CSCP CERTIFIED SUPPLY CHAIN PROFESSIONAL

MODULE 4: INTERNAL OPERATIONS AND INVENTORY

SECTION A: PLANNING OPERATIONS

APICS

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Section A Introduction

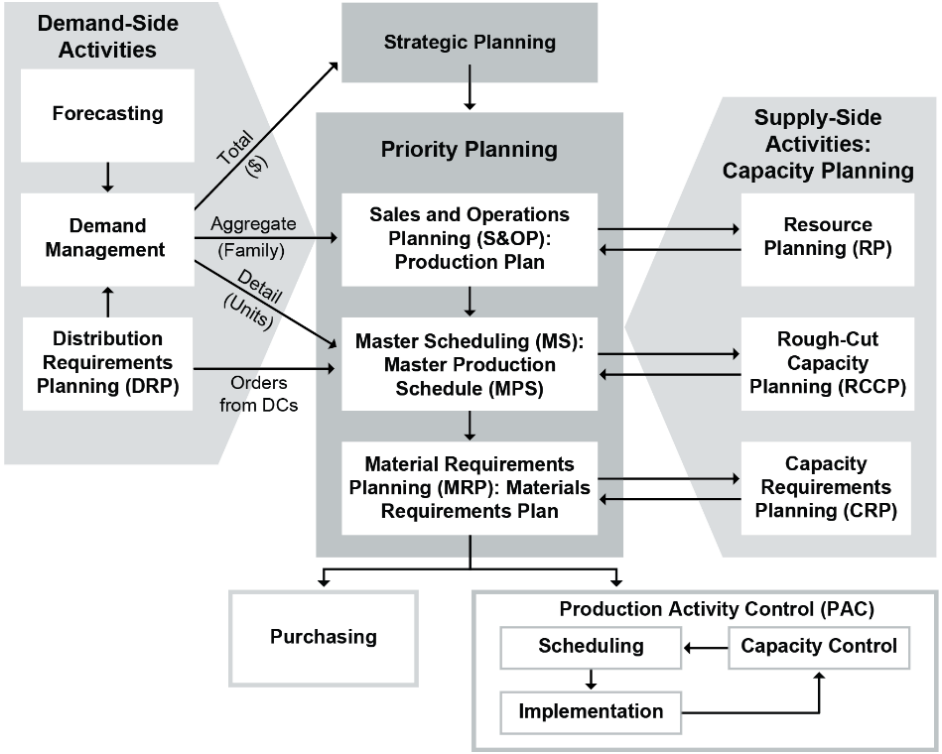
Section A Key Processes:

- Plan operations.
  - Develop master schedule.
  - Determine material requirements.

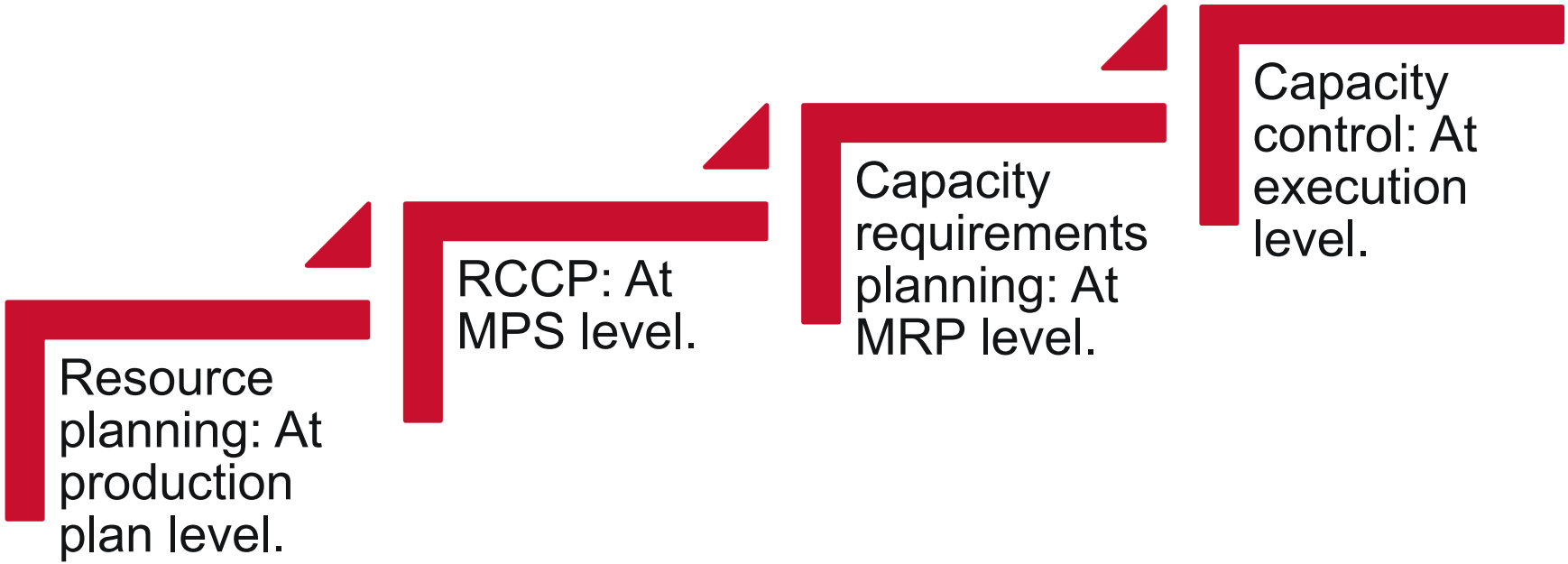
Section A Topics:

- Topic 1: Make-Versus-Buy, Outsourcing, and Offshoring
- Topic 2: Sourcing Requirements and Total Costs

Manufacturing Planning and Control



Stages of Verifying Capacity



Master Scheduling Grid and Time Fences

Period		1	2	3	4	5	6	7	8	9	10
Forecast		20	22	21	25	24	23	21	21	25	25
Customer orders		19	17	15	11	9	5	2	1	0	0
Project available balance (PAB)	50	31	14	49	24	0	27	6	35	10	35
Available-to-promise (ATP)		14		15			43		49		
Master production schedule (MPS)				50			50		50		50

Demand Time Fence

Planning Time Fence

Source: APICS Master Planning of Resources, Version 3.1.

Purposes of the Master Production Schedule

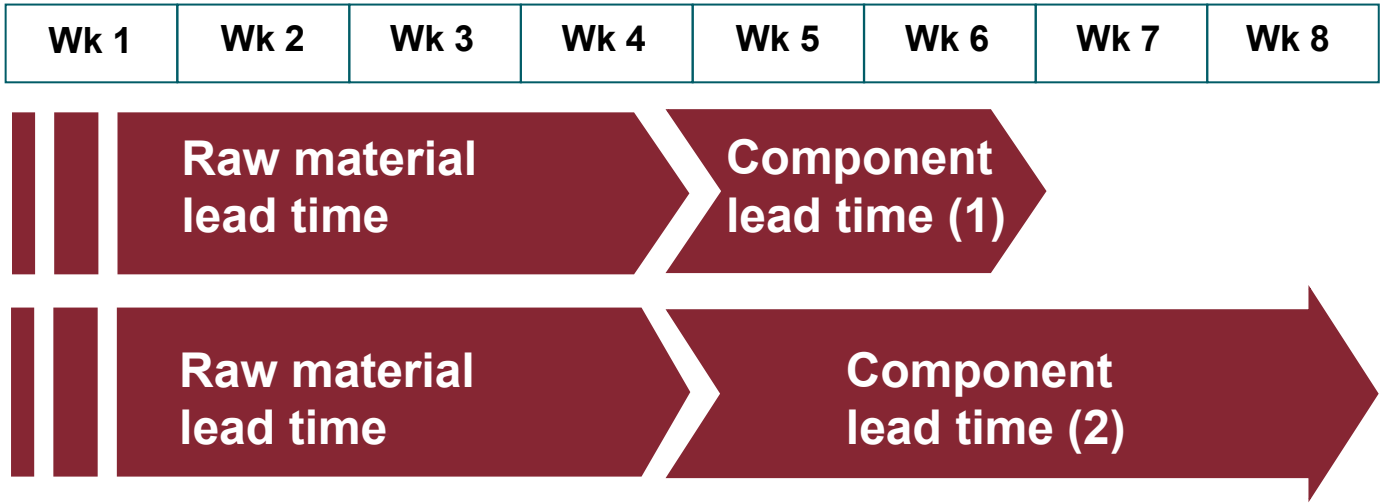
- Provide sales-operations “contract.”
  - Assure sales force of product availability.
  - Assure operations of sales force commitment.
- Balance supply with demand for:
  - Low inventory costs
  - Fewer stockouts
  - More efficient production.

Weekly Dates for Specific Products

Months	July				August			
Aggregate production plan (S&OP)	1,000				1,200			
Weeks	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
MPS: Weekly production of specific products								
LX30—30-ppm	50	50	50	75	75	75	50	100
LX21—21-pp	75	25	100	75	100	100	100	100
LX50—15-pp	50	150	150	150	75	125	150	150

Planning Horizon

- Amount of time plan extends into future
- At least equal to cumulative lead time for product



Projected Available Balance (PAB)

PAB Prior to DTF = Prior Period PAB + MPS − Customer Orders
Period 1 PAB = 50 Units + 0 Units − 19 Units = 31 Units

PAB After DTF = Prior Period PAB + MPS − Greater of Forecast or Customer Orders
Period 6 PAB = 0 Units + 50 Units − 23 Units = 27 Units

		Frozen Zone			Slushy Zone					Liquid Zone	
Period		1	2	3	4	5	6	7	8	9	10
Forecast		20	22	21	25	24	23	21	21	25	25
Customer orders		19	17	15	11	9	5	2	1	0	0
Project available balance (PAB)	50	31	14	49	24	0	27	6	35	10	35
Available-to-promise (ATP)											
Master production schedule (MPS)				50			50		50		50

Demand Time Fence

Planning Time Fence

Source: APICS Master Planning of Resources, Version 3.1.

Available-to-Promise (ATP)

First Period ATP = Inventory + MPS − ∑Customer Orders Before Next MPS
Period 1 ATP = 50 Units + 0 Units − (19 Units + 17 Units) = 14 Units

Following Period ATP = MPS − ∑Customer Orders Before Next MPS
Period 3 ATP = 50 Units − (15 Units + 11 Units + 9 Units) = 15 Units

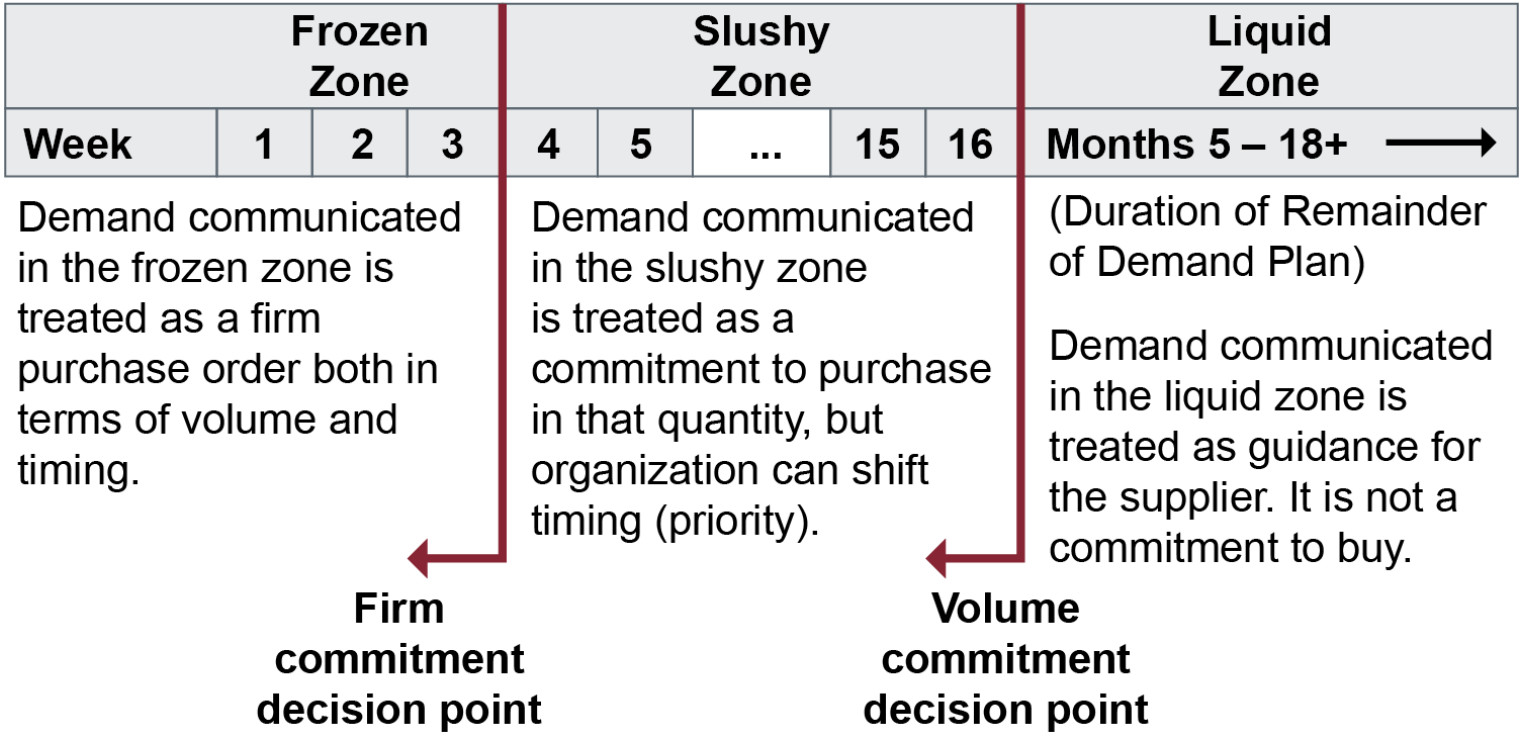
		Frozen Zone			Slushy Zone					Liquid Zone	
Period		1	2	3	4	5	6	7	8	9	10
Forecast		20	22	21	25	24	23	21	21	25	25
Customer orders		19	17	15	11	9	5	2	1	0	0
Project available balance (PAB)	50	31	14	49	24	0	27	6	35	10	35
Available-to-promise (ATP)		14		15			43		49		50
Master production schedule (MPS)				50			50		50		50

Demand Time Fence

Planning Time Fence

Source: APICS Master Planning of Resources, Version 3.1.

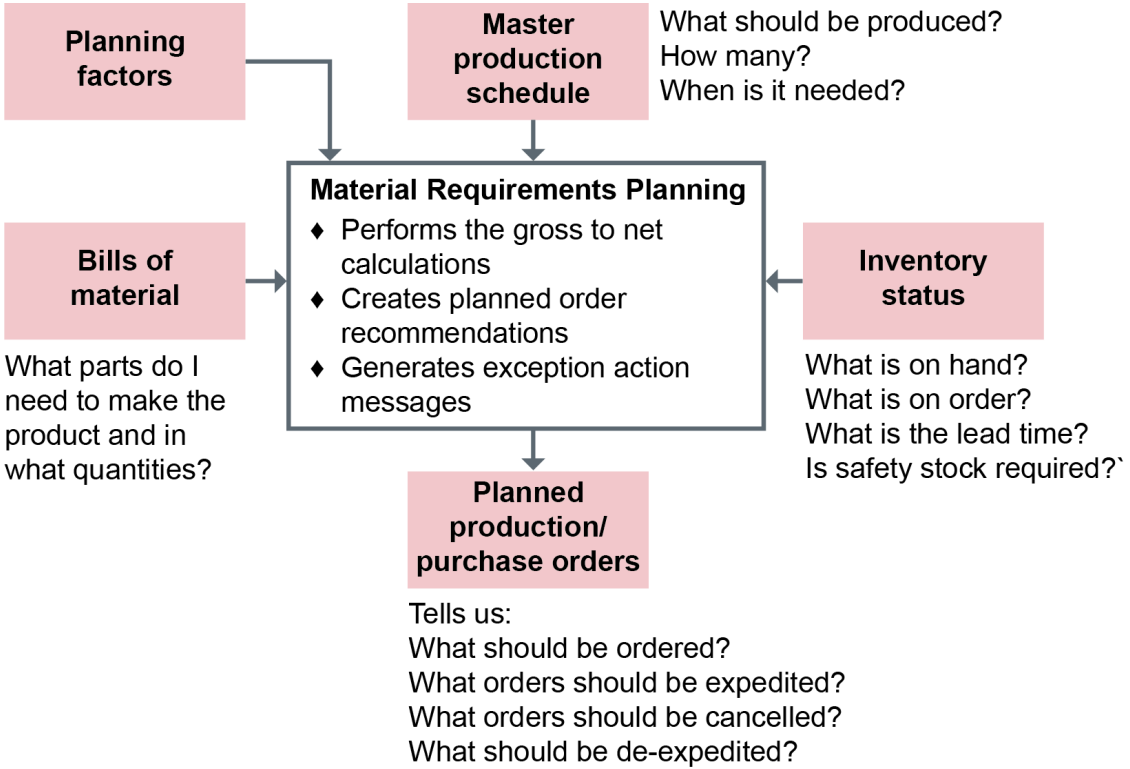
Commitment Decision Points



Materials Requirements Planning

- MRP plans production/purchase orders for dependent demand items only.
- Dependent demand doesn’t require estimation, only calculation.
- Some items can have both independent and dependent demand.

Materials Requirements Planning



Topic 2: Materials and Inventory

Bill of Material

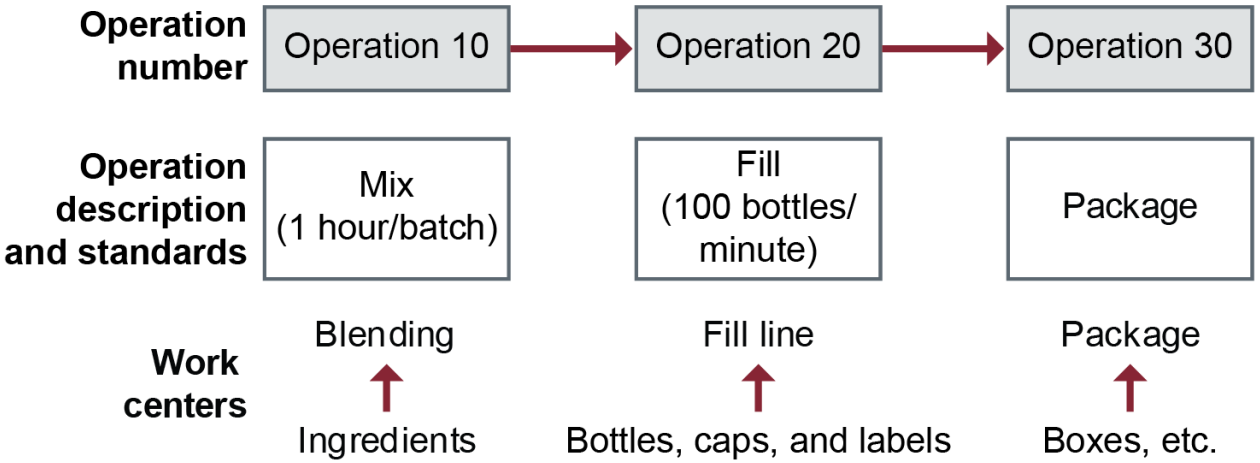
- Complete list of components for a manufactured or assembled item.
- “Explode” multilevel BOMs: expand to drill down into details.
- Modular (planning) BOMs are used for planning modular components.

Multilevel Bill of Material

Model: JTE-5000
Plant: 3000
Validity Date: 9/13/XX

Product Structure	Assembly	BOM Status	Short Text	Quantity
▼ JTE-5000 3000 1 01			1 Motor, Electric 1/2 HP	
▼ 0010 L JTE-4001	*		Stator Assembly	1
▼ JTE-4001 3000 1 01			1 Stator Assembly	
▼ 0010 L JTE-2002	*		Stator Leads	3
► JTE-2002 3000 1 01			1 Stator Leads	
0010 L JTE-1001			Terminal-Flag	1
0020 L JTE-1002			Wire-Stranded	1
▼ 0020 L JTE-3001	*		Stator Wire Coils	1
► JTE-3001 3000 1 01			1 Stator Wire Coils	
0010 L JTE-2001			Wire-Aluminum	25
▼ 0030 L JTE-3002	*		Stator Blank	60
► JTE-3002 3000 1 01			1 Stator Blank	
0010 L JTE-2003			Steel, Coiled	1
0020 L JTE-3004			Rotor Blank	1–
0040 L JTE-1004			Varnish	0.001
▼ 0020 L JTE-4002	*		Rotor Assembly	1
▼ JTE-4002 3000 1 01			1 Rotor Assembly	
▼ 0010 L JTE-3003	*		Shaft Rotor	1
► JTE-3003 3000 1 01			1 Shaft Rotor	
0020 L JTE-3004			Rotor Blank	60
0030 L JTE-3005			Aluminum	1
▼ 0030 L JTE-4003	*		End Bell-Top	1
▼ JTE-4003 3000 1 01			1 End Bell-Top	
0010 L JTE-3005			Aluminum	1
0020 L JTE-4004			End Bell-Bottom	1–
0040 L JTE-4004			End Bell-Bottom	1
0050 L JTE-4005			Screw-6", Motor Assembly	4

Routing File



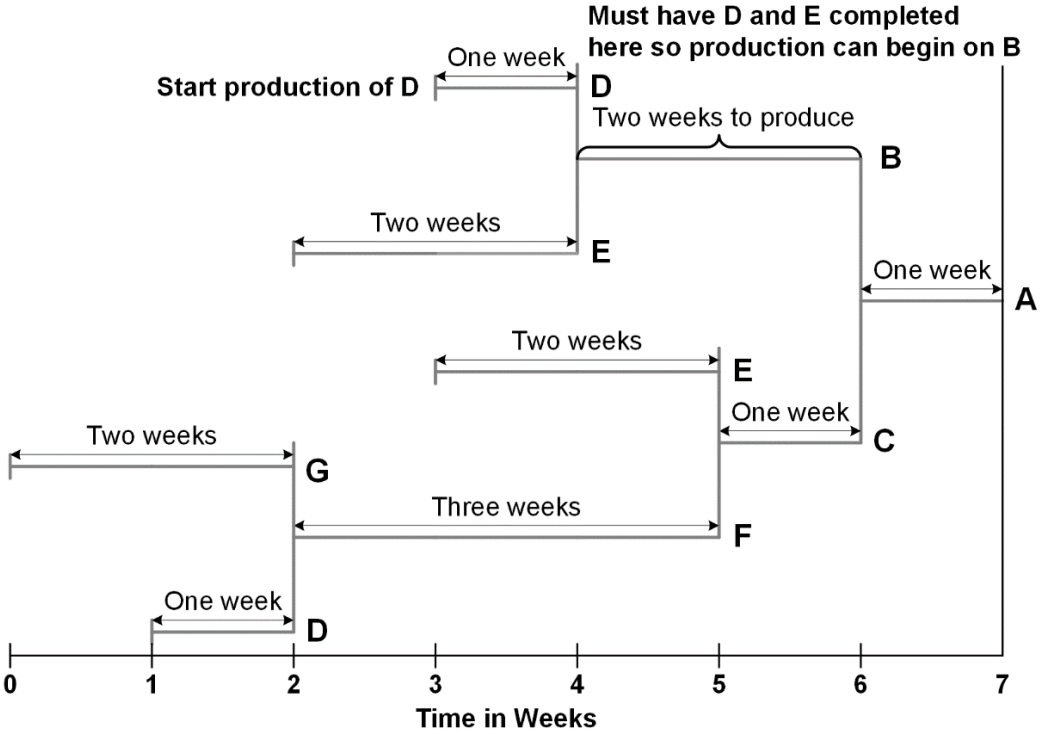
A **routing** for a product shows how it is manufactured in one or more operations. Each operation is identified by a sequence number and a description. The sequence number places the operations in the proper manufacturing sequence. The operations also identify where that process occurs and the standard setup and run times for the product. Tooling and testing requirements can also be included in the routing definition.

Lot-for-Lot and FOQ Replenishment

- Lot-for-lot
  - Exact number needed for production is number to make/buy
  - Often used for dependent demand items
- Fixed order quantity (FOQ)
  - Used in MRP when operations require fixed batch sizes and order quantities.

MRP Lot-Sizing Problem: Lot-for-Lot Technique										
Week		1	2	3	4	5	6	7	8	9	10
Gross Requirements		35	30	40		10	40	30		30	55
Scheduled Receipts											
Projected Available Balance (PAB)	35	0	0	0	0	0	0	0	0	0	0
Net Requirements			30	40		10	40	30		30	55
Planned Order Receipts			30	40		10	40	30		30	55
Planned Order Releases		30	40		10	40	30		30	55	

Offsetting



Managing MRP

- Avoiding system “nervousness”
  - Net change (not plan regeneration)
  - Time fences (rescheduling only with authorization)
  - Pegging components to end products in bill of material
- Is nervousness a red flag?
- Reconciling JIT/lean with MRP
  - Small bucket or bucketless
  - Balanced flow

Evolution of MRP Software

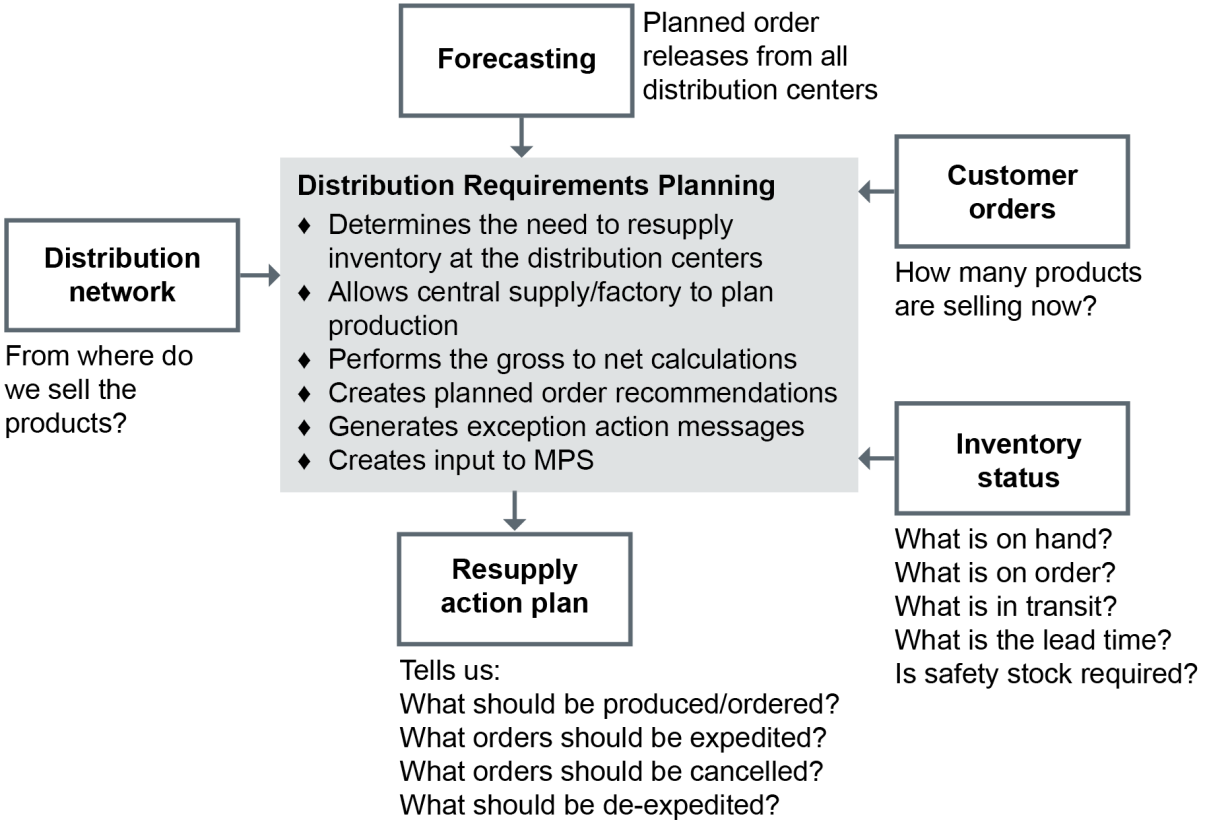
MRP	Closed-Loop MRP	MRP II (often just called MRP)	DDMRP
• Automates BOM • Improves on-time delivery; frees up time to plan • Assumes infinite capacity—hence, impossible schedules	• Refinement of MRP: provides feedback on capacity available • Tradeoff: installation and training costs	• Includes financials (crosses boundaries) • Makes capacity more visible • Translates detailed information to financial statements • Helps realign with plan	• Priority on what can and will be sold (not made) • Minimize cumulative lead time and cost • Some long-lead time materials held • Strategically placed, continually monitored buffer inventories

Distribution Requirements Planning

Push systems	Hybrid systems (e.g., DRP)	Pull systems
▪ Forecasts and schedules centrally coordinated. ▪ Drawbacks: – Customers don't determine own orders. – Doesn't account for local conditions.	▪ Push to given echelon, pull from there, use retail demand data. ▪ Benefits: – From push: Coordination and control – From pull: Local demand responsiveness	▪ Each partner sets own orders. ▪ Drawbacks: – Bullwhip effect if partners are not collaborating. – Ignores needs of other SC partners. – Ignores supplier's ability.

DRP Components

- DC demand forecasts determine gross requirement
- Safety stock for customer service
- Accurate lead time information
- Distribution system map



DRP Logic

DC A: Week		~	6	7
Gross Reqs.				300
PAB	170		170	270
Net Requirements				200
Planned Order Receipts				400
Planned Order Releases			400	

DC B: Week		~	6	7	8
Gross Reqs.					500
PAB	200		200	200	200
Net Requirements					400
Planned Order Receipts					500
Planned Order Releases			500		

Central Supply: Wk.		~	3	~	5	6	7
Gross Reqs.						900	
PAB	500		500		500	200	200
Net Requirements						600	
Planned Order Rec.						600	
Planned Order Rel.			600				

MS Grid: Week	~	2	3	4
Gross Reqs.			600	
PAB		0	200	200
MPS			800	

	Lot Size	Lead	SS
DC A	400	1 wk	70
DC B	500	2 wks	100
Central	600	3 wks	200
MS Grid	800	n/a	n/a

Source: APICS CPIM Basics of Supply Chain Management.

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SECTION B: CAPACITY AND PRODUCTION ACTIVITY CONTROL

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Section B Introduction

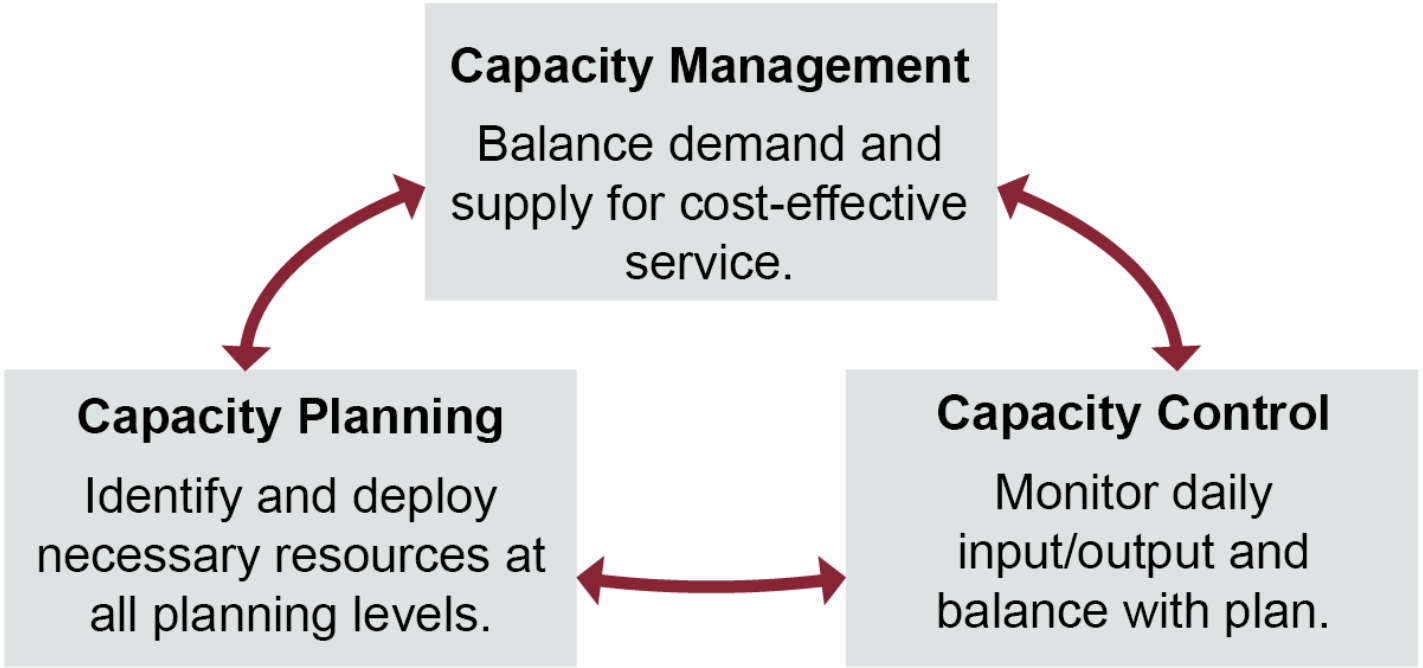
Section B Key Process:

- Evaluate capacity requirements.

Section B Topics:

- Topic 1: Capacity
- Topic 2: Production Activity Control

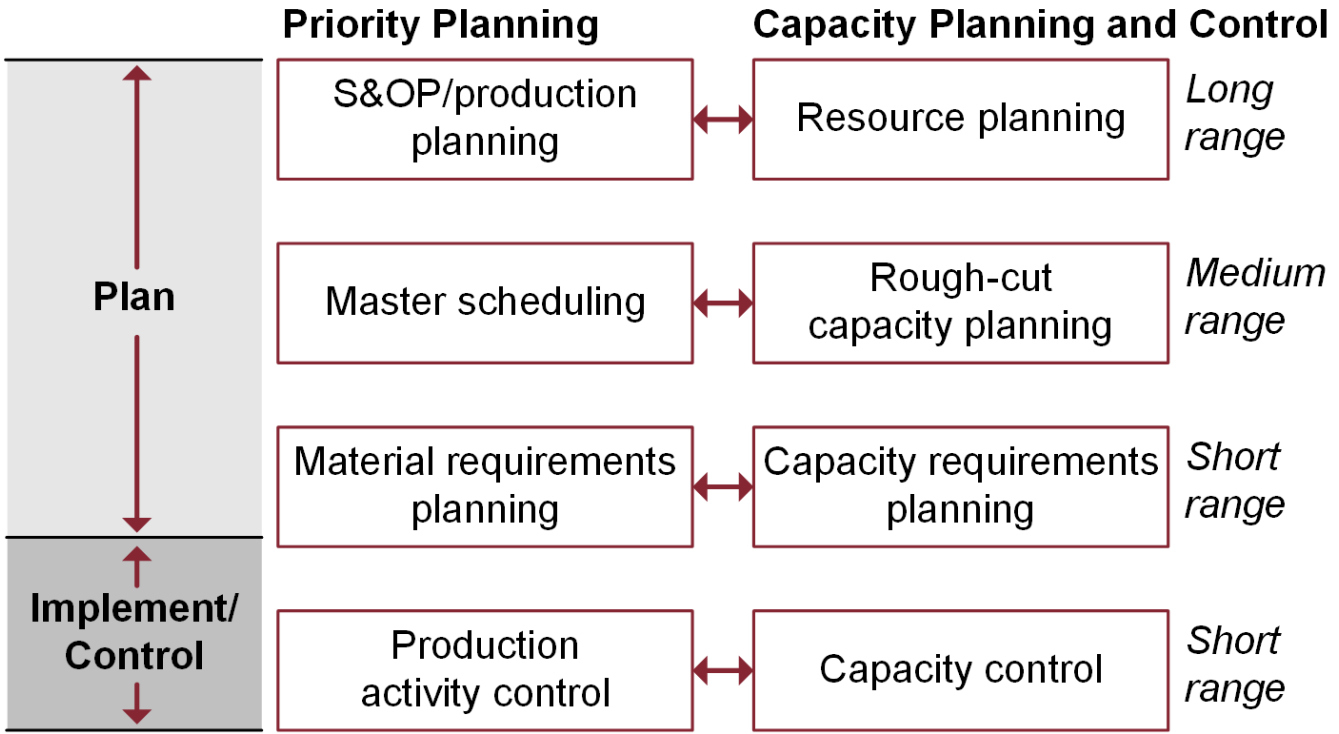
Capacity Management, Planning, and Control



Capacity Objectives

Too much	Just right	Too little
• Supply > demand • Layoffs, idle machines, unused storage • Excess inventory	• On-time fulfillment • Quality items • Optimal use of resources	• Demand > supply • Stockouts, broken orders, overtime, temps, work shifts, etc.

Planning Horizons



Resource Planning

This long-term plan may specify certain long-term capacity goals requiring capital investments.

Business plan

Production plan

This is the long-range production plan in terms of product families. It was created through the S&OP process.

Resource profile

For each product family, it identifies the amount of the resource required to make one unit of the average product family.

Resource Planning

This is the long-range capacity planning process. It calculates the load that will be placed on the resource, which needs to be compared to the capacity for the following key resources:

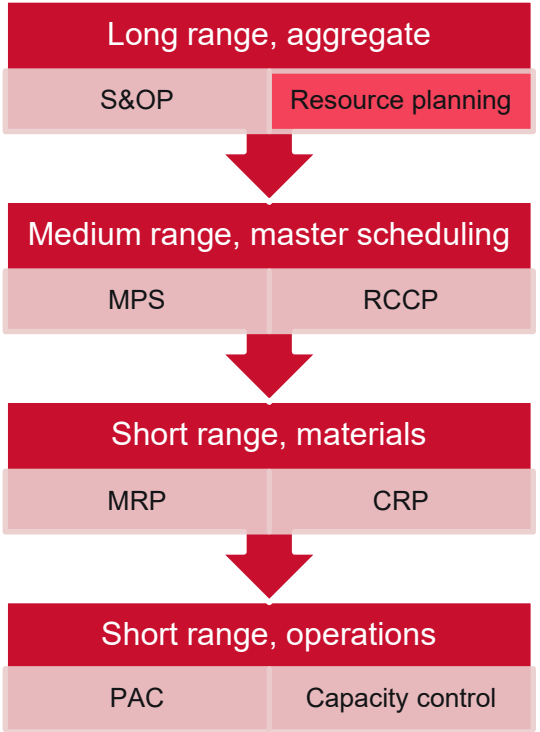
- Plant
- Equipment
- Workforce

Critical resources

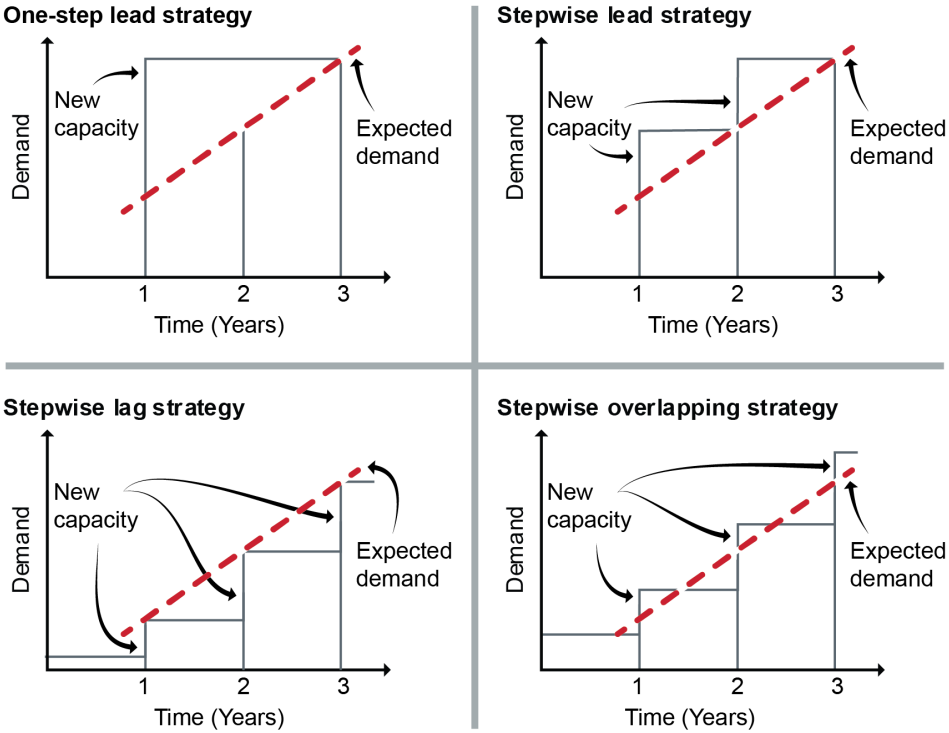
These are the bottlenecks that are currently restricting overall capacity at the product family level.

Action plan

The resource plan is evaluated against the available resources. When bottlenecks are identified, an action plan has to be put in place, i.e., modify the production plan or plan for the availability of additional resources, etc.



Four Ways to Stage Capacity Growth



Rough-Cut Capacity Planning

Preliminary master production schedule

The master scheduling software creates this proposed item-level schedule of production based on product demand and inventory balances.

Bill of resources

For each end item, it identifies the key raw materials for critical resources based on the resources required to make one unit of the specific models or types of end items.

Rough-Cut Capacity Planning

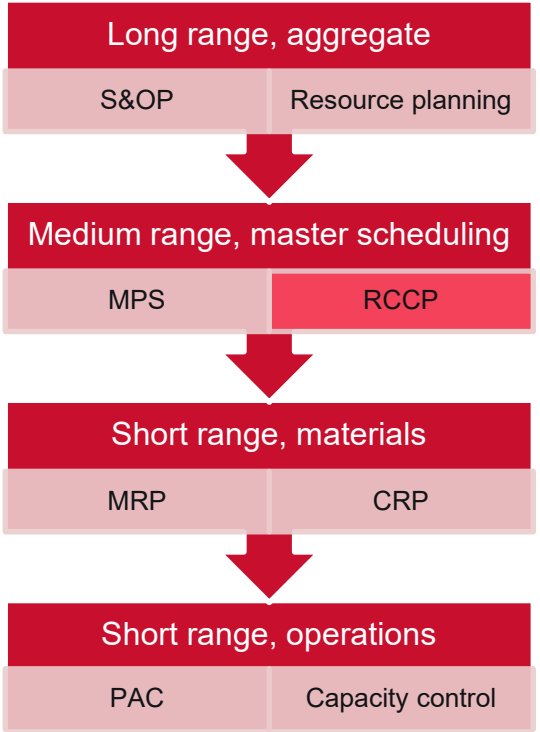
This is the mid-range capacity planning process. It validates critical resource (bottleneck) availability for the MPS.

Critical resources

These are the bottleneck operations, labor, or critical materials that are currently restricting overall capacity at the item level.

Master production schedule

If sufficient capacity is available in bottlenecks, the MPS is considered workable. If not, the master scheduler explores ways to increase capacity (e.g., overtime, use of alternate work centers, contracting out work). If these are not possible/ economical, the master scheduler will revise the MPS to be feasible.

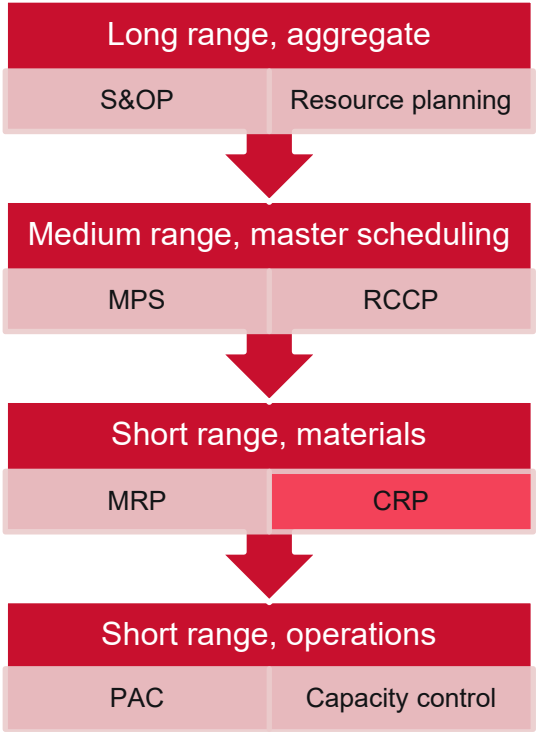


Rough-Cut Capacity Planning

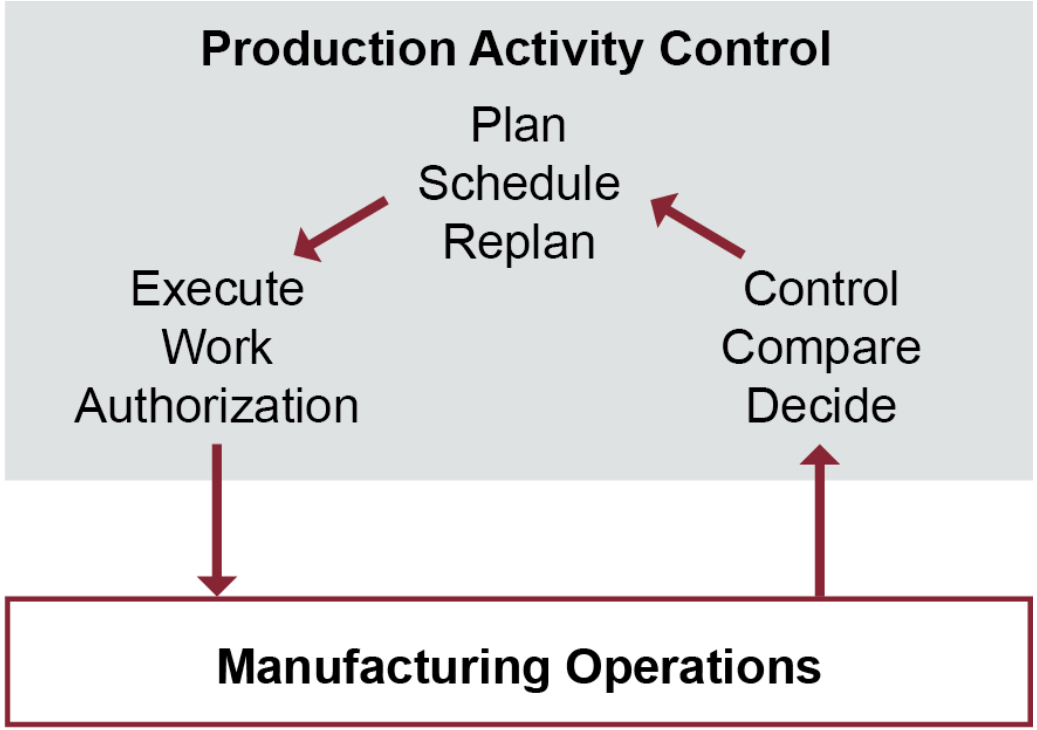
- Process of converting MPS into key resource requirements
- Comparison of load vs. available or demonstrated capacity for each key resource
- Medium-term
- Bottlenecks, gateway work centers, critical suppliers only

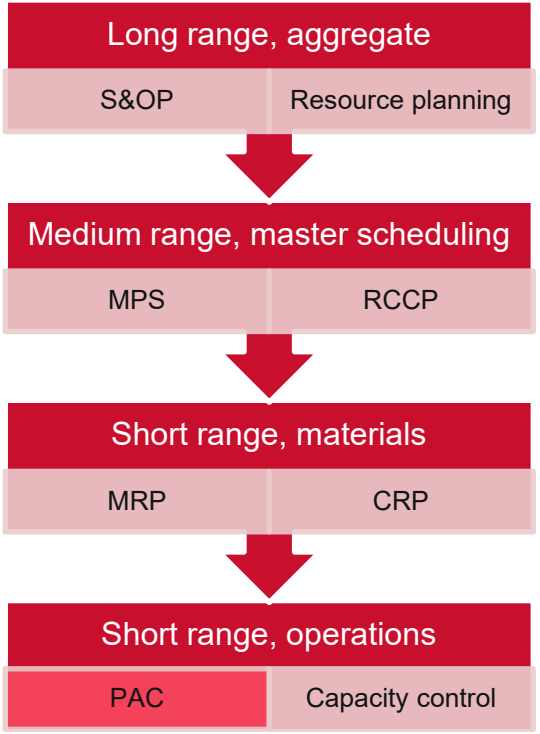
Capacity Requirements Planning (CRP)

- CRP takes place at level of MRP.
- Assigns each facility, work center, and operation a load and does load leveling.
- Steps to determine site capacity:
  - Check open order file.
  - Check planned order releases.
  - Check routing file.
  - Check work center file.
- Output: adjustment of load or capacity (or both) to meet plan, as required.



Production Activity Control (PAC)





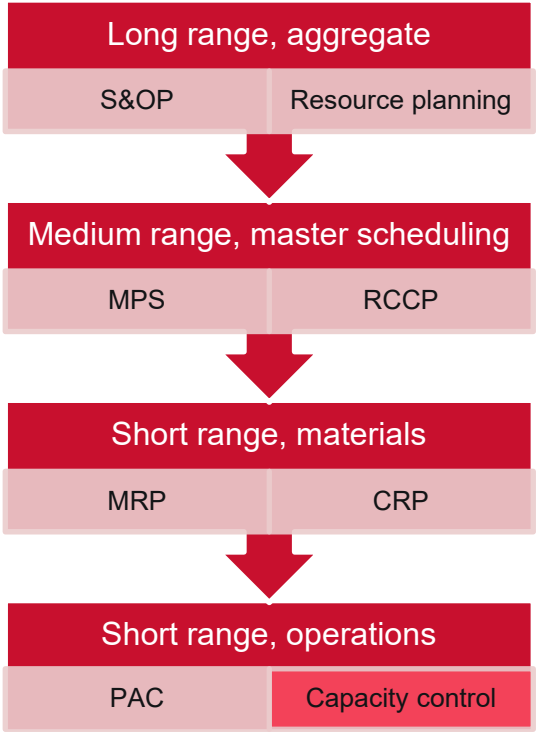
Source: CPIM Workbook.

Measuring Capacity

- Available Time = Hours of Operation × Number of Workers or Equipment
- $\text{Utilization} = \frac{\text{Hours Worked}}{\text{Available Hours}} \times 100$
- $\text{Efficiency} = \frac{\text{Standard Hours of Work}}{\text{Hours Worked}} \times 100$
- Rated Capacity = Available Time × Utilization × Efficiency
- $\text{Demonstrated Capacity} = \frac{\text{Output for } n \text{ Periods}}{n}$

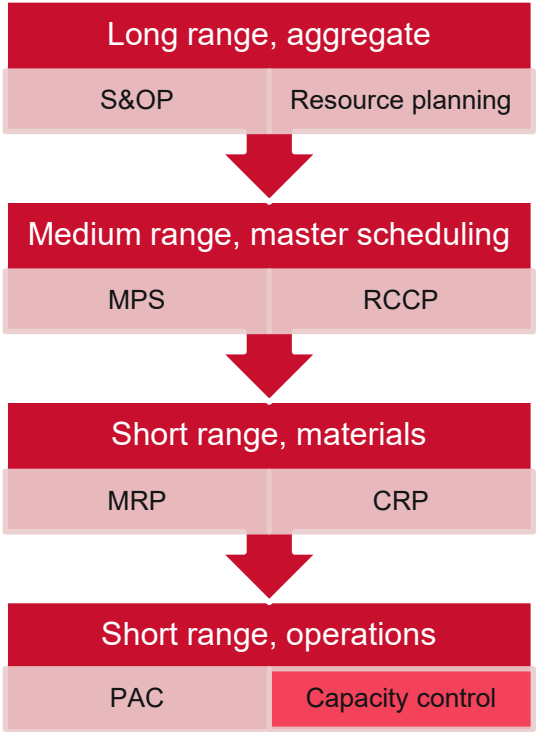
When Load and Capacity Are Out of Balance

- Change capacity to match load:
  - Add or reduce work hours.
  - Hire or lay off workers.
  - Shift workers to understaffed sites.
  - Change routings.
  - Hire subcontractors or temporary workers.
- Change load to match capacity:
  - Change lot sizes or schedule.



Continuous Improvement of PAC

- Concentrate on constraints.
- Use visual signals.
- Develop pull partnerships.
- Learn to be lean.



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SECTION C: INVENTORY

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Section C Introduction

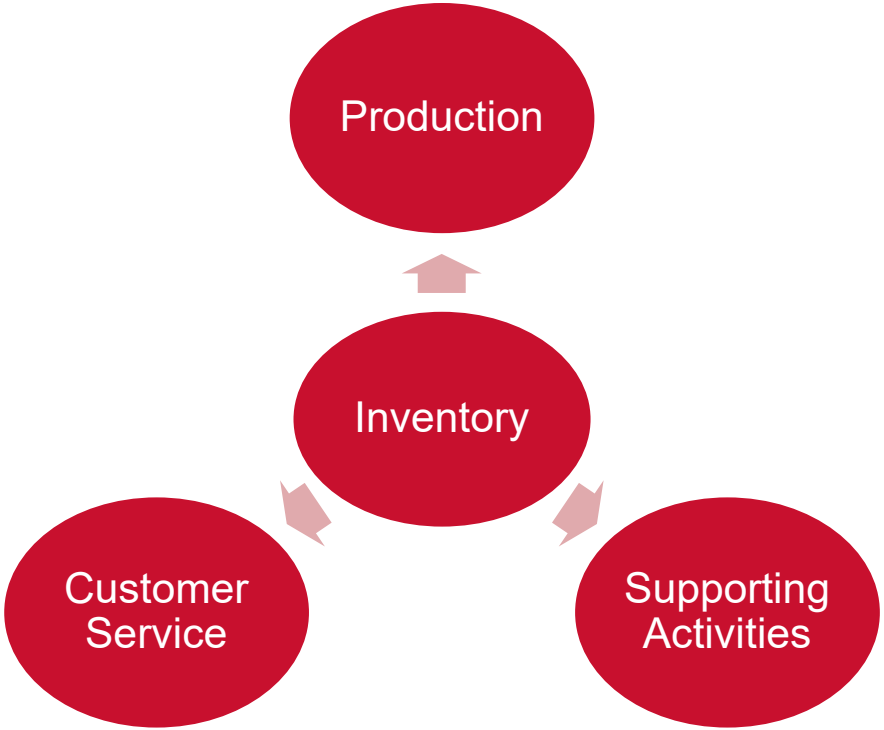
Section C Key Processes:

- Manage inventory.
  - Align inventory requirements with demand.
  - Manage MRO supplies.
  - Develop replenishment strategy.
  - Manage product traceability and chain of custody.
  - Define and execute physical inventory and cycle counting.
  - Manage product disposition and obsolescence.

Section C Topics:

- Topic 1: Inventory
- Topic 2: Replenishment Strategies
- Topic 3: Traceability, Accuracy, and Disposition

The Need for Inventory



- Production
  - Raw materials
  - Work-in-process items
- Customer service
  - Finished goods
  - Spare parts
- Supporting activities
  - Maintenance
  - Repair
  - Operating supplies

Types of Inventory

1) Raw materials

2) Work-in-process (WIP)

3) Finished goods (FG

Raw materials supplier → Component supplier → Manufacturer → Distributor → End customer

4) MRO

5) In-transit

Why Have Inventory?

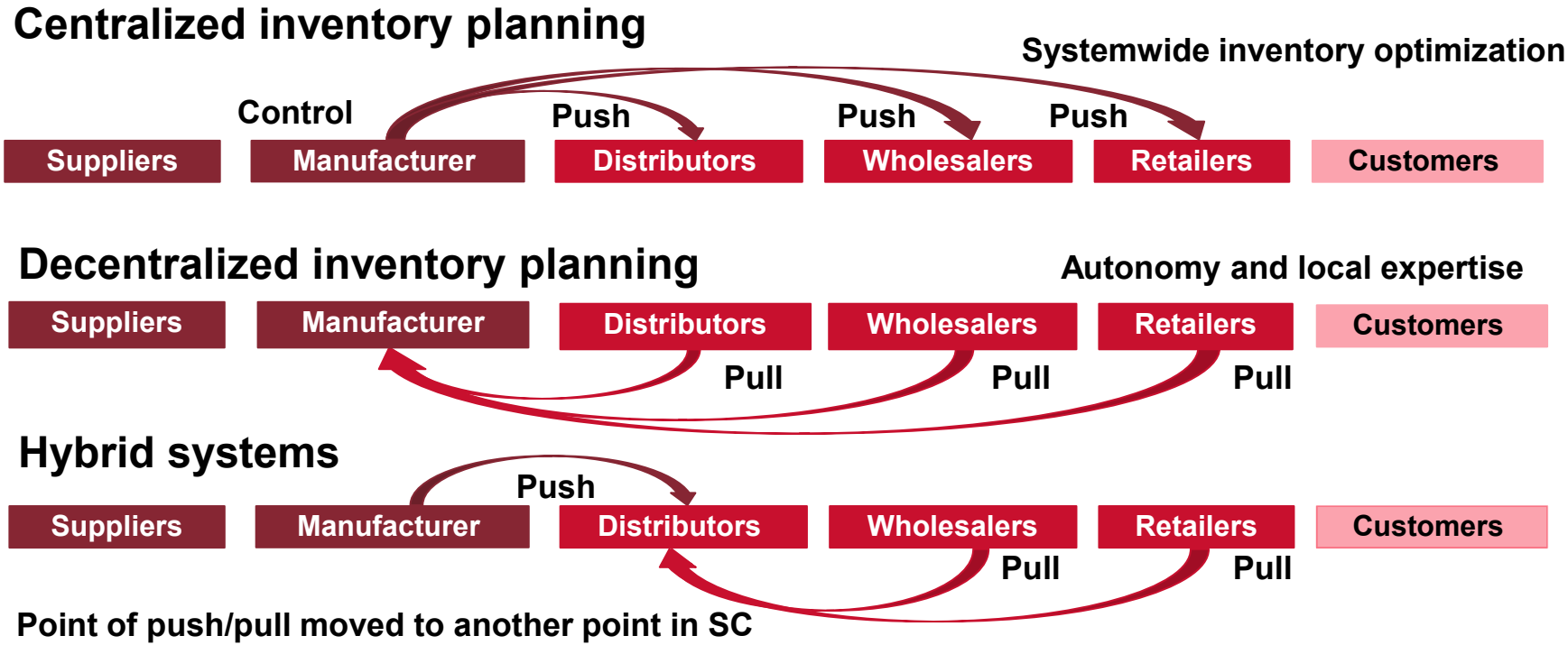
Inventory Functions	Cycle stock/lot size inventory
	Anticipation inventory
	Buffer inventory
	Safety stock
	Hedge inventory
	Decoupling

Inventory Costs

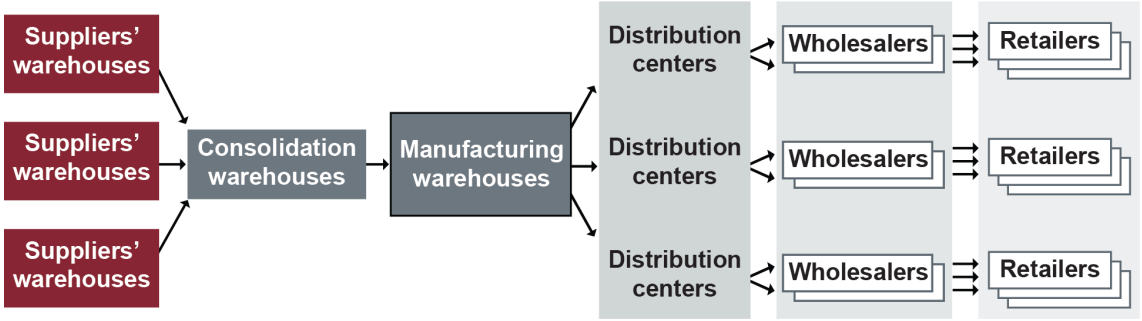
- *Acquisition costs: order quantity × unit cost*
- *Landed costs: product cost plus logistics costs*
- *Carrying (holding) costs: storage, capital, and risk costs*

- Storage costs
  - Rent, equipment leases, depreciation
  - Operating costs, material-handling expenses, power
  - Taxes
- Capital costs
  - Interest, financing, payments to creditors and investors
- Risk costs
  - Insurance, inventory value reductions, write-offs

Inventory Planning



Echelons and Echelon Inventory



- Echelons
  - Add costs.
  - Are a buffer for later echelons.
  - May provide consolidation or break-bulk to reduce total inventory/costs.
- Echelon inventory aggregates demand for more accurate order calculation.
  - Inventory at a node = all inventory at that echelon + all inventory at later SC points + in transit

Inventory Management Roles

Purchasing and materials management: adequate raw materials at low inventory cost

Manufacturing and finance: efficient and low-cost production balanced against low inventory cost

Sales and marketing: sufficient inventory to meet customer delivery requests and service levels

Factors Influencing Inventory Policies

- Customer demand
- Planning horizon
- Replenishment lead time
- Product variety
- Inventory costs
- Customer service requirements

Aggregate Inventory Management

Aggregate Inventory Management Objectives

Support organizational strategy and operations.

Support financial objectives.

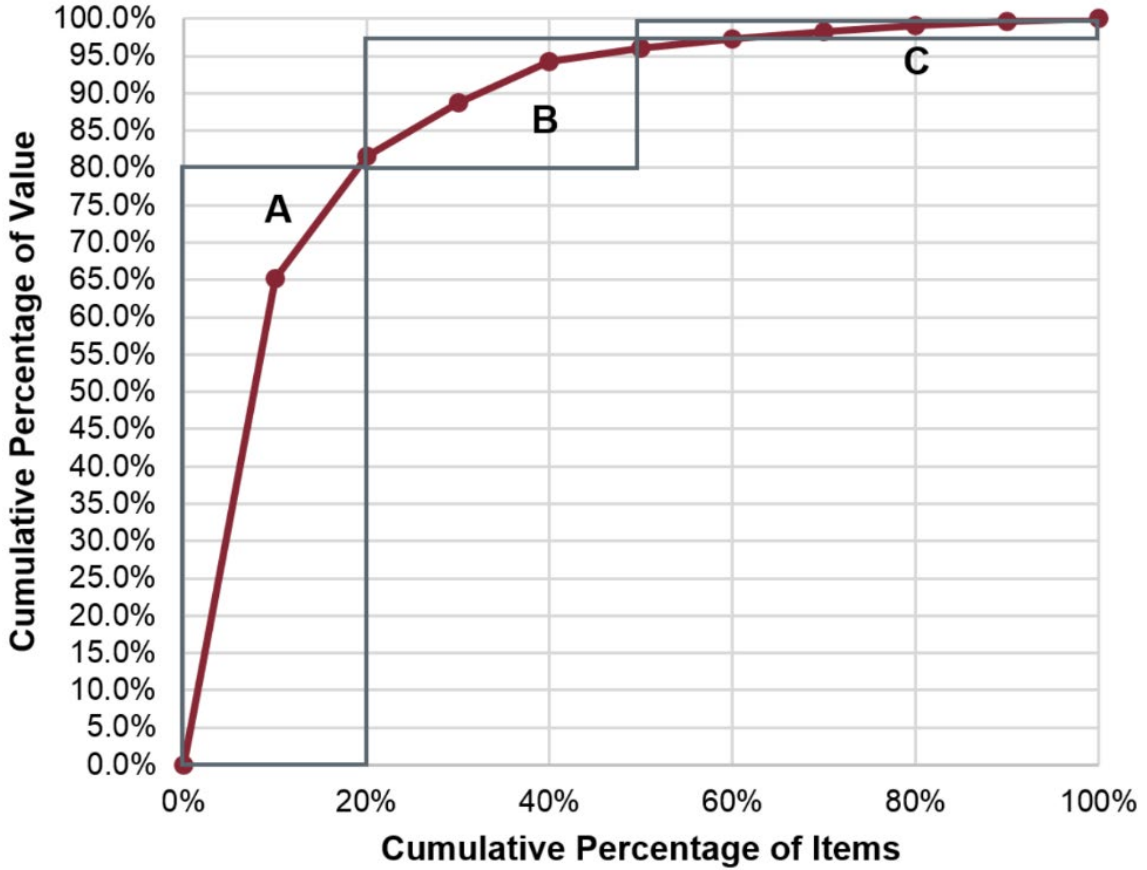
Balance:
- Customer service
- Operations efficiency
- Inventory investment cost objectives.

Ways to Aggregate Inventory

- Demand pattern
- Production process
- Stage of production flow
- Relative value to organization
- Product or SKU family or type
- Distribution pattern

ABC Inventory Classification: Pareto Analysis

- A: Better treatment, tighter controls
- B: Moderate treatment and control
- C: Looser controls, may not get safety stock



Item Inventory Management

- Goal is to enable planners to translate strategic inventory goals into measurable results (proper production and distribution of each SKU).
- Inventory rules
  - When to order inventory
  - How to determine order size per order
  - Relative importance of each inventory item
  - Inventory control procedures for individual items

Effects of Inventory on Financial Statements

Balance Sheet	Income Statement	Cash Flows
▪ Unsold inventory is current asset. ▪ Only profit margin portion contributes to net income when sold. ▪ Can determine average inventory from balance sheet.	▪ COGS: Product expenses booked when units sold. ▪ Operating expenses: Period expenses booked when incurred. ▪ Reducing costs is more effective than increasing sales volume.	▪ Decrease in inventory increases cash position. ▪ Inventory write-offs reduce owners' equity and may require reducing debts to maintain covenants.

Balance Sheet for Two Years (Assets)

What the organization owns

Assets expected to be converted to cash within one year

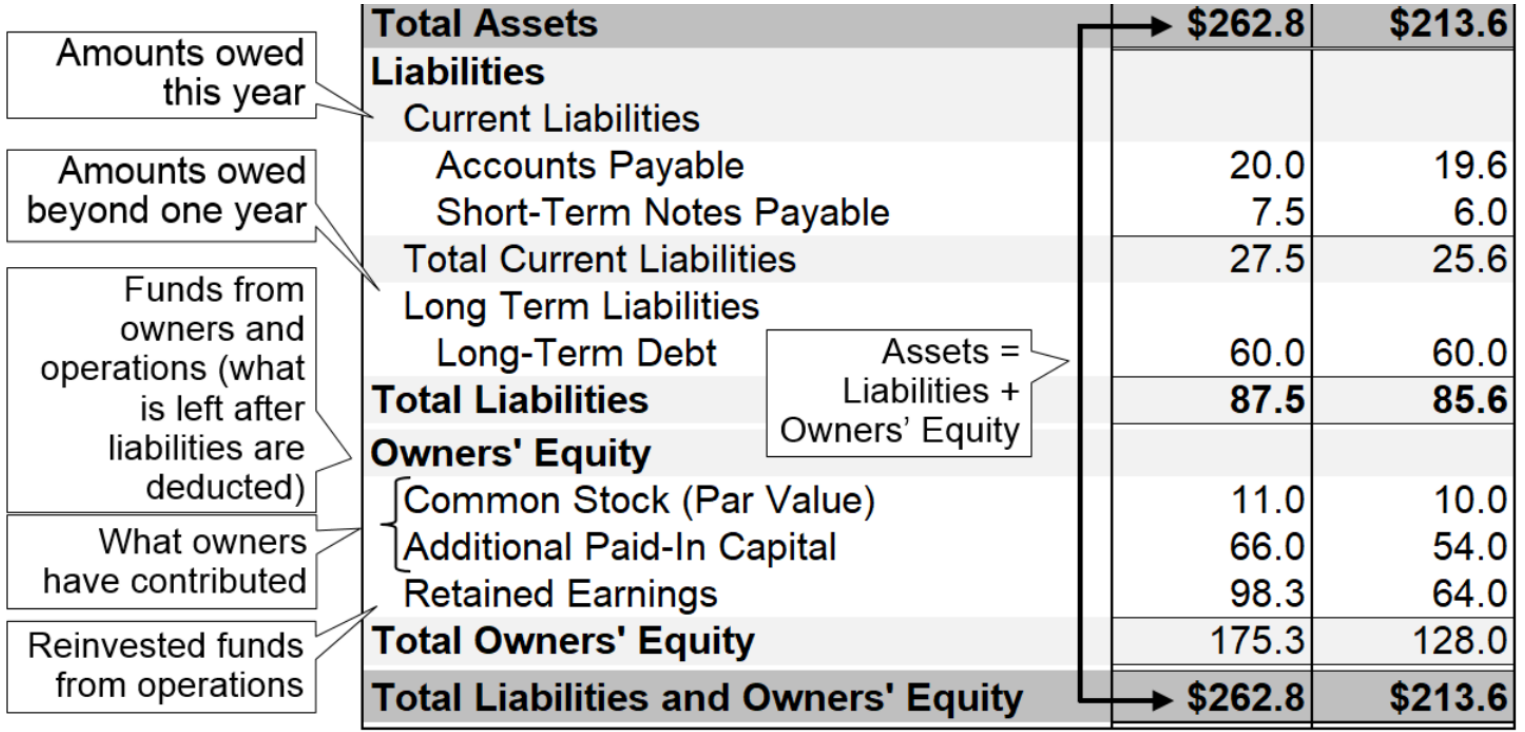
Long-term assets not easily converted to cash

Amounts owed to others

Statement of financial value at a point in time (end of year)

BALANCE SHEETS December 31,	In Millions (000,000) Year 2	 Year 1
Assets		
Current Assets		
Cash and Cash Equivalents	$96.5	$56.3
Inventory	59.9	60.4
Accounts Receivable	48.4	44.3
Total Current Assets	**204.9**	**161.1**
Fixed Assets		
Gross Property, Plant, and Equipment	70.0	60.0
Less: Accumulated Depreciation	12.1	7.5
Net Property, Plant, and Equipment	57.9	52.5
Total Assets	**$262.8**	**$213.6**

Balance Sheet for Two Years (Liabilities)



Total Assets	**$262.8**	**$213.6**
Liabilities		
Current Liabilities		
Accounts Payable	20.0	19.6
Short-Term Notes Payable	7.5	6.0
Total Current Liabilities	27.5	25.6
Long Term Liabilities		
Long-Term Debt	60.0	60.0
Total Liabilities	**87.5**	**85.6**
Owners' Equity		
Common Stock (Par Value)	11.0	10.0
Additional Paid-In Capital	66.0	54.0
Retained Earnings	98.3	64.0
Total Owners' Equity	175.3	128.0
Total Liabilities and Owners' Equity	**$262.8**	**$213.6**

Income Statement for Two Years

Reduce costs:

- Increase profit margin without needing to raise prices

INCOME STATEMENTS For the Years Ending (Profit or loss over a period of time)	In Millions (000,000s) except per share amts. Year 2	 Year 1
Revenue (Sales)	**$302.6**	**$276.9**
Less: Cost of Goods Sold (COGS)		
Direct Labor	38.3	37.6
Direct Materials	101.5	99.7
Factory Overhead	26.6	26.1
Less: Total Cost of Goods Sold (COGS)	166.4	163.4
Gross Profit	**136.2**	**113.5**
Less: Operating Expenses		
Selling Expenses	30.3	24.9
General and Administrative	27.2	22.2
Lease Expense	12.1	8.3
Less: Total Operating Expenses	69.6	55.4
Less: Depreciation	4.6	4.0
Less: Interest Expense	3.9	3.9
Net Income (Profit) Before Taxes	**58.1**	**50.3**
Less: Income Taxes	16.3	14.1
Net Income (Profit)	**$41.8**	**$36.2**
Net Income (as a Pct. of Revenue)	14%	13%
Net Income Per Share-Basic	**$3.95**	**$3.78**

Product expenses: these expenses are booked when the related units of inventory are sold.

Period expenses: these expenses are recorded in the period in which they are incurred.

Topic 1: Inventory

Statement of Cash Flows for Two Years

- Beware too much capital tied up in inventory
- Need sufficient cash

A viable firm needs positive cash flow from operations in most years.

Increase in inventory or accounts receivable reduces cash; a decrease will grow cash on hand.

Increase in accounts payable increases cash, while a decrease reduces cash.

Extra cash from financing means more debt or equity investments were issued; reduced cash means debt was paid down or dividends were paid to owners.

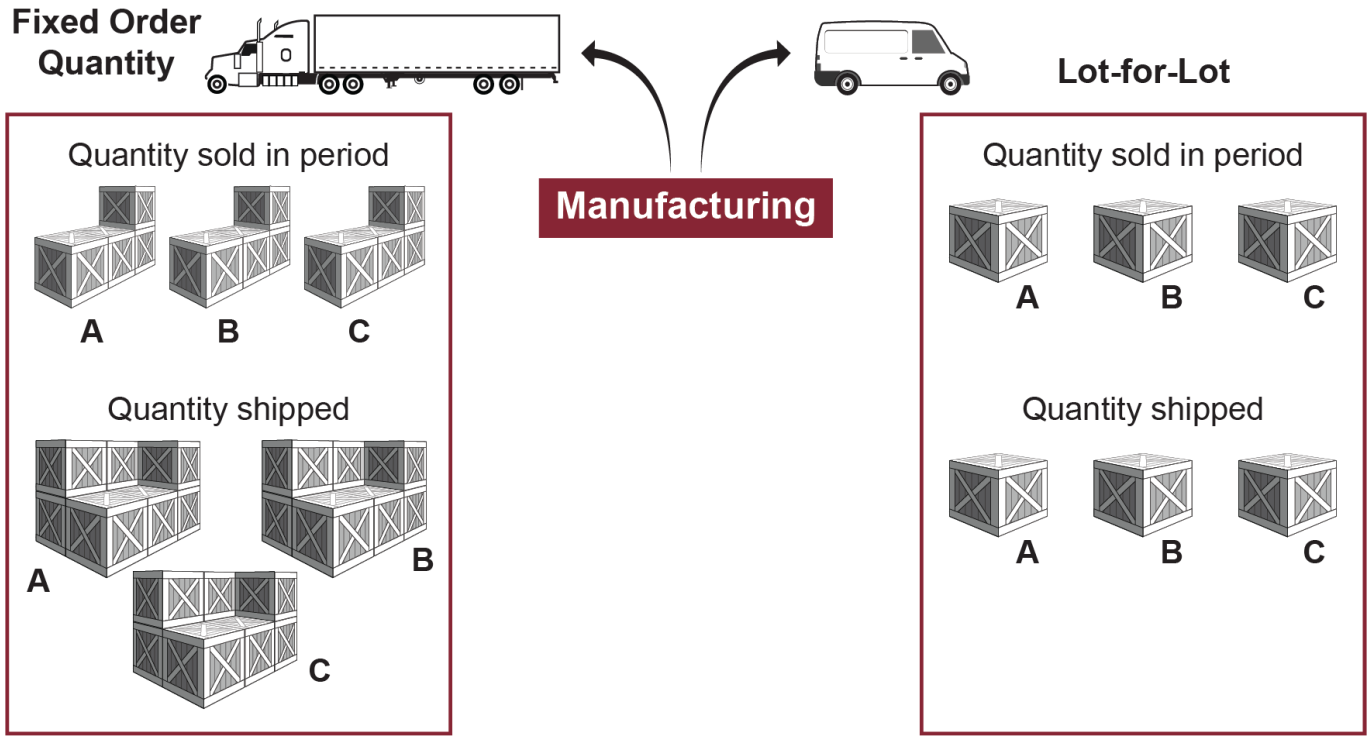
Net Income
+/– Change in (Δ) Operating
+/– Δ Investing
+/– Δ Financing
+ Beginning Cash
= Ending Cash

CASH FLOW STATEMENTS Year	In Millions (000,000) Year 2	Year 1
Operating Section		
After-Tax Net Income	$41.8	$36.2
Depreciation Add-Back	4.6	4.0
(Increase)/Decrease in Inventory	0.5	(8.6)
(Increase)/Decrease in Accounts Receivable	(4.1)	(4.1)
Increase/(Decrease) in Accounts Payable	0.4	1.8
Cash Flow from Operations	**43.2**	**29.3**
Investing Section		
Capex Spend (Capital Expenditures)	(10.0)	(10.0)
Cash Flow from Operations and Investment	**33.2**	**19.3**
Financing Section		
Additional Equity Capital	13.0	7.0
Less Dividends Paid	(7.5)	(5.0)
Increase/(Decrease) in Long-Term Debt	-	-
Increase/(Decrease) in Short-Term Notes	1.5	(1.5)
Cash Flow from Operations, Investments, and Financing	**40.2**	**19.8**
Beginning Cash Balance	56.3	36.5
Ending Cash Balance	**$96.5**	**$56.3**

Change in cash balance over a period of time

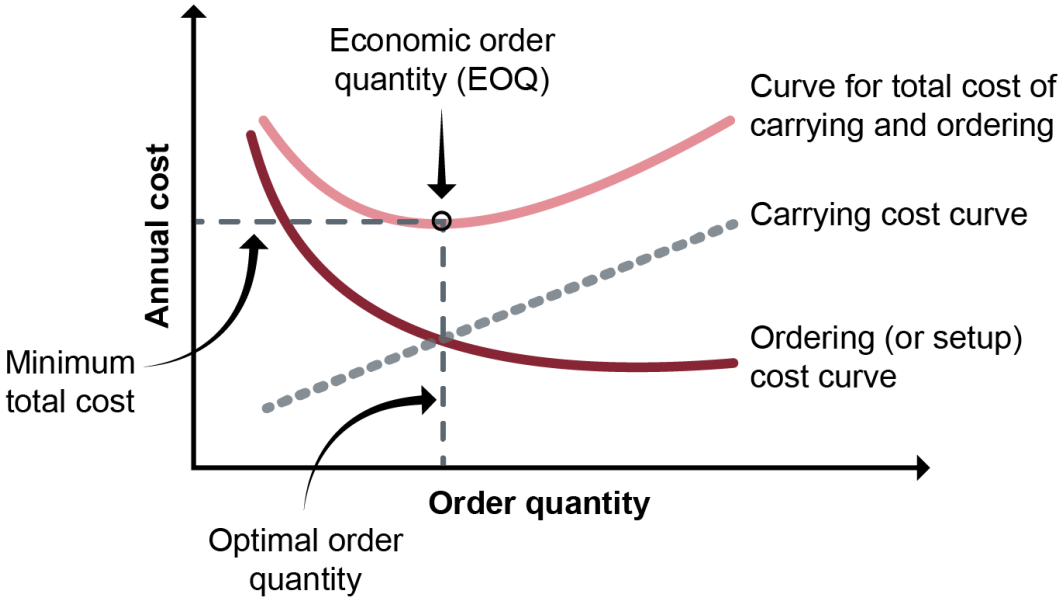
Investments in extra capacity reduce cash.

Lot-for-Lot versus Fixed Order Quantity (FOQ)



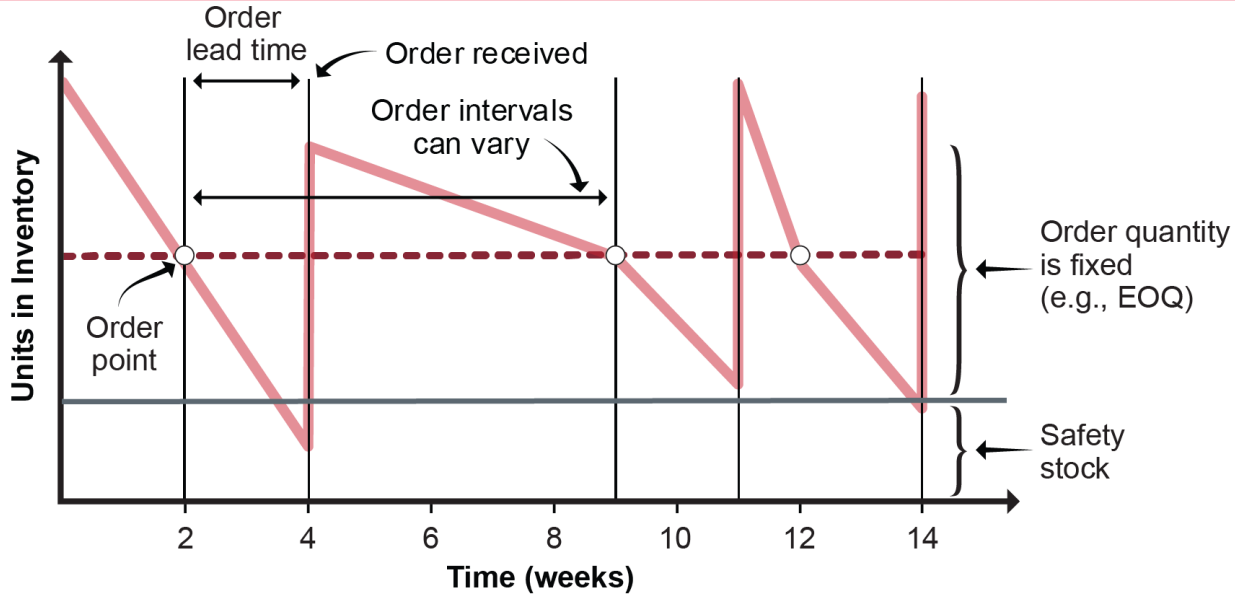
Economic Order Quantity (EOQ)

- Minimum cost: carrying costs = ordering costs
- $EOQ = \sqrt{\frac{2 \times A \times S}{i \times c}}$
  - Q = Order quantity in units
  - *i* = Annual carrying cost %
  - *c* = Unit cost in $
  - A = Annual usage in units
  - S = Ordering Cost in $/order



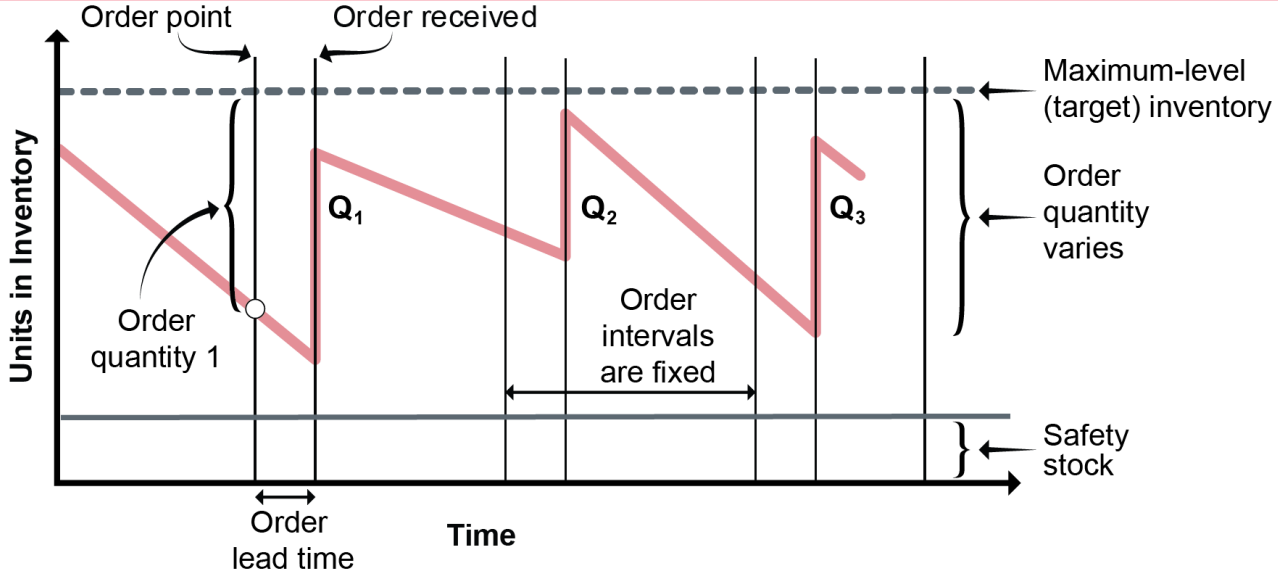
Ordering Systems: Order Point System

- *Order Point = Demand During the Lead Time + Safety Stock*
- *Order Point = (50 Units/Week × 2 Weeks) + 100 Units = 200 Units*



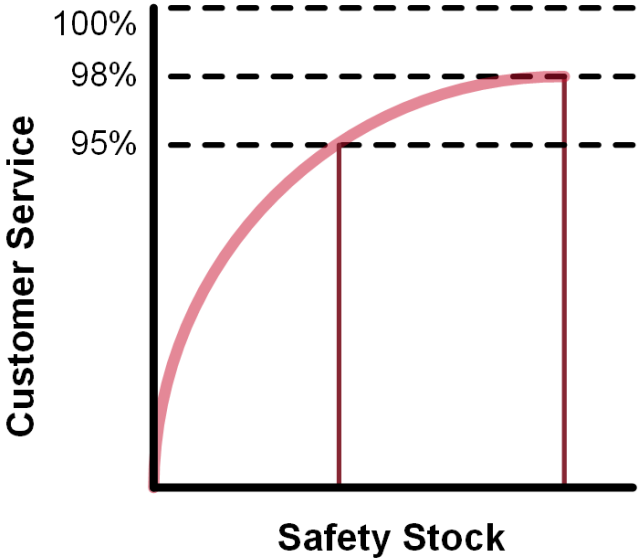
Ordering Systems: Periodic Review System

- *Maximum-Level Inventory = D × (T + L) + SS*
- *Order Quantity = Maximum-Level Inventory − Inventory On Hand*
- *D = Demand/unit of time, T = Order interval, L = Lead time, SS = Safety stock*



Safety Stock

- Inventory to protect against demand and lead time variations.
- Set/review target frequency for use.
- Methods for setting level: fixed amount, coverage, statistical.
- Need to balance cost of safety stock and cost of stockouts.
- To decrease: less frequent orders, less demand variability, shorter lead time, more accurate forecasts.
- Organizational, regulatory, or industry requirements may mandate a minimum level of safety stock.



Safety Lead Time

- Replenishment orders placed before (or after) normal order point.
- Could result in overstocks.
- Can impact bullwhip effect.
- Large orders with long lead times, e.g., on container ships, could result in significant overstocks (or stockouts).

Product Traceability and Configuration Management

- Reduces size of recalls
- Differentiates for region-specific bans
- Compliance audits
- Compliance with free trade zone agreements and labels such as “Made in U.S.A.”
- Customs inspections

Assessing Inventory Accuracy

Periodic Count

- Necessary for, e.g., retail.
- Traditional method, requires store shutdown.
- Annual count of all items.
- Often done by temporary employees.
- Disruptive, expensive, error-prone.

Cycle Count

- Count some items each day.
- Count all items a set number of times annually.
- Count A items more often than B or C items.
- Timely correction of errors, no store shutdown.

Assessing Inventory Accuracy

Cycle Counting Example

Class	Qty.	Policy	Items/Day
A	1,000	Per month 20 days	1,000/20 = 50/day
B	3,500	Per quarter 60 days	3,500/60 = 58/day
C	5,500	Semi-annually 120 days	5,500/120 = 46/day
			154/day

Improving Tracking and Counting

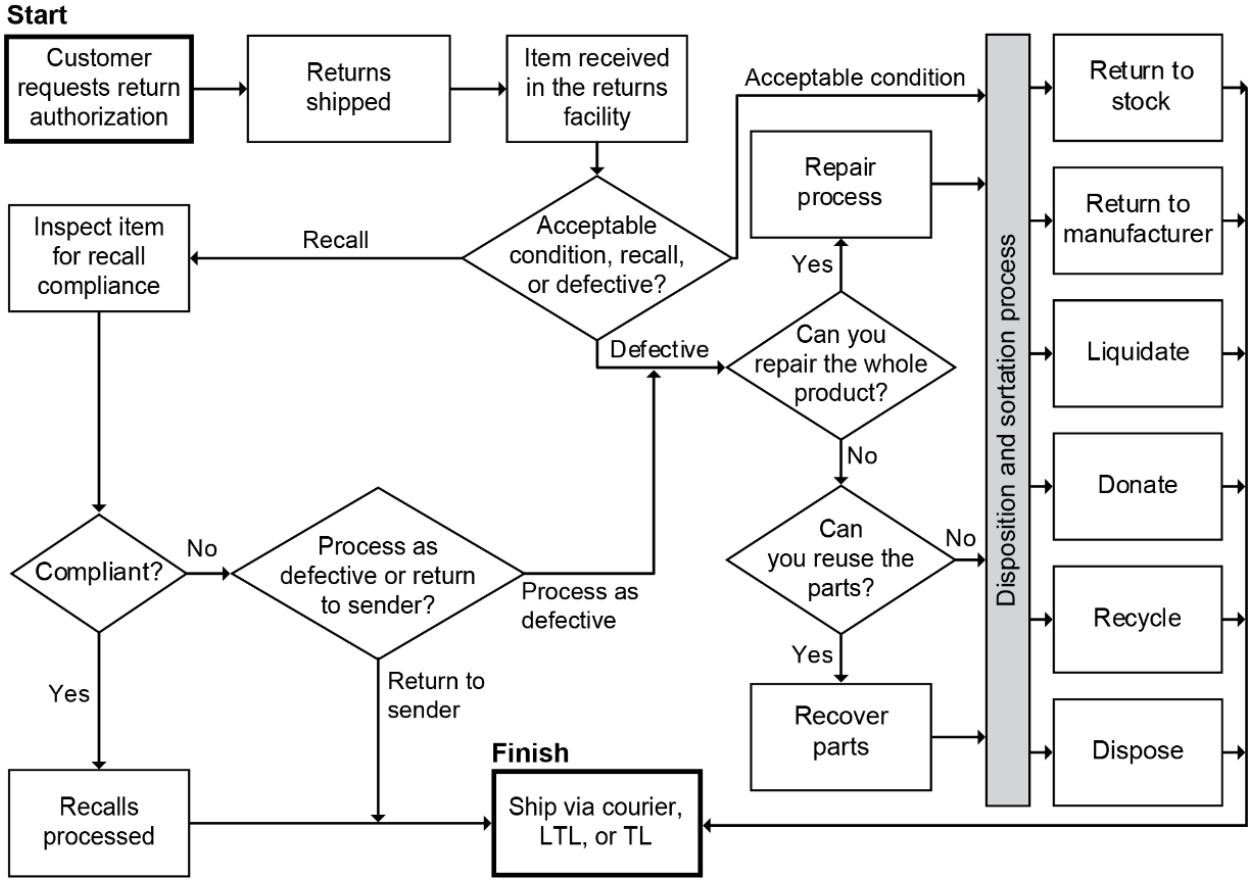
- Keep it secure.
- Keep it neat.
- Make labels easily visible and put on everything.
- Use bins and arrangements to ease counting.
- Treat A, B, C items suitably.
- Use technology.

Product End-of-Life

- Use end-of-life management for phase-out and phase-in plan.
- Set end-of-sales strategy.
  - Official communication needed so as not to ruin sales
  - May need time for supply chain inventory to sell
- Set end-of-service strategy.
  - Could stay profitable or be loyalty generator
  - Provide less expensive services
- Revisit equipment and space use.
- Consider backward compatibility.
- Accept product at end of life.
- Do risk and crisis management.

Disposition of Returned Products

- Assess and categorize
- Return material authorization or policy
- Centralize



Adapted from © "Reverse Logistics Process Flow," Greve-Davis. Used with permission.

CSCP CERTIFIED SUPPLY CHAIN PROFESSIONAL

SECTION D: PERFORMANCE AND CONTINUOUS IMPROVEMENT

APICS

ASCM

Section D Introduction

Section D Key Processes:

- Measure and assess performance.
  - Report against KPIs and other objectives.
  - Compare operational performance against the plan.
  - Evaluate inventory accuracy.
  - Compare financial performance against the plan.
- Analyze and utilize applicable continuous improvement philosophies.

Section D Topics:

- Topic 1: Operations, Inventory, and Financial Performance
- Topic 2: Continuous Improvement
- Topic 3: Quality Tools
- Topic 4: Continuous Improvement Methods

Metrics and KPIs

Metrics

You get what you measure.

1. Determine objectives and define success criteria.
2. Select metrics.
3. Set challenging but feasible targets.
4. Ensure measurements occur.
5. Consolidate, analyze, and report.

Key Performance Indicators (KPIs)

- All KPIs are metrics but not all metrics are KPIs.
- Use balanced scorecard (e.g., learning and growth for SC improvements).
- Limit KPIs to be workable.
- Set baselines/targets.
- Assess impact on customers and bottom line.
- Monitor KPI performance.

Key Performance Indicators (KPIs)

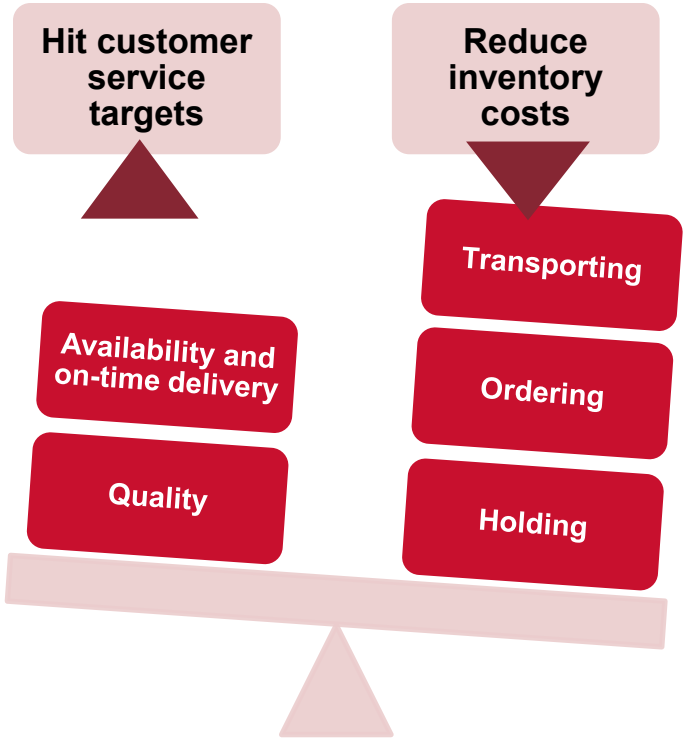
Apply KPIs only to processes and activities that directly enable organizational and supply chain strategies.

New Product KPIs	Merchandise KPIs	Replenishment KPIs
• Internal failure rate • External failure rate • Introduction lead time	• Market share • Volume growth • Total SC inventory turns (across chain)	• Order fill rate • On-time delivery • Order fulfillment lead time

Operations KPIs

- % MPS completed as scheduled
- # of time fence violations
- Standard vs. actual production yield
- Quality metrics
- Inventory turnover by raw material turns, WIP turns, etc.

Inventory Management KPIs



Methods of Tracking Inventory

Order of steps is important:

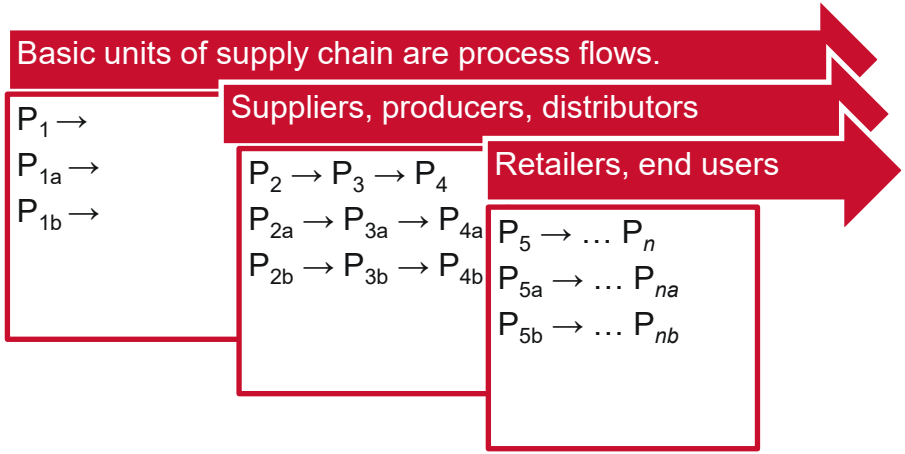
1. Identify the item by SKU.
2. Verify the quantity.
3. Request and get approval for move or get order.
4. Execute the inventory movement.
5. Create a record of the transaction completion.

Total Quality Management (TQM)

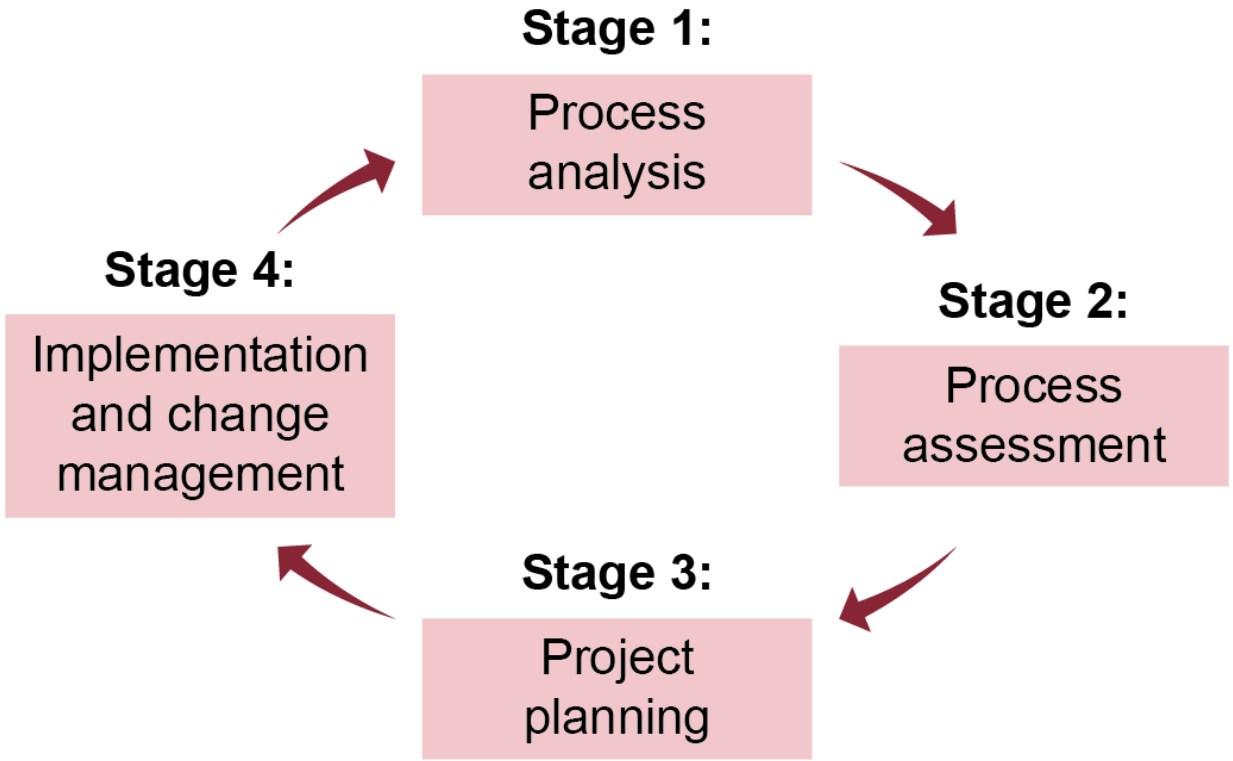
- Management approach to long-term success through customer satisfaction.
- Guiding principles:
  - Actions show management commitment.
  - Fix processes rather than assigning blame.
  - Place customer at center of improvement discussions.
  - Suppliers are partners, not adversaries.
  - Standard performance measures enable tracking over time.

Reasons to Adopt Continuous Improvement

- *Supply chain management is process-oriented.*
- *Supply chains are dynamic.*
- *Supply chains evolve.*
- *Continuous improvement of supply chain design can reduce costs of poor quality.*



Continuous Improvement Model



Improvement Initiatives

Personnel Improvement Initiatives

- Developing knowledge, skills and abilities.
- Consider individual learning styles: visual, tactile, and auditory.

Process Analysis and Improvement

- Top-down direction
- Bottom-up implementation
- Strategic alignment and prioritization
- “As is” state
- “To be” can start with “low hanging fruit”

Process Analysis and Improvement: Visibility

"You can't fix what you can't see."

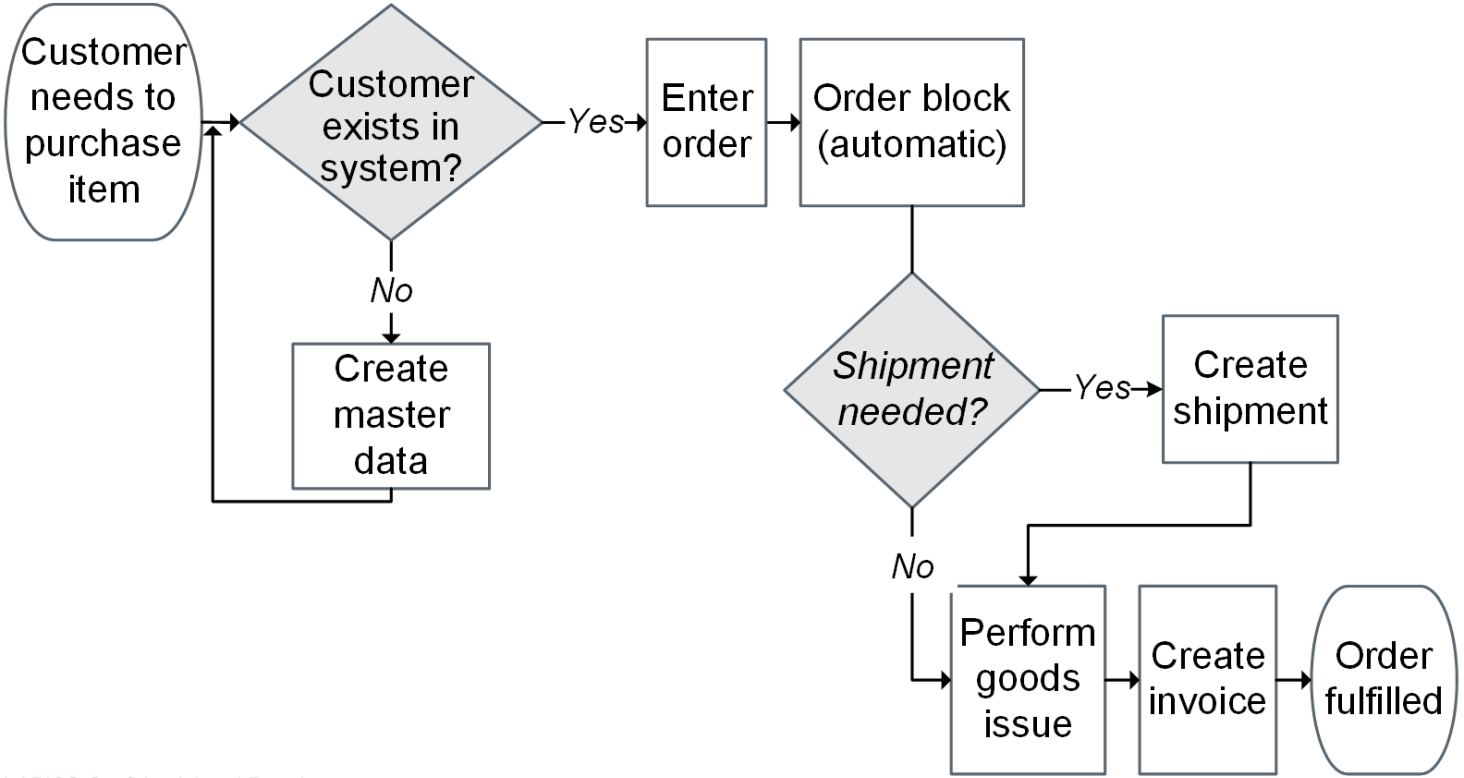
"Facts Are Your Friends"

Benchmarking

Setting goals by comparison to another entity or authoritative definition of excellence

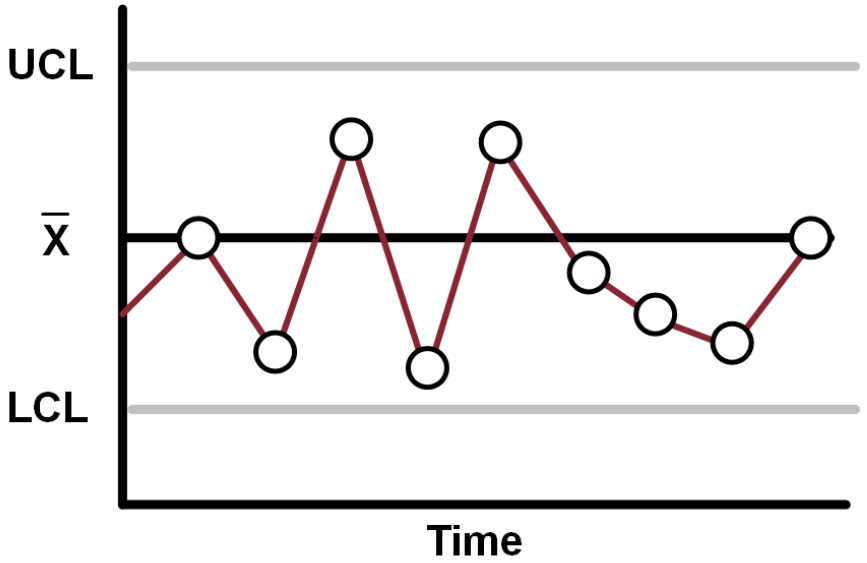
Competitive Benchmarking	Best-in-Class Benchmarking	Process Benchmarking
Setting goals by reference to a competitor	Setting goals by reference to the best performer	Setting process goals by reference to an authoritative process description

Seven Basic Tools of Quality: Process Map



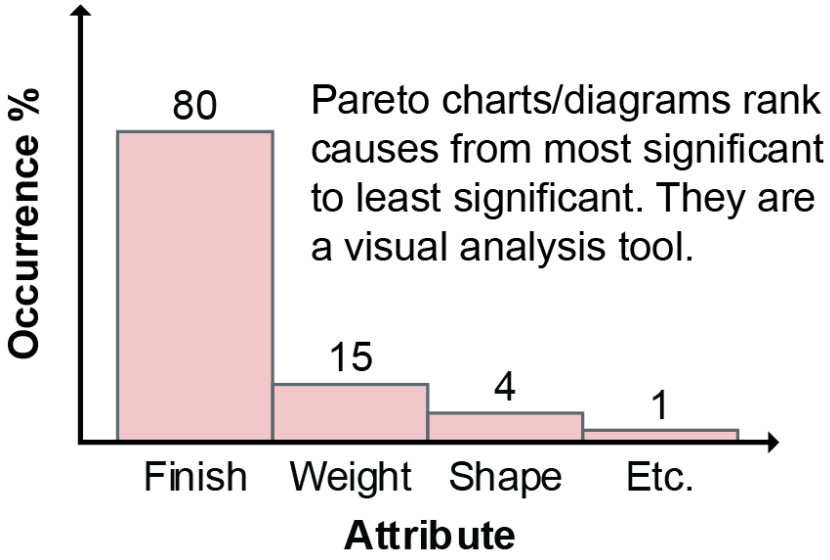
Seven Basic Tools of Quality: Control Chart

- Makes variance visible
- Statistical process control
- Contains samples from sequences
- Reveals spikes indicating process control problems
- Examples
  - Component measurement conformance
  - Wait time for service
  - Percentage of event occurrence



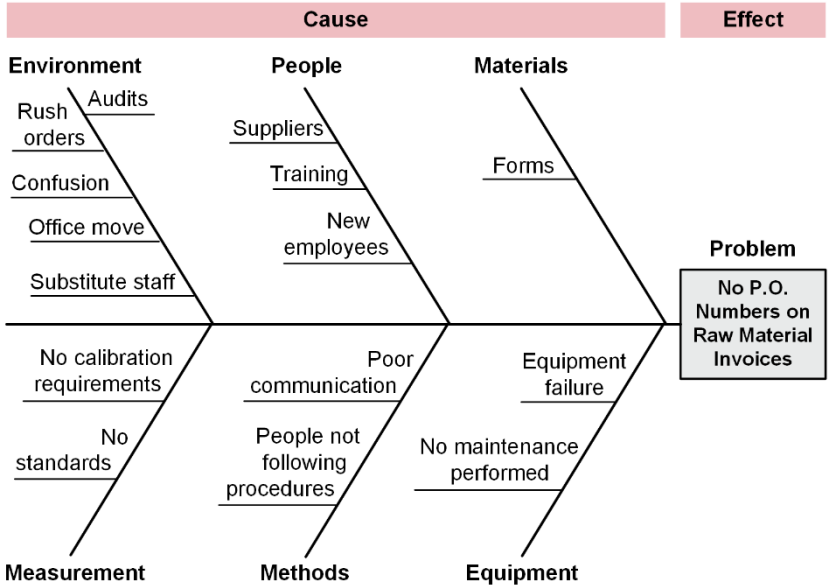
Seven Basic Tools of Quality

Pareto Chart



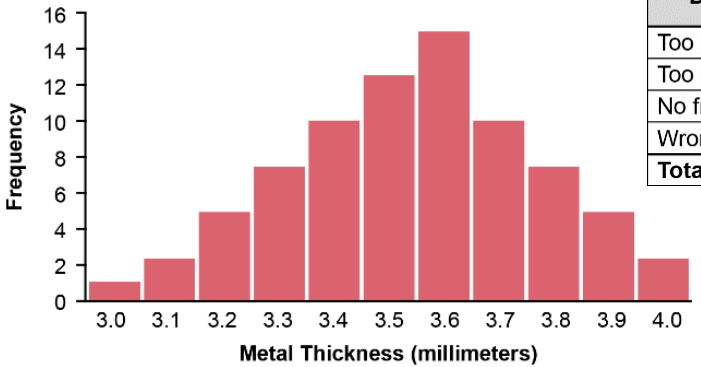
Pareto charts/diagrams rank causes from most significant to least significant. They are a visual analysis tool.

Cause-and-Effect Diagram



Seven Basic Tools of Quality

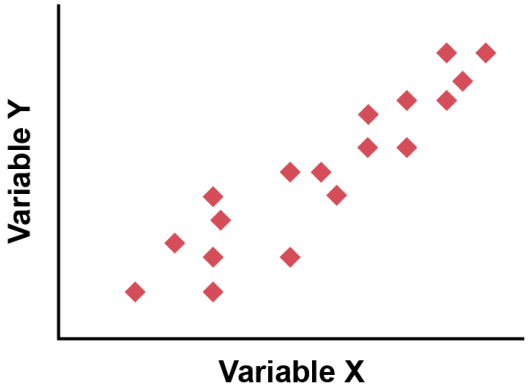
Histogram



Check Sheet

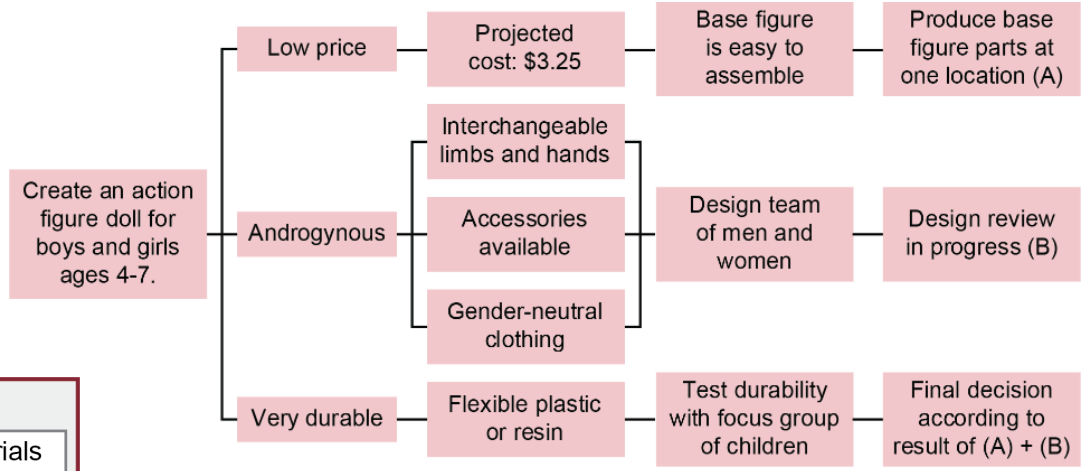
Defect	February				
	1	2	3	4	Total
Too pink	𝍸 I	III	I	𝍸 II	17
Too red	I	I	—	II	4
No fragrance	II	—	I	III	6
Wrong size	IIII	II	I	𝍸	12
Totals	**13**	**6**	**3**	**17**	**39**

Scatter Chart



Seven New Tools

Tree Diagram



Affinity Diagram

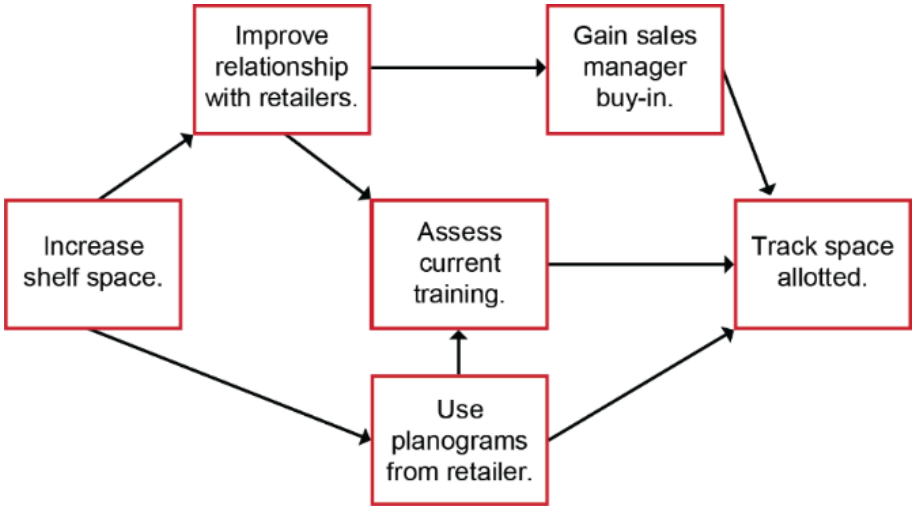
Issue: Product recall causes		
Inspection	Customer feedback	Product materials
Frequency	Costs	Return processes

Seven New Tools

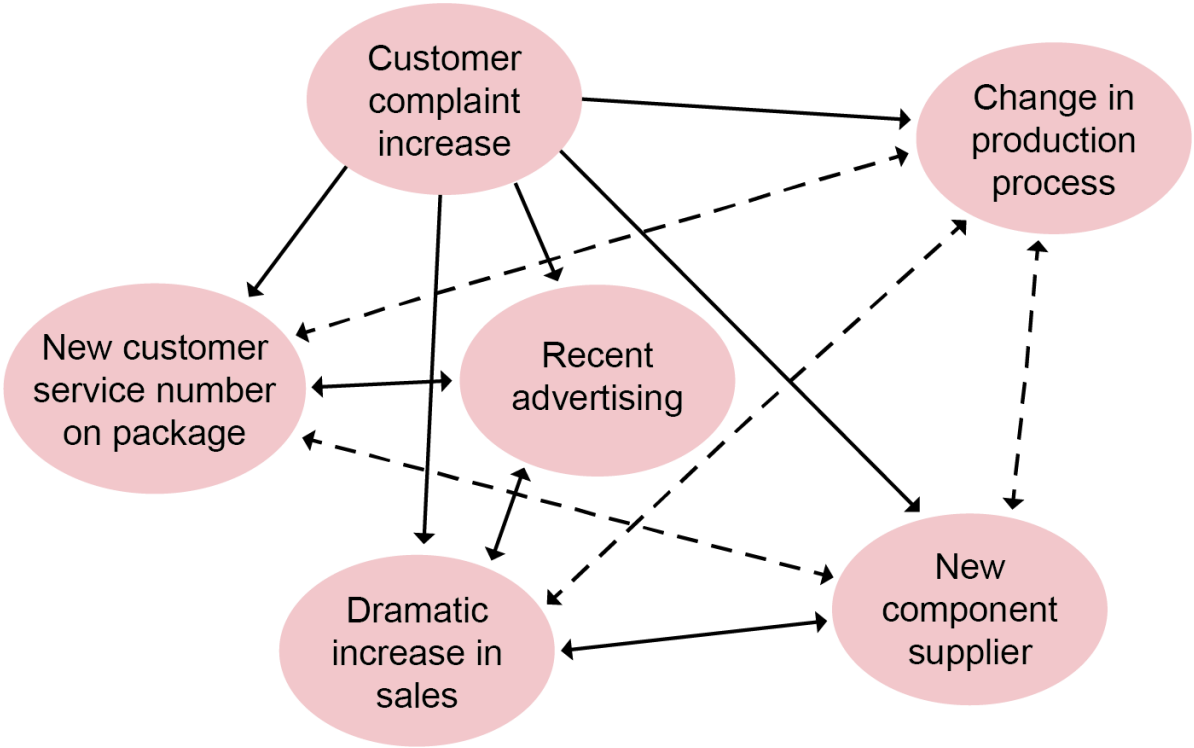
Matrix Diagram

Specification	Customer A	Customer B	Customer C
Width	≤.789 inch	≤.790 inch	≤.785 inch
Length	≤1.11 inch	≤1.20 inch	≤1.01 inch
Thickness	≤.55 inch	≤.575 inch	≤.545 inch
Color (Pantone)	#127	#130	#129

Process Decision Program Chart

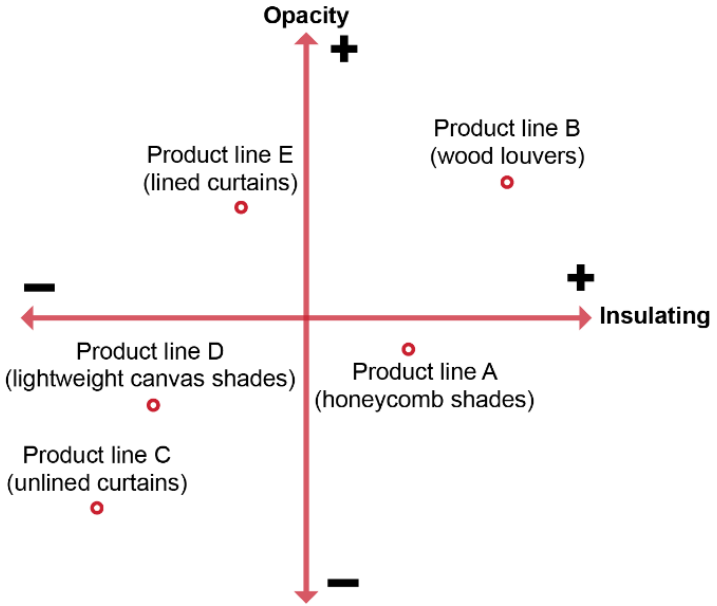


Seven New Tools: Relationship Diagram

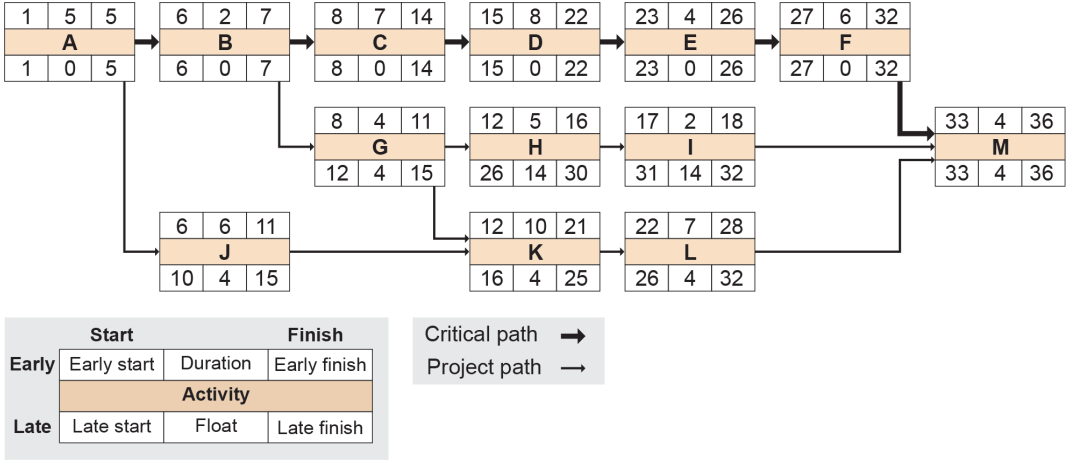


Seven New Tools

Matrix Data Analysis Chart



Activity Network Diagram



Eight Types of Waste

- *Any activity that adds no value in eyes of customer*
- *Byproduct of process or task needing special control*

Type	Description
Process	Taking unneeded steps in work; inefficiencies
Movement (transportation)	Moving products unnecessarily
Methods (motion)	Wasted time or efforts by operators
Product defects	Products/services that do not meet specifications
Waiting time	Queuing delays
Overproduction	Making more product than required
Excess inventory	Holding stock not required to fulfill customer orders
Unused people skills	Waste of knowledge or capabilities

Lean Supply Chain Thinking

Lean Objectives

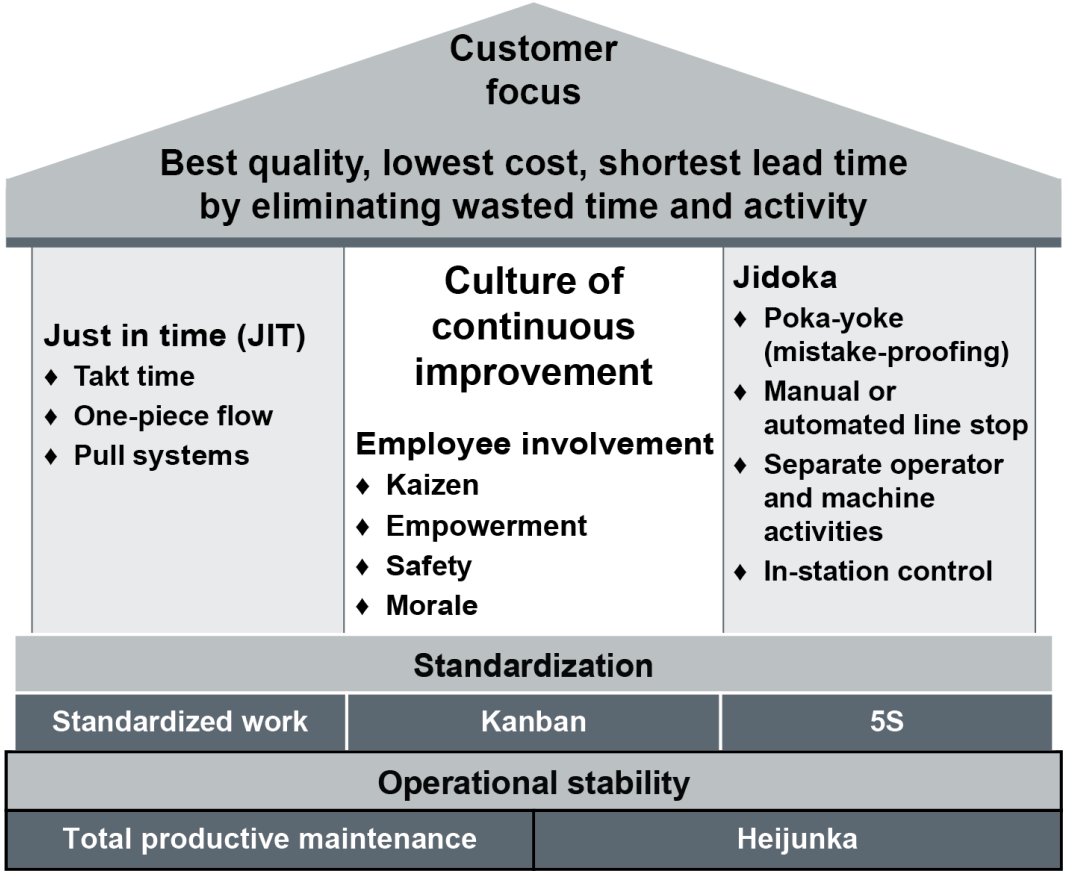
- Eliminate waste in value streams.
- Meet customer demand.
- Increase velocity.
- Reduce need for working capital.
- Increase inventory turns.
- Gain market share.
- Increase profitability.
- Develop the workforce.
- Produce perfect quality.

Five Lean Principles

- Create value for the customer.
- Identify all steps across a value stream.
- Create value flow.
- Pull products based upon customer demand.
- Strive for perfection by continually removing successive layers of waste.

Topic 4: Continuous Improvement Methods

House of Toyota



Source: APICS Lean Enterprise Workshop Series.

Additional Lean Considerations

Value stream mapping

- Map
  - Steps for broad range of SC processes
  - Management and information systems
- Current vs. future state
- Value-added versus non-value-added

Kaizen event/ Kaizen blitz(sm)

- Event
  - Time-boxed
  - Embed in long-term plans
- Blitz
  - Rapid improve-ment of limited process area
  - Implement in week or less

Five Ss

- Sort (seiri)
- Simplify (set in order) (seiton)
- Scrub (seiso)
- Standardize (seiketsu)
- Sustain (shitsuke)

Source: Adapted from *Five Pillars of the Visual Workplace* by Hiroyuki Hirano.

Additional Lean Considerations (continued)

Setup time reduction

- Major impact on cost and product variety.
- Reduction in time and materials.

Total productive maintenance

- Preventive maintenance.
- Efforts to adapt, modify, or refine equipment to:
  - Increase flexibility
  - Reduce material handling
  - Promote continuous flows.

Three major areas of waste

- **Muda** (consumes resources, creates no value).
- **Mura** (unevenness).
- **Muri** (over-burdening).

Just in Time (JIT)

Just-in-Time (JIT) Elements

1. Have inventory only when needed.
2. Quality at zero defects level.
3. Reduce lead times by:
   - Reducing setup times.
   - Reducing queue lengths.
   - Reducing lot sizes.
4. Review and revise operations.
5. Strong supplier relationships.
6. Multiskilled labor force.
7. Move toward cellular manufacturing environment.

JIT Philosophy

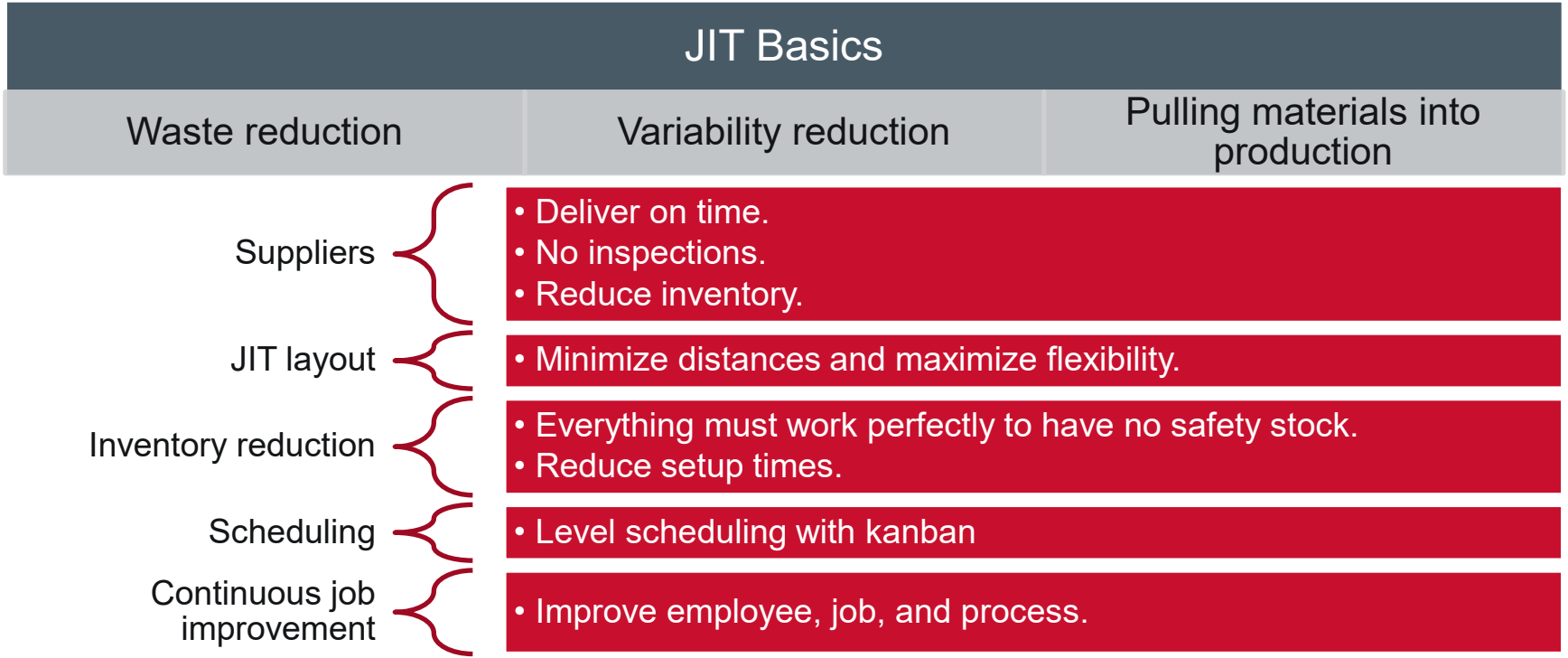
- Eliminate all waste.
- Strive for continuous productivity improvements.

Applies to the following forms of manufacturing environments: job shops, process, repetitive.

JIT Benefits

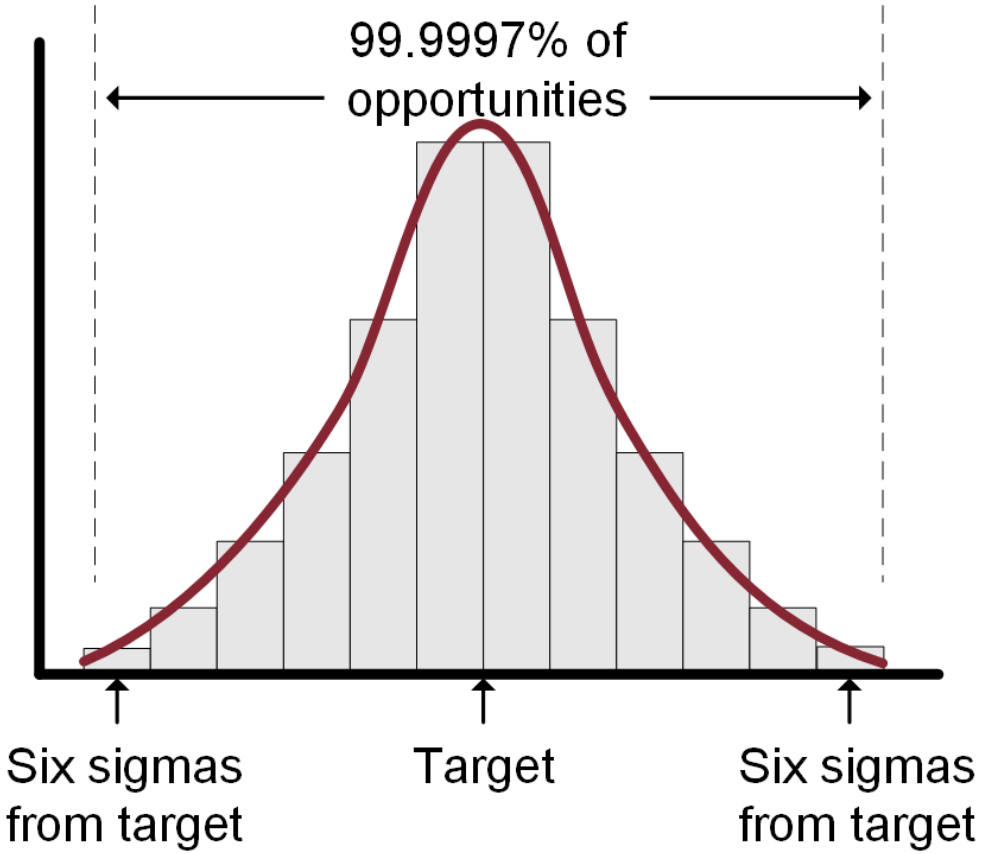
- Manufacturing cycle time reduction
- Inventory reduction
- Labor cost reduction
- Quality cost reduction
- Material cost reduction
- Improved vendor relationships

Just-in-Time (JIT)



Six Sigma

- Aim for “zero defects.”
- Tolerate no more than 3.4 defects per million opportunities (99.9997% of opportunities with no defect).



Elements of Six Sigma

Customer

- Customer expectations define quality.
- Multiple opportunities for defects in each interaction/item.

Process

- Take outside-in (customer) view of process.
- Minimize total errors and variability.

Employee

- Full participation.
- Implement from below.
- Green belt, black belt, master black belt.

Five-Phase Six Sigma Process: DMAIC

- Define the nature of the problem.
- Measure existing performance; record information about underlying causes.
- Analyze information to find root causes.
- Improve process by effecting solutions to problem.
- Control process until solutions become ingrained.

Theory of Constraints (TOC)

Any system, such as a supply chain or a production process, contains at least one element (constraint) that limits its maximum throughput.

Five-step TOC process:

1. Identify the constraint.
2. Exploit the constraint.
3. Subordinate other processes to the constraint.
4. Elevate the constraint.
5. Repeat the cycle.