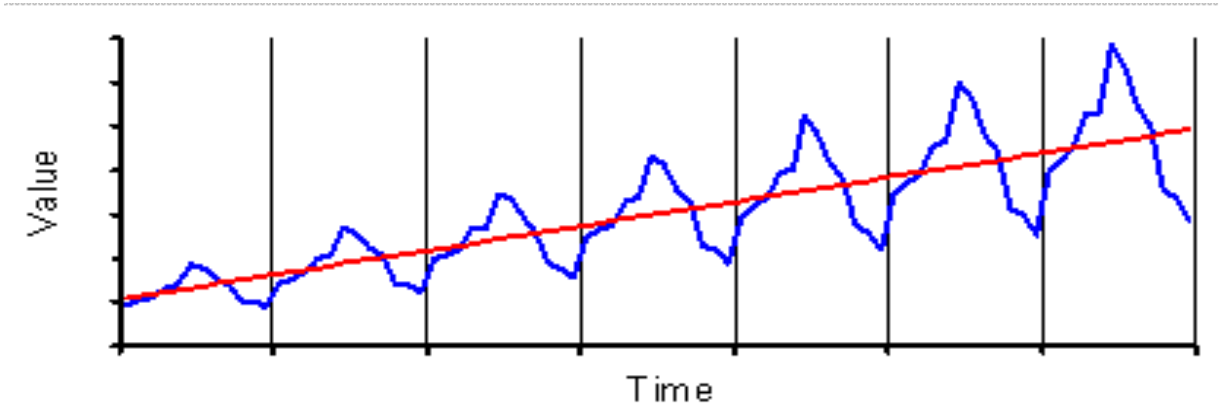
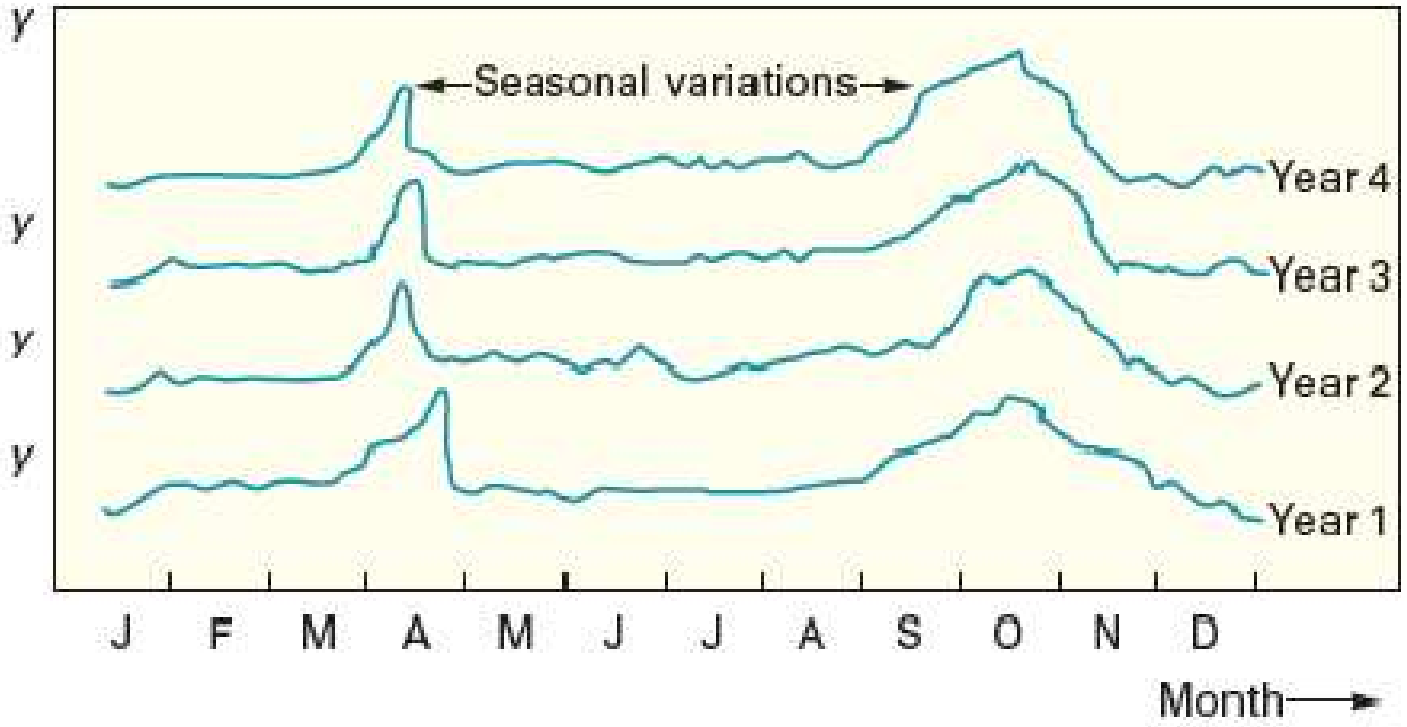
UNIT 5

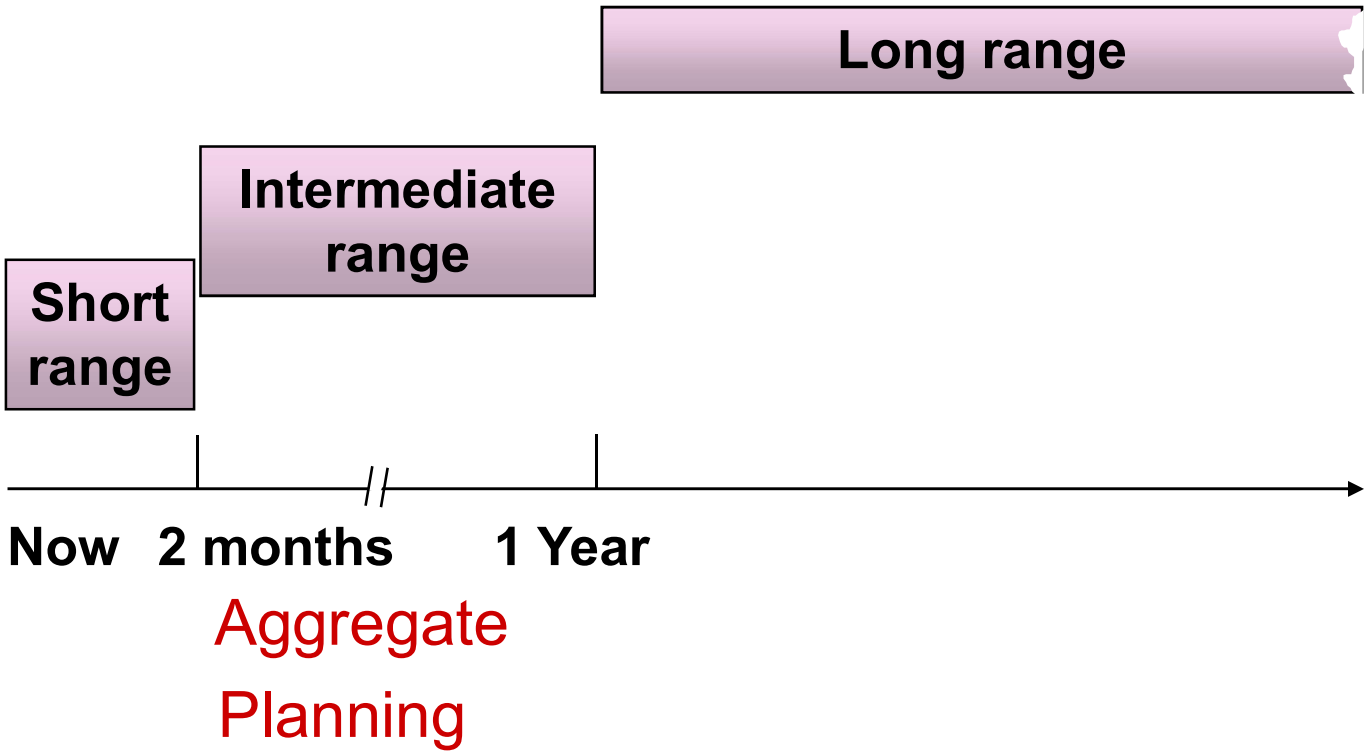
AGGREGATE PLANNING & MASTER SCHEDULING

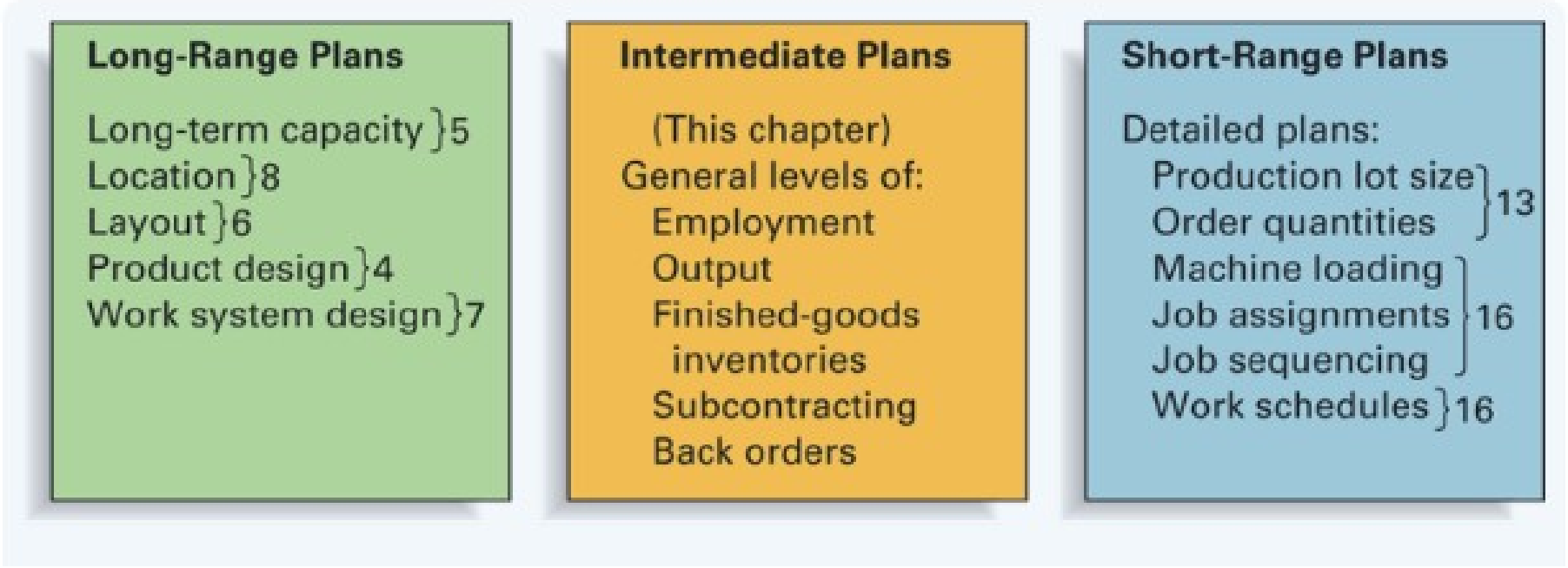
- Seasonal variations in demand are quite common in many industries.
- Hence, organizations have to be prepared in dealing with such uneven demand.
- Also organizations cannot predict exactly the quantity and timing of demands in advance.
- Even so, they must be prepared in advance in order to be able to handle demand.
- They use a process often referred to as *aggregate planning.*


Value
Time


y
Seasonal variations
Year 4
y
Year 3
y
Year 2
y
Year 1
J F M A M J J A S O N D
Month

Capacity Decisions




Long-Range Plans
Long-term capacity } 5
Location } 8
Layout } 6
Product design } 4
Work system design } 7
Intermediate Plans
(This chapter)
General levels of:
Employment
Output
Finished-goods inventories
Subcontracting
Back orders
Short-Range Plans
Detailed plans:
Production lot size } 13
Order quantities
Machine loading } 16
Job assignments
Job sequencing
Work schedules } 16

*The goal of **aggregate planning** is to achieve a production plan that will effectively utilize the organization's resources to match expected demand.*

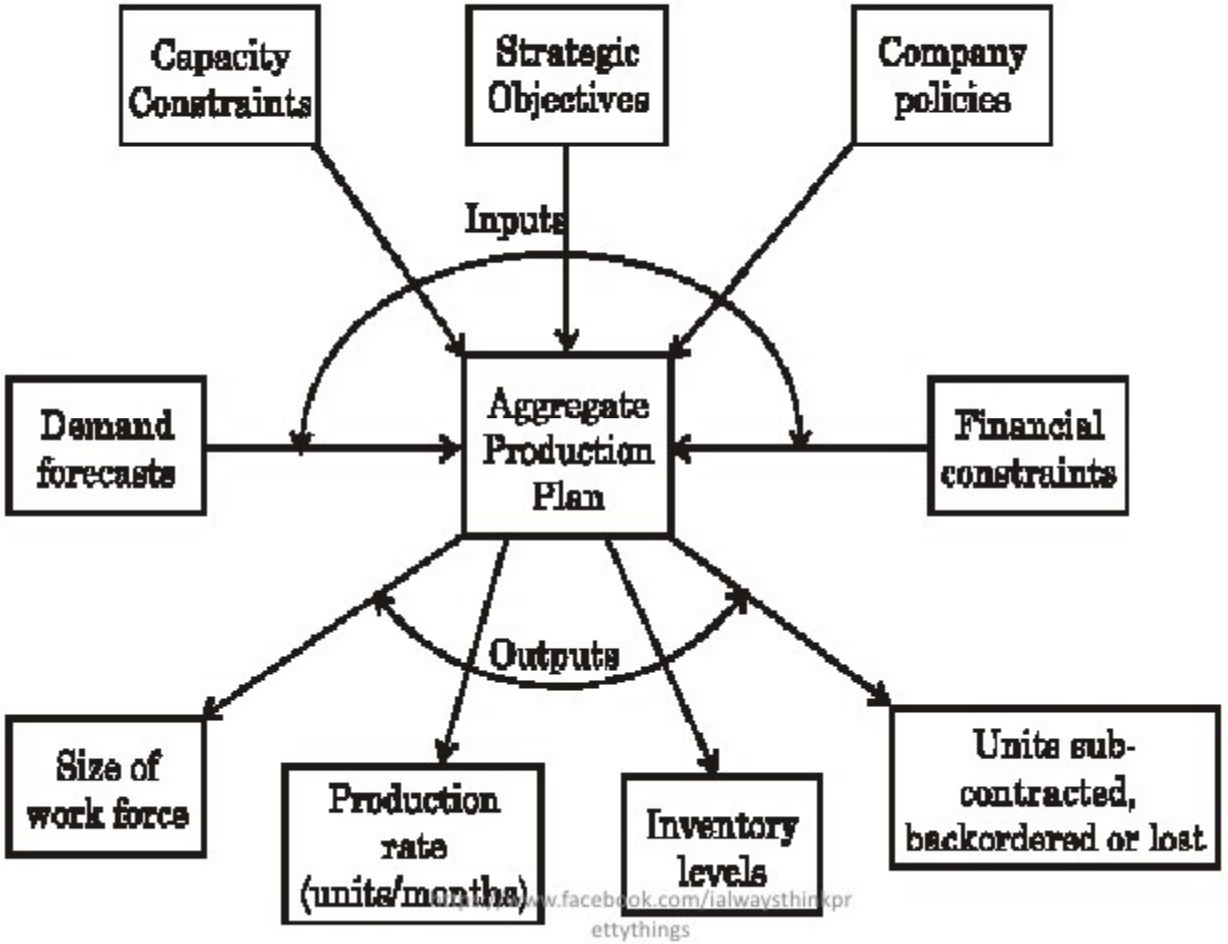
Aggregate planning decisions are strategic decisions that define the framework within which operating decisions will be made.

- They are the starting point for scheduling and production control systems.
- They provide input for financial plans;
- They involve forecasting input and demand management
- They may require changes in employment levels.

An Overview of Aggregate Planning

Inputs	Outputs
Demand forecast Resources Workforce Facilities Policies Subcontracting Overtime Inventory levels Back orders Costs Inventory carrying Back orders Hiring/firing Overtime Inventory changes Subcontracting	Total cost of a plan Projected levels of Inventory Output Employment Subcontracting Backordering

Inputs to and Outputs from Aggregate Production Planning



Aggregate Planning Strategies

Aggregate planning strategies can be described as *proactive, reactive,* or *mixed.*

Proactive strategies involve demand options: They attempt to alter demand so that it matches capacity.

Reactive strategies involve capacity options: They attempt to alter capacity so that it matches demand.

Mixed strategies involve an element of each of these approaches.

Proactive – Demand Options: Alter demand to match capacity.

- Pricing
- Promotion
- Back orders
- New demand

Pricing: Pricing differentials are commonly used to shift demand from peak periods to off-peak periods.

- Some hotels, offer lower rates for weekend stays.
- Some airlines offer lower fares for night travel.
- Movie theaters may offer reduced rates for matinees

Promotion: Advertising and other forms of promotion, such as displays and direct marketing, can sometimes be very effective in shifting demand.

Back orders: An organization can shift demand fulfillment to other periods by allowing back orders. That is, orders are taken in one period and deliveries promised for a later period.

New demand: Develop new demand when capacity is under used.

Example - bus transportation, “insourcing”.

Reactive – Capacity Options: Alter capacity to match demand.

- Hire and layoff workers
- Overtime
- Part-time workers
- Inventories
- Subcontracting

Hire and layoff workers: When demand exceeds hire workers and during off season layoff workers. Hiring costs include recruitment, and training to bring new workers “up to speed.” Quality may suffer.

Overtime: The use of overtime can be attractive in dealing with seasonal demand peaks by reducing the need to hire and train people who will have to be laid off during the off-season.

Overtime also permits the company to maintain a skilled workforce and employees to increase earnings.

Part-time workers: Seasonal work requiring low-to-moderate job skills lends itself to part-time workers, who generally cost less than regular workers.

Department stores, restaurants, and supermarkets make use of part-time workers.

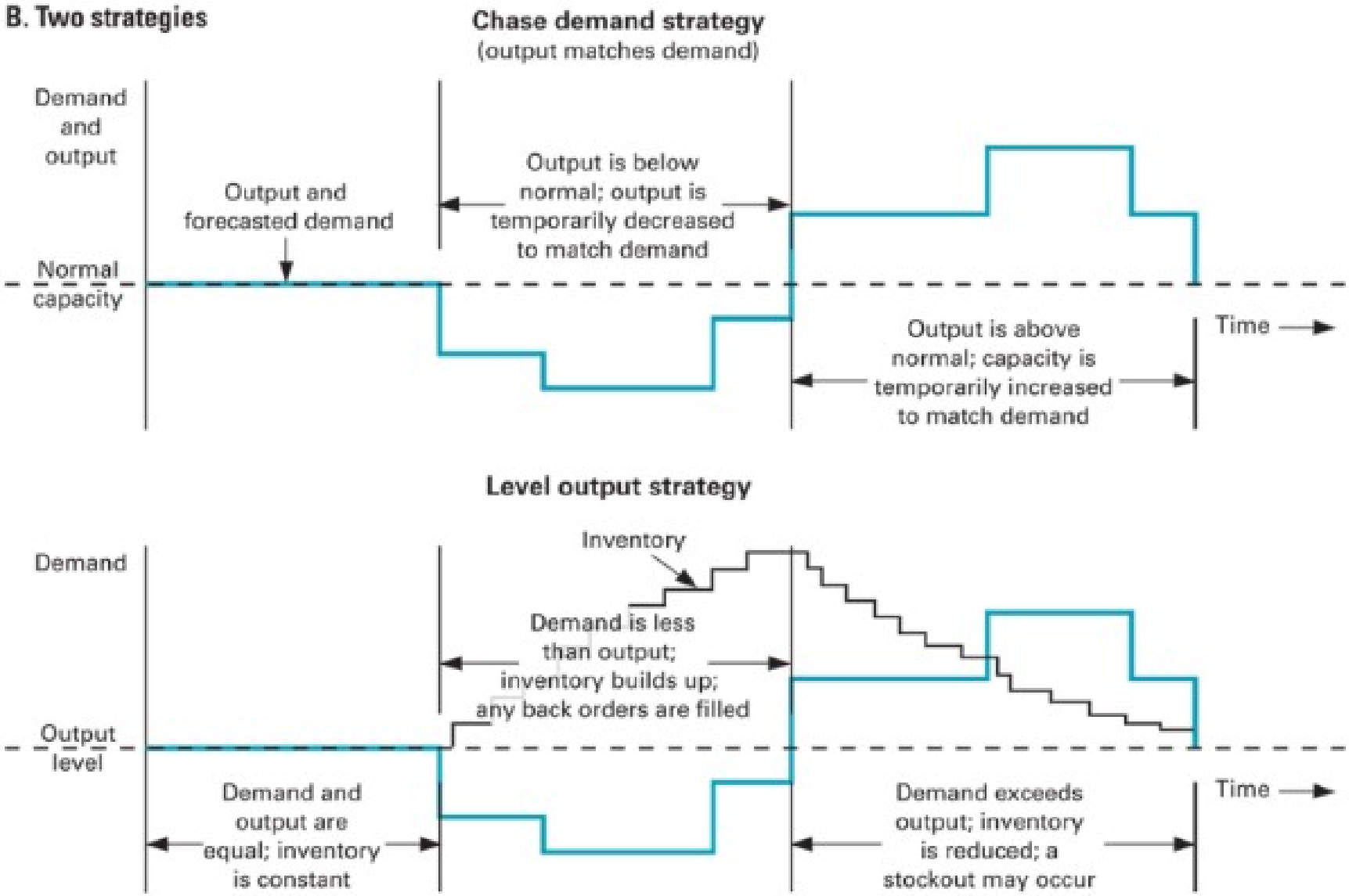
Inventories: Goods produced in one period is sold or shipped them in another period. It includes storage costs, cost of insurance, deterioration, spoilage, breakage, and so on.

Subcontracting: Subcontracting enables planners to acquire temporary capacity, although it affords less control over the output and may lead to higher costs and quality problems. Conversely, in periods of excess capacity, an organization may subcontract *in,* that is, conduct work for another organization.

Basic Strategies:

Level Capacity Strategy: Maintaining a steady rate of output while meeting variations in demand by using a combination of inventories, overtime, subcontracting and back orders.

Chase Demand Strategy: Matching capacity to demand i.e, operations would be planned to meet expected demand for that period.


B. Two strategies
Chase demand strategy
(output matches demand)
Demand and output
Output and forecasted demand
Output is below normal; output is temporarily decreased to match demand
Normal capacity
Output is above normal; capacity is temporarily increased to match demand
Time
Level output strategy
Inventory
Demand
Demand is less than output; inventory builds up; any back orders are filled
Output level
Demand and output are equal; inventory is constant
Demand exceeds output; inventory is reduced; a stockout may occur
Time

Level Capacity Strategy:

- Maintain steady output
- maintain a steady work force as hiring and layoffs can have a major impact on the morale of employees
- Inventory can take up large storage area and costs.

Chase Demand Strategy:

- Vary output to demand needs
- Inventories can be kept relatively low
- Lack of stability in operations
- Also when actual demand doesn’t meet forecast, morale of employees can suffer.

Techniques for Aggregate Planning

1. Spreadsheet technique
2. Linear – Transportation Model technique

1. Spreadsheet technique

a) Prepare the ideal plan.

b) Calculate the costs such as regular time, overtime, subcontracts, hire/layoff, inventory, back orders.

c) Compute total cost of plan.

1. A leading sparkplug manufacturer has the forecast for the next six periods.

Period	1	2	3	4	5	6
Forecast	200	200	300	400	500	200

There are 14 workers and each produce 20 units per period.

Overtime per period is 40 units.

Costs

Regular time – Rs 200/unit

Overtime - Rs 300/unit

Inventory - Rs 100/unit

Back orders - Rs 500/unit

Prepare an aggregate plan and its cost.

2.

MONTH	1	2	3	4	5	6	7	8
FORECAST	120	135	140	120	125	125	140	135

Normal capacity is 130 units, its cost is Rs 60/unit. Overtime has a cost of Rs 90/unit. Inventory cost is Rs 2/unit. Backlog cost is Rs 90/unit.

a. Develop a chase plan that matches the forecast.

b. Develop a level plan that uses inventory to absorb fluctuations.

2. Prepare a aggregate plan

Period	1	2	3	4	5	6	7	8	9
Forecast	190	230	260	280	210	170	160	260	180

The firm has 21 employees who can produce 10 units per period.
To meet the demand the firm will hire 1 person from period 1 to period 5 at an addition cost of Rs 500.

Regular time cost is Rs 600 per unit
Inventory carrying cost is Rs 500 per unit per period.
Backorder cost Rs 1000 per unit

Prepare an aggregate plan and its cost.

Period	1	2	3	4	5	6
Forecast	200	200	300	400	500	200

MONTH	1	2	3	4	5	6	7	8
FORECAST	120	135	140	120	125	125	140	135

Period	1	2	3	4	5	6	7	8	9
Forecast	190	230	260	280	210	170	160	260	180

2. Linear – Transportation Model technique

This method is used to obtain optimal solutions by allocating scarce resources in terms of cost minimization or profit maximization.

The goal is to minimize the sum of costs related to regular labour time, overtime, subcontracting, carrying inventory etc.

Method

a) Prepare a table allocating cost for each period.

b) Meet demand with the lowest possible alternative.

c) Compute the cost of operations.

Various costs –

rt – regular time cost per unit

ot – overtime cost per unit

s – subcontracting cost per unit

b – backorder cost per unit

1. Given the following information set up the transportation table and solve for minimum cost plan-

	PERIOD		
	1	2	3
Demand	550	700	750
Capacity			
Regular	500	500	500
Overtime	50	50	50
Subcontract	120	120	100
Beginning inventory	100		
Costs			
Regular time	$60 per unit		
Overtime	$80 per unit		
Subcontract	$90 per unit		
Inventory carrying cost	$1 per unit per month		
Back-order cost	$3 per unit per month		

Period		1	2	3
	Beginning Inventory			
1	Regular			
	Overtime			
	Subcontract			
2	Regular			
	Overtime			
	Subcontract			
3	Regular			
	Overtime			
	Subcontract			
	Demand	**550**	**700**	**750**

2. Using Transportation model, allocate production capacity to satisfy demand at minimum cost.

	1	2	3	4
Demand	100	50	70	80
Capacity				
Regular	60	50	60	65
Overtime	18	15	18	20
Subcontracting	20	20	20	20

Initial inventory = 20

Final inventory = 25

Cost per Unit (Rs)

Regular time -100; Overtime -125

Subcontract -130 Carrying cost per period - 4

PERIOD		1	2	3	4
	Beginning Inventory				
1	Regular				
	Overtime				
	Subcontract				
2	Regular				
	Overtime				
	Subcontract				
3	Regular				
	Overtime				
	Subcontract				
4	Regular				
	Overtime				
	Subcontract				
	Demand	**100**	**50**	**70**	**80**

2. The supply, demand, cost, inventory for a company which has constant workforce is given below. Using transportation model format, allocate production capacity to satisfy demand at minimum cost.

	1	2	3	4
Demand	160	150	160	180
Capacity				
Regular	150	150	150	150
Overtime	10	10	0	10
Subcontracting	10	10	10	10

Cost per Unit (Rs)

Regular time	50
Overtime	75
Subcontract	80

Inventory per period 4

Beginning inventory is zero.

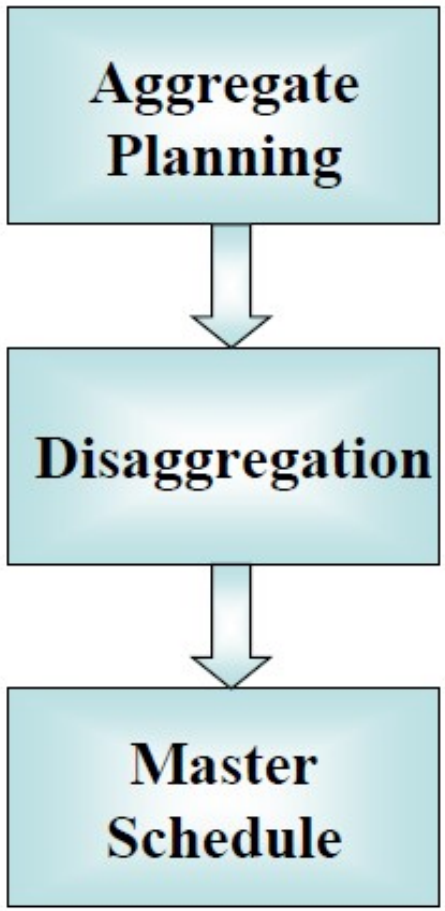
No Back orders are allowed.

PERIOD		1	2	3	4
	Beginning Inventory				
1	Regular				
	Overtime				
	Subcontract				
2	Regular				
	Overtime				
	Subcontract				
3	Regular				
	Overtime				
	Subcontract				
4	Regular				
	Overtime				
	Subcontract				
	Demand	**160**	**150**	**160**	**180**

MASTER SCHEDULE

Disaggregating the Aggregate Plan

- Breaking down the aggregate plan into specific product requirements in order to determine labor requirement, materials and inventory requirements.
- Translating the production plan into meaningful terms for production.
- The result of the disaggregating the aggregate planning is the *Master schedule*.


Aggregate Planning
Disaggregation
Master Schedule

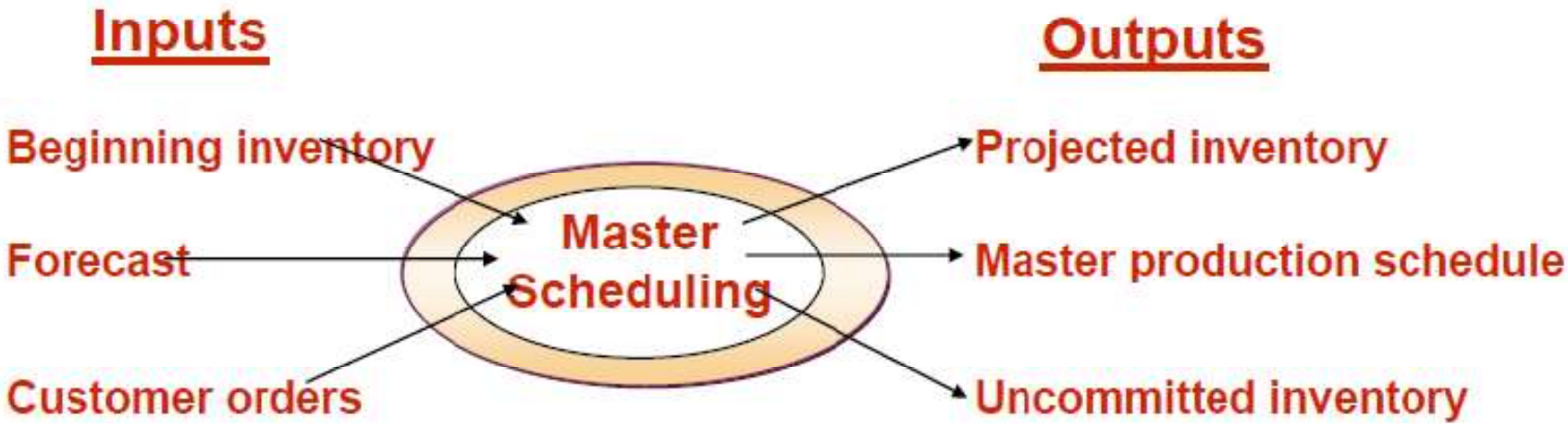
MASTER SCHEDULING

- The result of disaggregating an aggregate plan.
- *It shows the quantity and timing of specific end items for a scheduled time (6 to 8 weeks ahead).*
- It shows planned output for individual products along with time of production.
- Shows when completed orders are to be shipped.

Functions of Master Scheduling:

- Interfaces with
  - Marketing
  - Capacity planning
  - Production planning
  - Distribution planning
- Evaluates impact of new orders
- Provides delivery dates for orders
- Deals with problems
  - Production delays
  - Revising master schedule
  - Insufficient capacity

MASTER SCHEDULING PROCESS



The *master production schedule (MPS)* indicates the quantity and timing of planned production, taking into account on-hand inventory and customer orders.

Inputs

Beginning Inventory – Quantity on hand.

Forecast – Demand for that time period.

Customer orders – Guaranteed quantities already committed to customers.

Outputs

Projected Inventory – Quantities on hand after orders are fulfilled.

= Inventory from previous period – Current period requirements

MPS – Time period when actual production should take place.

Uncommitted Inventory or Available-to-promise (ATP) – Quantities available after fulfilling customer orders.

*calculated for the first period and MPS periods.

= (Beginning Inv + MPS) – (sum of customer orders until next MPS)

Master Scheduling Process

Example –

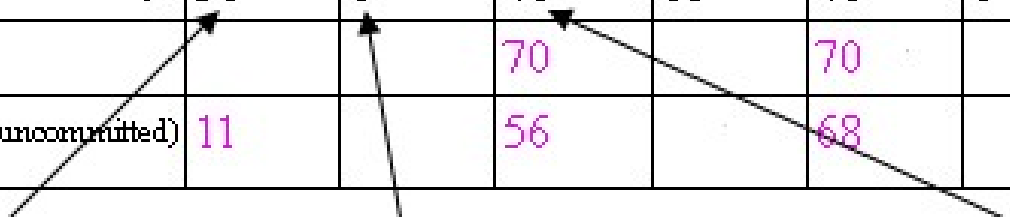
Forecast for 4 weeks of June is 30 units each and 4 weeks of July is 40 units each.

Customer orders – 33, 20, 10, 4, 2

Beginning Inventory – 64 units

Assume production size is 70 units

64(beginning inventory)	June				July			
	1	2	3	4	5	6	7	8
Forecast	30	30	30	30	40	40	40	40
Customer order (committed)	33	20	10	4	2			
Projected on-hand inventory	31	1	41	11	41	1	31	61
MPS			70		70		70	70
ATP inventory (uncommitted)	11		56		68		70	70



Testing of Master schedule

Once a tentative master schedule is prepared, it must be validated. This validation is known as *rough-cut capacity planning (RCCP).*

Rough-cut capacity : Approximate balancing of capacity and demand to test the feasibility of the master schedule.

- It involves testing the feasibility of proposed master schedule to available capacity and capacity constraints.
- It means checking capacities of production and warehouse facilities, labor, and vendors to assure that no gross deficiencies exist.

1. Prepare a master schedule for the following situation.

   The forecast for each period is 70 units.

   The starting inventory is zero.

   The MPS rule is to schedule production if the projected inventory on hand is negative.

   The production lot size is 100 units.

Period	Customer Orders
1	80
2	50
3	30
4	10

Starting Inv	1	2	3	4
Forecast				
Customer orders				
Projected on-hand inventory				
MPS				
ATP (uncommitted)				

2. Prepare a master schedule for the following situation.

The forecast for next eight week is 50 units.

The MPS rule is to schedule production if the projected inventory on hand is negative.

The production lot size is 75 units and no beginning inventory.

Week	Customer Orders
1	52
2	35
3	20
4	12

Starting Inv	1	2	3	4	5	6	7	8
Forecast								
Customer orders								
Projected on-hand inventory								
MPS								
ATP (uncommitted)								

Solution:

	June				July			
	1	2	3	4	5	6	7	8
Forecast	50	50	50	50	50	50	50	50
Customer Orders	52	35	20	12				
Projected on-hand inventory	23	48	73	23	48	73	23	48
MPS	75	75	75		75	75		75
ATP	23	40	43		75	75		75

Numericals

- Utilization and Efficiency.
- Capacity planning – Break-even volume, Total cost, Profit, concept of indifference.
- Location planning – Alternatives draw graph, range, Factor rating.
- Aggregate planning – Prepare an aggregate plan and its cost, Minimum cost plan