

# **Material Requirements Planning (MRP)**

# Outline

## **DEPENDENT INVENTORY MODEL REQUIREMENTS**

**Master Production Schedule**

**Bills of Materials**

**Accurate Inventory records**

**Purchase Orders Outstanding**

**Lead Times for Each Component**

## **MRP STRUCTURE**

# Collins Industries

- ◆ Largest manufacturer of ambulances in the world
- ◆ International competitor
- ◆ 12 major ambulance designs
  - ◆ 18,000 different inventory items
    - ◆ 6,000 manufactured parts
    - ◆ 12,000 purchased parts
  - ◆ MRP: IBM's MAPICS

# Collins Industries

- ◆ Collins requires:
  - ◆ Material plan must meet both the requirements of the master schedule and the capabilities of the production facility
  - ◆ Plan must be executed as designed
  - ◆ Effective “time-phased” deliveries, consignments, and constant review of purchase methods
  - ◆ Maintenance of record integrity

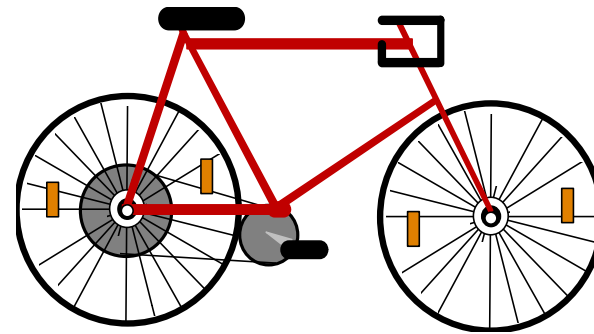
# Material Requirements Planning (MRP)

- ◆ Manufacturing computer information system
- ◆ Determines *quantity* & *timing* of dependent demand items

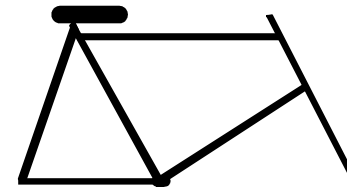
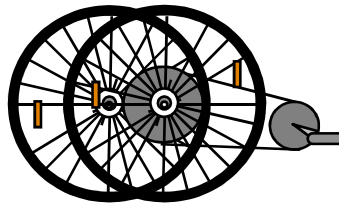


# MRP: Types of Items

- ◆ Independent demand items; complete product ready for use

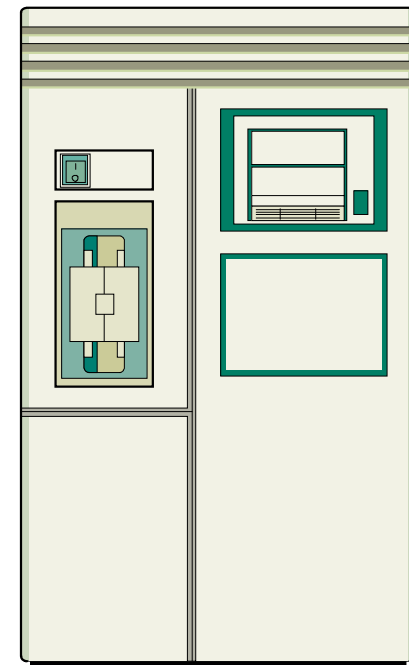


- ◆ Dependent demand items; sub-assemblies, components



# MRP Requirements

- ◆ Computer system
- ◆ Mainly discrete products
- ◆ Accurate bill-of-material
- ◆ Accurate inventory status
  - ◆ 99% inventory accuracy
- ◆ Stable lead times



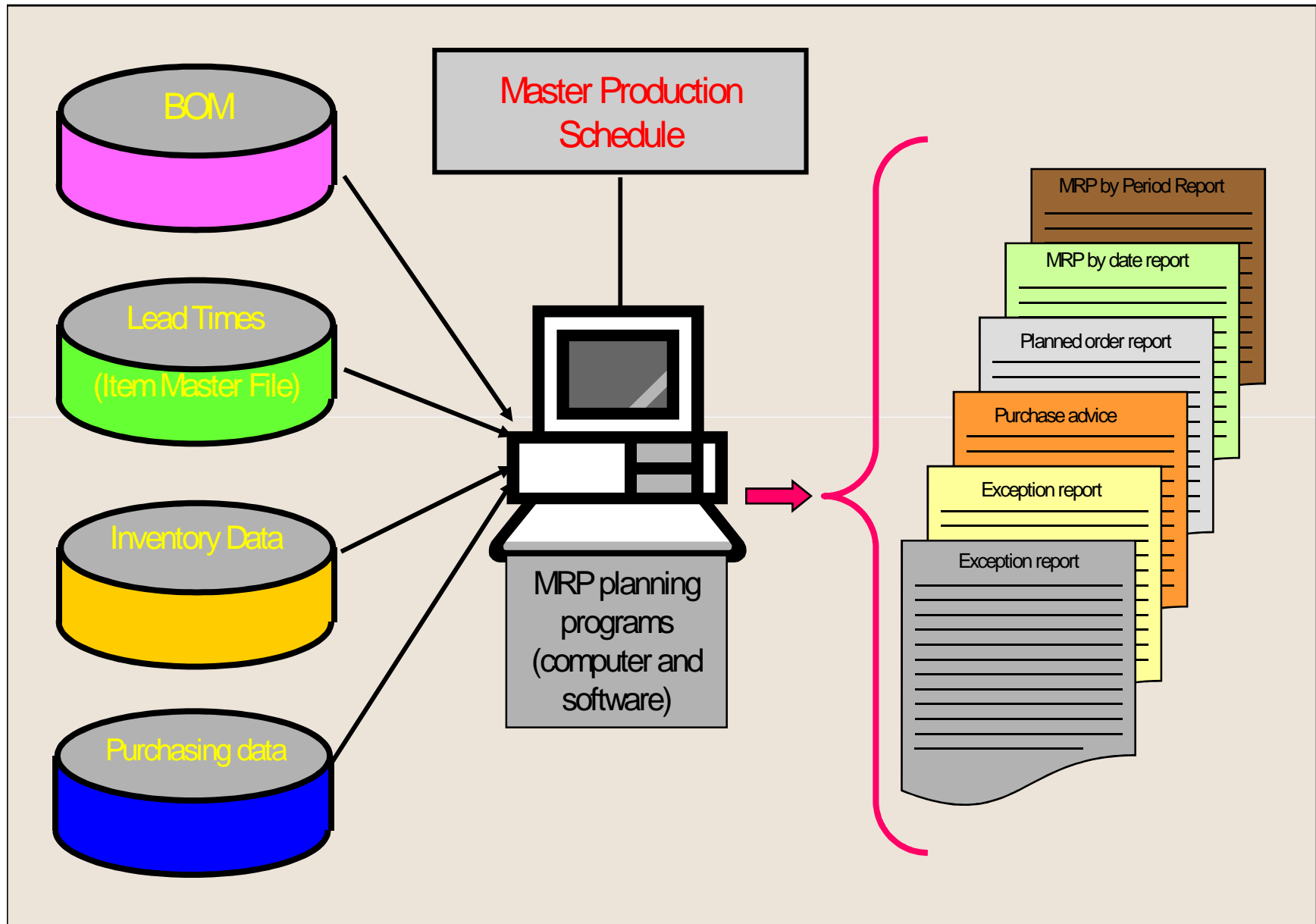
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# MRP Benefits

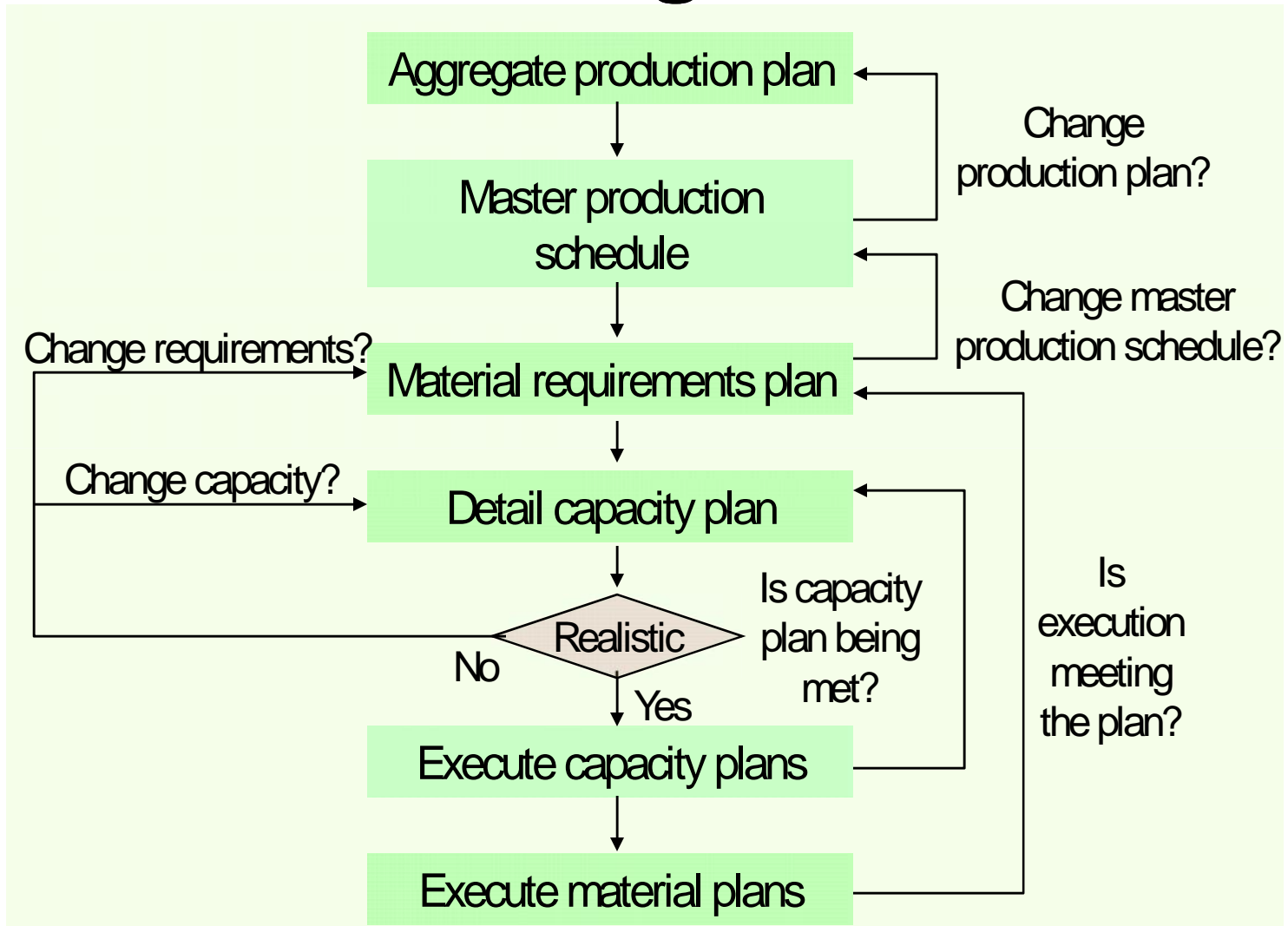
- ◆ Increased customer satisfaction due to meeting delivery schedules
- ◆ Faster response to market changes
- ◆ Improved labor & equipment utilization
- ◆ Better inventory planning & scheduling
- ◆ Reduced inventory levels without reduced customer service



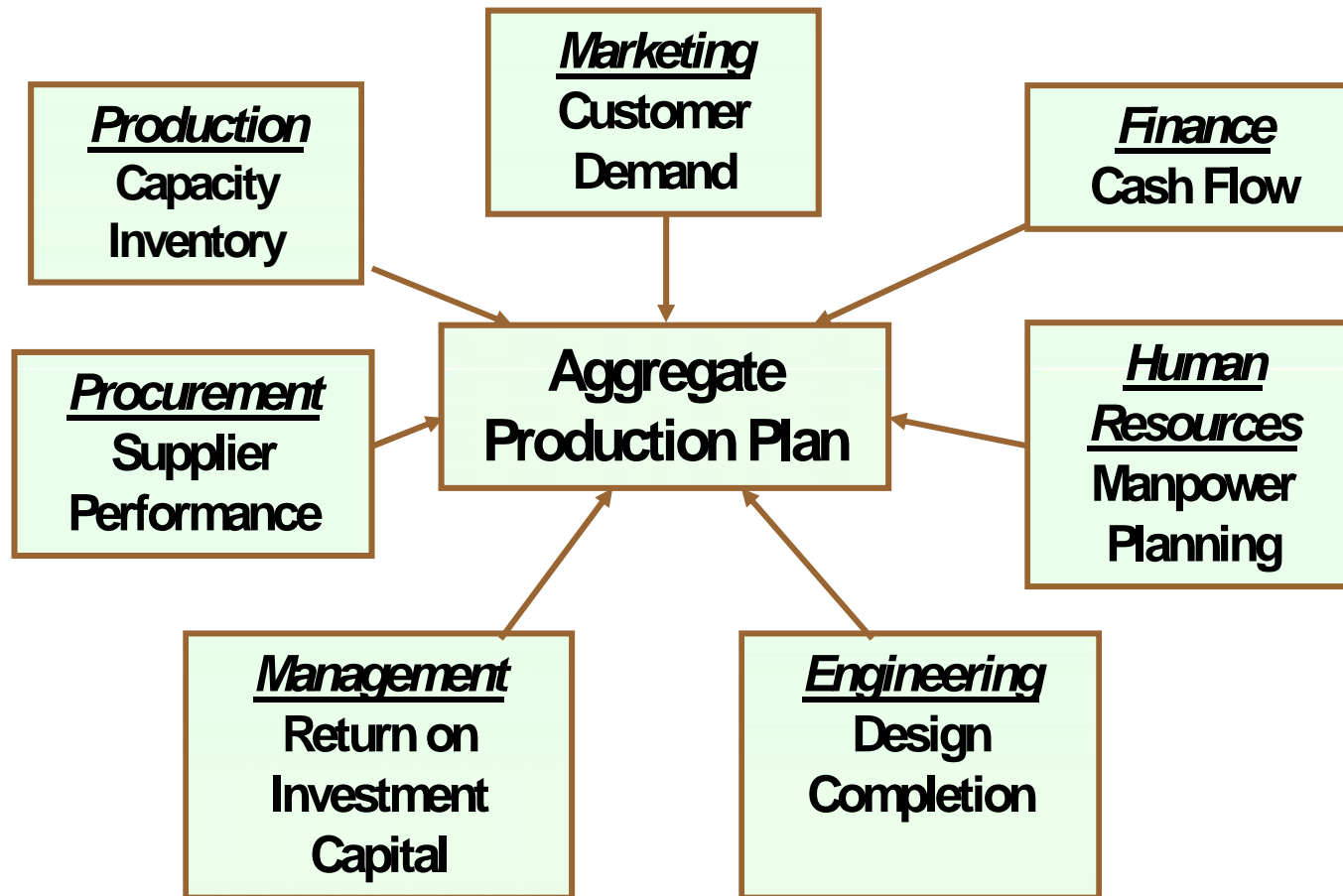
# Structure of the MRP System



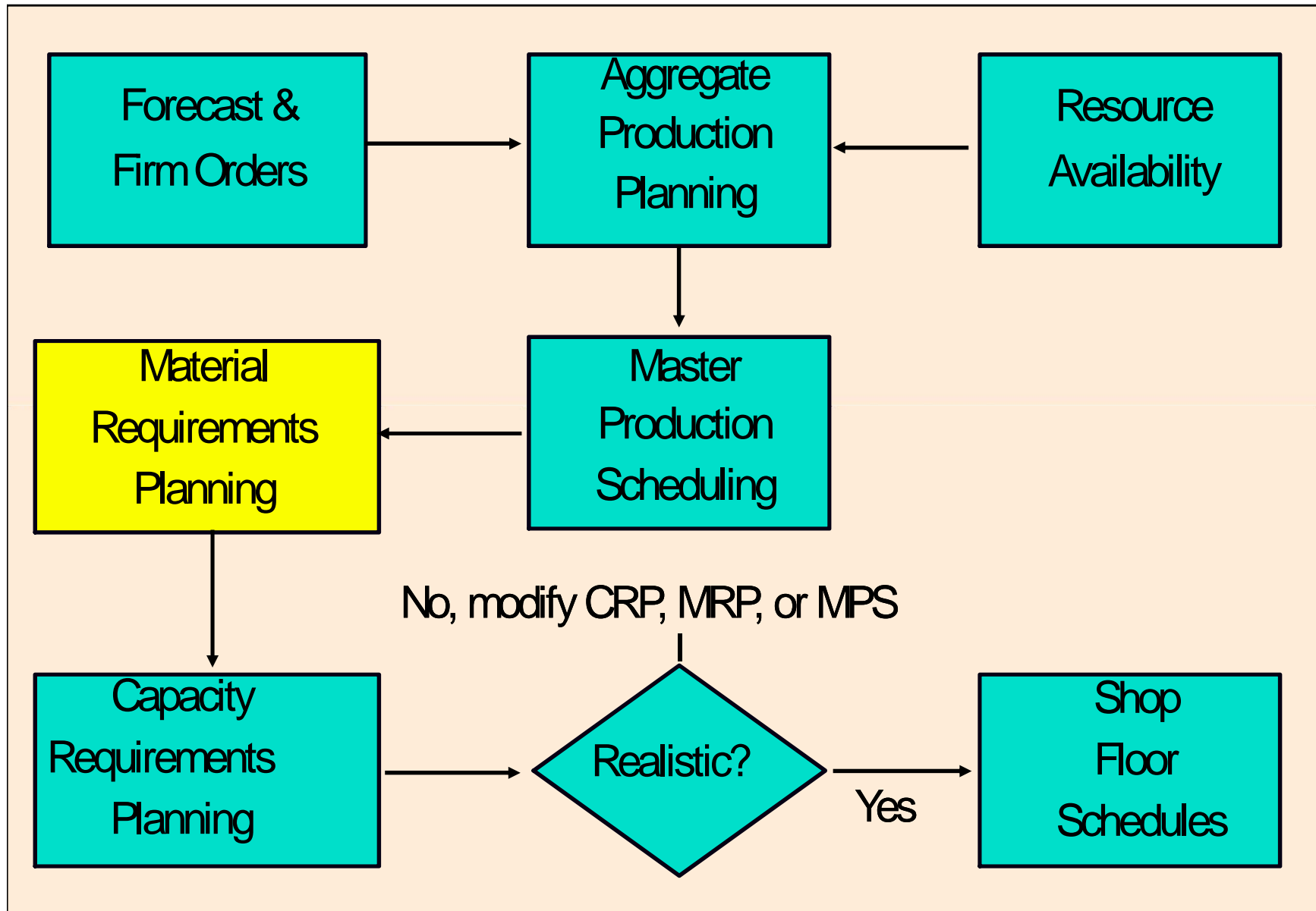
# The Planning Process



# Inputs to the Production Plan



# MRP and The Production Planning Process



# MRP INPUT DATA

MRP modeling requires that the operations manager know the:

master production schedule (MPS)

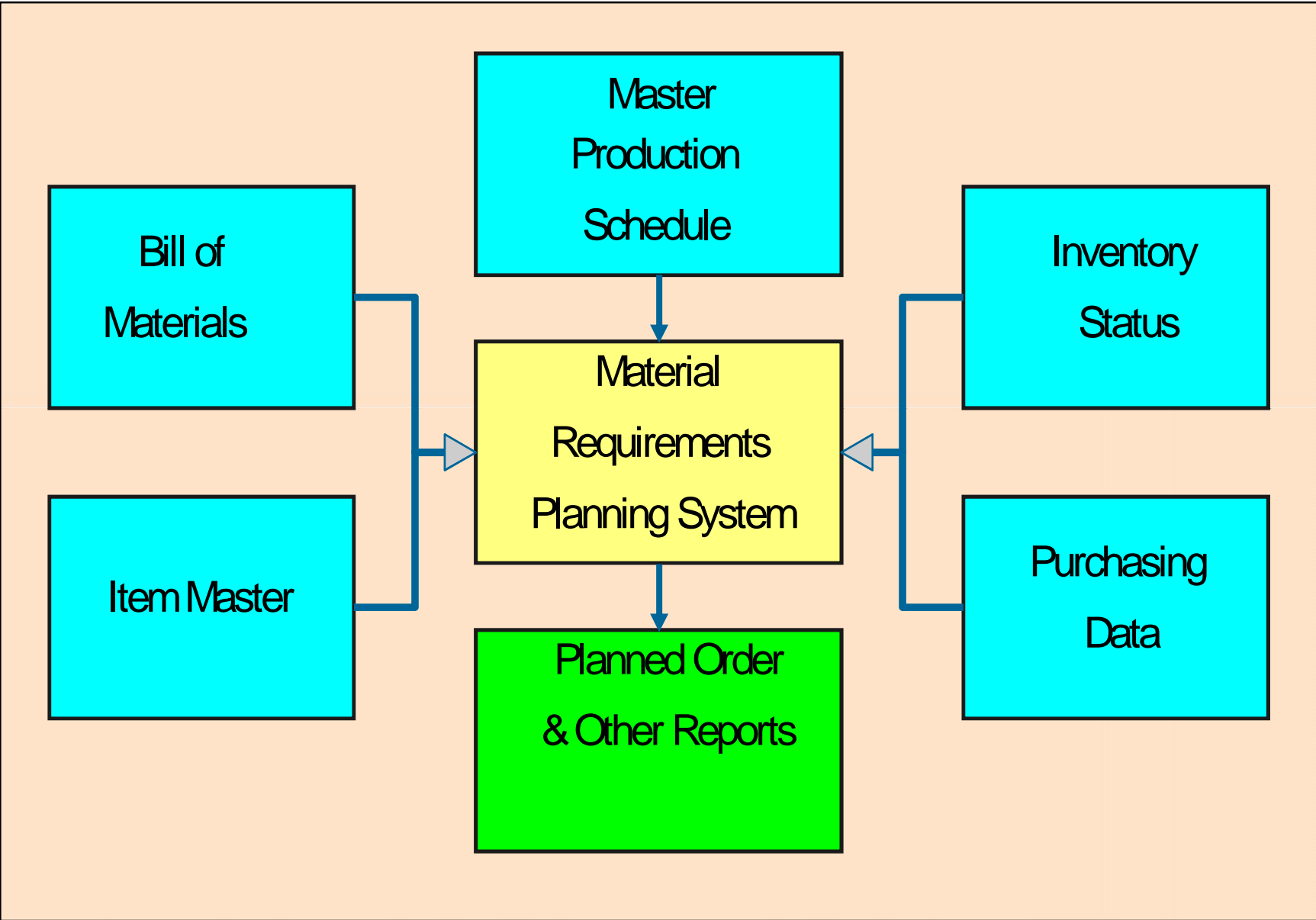
specifications or bills-of-material (BOM)

inventory availability

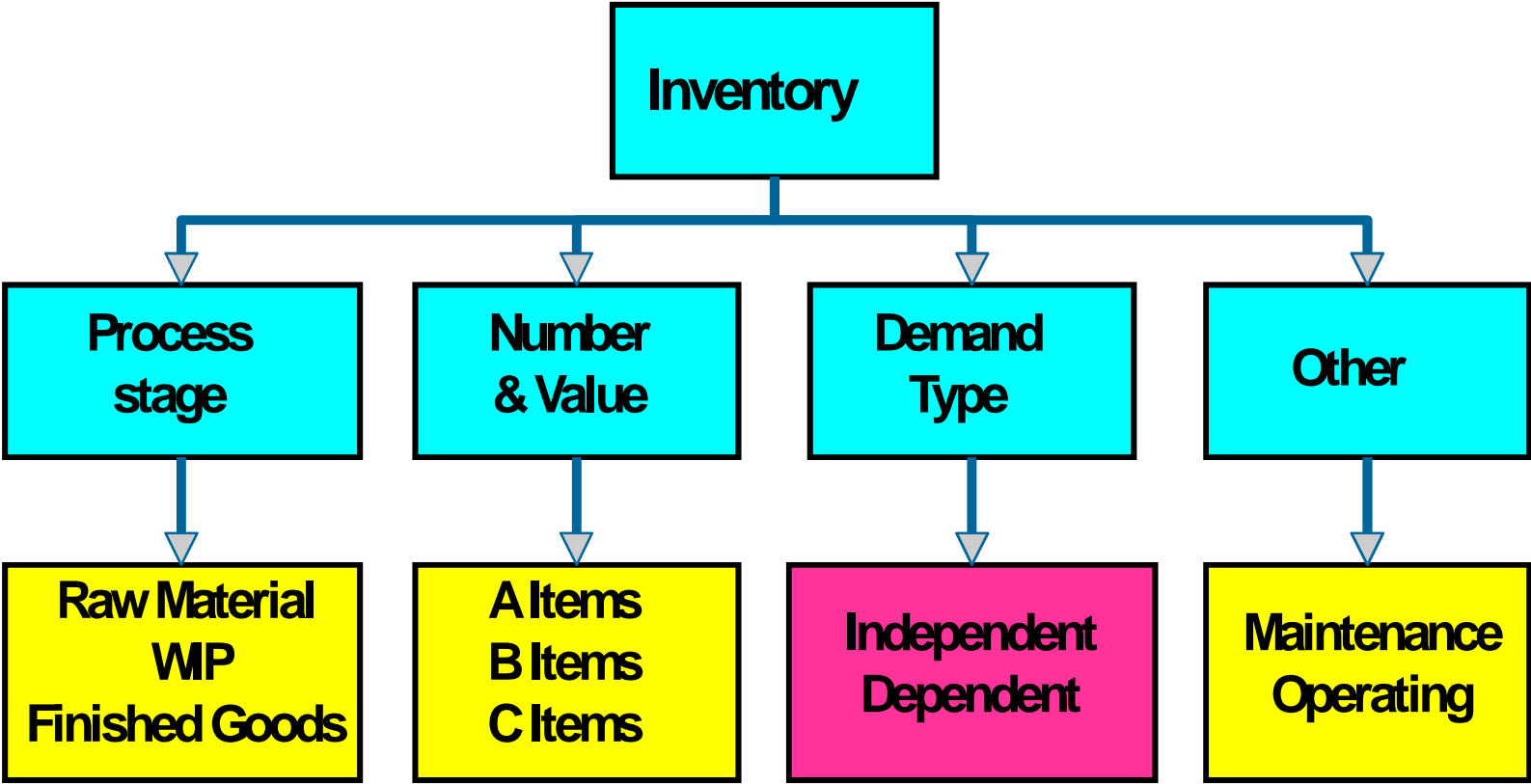
purchase orders outstanding

lead times

# MRP Systems - Input and Output



# Inventory Classifications



# WHY INVENTORIES ARE CENTRAL?

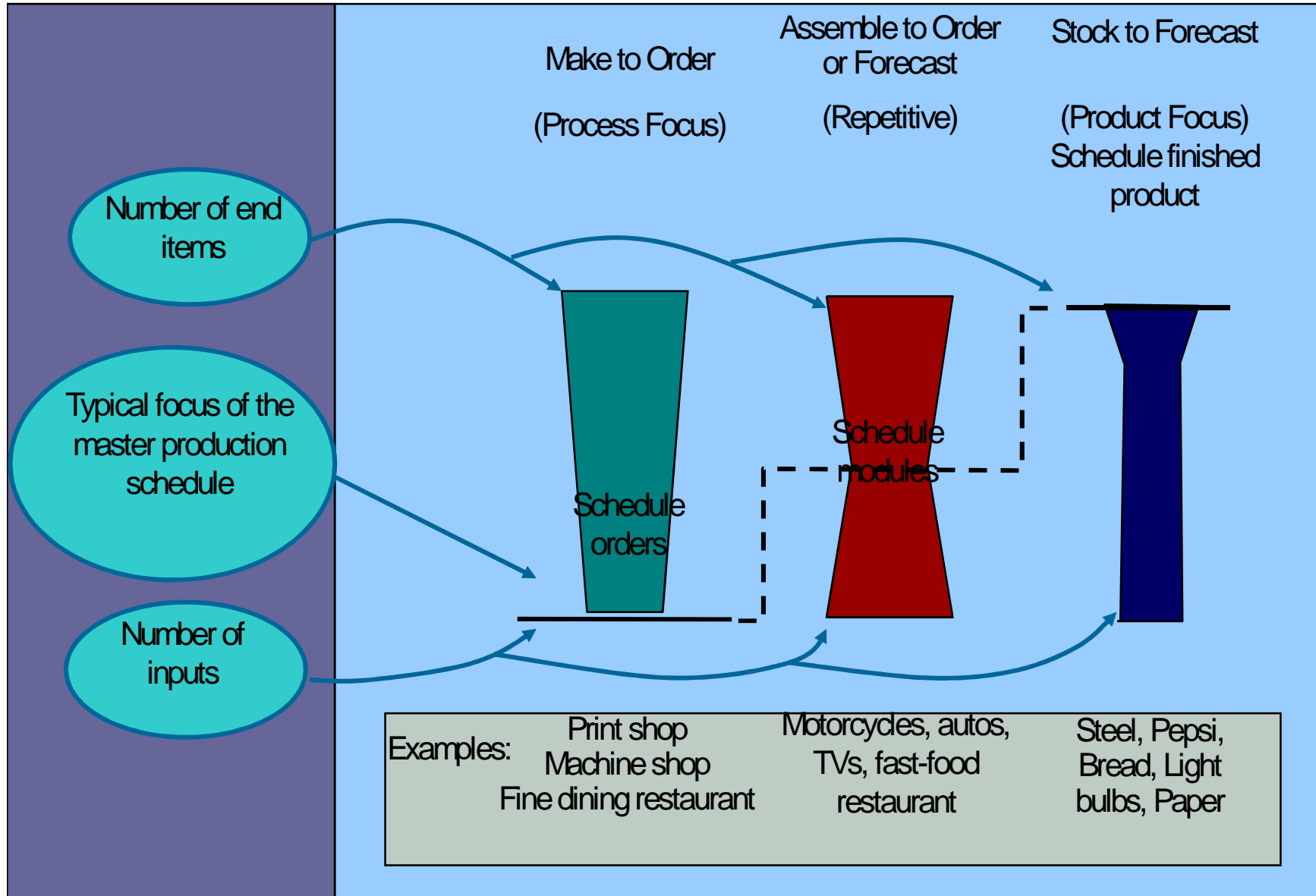
- ◆ Purpose of any production system is creation of *finished* product right on *time* at right *place* in right *quantity* at low *cost* with best *quality*
- ◆ *Inventories are finished products created earlier than their demand time*



# Dependent versus Independent Demand

<b>Item</b>	<b>Materials With Independent Demand</b>	<b>Materials With Dependent Demand</b>
<b>Demand Source</b>	<b>Company Customers</b>	<b>Parent Items</b>
<b>Material Type</b>	<b>Finished Goods</b>	<b>WIP &amp; Raw Materials</b>
<b>Method of Estimating Demand</b>	<b>Forecast &amp; Booked Customer Orders</b>	<b>Calculated</b>
<b>Planning Method</b>	<b>EOQ &amp; ROP</b>	<b>MRP</b>

# Typical Focus of the Master Production Schedule



## Aggregate Production Plan Leads to Master Production Schedule (MPS)

Months	January				February			
Aggregate Production Plan (shows the total quantity of amplifiers)	1,500				1,200			
Weeks	1	2	3	4	5	6	7	8
Master Production Schedule (Shows the specific type and quantity of amplifier to be produced)								
240 watt amplifier	100		100		100		100	
150 watt amplifier		500		500		450		450
75 watt amplifier			300				100	

# Master Production Schedule

- ◆ Shows items to be produced
  - ◆ End item, customer order, module
- ◆ Derived from aggregate plan

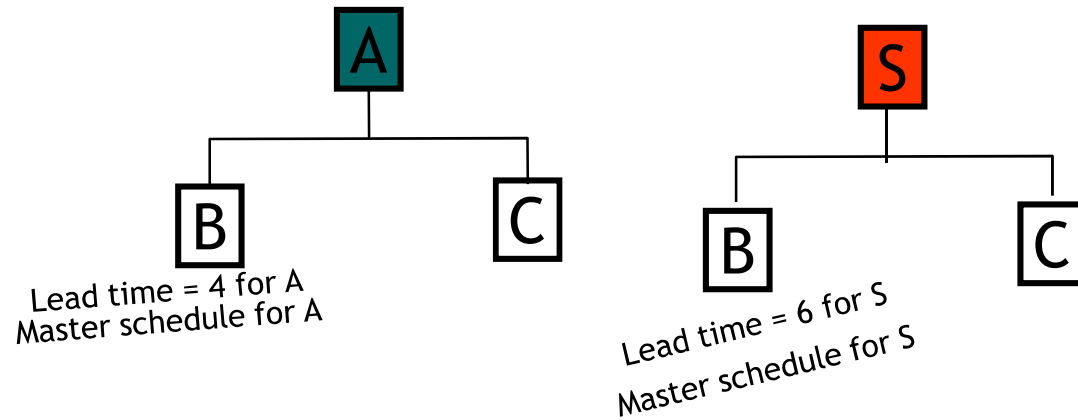
## Example

Item/Week	Oct 3	Oct 10	Oct 17	Oct 24
Drills	300	200	310	300
Saws	300	450	310	330

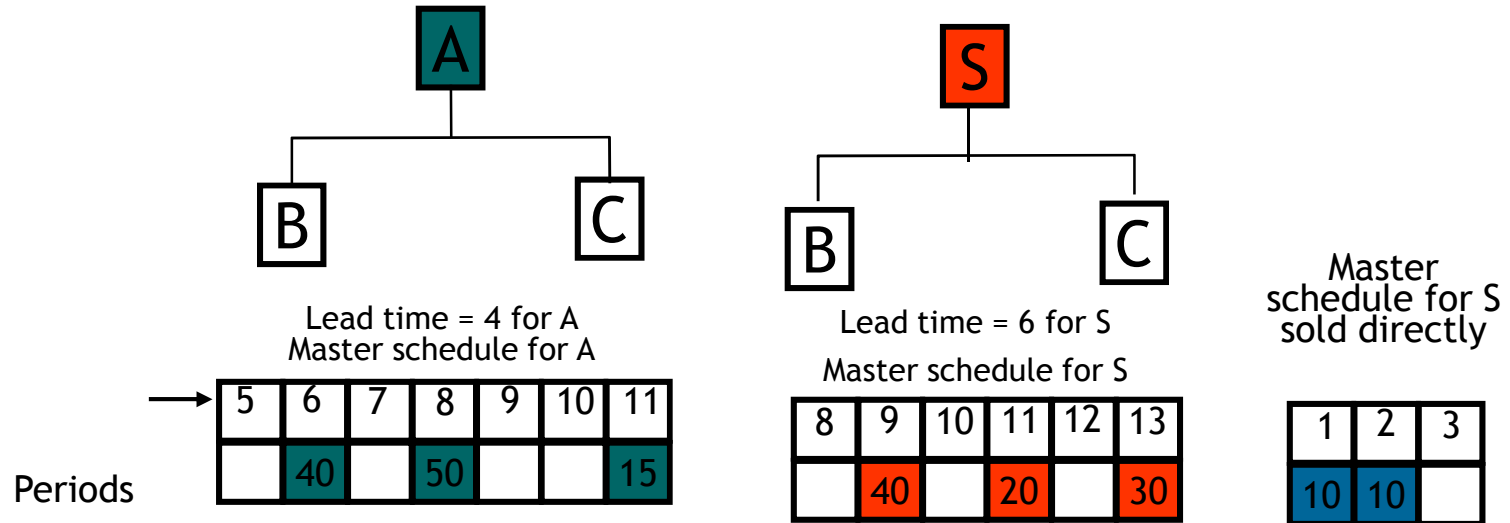
# Derivation of Master Schedule

A and S are End Items

B and C are used to make A  
and S



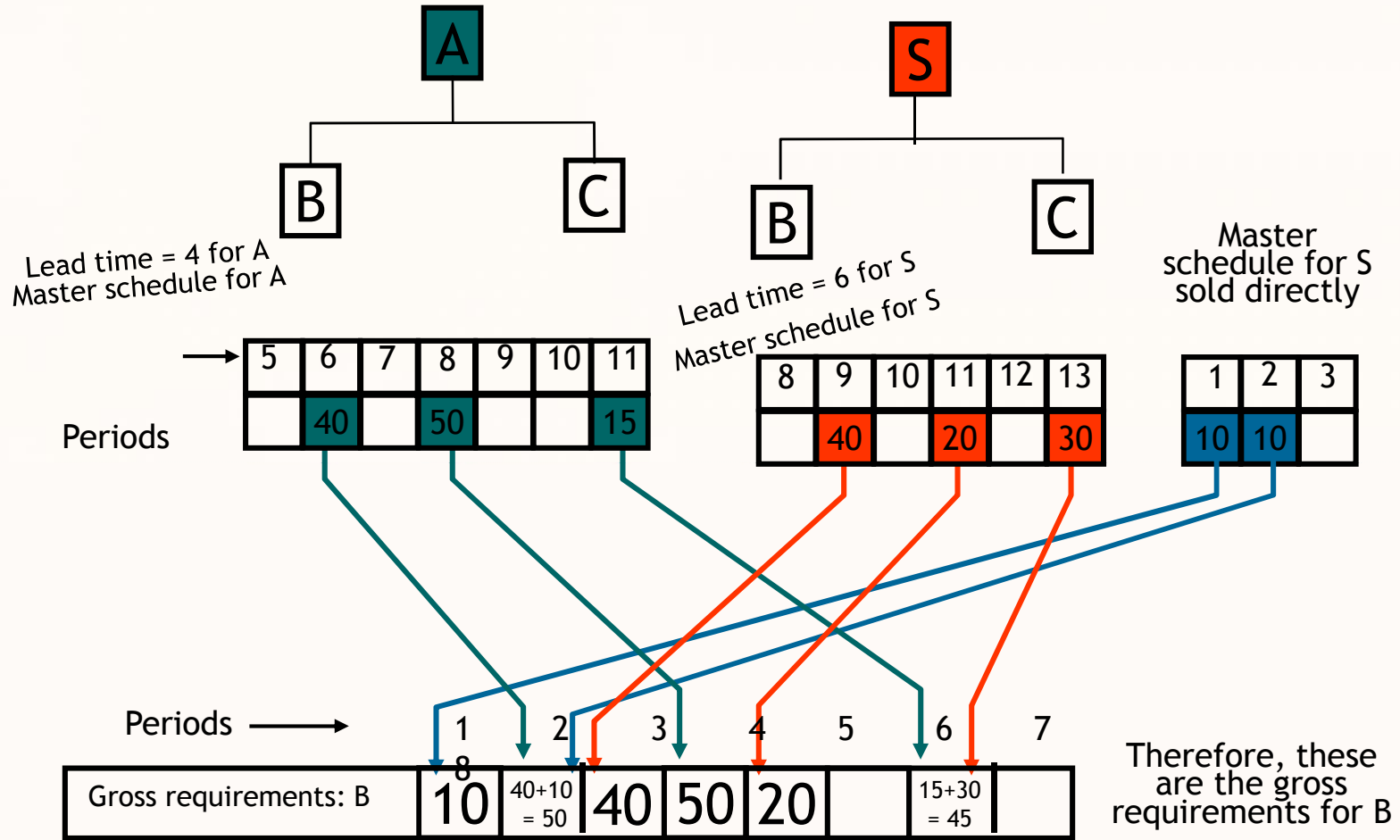
# Derivation of Master Schedule



A is required  
 Week 6 : 40  
       8 : 50  
      11 : 15

S is required  
 Week 9 : 40  
      11 : 20  
      13 : 13

# Derivation of Master Schedule



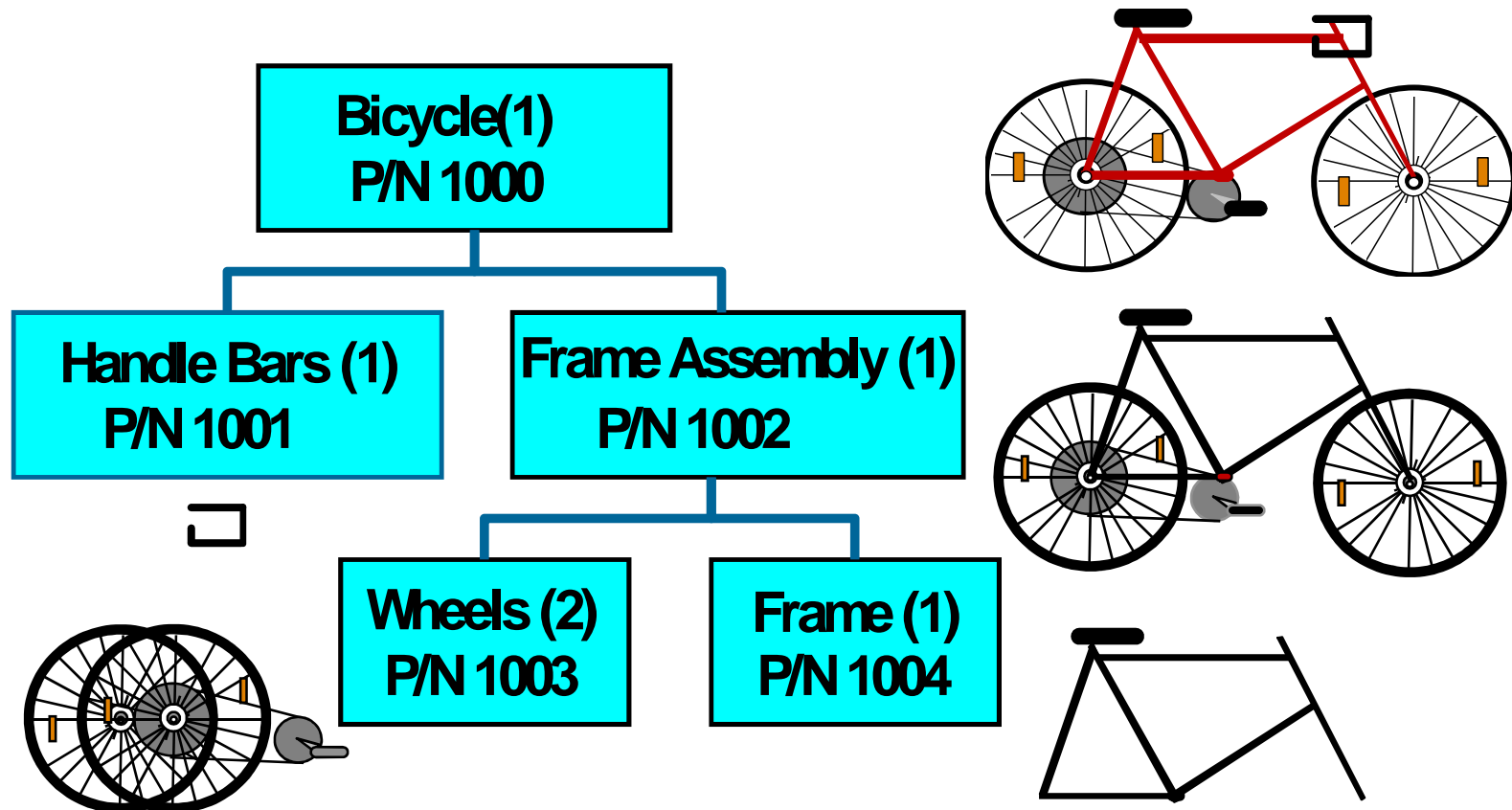
## B Requirements

# Bill-of-Material (BOM)

- ◆ List of components & quantities needed to make product
- ◆ Provides product structure (tree)
  - ◆ Parents: Items above given level
  - ◆ Children: Items below given level
- ◆ Shows low-level coding
  - ◆ Lowest level in structure item occurs
  - ◆ Top level is 0; next level is 1 etc.



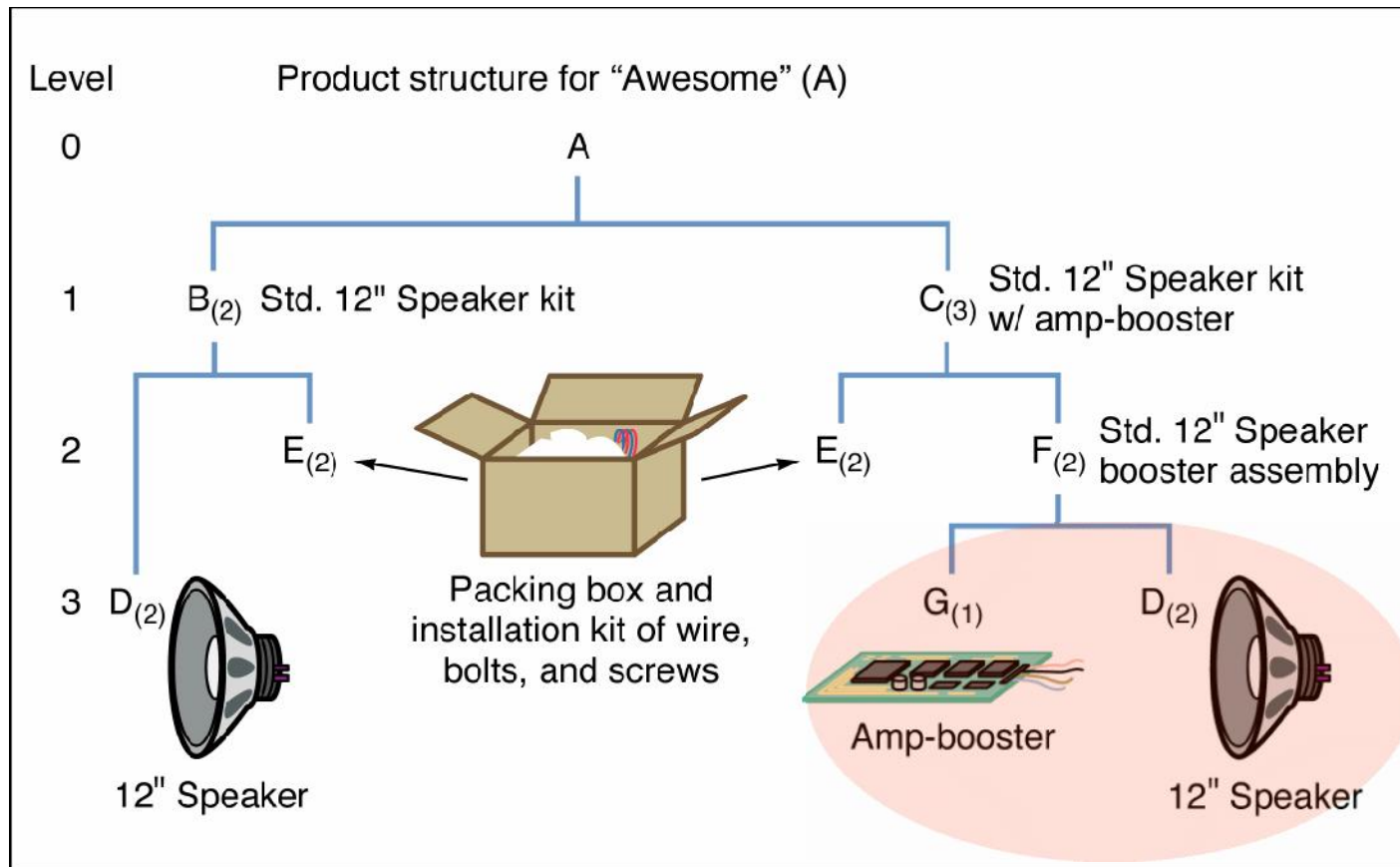
# Bill-of-Material Product Structure Tree



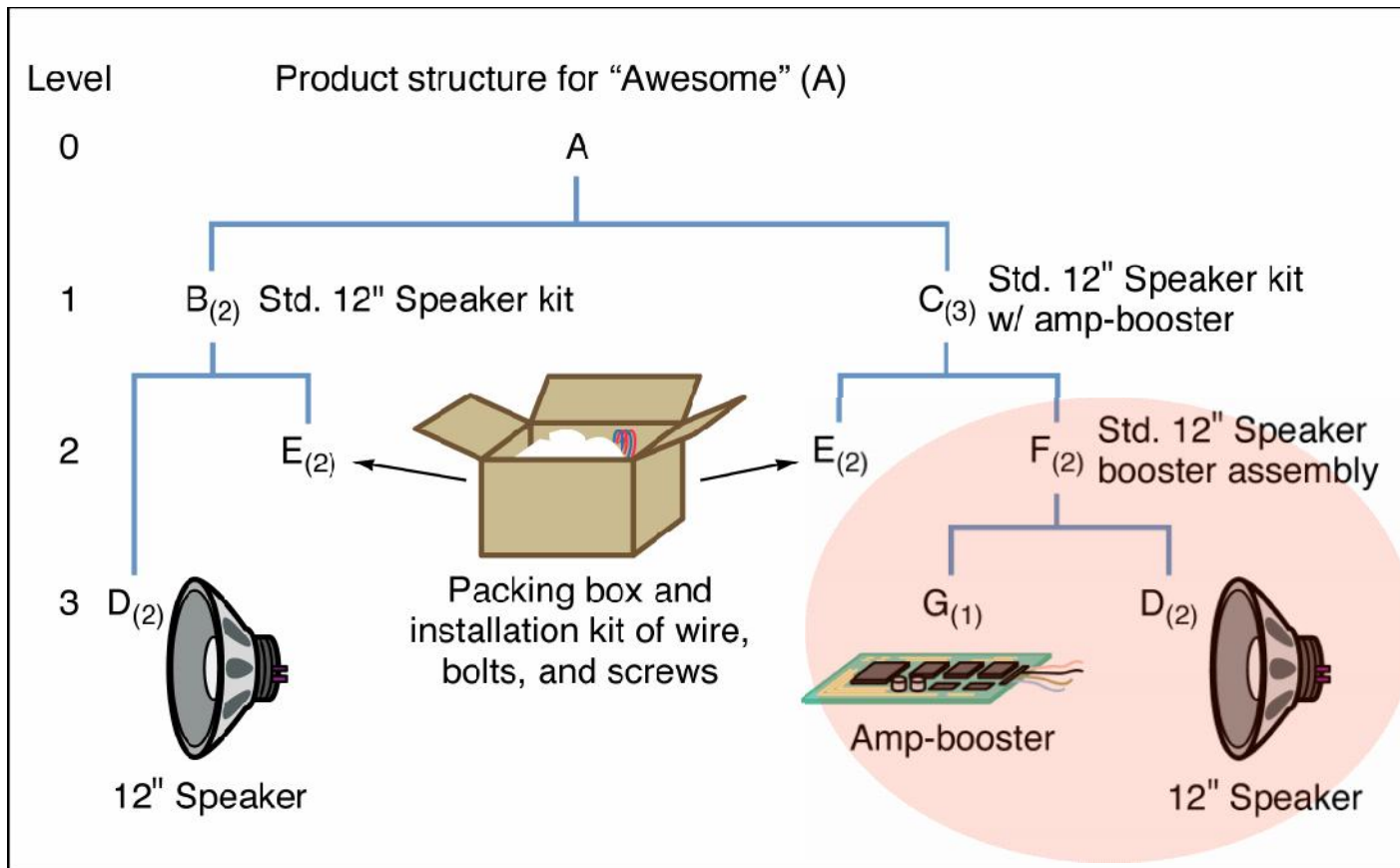
# Special Bills-of-Material

- ◆ Modular bills
  - ◆ Modules are final components used to make assemble-to-stock end items
- ◆ Planning bills
  - ◆ Used to assign artificial parent
  - ◆ Reduces number of items scheduled
- ◆ Phantom bills
  - ◆ Used for subassemblies that exist temporarily

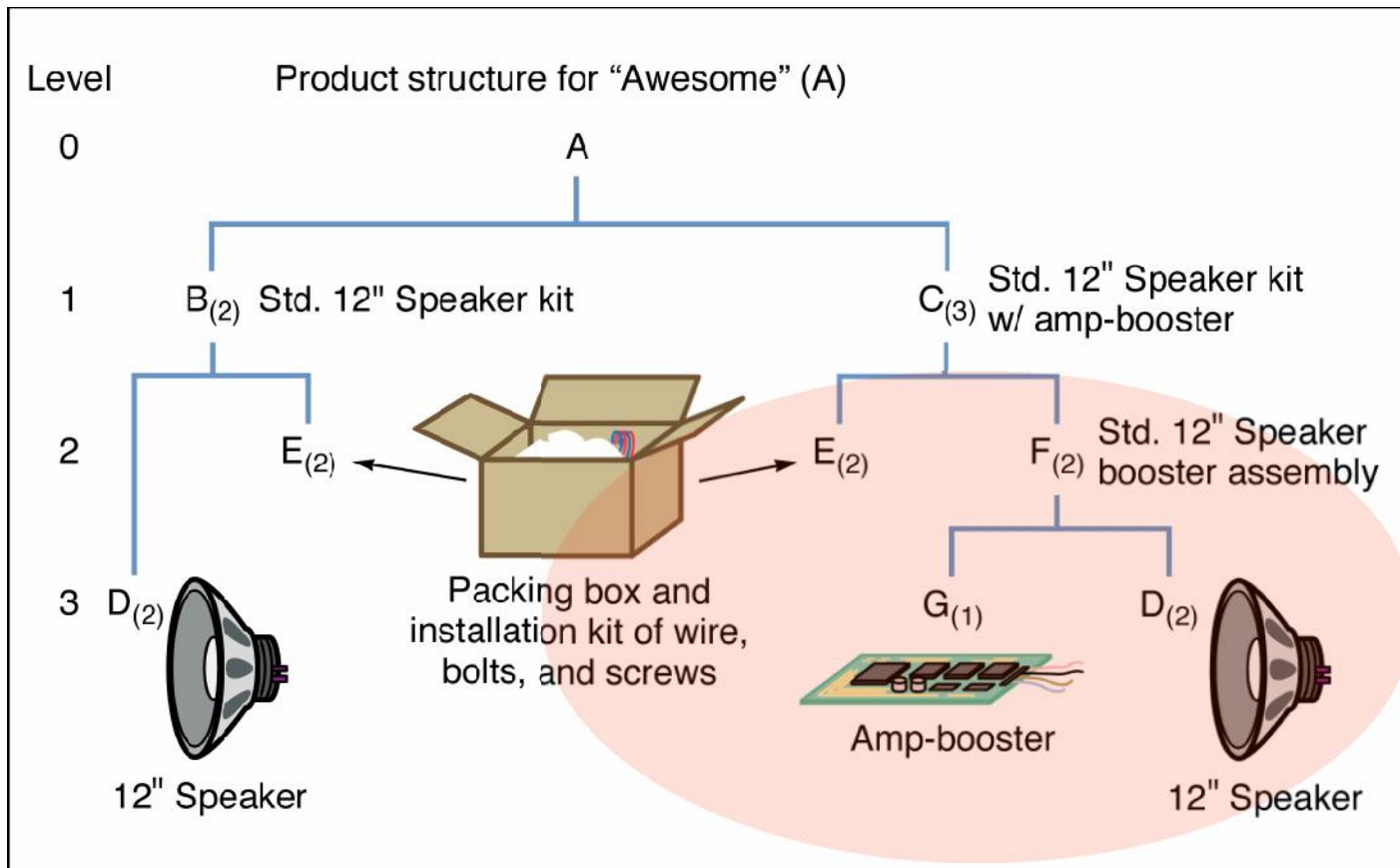
# Product Structure for "Awesome" A



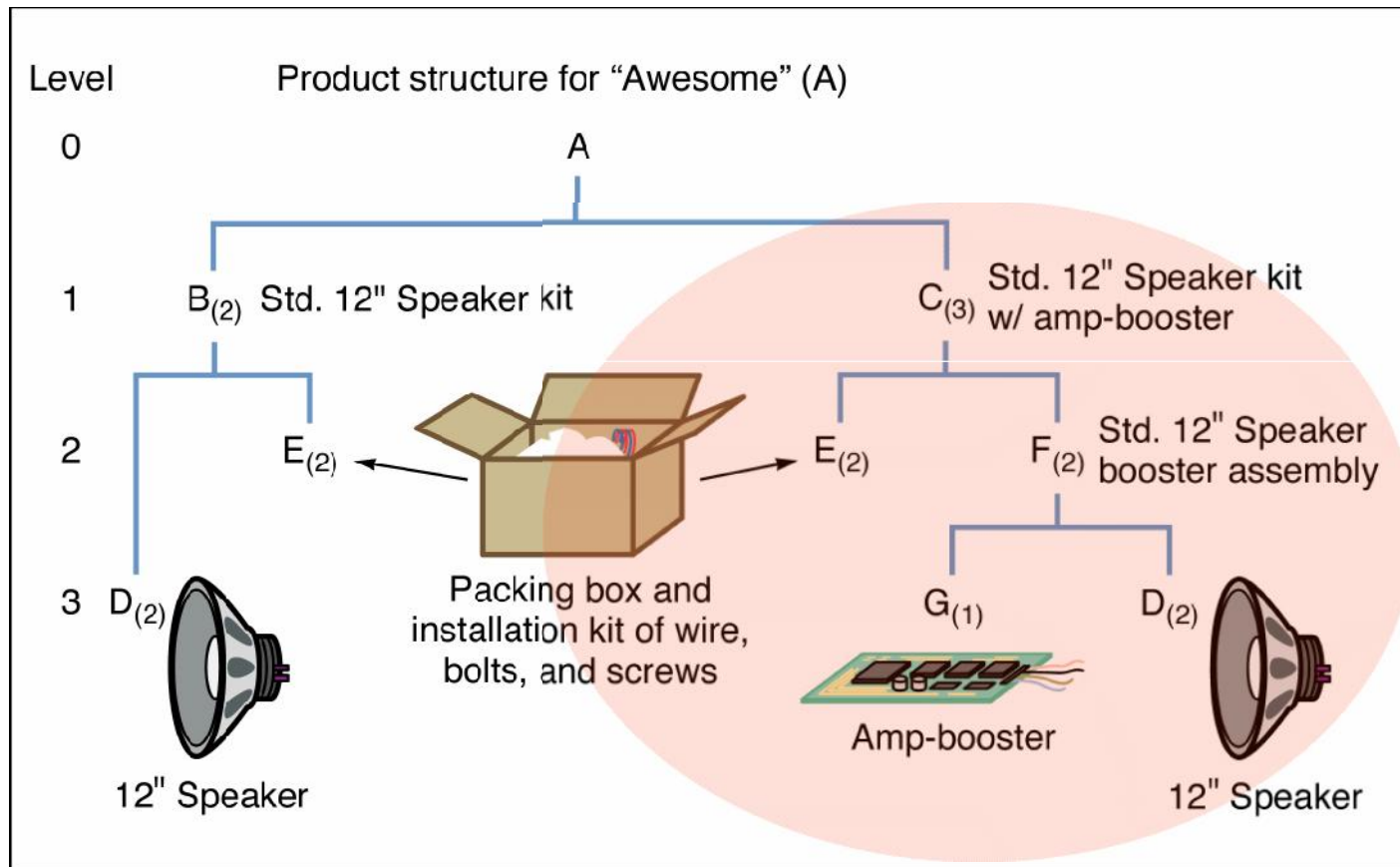
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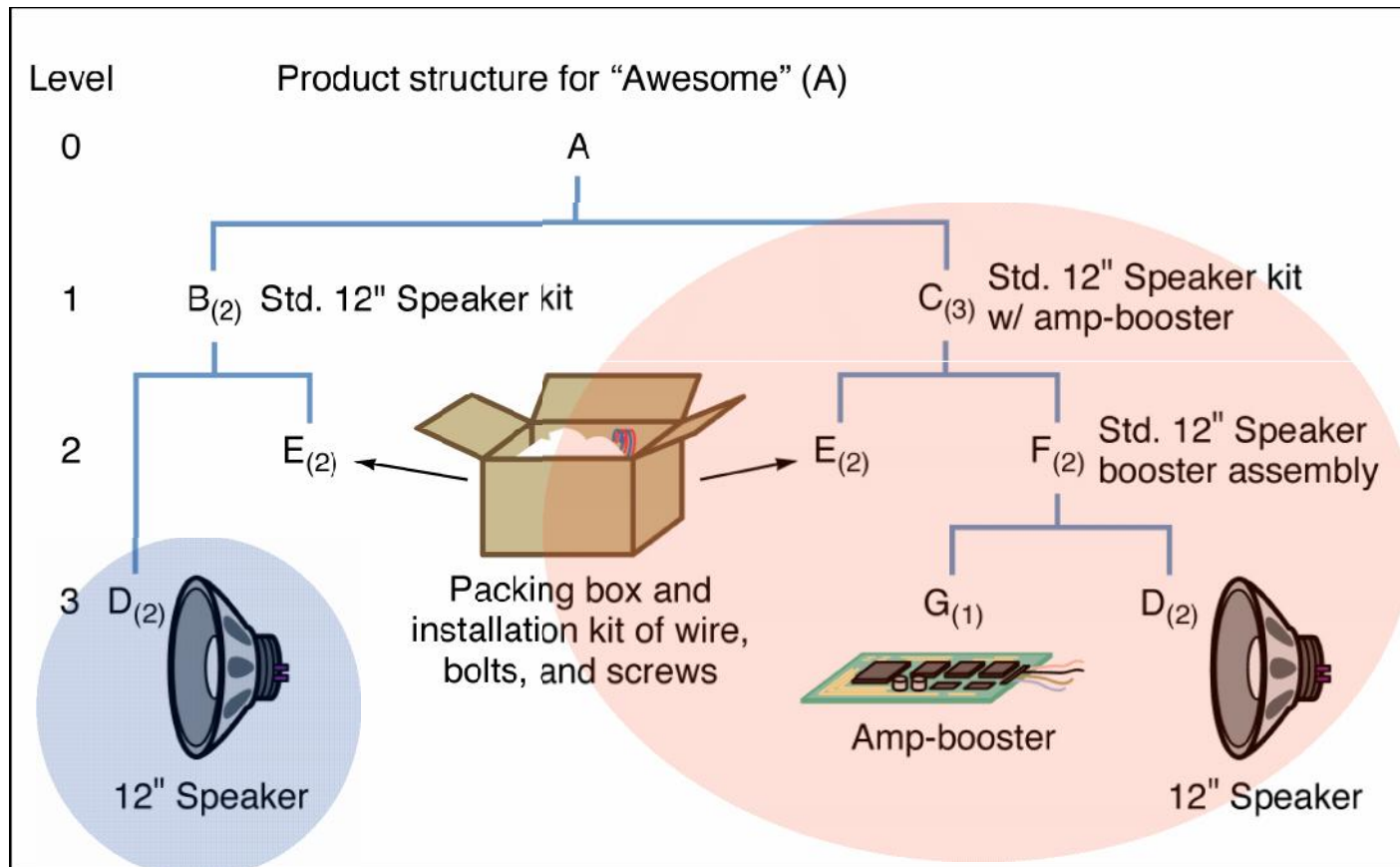
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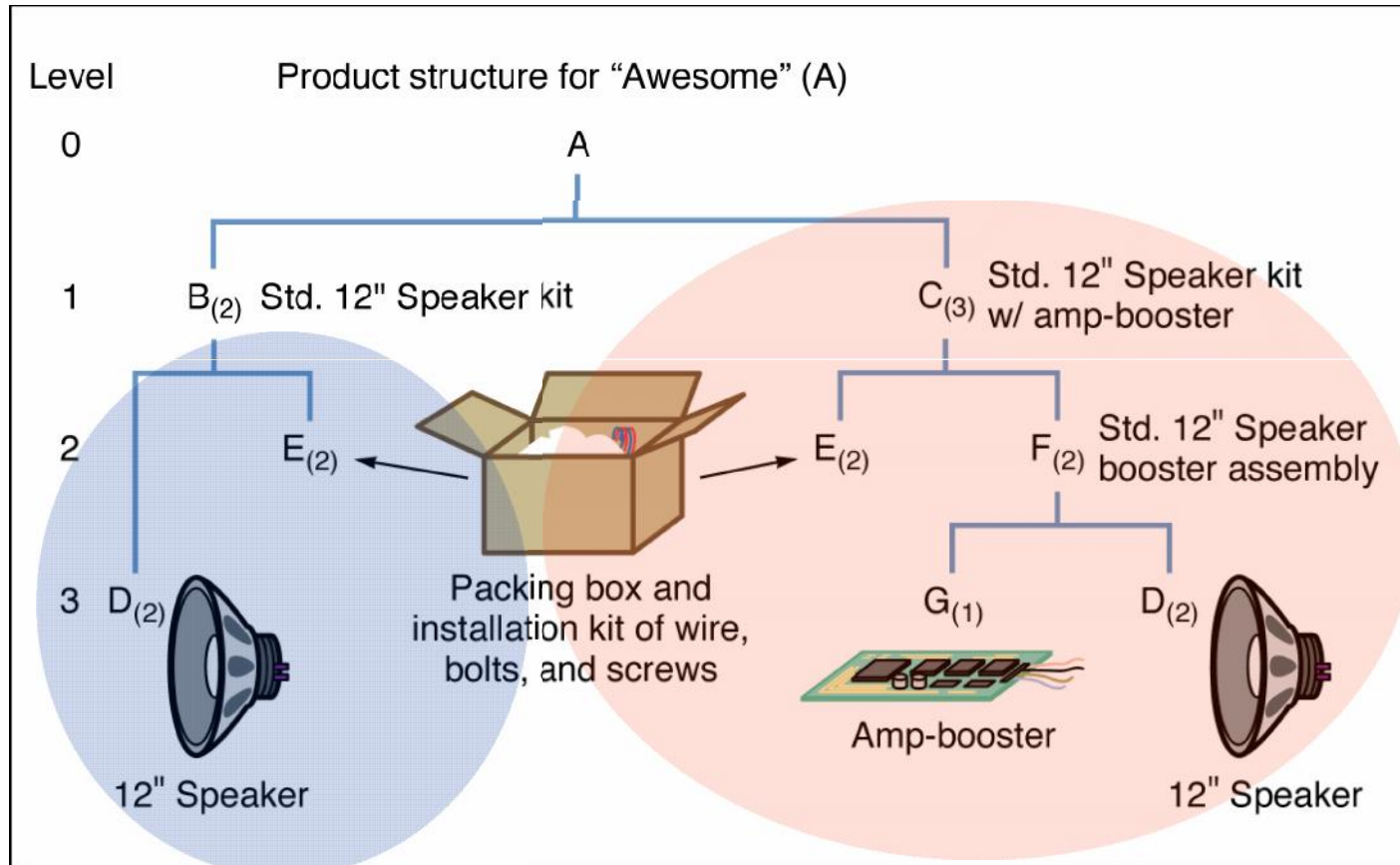
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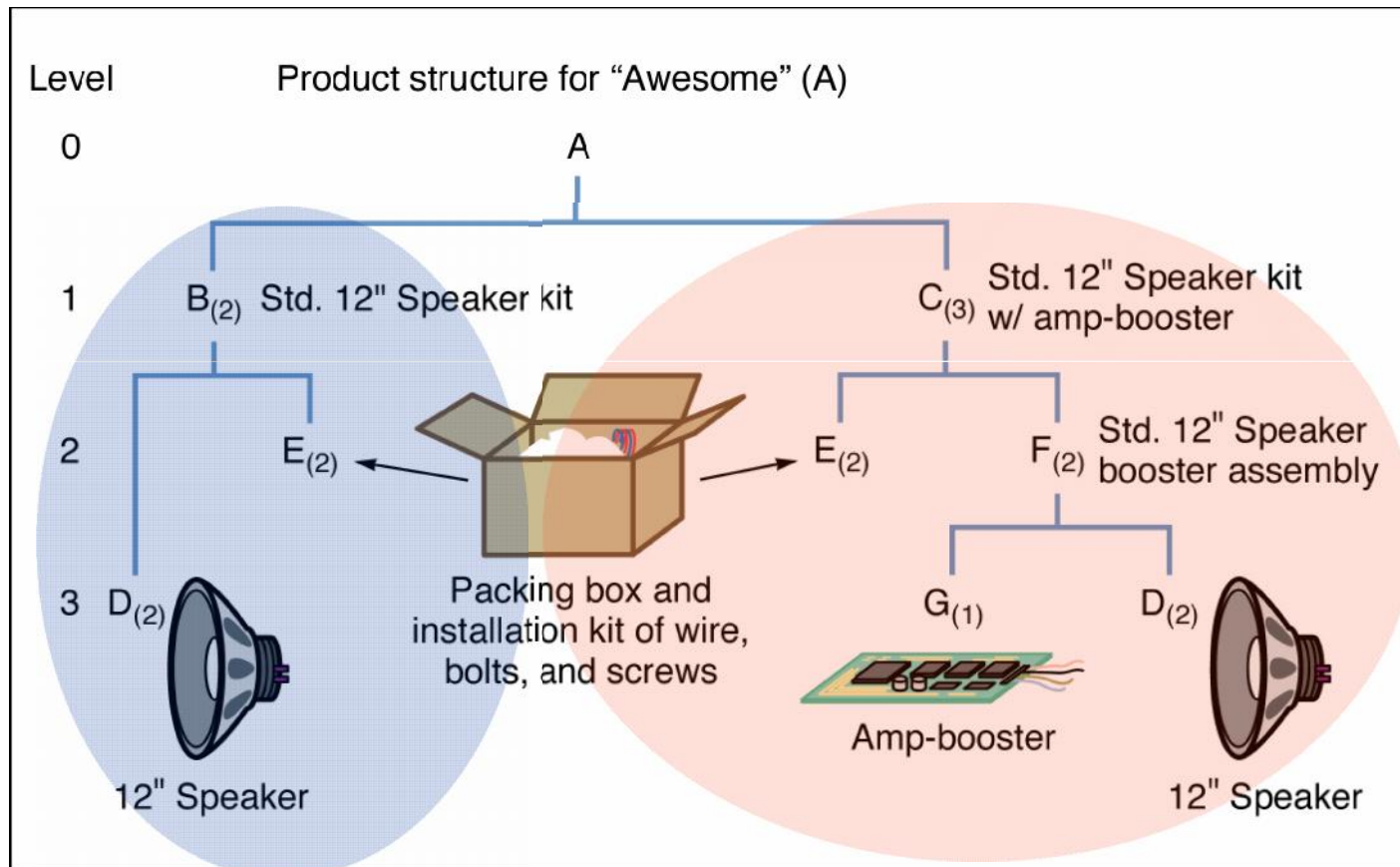


# Product Structure for "Awesome" A

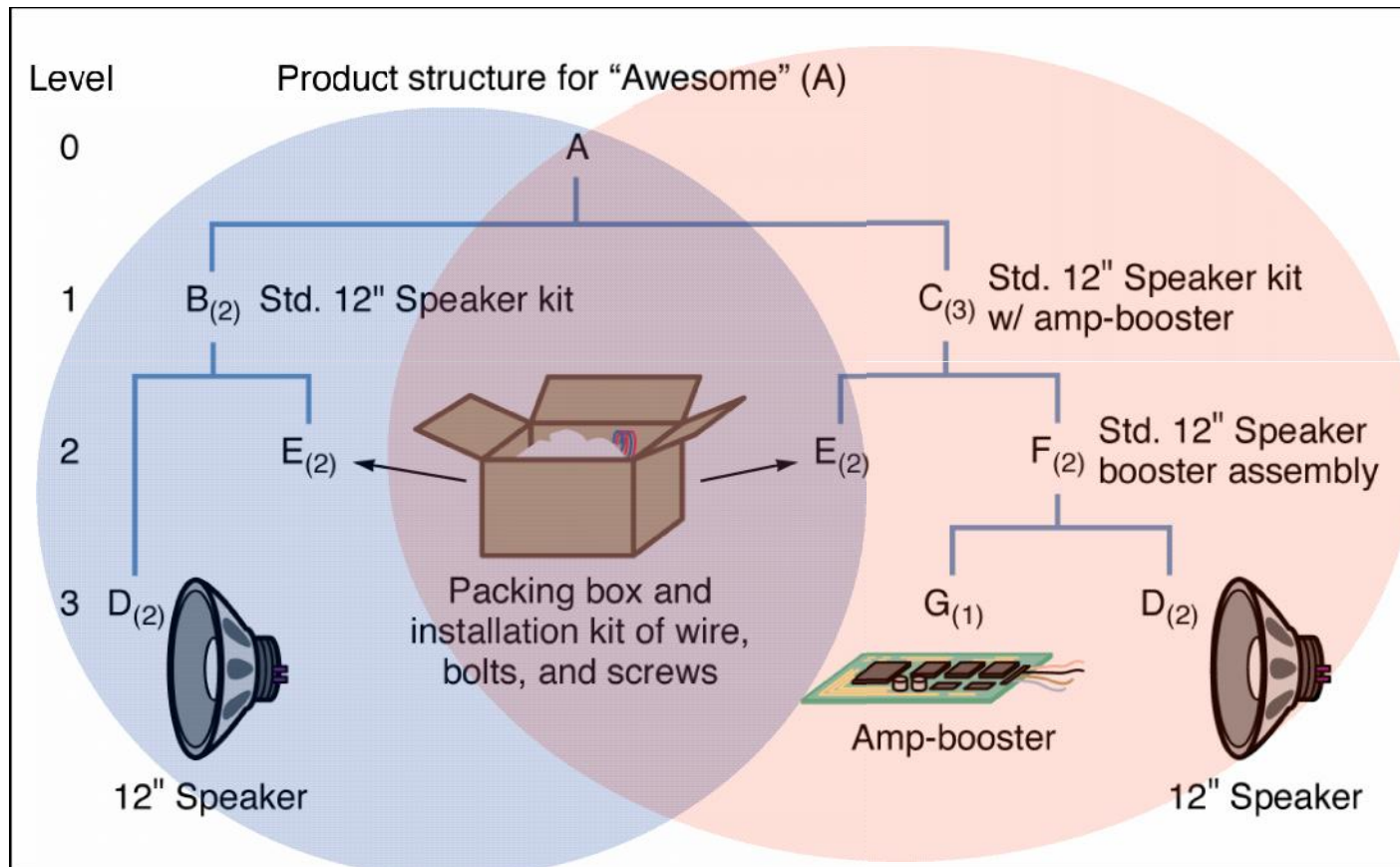




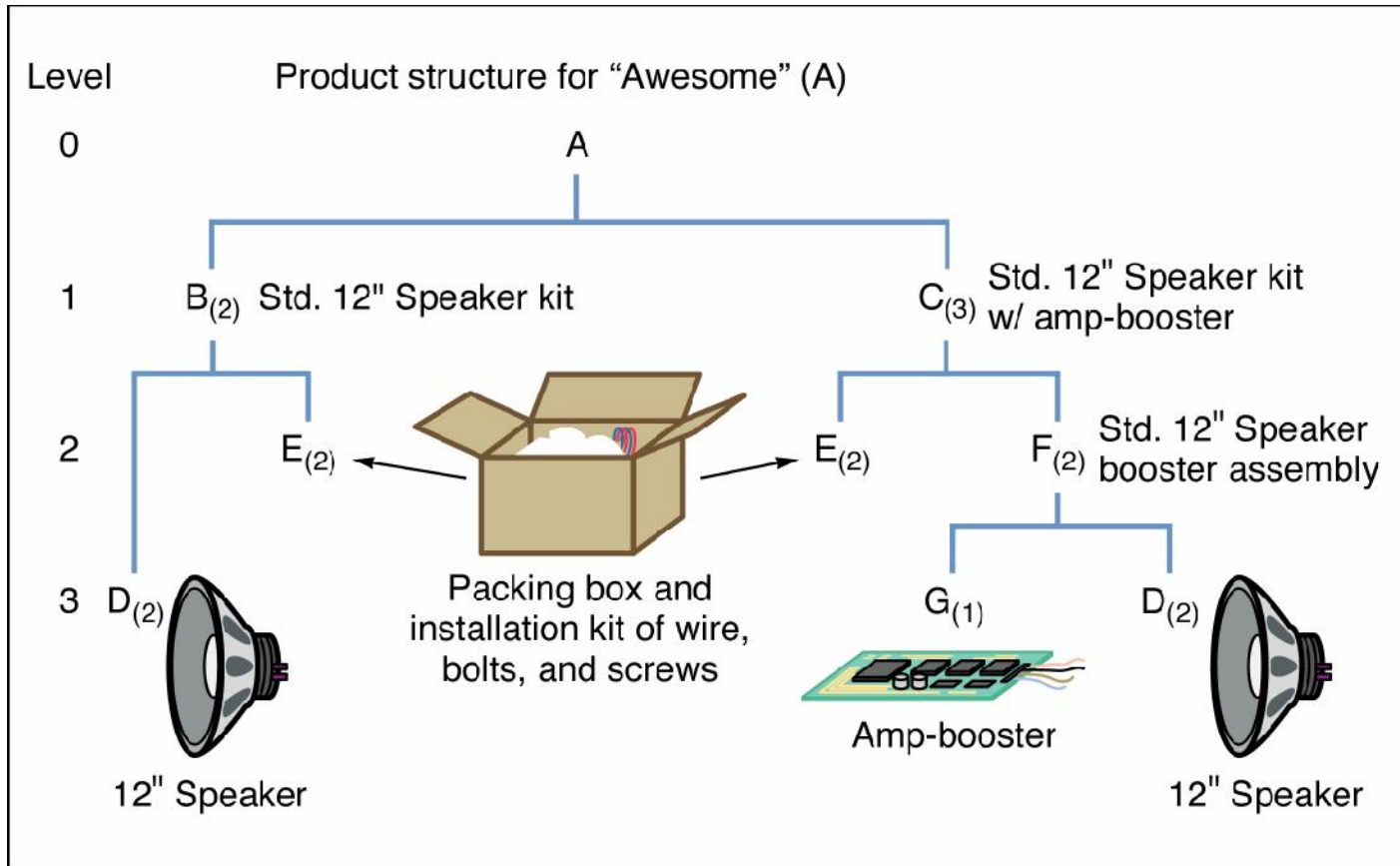
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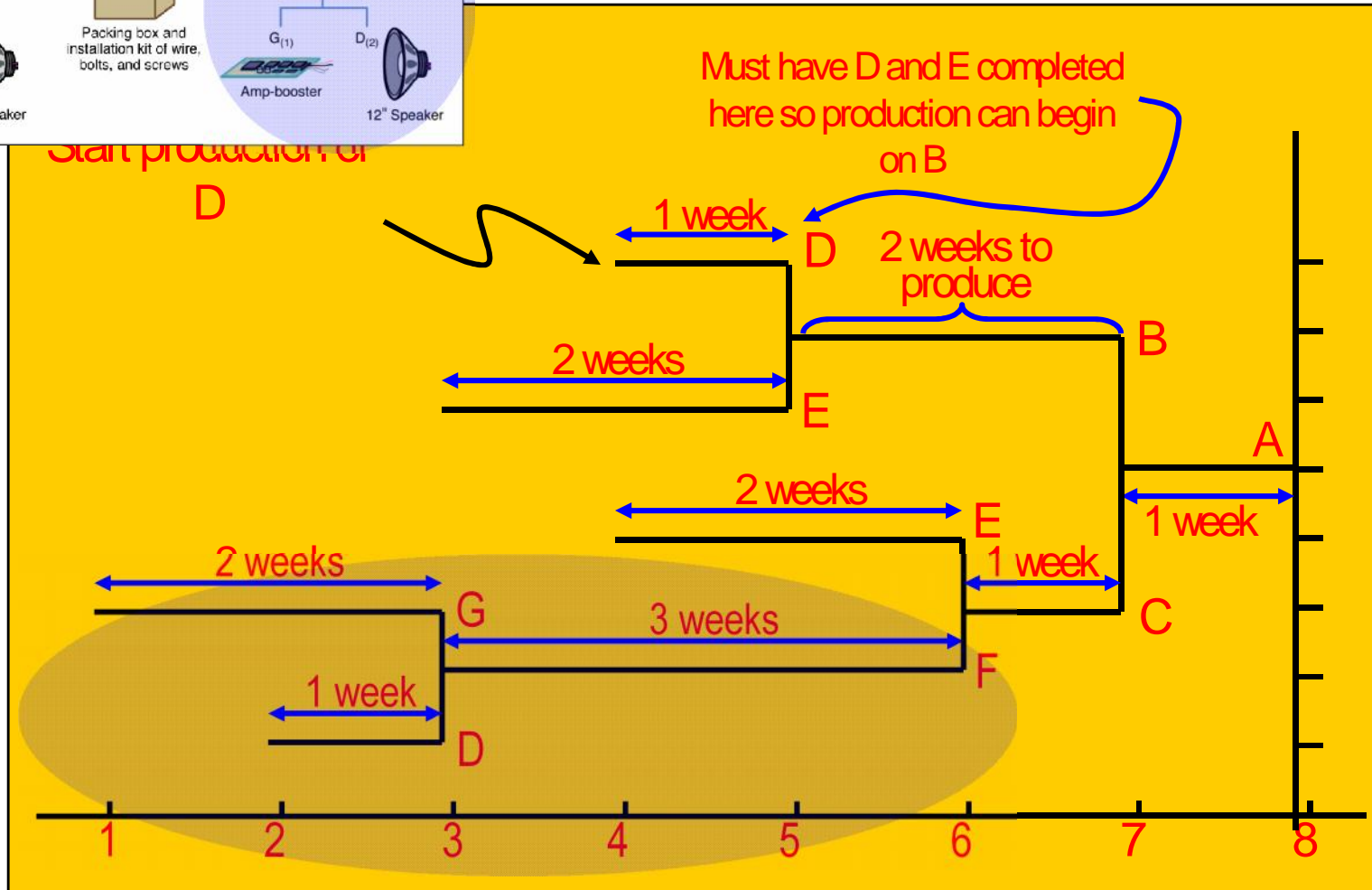
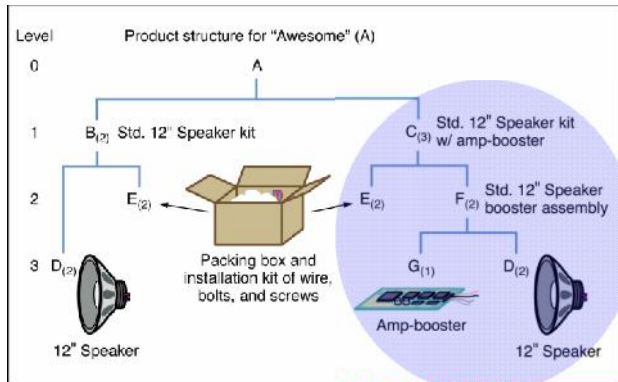


# Product Structure for “Awesome” A

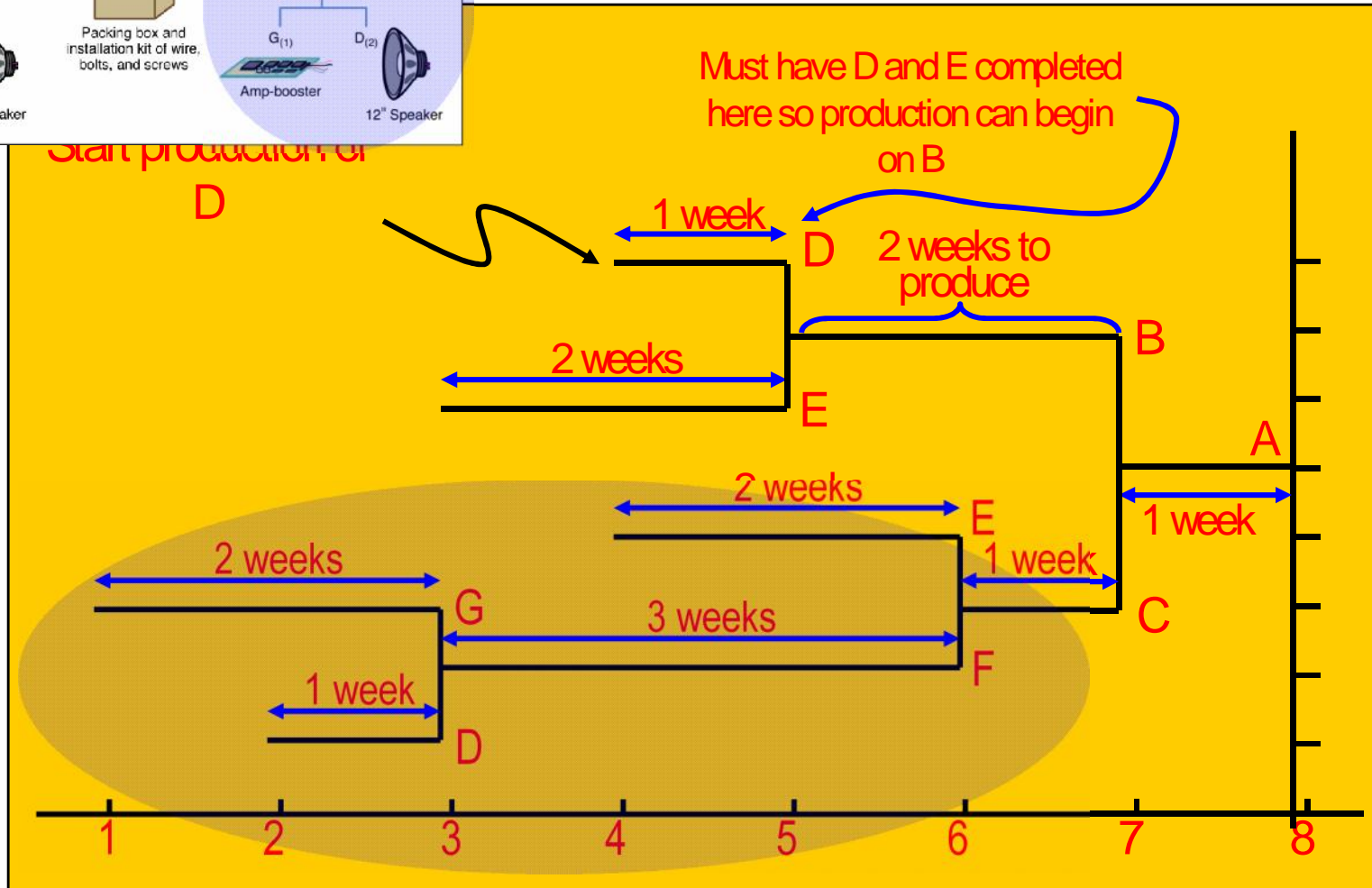
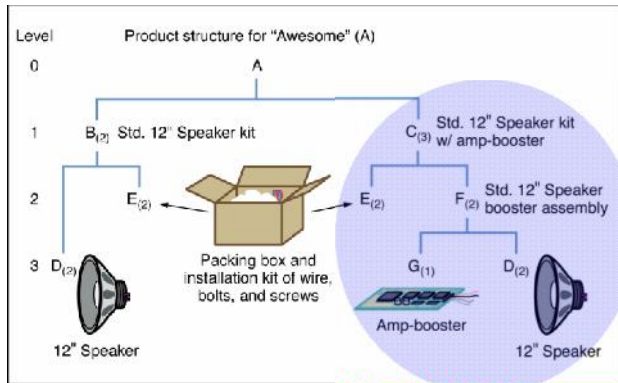




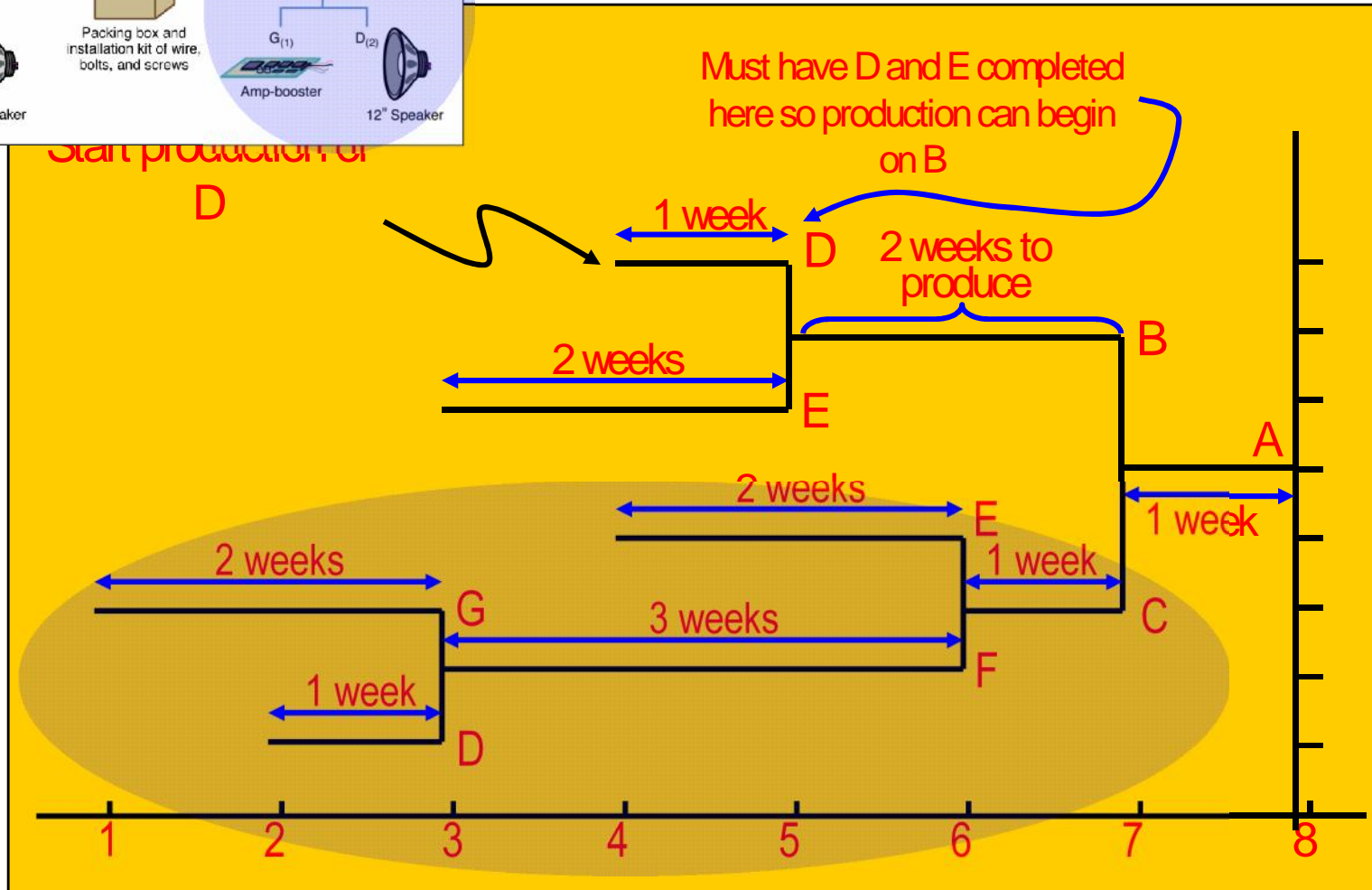
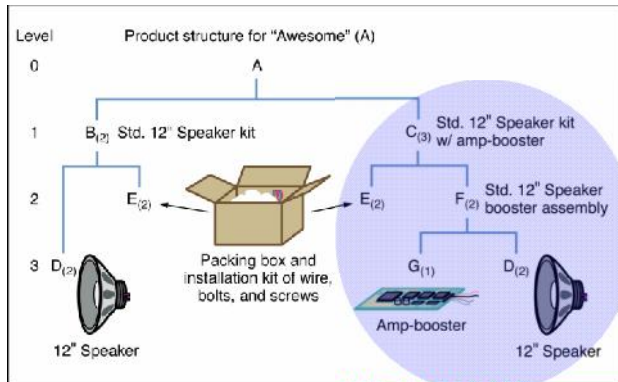
# Time-Phased Product Structure



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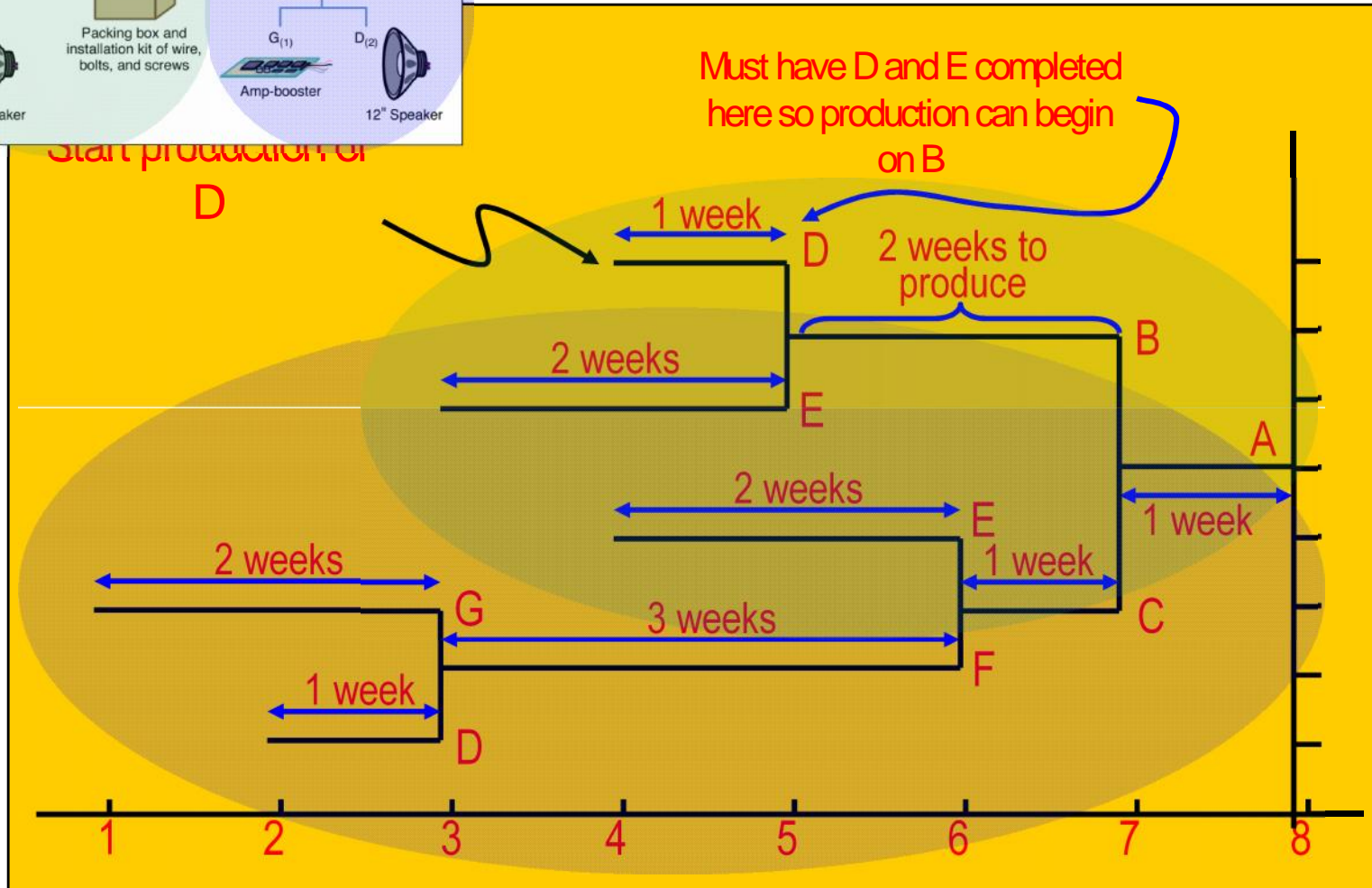
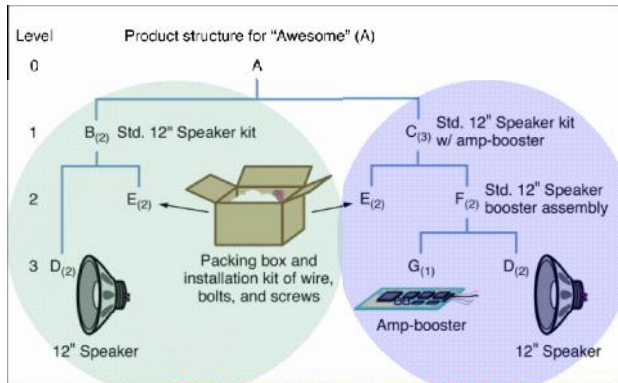








# Time-Phased Product Structure



# Gross Material Requirements Plan for 50 “Awesome A” Speaker Kits

	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
D. Required date					200				
Order release date				200					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						
Order release date		600							1 week
G. Required date			300						
Order release date	300								2 weeks

You can interpret the gross material requirements shown in Table 14.3 as follows: If you want 50 units of A at week 8, you must start assembling A in week 7. Thus, in week 7, you will need 100 units of B and 150 units of C. These two items take 2 weeks and 1 week, respectively, to produce. Production of B, therefore, should start in week 5, and production of C should start in week 6 (lead time subtracted from the required date for these items). Working backward, we can perform the same computations for all of the other items. The material requirements plan shows when production of each item should begin and end in order to have 50 units of A at week 8.



# MRP Table Parameters

◆ GR(t) : gross requirements

total demand in a period t

SR(t) :

expected receipt of the item in period t from  
previous (outstanding) orders

OHI(t) : on-hand inventory at beginning of t

NR (t) : net requirements ;  $NR(t) = GR(t) - SR(t) - OHI(t)$

POT(t): planned order receipts

POR(t): planned order release

# MRP Table Calculations

- ◆ OHI(t) : on-hand inventory

$$\begin{aligned} \text{OHI}(t) &= 0; && \text{if } \text{GR}(t) - \{\text{SR}(t) + \text{OHI}(t)\} > 0 \\ &= \{\text{SR}(t) + \text{OHI}(t)\} - \text{GR}(t); && \text{otherwise} \end{aligned}$$

# MRP Table Calculations

- ◆ NR(t) : net requirements is expected shortage

$$\begin{aligned} \text{NR}(t) &= 0; && \text{if } \{\text{SR}(t) + \text{OHI}(t)\} - \text{GR}(t) > 0 \\ &= \text{GR}(t) - \{\text{SR}(t) + \text{OHI}(t)\}; && \text{otherwise} \end{aligned}$$

# MRP Table Calculations

- ◆ POR(t) : planned order release  
issue an order of manufacturing/buying  
according to NR(t+L)

where L = lead time of order replenishment



# MRP Table Calculations

- ◆ POT(t) : planned order receipt  
receiving the consignment as a result of POR  
made in period (t+L)

# MRP CALCULATIONS

		1	2	3	4	5	6	7
Gross Requirements		35	30	40	0	10	40	30
Scheduled Receipts								
Projected on Hand	35	35	0	0	0	0	0	0
Net Requirements		0	30	40	0	10	40	30
Planned Order Receipts			30	40		10	40	30
Planned Order Releases		30	40		10	40	30	