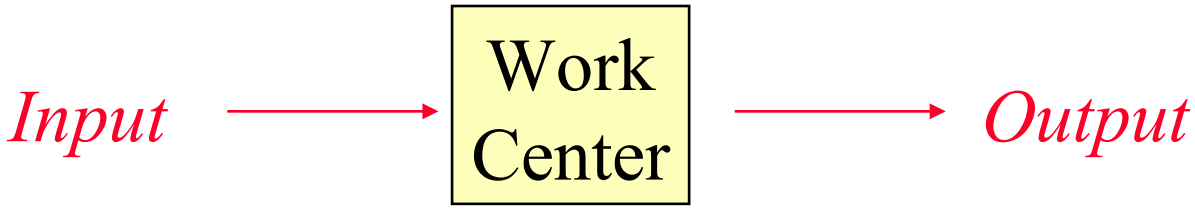
Drop A out, select the next smallest time. There is a tie in two stages for two different jobs. In this case, place the job with the smallest time in the first stage as early as possible in the unfilled job sequence.

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

Principles of Work Center Scheduling

Input/Output Control



- Planned input should *never exceed* planned output (*Exhibit 15.8)*
- 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.

Shop-Floor Control System

A system for utilizing data from the shop floor as well as data processing files to maintain and communicate status information on shop orders and work centers

Functions

1. Assigning priority of each shop order.
2. Maintaining work-in-process quantity information.
3. Conveying shop-order status information to the office.
4. Providing actual output data for capacity control purposes.
5. Providing quantity by location and by shop order for WIP inventory and accounting purposes.
6. Providing measurement of efficiency, utilization, and productivity of manpower and machines.

Tools for Shop Floor Control

>>>>Data Integrity (accuracy, timeliness)

- Gantt Charts
- Daily Dispatch
- Status and exception reports (exhibit 15.7b)
- Input/output control report (exhibit 15.7c)