Aggregate planning strategies

Pure strategy | Mixed strategy

Pure strategy:

If the demand and supply is regulated by any one of the following strategy, i.e.

(a) Utilizing inventory through constant work force.
(b) Varying the size of workforce.
(c) Subcontracting.
(d) Making changes in demand pattern.

Mixed strategy:

If the demand and supply is regulated by mixture of the strategies as mentioned, it is called mixed strategy.

6.4 Sequencing

The order in which jobs pass through the machines or work stations is called sequencing. The relative priorities are based on certain rules as discussed in the following:

1. First Come, First Served (FCFS) rule: This is a fair approach particularly applicable to people. In case of inventory management, it is First In First Out (FIFO). That means the 1^{st} piece of inventory at a storage area is the 1^{st} one to be used.
2. The shortest processing time (SPT) rule: SPT rule sequences jobs in increasing order of their processing times (including set up).
3. The Earliest Due Date (EDD) rule: Sequences jobs in order of their due dates, earliest first.
4. The critical ratio (CR) rule: Sequences jobs in increasing order of their critical ratio.

$$CR = \frac{\text{Due date- Today's date}}{\text{Remaining processing time}}$$

If $CR>1$ The job is ahead of schedule.
If $CR<1$ The job is behind schedule.
If $CR=1$ The job is exactly on schedule.

5. The Slack Time Remaining (STR) rule: It employs that the next job processed is the one that has the least amount of slack time.
Slack = (Due date – Today's date) – Remaining processing time

6.5 Sequencing of n jobs through 2 machines (Johnson's rule)

Considering 2 machines and 'n' jobs as shown in Table 6.1.

Table 6.1 Job sequencing for n jobs

1	t_{11}	t_{12}
2	t_{21}	t_{22}
3	t_{31}	t_{32}
4	t_{11}	t_{42}
.	.	.
.	.	.
i	t_{i1}	t_{i2}
.	.	.
n	t_{n1}	t_{n2}

Step 1: Find the minimum among t_{i1} and t_{i2}.

Step 2(a): If the minimum processing time requires m/c-1, place the associated job in the 1st available position in sequence.

Step 2(b): If the minimum processing time requires machine-2, place the associated job in the last available position in sequence.

Step 3: Remove the assigned job from the table and return to Step 1 until all positions in sequence are filled. (Ties may be considered randomly)

The above algorithm is illustrated with the following example.

Ex.1 Consider two machines and six jobs flow shop scheduling problem. Using Johnson's algorithm, obtain the optimal sequence which will minimize the makespan.

Job	Time taken by machines	
	1	2
1	5	4
2	2	3
3	13	14
4	10	1
5	8	9
6	12	11
Sum	50	42

Solution: The working of the algorithm is summarized in the form of a table which is shown below.

Stage	Unscheduled job	Min	Assignment	Partial sequence/ Full sequence
1	1 2 3 4 5 6	t_{42}	Job 4-[6]	× × × × × 4
2	1 2 3 5 6	t_{21}	Job 2-[1]	2 × × × × 4
3	1 3 5 6	t_{12}	Job 1-[5]	2 × × × 1 4
4	3 5 6	t_{51}	Job 5-[2]	2 5 × × 1 4
5	3 6	t_{62}	Job 6-[4]	2 5 × 6 1 4
6	3	t_{31}	Job 3-[3]	2 5 3 6 1 4

Now the optimal sequence is 2-5-3-6-1-4.

The makespan is determined as shown below.

Job	M/C-1		M/C-1		Idle time on m/c-2
	Time in	Time out	Time in	Time out	
2	0	2	2	5	2
5	2	10	10	19	5
3	10	23	23	37	4
6	23	35	37	48	0
1	35	40	48	52	0
4	40	50	52	53	0

The makespan for this schedule is 53.

6.6 Line balancing

Plants having continuous flow process and producing large volume of standardized components prefer conveyor assembly line. Here the work centres are sequenced in such a way that at each stage a certain amount of total work is carried out so that at the end of conveyor line, the final product comes out. This requires careful preplanning to balance the timing between each work centres so that idle/waiting time is minimized. This process of internal balancing is called Assembly line balancing.

Line balancing is defined as the procedure for creating work stations and assigning tasks to them according to a predetermined technological sequence such that the idle time at each work station is minimized.

In perfect line balancing, each work centre completes its assigned work within a fixed time duration so that output from all operations are equal on the line. Such a perfect balancing is difficult to achieve. Certain work station/centre take more operation time causing subsequent work centre to become idle.

Balancing may be achieved by

- Rearrangement of work stations
- Adding m/c and or workers at some work stations.

So that all work centres take about the same amount of time.

Some terminologies used in line balancing:

1. Work station: It is a location on the assembly line where specified work is performed.
2. Cycle time: It is the amount of average time a product spends at one work station

$$\text{Cycle time (CT)} = \frac{\text{Available time period}}{\text{Total no. of products/output}}$$

3. Task : The smallest grouping of work that can be assigned to a work station.
4. Task time: Standard time to perform task.
5. Station time: Total standard time at a particular work station.

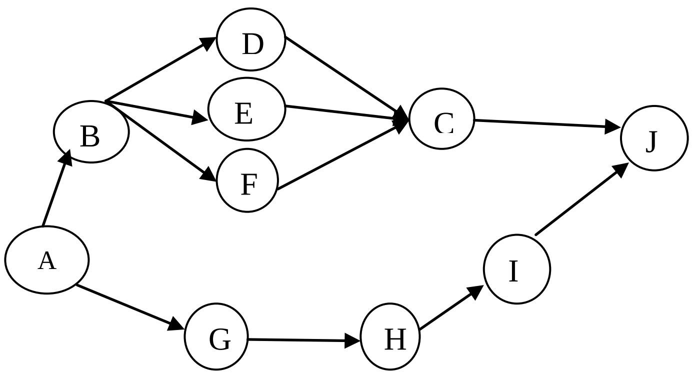
A typical example will clarify the procedure of line balancing.

Ex: A company is setting an assembly line to produce 192 units per 8 hour shift. The information regarding work elements in terms of times and intermediate predecessors are given below:

Work element	Time (Sec)	Immediate predecessor
A	40	None
B	80	A
C	30	D,E,F
D	25	B
E	20	B
F	15	B
G	120	A
H	145	G
I	130	H
J	115	C,I
Total	720	

1. What is the desired cycle time?
2. What are the theoretical numbers of stations?
3. Use largest work element time rule to work out a solution on a precedence diagram.
4. What are efficiency and balance delay of the solution obtained?

Solution: The precedence diagram is represented as shown below:



(a) Cycle time: 8hours/192 units = 150 sec/unit.
(b) Sum of the time of all work elements = 720 secs
So, minimum number of work station = 720/150 = 4.8 = 5 stations.