Resource Planning

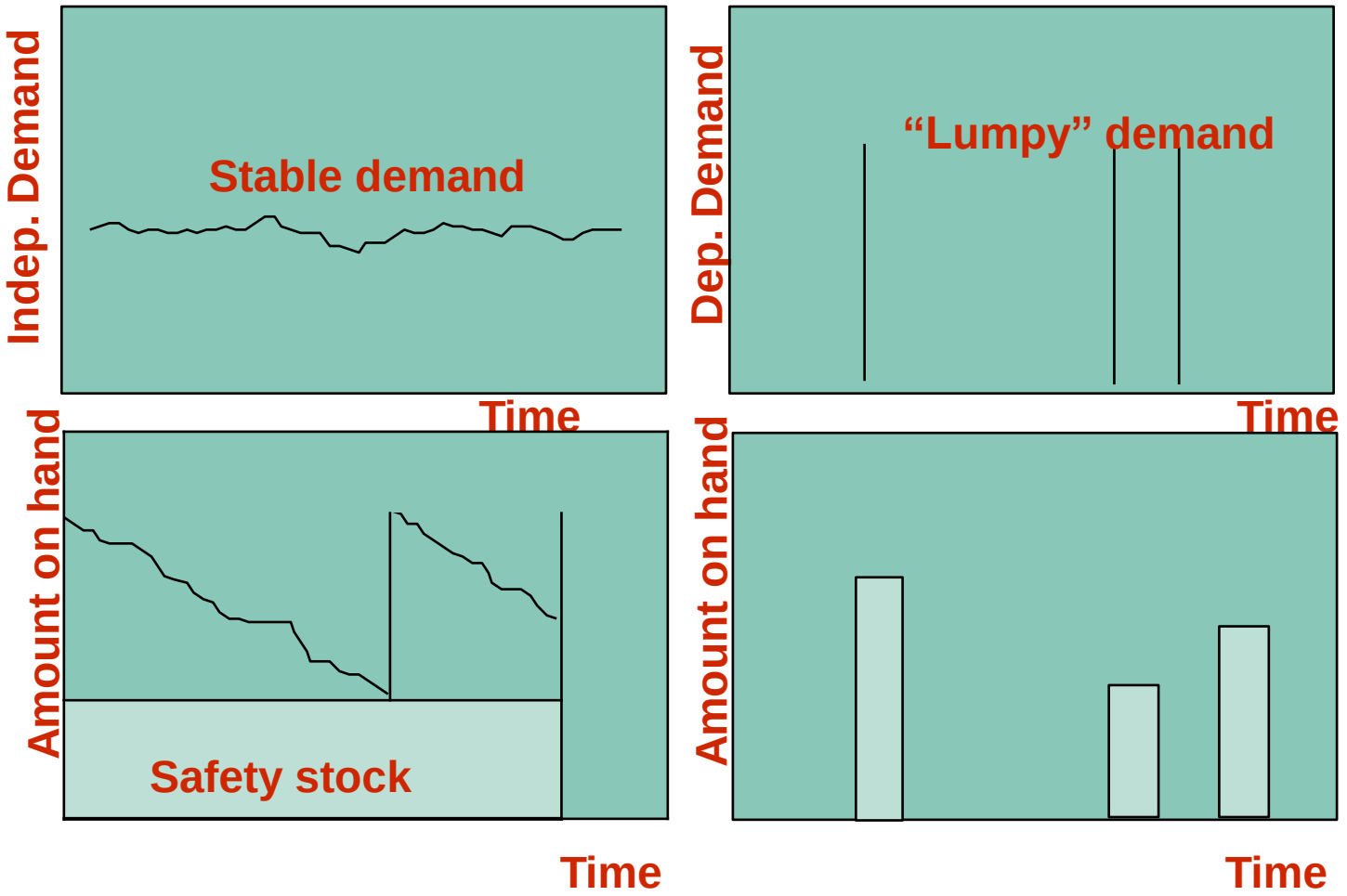
MRP (Material Requirement Planning)

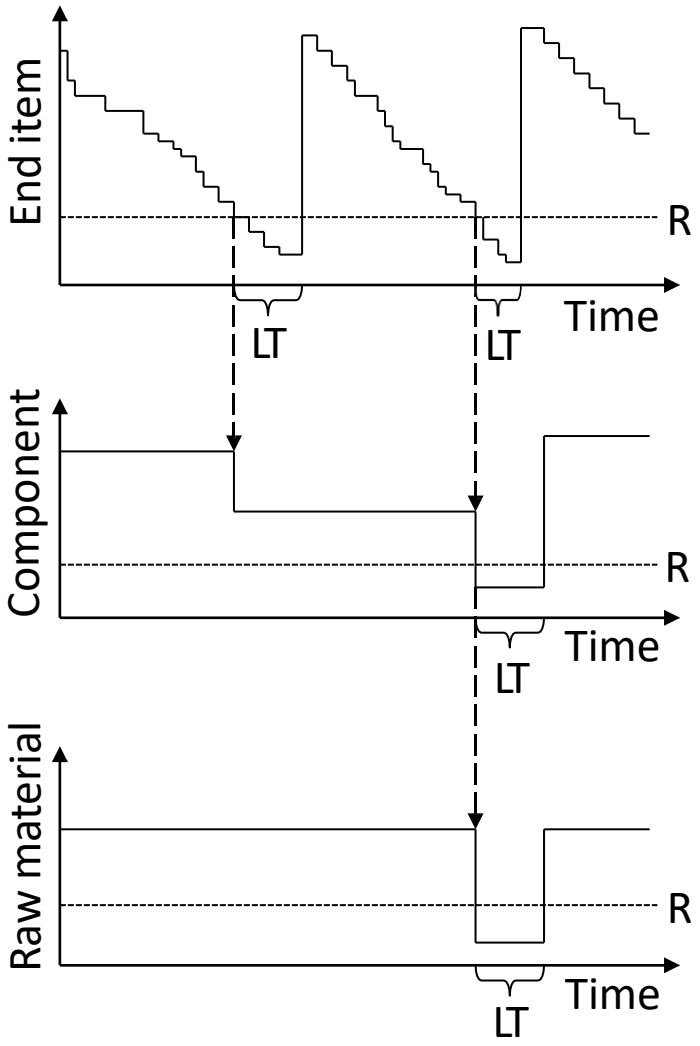
- Dependent demand
- Discrete demand
- Complex product
- Assemble to order
- Erratic orders

Dependant Demand

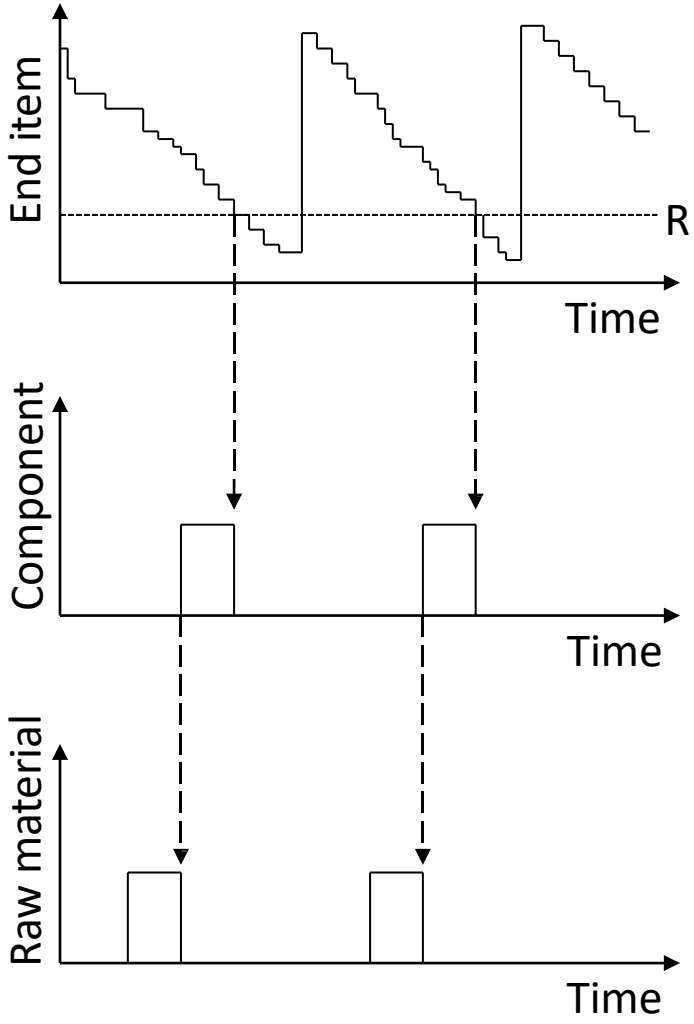
Dependent demand: Demand for items that are subassemblies or component parts to be used in production of finished goods.

For any product for which a schedule can be established, dependent demand techniques should be used.





Order point system with dependent demand



The MRP approach

Dependant Demand

- The demand for one item is related to the demand for another item
- Given a quantity for the end item, the demand for all parts and components can be calculated.
- In general, used whenever a schedule can be established for an item
- MRP is the common technique

MRP

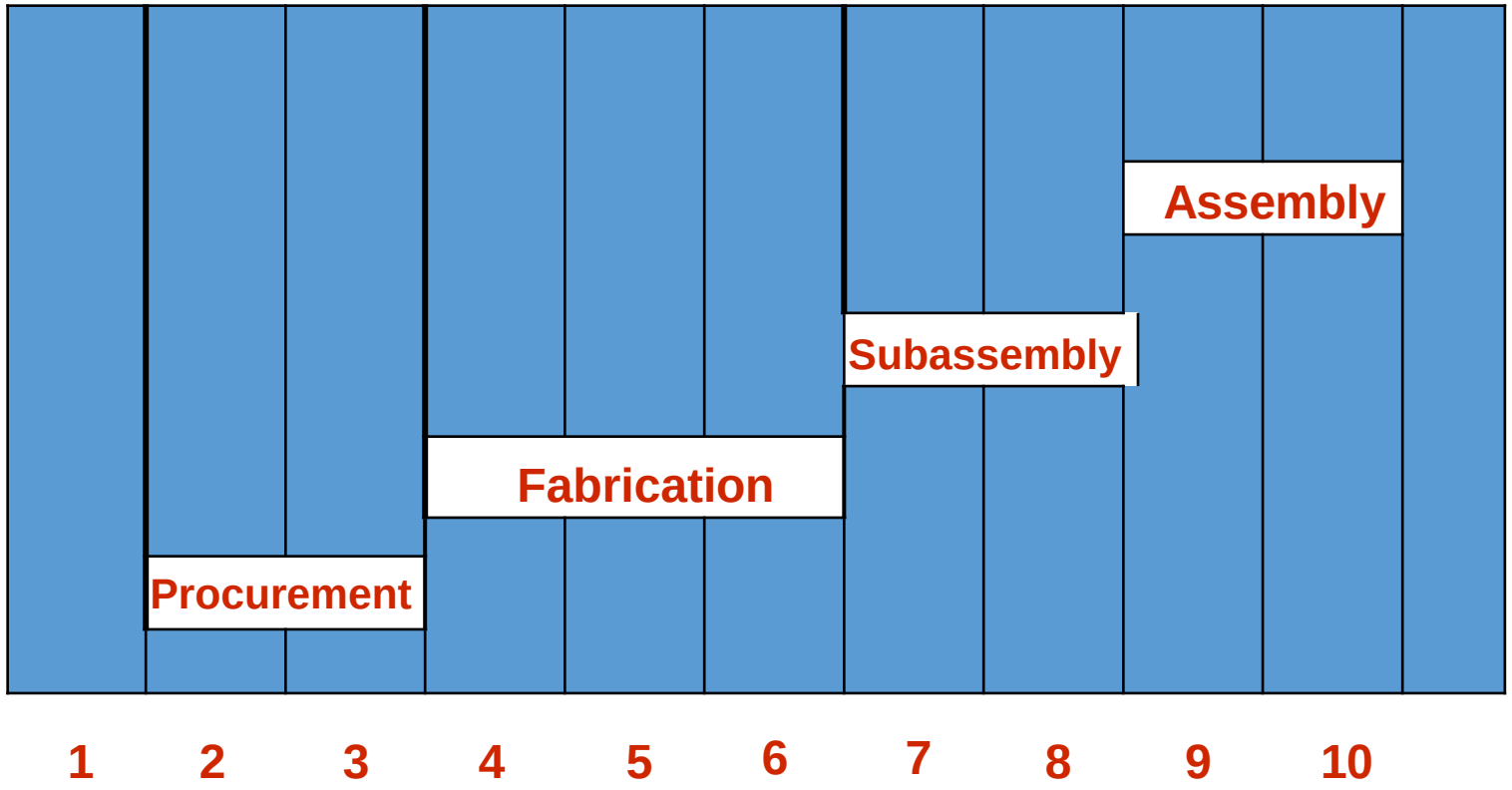
- *Material requirements planning (MRP):* Computer-based information system for ordering and scheduling of *dependent demand* inventories.

- It is a production planning process that starts from the demand for finished products (independent demand) and plans the production step by step of subassemblies and parts (dependent demand).
- The quantities represent production not demand
- The quantities represent what needs to be produced, not what can be produced.
- Sink with demand and production.

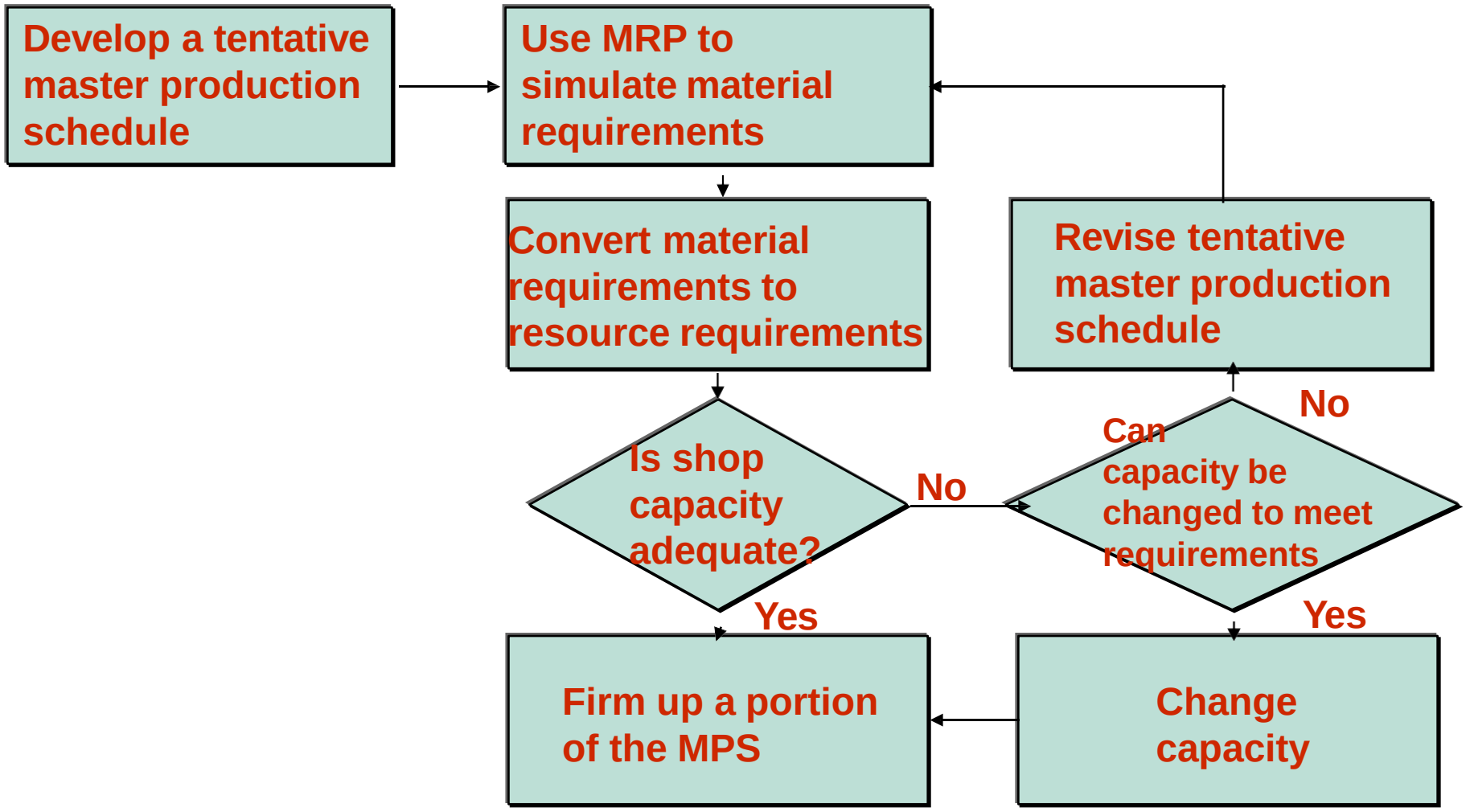
Product structure file

- Once MPS set, the MRP system accesses the PSF to compute component wise need to be scheduled.
- PDS contains BOM for every product.
- Phantom Bills: These are used for transient subassemblies that never see in a stockroom. Typically zero lead time.
- K-bills: kit BoM –a group of items such as fasteners, nuts, bolts etc.
- Modular bills
- Time-phased bills

Planning Horizon and Cumulative Lead Time



MRP Planning



MRP Inputs (1. MPS)

- Master Production Schedule: MPS
- Time-phased plan specifying timing and quantity of production for each end item.
- MPS comes from sales and marketing
- MPS covers about 1-3 months into the future
  - Must cover cumulative lead time

Cumulative lead time: The sum of the lead times that sequential phases of a process require, from ordering of parts or raw materials to completion of final assembly.

- Sometimes MPS is capacity filtered

MRP inputs (2. BOM)

Bill of materials (BOM): A listing of all of the raw materials, parts, subassemblies, and assemblies needed to produce one unit of a product.

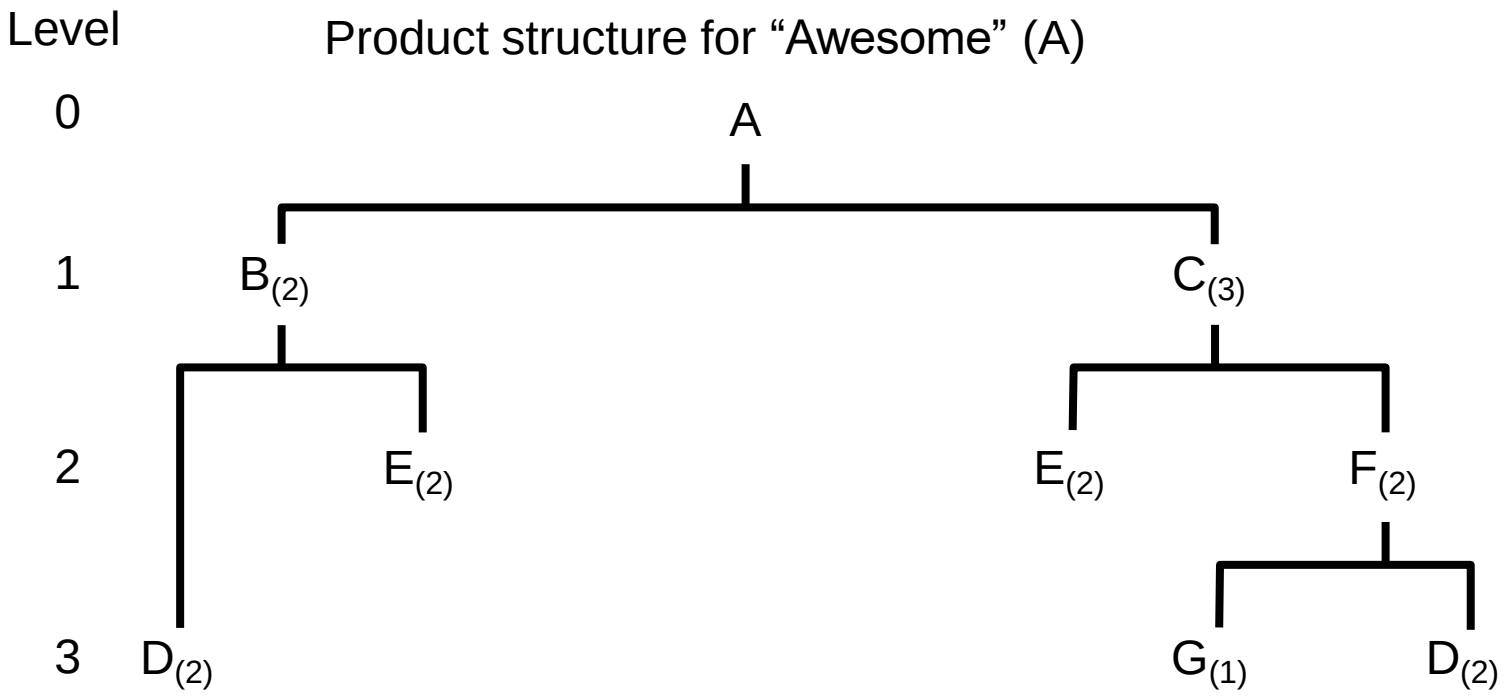
Product structure tree: Visual depiction of the requirements in a bill of materials, where all components are listed by levels.

Most often people do not use the term product structure tree. Instead use BOM to mean the product structure tree.

MRP input (3.Inventory levels)

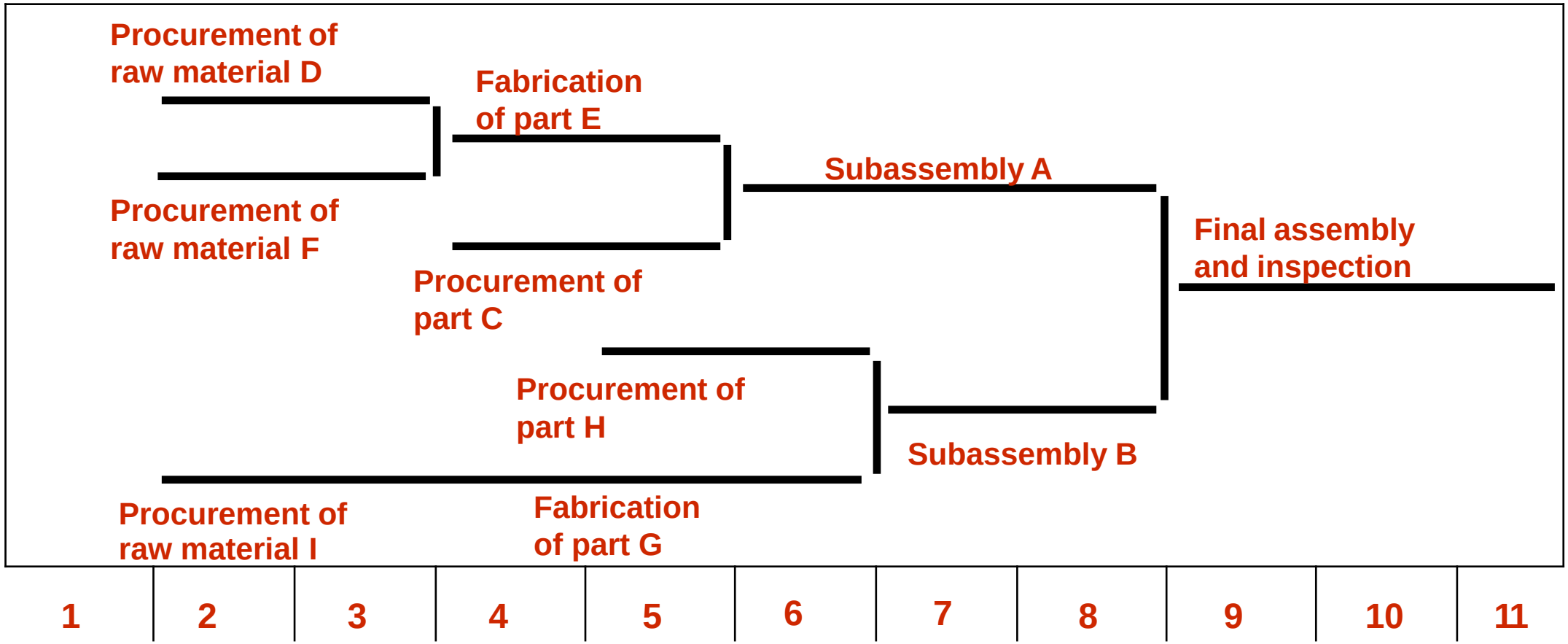
- Beginning inventory on hand
- Scheduled receipts
  - Pipeline inventory not received yet but it is in the process of coming to the inventory. We know when this will be available for use.

Product Structure Tree



Source: Heizer and Render, Operations Management, Eleventh Edition

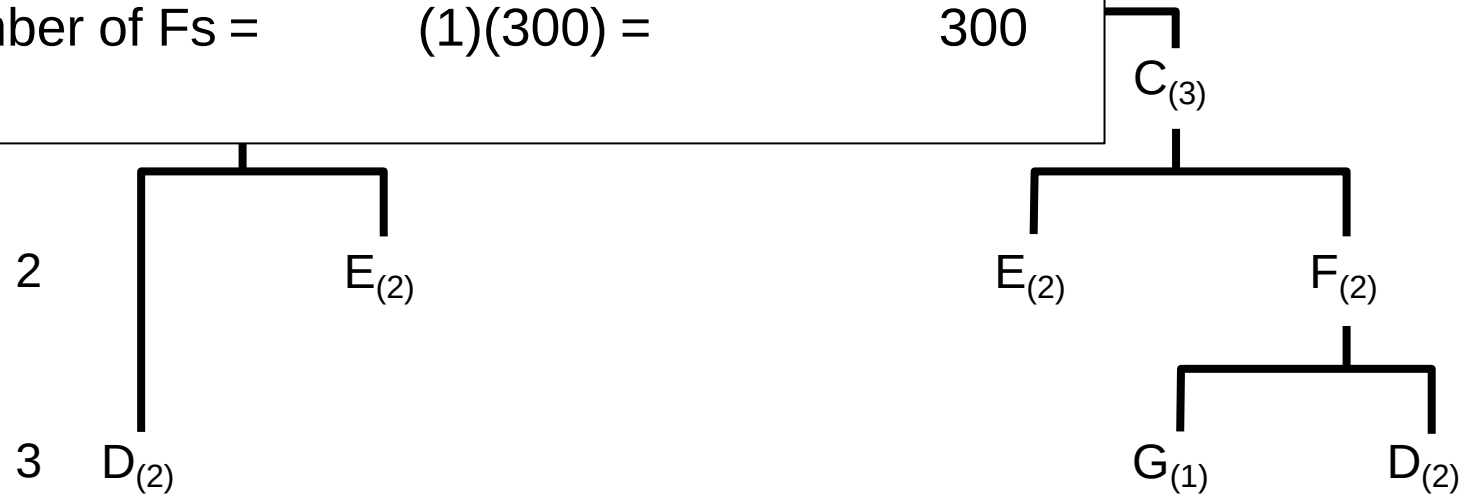
Assembly Time Chart



BOM Example

For an order of 50 Awesome speaker kits

Part B:	2 x number of As =	(2)(50) =	100
Part C:	3 x number of As =	(3)(50) =	150
Part D:	2 x number of Bs		
	+ 2 x number of Fs =	(2)(100) + (2)(300) =	800
Part E:	2 x number of Bs		
	+ 2 x number of Cs =	(2)(100) + (2)(150) =	500
Part F:	2 x number of Cs =	(2)(150) =	300
Part G:	1 x number of Fs =	(1)(300) =	300



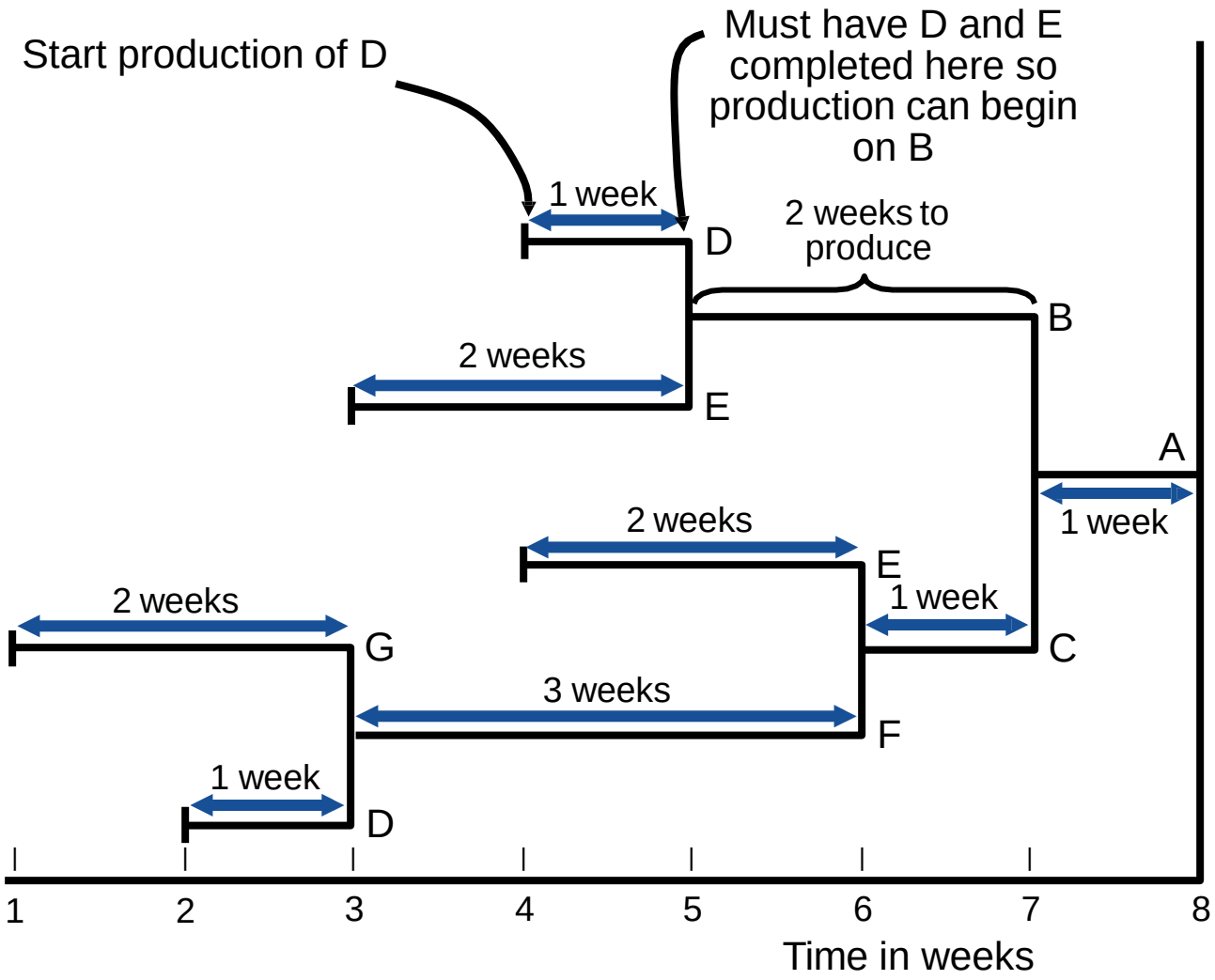
Lead Times for Components

- The time required to purchase, produce, or assemble an item
  - For production – the sum of the *move*, *setup*, and *assembly* or *run times*
  - For purchased items – the time between the recognition of a need and when its available for production.

Lead Times for Awesome Speaker Kits (As)

COMPONENT	LEAD TIME
A	1 week
B	2 weeks
C	1 week
D	1 week
E	2 week
F	3 weeks
G	2 weeks

Time-Phased Product Structure



Source: Heizer and Render, Operations Management, Eleventh Edition

Determining Gross Requirements

- Starts with a production schedule for the end item – 50 units of Item A in week 8
- Using the lead time for the item, determine the week in which the order should be released – a 1 week lead time means the order for 50 units should be released in week 7.
- This step is often called “lead time offset” or “time phasing”

Determining Gross Requirements

- From the BOM, every Item A requires 2 Item Bs – 100 Item Bs are required in week 7 to satisfy the order release for Item A
- The lead time for the Item B is 2 weeks – release an order for 100 units of Item B in week 5
- The timing and quantity for component requirements are determined by the order release of the parent(s)

Determining Gross Requirements

- The process continues through the entire BOM one level at a time – often called “explosion”
- By processing the BOM by level, items with multiple parents are only processed once, saving time and resources and reducing confusion
- Low-level coding ensures that each item appears at only one level in the BOM

Gross Requirements Plan (GRP)

GRP Plan for 50 Awesome Speaker Kits (As) with Order Release Dates Also Shown									
	WEEK								LEAD TIME
	1	2	3	4	5	6	7	8	
A. Required date								50	
Order release date							50		1 week
B. Required date							100		
Order release date					100				2 weeks
C. Required date							150		
Order release date						150			1 week
E. Required date					200	300			
Order release date			200	300					2 weeks
F. Required date						300			
Order release date			300						3 weeks
D. Required date			600		200				
Order release date		600		200					1 week
G. Required date			300						
Order release date	300								2 weeks

Determining Net Requirements

- Starts with a production schedule for the end item – 50 units of Item A in week 8

- Because there are 10 Item As on hand, only 40 are actually required –

  (net requirement) = (gross requirement – on-hand inventory)

- The planned order receipt for Item A in week 8 is 40 units = 40 = 50 – 10

Determining Net Requirements

- Following the lead time offset procedure, the planned order release for Item A is now 40 units in week 7
- The gross requirement for Item B is now 80 units in week 7
- There are 15 units of Item B on hand, so the net requirement is 65 (80-15) units in week 7
- A planned order receipt of 65 units in week 7 generates a planned order release of 65 units in week 5 (2 wk LT).

Determining Net Requirements

- A planned order receipt of 65 units in week 7 generates a planned order release of 65 units in week 5. (2 wk LT)
- The on-hand inventory record for Item B is updated to reflect the use of the 15 items in inventory and shows no on-hand inventory in week 8.
- This is referred to as the Gross-to-Net calculation and is the third basic function of the MRP process

Net Requirements Plan

ITEM	ON HAND	ITEM	ON HAND
A	10	E	10
B	15	F	5
C	20	G	0
D	10		

Lot Size	Lead Time (weeks)	On Hand	Safety Stock	Allo-cated	Low-Level Code	Item Identi-fication		Week 1	2	3	4	5	6	7	8
Lot-for-Lot	1	10	—	—	0	A	Gross Requirements								50
							Scheduled Receipts								
							Projected On Hand 10	10	10	10	10	10	10	10	10
							Net Requirements								40
							Planned Order Receipts								40
							Planned Order Releases							40	
Lot-for-Lot	2	15	—	—	1	B	Gross Requirements							80[A]	
							Scheduled Receipts								
							Projected On Hand 15	15	15	15	15	15	15	15	
							Net Requirements							65	
							Planned Order Receipts							65	
							Planned Order Releases					65			
Lot-for-Lot	1	20	—	—	1	C	Gross Requirements							120[A]	
							Scheduled Receipts								
							Projected On Hand 20	20	20	20	20	20	20	20	
							Net Requirements							100	
							Planned Order Receipts							100	
							Planned Order Releases						100		

Net Requirements Plan

Lot-for-Lot	2	10	—	—	2	E	Gross Requirements						130^{B}	200^{C}		
							Scheduled Receipts									
							Projected On Hand	10	10	10	10	10	10			
							Net Requirements						120	200		
							Planned Order Receipts						120	200		
							Planned Order Releases				120	200				
Lot-for-Lot	3	5	—	—	2	F	Gross Requirements							200^{C}		
							Scheduled Receipts									
							Projected On Hand	5	5	5	5	5	5	5		
							Net Requirements							195		
							Planned Order Receipts							195		
							Planned Order Releases				195					
Lot-for-Lot	1	10	—	—	3	D	Gross Requirements				390^{F}		130^{B}			
							Scheduled Receipts									
							Projected On Hand	10	10	10	10					
							Net Requirements				380		130			
							Planned Order Receipts				380		130			
							Planned Order Releases			380		130				
Lot-for-Lot	2	0	—	—	3	G	Gross Requirements				195^{F}					
							Scheduled Receipts									
							Projected On Hand				0					
							Net Requirements				195					
							Planned Order Receipts				195					
							Planned Order Releases		195							

Safety Stock

- BOMs, inventory records, purchase and production quantities may not be perfect
- Consideration of safety stock may be prudent
- Should be minimized and ultimately eliminated
- Typically built into projected on-hand inventory

MRP limitation

- MRP does not do detailed scheduling–it plans
- Works best in product-focused, repetitive environments
- Requires fixed lead time and infinite size time **buckets**

Warehouse location exercise

An e-commerce company wants to locate a warehouse from which it will ship products to four demand points. The location (in the x-y plane) of the four demand points and annual shipment needed by each demand point is given in Table. The company needed an optimized warehouse location to optimize total distance travelled from central warehouse to demand points.

Demand Point	X-coordinate	Y-coordinate	Annual shipment cost
1	5	10	200
2	10	5	150
3	0	12	200
4	12	0	300

Using load distance method of facility.

- The load-distance method is **a mathematical model used to evaluate locations based on proximity factors**.
- The objective is to select a location that minimizes the total weighted loads moving into and out of the facility.
- The distance between two points is expressed by assigning the points to grid coordinates on a map.

Three different way to compute the distance
Actual
Euclidean
Rectilinear

Steps in load distance method

- Find the product of load and the distance from each facililty centers/customer points.
- Find the sum of the product for each perspective locations.
- Select the smallest value of the sum as the most suitable location.

Decision variables

X=x-coordinate of the warehouse

Y=y-coordinate of the warehouse

Objective function

Min load1*sqrt((x1-x)^2+(y1-y)^2)+**load2*sqrt((x2-x)^2+(y2-y)^2)**+load1*sqrt((x3-x)^2+(y3-y)^2)+ load4*sqrt((x4-x)^2+(y4-y)^2)

Company's warehouse to Distributors warehouse transport problem

- Objective: The optimal quantity of cement that should be delivered from company's each warehouse to different distributor's warehouse in order to minimise the transport cost.

Company Warehouse	Distributor Warehouse
Vizag	Raipur
Vijaywada	Bhubaneshwar
Hydrabad	Vizag
	Vijayawada
	Guntur
	Rajahmundry
	Karimnagar

Average shipping cost of per packet

	Vizag	Vijaywada	Hydrabad
Vizag	15	160	100
Vijaywada	160	12	260
Raipur	154	315	56
Bhubnewar	245	410	190
Guntur	130	290	58
Rajahmundri	125	427	204
Karimnagar	215	375	160

- Storage capacity of company warehouse

Vizag>>> 6000

Vijayawada>>> 4000

Hyderabad>>> 5000

Demand at distributors warehouses

- **Vizag 1200**
- Vijayawada 1600
- Raipur 1800
- Bhubaneswar 2100
- Guntur 1300
- Rajahmundry 2900
- Karimnagar 1700