Maintenance Capacity Planning

Maintenance Capacity Planning

Maintenance capacity planning is performed to determine the optimal level of resources required to meet the forecasted maintenance load

Maintenance Capacity planning procedures:

- Determine the total maintenance load
- Estimate the required spare parts and material to meet the load
- Determine the equipment and tools necessary for all types of maintenance work
- Determine the skills and the number of workers for each skill
- Provide special plans for highly computerized equipment

Maintenance Capacity Planning

Four basic strategies are used to match the fixed capacity with fluctuating monthly maintenance demands:

1. Chase strategy: performing the exact amount of maintenance workload required for each month, without advancing or delay
2. Levelling strategy: the peaks of demand are distributed to periods of lower demand, aiming to have a constant level of monthly maintenance activity
3. Demand management: the maintenance demand itself is levelled by distributing preventive maintenance equally among all periods
4. Subcontracting: regular employees perform a constant level of monthly maintenance activity, leaving any excess workload to contractors

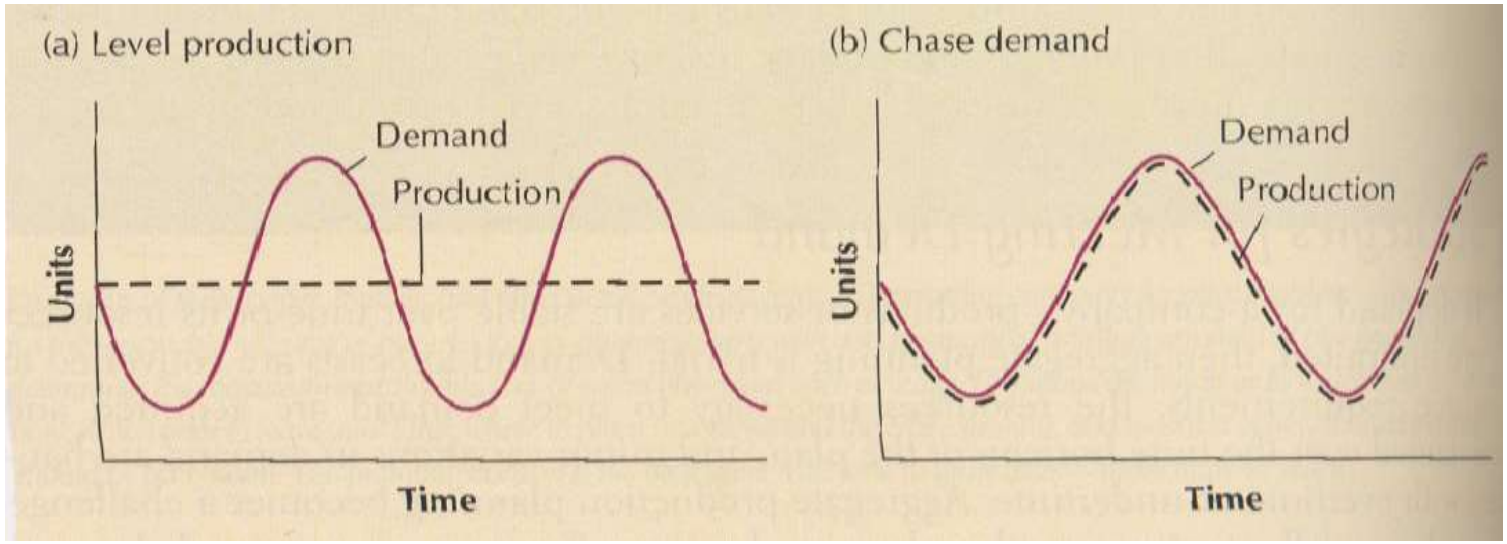
Maintenance Capacity Planning

The Extremes

Level Strategy ⟷ **Chase Strategy**

Production rate is constant

Production equals demand



Maintenance Capacity Planning

Sources of Craftsmen

- Regular workers
- Overtime in-house workers
- Contract maintenance workers

The best mix is determined by using cost and availability measures

Capacity Planning Techniques

Capacity Planning Techniques

- Deterministic models
- Stochastic models

Capacity Planning Techniques

Deterministic models:

Assumes the following are fixed constants:

- Forecasted maintenance load
- Standard times
- Other variables

Types of deterministic techniques:

- Heuristic tableau method
- Linear programming

Capacity Planning Techniques

Stochastic models :

Assumes the following are random variables with certain probability distributions:

- Forecasted maintenance load
- Standard times
- Other variables

Types of deterministic techniques:

- Queuing models.
- Stochastic discrete event simulation

Capacity Planning Techniques

Heuristic Tableau Method

For each maintenance craft, the required capacity is given by the forecasted workload for each period. The available capacity for each period is given by the quantity of available resources of different categories. Each of these categories, such as regular time, overtime, and subcontract, has its own cost.

Capacity Planning Techniques

Heuristic Tableau Method

Principles and guidelines:

- Maintenance work load is classified into grades according to the skill the work requires and the priority of the work.
- All priority work is performed by regular in-house workers as much as possible.
- If it is not possible to satisfy grade 1 work by regular in-house workers, use overtime.
- No backlog is allowed for grade 1 work.

Capacity Planning Techniques

Heuristic Tableau Method...

- The staffing level must be determined based on the average maintenance load with a healthy backlog from grade 2 work carried out into the system.
- The grade 2 work can be met with overtime or contract maintenance.
- The overtime capacity is at most 25% of the regular in-house capacity.
- The maximum for backlog is 100 man-hours. If the backlog exceeds this limit, subcontracting is utilized and it is assumed that subcontracting can provide as much capacity as needed.

Capacity Planning Techniques

Steps of Heuristic Tableau Method

- FM_t = Total forecasted Maintenance load.
- B_{t-1} = Maintenance workload backlog from period t-1
- TM_t = Total Maintenance workload for period t;

$$TM_t = FM_t + B_{t-1}$$

- $TM_{i,t}$ = Total Maintenance workload of grade i in period t, i=1,2 as needed.
- $RM_{i,t}$ = Regular in-house capacity for Maintenance workload of grade i in period t
- $OM_{i,t}$ = Overtime capacity for Maintenance workload of grade i in period t
- $CM_{i,t}$ = Contract capacity for Maintenance work of grade i in period t

Capacity Planning Techniques

Steps of Heuristic Tableau Method

- C_r = Hourly cost of trade on regular time
- C_o = Hourly cost of trade on overtime
- C_s = Hourly cost of subcontracting
- B_t = Backlog in man-hours at the beginning of period t
- CR_t = Capacity of in-house regular time in period t
- CO_t = Capacity of in-house overtime in period t
- CS_t = Capacity of subcontracting in period t
- FM_t = Forecasted maintenance load in period t

Capacity Planning Techniques

Steps of Heuristic Tableau Method

- The transportation tableau in shows the setup for a three-period planning horizon, with three resources for maintenance work in each period (m = R: regular time, m = O: overtime, m = S: subcontract). Assigning an infinite cost (∞) prohibits assigning any maintenance work to the given (i, j) cell.

- After the modified transportation tableau is constructed, it is solved by the **least-cost assignment heuristic**. This heuristic assigns as much as possible (the minimum of supply and demand) to the available (unassigned) cell with the least cost. After each assignment, the supply and demand for the given cell are updated, and the process continues until all demands have been assigned. Although this technique does not guarantee an optimum solution, it is an effective heuristic that frequently leads to optimum solutions.

Capacity Planning Techniques

Periods	Period Sources	1	2	3	Capacity
1	Regular Time	C_r	∞	∞	CR1
	Overtime	C_o	∞	∞	CO1
	Subcontract	C_s	∞	∞	CS1
2	Regular Time	$C_r + \pi$	C_r	∞	CR2
	Overtime	$C_o + \pi$	C_o	∞	CO2
	Subcontract	$C_s + \pi$	C_s	∞	CS2
3	Regular Time	$C_r + 2\pi$	$C_r + \pi$	C_r	CR3
	Overtime	$C_o + 2\pi$	$C_o + \pi$	C_o	CO3
	Subcontract	$C_S + 2\pi$	$C_s + \pi$	C_s	CS3
	Maintenance load	M_1	M_2	M_3	

Example

Assume we have three time periods with maintenance loads 400, 300, and 500, respectively. The in-house regular capacity is 200, 350, and 300 for periods 1, 2, and 3, respectively. The overtime is at most 25% of the in-house capacity. Subcontracting is abundant and, technically, there is no limit on this source. The cost of performing one in-house man-hour is taken to be 1 unit, overtime per man-hour costs 50% more than regular time (i.e., 1.5 units), and subcontracting costs 2 units. Backlogging of one man-hour costs $\pi = 0.3$. The capacity for subcontracting can be taken as a large number and, for purposes of demonstration, is taken to be 500 man-hours.

Example

Period	Sources	Period 1	Period 2	Period 3	Capacity
1	Regular time	1 [200]	∞	∞	200
	Overtime	1.5 [40]	∞	∞	40
	Subcontract	2 [30]	∞	∞	500
2	Regular time	1.3 [50]	1 [300]	∞	350
	Overtime	1.8 [80]	1.5	∞	80
	Subcontract	2.3	2	∞	500
3	Regular time	1.6	1.3	1 [300]	300
	Overtime	2.1	1.8	1.5 [75]	75
	Subcontract	2.6	2.3	2 [125]	500
	Maintenance load	400	300	500	