

# IE 314: Operations Management

## Shot-Term Scheduling

Lecture

7

KAMAL





# DISCUSSION QUESTIONS

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1. What is the overall objective of scheduling?
2. List the four criteria for determining the effectiveness of a *scheduling* decision. How do these criteria relate to the four criteria for *sequencing* decisions?
3. Describe what is meant by “loading” work centers. What are the two ways work centers can be loaded? What are two techniques used in loading?
4. Name five priority sequencing rules. Explain how each works to assign jobs.
5. What are the advantages and disadvantages of the shortest processing time (SPT) rule?



# Discussion Questions

1. Scheduling's objective is to optimize the use of resources so that production objectives are met.
2. Four criteria for scheduling are: minimizing completion time, maximizing utilization, minimizing work-in-process inventory, and minimizing customer waiting time. There is a one-to-one correspondence between minimizing completion time and minimizing flowtime.
3. Loading is the assignment of jobs to work processing centers. Work centers can be loaded by capacity or by assigning specific jobs to specific work centers. Gantt charts and the assignment method are loading techniques.
4. Five priority sequencing rules are:
  - First come, first served (FCFS); or First in, first out (FIFO): Jobs are sequenced in the order in which they arrive at the workstation.
  - Earliest due date (EDD): Jobs are sequenced in the order in which they are due for delivery to the customer.
  - Shortest processing time (SPT): Jobs are sequenced in order of the processing time required at the workstation, with the job requiring the least processing time at the workstation scheduled first.
  - Longest processing time (LPT): Jobs are sequenced in order of the processing time required at the workstation, with the job requiring the longest processing time at the workstation scheduled first.
  - Critical ratio (CR): Jobs are sequenced in order of increasing critical ratio (the ratio of *time required by work left to be done* to *time left to do the work*).
5. SPT minimizes the average flow time, average lateness, and average number of jobs in the system. It maximizes the number of jobs completed at any point. The disadvantage is that long jobs are pushed back in the schedule.



6. What is a due date?
7. Explain the terms "flow time" and "lateness."
8. Which shop-floor scheduling rule would you prefer to apply if you were the leader of the only team of experts charged with defusing several time bombs scattered throughout your building? You can see the bombs; they are of different types. You can tell how long each one will take to defuse. Discuss.
9. When is Johnson's rule best applied in job-shop scheduling?
10. State the four effectiveness measures for dispatching rules.
11. What are the steps of the assignment method of linear programming?



# Discussion Questions

6. A due date may range from a (meaningless) promise to a contractual obligation. It is a target with or without penalties.
7. Flow time is the length of time a job is in the system; lateness is completion time minus due date.
8. Most students will go for EDD, to gain minimum lateness. Others will go for SPT, on the grounds that the team can't afford to tackle a job with an early due date and a long processing time. Interesting to see student assumption about sequence, damage, etc.
9. Johnson's rule is used to sequence several jobs through two work centers.
10. Four effectiveness measures for dispatching rules: average completion time, average number of jobs in the system, average job lateness, and utilization.
11. The *assignment method* involves adding and subtracting appropriate numbers in the problem's table in order to find the lowest opportunity cost for each assignment. The four steps are detailed in the chapter.
12. Advantages of level material use are:
  - Lower inventory costs
  - Faster product throughput (shorter lead times)
  - Improved component and product quality
  - Reduced floor space requirement
  - Improved communication between employees because they are closer together
  - A smoother production process because large lots have no hidden problems



# Example 4 – p.624

Job/Machine	A	B	C
R-34	11\$	14\$	6 \$
S-66	8 \$	10\$	11\$
T-50	9 \$	12\$	7 \$

The Akron Police Department has five detective squads available for assignment to five open crime cases. The chief of detectives, Paul Kuzdrall, wishes to assign the squads so that the total time to conclude the cases is minimized. The average number of days, based on past performance, for each squad to complete each case is as follows:

SQUAD	CASE				
	A	B	C	D	E
1	14	7	3	7	27
2	20	7	12	6	30
3	10	3	4	5	21
4	8	12	7	12	21
5	13	25	24	26	8

Each squad is composed of different types of specialists, and whereas one squad may be very effective in certain types of cases, it may be almost useless in others.

- Solve the problem by using the assignment method.
- Assign the squads to the above cases, but with the constraint that Squad 5 cannot work on Case E because of a conflict.



# EXERCISE 15.7

(a)

Squad	A	B	C	D	E
1	<del>10</del>	<del>4</del>	<del>0</del>	<del>4</del>	<del>24</del>
2	<del>13</del>	<del>1</del>	<del>6</del>	<del>0</del>	<del>24</del>
3	6	0	1	2	18
4	0	5	0	5	14
5	4	17	16	18	0

**1 ↔ C, 2 ↔ D, 3 ↔ B, 4 ↔ A, 5 ↔ E**

$$3 + 6 + 3 + 8 + 8 = \$28$$





## EXERCISE 15.7

(b)


Squad	A	B	C	D	E
1	<del>1</del> 1	<del>4</del>	<del>0</del>	<del>4</del>	<del>1</del> 0
2	<del>1</del> 4	<del>1</del>	<del>6</del>	<del>0</del>	<del>1</del> 0
3	<del>7</del>	<del>0</del>	<del>1</del>	<del>2</del>	<del>4</del>
4	<del>1</del>	<del>5</del>	<del>0</del>	<del>5</del>	<del>0</del>
5	<del>0</del>	<del>1</del> 2	<del>1</del> 1	<del>1</del> 3	<del>2</del> 3

**1 ↔ C, 2 ↔ D, 3 ↔ B, 4 ↔ E, 5 ↔ A**

$$3 + 6 + 3 + 21 + 13 = \$46$$

••• **15.9** James Gross, chairman of the College of Oshkosh's business department, needs to assign professors to courses next semester. As a criterion for judging who should teach each course, Professor Gross reviews the past 2 years' teaching evaluations (which were filled out by students). Since each of the four professors taught each of the four courses at one time or another during the 2-year period, Gross is able to record a

course rating for each instructor. These ratings are shown in the following table.

- Find the assignment of professors to courses to maximize the overall teaching rating.
- Assign the professors to the courses with the exception that Professor Fisher cannot teach Statistics. 

Professor	Course			
	Statistics	Management	Finance	Economics
W. W. Fisher	90	65	95	40
D. Golhar	70	60	80	75
Z. Hug	85	40	80	60
N. K. Rustagi	55	80	65	55



## EXERCISE 15.9

Squad	STAT	MGT	FIN	ECON
W.W.F	5	30	0	50
D.G	10	20	0	0
Z.H.	0	45	5	20
N.K.R.	25	0	15	20

**Z.H ↔ STAT, W.W.F ↔ FIN, D.G ↔ ECON, N.K.R ↔ MGT**

$$95 + 75 + 80 + 85 = 335$$

•• **15.12** An Alabama lumberyard has four jobs on order, as shown in the following table. Today is day 205 on the yard's schedule.

Job	Due Date	Remaining Time (days)
A	212	6
B	209	3
C	208	3
D	210	8

PX

In what sequence would the jobs be ranked according to the following decision rules:

- a) FCFS
- b) SPT
- c) LPT
- d) EDD
- e) Critical ratio

Which is best and why? Which has the minimum lateness?





# EXERCISE 15.12

Critical Ratio					
Job	Processing Time	Start Date	End Date	Due Date	Lateness
D	8	205	212	210	2
C	3	213	215	208	7
A	6	216	221	212	9
B	3	222	224	209	15
		Total Lateness			33



## EXERCISE 15.12

Dispatching	Sequence	Avg Flow Time	Avg # of Jobs	Avg # of Lateness
FCFS	A-B-C-D	11.75	2.4	6.5
SPT	B-C-A-D	10.25	2.1	5
LPT	D-A-C-B	14.8	3	9
EDD	C-B-D-A	10.8	2.2	5.25
CR	D-C-A-B	14	2.8	8.3

SPT is the best all-around

•• **15.13** The following jobs are waiting to be processed at Rick Carlson's machine center. Carlson's machine center has a relatively long backlog and sets fresh schedules every 2 weeks, which do not disturb earlier schedules. Below are the jobs received during the previous 2 weeks. They are ready to be scheduled today, which is day 241 (day 241 is a work day). Job names refer to names of clients and contract numbers.

<b>Job</b>	<b>Date Job Received</b>	<b>Production Days Needed</b>	<b>Date Job Due</b>
BR-02	228	15	300
CX-01	225	25	270
DE-06	230	35	320
RG-05	235	40	360
SY-11	231	30	310

- Complete the table below. (Show your supporting calculations.)
- Which dispatching rule has the best score for flow time?
- Which dispatching rule has the best score for utilization metric?
- Which dispatching rule has the best score for lateness?
- Which dispatching rule would you select? Support your decision.



# EXERCISE 15.13

LPT						
Job	Date Received	Processing Time	Flow Time	Completion Date	Due Date	Lateness
RG	235	40	40	280	360	0
DE	230	35	75	315	320	0
SY	231	30	105	345	310	35
CX	228	25	130	370	270	100
BR	225	15	145	385	300	85
		145	495			220





## EXERCISE 15.13

Dispatching	Sequence	Flow Time	Utilization	Avg # of Jobs	Avg Lateness
FCFS	CX-BR-DE-SY-RG	390	37.2%	2.69	12
SPT	BR-CX-SY-DE-RG	375	38.6%	2.59	12
EDD	CX-BR-SY-DE-RG	385	37.6%	2.66	10
LPT	RG-DE-SY-CX-BR	495	29.3%	3.41	44



# Quiz

Job	Date Received	Production Days Needed	Due Date
1	215	30	260
2	220	20	290
3	225	40	300
4	240	50	320
5	250	20	340

Following: FCFS, SPT, LPT, EDD, Critical Ratio.  
Which is the best and why?