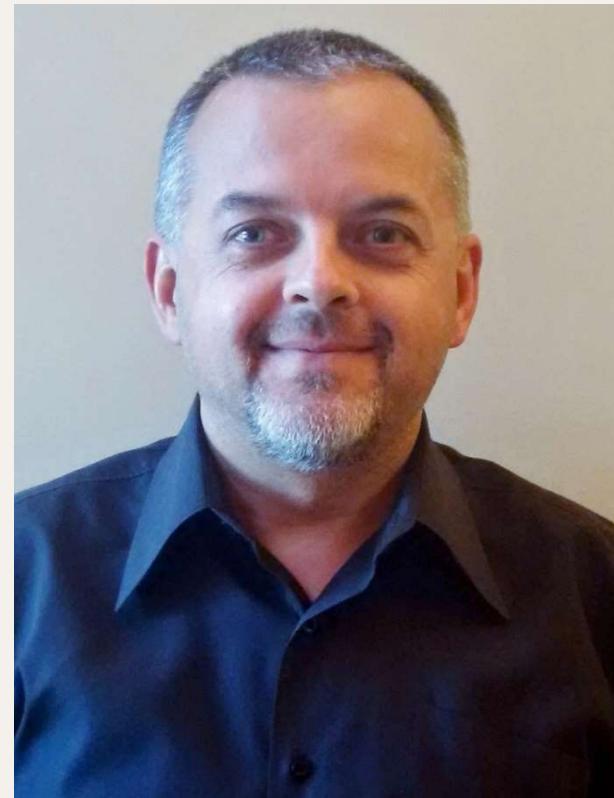


# Section 1

# The instructor profile

- Industrial Engineer
- MBA
- CSCP - ASCM
- CPIM - ASCM
- CLTD - ASCM
- 30+ years experience
- Senior Management



# Course Overview

- Introduction to Supply Chain
- Requires very little Supply Chain knowledge
- Will provide an understanding of the basics
- Will provide the relevant terminology
- Will provide the tools
- The importance of Supply Chain

# Course Overview

- Supply Chains
- Demand & Forecasting
- Manufacturing Environments
- Manufacturing Layouts
- Production Planning
- Master Production Schedule (MPS)
- Material Requirements Planning (MRP)
- Capacity Planning
- Bill-of-Material
- Lead-Times
- Utilization & Efficiency
- Production Activity Control

# Course Overview

- Customer Service
- Economic Order Quantity
- ABC Analysis
- Supply Chain Sustainability

# Section 2

# What is a Supply Chain?

*The job of a Supply Chain is to get the “right product, to the right customer, at the right time, at the right place, in the right quantity, in the right condition and at the right cost.”*

# Traditional Supply Chain

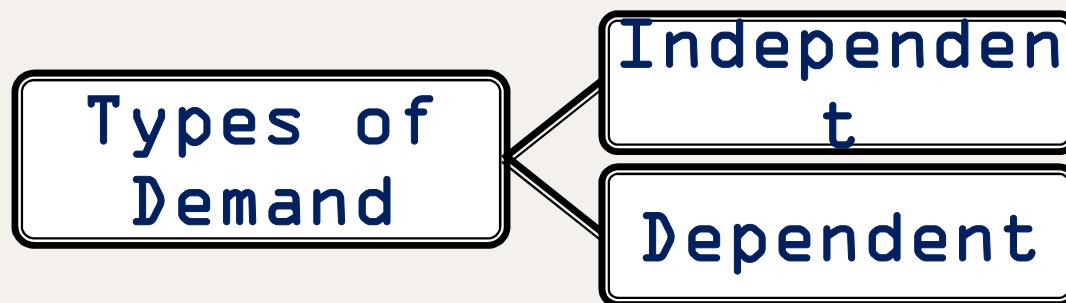


# Complex Supply Chain



# What is Demand?

*Refers to the need for a particular item, product, component or service.*



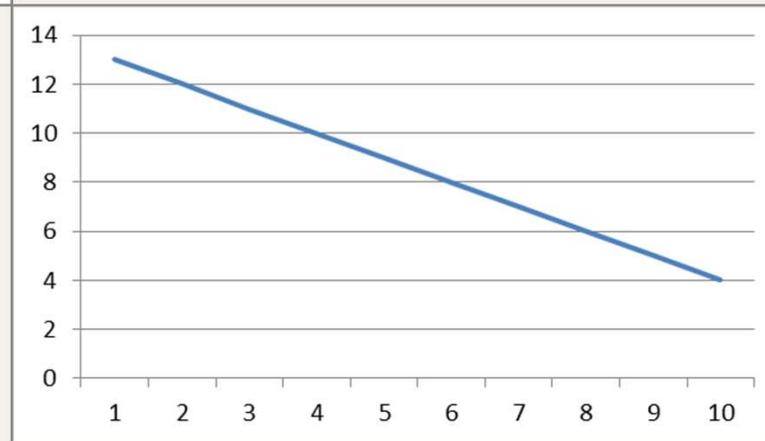
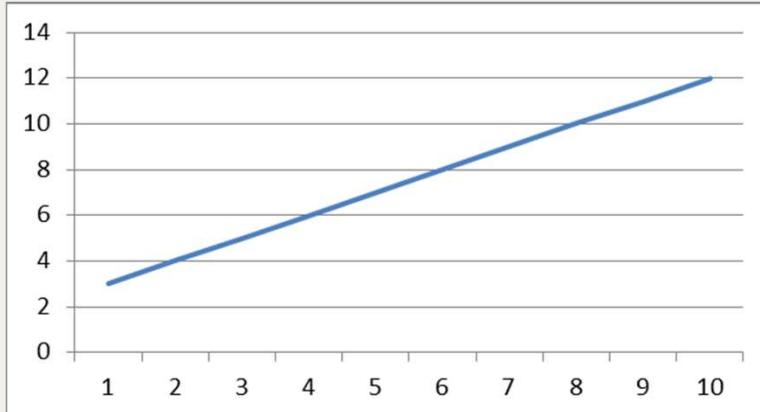
# Understanding Demand

*Understanding the behavior of demand becomes a step in being able to predict it.*

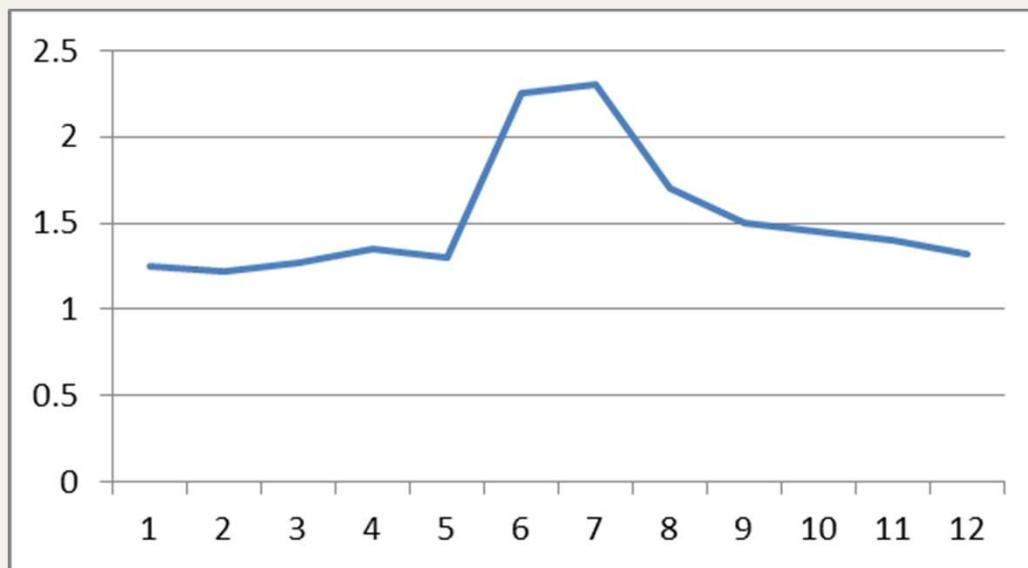
# Forecasting Demand

- Trend
- Random Fluctuations
- Seasonal Fluctuations
- Cyclical

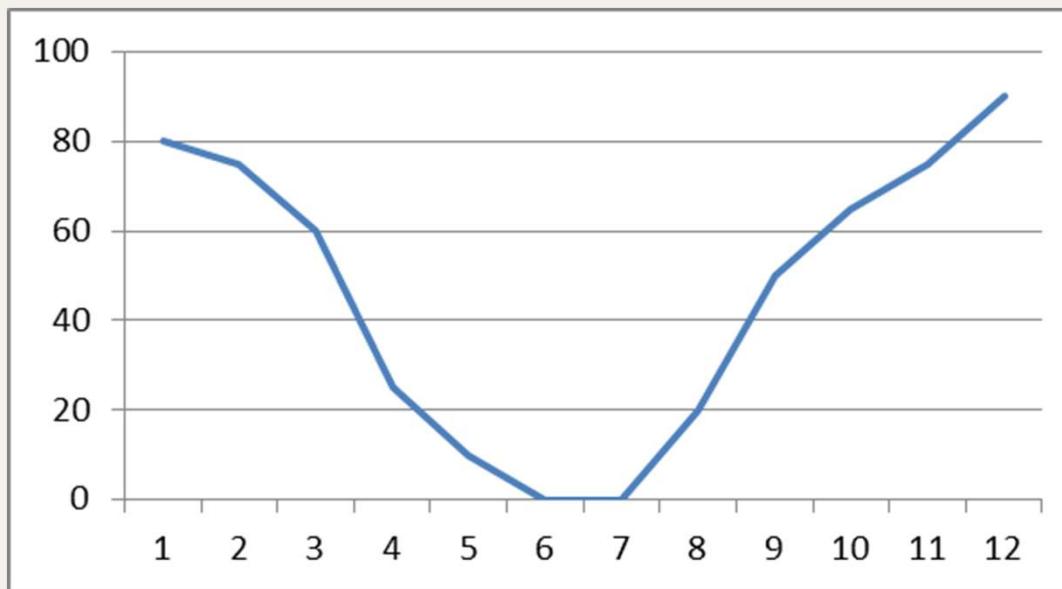
# Trend



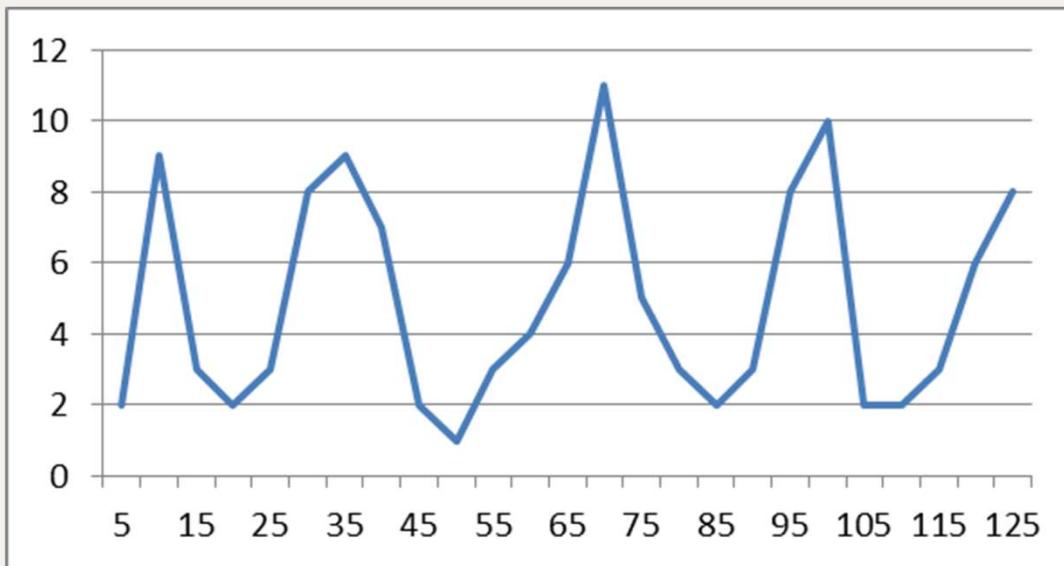
# Random Fluctuation



# Seasonal Fluctuation



# Cyclical



# Section 3

# Forecasting Techniques

## QUANTITATIVE vs. QUALITATIVE

- Moving Average
- Weighted Average
- Exponential Smoothing
- Naive
- Expert Opinion
- Management Estimate
- Focus Group
- Survey

# Simple Moving Average Forecast

Month	Demand	3 Month Average		Forecast
1	88			
2	88			
3	95	271	90.33	
4	92	275	91.67	90
5	94	281	93.67	92
6	103	289	96.33	94
7	106	303	101.00	96
8	110	319	106.33	101
9	112	328	109.33	106
10				109

# Weighted Moving Average Forecast

Month	Demand	3 Month Average	Forecast
1	88		
2	88		
3	95	(95x0.75 + 88x0.2 +88x0.05) = 93.25	
4	92	(92x0.75 + 95x0.2 +88x0.05) = 92.4	93
5	94	(94x0.75 + 92x0.2 +95x0.05) = 93.65	92
6	103	100.65	94
7	106	104.8	101
8	110	108.85	105
9	112	111.3	109
10			111

Factor	Weight	Description
D1 =	75%	Most recent demand
D2 =	20%	2nd most recent demand
D3 =	5%	3rd most recent demand

# Exponential Smoothing

Month	Demand	Forecast
1	88	
2	88	
3	95	
4	92	93
5	94	93
6	103	93
7	106	96
8	110	99
9	112	102
10		

$(92 \times 0.3 + 93 \times 0.7) = 92.7$

$(94 \times 0.3 + 93 \times 0.7) = 93.3$

Factor	Weight
$\alpha =$	0.3
$(1 - \alpha) =$	0.7

# Forecasting Techniques

## QUANTITATIVE vs. QUALITATIVE

- Moving Average
- Weighted Average
- Exponential Smoothing
- Naive
- Expert Opinion
- Management Estimate
- Focus Group
- Survey

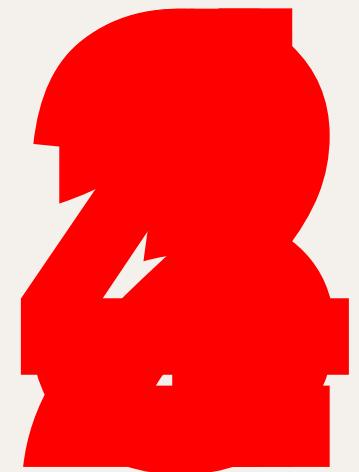
# Forecasting Techniques

## QUANTITATIVE vs. QUALITATIVE

- Moving Average
- Weighted Average
- Exponential Smoothing
- Naive
- Expert Opinion
- Management Estimate
- Focus Group
- Survey

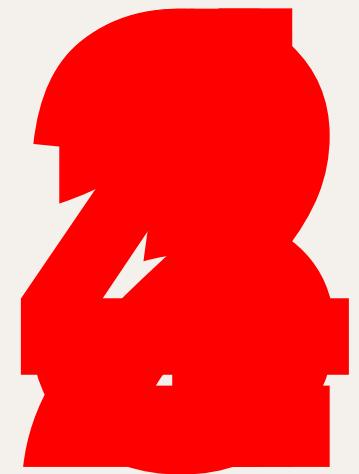
# Exercise – Moving Average

Month	Demand	Forecast 3 Month Avg
1	90	
2	89	
3	87	
4	92	89
5	94	89
6	101	91
7	99	96
8	100	98
9	105	100
10	108	101
11	110	104
12	105	108



# Exercise – Moving Average

Month	Demand	Forecast 4 Month Avg
1	90	
2	89	
3	87	
4	92	
5	94	90
6	101	91
7	99	94
8	100	97
9	105	99
10	108	101
11	110	103
12	105	106



# Section 4

# Understanding Forecast Error

*Managing the accuracy of a forecast requires minimizing the errors between the actual demand and the forecasted demand.*

# Measuring Forecast Error

- Cumulative Sum of Error
- Mean Square Root
- Mean Absolute Deviation
- Mean Absolute Percent Error

# Cumulative Sum of Error

Month	Forecast	Demand	Cumulative Sum of Error
January	1120	1400	280
February	999	960	-39
March	1005	1440	435
April	850	1175	325
May	950	815	-135
June	1236	775	-461
July	995	880	-115
August	1125	930	-195
September	1050	1550	500
October	995	665	-330
November	1030	1305	275
December	875	550	-325
Total	12230	12445	215
Cumulative Sum of Error			215

# Mean Square Root

Month	Forecast	Demand
January	1120	1400
February	999	960
March	1005	1440
April	850	1175
May	950	815
June	1236	775
July	995	880
August	1125	930
September	1050	1550
October	995	665
November	1030	1305
December	875	550
Total	12230	12445

Mean Square Root

Cumulative Sum of Error	Mean Square Root
280	78400
-39	1521
435	189225
325	105625
-135	18225
-461	212521
-115	13225
-195	38025
500	250000
-330	108900
275	75625
-325	105625
215	1196917

316

$$280 \times 280 = 78400$$

$$-39 \times -39 = 1521$$

$$\rightarrow 1196917/12 = 99743$$

$$\sqrt{99743} = 315.82$$

# Mean Absolute Deviation

Month	Forecast	Demand
January	1120	1400
February	999	960
March	1005	1440
April	850	1175
May	950	815
June	1236	775
July	995	880
August	1125	930
September	1050	1550
October	995	665
November	1030	1305
December	875	550
<b>Total</b>	<b>12230</b>	<b>12445</b>

Cumulative Sum of Error
280
-39
435
325
-135
-461
-115
-195
500
-330
275
-325
<b>215</b>

Mean Absolute Deviation
280
39
435
325
135
461
115
195
500
330
275
325
<b>3415</b>

Mean Absolute Deviation

$$3415/12 = 284.58$$

285

# Mean Absolute Percent Error

Month	Forecast	Demand
January	1120	1400
February	999	960
March	1005	1440
April	850	1175
May	950	815
June	1236	775
July	995	880
August	1125	930
September	1050	1550
October	995	665
November	1030	1305
December	875	550
<b>Total</b>	<b>12230</b>	<b>12445</b>

Mean Absolute Percent Error

Mean Absolute Deviation / Demand X 100%

$$280 / 1400 \times 100\% \\ 39 / 960 \times 100\%$$

Mean Absolute Deviation	Mean Absolute Percent Error
280	20%
39	4%
435	30%
325	28%
135	17%
461	59%
115	13%
195	21%
500	32%
330	50%
275	21%
325	59%
<b>3415</b>	<b>354%</b>

$$354\% / 12 = 30\%$$

30%

# Understanding Forecast Error Part 2

*As a Supply Chain Professional, always choose the forecasting technique that best fits the data to minimize the forecast error.*

*Minimizing the error will give you the most accurate forecast.*

# Summary - Forecast Error

Month	Forecast	Demand
January	1120	1400
February	999	960
March	1005	1440
April	850	1175
May	950	815
June	1236	775
July	995	880
August	1125	930
September	1050	1550
October	995	665
November	1030	1305
December	875	550
<b>Total</b>	<b>12230</b>	<b>12445</b>

Cumulative Sum of Error	Mean Square Root	Mean Absolute Deviation	Mean Absolute Percent Error
280	78400	280	20%
-39	1521	39	4%
435	189225	435	30%
325	105625	325	28%
-135	18225	135	17%
-461	212521	461	59%
-115	13225	115	13%
-195	38025	195	21%
500	250000	500	32%
-330	108900	330	50%
275	75625	275	21%
-325	105625	325	59%
<b>215</b>	<b>1196917</b>	<b>3415</b>	<b>354%</b>

Cumulative Sum of Error

215

Mean Square Root

316

Mean Absolute Deviation

285

Mean Absolute Percent Error

30%

# Exercise – Measuring Forecast Error

Month	Forecast	Demand
January	1350	1275
February	1200	999
March	1250	1375
April	1150	1015
May	1275	1325
June	1300	1375
<b>Total</b>	<b>7525</b>	<b>7364</b>

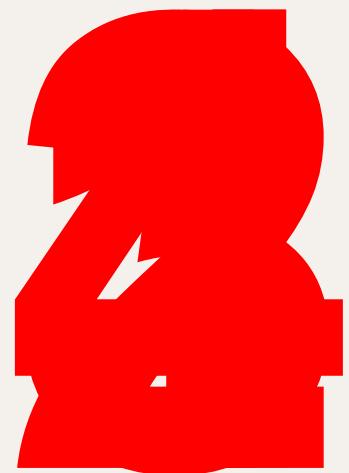
Cumulative Sum of Error	Mean Absolute Deviation
-75	75
-201	201
125	125
-135	135
50	50
75	75
<b>-161</b>	<b>661</b>

Cumulative Sum of Error

-161

Mean Absolute Deviation

110



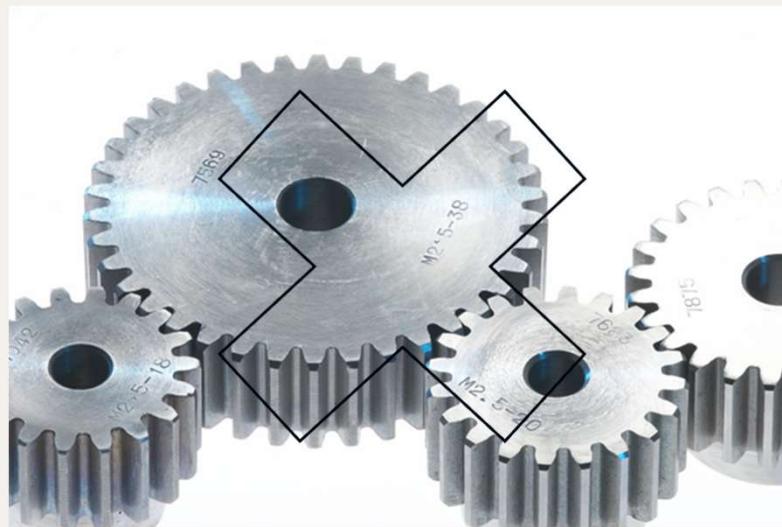
# Quiz

1	Which forecasting method uses the average demand for a past number of periods?	
a	Trend Analysis	
b	Linear Smoothening	
c	Moving Average	Answer
d	None of the above	
2	What assumption is made about forecasting methods?	
a	Demand variation must be linear	
b	The past is an acceptable indicator of the future	Answer
c	Demand variation must be small	
d	The past is not an acceptable indicator of the future	
3	End item A is made from subcomponents B & C. Subcomponent B is made from part D and raw material E. Which component should be forecast?	
a	A, B, C, D and E	
b	B and C	
c	D and E	
d	Only A	Answer
4	Which of the following is typical of demand?	
a	It contains average variation	
b	It contains seasonal fluctuations	Answer
c	It does not contain random fluctuations	
d	All of the above	
5	Which of the following does not belong?	
a	Trend	
b	Cyclical	
c	Average	
d	Random Fluctuations	Answer

# Section 5

# Introduction to Manufacturing

*Transforms raw materials into finished goods that meet the needs of customers.*



# Choosing a Mfg Environment

- ETO - Engineer-to-Order
- MTO - Manufacture-to-Order
- ATO - Assemble-to-Order
- MTS - Manufacture-to-Stock

# Manufacturing Environments

- ETO - Engineer-to-Order

# Manufacturing Environments

- ETO - Engineer-to-Order
- MTO - Manufacture-to-Order

# Manufacturing Environments

- ETO - Engineer-to-Order
- MTO - Manufacture-to-Order
- ATO - Assemble-to-Order

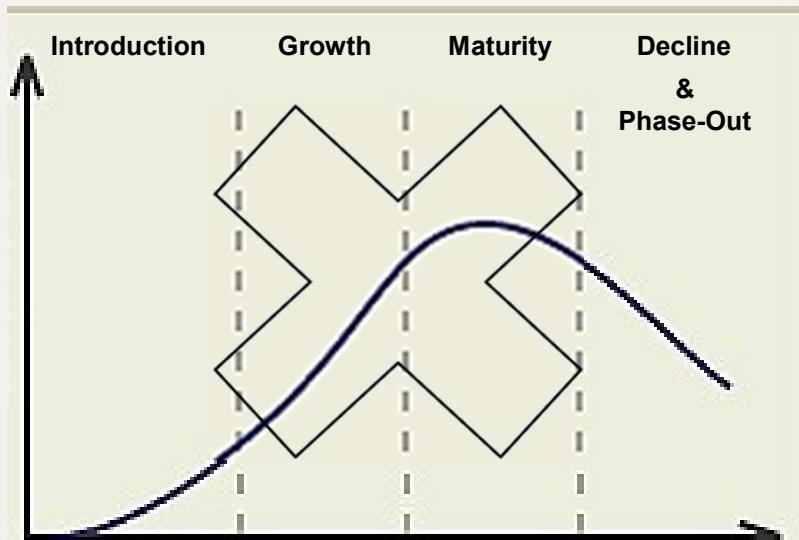
# Manufacturing Environments

- ETO - Engineer-to-Order
- MTO - Manufacture-to-Order
- ATO - Assemble-to-Order
- MTS - Manufacture-to-Stock

# Manufacturing Environments

- ETO - Engineer-to-Order
- MTO - Manufacture-to-Order
- ATO - Assemble-to-Order
- MTS - Manufacture-to-Stock

# Product Life Cycle



- Introduction Stage
- Growth Stage
- Maturity Stage
- Decline Stage
- Phase-Out Stage

# Choosing a Manufacturing Layout

- Project

# Choosing a Manufacturing Layout

- Project
- Intermittent

# Choosing a Manufacturing Layout

- Project
- Intermittent
- Cell

# Choosing a Manufacturing Layout

- Project
- Intermittent
- Cell
- Product
  - Linear or Repetitive
  - Continuous

# Meeting Customer Expectations

- Cost
- Quality
- Speed
- Dependability
- Flexibility

# Meeting Customer Expectations

- Cost

# Meeting Customer Expectations

- Cost
- Quality

# Meeting Customer Expectations

- Cost
- Quality
- Speed

# Meeting Customer Expectations

- Cost
- Quality
- Speed
- Dependability

# Meeting Customer Expectations

- Cost
- Quality
- Speed
- Dependability
- **Flexibility**

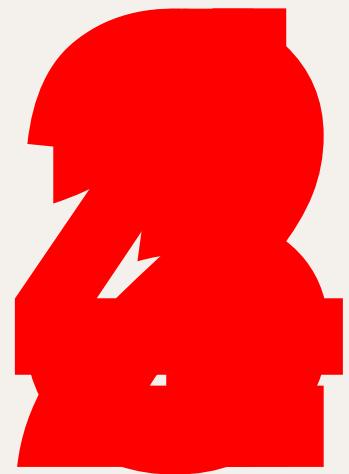
# Meeting Customer Expectations

- Cost
- Quality
- Speed
- Dependability
- Flexibility

# Exercise – Match the Word & Phrase

B	A production environment where an item is manufactured after receipt of a customer order.
D	The time span of a product from the time it is introduced into the market to the time people stop buying it.
C	A network used to deliver products or services from raw materials to end customers.
E	Equipment and workers are arranged in a linear flow.
A	A manufacturing environment where a product is assembled after receipt of a customer order.

A	Assemble-to-Order
B	Manufacture-to-Order
C	Supply Chain
D	Product Life Cycle
E	Cell Layout



# Quiz

1	Which of the following manufacturing strategies has the longest delivery lead-time?	
a	ATO	
b	MTS	
c	ETO	
d	MTO	Answer
2	Why is manufacturing important to the economy?	
a	It decreases employment and prevents waste.	
b	It creates wealth and reduces waste.	
c	It adds value to products and creates wealth.	
d	None of the above.	Answer
3	Which of the following is not associated with an Intermittent layout?	
a	Uses lots and batches	
b	MTS	
c	Equipment is not dedicated	
d	Job Shop	Answer
4	Which of the following manufacturing strategies has the shortest delivery lead-time?	
a	ATO	
b	MTS	
c	ETO	
d	MTO	Answer
5	In the Product Life Cycle, at what stage is the product most expensive?	
a	Growth	
b	Decline	
c	Maturity	
d	Introduction	Answer

# Section 6



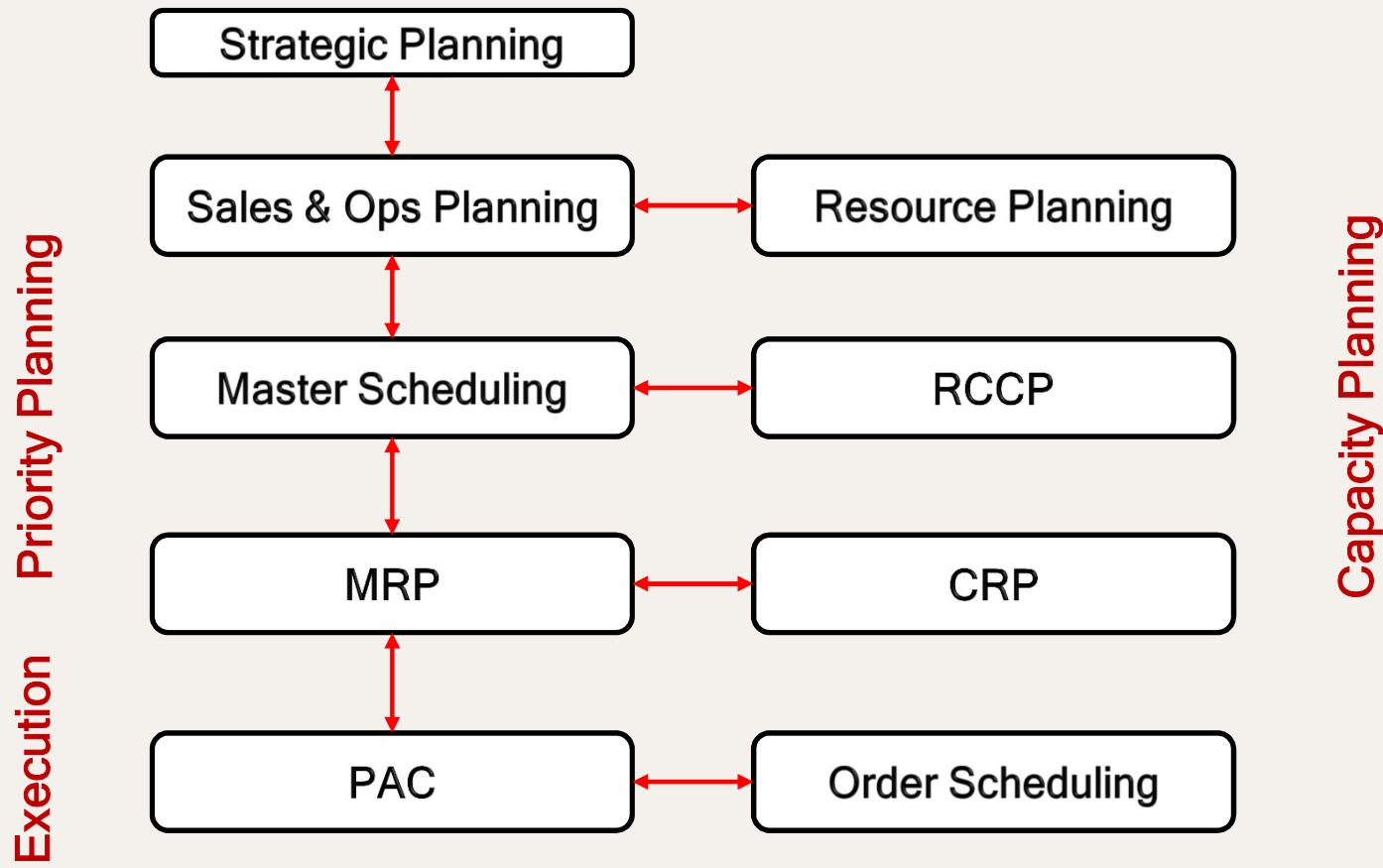
*Welcome to*

*Sales*

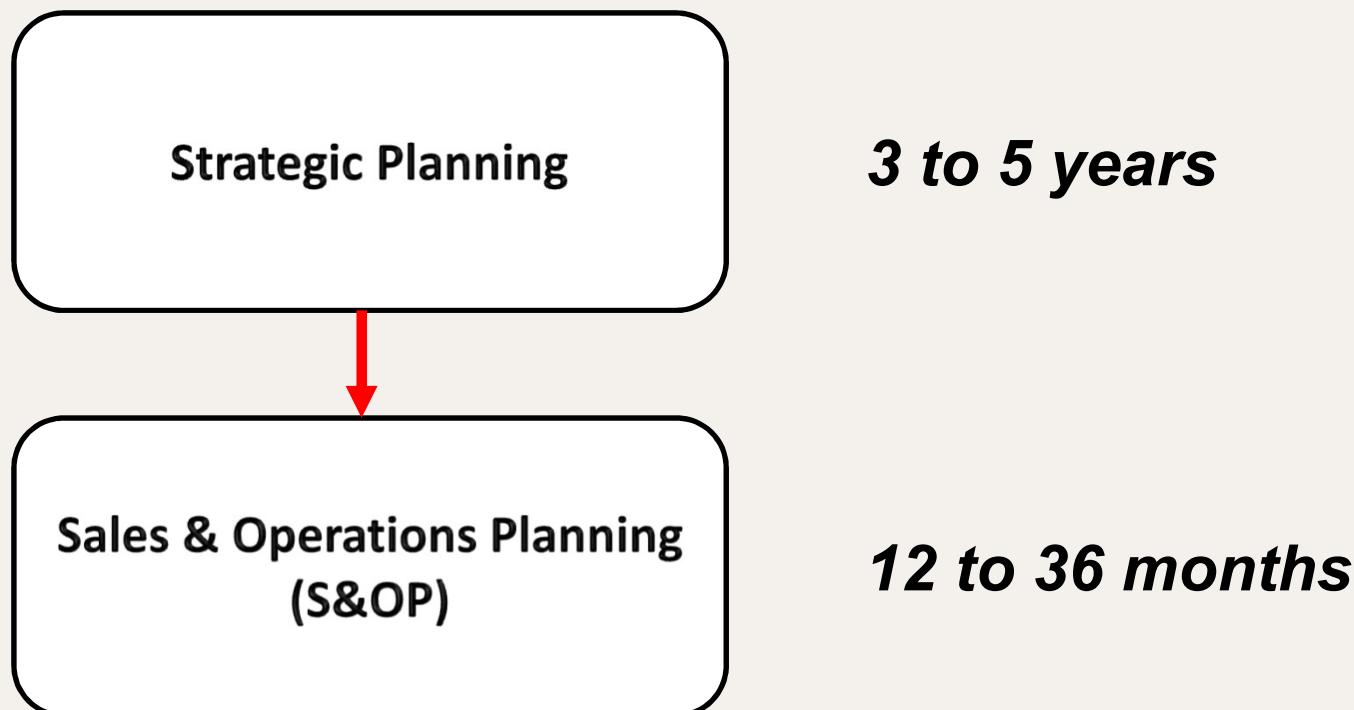
*&*

*Operations Planning*

# Manufacturing, Planning & Control



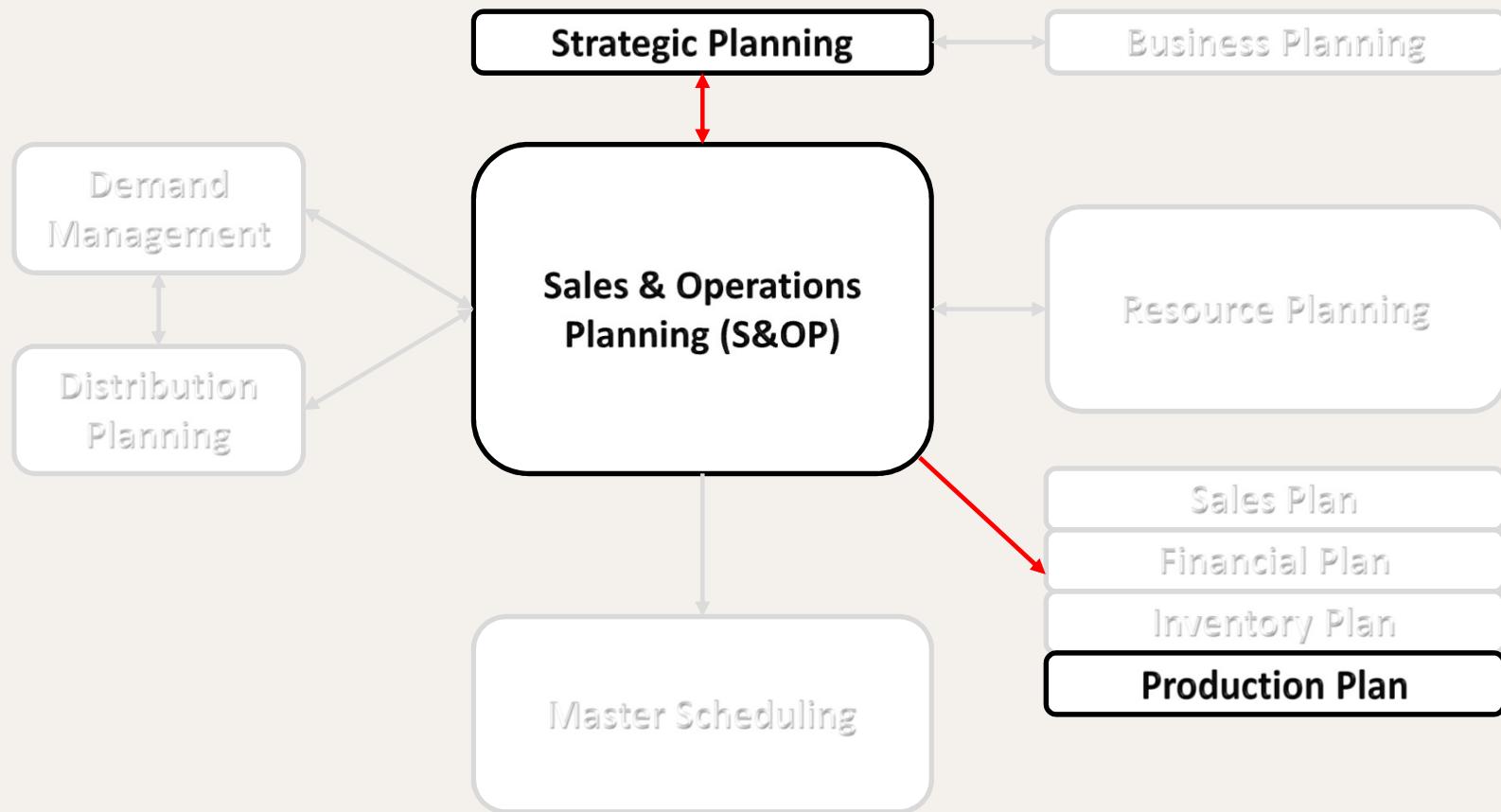
# Planning Horizon



# What is Production Planning?

*Is a process in a manufacturing business that establishes a production rate, typically monthly, for a family of parts over a 12 to 36 month planning horizon.*

# Production Planning



# Developing a Production Plan

# Developing a Production Plan

- Chase Strategy

# Developing a Production Plan

- Chase Strategy
- Level Production Strategy

# Developing a Production Plan

- Chase Strategy
- Level Production Strategy
- Hybrid Strategy

# Developing a Production Plan

- Chase Strategy
- Level Production Strategy
- Hybrid Strategy
- Subcontracting Strategy

# Exercise - Calculating Expected Ending Inventory

Period	1	2	3	4	5	6
Forecast	500	450	550	700	750	800
Production Plan	600	600	600	600	600	600
Ending Inventory	300	450	500	400	250	50

Beginning Inventory Period 1 = 200

Ending Inventory = Beginning Inventory + Production Plan - Forecast

# Exercise - Developing A Level Production Plan

Period	1	2	3	4	5	6
Forecast	40	45	70	58	75	80
Production Plan	53	53	53	53	53	53
Ending Inventory	113	121	104	99	77	50

Beginning Inventory Period 1 = 100

Ending Inventory Period 6 = 50

Calculate total demand = 368

Calculate total production needed =  $368 - 100 + 50 = 318$

Calculate production rate each period =  $318/6 = 53$

# Resource Requirements Planning (RRP)

- Is a check on resources needed to support the Production Plan.
- Deals with capacity at the product family level and determines the need for long-lead resources.

# Lack of Resources

- Hire more workers or buy more equipment.

# Lack of Resources

- Hire more workers or buy more equipment.
- Subcontract the work.

# Rough Calculation Example - RRP

Monthly Production Rate is 1000 bicycles.

1 hour welding per bicycle = 1000 hours welding per month.

1 welding operator & 1 welding machine = 40 hours welding per week = 160 hours welding per month

2<sup>nd</sup> welding operator on afternoon shift = 160 hours welding per month

3<sup>rd</sup> welding operator on night shift = 160 hours welding per month

Total: 480 hours welding per month

Buy another welding machine and hire 3 more welding operators:

Total: 480 hours welding per month

Work some overtime:

Total: 40 hours welding per month

**Grand Total: 1000 hours welding per month**

# Lack of Resources

- Hire more workers or buy more equipment.
- Subcontract the work.

# Lack of Resources

- Hire more workers or buy more equipment.
- Subcontract the work.
- Reduce plan & output.

# Exercise – RRP

## Assumptions:

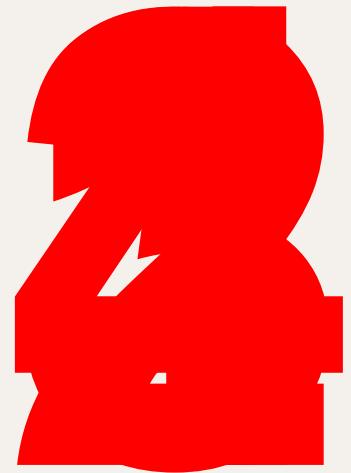
- 1 machine and 1 operator – Can produce 40 hrs per week or 160 hrs per month.
- Capacity can be further increased by 15% through overtime.
- External company nearby can perform 250 hrs of the work per month at a very reasonable price comparable to your own internal costs.
- Each bicycle will require 0.15 hrs of tube bending.

Verify if you have a capacity shortage and recommend a solution...

## Solution:

Monthly tube bending required:  $1000 \times 0.15 = 150$  hrs

Your capacity available is  $160 + 15\% = 184$  hrs. You are okay with current resources to meet the required demand.



# Exercise – RRP

Assumptions:

- 1 machine and 1 operator – Can produce 40 hrs per week or 160 hrs per month.
- Capacity can be further increased by 15% through overtime.
- External company nearby can perform 250 hrs of the work per month at a very reasonable price comparable to your own internal costs.
- Each bicycle will require 0.35 hrs of tube bending.

Verify if you have a capacity shortage and recommend a solution...

# Exercise – RRP

Solution:

Monthly tube bending required:  $1000 \times 0.35 = 350$  hrs

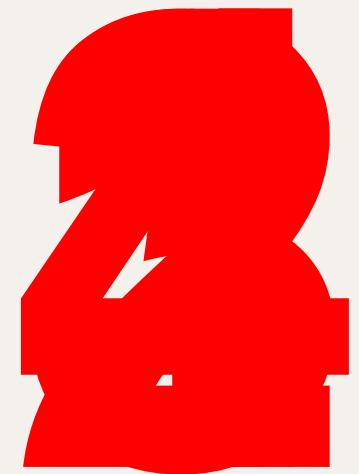
Max capacity is  $160 + 15\% = 184$  hrs.

Using 10%, available capacity is  $160 + 10\% = 176$  hrs.

Recommendation is to hire another operator and each can work 10% overtime which will give you slightly over 350 hrs each month,

or,

instead of hiring another operator you can subcontract half the work to the external company.



# Quiz

1	Production Planning is associated with?					
a	Annual Planning					
b	Strategic Planning					
c	Sales and Operations Planning					
d	Short range planning					
						Answer
2	The Chase strategy leads to?					
a	Production levelling.					
b	Demand matching.					
c	Inventory buildup.					
d	Lower costs.					
						Answer
3	If your opening inventory is 200 units, ending inventory is 75 units, sales are 300 units, what amount needs to be produced?					
a	150					
b	125					
c	200					
d	175					
						Answer
4	The Hybrid strategy is?					
a	A combination of Chase and Level.					
b	A combination of Level and Subcontract					
c	A combination of Chase and Subcontract					
d	None of the above					
						Answer
5	Resource Requirements Planning?					
a	Is a Medium range planning tool					
b	Supports the Daily Plan.					
c	Supports the Production Plan.					
d	Is a Short range planning tool.					
						Answer

# Section 7



# What is Master Production Schedule (MPS)?

*Medium range plan*

*More detailed schedule*

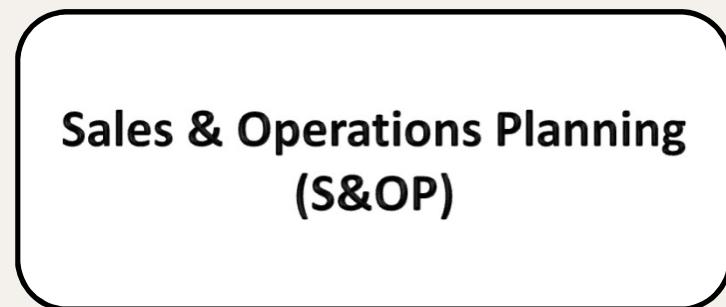
*End-item level to customer*

*Specific models*

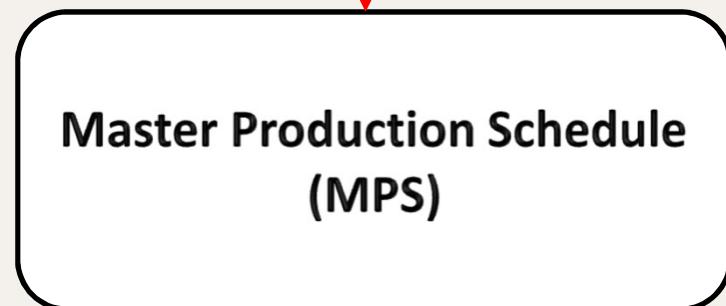
*Quantities*

*Completion dates*

# Master Scheduling



**Production Plan**  
*1000 bicycles per month*  
**Product Family Level**



**MPS**  
*250 adult, 250 kid, 500 racing*  
**End-Item Level**

# Exercise - MPS plus Projected Available Balance (PAB)

Lot size = 50 pcs.

Period		1	2	3	4	5	6
Forecast		30	30	30	30	30	30
Projected Available Balance	40	10	30	0	20	40	10
Master Production Schedule			50		50	50	

Ending PAB = Beginning PAB + MPS Receipt - Customer Forecast

# Rough Cut Capacity Planning (RCCP)

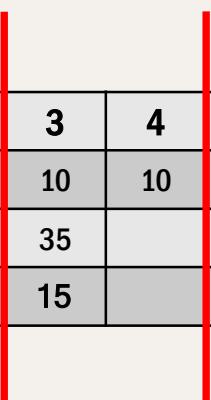
- Is a check on resources needed to support the Master Production Schedule.
- It deals with the need for capacity to support components at the end-item level.
- More detail level of capacity which uses weekly (not monthly) time intervals.

# Available-to-Promise (ATP)

*It is the portion of a company's inventory and production that is uncommitted and therefore available for customer order promising.*

# Exercise - Available-to-Promise (ATP)

Period	1	2	3	4	5	6
Forecast	20	10	10	10		30
MPS Receipt	35		35		35	
ATP	5		15		5	



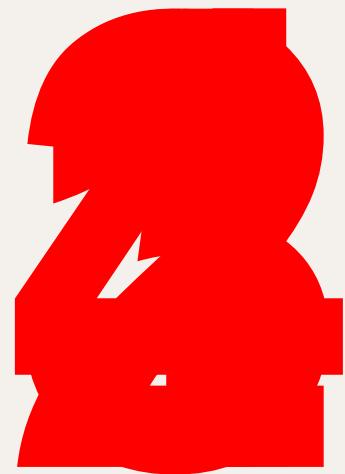
Calculate ATP for each period in which an MPS receipt is scheduled.

# Exercise – MPS

Lot size = 200 pcs.

Period		1	2	3	4	5	6
Forecast		60	130	280	100	80	180
Projected Available Balance	100	40	110	30	130	50	70
Master Production Schedule			200	200	200		200

Ending PAB = Beginning PAB + scheduled MPS - Forecast



# Quiz

1	Which is not associated with an MPS?					
a	Specific configurations					
b	Quantities					
c	Due-dates					
d	Resource Requirements Planning					Answer
2	RCCP checks capacity for?					
a	PAB					
b	RRP					
c	MPS					Answer
d	Promising					
3	The MPS receives data from?					
a	Production Plan					Answer
b	Master Production Schedule					
c	Daily Plan					
d	Short range plan.					
4	What is the name for the inventory and production that is available for customer order promising?					
a	PAB					
b	MPS					
c	RCCP					
d	ATP					Answer
5	PAB stands for?					
a	Projected And Probable Balance					
b	Probable Available Balance					
c	Projected Available Balance					Answer
d	None of the above					

# Section 8

# What is Material Requirements Planning (MRP)?

A bridge

Uses software

Needs Due Dates

Short Range Plan

Use of Time-Phasing

Needs qts

# MRP creates the Priority Plan

When orders  
should be released

Everything needed  
to complete an  
end-item

When materials  
need to be  
ordered

Focus on dependent  
demand items

# What is a Work Center

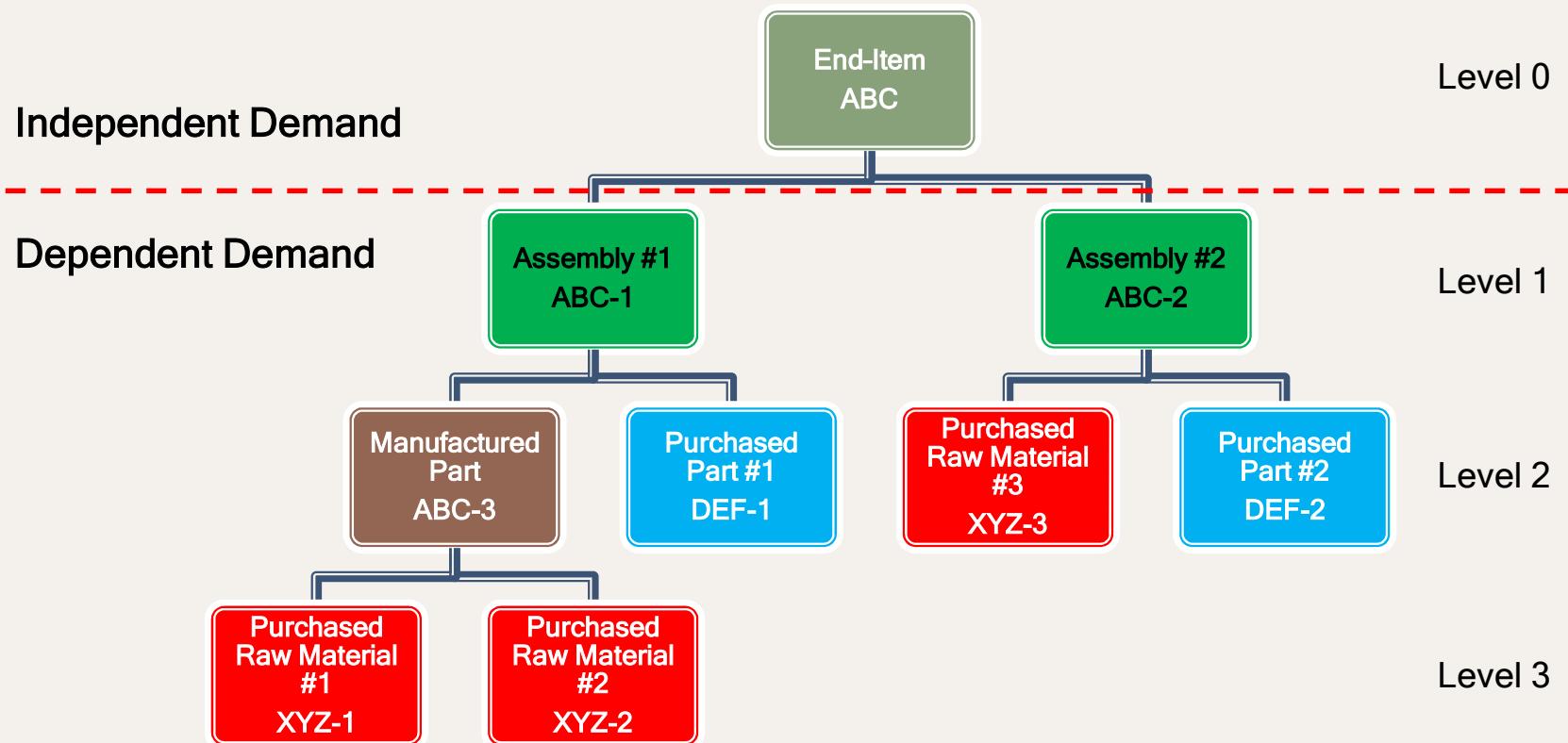
*A work center usually represents a factory or manufacturing location, a single machine or group of similar machines which performs a specific task or it can represent a specialized shop such as painting or assembly.*



# Summarized Bill of Material (BOM)

<b>Part Number</b> <b>ABC</b>			
<u>Part Number</u>	<u>Description</u>	<u>Qty Req'd</u>	<u>Unit of Measure</u>
ABC-1	Assembly #1	1	Each
ABC-2	Assembly #2	1	Each
ABC-3	Manufactured Part	1	Each
DEF-1	Purchased Part #1	1	Each
DEF-2	Purchased Part #2	1	Each
XYZ-1	Raw Material #1	1	Inch
XYZ-2	Raw Material #2	1.5	Inches
XYZ-3	Raw Material #3	1	Each

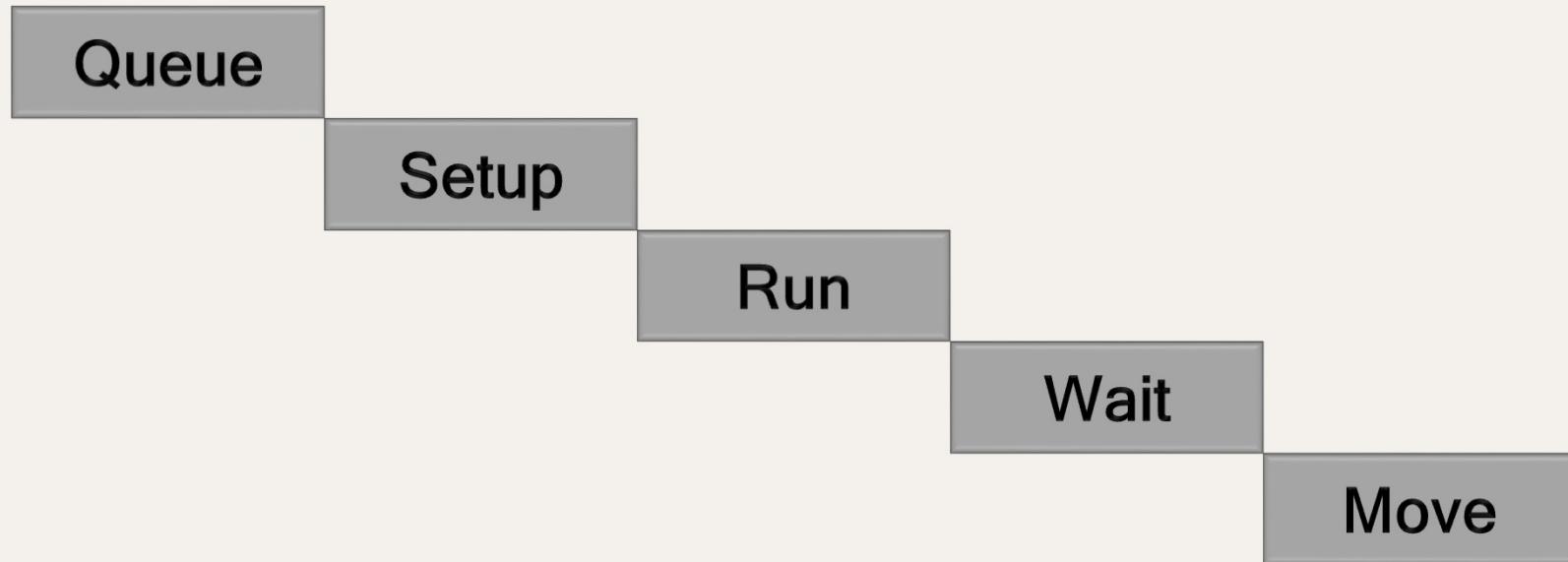
# Bill of Material (BOM)



# Lead Time is Defined as ...

*A SPAN OF TIME REQUIRED  
TO PERFORM A PROCESS*

# Elements of Manufacturing Lead Time



# What is a Part Number?

*Is a unique identifier of an item.*

*Can also be referred to as Item  
Number, Product Number, Stock  
Code and Stock Number.*

# Part Numbers ...

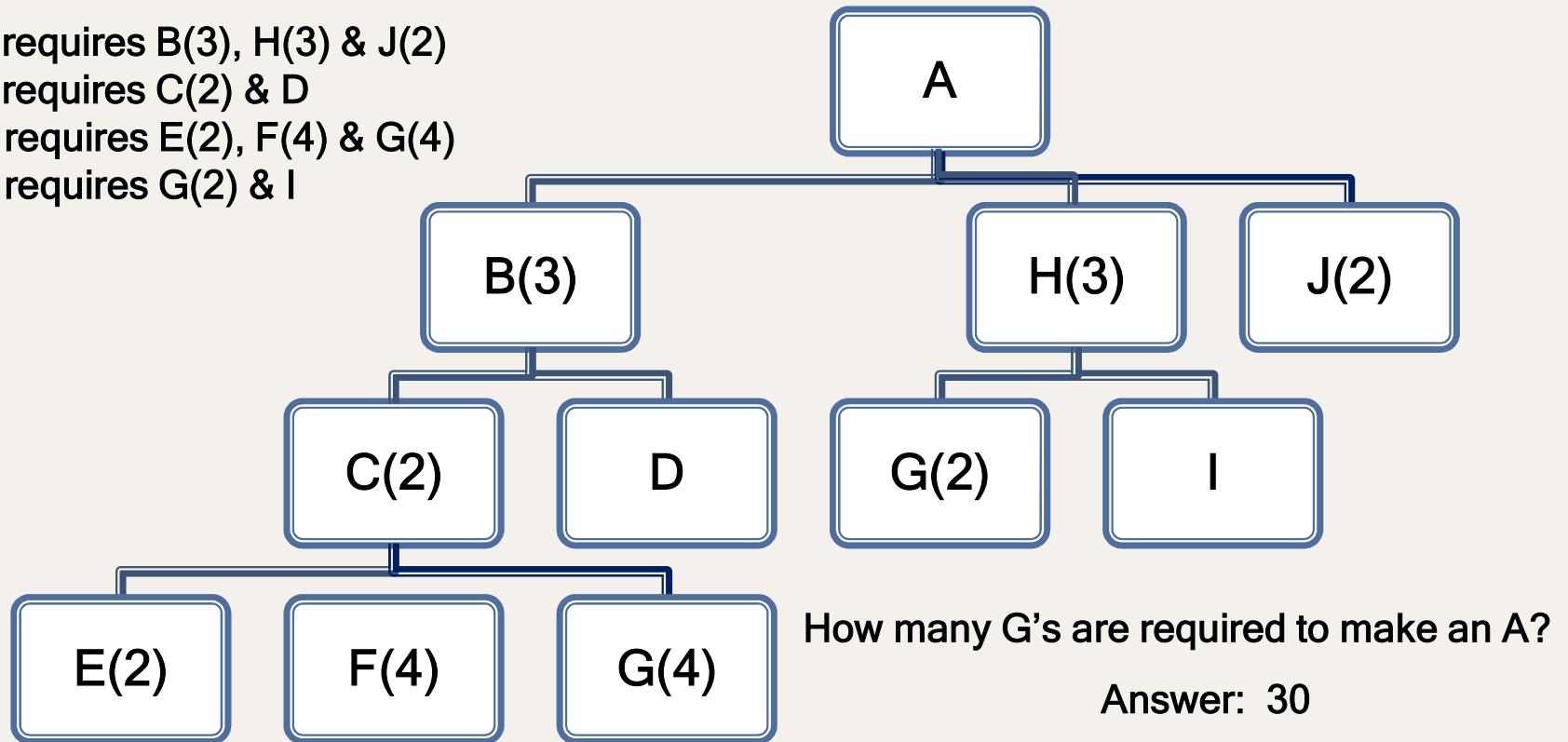
- Should be assigned to each item
- Should be unique
- Should follow a common format
- Should never be re-used or re-assigned
- Should be created and managed by a dedicated person(s)

# Inputs to MRP

- MPS
- BOM
- Inventory Status
- Planning Factors

# Exercise - Bill of Material (BOM)

- A requires B(3), H(3) & J(2)
- B requires C(2) & D
- C requires E(2), F(4) & G(4)
- H requires G(2) & I

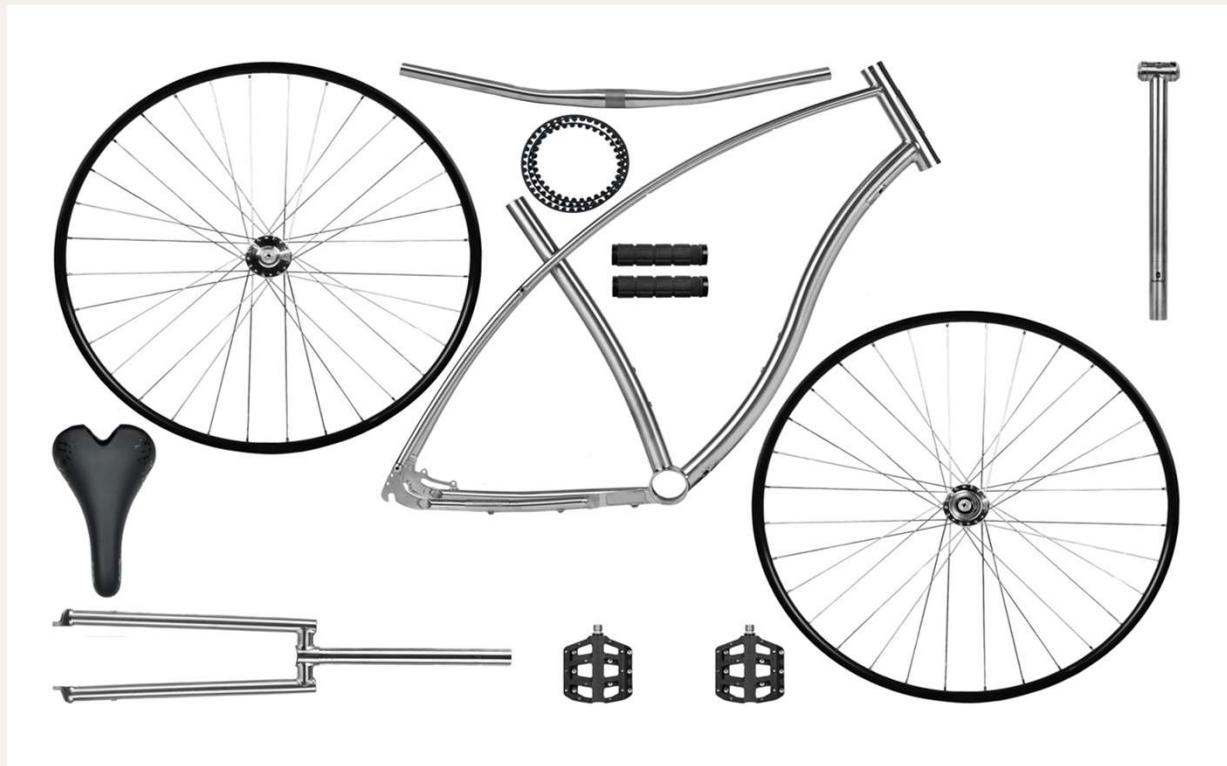


# Section 9

# MRP Offsetting & Exploding

- Lead Time Offsetting
- Exploding

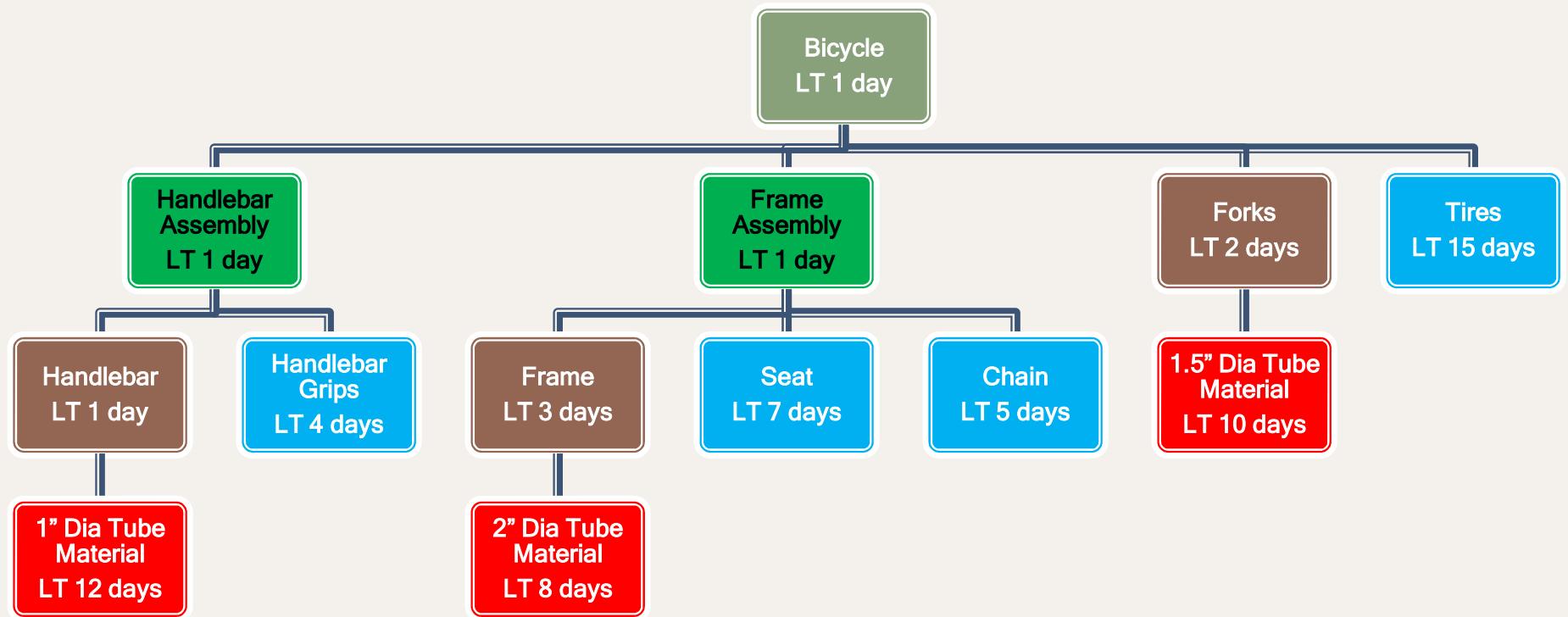
# Bicycle Parts



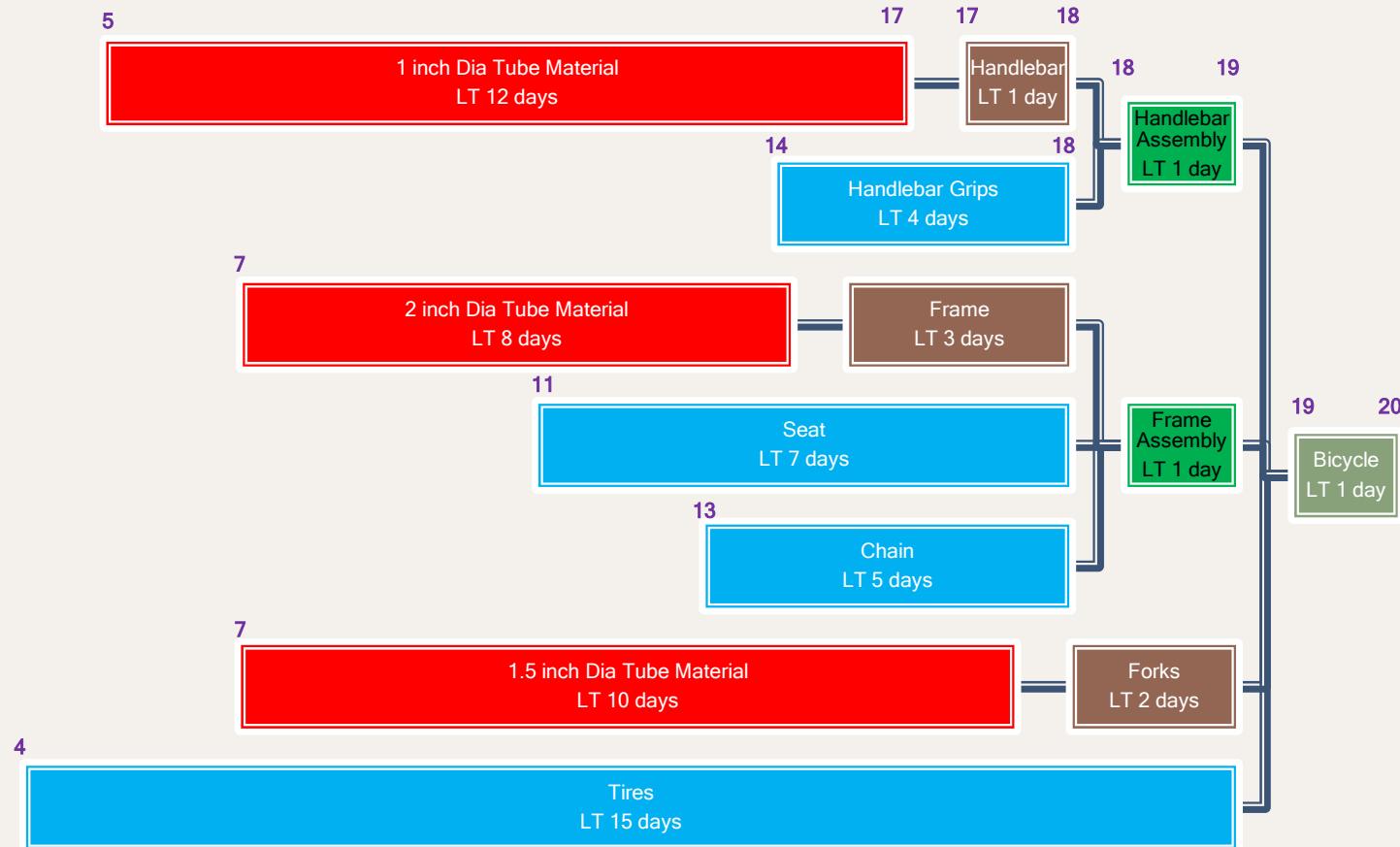
# Summarized Bill of Material (BOM)

Bicycle ABC			
<u>Part Number</u>	<u>Description</u>	<u>Qty Req'd</u>	<u>Unit of Measure</u>
ABC-1	Handlebar Assembly	1	Each
ABC-2	Frame Assembly	1	Each
ABC-3	Forks	1	Each
ABC-4	Tires	2	Each
DEF-1	Handlebar	1	Each
DEF-2	Handlebar Grips	2	Each
DEF-3	Frame	1	Each
DEF-4	Seat	1	Each
DEF-5	Chain	1	Each
XYZ-1	1 inch Dia Handlebar Tube Material	2	Feet
XYZ-2	2 inch Dia Frame Tube Material	8	Feet
XYZ-3	1.5 inch Dia Forks Tube Material	3	Feet

# Bill of Material (BOM)

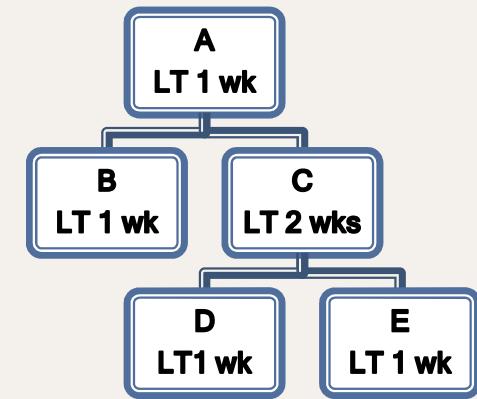


# Understanding Time-Phasing



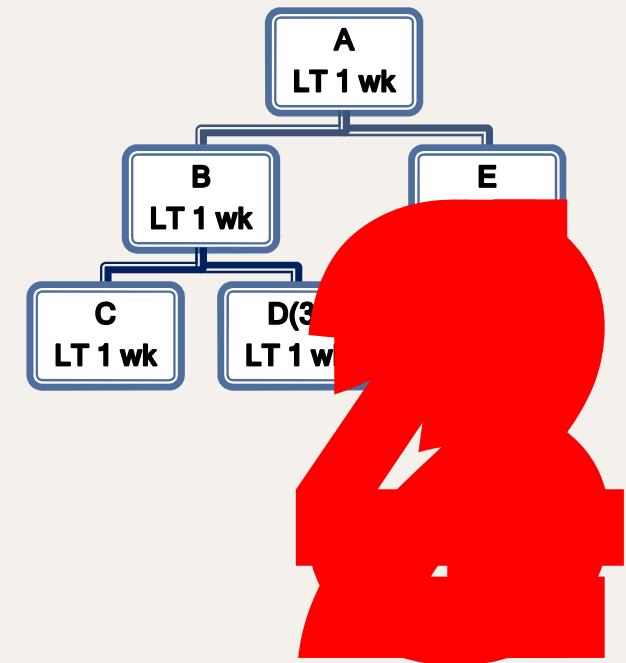
# Exercise – Time-Phasing

Item Number	Planned Order	Week				
		1	2	3	4	5
A	Receipt					100
	Release				100	
B	Receipt				100	
	Release			100		
C	Receipt				100	
	Release		100			
D	Receipt		100			
	Release	100				
E	Receipt		100			
	Release	100				



# Exercise – Time-Phasing

Item Number	Planned Order	Week					
		1	2	3	4	5	6
A	Receipt						200
	Release					200	
B	Receipt					200	
	Release				200		
C	Receipt				200		
	Release			200			
D	Receipt				600		
	Release			600			
E	Receipt					200	
	Release			200			
F	Receipt			400			
	Release		400				



# MRP - Functions

- Lead Time Offsetting, explosion calculations, inventory calculations
- Create Action and Exception messages

# MRP - Use of Software

- Planned Order
- Released Order
- Firm Planned Order

# Time Fences and Zones

- Liquid Zone
- Slushy Zone
- Frozen Zone

# Section 10



# Capacity Requirements Planning (CRP)

- Is a check on resources needed to support the Material Requirements Plan.
- It determines in detail the amount of labor and equipment resources needed to support the production requirements.

# Capacity Requirements Planning (CRP) in detail

*The process of calculating in detail the amount of labor and equipment resources necessary to accomplish a desired level of production output.*

# Determining Available Capacity

- Available Time
- Utilization
- Efficiency

# Available Time

If a manufacturing department in a company has 5 machines that work 8 hours a day and five days a week, what is the available time of that department?

Using the formula: Available Time (hrs) = number of machines x number of hours/day x number of days/week.

*Answer:  $5 \times 8 \times 5 = 200 \text{ hrs/week}$*

# Available Time

The company receives a new contract and the department buys a new machine and adds a 2nd shift, what is the available time?

*Answer:  $6 \times 16 \times 5 = 480 \text{ hrs/week}$*

# Utilization

If a department is available for 200 hrs/week but the hours actually worked only amounts to 150 hrs, what is the utilization of the department?

Using the formula: Utilization = hours actually worked divided by available hours x 100%

*Answer:*  $150/200 \times 100\% = 75\%$

# Efficiency

If a department has an output of 250 standard hours for the week and actually worked 200 hours, what is the efficiency?

Using the formula: Efficiency = standard hours of work divided by hours actually worked x 100%

*Answer:*  $250/200 \times 100\% = 125\%$

# Rated Capacity

Using the data from the earlier examples, available time = 200 hrs/week, utilization = 75%, efficiency = 125%, what is the rated capacity?

Using formula:

Rated Capacity = available time x utilization x efficiency

*Answer:*

*200 hrs/week x 75% x 125% = 187.5 or 188 hrs/week*

# Exercise – Rated Capacity

A company that manufactures tire rims has a department of 4 machines that work 8 hours a day, six days a week. Last week due to vacation and illness, actual hours worked by the department was 144 hours. The department on average achieves 115% efficiency.

What is the department's Rated Capacity for the week.

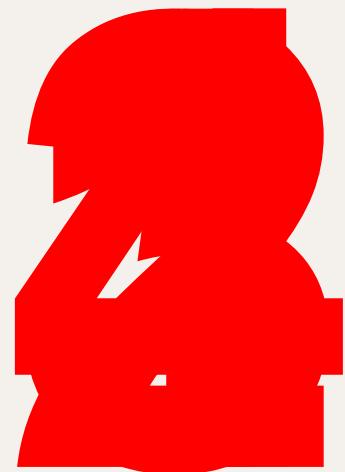
*Answer:*

*Available Time:  $4 \times 8 \times 6 = 192 \text{ hrs/week}$*

*Utilization:  $144 \text{ hrs} / 192 \text{ hrs} \times 100\% = 75\%$*

*Efficiency = 115%*

*Rated Capacity =  $192 \text{ hrs} \times 75\% \times 115\% = 165.6 \text{ or } 166 \text{ hrs}$*



# Quiz

1	Which of the following does not belong?					
a	Frozen Zone					
b	Liquid Zone					
c	Soft Zone					
d	Slushy Zone					
						Answer
2	Which of the following is not an input to MRP?					
a	Safety Stock					
b	BOM					
c	Scrap factor					
d	All are an input to MRP					
						Answer
3	Which of the following is true about time fences?					
a	Changes can be made easily in the liquid zone					
b	Making schedule changes in the future are costly.					
c	Changes can be made easily in the frozen zone					
d	None of the above					
4	Which is not an element of lead time?					
a	Transfer					
b	Run					
c	Setup					
d	Queue					
5	CRP is a capacity check on?					
a	MPS					
b	RCCP					
c	MRP					
d	Rate					

# Section 11

# What is Production Activity Control?

- Executes the Master Production Schedule and the Material Requirements Plan
- Ensures resources are used optimally
- Minimizes the work-in-process
- Ensures customers receive their orders on-time

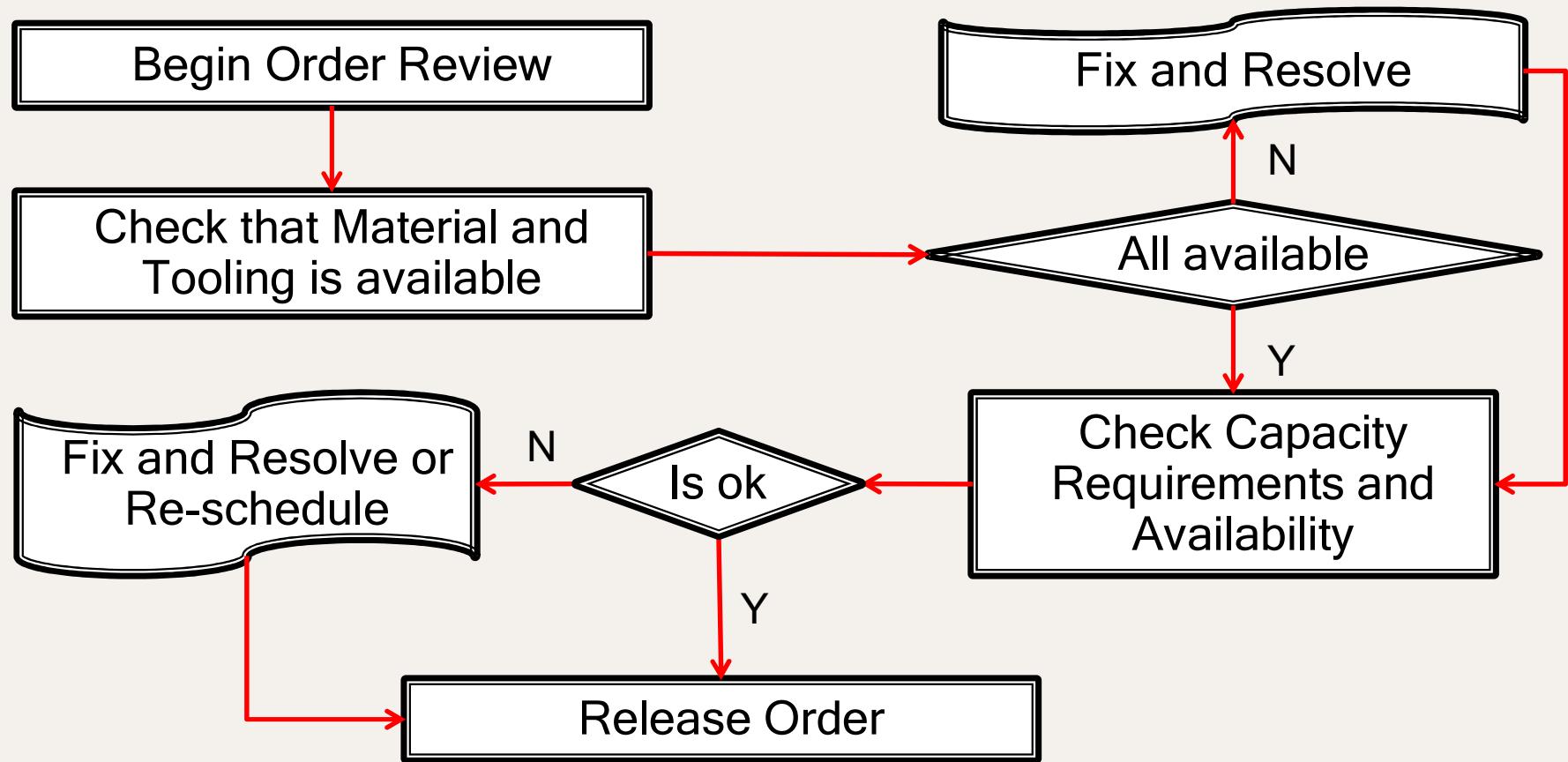
# PAC responsibilities include...

- Makes sure resources are ready when needed.
- Provides detail scheduling.
- Releases orders to begin manufacturing.
- Completes orders in the proper sequence.

# PAC responsibilities include...

- Monitors WIP, LTs & queues.
- Tracks production output.
- Ensures plans are achievable.
- Sharing information with Manufacturing and Scheduling.

# Order Release Process



# Quiz

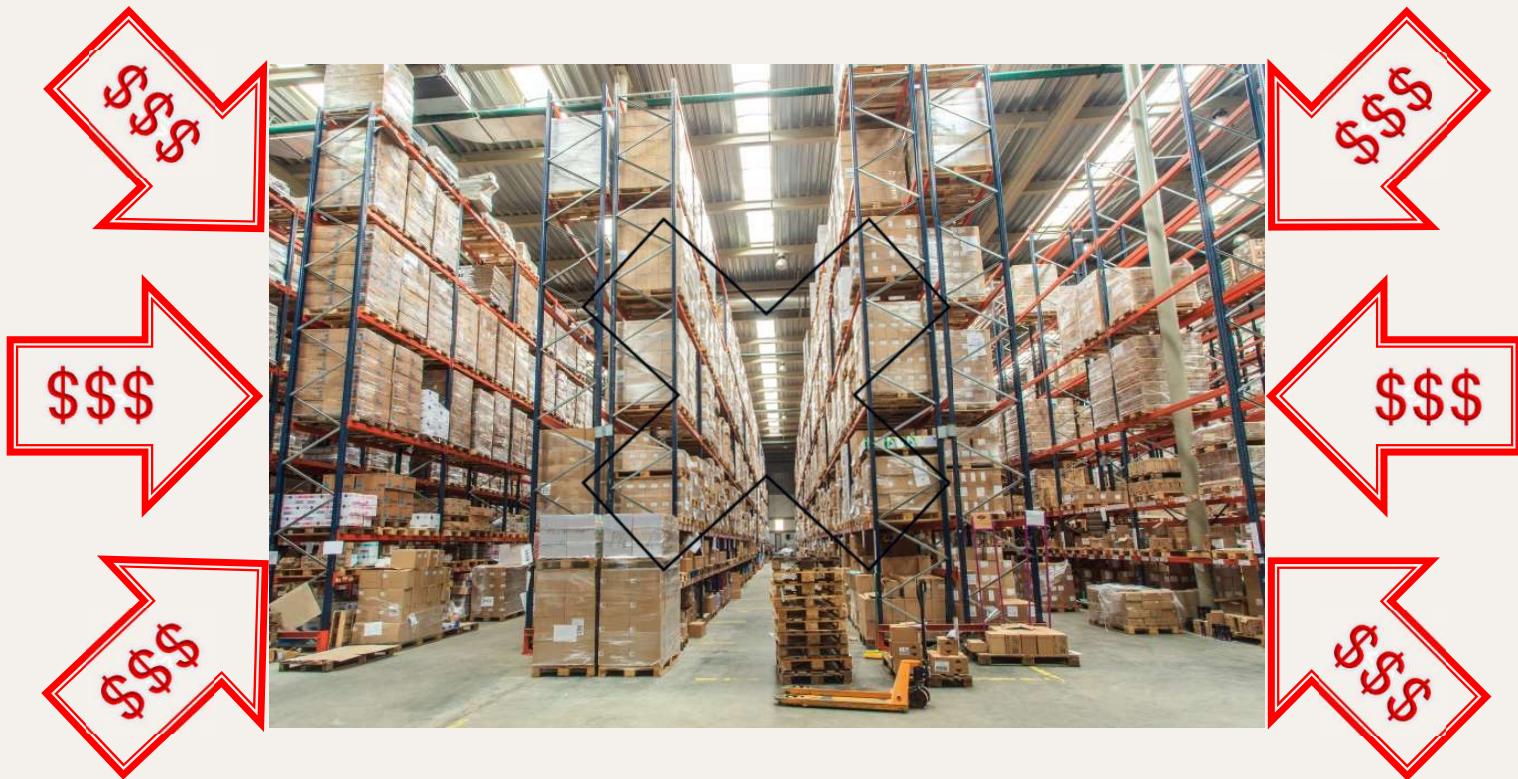
1	What is the liquid zone?						
a	Has many open orders.						
b	Schedule changes are difficult to make						
c	It is a point in time that is beyond the planning time fence.						Answer
d	It is within the lead time of a part						
2	How many elements of lead time are there?						
a	4						
b	7						
c	5						Answer
d	6						
3	Utilization is?						
a	Available hours divided by actual hours worked						
b	Hours each day divided by 24						
c	Hours each week divided by 40						
d	Hours actually worked divided by available hours						Answer
4	A Planned Order?						
a	This is an order that has been released into work.						
b	This is an order that is created by the MRP software to satisfy demand.						Answer
c	This is an order that cannot be changed once created.						
d	This order is not under the control of MRP.						
5	CRP is?						
a	The most detailed capacity check.						Answer
b	The least detailed capacity check.						
c	Customer Relationship Planning						
d	Customer Requirements Planning						

# Section 12



# What is Inventory?

- Raw Material
- Work-in-Process
- Finished Products
- MRO



# Customer Service

- A commitment / a mission
- A performance measure
- A task

# Customer Service & Safety Stock



# Stock-out

*A product is not available when and where a customer needs it.*

*Caused by:*

- *Demand exceeds available inventory*
- *Production & Supplier problems*

# Stock-out

- Customer waits for product to become available
- Back-order is created for the customer
- Customer goes elsewhere and seller loses sale
- Seller loses customer and all future sales

# Stock-out Cost

- Creating a backorder
- Lost sale, Loss of all future sales
- Expediting
- Added manufacturing
- Added purchasing

# Carrying Costs vs. Ordering Costs

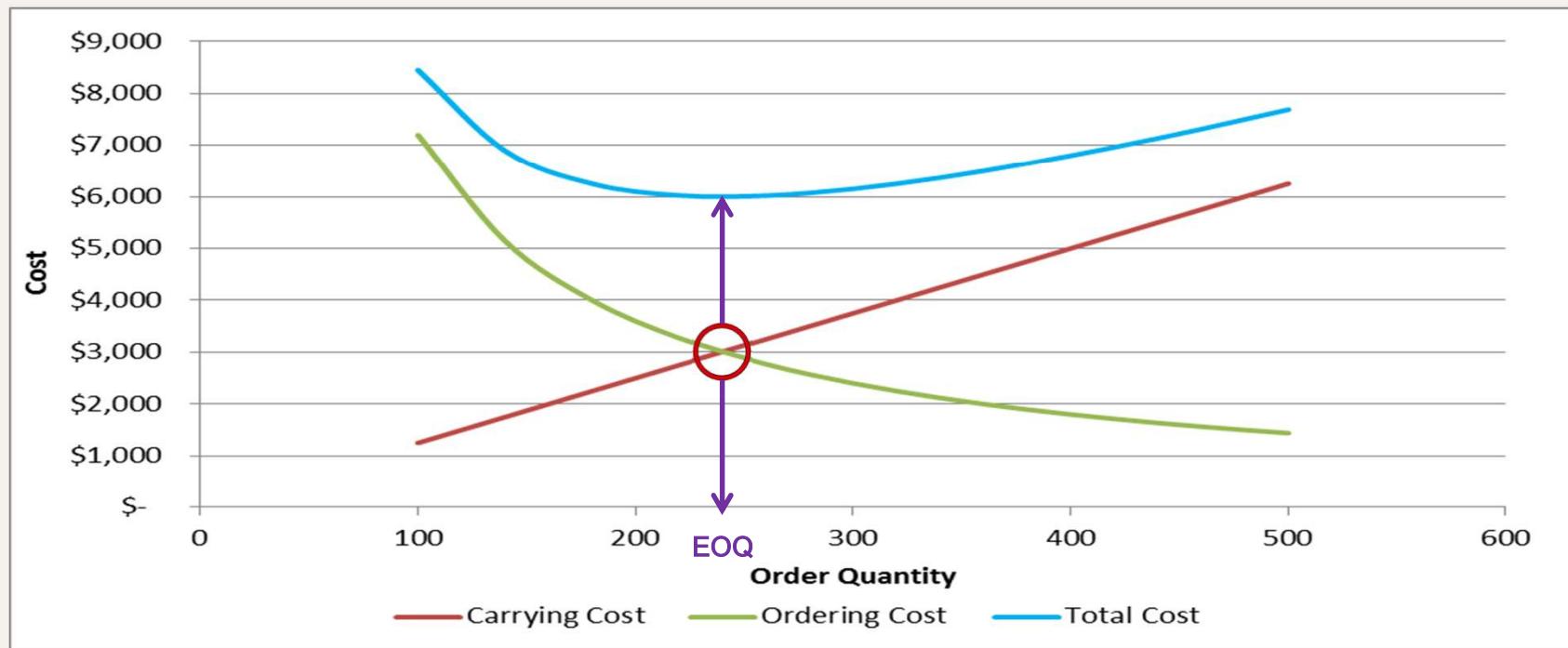
## Carrying Costs:

- Capital Costs
- Storage Costs
- Risk Costs

## Ordering Costs:

- Factory Orders
- Purchase Orders

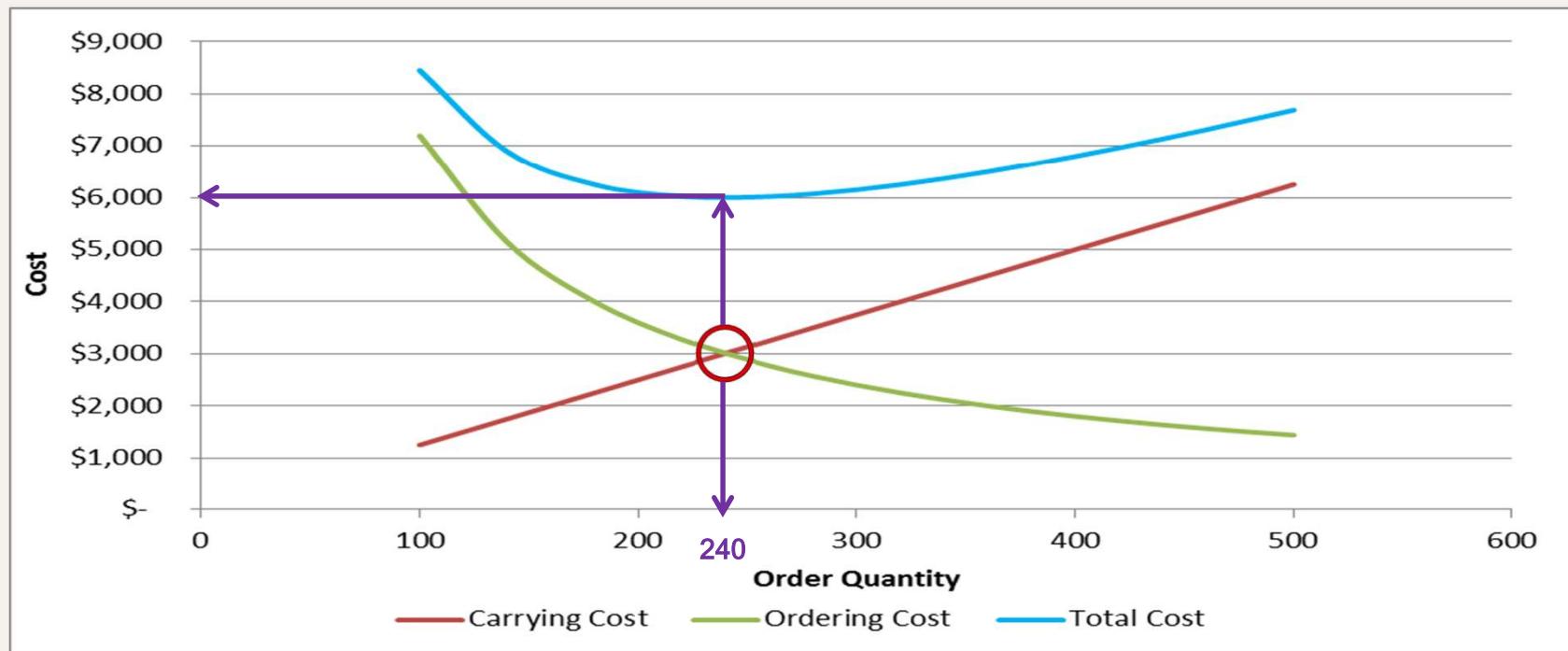
# Carrying Costs vs. Ordering Costs



# What is EOQ?

*Economic Order Quantity is a lot sizing rule used to calculate how much material to order.*

# Carrying Costs vs. Ordering Costs



# Inventory Management

Raw Material

+

Value (labor & overhead)

=

Sale of Finished Component & Receipt of Cash

=

Pay Workers, Vendors & Expenses

# Level of Inventory

Provides Stability

Global Markets

Raw Material

Finished Goods

Due to Uncertainty

Minimize Impact

# Inventory Management

1. Vendor Managed Inventory (VMI)
2. Consignment Inventory
3. ABC Analysis

# ABC Analysis

Class	Percent of Items	Percent of Impact
A	20	80
B	30	15
C	50	5

# ABC Analysis

A

B

C

D

E

F

G

Item Number	Sales (\$)
1	\$ 15,289.00
2	\$ 158,427.00
3	\$ 644.00
4	\$ 8,893.00
5	\$ 48,149.00
6	\$ 4,589.00
7	\$ 29,962.00
8	\$ 221,873.00
9	\$ 1,362.00
10	\$ 19,112.00
Total	\$ 508,300.00

Item Number	Sales (\$)
8	\$ 221,873.00
2	\$ 158,427.00
5	\$ 48,149.00
7	\$ 29,962.00
10	\$ 19,112.00
1	\$ 15,289.00
4	\$ 8,893.00
6	\$ 4,589.00
9	\$ 1,362.00
3	\$ 644.00
Total	\$ 508,300.00

Cum. Sales	Cumulative %
\$ 221,873.00	44% <small>221873 508300</small>
\$ 380,300.00	75% <small>380300 508300</small>
\$ 428,449.00	84% <small>428449 508300</small>
\$ 458,411.00	90% <small>458411 508300</small>
\$ 477,523.00	94%
\$ 492,812.00	97%
\$ 501,705.00	99%
\$ 506,294.00	100%
\$ 507,656.00	100%
\$ 508,300.00	100%

Classification
A
A
B
B
B
C
C
C
C
C

# Quiz

1	Which is not part of Capacity Planning?						Answer
a	Workload Check						
b	Resource Planning						
c	CRP						
d	RCCP						
2	Which is part of the MPC Execution stage?						Answer
a	Strategic Planning						
b	S&OP						
c	PAC						
d	MRP						
3	Which is not part of Priority Planning?						Answer
a	S&OP						
b	MRP						
c	PAC						
d	MPS						
4	What is a disadvantage of the Level Production strategy?						Answer
a	May increase scrap.						
b	May result in lower production costs.						
c	May require an external source.						
d	May result in an inventory buildup.						
5	The Frozen zone is also referred to as?						Answer
a	Cold Zone						
b	Ice Zone						
c	Cool Zone						
d	None of the above						

# Section 13



# What is Sustainability?

*Meeting the needs of today without  
compromising the needs of tomorrow.*

# Sustainability

Water Conservation

Climate Change CO<sub>2</sub> Emissions

Waste Reduction

Environment

Recycling

Renewable Energy

Greenhouse Gases

Going Green

Energy Conservation

# Sustainability - 4R's

- Re-Use
- Re-Manufacture
- Re-Conditioning
- Re-Cycling

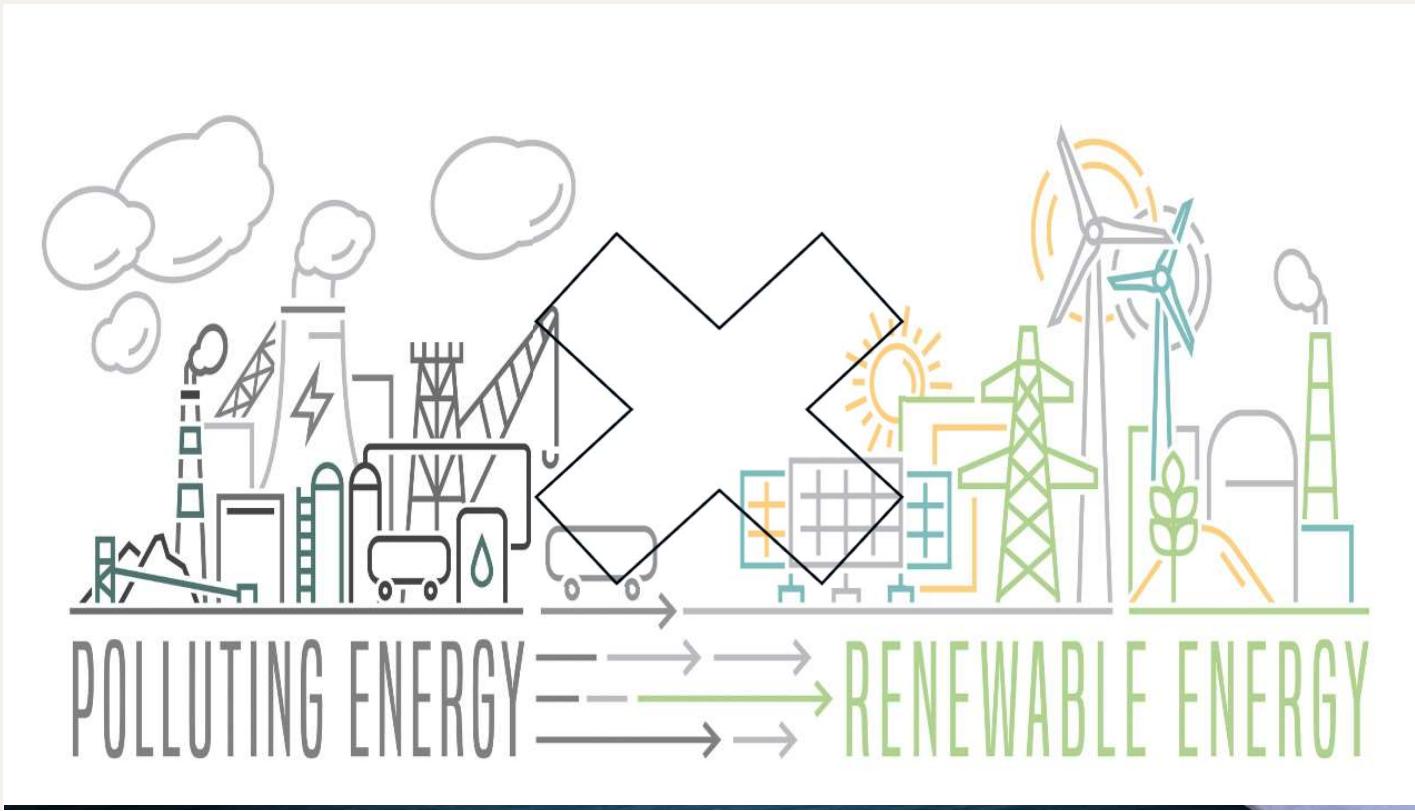
# Supply Chain Sustainability



# Sustainability & Innovation

*Sustainability drives innovation and to  
think out-of-the-box.*

# Sustainability & Innovation



# Green Parking



# Key Card

Fig. 1

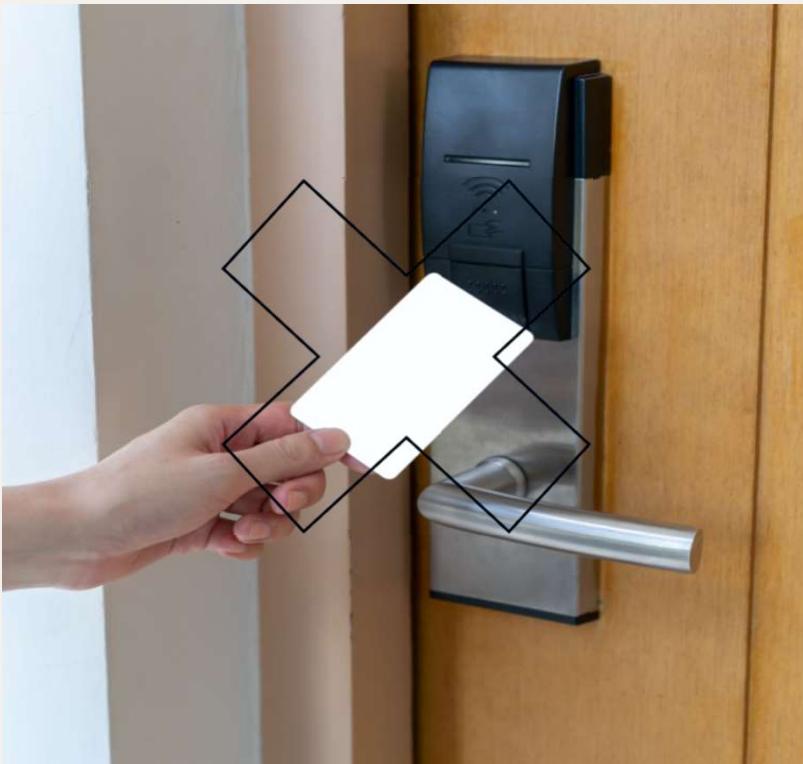


Fig. 2



# Sustainability - Hotel



# Sustainability KPI

*A measure of the environmental, social  
and financial performance.*

# Triple Bottom Line



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# Quiz

1	Which is not a form of inventory management?				
a	VMI				
b	ABC analysis				
c	Efficiency				
d	Consignment				Answer
2	Ordering costs do not include?				
a	Scheduling				
b	Cost of receiving the product				
c	Issuing a purchase order				
d	Utilities				Answer
3	Which is not an inventory carrying cost?				
a	Obsolescence				
b	Capital Cost				
c	Pilferage				
d	Ordering				Answer
4	Which of the following is not considered inventory?				
a	WIP				
b	P.O.				Answer
c	Raw material				
d	Consumables				
5	Which does not belong with regards to Safety Stock?				
a	Reduces customer satisfaction				
b	Buffer stock				
c	Prevents stock-outs				
d	Extra product				Answer

# Section 14

# Exam Prep Comments



# Exam #1 - Vocabulary

1	Which of the following is an objective of purchasing?				
	a To ensure goods are always purchased at the lowest price				
	b To keep many sources of supply available to ensure competitive pricing				
	c To control budgetary expenditures of all employees through sound P.O. control				
	d To obtain goods and services of the required quality and right cost			Answer	
2	Which of the following statements is true?				
	a Value starts with the customer				
	b Cost buildup and storage add value to a product				
	c Cost and value are interchangeable			Answer	
	d Lean manufacturing means always having product ready for the customer				
3	If the order quantity is increased, which of the following occurs?				
	a The cost of carrying inventory decreases and the cost of ordering increases				
	b The cost of carrying inventory increases and the cost of ordering increases				
	c The cost of carrying inventory decreases and the cost of ordering decreases			Answer	
	d The cost of carrying inventory increases and the cost of ordering decreases				
4	Which of the following costs is relevant to inventory management decisions?				
	a marketing costs				
	b run costs				
	c new product development costs			Answer	
	d storage costs				
5	What is the name of materials used in the production process that do not become part of the product?				
	a finished goods				
	b maintenance, repair and operating supplies			Answer	
	c raw materials				
	d WIP				
6	Which of the following statements is most accurate?				
	a Work centers feeding a bottleneck should work at full capacity				
	b A time buffer should be established after a bottleneck				
	c A bottleneck will control the throughput of all product processed by it				Answer
	d Work centers located after a bottleneck should work at full capacity				
7	Which term indicates the percentage of time the work center is active compared to the available time?				
	a uptime				
	b utilization				Answer
	c efficiency				
	d effectiveness				
8	Which statement is correct?				
	a Gross requirements come from the planned order receipt of the parent				
	b Scheduled receipts show when goods were put into inventory				
	c When an order is released it becomes a planned order				
	d Planned order receipts show when the order is needed				Answer
9	Which of the following is a major input to an MRP system?				
	a the production plan				
	b the capacity plan				
	c the sales plan				
	d the MPS				Answer
10	Which of the following statements is most accurate about the MPS?				
	a It is an agreed upon plan between finance and manufacturing				
	b If it is poorly done, you can expect past due schedules and unreliable delivery promises				Answer
	c It is a plan for families of products that manufacturing expects to make over some period in the future				
	d It provides input to the production plan				

# Exam #1 - Vocabulary

11	Under which of the following circumstances will firms generally make-to-stock? a Required delivery times are shorter than the time needed to make the product b Demand is unpredictable c Many product options exist d Customers require special engineering	Answer
12	For the purposes of production planning, product families should be established on the basis of a The availability of machinery b Similarity of manufacturing process c The availability of materials d Market segments	Answer
13	Why is it important to monitor the forecast? a To satisfy marketing's need to know b To compare the actual sales with the forecast c To improve our forecasting methods d To utilize actual sales data	Answer
14	Which of the following statements is true about the product layout or the continuous process? a There is little buildup of WIP inventory b Workflow is lumpy c A wide variety of different products can be produced d Workstations are located according to the type of machinery	Answer
15	Which of the following are primary activities of MPC? a sales support, implementation and control b inventory management and cost reduction c production planning and inventory management d sales support and cost reduction	Answer

# Exam #2 - Vocabulary

1	Which of the following is an advantage of work cells? a Reduced worker skills required b Maximum machine utilization c Reduced material movement d Larger batches and lower unit costs				6	Which of the following is concerned with very short-term detailed planning of the flow of orders through manufacturing? a PAC b MRP c production planning d master production scheduling		
2	Which of the following statements is true regarding Pareto analysis? a It separates the significant few from the trivial many b It assigns weighted costs associated with internal versus external failure costs c It is an extension of the 50/50 rule of quality d It uses the six categories of quality		Answer		7	Which of the following shows the capacity required at each work center based on planned and released orders for each time period of the plan? a work center profile b scheduled order profile c load profile d none of the above		
3	Safety stock will depend on which of the following? a variability of demand b cost of placing an order c product obsolescence d cost of carrying inventory		Answer		8	Which of the following statements is true? a The same part on different BOM's will have different numbers b The same part number can be used to identify similar products c A part has one and only one part number d An item can be either a parent or a component, but not both		
4	What is the name given to inventories of items that are purchased or manufactured in quantities greater than needed immediately? a transportation inventory b fluctuation inventory c lot-size inventory d scheduled receipts		Answer		9	Which of the following is an objective of MRP? a Keep priorities current b Minimize inventory investment c Determine the forecast d Keep the factory busy		
5	Which of the following statements is most accurate about inventory management? a Inventory does not cost much to carry b Inventory is not important at the production planning level c Inventories are usually insignificant on the balance sheet d Inventories and production must be managed together		Answer		10	Which of the following is an objective of an MPS? a Minimize inventory investment b Maintain the desired level of customer service c Maximize utilization of equipment d Support the sales department		

# Exam #2 - Vocabulary

11	If the opening inventory is 100 units, sales are 500 units and the ending inventory is 200 units, what will manufacturing produce?						
a	300 units						
b	400 units						
c	500 units						
d	600 units						Answer
12	Which of the following statements is most accurate?						
a	Forecasts are almost always accurate						
b	A forecast for sales next year will not be as accurate as a forecast for a year from now						
c	Forecasts for families of products should be built up from individual product forecasts						
d	Independent demand items should be forecast						Answer
13	What assumption is made about quantitative forecasting methods?						
a	Random variations are small						
b	The past is a valid indicator of the future						Answer
c	Demand trend is seldom linear						
d	Seasonal variations are small						
14	Which of the following manufacturing environments or manufacturing strategies produces the longest delivery lead-time?						
a	Continuous manufacturing						
b	MTO						Answer
c	ATO						
d	MTS						
15	Which of the following is used to determine the feasibility of the material requirements plan?						
a	resource requirements planning						
b	rough cut capacity planning						
c	capacity requirements planning						Answer
d	work center capacity control						

# Exam #3 – Developing a Level Production Plan

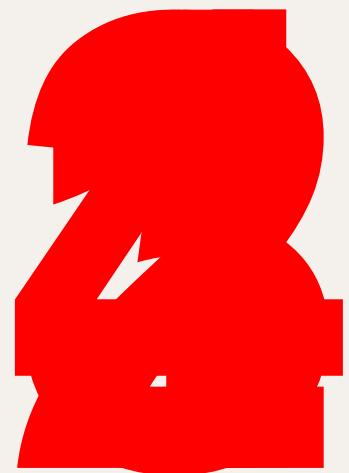
Period	1	2	3	4	5	Total
Forecast Demand	55	60	65	60	60	300
Production	58	58	58	58	58	290
Ending Inventory	50	51	44	42	40	

Opening Inventory Period 1 =	50	units
Ending Inventory Period 5 =	40	units

PAUSE

Calculate the following and enter in the chart:

Total Demand =	300	units	Production for Each Period =	58	units
Total Production Needed =	290	units	Ending Inventory for Period 3 =	44	units



# Exam #4 – Calculate PAB, ATP, MPS

Period	1	2	3	4	5
Forecast	10	22	20	24	28
Customer Orders	5	26	15	6	30
PAB	15	10	14	29	35
ATP	10	4	15	24	0
MPS Receipt	0	30	30	30	30

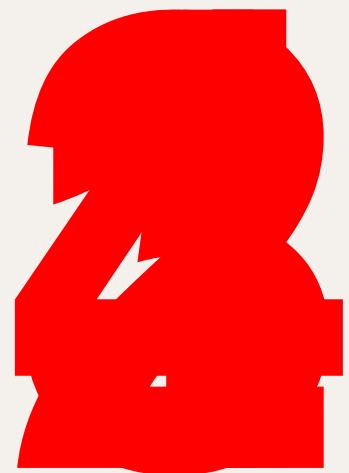
Lot Size = 30 pcs.

Stock On Hand = 15 pcs.

Safety Stock = 6 pcs.

Demand Time Fence = 3 periods

PAUSE



# CONGRATULATIONS



# CELEBRATE YOUR ACCOMPLISHMENTS

# Next Steps...

Choose your next course:

- Supply Chain: Understanding the Basics
- Supply Chain: Planning of Resources & Detailed Scheduling
- Supply Chain: Control of Operations & Managing Resources

# Course Creator Acknowledgements:

- Teachings from ASCM – Association for Supply Chain Management, formerly APICS - The Association for Supply Chain and Operations Management.
- Teachings from Supply Chain Management by Coyle, Langley, Novack, Gibson.