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MODULE 2:
SALES AND OPERATIONS PLANNING

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Module 2 Overview

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

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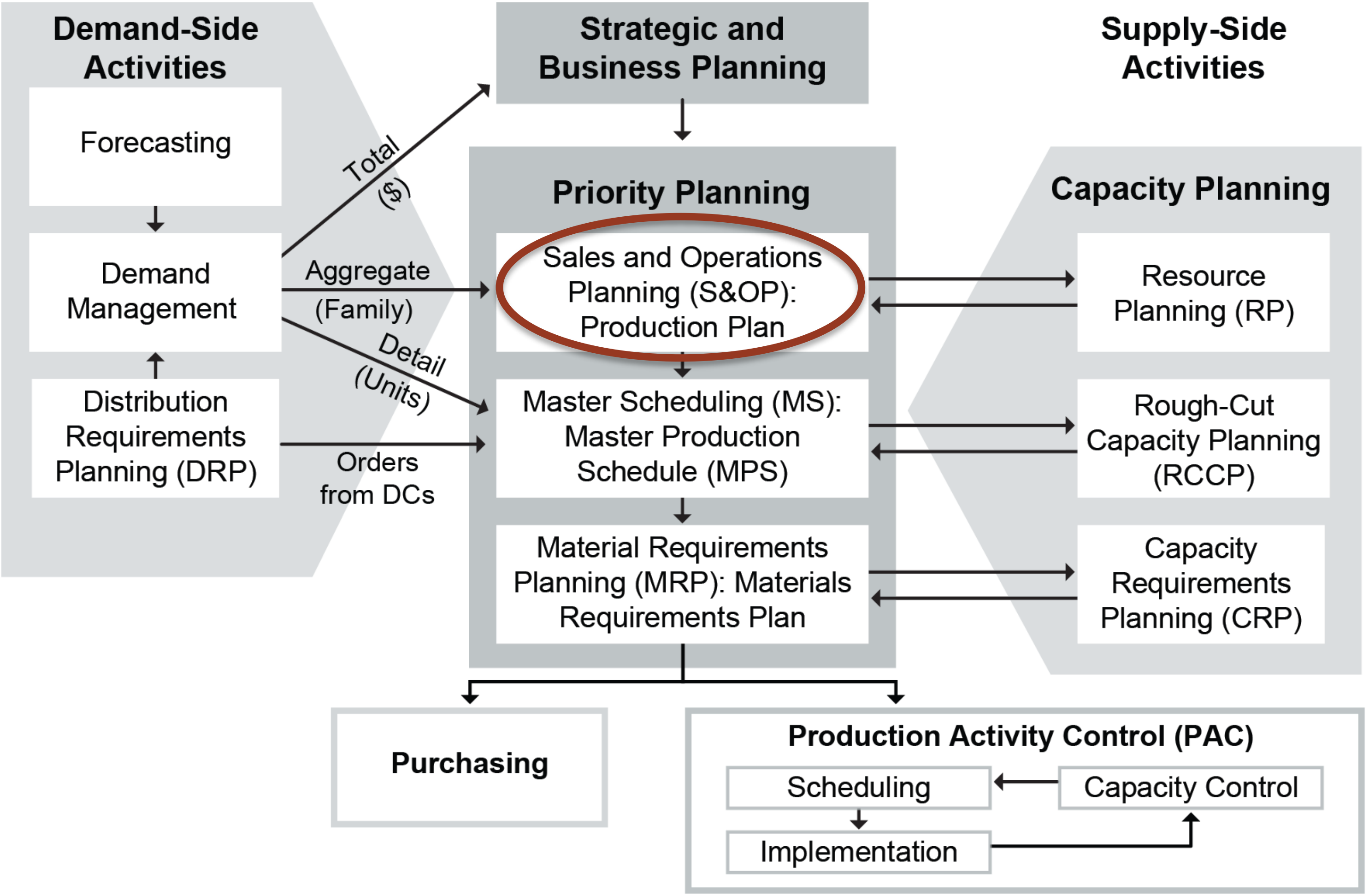
Section A Learning Objectives

- 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

S&OP Road Map and Key Linkages

Planning Hierarchy

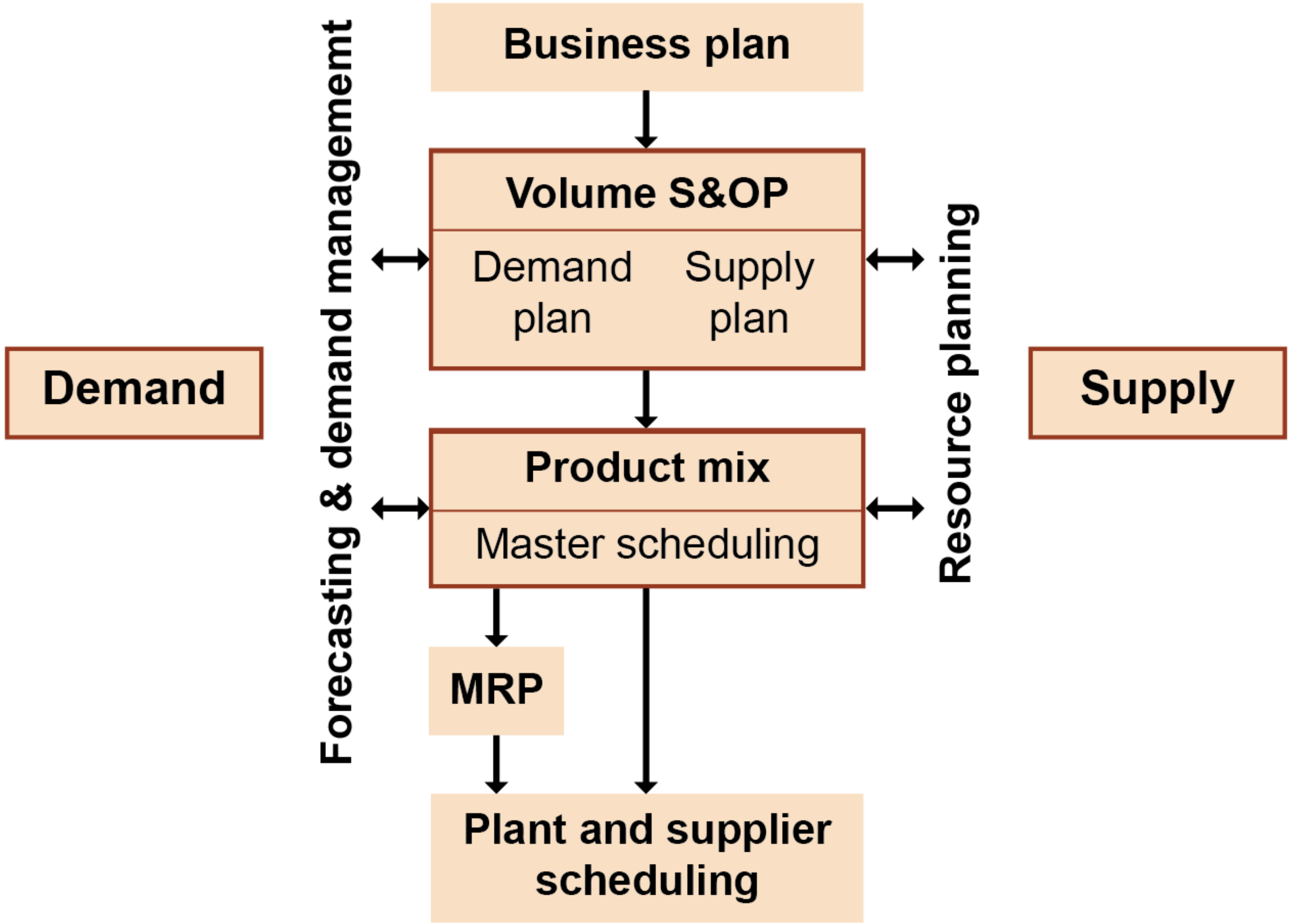


Need for and Benefits of S&OP Integration

- 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

S&OP Road Map and Key Linkages

S&OP Supply/Demand and Volume/Mix Concepts



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.

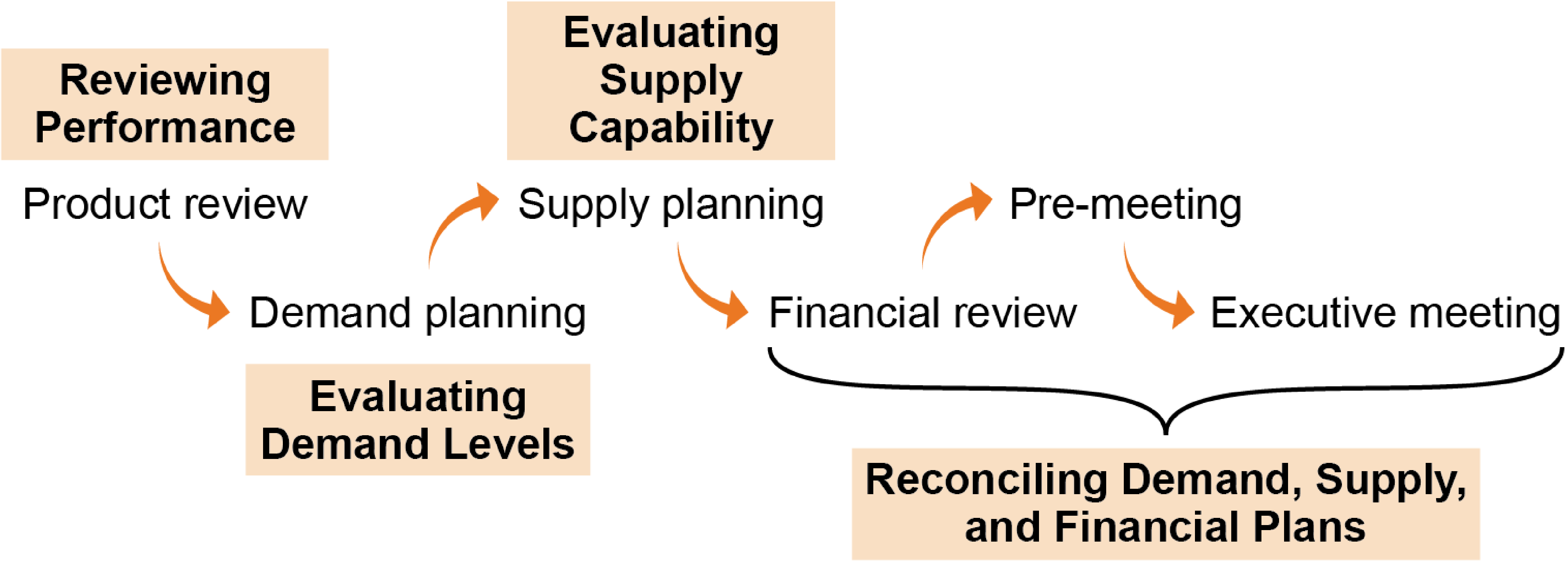
S&OP Roles and Process

S&OP Roles

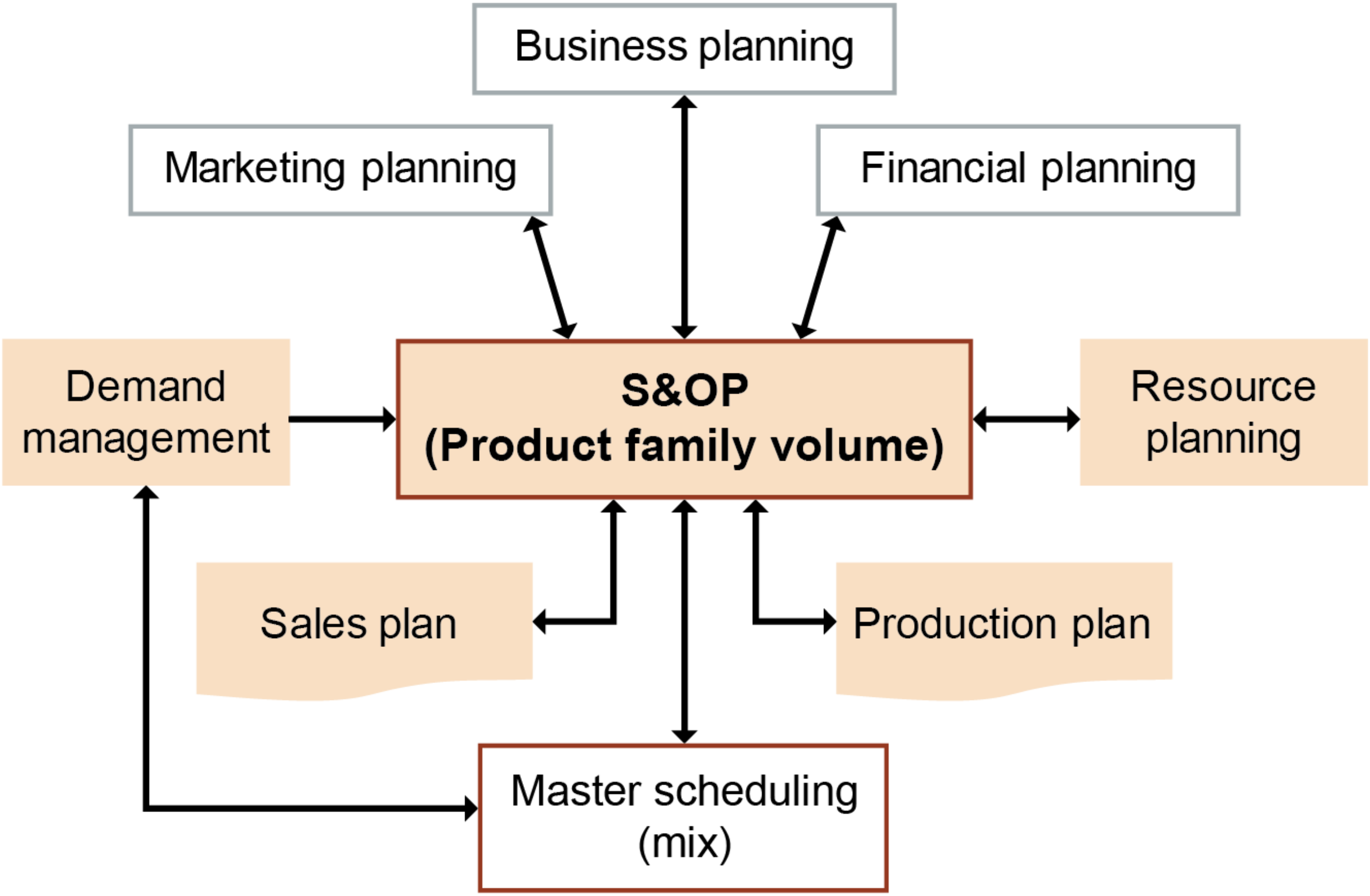
- Executive champion/sponsor
- S&OP process owner
- Demand planning team
- Supply planning team
- Pre-S&OP team
- Executive S&OP team

S&OP Roles and Process

S&OP Process



S&OP Key Inputs and Outputs



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

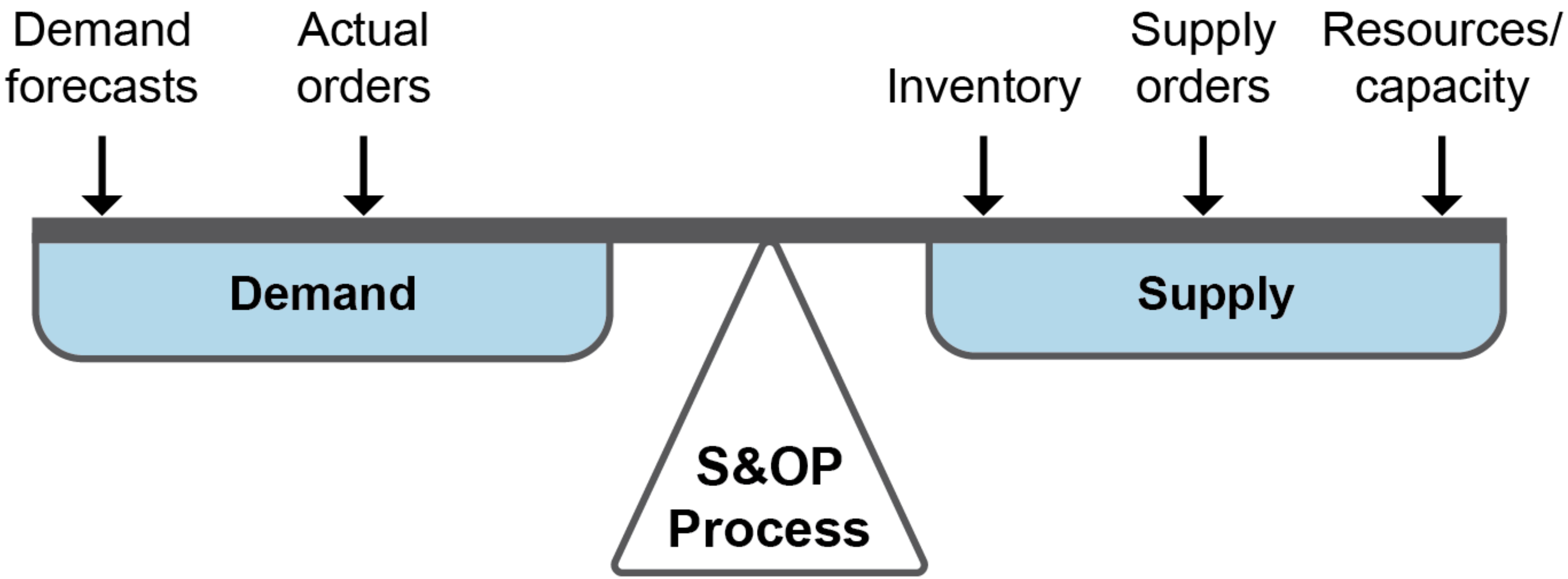
Manufacturing Environments and S&OP

	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)

Synchronizing Supply and Demand

Product family level

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



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

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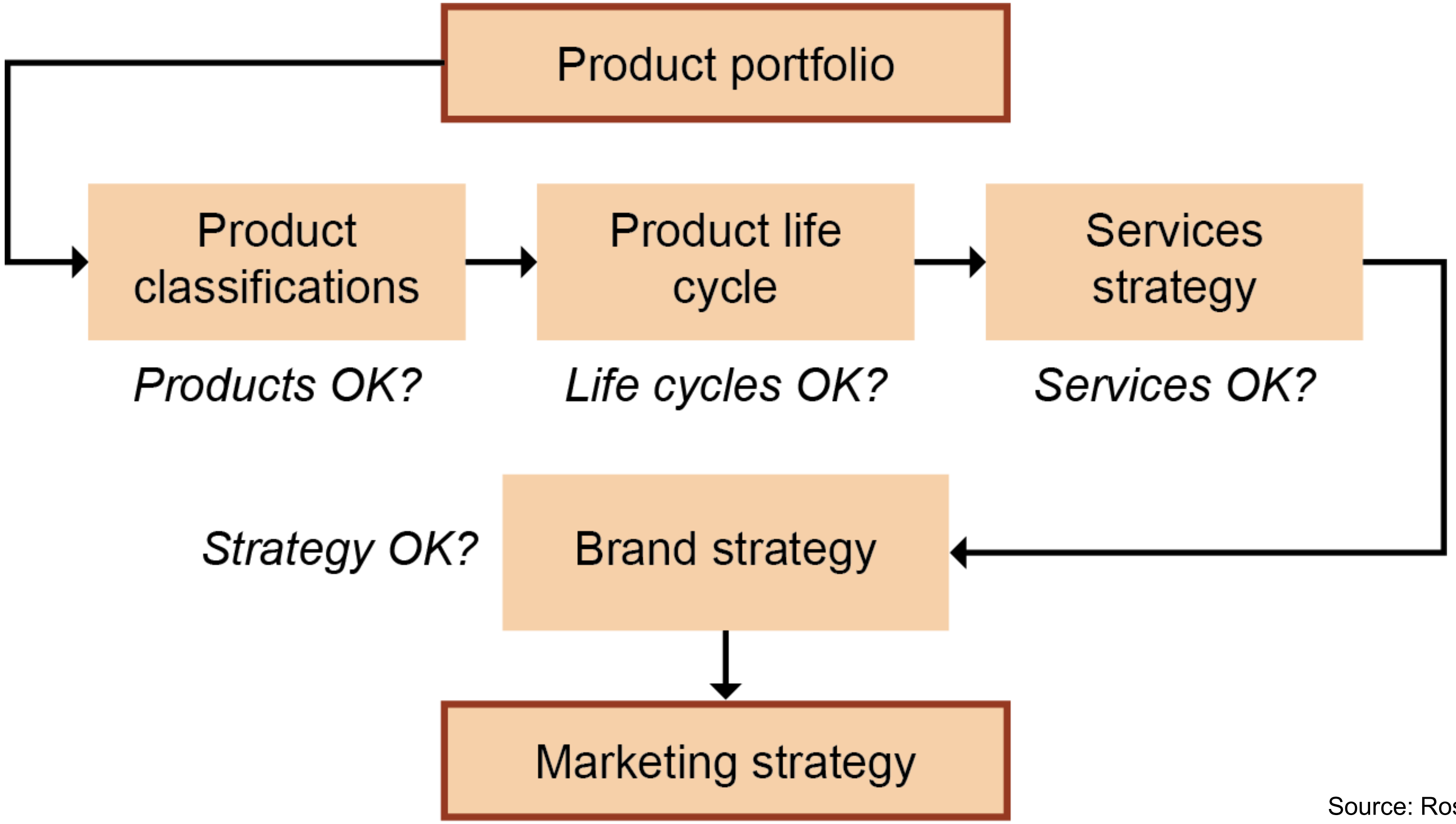
Section B Learning Objectives

- 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

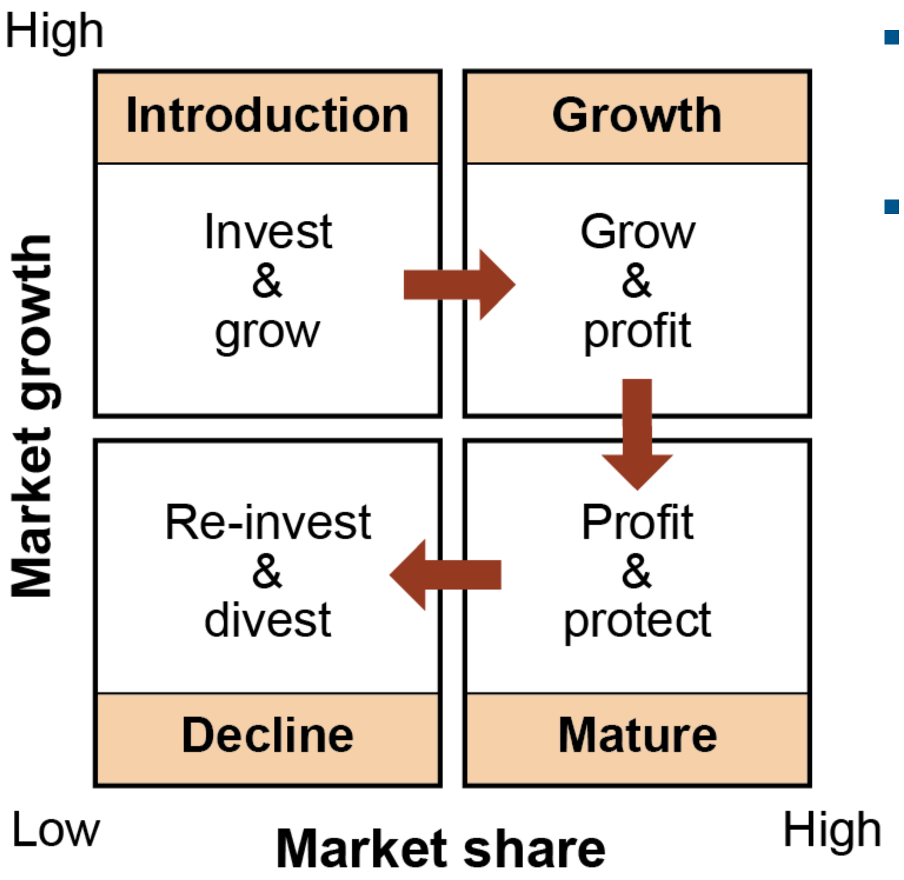
Aligning Portfolio with Market/Marketing Strategy



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

Aggregate Demand and Supply Plans

Brand Strategy and NPI Review



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

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

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

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Supply Plan Elements

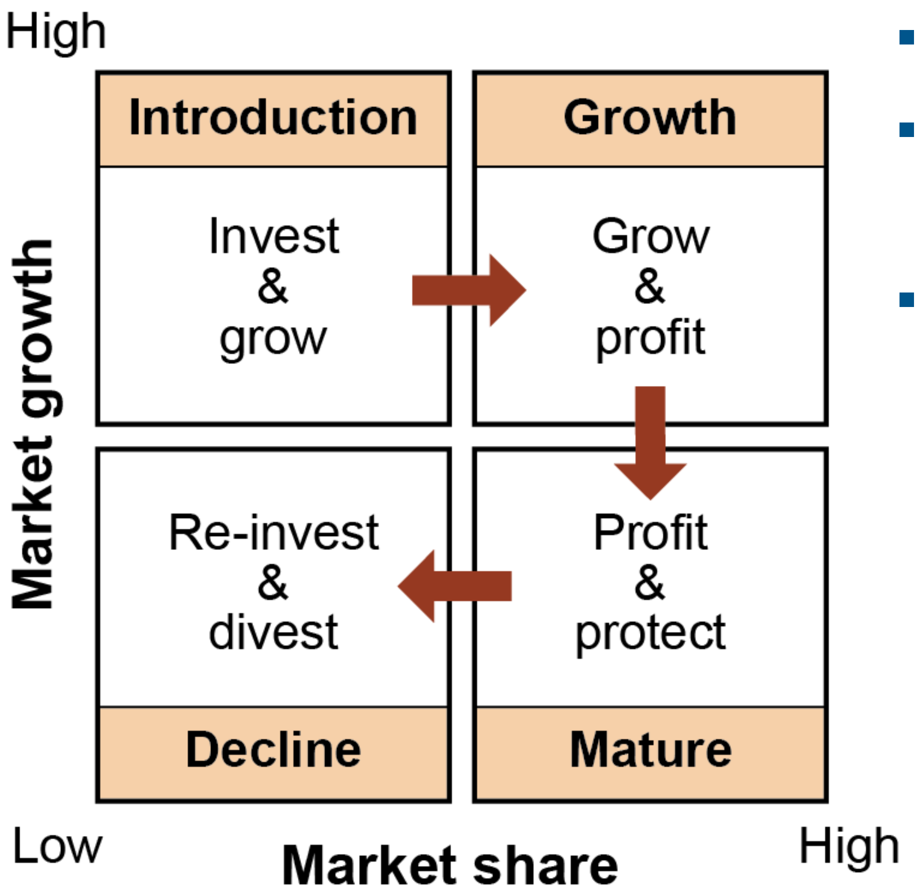
Production plan	Inventory plan
Resource plan	Distribution plan

Aggregate Demand and Supply Plans

Tradeoffs with Supply Plans

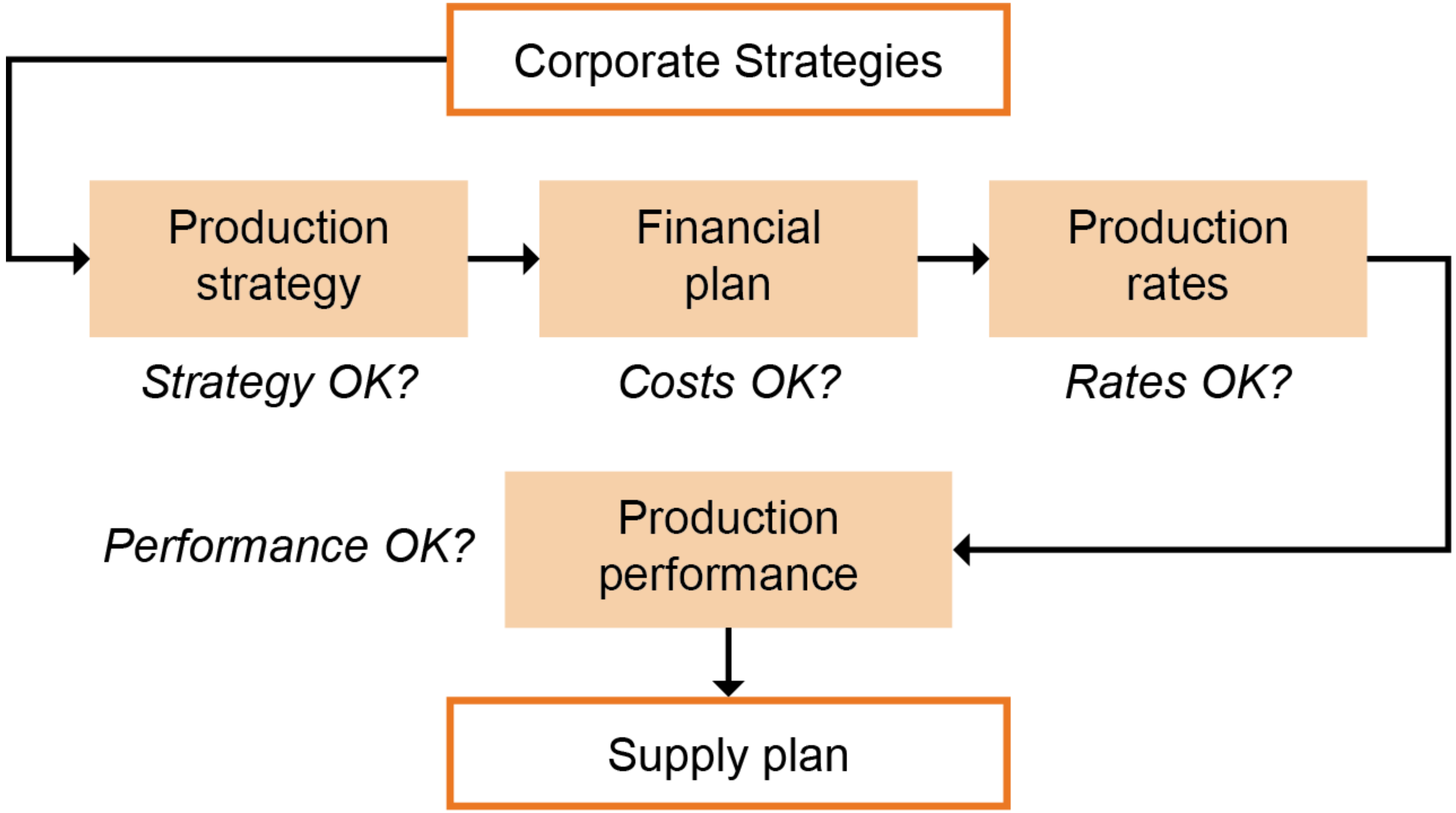
- **Customer service levels**
  - Acceptable lead times
  - Complete, accurate orders without substitution
  - Right quality and price
- **Costs of production**
  - Minimal number of setups
  - Longer runs, high utilization
  - Low material cost
- **Investment objectives**
  - Low work in process
  - High turnover
  - Fast throughput

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

Production and Inventory Plan Development



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

Production Plan

Basic information

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

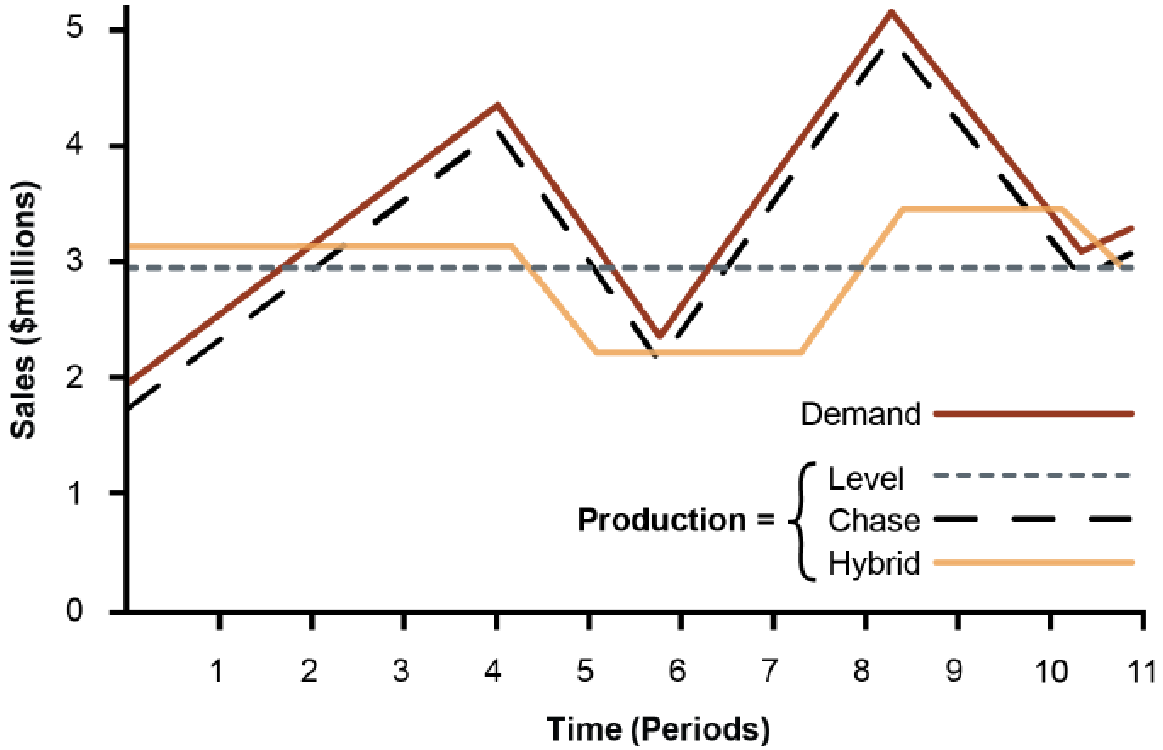
MTS/MTO differences

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

Production Planning Methods

Level, chase, hybrid, outsourcing/subcontracting

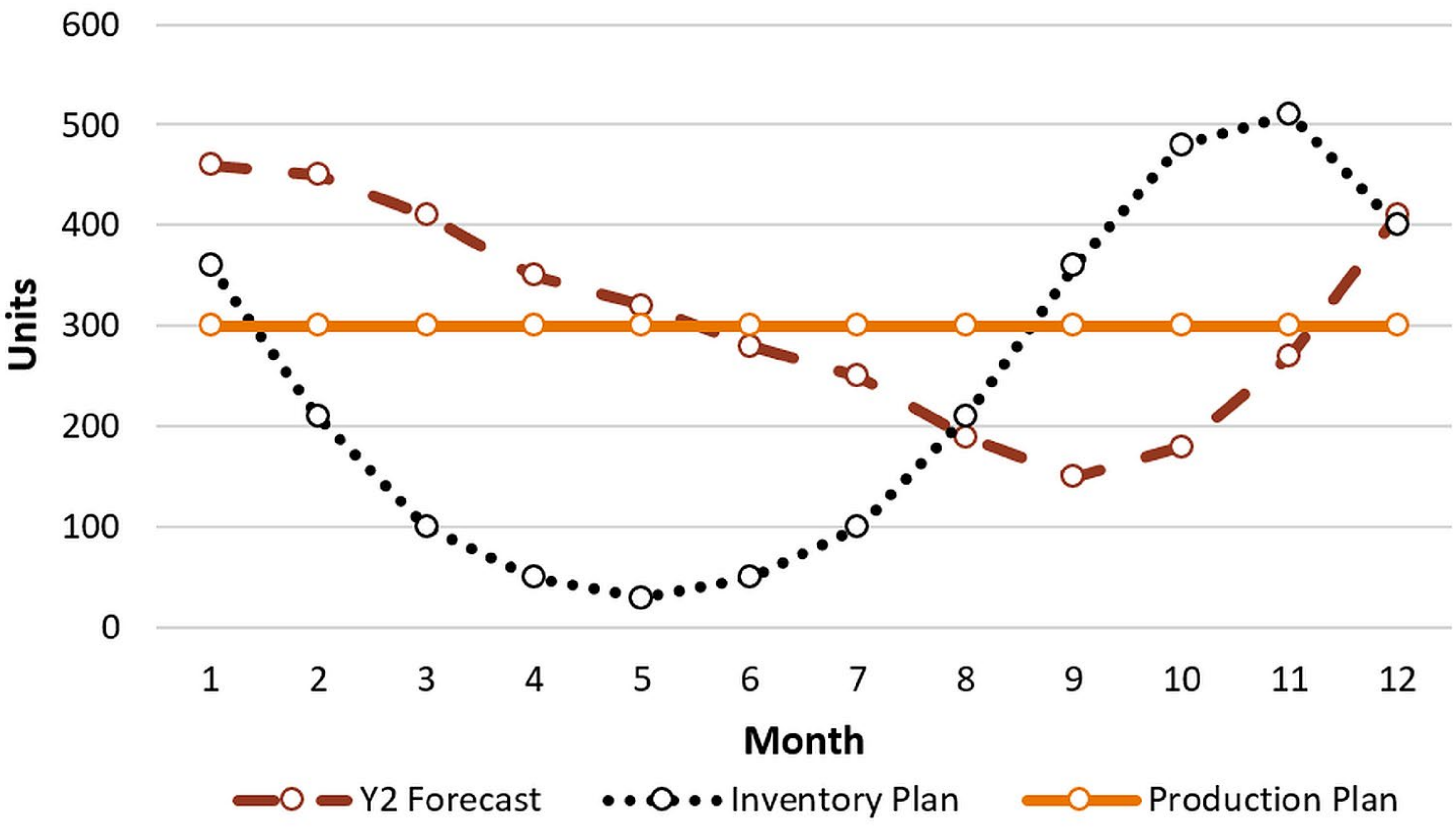
(Note: Outsourcing/subcontracting are not shown in graphic.)



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



Production Planning Grid and Production Methods

Level Production Strategy

Benefits	Risks
▪ Stable labor costs	▪ Cost of carrying excess inventory
▪ Special customer requests	▪ Subcontracting or overtime costs
▪ Improved quality control	▪ Backorder costs
▪ Better cash flow	▪ Cost of expedited shipping
▪ Minimized smoothing costs	▪ Loss of customer goodwill
▪ Reduced cost of hiring	▪ Using forecast data
▪ Stable workforce	

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

Present

History PTF

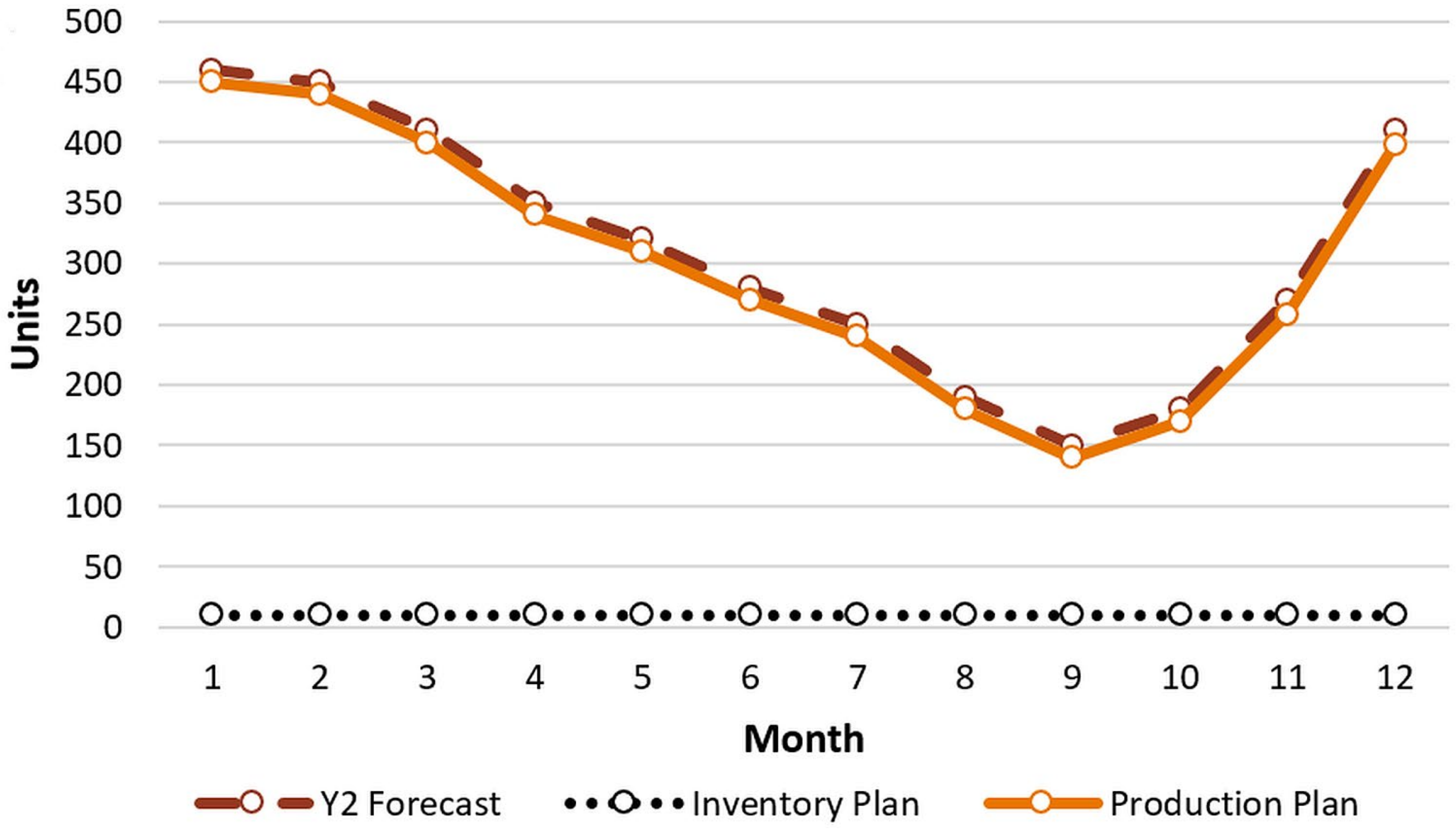
Units in 1,000s

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**	**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										

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



Production Planning Grid and Production Methods

Chase Production Strategy

Benefits	Risks
▪ Changes output capacity to meet demand ▪ Low inventory costs	▪ 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

Production Planning Grid and Production Methods

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

Present

History | PTF

Units in 1000s

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**	**190**	**190**	**110**	**240**	**330**	**360**
Actual sales		43	70	87										
Difference		-7	-10	7										
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Actual production		105	100	100										
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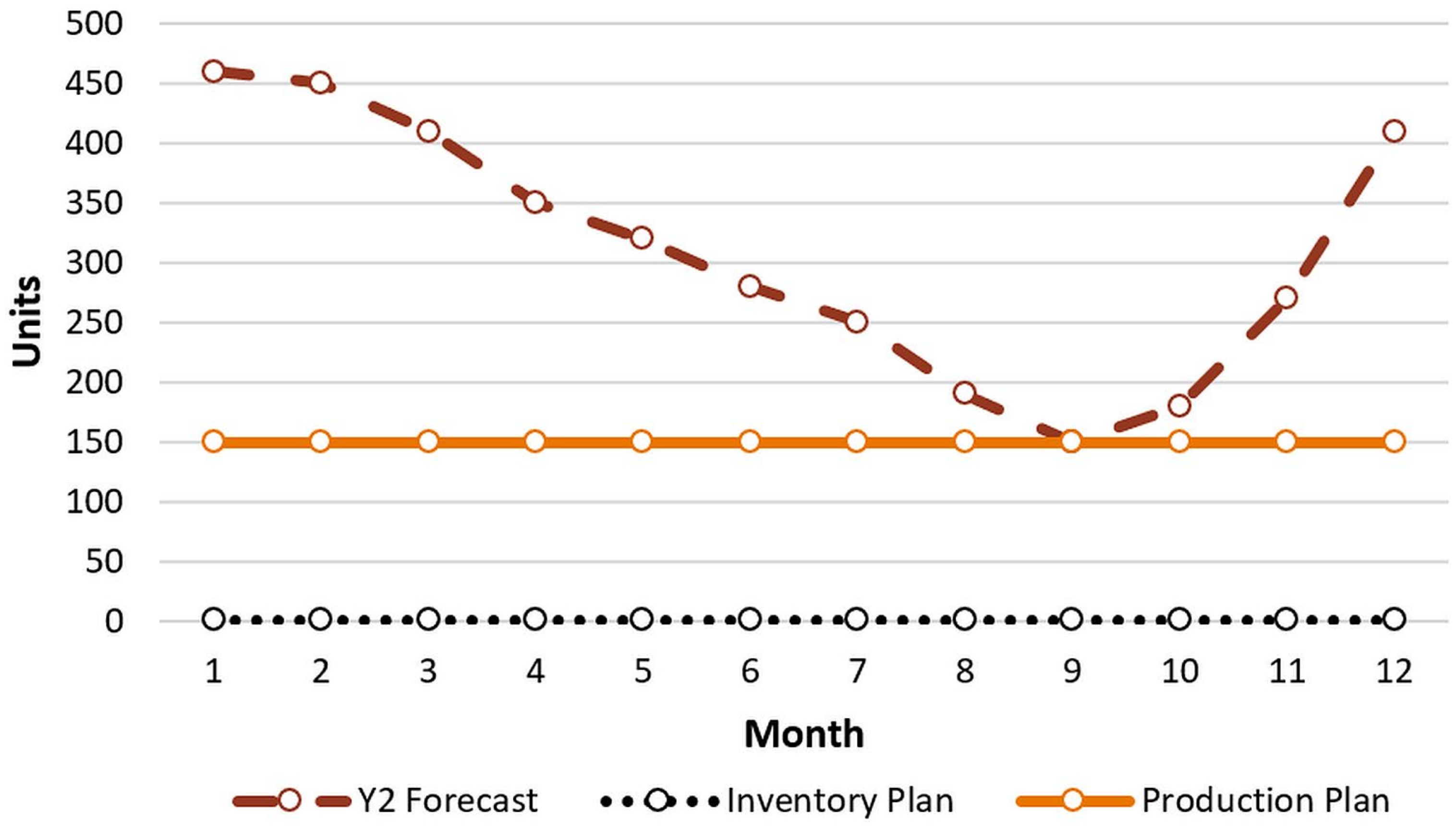
Inventory plan	**20**	**70**	**90**	**110**	**145**	**145**	**145**	**145**	**145**	**145**	**145**	**145**	**145**	**145**
Actual inventory	20	82	112	125										
Difference		12	22	15										

Outsourcing/Subcontracting Production Strategy

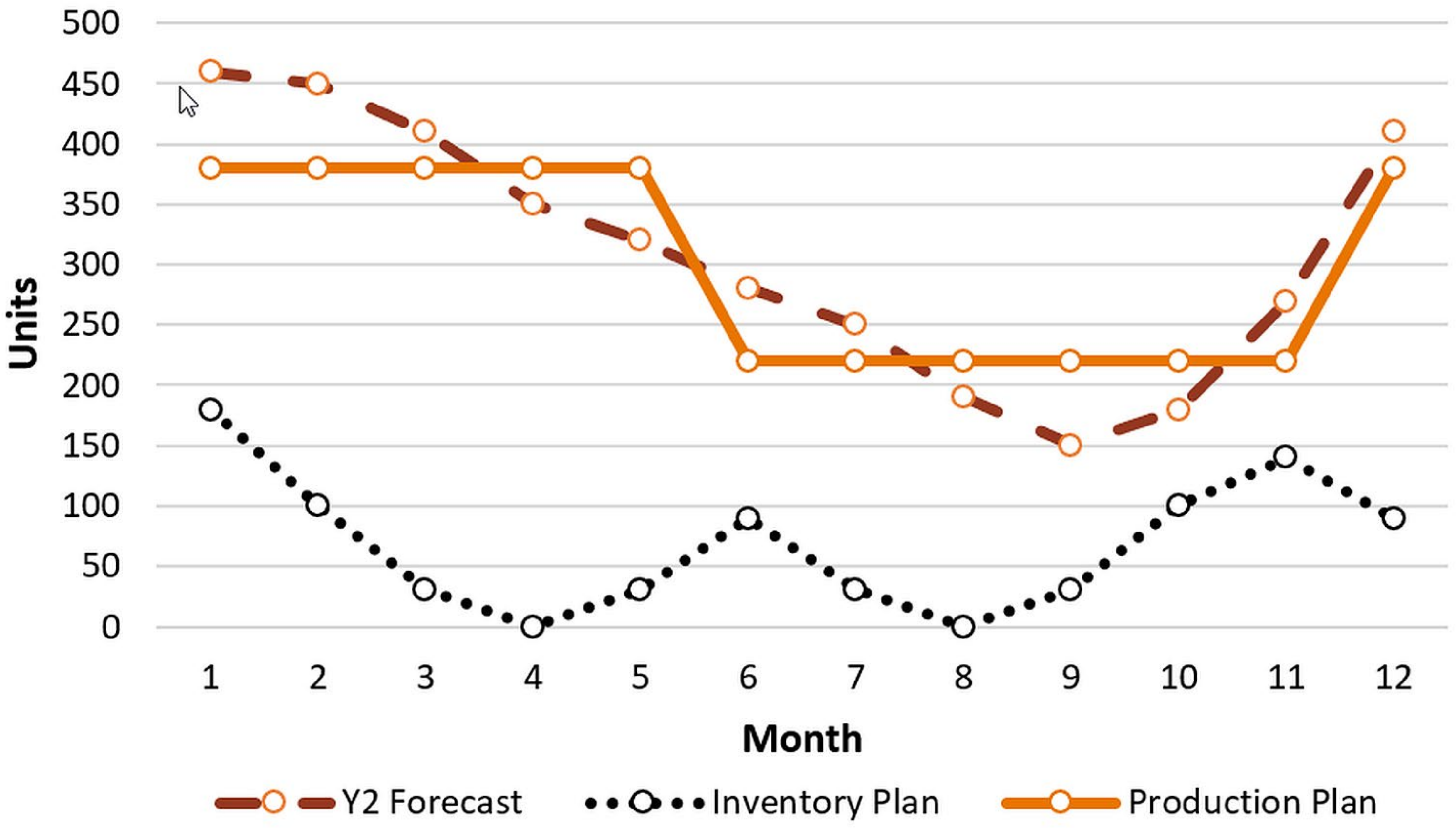
- Minimum level, outsourcing/subcontracting excess demand
- Leveling benefits without changed costs
- Lower profit margins
- Quality or availability issues
- Flow (line or continuous)



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



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Hybrid Production Strategy

Benefits	Risks
▪ Balances large fluctuations in demand ▪ Takes into consideration volatile demand ▪ Smooths out seasonal demand	▪ Availability of an appropriately skilled workforce ▪ Level of coordination

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

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

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

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

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 = 55 + 60 + 65 + 60 + 60 = 300

Total production needed = Total Forecast Demand + Ending Inventory – Opening Inventory
= 300 + 40 – 50 = 290 Units

Production each period = Total Units/Number of Periods =
290 / 5 = 58 Units

Ending inventory for period 1 = Opening Inventory + Production – Forecast Demand
= 50 + 58 – 55 = 53 Units

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

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

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 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 Units

Working Days/Qtr. = 63

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.

Resource Planning Steps

1. Determine bill of key resources for each product family in production plan.
2. Determine units of measure for each key resource.
3. Determine key resource capacity availability for each resource by period.
4. Calculate load on each key resource by time period.
5. Compare load to available capacity in each time period for each resource.
6. Revise production plan or adjust capacity as necessary.

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

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

Commercial Door Example: Bill of Resources

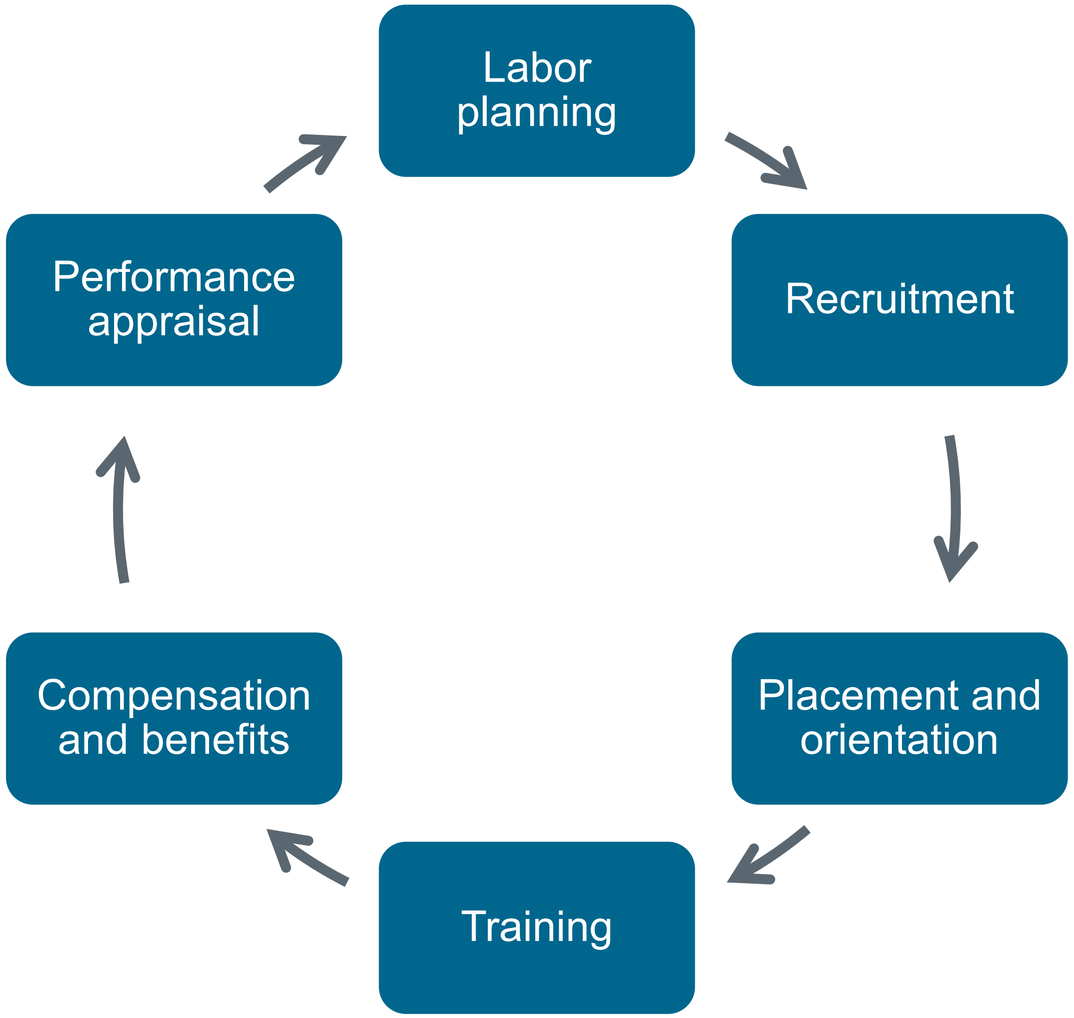
Families A, B and C: Vandalproof Glass Commercial Doors				
Product	Family A: In-Stock All-Glass	Family B: Custom All-Glass	Family C: Custom Small Window	**SUM**
Polycarbonate, Recycled (tons)	0.0036	0.0038	0.0009	**0.0083**
Labor (standard hours)	3.3	3.9	2.7	**9.9**
Work Center 23 (standard hours)	0.6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

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Section C Overview

Section C Learning Objectives

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

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.

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

S&OP Supply Chain Flow

Demand

S&OP provides approved production plan based on demand

Replenishment

Ensure replenishments are available by:

- Producing a master schedule
- Creating logistics S&OP, supply plan, and master schedule

Manufacturing

Execute the production plans

Tradeoffs, Alternatives, and Approved Plan

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