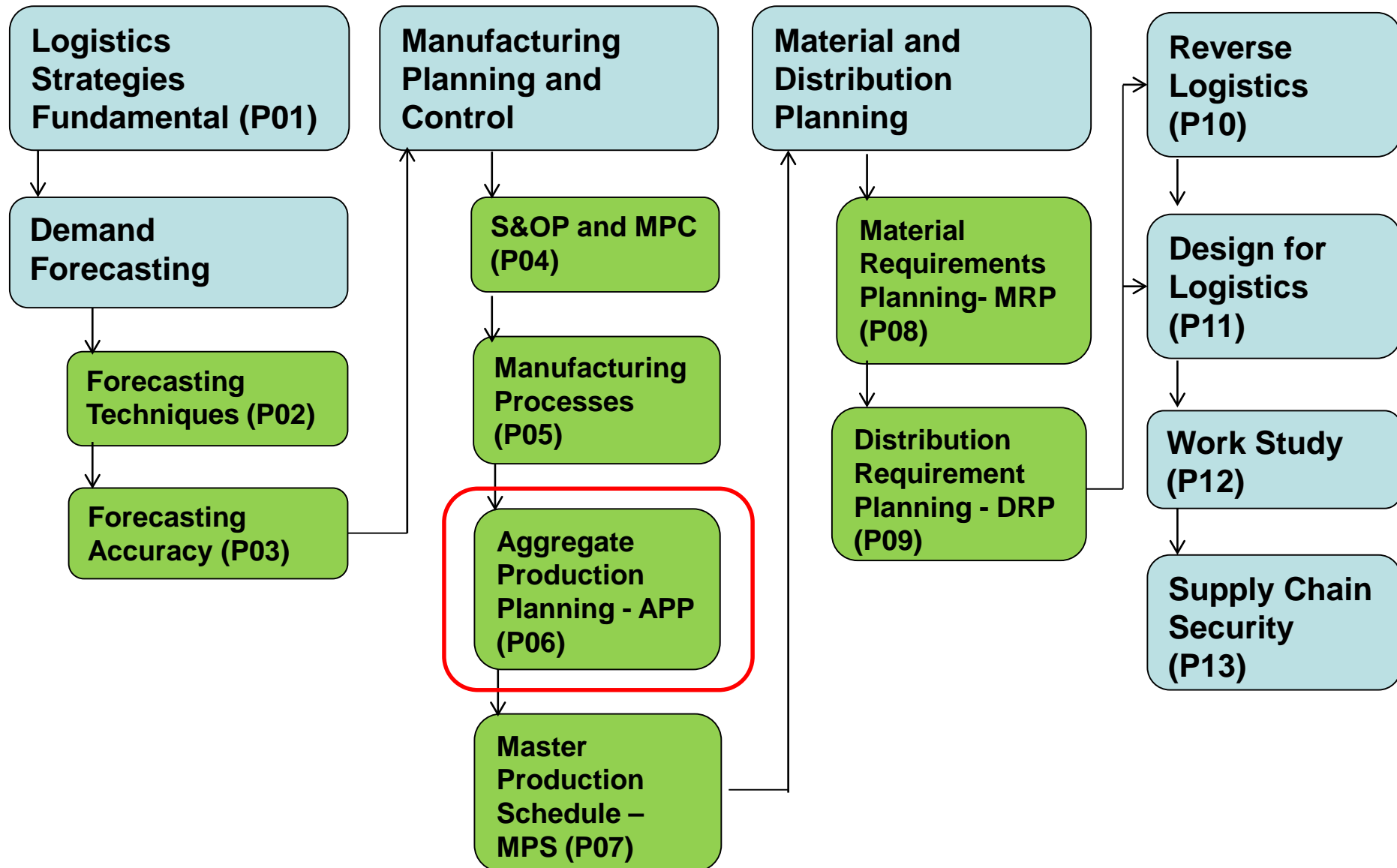


Problem 06

Inventory versus Workforce

SCHOOL OF
ENGINEERING
E222 – Logistics
Planning and
Control

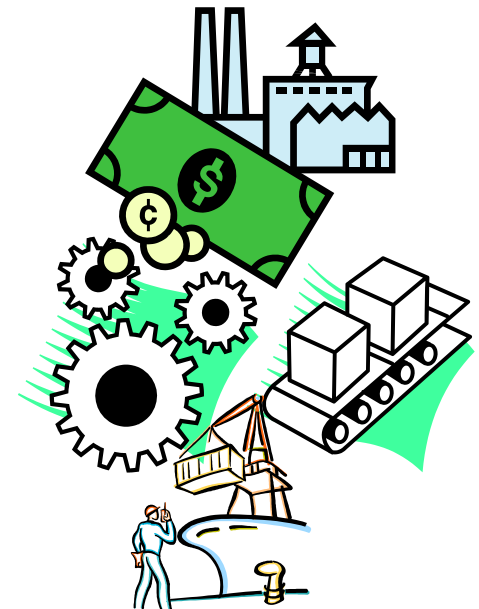
E222 Logistics Planning and Control – Topic Tree



P06 – Workforce versus Inventory



- Describe Production Planning
- Illustrate the Key Aspects of Aggregate Planning
- Explain the pros and cons of Aggregate Production Plans
- Calculation of Aggregate Production Plans
 - Zero-Inventory Plan
 - Level Work-Force Plan
 - Mixed Aggregate Plan

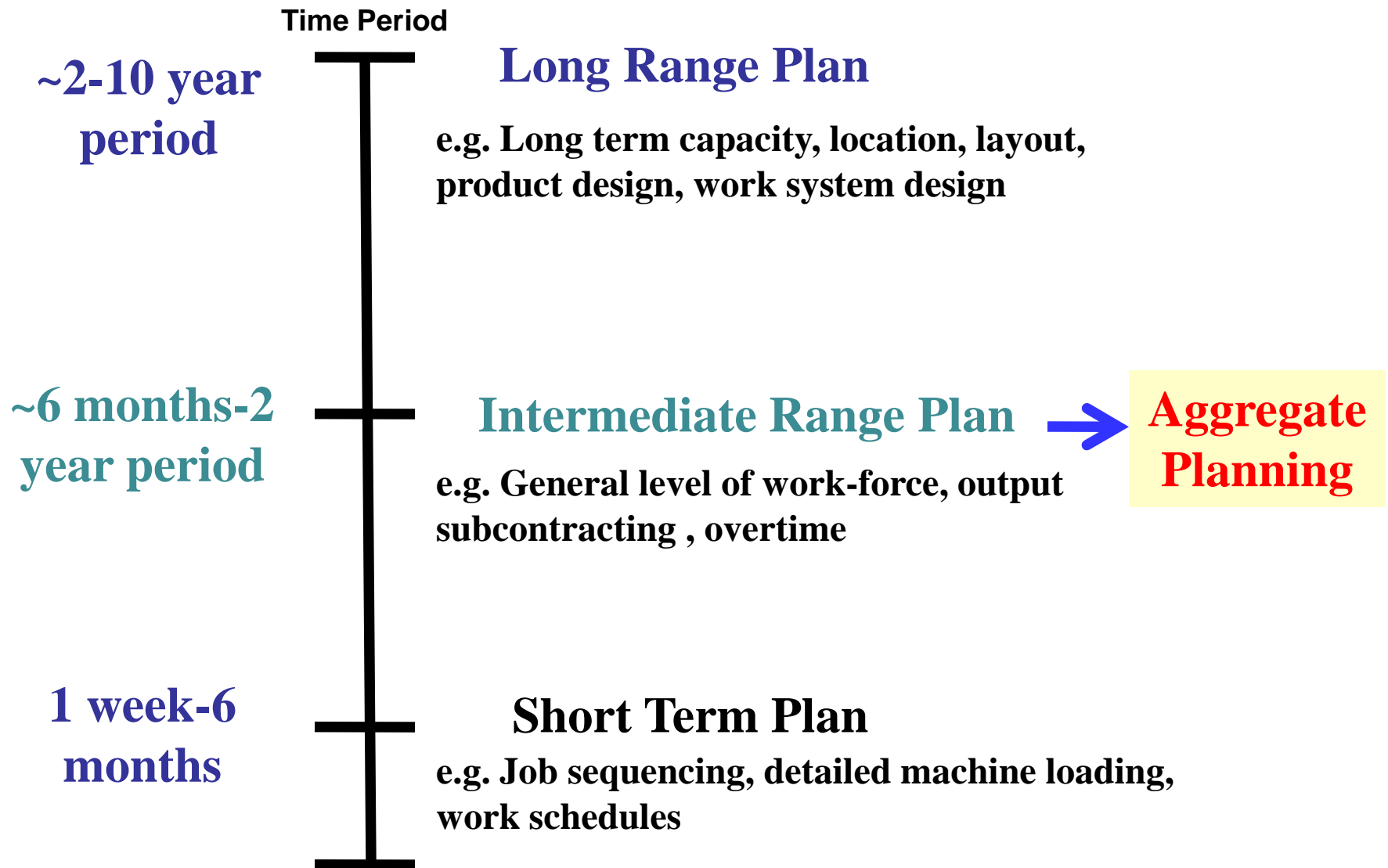


Production Planning



- **Production Plan-** Determines how much and when to make a product
 - ✓ **Goal:** To match production rate and demand rate so that products are made when needed
- Factors constituting the complexity of Production Planning Function:
 - i. Number of products
 - ii. Demand pattern & uncertainty
 - iii. Number of periods in planning horizon
 - iv. Alternative production processes
 - v. Subcontracting
 - vi. Overtime
 - vii. Inventory

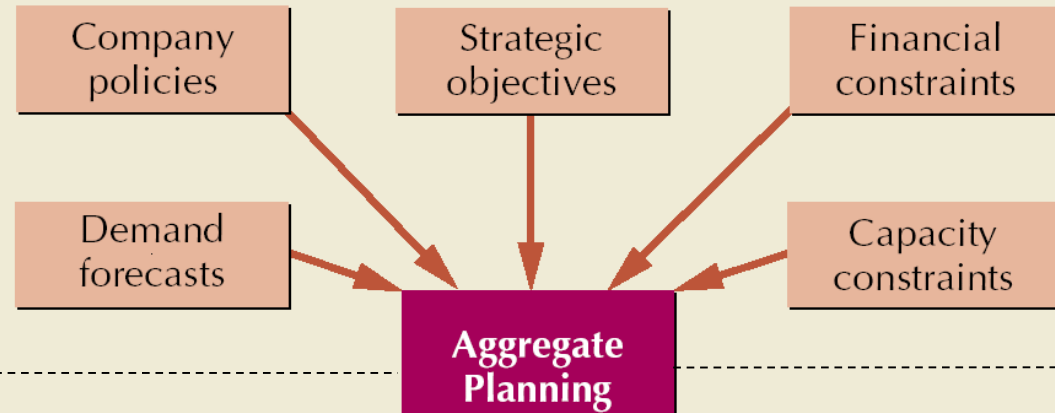
Production Planning



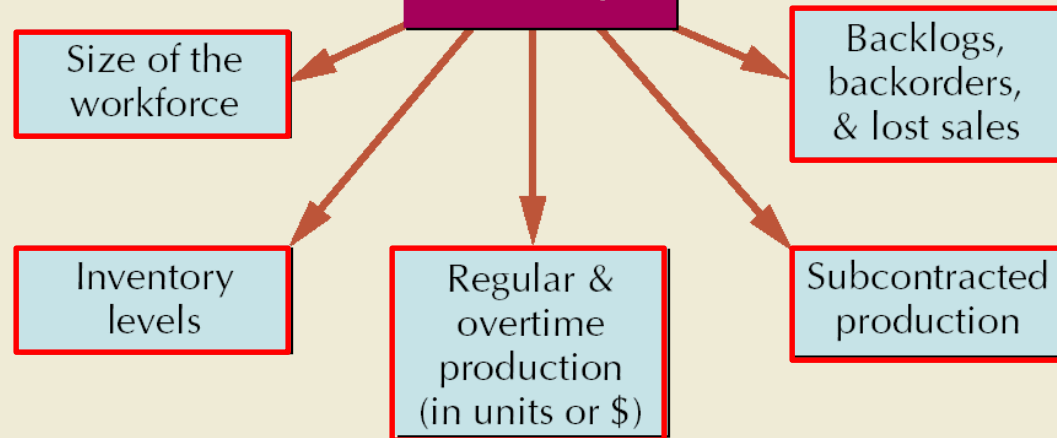
Aggregate Production Planning



**Business
planning by top
management**



**Manufacturing
management
and planning**



Aggregate Production Planning



- Intermediate range planning is also referred to as **Aggregate Production Planning**
- **Focus:** Determining volume of product family ('aggregate unit') to produce, not mix of individual products
- **Aim:** To balance demand and supply (production) at the lowest cost

Aggregate Production Planning



- **Three key aspects** of Aggregate Production Planning

1. Capacity

- How much a production system can make
- To satisfy demand, system capacity should exceed demand , at least over the long run

2. Aggregate Units

- A variety of products is produced over intermediate and long range period. They are lumped together to form **aggregate units**
- Different products in aggregate units share the same production capacity

3. Costs

- **Production costs:** E.g. Material, direct labor, overtime and subcontracting costs
- **Inventory costs:** E.g. Holding and shortage costs
- **Capacity change costs:** E.g. Hiring and training costs, separation costs

Types of Aggregate Production Plan



1. Zero-Inventory Plan

- Also known as **Lot-for-lot** , **Chase** or **Just-in-time** plan
- Each month, produces exactly the amount demanded
- No inventory is carried over
- Workers are added when demand increases and layoff when demand decreases

(+) Advantages

- Eliminate inventory cost

(-) Disadvantages

- Cost of adjusting output rates and/or workforce levels
- Variability in workforce is an undesirable phenomenon seen by many
- May incur the cost of unused capacity

Types of Aggregate Production Plan



2. Level Work-Force Plan

- Also called **Level production** or **Constant work-force** plan
- Same number of workers used in each period
- Uses inventory produced in off-peak periods to satisfy demand in peak periods

(+) Advantages

- Stable output rates and workforce
- Resource are fully utilized

(-) Disadvantages

- Greater inventory costs
- Increased overtime & idle time



3. Mixed Aggregate Plan

- Combination of **Zero-inventory plan** & **Level Work-Force plan**
 - ✓ *Examples: Inventory level cannot exceed x dollars; no more than y% of workers can be laid off in a month*
- Allows inventory, backorders and changing work-force levels
- Usually yields better outcome than Zero-Inventory plan and Level Work-Force plan
- How? → *Trial & error ,make changes using spreadsheet*

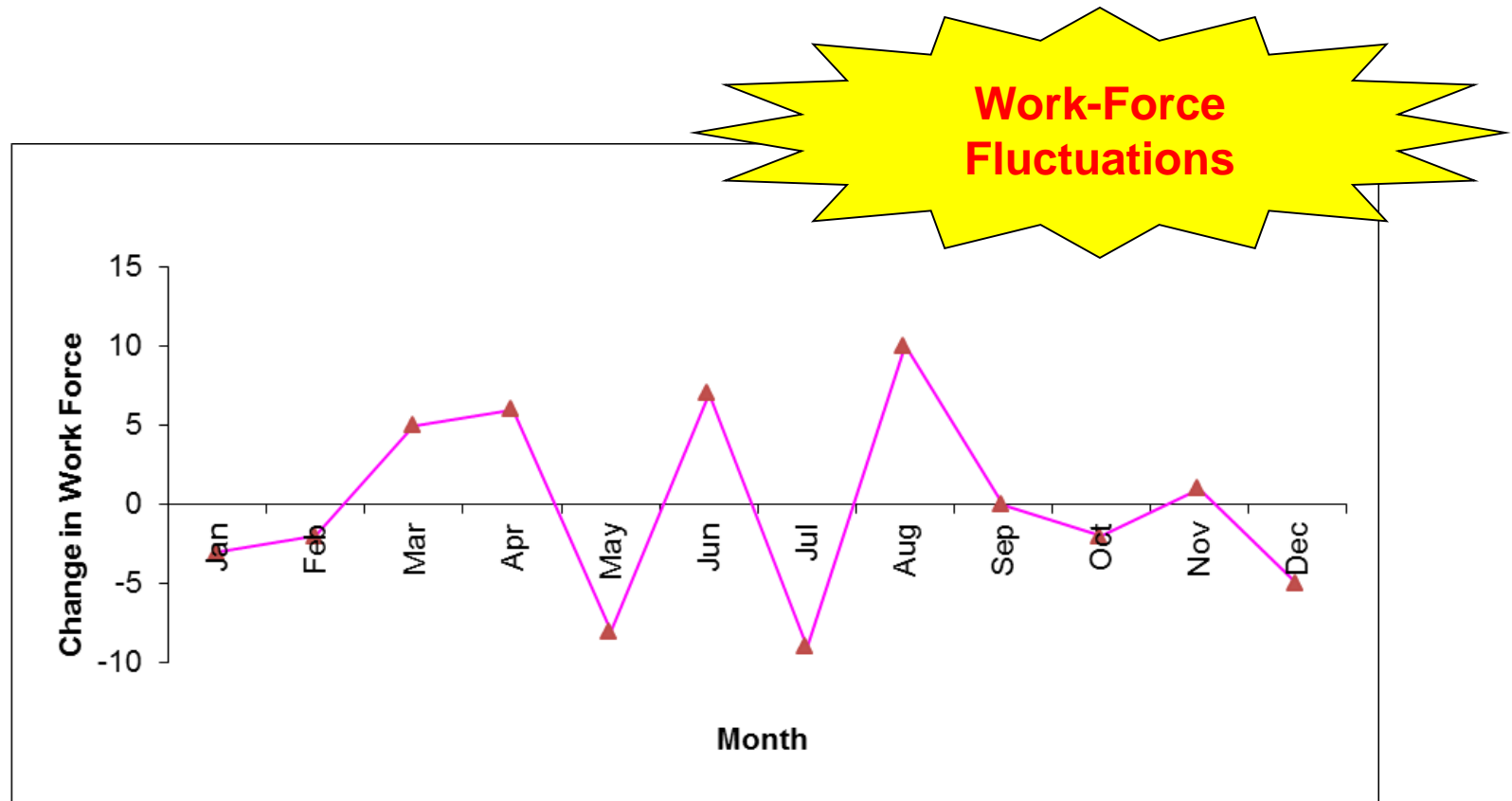
Today's Problem: Zero-Inventory Plan



Aggregate Plan	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days/Month	22	22	22	22	22	22	22	22	22	22	22	22	264
Units/Worker/Month	1,760	1,760	1,760	1,760	1,760	1,760	1,760	1,760	1,760	1,760	1,760	1,760	21,120
Demand	20,000	16,000	26,000	36,000	22,000	34,400	18,400	36,800	36,000	32,000	35,200	24,800	337,600
Workers needed	12	10	15	21	13	20	11	21	21	19	20	15	198
Workers available	15	12	10	15	21	13	20	11	21	21	19	20	NA
Workers hired	0	0	5	6	0	7	0	10	0	0	1	0	29
Hiring cost (\$)	0	0	1,000	1,200	0	1,400	0	2,000	0	0	200	0	5,800
Workers laid off	3	2	0	0	8	0	9	0	0	2	0	5	29
Lay-off cost (\$)	1,200	800	0	0	3,200	0	3,600	0	0	800	0	2,000	11,600
Workers used	12	10	15	21	13	20	11	21	21	19	20	15	198
Labor cost (\$)	25,344	21,120	31,680	44,352	27,456	42,240	23,232	44,352	44,352	40,128	42,240	31,680	418,176
Units produced	20,000	16,000	26,000	36,000	22,000	34,400	18,400	36,800	36,000	32,000	35,200	24,800	337,600
Net Inventory	0	0	0	0	0	0	0	0	0	0	0	0	NA
Holding Cost (\$)	0	0	0	0	0	0	0	0	0	0	0	0	0
Backorder Cost (\$)	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Cost (\$)	26,544	21,920	32,680	45,552	30,656	43,640	26,832	46,352	44,352	40,928	42,440	33,680	435,576

- Each month, produces exactly the amount demanded
- No inventory is carried over
- Workers are added when demand increases and layoff when demand decreases

Today's Problem: Zero-Inventory Plan



Today's problem: Level Work-Force Plan



Note: Assuming backorder

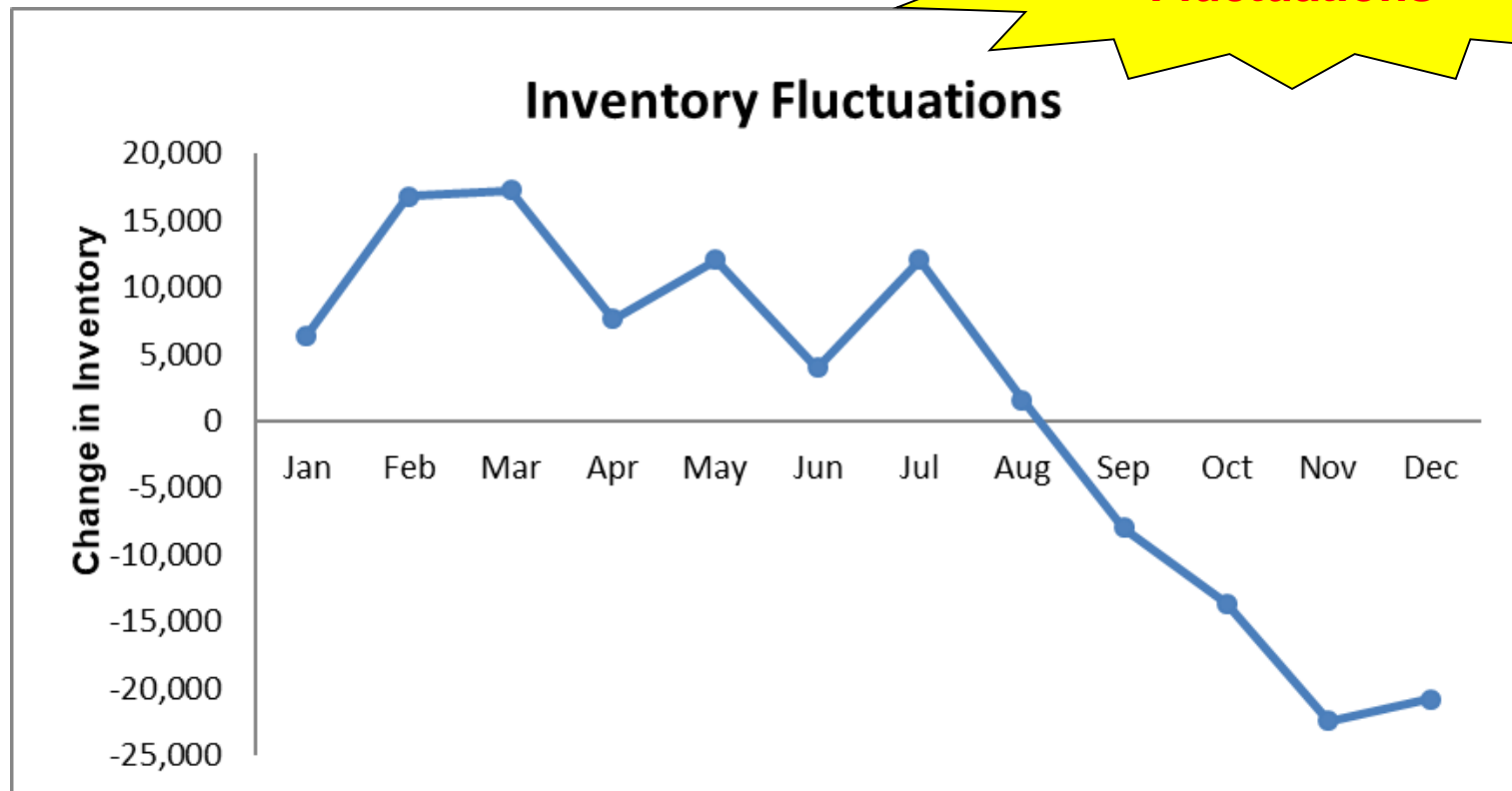
Aggregate Plan	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days/Month	22	22	22	22	22	22	22	22	22	22	22	22	264
Units/Worker/Month	1,760	1,760	1,760	1,760	1,760	1,760	1,760	1,760	1,760	1,760	1,760	1,760	21,120
Demand	20,000	16,000	26,000	36,000	22,000	34,400	18,400	36,800	36,000	32,000	35,200	24,800	337,600
Workers needed	15	15	15	15	15	15	15	15	15	15	15	15	180
Workers available	15	15	15	15	15	15	15	15	15	15	15	15	NA
Workers hired	0	0	0	0	0	0	0	0	0	0	0	0	0
Hiring cost (\$)	0	0	0	0	0	0	0	0	0	0	0	0	0
Workers laid off	0	0	0	0	0	0	0	0	0	0	0	0	0
Lay-off cost (\$)	0	0	0	0	0	0	0	0	0	0	0	0	0
Workers used	15	15	15	15	15	15	15	15	15	15	15	15	180
Labor cost (\$)	31,680	31,680	31,680	31,680	31,680	31,680	31,680	31,680	31,680	31,680	31,680	31,680	380,160
Units produced	26,400	26,400	26,400	26,400	26,400	26,400	26,400	26,400	26,400	26,400	26,400	26,400	316,800
Net Inventory	6,400	16,800	17,200	7,600	12,000	4,000	12,000	1,600	-8,000	-13,600	-22,400	-20,800	NA
Holding Cost (\$)	3,840	10,080	10,320	4,560	7,200	2,400	7,200	960	0	0	0	0	46,560
Backorder Cost (\$)	0	0	0	0	0	0	0	0	6,400	10,880	17,920	16,640	51,840
Total Cost (\$)	35,520	41,760	42,000	36,240	38,880	34,080	38,880	32,640	38,080	42,560	49,600	48,320	478,560

- Same number of workers used in each period
- Uses inventory produced in off-peak periods to satisfy demand in peak periods

Today's problem: Level Work-Force Plan



**Inventory
Fluctuations**



Today's problem: Mixed Aggregate Plan



Aggregate Plan	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days/Month	22	22	22	22	22	22	22	22	22	22	22	22	264
Units/Worker/Month	1,760	1,760	1,760	1,760	1,760	1,760	1,760	1,760	1,760	1,760	1,760	1,760	21,120
Demand	20,000	16,000	26,000	36,000	22,000	34,400	18,400	36,800	36,000	32,000	35,200	24,800	337,600
Workers needed	12	10	15	21	13	20	11	21	21	19	20	15	198
Workers available	15	11	11	13	20	16	16	12	21	20	18	19	NA
Workers hired	0	0	2	7	0	0	0	9	0	0	1	0	19
Hiring cost (\$)	0	0	400	1,400	0	0	0	1,800	0	0	200	0	3,800
Workers laid off	4	0	0	0	4	0	4	0	1	2	0	4	19
Lay-off cost (\$)	1,600	0	0	0	1,600	0	1,600	0	400	800	0	1,600	7,600
Workers used	11	11	13	20	16	16	12	21	20	18	19	15	192
Labor cost (\$)	23,232	23,232	27,456	42,240	33,792	33,792	25,344	44,352	42,240	38,016	40,128	31,680	405,504
Units produced	19,360	19,360	22,880	35,200	28,160	28,160	21,120	36,960	35,200	31,680	33,440	26,400	337,920
Net Inventory	-640	2,720	-400	-1,200	4,960	-1,280	1,440	1,600	800	480	-1,280	320	NA
Holding Cost (\$)	0	1,632	0	0	2,976	0	864	960	480	288	0	192	7,392
Backorder Cost (\$)	512	0	320	960	0	1,024	0	0	0	0	1,024	0	3,840
Total Cost (\$)	25,344	24,864	28,176	44,600	38,368	34,816	27,808	47,112	43,120	39,104	41,352	33,472	428,136

- Combination of **Zero-inventory plan** & **Level Work-Force plan**
- Allows inventory, backorders and changing work-force levels

Comparing the Aggregate Production Plans



	Zero Inventory Plan	Level Work-Force Plan (With Backorder)	Suggested Mixed Plan
Hiring Cost (\$)	5,800	0	3,800
Lay-off Cost (\$)	11,600	0	7,600
Labour Cost (\$)	418,176	380,160	405,504
Holding Cost (\$)	0	46,560	7,392
Backorder Cost (\$)	0	51,840	3,840
Total Cost (\$)	435,576	478,560	428,136

- “Pure Strategies” (zero-inventory & level workforce plan) are useful as basis for drafting a realistic aggregate plan
 - Instances of high inventory & backorder costs > **zero-inventory plan** is favored
 - Industries employing highly skilled labor > **level workforce plan** is prevalent
- **Mixed Aggregate Plan** satisfies demand and **yields better outcome in terms of total cost** compared to “pure strategies”

Learning Outcomes



- Describe Production Planning
- Illustrate the Key Aspects of Aggregate Planning
- Explain the pros and cons of Aggregate Production Plans
- Calculation of Aggregate Production Plans
 - Zero-Inventory Plan
 - Level Work-Force Plan
 - Mixed Aggregate Plan