

CPIM CERTIFIED IN PLANNING AND INVENTORY MANAGEMENT

MODULE 2: SALES AND OPERATIONS PLANNING

Sales and Operations Planning (S&OP)

- Section A: S&OP Purpose and Process
- Section B: Aggregate Demand and Supply Plans
- Section C: Reconciling S&OP Plans

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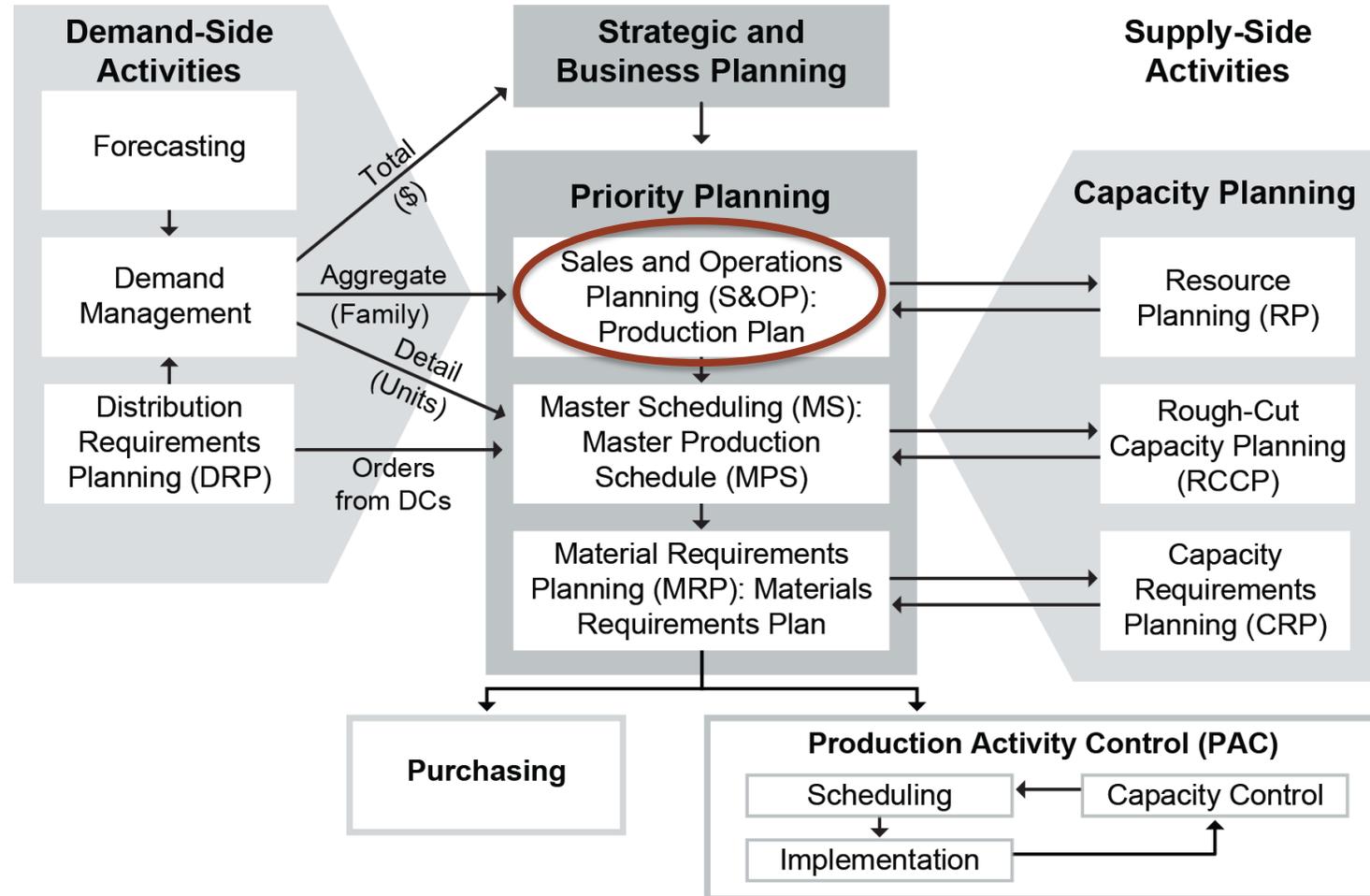
SECTION A: S&OP PURPOSE AND PROCESS

Section A Learning Objectives

- Principles of S&OP
- Linkages between S&OP and strategic plans
- S&OP process and participants
- S&OP inputs and outputs
- Planning factors: units of measure, product families, planning horizon

Topic 1: S&OP Road Map and Key Linkages

Planning Hierarchy



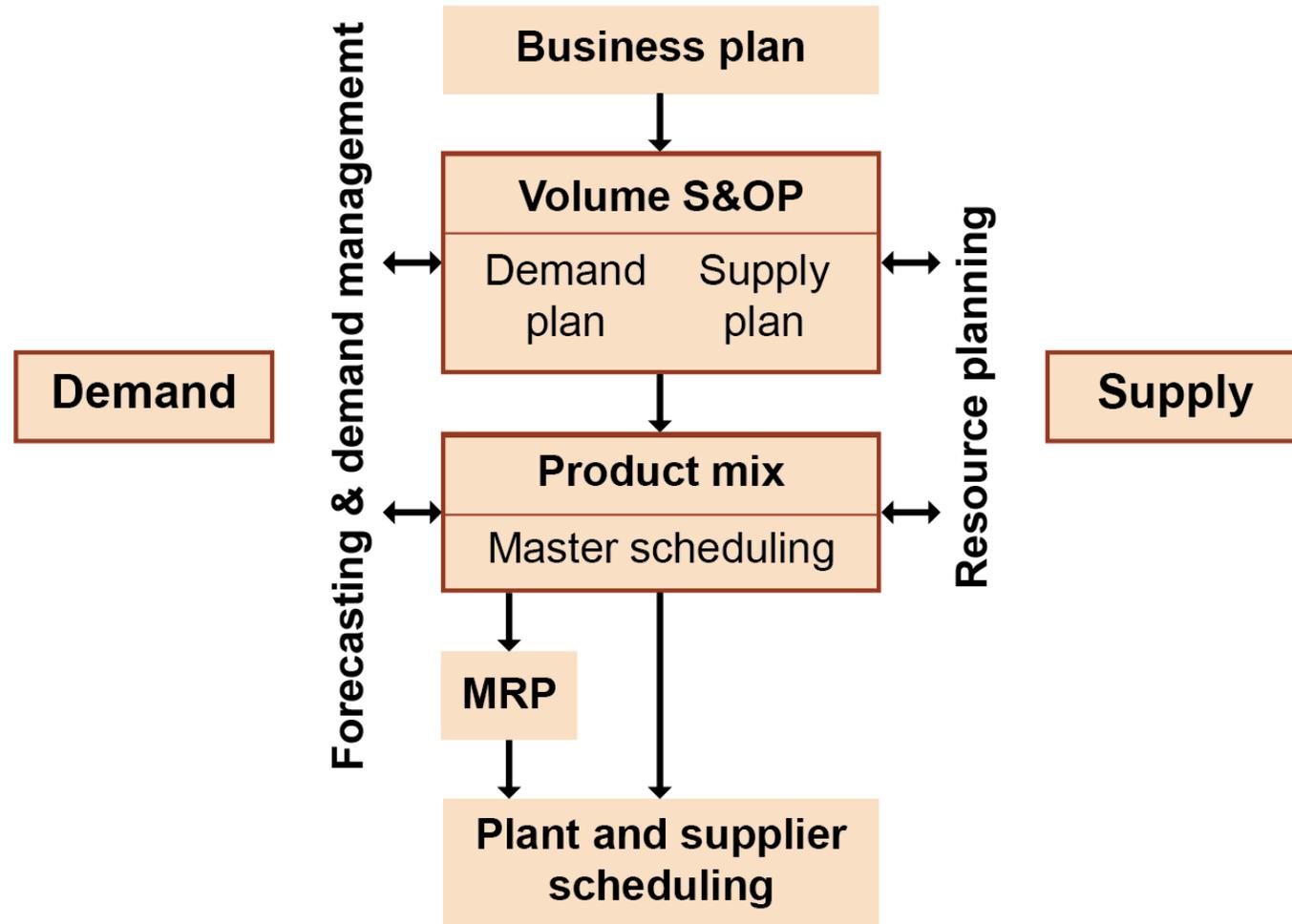
Topic 1: S&OP Road Map and Key Linkages

Need for and Benefits of S&OP Integration

- Production plans consistent with business plan
- Enterprise-wide demand and supply visibility
- Better promotional planning and budget forecasting
- Improved product life cycle management
- Improved customer service levels
- Improved inventory management and faster inventory turnover
- More stable production rates
- Faster and more controlled new product introductions
- Reduced obsolescence
- Shorter customer lead times for MTO products

Topic 1: S&OP Road Map and Key Linkages

S&OP Supply/Demand and Volume/Mix Concepts



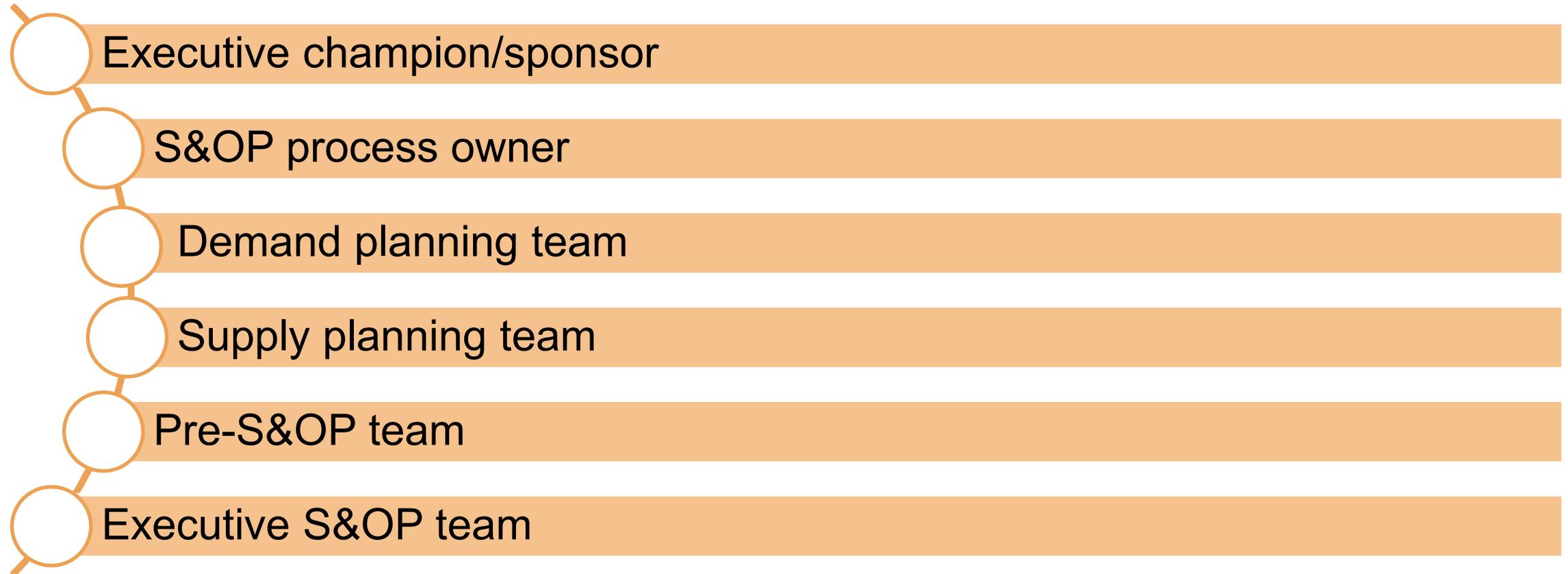
Topic 1: S&OP Road Map and Key Linkages

Key S&OP Linkages

MPC Process	Linkage to S&OP
Demand planning	Reports all demand sources affecting manufacturing capacity, forecasts/customer orders placed at all levels of distribution network, interplant transfers, and service requirements.
Resource planning	Estimates capacity requirements for alternative sales and operations plans being considered and changes in current production plan. Ensures that adequate key resources are in place to support master scheduling.
Master scheduling	Disaggregates production plan from family to end-item mix level. Planned MPS end-item quantities must agree with product family volume for manufacturing to meet schedule.
Distribution planning	Rolled up to central supply source to determine aggregate distribution inventory demand. Distribution resources can move and store product at stocking locations per customer demand.

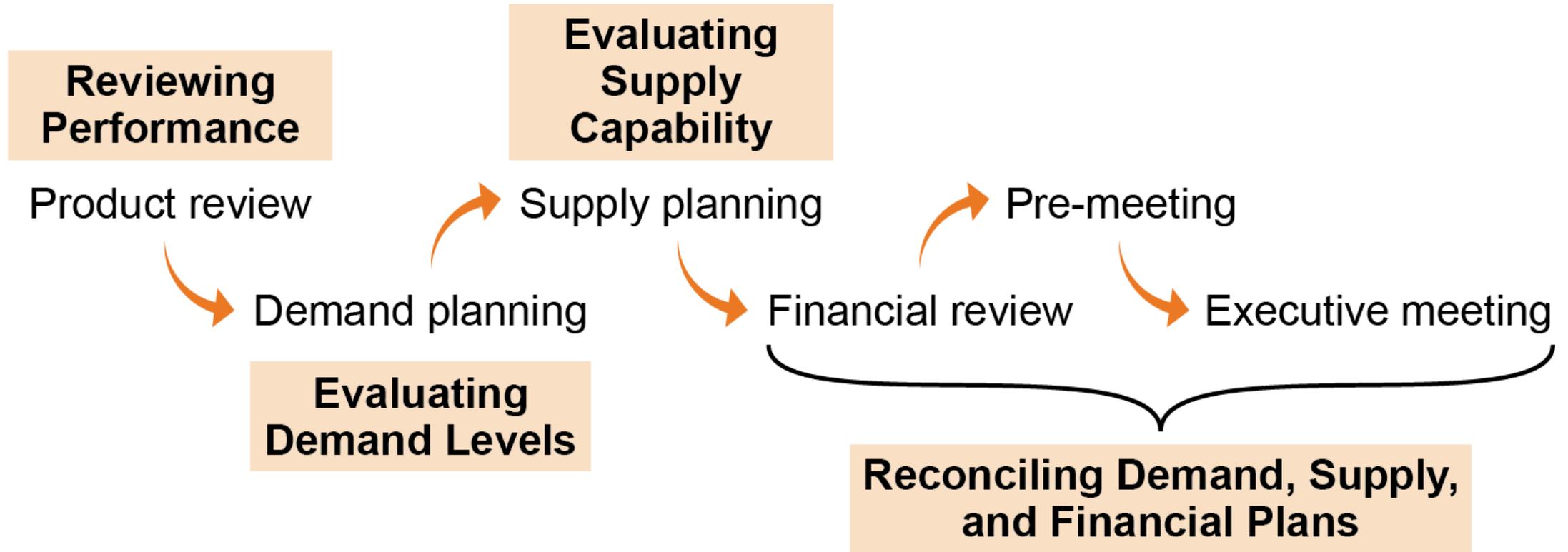
Topic 2: S&OP Roles and Process

S&OP Roles



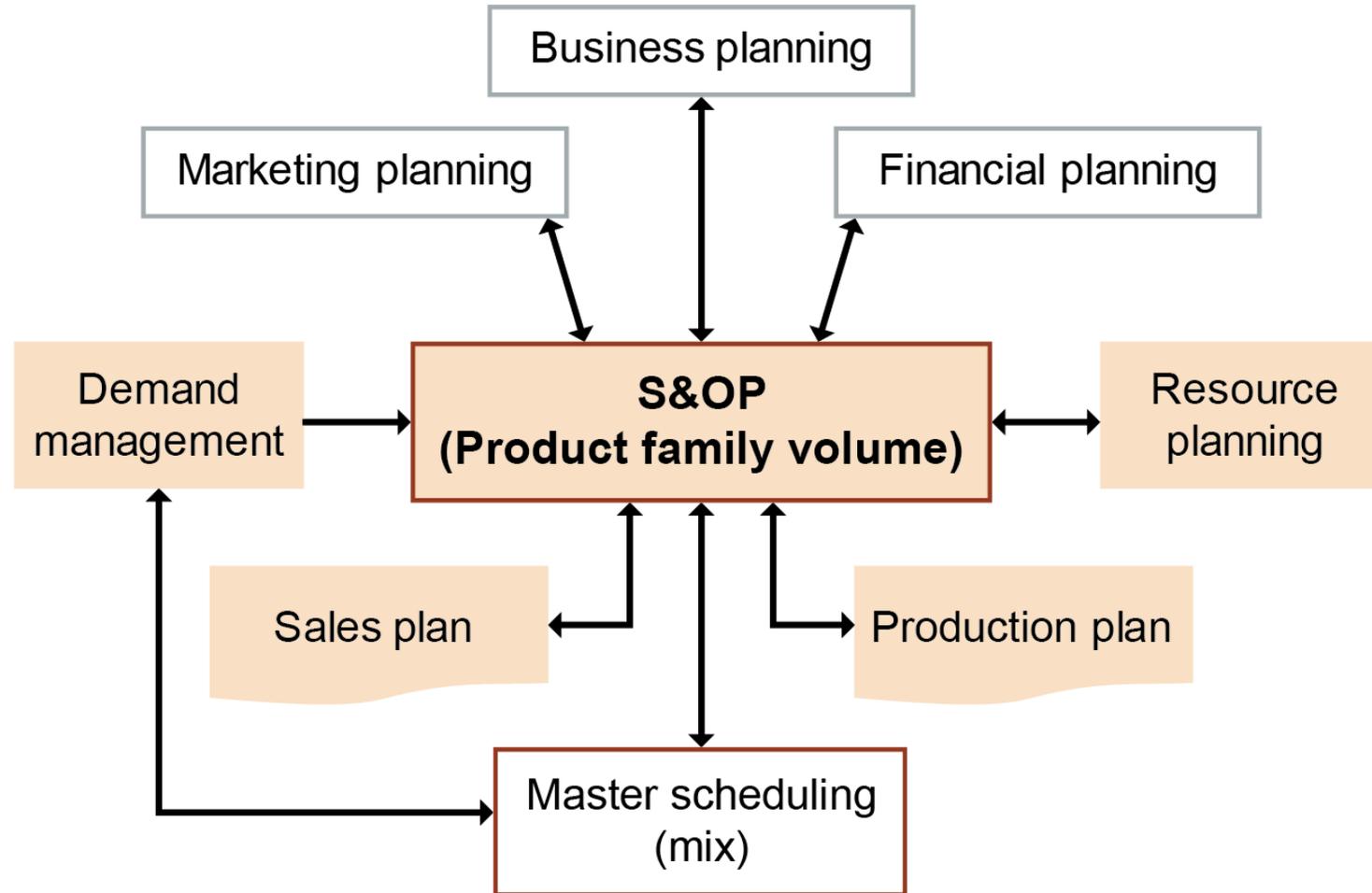
Topic 2: S&OP Roles and Process

S&OP Process



Topic 3: Integrating and Balancing Roles of S&OP

S&OP Key Inputs and Outputs



Topic 3: Integrating and Balancing Roles of S&OP

Planning Factors

Units of measure

- Measurements aligned
- Total units per product line
- Dollar value of total monthly output
- Total output by factory
- Direct labor hours

Product families/lines

- Product/service hierarchy
 - Family: meaningful for production and capacity planning
 - Line: meaningful for sales and marketing
- Best if different views share common ground
- Optimal: 6–12 logical and representative families

Planning horizons

- Minimum length = annual business plan
- Ideal = 18 months

Topic 3: Integrating and Balancing Roles of S&OP

Manufacturing Environments and S&OP

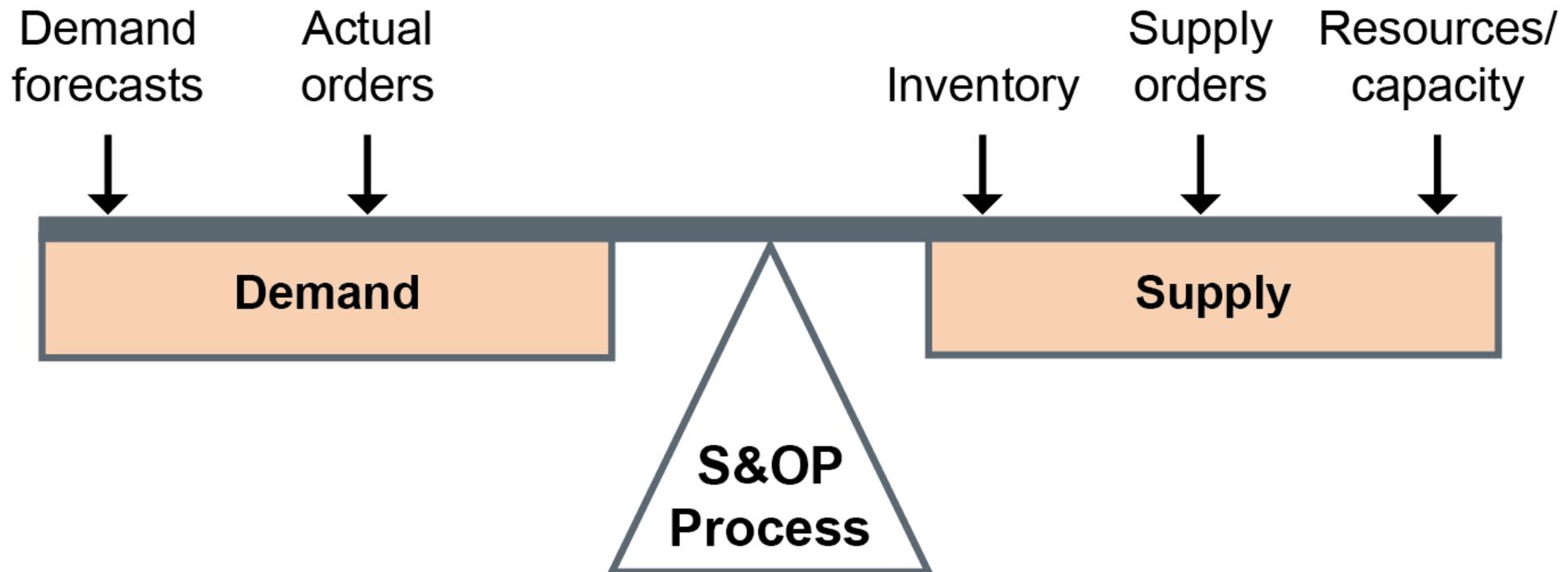
	Manufacturing Environments			
	ETO	MTO	ATO	MTS
Information needed for S&OP	Product specifications from customer, engineering capacity needed, project schedule	Demand forecast (product family), design/material specifications from engineering	Demand forecast (product family), accurate configuration options	Demand forecast (product family)

Topic 3: Integrating and Balancing Roles of S&OP

Synchronizing Supply and Demand

Product family level

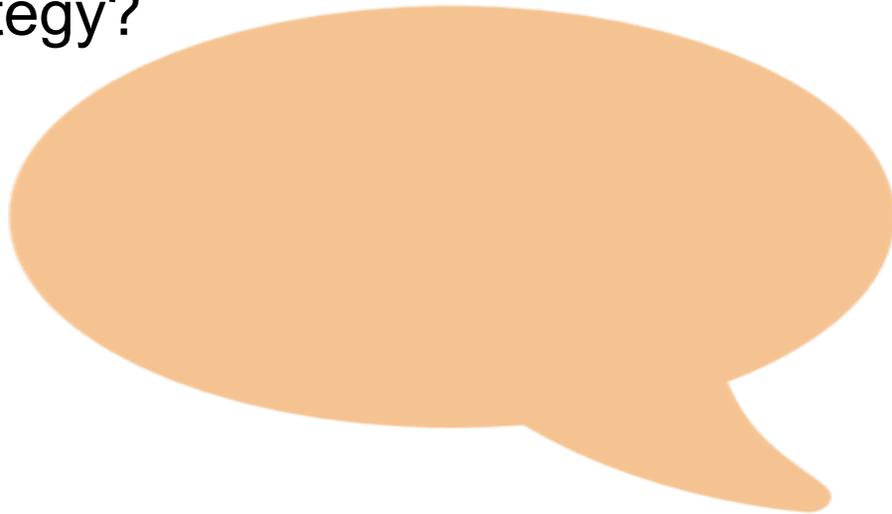
S&OP plans and synchronizes supply and demand at the product family level.



Topic 3: Integrating and Balancing Roles of S&OP

Making Tradeoffs

What happens when management makes an add-on or changes its strategy?



- Cascading effect on the tactical plans in the other areas of the organization
- Requires making tough decisions



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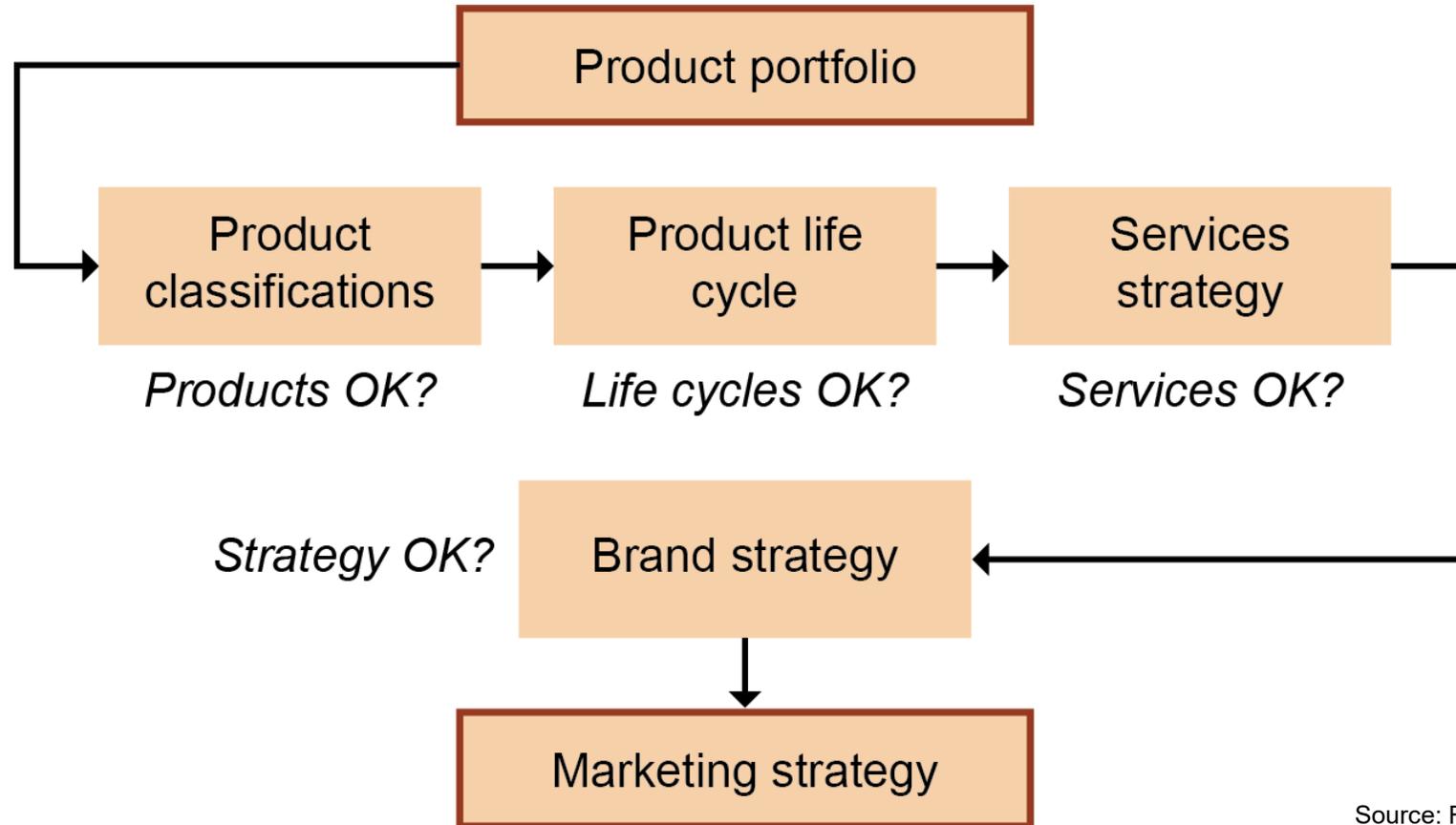
SECTION B: AGGREGATE DEMAND AND SUPPLY PLANS

Section B Learning Objectives

- Aggregate demand plan
- Aggregate supply plan and key supply capabilities
- Product life cycle considerations
- Aligning production plan and organizational strategy plus production planning method (chase, level, hybrid)
- Resource plan
- Staffing based on HR policies, labor pool, and labor skills matrix
- Strategic buffers

Topic 1: Aggregate Demand and Supply Plans

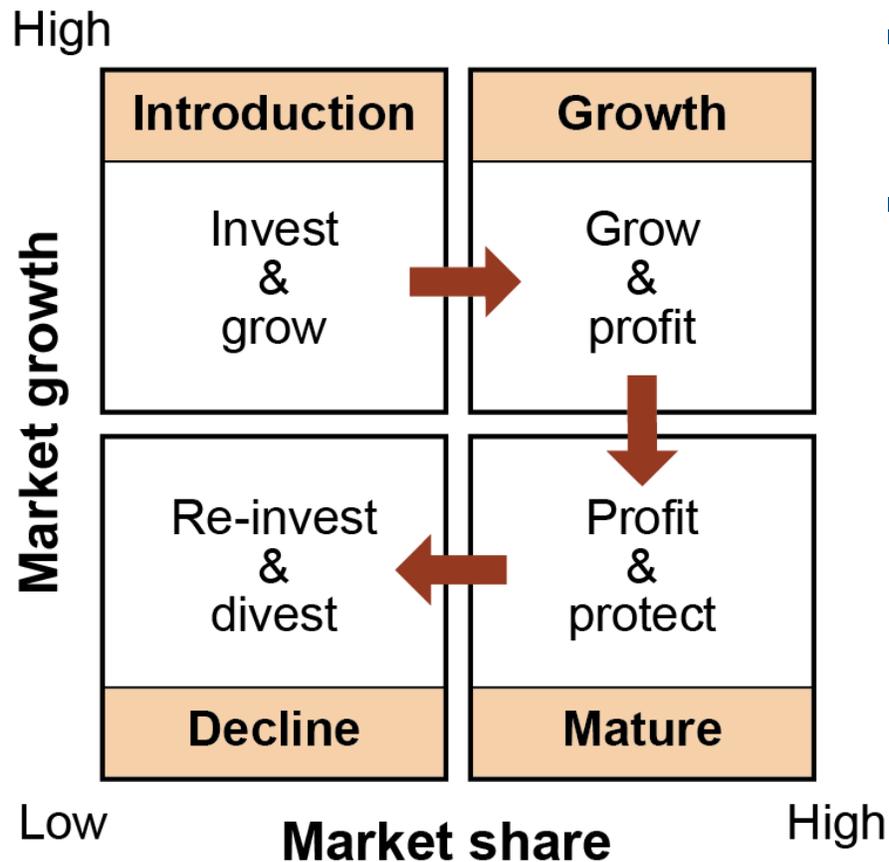
Aligning Portfolio with Market/Marketing Strategy



Source: Ross, *Distribution Planning and Control*, 3rd edition.

Topic 1: Aggregate Demand and Supply Plans

Brand Strategy and NPI Review



- Marketing investment decisions are tied to expected demand.
- Estimating demand for new production introductions is problematic.

Source: Ross,
*Distribution Planning
and Control*, 3rd edition.

Topic 1: Aggregate Demand and Supply Plans

Sources of Demand to Review

- Customer demand forecasts
- Customer orders
- Interplant demand and interplant/intracompany transfers (transfer pricing)
- Forecasts and actual orders of spare parts
- Exhibitions and pilot projects
- New product introductions
- Pipeline and safety stock build-ups
- Quality assurance needs
- Charitable donations

Topic 1: Aggregate Demand and Supply Plans

Supply Plan Elements

Production plan

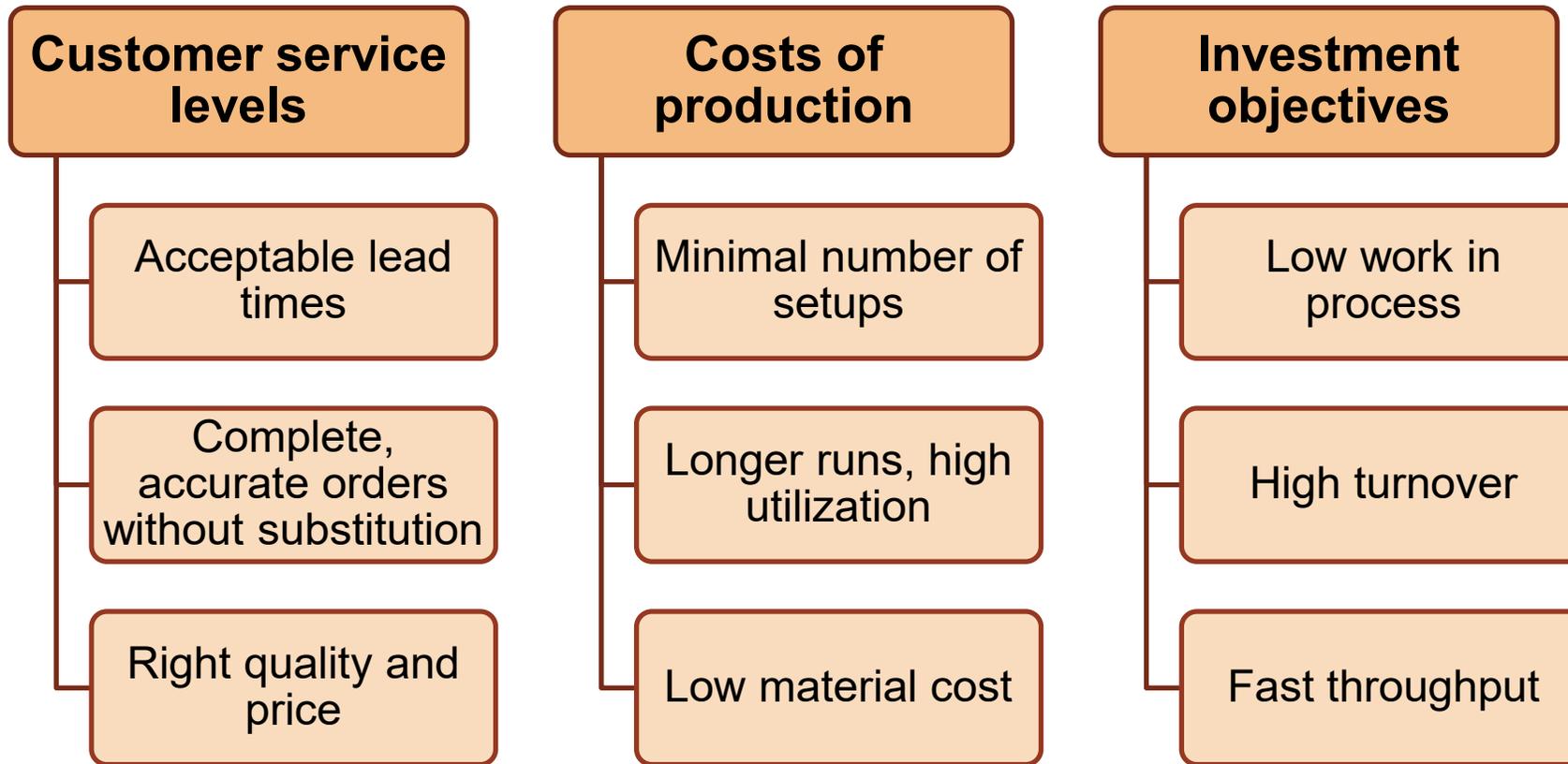
Inventory plan

Resource plan

Distribution plan

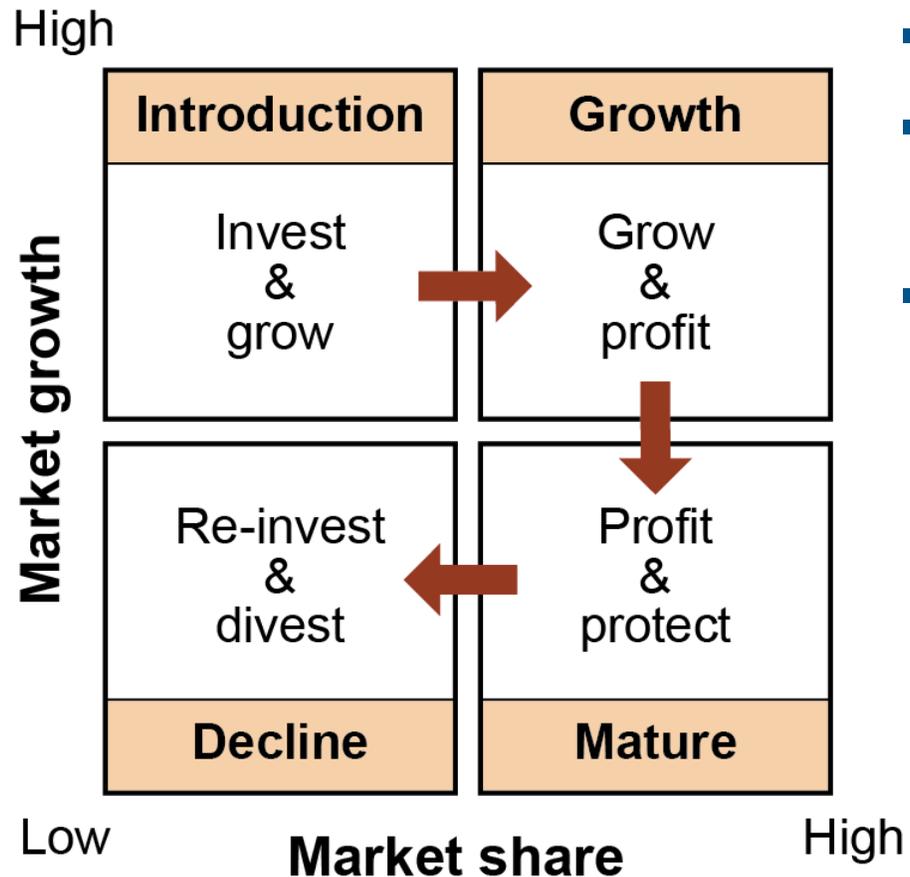
Topic 1: Aggregate Demand and Supply Plans

Tradeoffs with Supply Plans



Topic 1: Aggregate Demand and Supply Plans

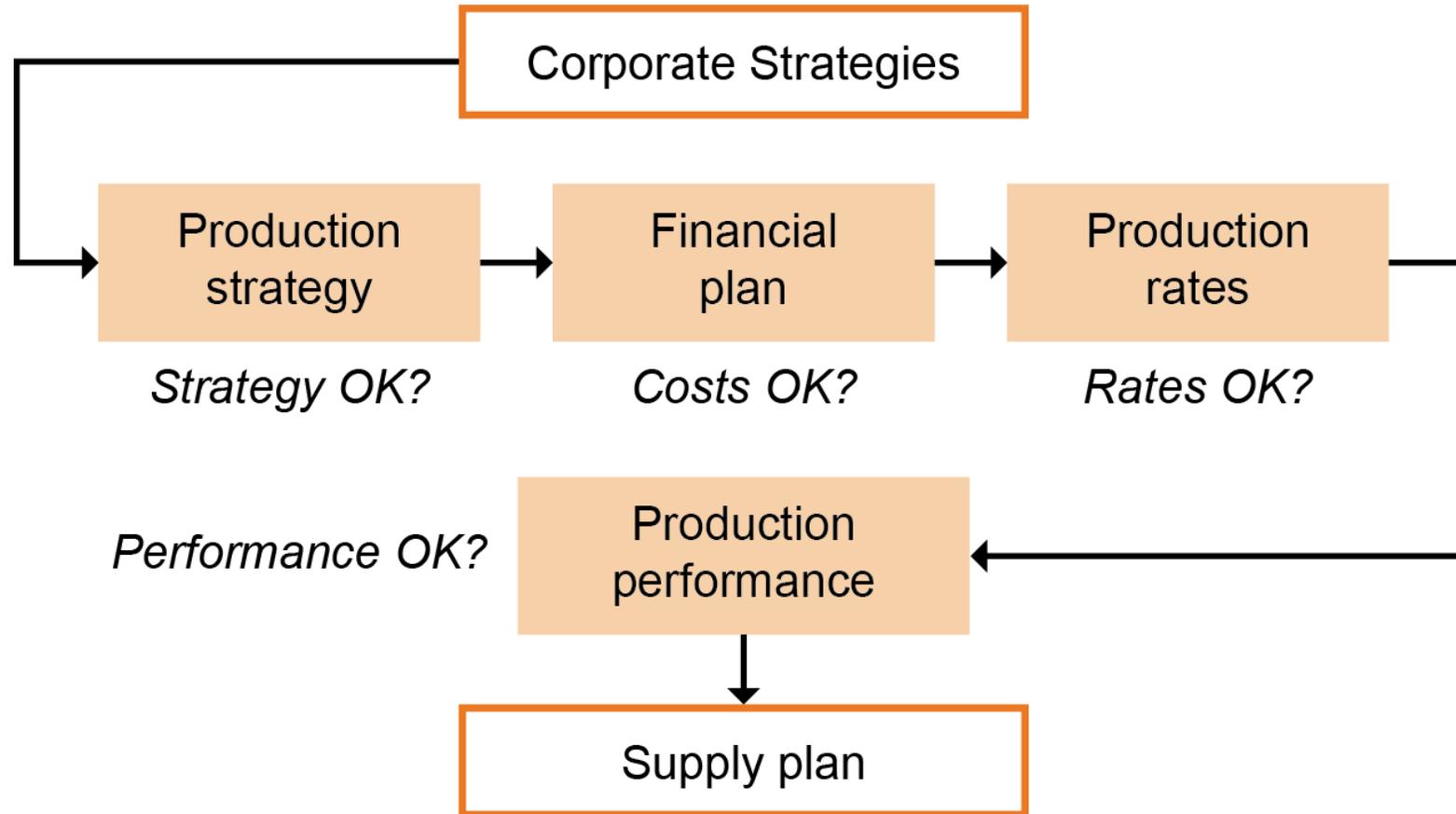
Product/Brand Management from Supply Perspective



- Capacity: increase in early stages
- Supply chain: more complex in later stages
- New product introduction supply strategy
 - Transition to new capacity
 - Eliminate old inventory

Topic 1: Aggregate Demand and Supply Plans

Production and Inventory Plan Development



Topic 2: Production Planning Grid and Production Methods

Make-to-Stock S&OP Grid

Units in 1,000s

	History			Present ↓	PTF									
Product family A	D	J	F	M	A	M	J	J	A	S	Q 4	Q 1	Q 2	
Sales plan	50	80	80	80	100	100	120	150	150	100	200	300	330	
Actual sales	43	70	87											
Difference	-7	-10	7											
Cumulative difference	-7	-17	-10											
Production plan	100	100	100	100	100	100	100	100	100	100	300	300	300	
Actual production	105	100	100											
Difference	5	0	0											
Cumulative difference	5	5	5											
Inventory plan	20	70	90	110	145	145	145	125	75	25	25	125	125	95
Actual inventory	20	82	112	125										
Difference	12	22	15											

PTF: planning time fence

Topic 2: Production Planning Grid and Production Methods

Production Plan

Basic information

- Sales plan by period for planning horizon
- Opening inventory
- Desired ending inventory
- Any past-due customer orders (backorders)

MTS/MTO differences

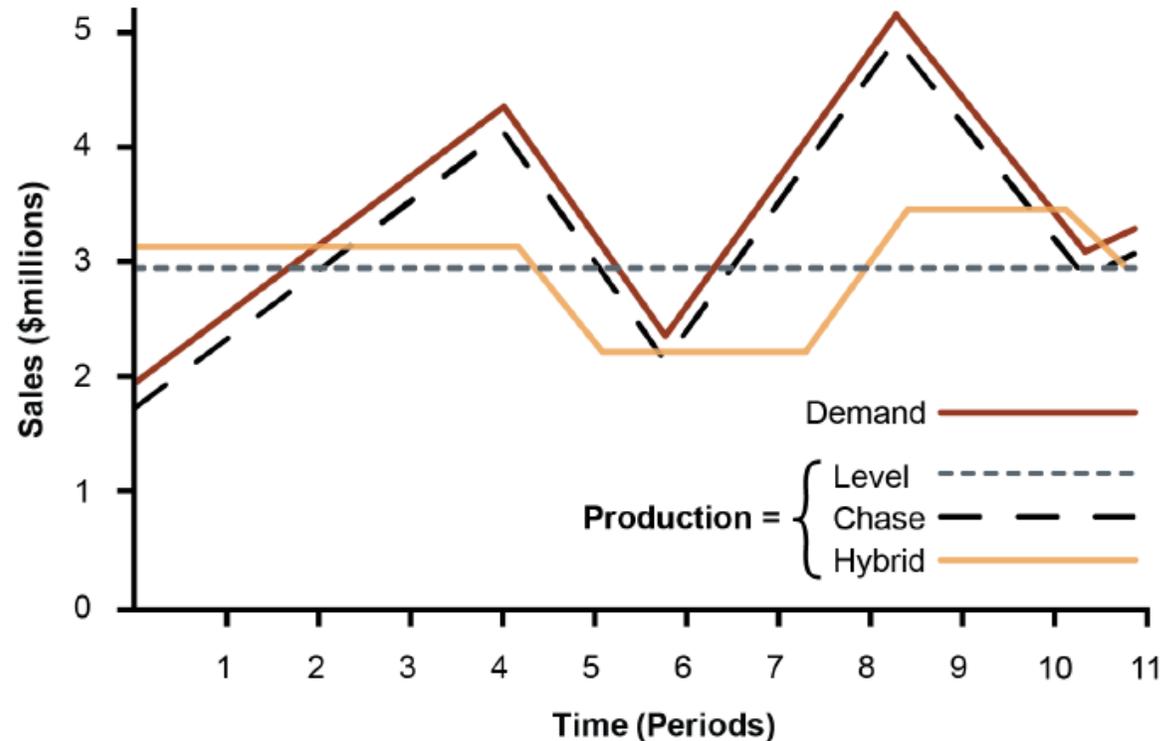
- MTO history
- Sales plan
- Production plan
- Backlog plan

Topic 2: Production Planning Grid and Production Methods

Production Planning Methods

Level, chase, hybrid, outsourcing/subcontracting

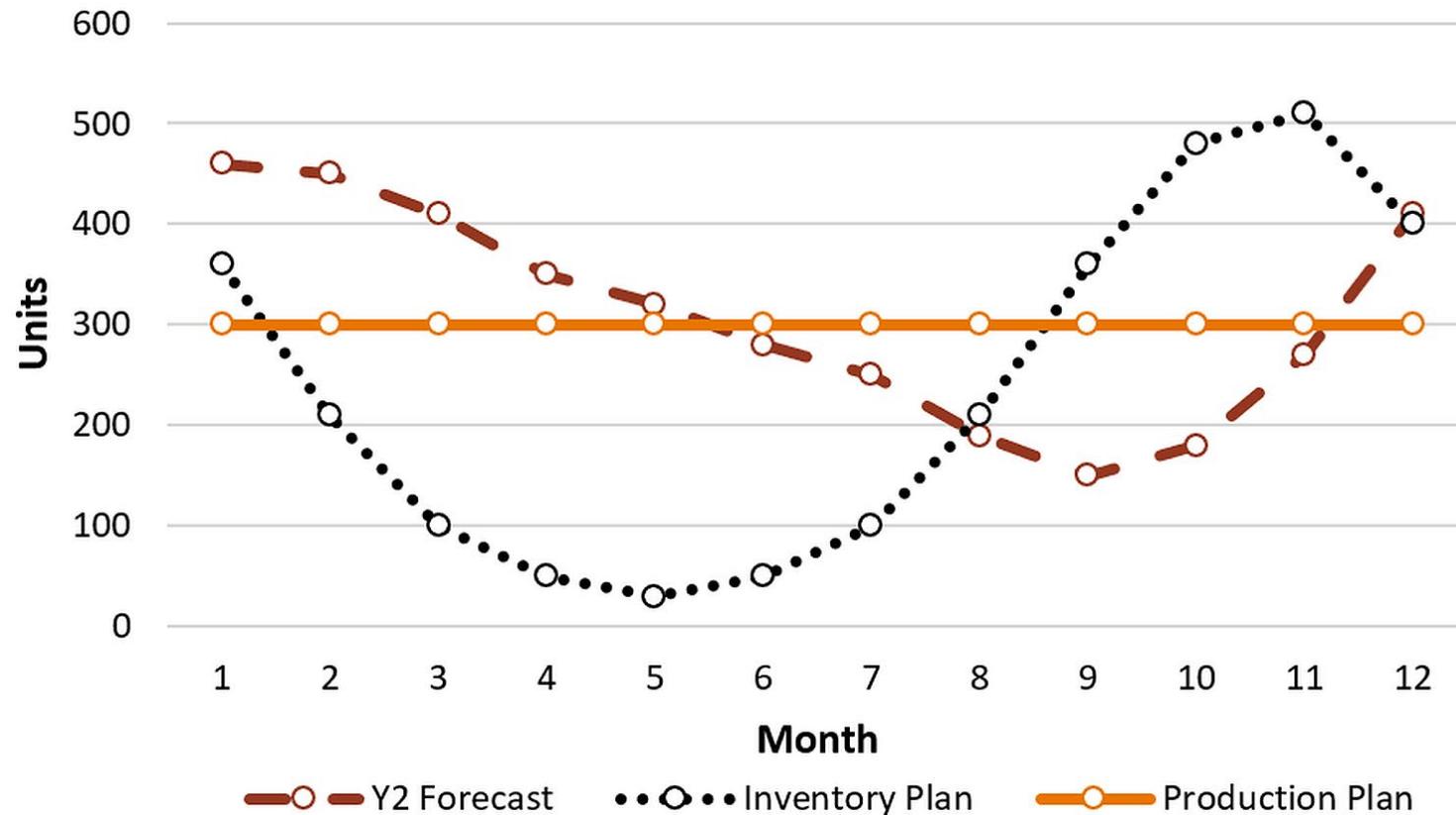
(Note: Outsourcing/subcontracting are not shown in graphic.)



Topic 2: Production Planning Grid and Production Methods

Level Production Strategy

- Produce at average demand level, modified by inventory
- Stability
 - Setups
 - Labor/capacity
- High inventory holding costs
- Forecast accuracy
- Seasonality



Topic 2: Production Planning Grid and Production Methods

Level Production Strategy

Benefits	Risks
<ul style="list-style-type: none">▪ Stable labor costs▪ Special customer requests▪ Improved quality control▪ Better cash flow▪ Minimized smoothing costs▪ Reduced cost of hiring▪ Stable workforce	<ul style="list-style-type: none">▪ Cost of carrying excess inventory▪ Subcontracting or overtime costs▪ Backorder costs▪ Cost of expedited shipping▪ Loss of customer goodwill▪ Using forecast data

Topic 2: Production Planning Grid and Production Methods

Make-to-Stock S&OP Grid–Level Exercise

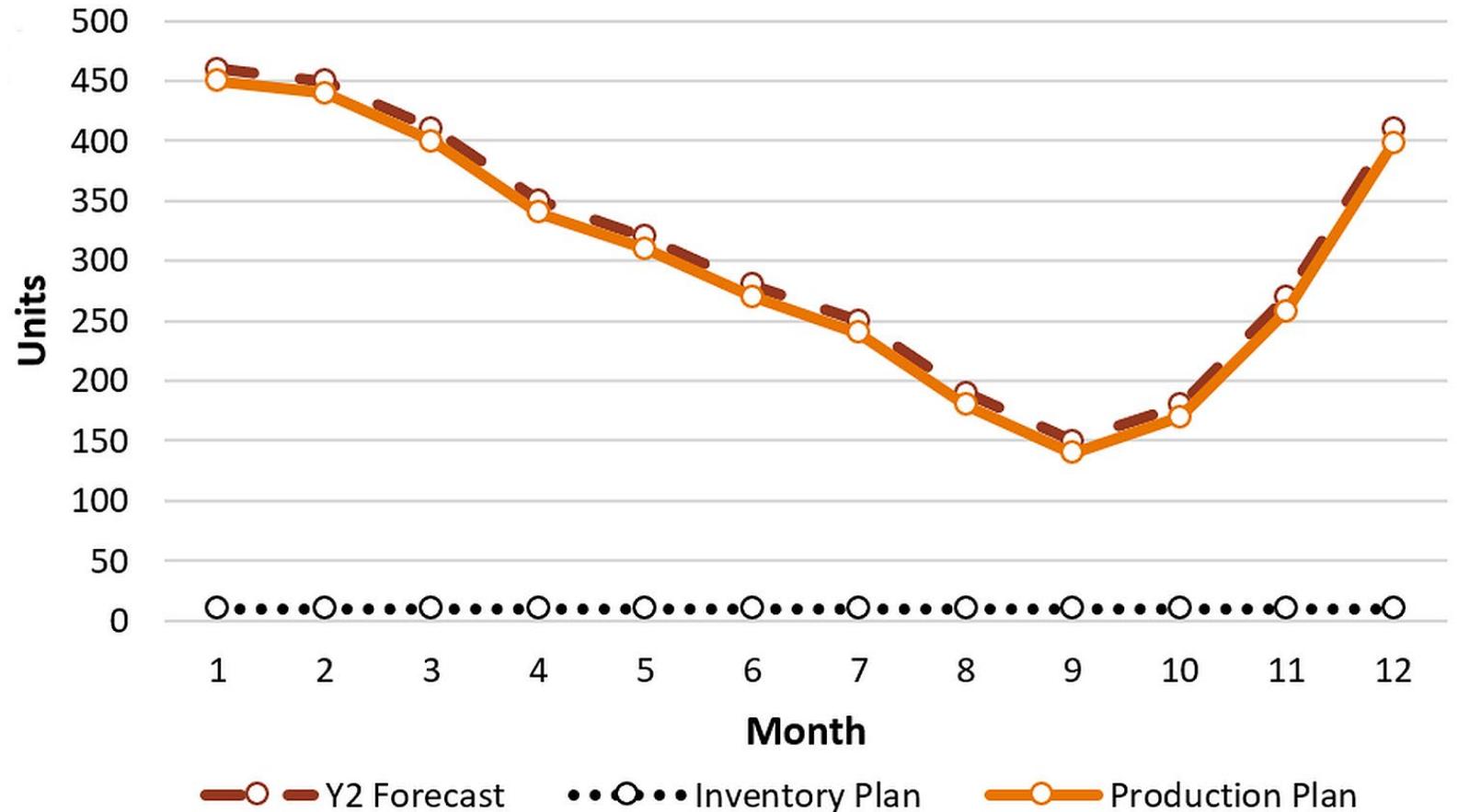
Units in 1,000s

		History			Present	PTF									
		D	J	F	M	A	M	J	J	A	S	Q 4	Q 1	Q 2	
Product family A															
Sales plan		50	80	80	80	100	100	120	190	190	110	240	330	360	
Actual sales		43	70	87											
Difference		-7	-10	7											
Cumulative difference		-7	-17	-10											
Production plan		100	100	100	100	100	115	115	115	115	115	345	345	345	
Actual production		105	100	100											
Difference		5	0	0											
Cumulative difference		5	5	5											
Inventory plan		20	70	90	110	145	145	160	155	80	5	10	115	130	115
Actual inventory		20	82	112	125										
Difference		12	22	15											

Topic 2: Production Planning Grid and Production Methods

Chase (Demand Matching) Production Strategy

- Demand = production
- Low inventory cost
- Production variability
 - Hire/lay off
 - Excess/idle capacity
 - Setups
- Perishable



Chase Production Strategy

Benefits	Risks
<ul style="list-style-type: none">▪ Changes output capacity to meet demand▪ Low inventory costs	<ul style="list-style-type: none">▪ High smoothing costs▪ Insecure, unhappy, overworked employees▪ Availability of an appropriately skilled workforce▪ Constantly changing short-term capacity▪ Erratic utilization of plant and equipment▪ Overtime cost premiums▪ Overtime/undertime may be insufficient

Topic 2: Production Planning Grid and Production Methods

Make-to-Stock S&OP Grid–Chase Exercise

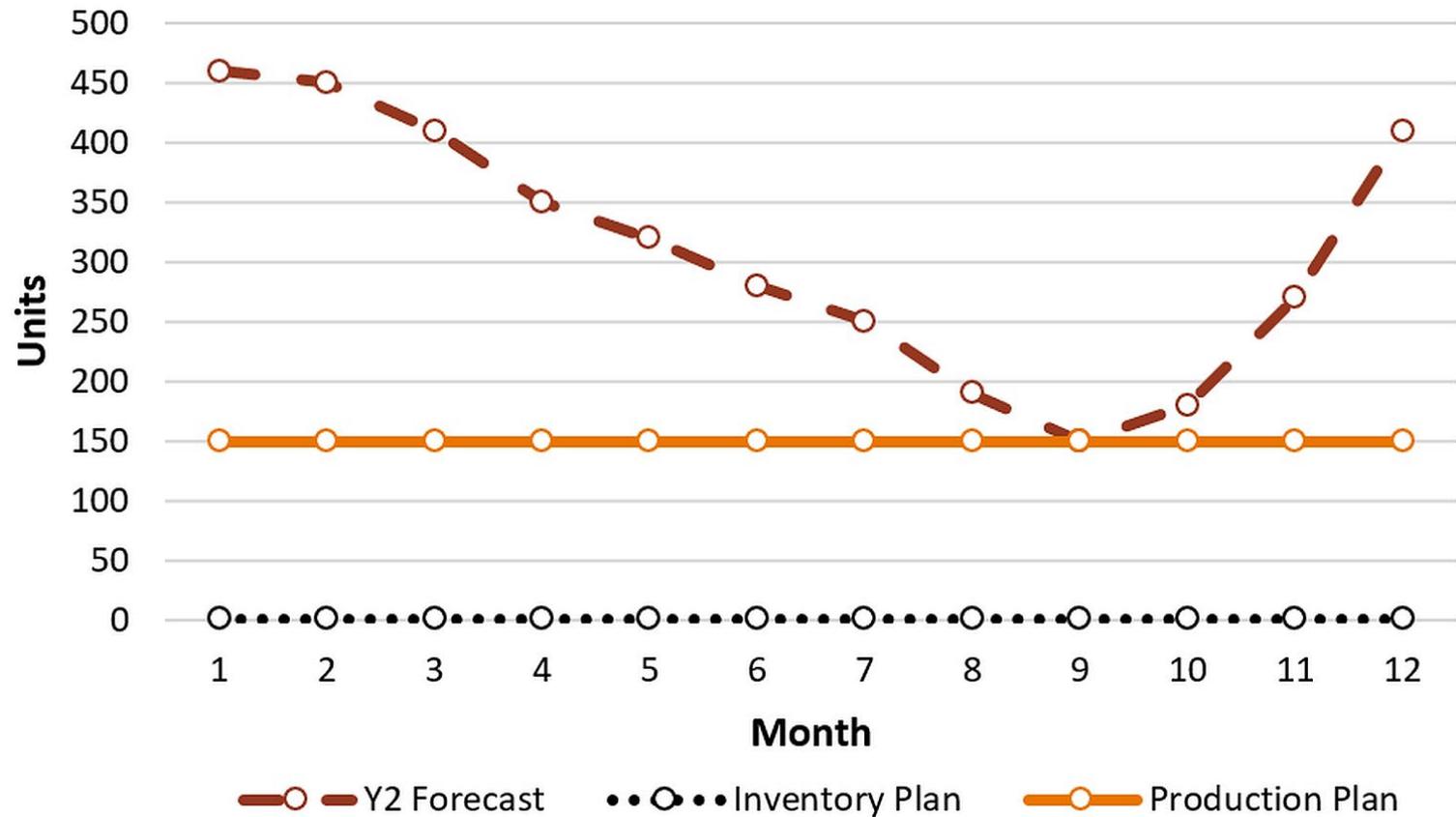
Units in 1000s

		History			Present	PTF								
		D	J	F	M	A	M	J	J	A	S	Q 4	Q 1	Q 2
Product family A														
Sales plan		50	80	80	80	100	100	120	190	190	110	240	330	360
Actual sales		43	70	87										
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Actual inventory	20	82	112	125										
Difference		12	22	15										

Topic 2: Production Planning Grid and Production Methods

Outsourcing/Subcontracting Production Strategy

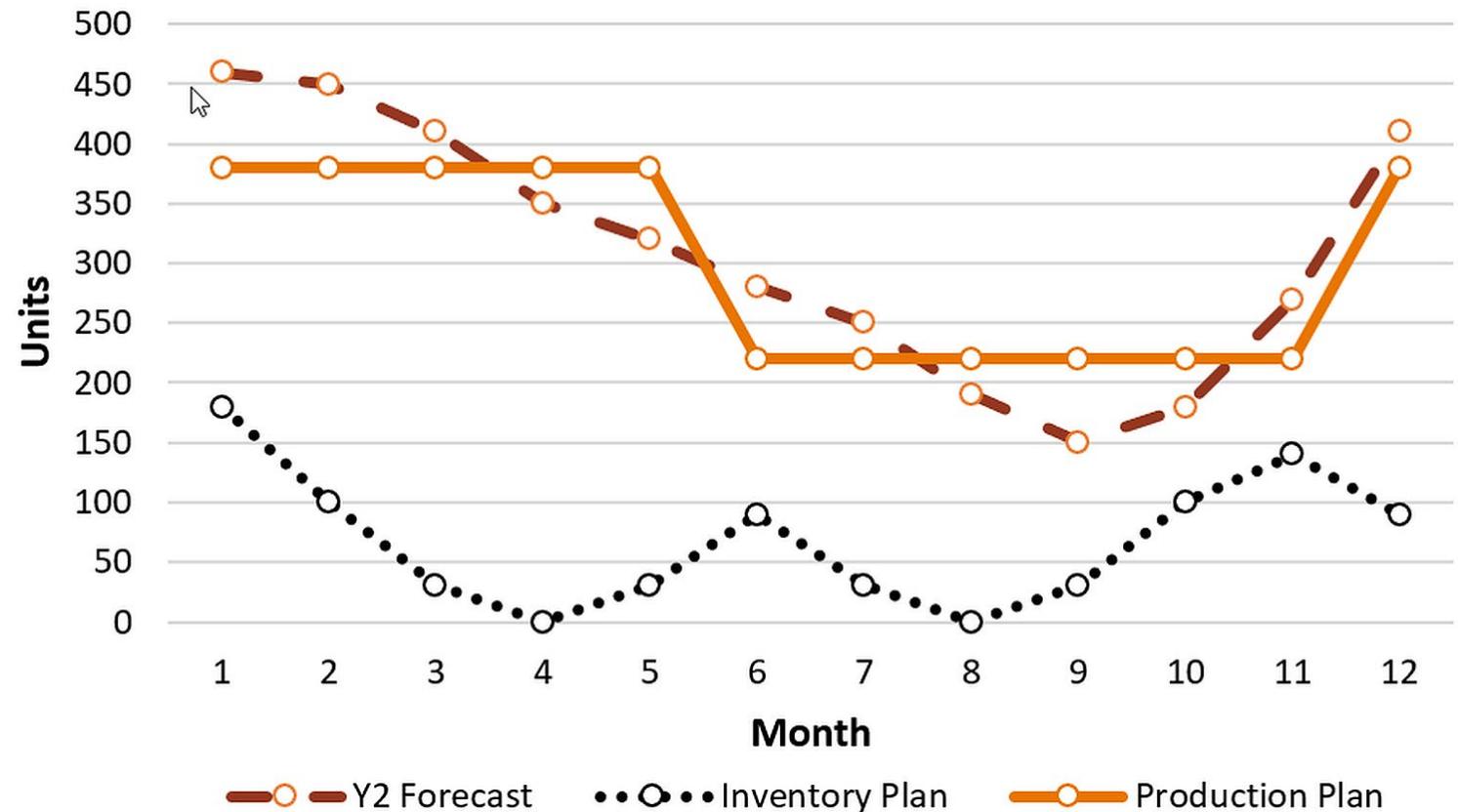
- Minimum level, outsourcing/subcontracting excess demand
- Leveling benefits without changed costs
- Lower profit margins
- Quality or availability issues
- Flow (line or continuous)



Topic 2: Production Planning Grid and Production Methods

Hybrid Production Strategies

- Custom solutions
- For example, high and low level
- Chase and level production to some extent
- Forecast accuracy or safety stock



Hybrid Production Strategy

Benefits	Risks
<ul style="list-style-type: none">▪ Balances large fluctuations in demand▪ Takes into consideration volatile demand▪ Smooths out seasonal demand	<ul style="list-style-type: none">▪ Availability of an appropriately skilled workforce▪ Level of coordination

Topic 2: Production Planning Grid and Production Methods

Production Plan and Make-to-Stock Level Example

- Medium-term tactical plan
- Forecast demand per time bucket (includes backorders)
- Opening and ending inventory (for leveling)
- Scenario: accurate forecast, stable demand, make-to-stock level strategy

Family A: Vandalproof Commercial Doors, In-Stock All-Glass														
Month	0	1	2	3	4	5	6	7	8	9	10	11	12	SUM
Sales Plan		460	450	410	350	320	280	250	190	150	180	270	410	3,720
Production (Leveled)														
Ending Inventory	520												400	

Total Production = Total Forecast + Backorders + Ending Inventory – Opening Inventory
= 3,720 + 0 + 400 – 520 = 3,600 Units

Topic 2: Production Planning Grid and Production Methods

Make-to-Stock, Level Production Plan

- 3,600 Units/12 = 300 Units per Month

Family A: Vandalproof Commercial Doors, In-Stock All-Glass														
Month	0	1	2	3	4	5	6	7	8	9	10	11	12	SUM
Sales Plan		460	450	410	350	320	280	250	190	150	180	270	410	3,720
Production (Leveled)		300	300	300	300	300	300	300	300	300	300	300	300	3,600
Ending Inventory	520	360	210	100	50	30	50	100	210	360	480	510	400	
Average Inventory		440	285	155	75	40	40	75	155	285	420	495	455	

Ending Inventory = Prior Period Ending Inventory + Production – Demand (Sales Plan)

Period 1 = 520 + 300 – 460 = 360 Units

Average Inventory =
$$\frac{\text{Prior Period Inventory} + \text{Current Period Inventory}}{2}$$

If carrying cost equals \$10/unit per month: \$10 x 440 = \$4,400 for period 1.

Topic 2: Production Planning Grid and Production Methods

MTS Level Production Plan Exercise

Period	1	2	3	4	5	Total
Forecast demand	55	60	65	60	60	
Production						
Ending inventory						

Example: Opening inventory = 50 units
Desired ending inventory = 40 units

Total forecast demand = $\frac{55 + 60 + 65 + 60 + 60}{5} = 300$

Total production needed = Total Forecast Demand + Ending Inventory – Opening Inventory
= $\frac{300}{5} + \frac{40}{5} - \frac{50}{5} = \frac{290}{5}$ Units

Production each period = Total Units/Number of Periods =
 $\frac{290}{5} = 58$ Units

Ending inventory for period 1 = Opening Inventory + Production – Forecast Demand
= $\frac{50}{5} + \frac{58}{5} - \frac{55}{5} = \frac{53}{5}$ Units

Topic 2: Production Planning Grid and Production Methods

Level and Chase Detailed Calculations: Company Planning Data

Annual forecast	4,000	Units	Employee productivity per day	1.593625	Units per day
Beginning inventory	1,000	Units	Current number of workers	10	Workers
Level ending inventory	1,400	Units	HR costs per hire or layoff	\$4,000	Dollars
Chase ending inventory	50	Days of supply	Quarterly wages per worker	\$6,000	Dollars
Hybrid ending inventory	1,000	Units	Number of working days in year	251	Days
Quarterly inventory holding cost per unit	\$40	Dollars	Average working days per quarter	63	Days
Quarterly production per worker	100	Units	Forecast for Y2, Q1 (for chase)	400	Units

Topic 2: Production Planning Grid and Production Methods

Detailed Calculation of Level Production

Leveled Production Plan: Family A						
Quarter	0	1	2	3	4	SUM
Forecast		400	1,000	600	2,000	4,000
Production (leveled)	1,000	1,100	1,100	1,100	1,100	4,400
Ending inventory	1,000	1,700	1,800	2,300	1,400	
Days of supply		107	113	144	88	
Change in production		100	0	0	0	
Change in workers		1	0	0	0	
Number of workers	10	11	11	11	11	
Inventory holding		\$68k	\$72k	\$92k	\$56k	\$288k
HR change costs		\$4k	\$0	\$0	\$0	\$4k
Wages		\$66k	\$66k	\$66k	\$66k	\$264k
Total cost		\$138k	\$138k	\$158k	\$122k	\$556k

Topic 2: Production Planning Grid and Production Methods

Calculating Chase Production (by Days of Supply)

Chase Production Plan: Family A						
Quarter	0	1	2	3	4	SUM
Forecast		400	1,000	600	2,000	4,000
Production (chase)	1,000	194	683	1,711	730	3,317
Days of supply	50	50	50	50	50	
Ending inventory	1,000	794	476	1,587	317	
Change in production		-806	489	1,029	-981	
Number of workers	10	1.9	6.8	17.1	7.3	
Number of hires (fires)		-8.1	4.9	10.3	-9.8	
Inventory holding		\$32k	\$19k	\$63k	\$13k	\$127k
HR change costs		\$32k	\$20k	\$41k	\$39k	\$132k
Wages		\$12k	\$41k	\$103k	\$44k	\$200k
Total cost		\$76k	\$80k	\$207k	\$96k	\$459k

Q1 ending inventory
(if no production)

$$1,000 - 400 = 600 \text{ Units}$$

Q2 will go negative if
no production.

$$\frac{1,000 \text{ Units}}{63 \text{ Days/Q}} \times 50 \text{ Units/Day} = 794 \text{ Units}$$

$$794 - 600 = 194 \text{ Units}$$

$$\text{Working Days/Qtr.} = 63$$

Topic 2: Production Planning Grid and Production Methods

Key Cost Factors

Workforce changes

- Relevant for chase or hybrid methods
- Assumptions
 - Employee productivity is X units per month.
 - Cost of hiring or layoffs is \$X per worker.

Inventory changes

- Cost higher for level method
- Assumptions
 - Value of inventory is based on inventory available at month's end.
 - Value of finished goods inventory is \$X per unit.
 - Cost of inventory is based on rate of X% per month.

Evaluating Resource Plans

Objectives

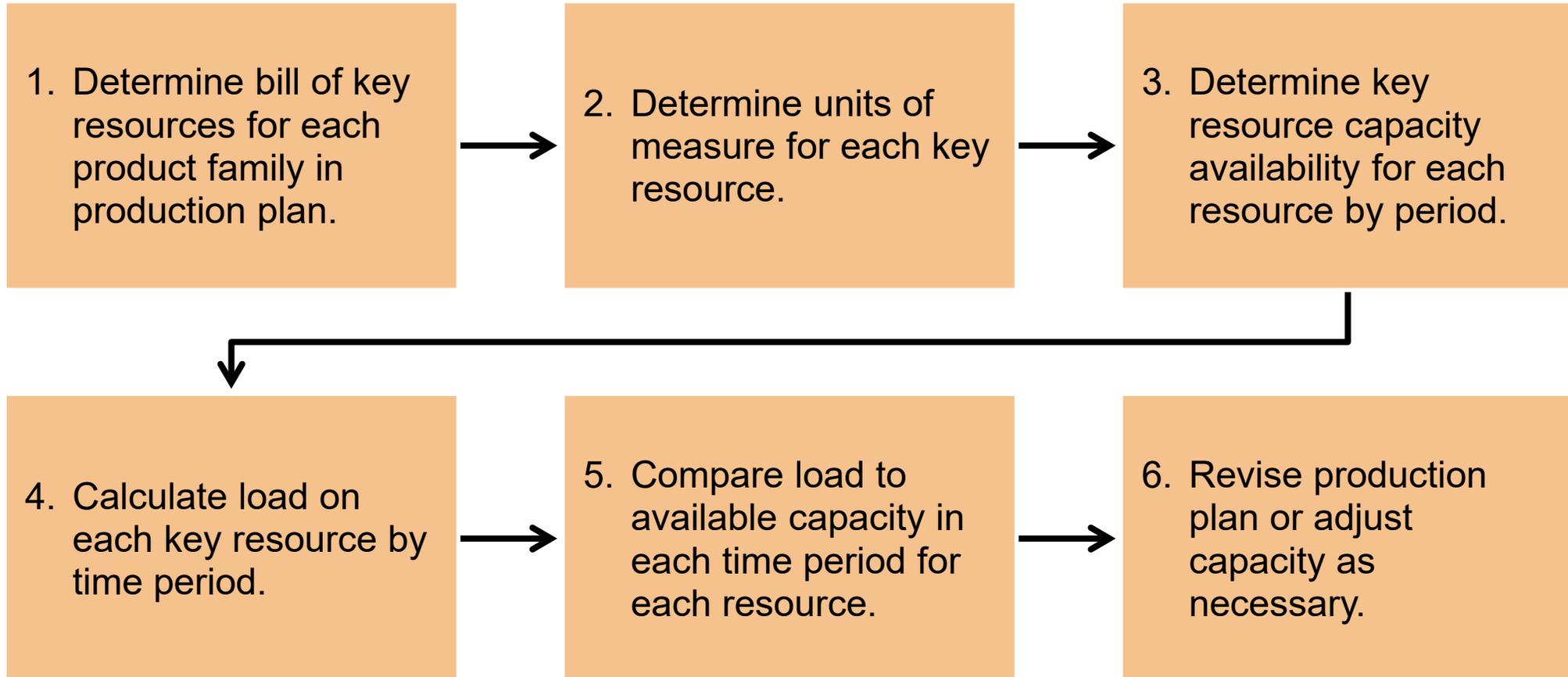
- Evaluate feasibility of production plan.
- Capacity check to address adequacy of resources with long lead times.

Bill of resources

- Information critical to resource planning at product family level.
- Connects resources with product families that need them in production process.

Topic 3: Resource Planning, HR, and Strategic Buffers

Resource Planning Steps



Topic 3: Resource Planning, HR, and Strategic Buffers

Bill of Resources

Bill of Resources—Family Level (per 1,000 Units)					
Key Resources					
	UOM	A	B	C	D
Machining time	Hours	5	5	10	1
Packaged product space	Cubic feet	10	10	10	20
Non-clean-room labor	Hours	75	15	25	50
Oven-curing space	Cubic feet	10	10	20	30
Clean-room labor	Hours	20	10	15	40
Quarantine	Cubic feet	24	24	60	80
Gold	Troy ounce	8	8	8	16

Topic 3: Resource Planning, HR, and Strategic Buffers

Resource Planning Exercise

	UOM	Product Families				Total Load	Capac. Avail.	Load %
		A	B	C	D			
Production plan: Quarter 1 (in 1,000s)		100	80	40	60			
Machining time	Hours	500	400	400	60	1,360	1,500	91
Packaged product space	Cubic feet	1,000	800	400	1,200	3,400	3,600	94
Non-clean-room labor	Hours	7,500	1,200	1,000	3,000	12,700	9,600	132
Oven-curing space	Cubic feet	1,000	800	800	1,800	4,400	3,600	122
Clean-room labor	Hours	2,000	800	600	2,400	5,800	6,000	97
Quarantine	Cubic feet	2,400	1,920	2,400	4,800	11,520	12,000	96
Gold	Troy ounce	800	640	320	960	2,720	3,000	91

UOM: unit of measure

Topic 3: Resource Planning, HR, and Strategic Buffers

Commercial Door Example: Bill of Resources

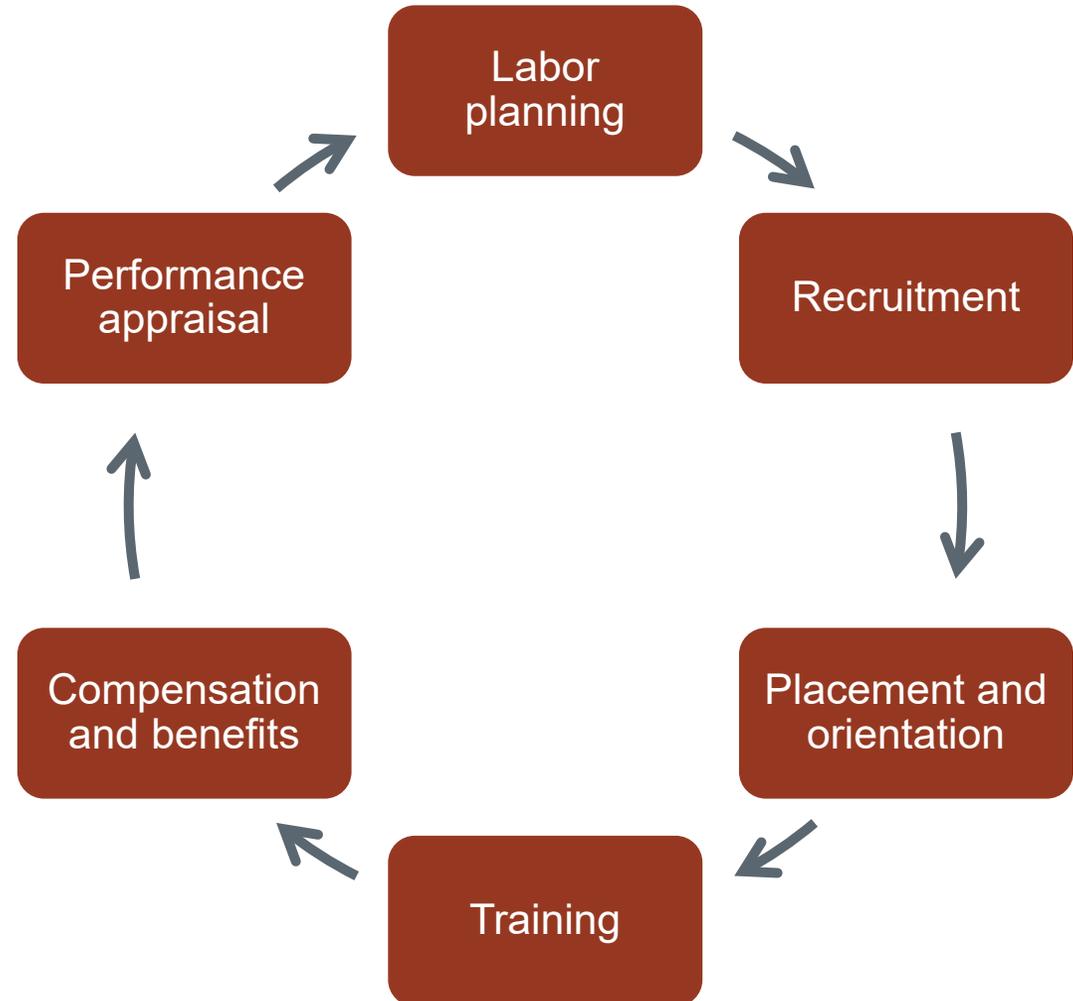
Families A, B and C: Vandalproof Glass Commercial Doors				
Product	Family A:	Family B:	Family C:	SUM
	In-Stock All-Glass	Custom All-Glass	Custom Small Window	
Polycarbonate, Recycled (tons)	0.0036	0.0038	0.0009	0.0083
Labor (standard hours)	3.3	3.9	2.7	9.9
Work Center 23 (standard hours)	0.6	0.7	0.2	1.5

Load for period 1: Rate × Units (e.g., 900 × 3.3 = 2,970 standard hours).

Families A, B and C: Vandalproof Glass Commercial Doors							
	Family A:	Family B:	Family C:	Total Load	Capacity Available	Load (%)	Target Load (%)
	In-Stock All-Glass	Custom All-Glass	Custom Small Window				
Q1 Production Plan (units)	900	1,500	2,400	4,800			
Polycarbonate, Recycled (tons)	3.24	5.70	2.16	11.10	15.00	74%	<80%
Labor (standard hours)	2,970	5,850	6,480	15,300	19,500	78%	<80%
Work Center 23 (standard hours)	630	1050	480	2,160	2,700	80%	<80%

Role of HR in Resource Planning: Job Design and Staffing

- Unique needs of manufacturing environment
 - Degree of training
 - Flexibility
- Cross-training
- Employee empowerment



Decoupling Points and Strategic Buffers in DDMRP

- Generic buffers: bullwhip effect and carrying cost.
- Strategic buffers in demand-driven MRP (DDMRP) use criteria:
 - Customer lead time improvement can create order winners.
 - Degree of demand/supply variability.
 - Best BOM locations for keeping options open or lead time compression.
 - Bottlenecks, CCRs, pace setters (per TOC scheduling).
- Strategic buffers isolate system nervousness.
- Buffers dynamically adjust by zone: red (at min/max), yellow (100% of average daily usage over lead time), green (in optimal range).

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SECTION C: RECONCILING S&OP PLANS

Section C Learning Objectives

- Changing the resource plan
- Prioritizing demand
- S&OP tradeoffs
- Assessing risks in alternative plans

Topic 1: Synchronizing Supply and Demand

Changing Supply/Resource Plans and Prioritizing Demand

Changes can be...

- Acquisitions
- Facility start-up/shutdown
- Hiring, layoffs, shift changes
- Adding and removing tooling and equipment
- Agility and flexibility
- Outsourcing and subcontracting
- Education and training

Prioritizing demand

- Part of demand management: planning, communicating, influencing, and prioritizing demand
- Resequencing demand priorities or convincing customers to accept substitutes
- Volume is main change at S&OP level

Evaluating Alternative Plans and Related Risks

- Alternatives optimize both cost and value:
 - Alternative baselines for planning
 - Undertime
 - Overtime
 - Outside contracting
- Risks are organization-specific:
 - Consider pluses and minuses not in analysis.
 - Keep it simple.

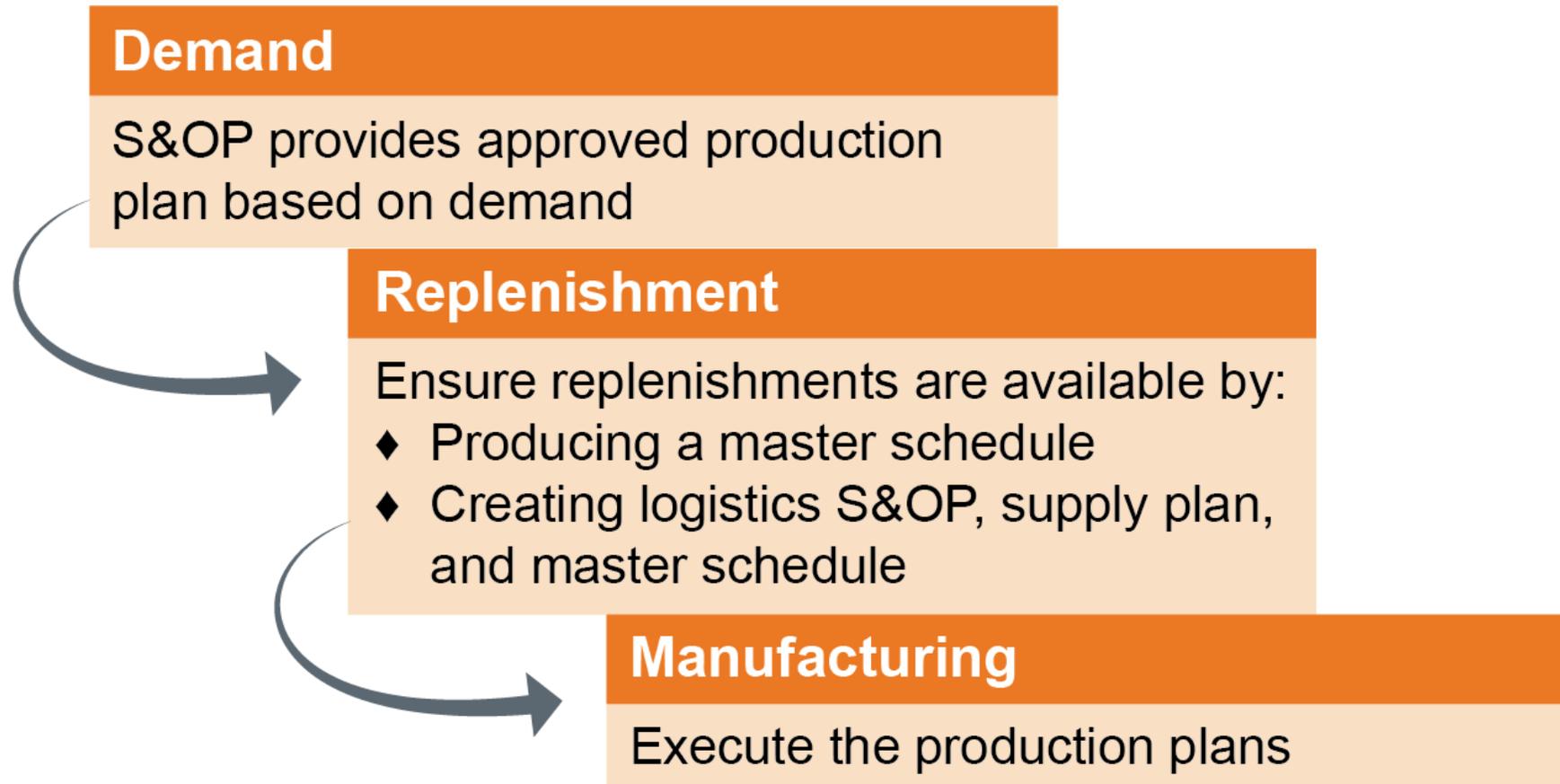
Topic 2: Tradeoffs, Alternatives, and Approved Plan

Planning Factor Tradeoffs by Production Strategy

	Customer Service Level	Inventory Level	Backlog Level
MTS	Customer: short delivery time	Forecast drives production; orders pulled from inventory	Demand > forecast = backlog Stockout = degraded service
MTO	Wait OK for exact order but manage expectations	No excess inventory but late materials may delay too much	Full utilization may add MTS but risks unacceptable backlog
ATO	Manage expectations with quoted lead times based on size of backlog	Flexibility and speed but still could have excess inventory of modules	Full utilization may add MTS but risks unacceptable backlog
ETO	Research before providing delivery estimates	Special order planning needed	Design changes can lead to backorders, disruptions

Topic 2: Tradeoffs, Alternatives, and Approved Plan

S&OP Supply Chain Flow



Common Planning Mistakes for All Industry Sizes/Types

- Indecision by senior management
- Lack of alignment between corporate strategy and S&OP
- Making a single number plan while omitting rest of S&OP
- Poor S&OP meeting protocol
- Short-term view of S&OP
- Lack of objectivity
- Leadership focused on history
- Product life cycle stages not managed as part of S&OP
- External business trends not factored in
- Lack of regular measurements and consistent metrics
- Competition and office politics that slows or derails success