KEMENTERIAN PENGAJIAN TINGGI

POLITEKNIK MALAYSIA
PORT DICKSON

MANUFACTURING CONTROL by Material Requirement Planning (MRP) For Beginner

RAFIDAH AZIZ THAM SOOK CHAN

POLITEKNIK
MALAYSIA
PORT DICKSON

MANUFACTURING CONTROL by Material Requirement Planning (MRP) For Beginner

Perpustakaan Negara Malaysia Cataloguing-in-Publication Data

Rafidah Aziz, 1981-
MANUFACTURING CONTROL by Material Requirement Planning (MRP) for Beginner /
RAFIDAH AZIZ, THAM SOOK CHAN.
Mode of access: Internet
eISBN 978-967-2897-59-0
1. Material requirements planning.
2. Production planning.
3. Manufacturing industries.
4. Government publications--Malaysia.
5. Electronic books.
I. Tham, Sook Chan, 1979-. II. Title.
658.503

PUBLISHED BY:

Politeknik Port Dickson

KM14, Jalan Pantai, 71050 Si Rusa

Port Dickson, Negeri Sembilan

OCTOBER 2022

Copyright Each part of this publication may not be reproduced or distributed in any forms by any means or retrieval system without prior written permission.

Contents

Manufacturing Control by Material Requirement Planning (MRP) for Beginner

ABSTRACT

Manufacturing Control is a course that provides production scheduling information. It also includes knowledge in managing the MRP system (material management), scheduling production, and controlling inventory. Hence, as a starting point to prepare students to understand more about manufacturing process controlling activities, this e-book is focused only on the Material Requirement Planning (MRP) system. The contents in this e-book are relevant to the syllabus for Diploma of Mechanical Engineering (Manufacturing) students at the polytechnic. It touches on the basic concept of MRP and how this MRP system works in inventory control.

There are simple notes, figures, examples of problem solutions and checkpoint exercises to accomplish the learning process for this topic and ease students to study it as reference. It also includes interactive YouTube links, Tips and Hints to help students understand better in this topic.

Acknowledgement

PATRON
Dr. Ishak bin Mohamad
Director, Politeknik Port Dickson

ADVISORS
Abdul Rahim bin Ibrahim
Deputy Director (Academic), Politeknik Port Dickson
Khairun Syatirin bin Md Salleh
Head of Mechanical Engineering Department, Politeknik Port Dickson

EDITOR
Zainal Abidin bin Ab Kasim
Mechanical Engineering Department, Politeknik Port Dickson

FACILITATORS
Nin Hayati Binti Mohd Yusof
Ragunathan a/l Jayaraman
Che Azlina Binti Che Norohoseni

WRITERS
Rafidah Binti Aziz
Tham Sook Chan

We would like to convey our utmost gratitude to the Department of Polytechnic and Community College Education particularly the E-learning and Instructional Division (BIPD) for funding our e-book project.

We hereby declare that this module is our original work. To the best of our knowledge it contains no materials previously written or published by another person. However, if there is any, due acknowledgement and credit are mentioned accordingly in the e-book.

acknowledgement

CHAPTER 1

DEFINITION CONCEPT OF MRP

After completing this lesson, you are expected to be able to:

- Define the meaning of MRP.
- Understand Independent Demand and Dependent Demand.

1.1 Introduction of MRP

The technique used to calculate the number of parts, components, and materials required to make a product is known as **materials requirements planning (MRP).** When each of the materials, parts, and components should be ordered or produced, MRP provides time scheduling information (Heizer & Render, 2008).

MRP is a piece of software. A computer-based information system that determines **what is needed, how much is needed, and when is needed** for dependent-demand inventories. In short, MRP is driven by dependent demand. Both independent and dependent demand would be included in MRP even if neither deals with raw materials.

1.2 Independent and Dependent Demand

MRP can also be divided into two categories:

Figure 1.1: Division of MRP *(Robert Victor, 2019)*

Products or components that are sent to customers as finished goods are referred to as **independent demand**. While, raw resources, component parts, or subassemblies required to make a final product are referred to as **dependent demand**. **Dependent demand** is derived from the demand for a finished good.

Independent Demand Vs Dependent Demand

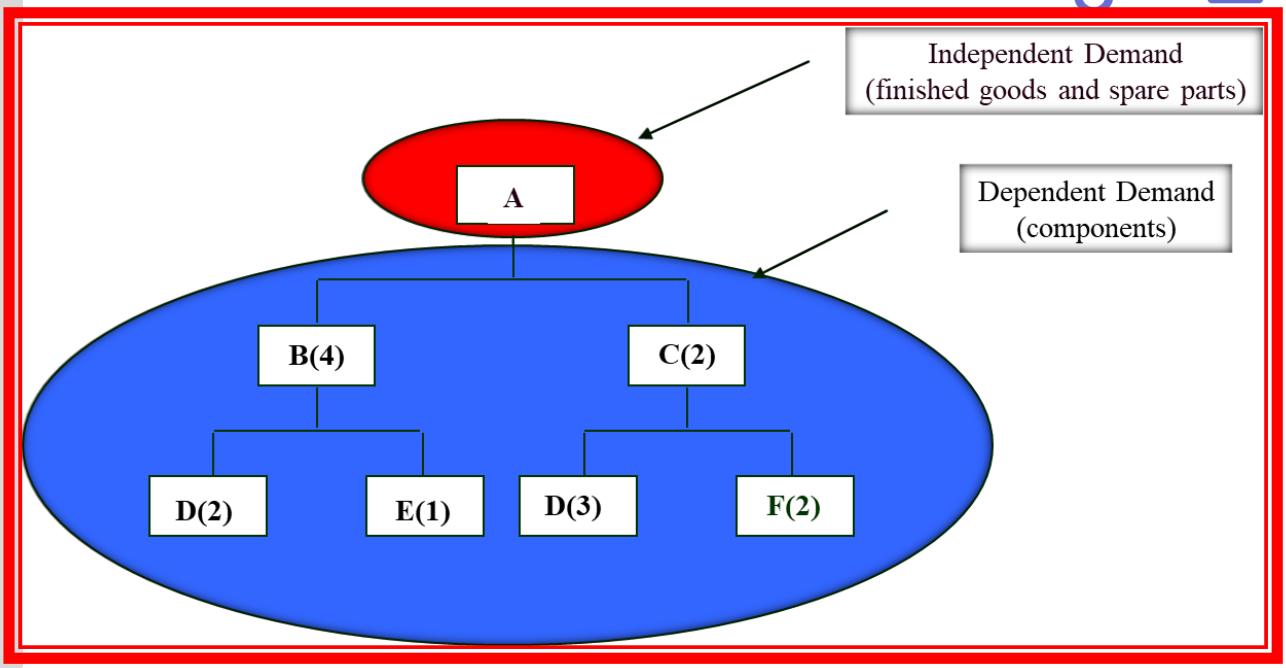


Figure 1.2: Structure Tree *(Stevenson, 2005)*

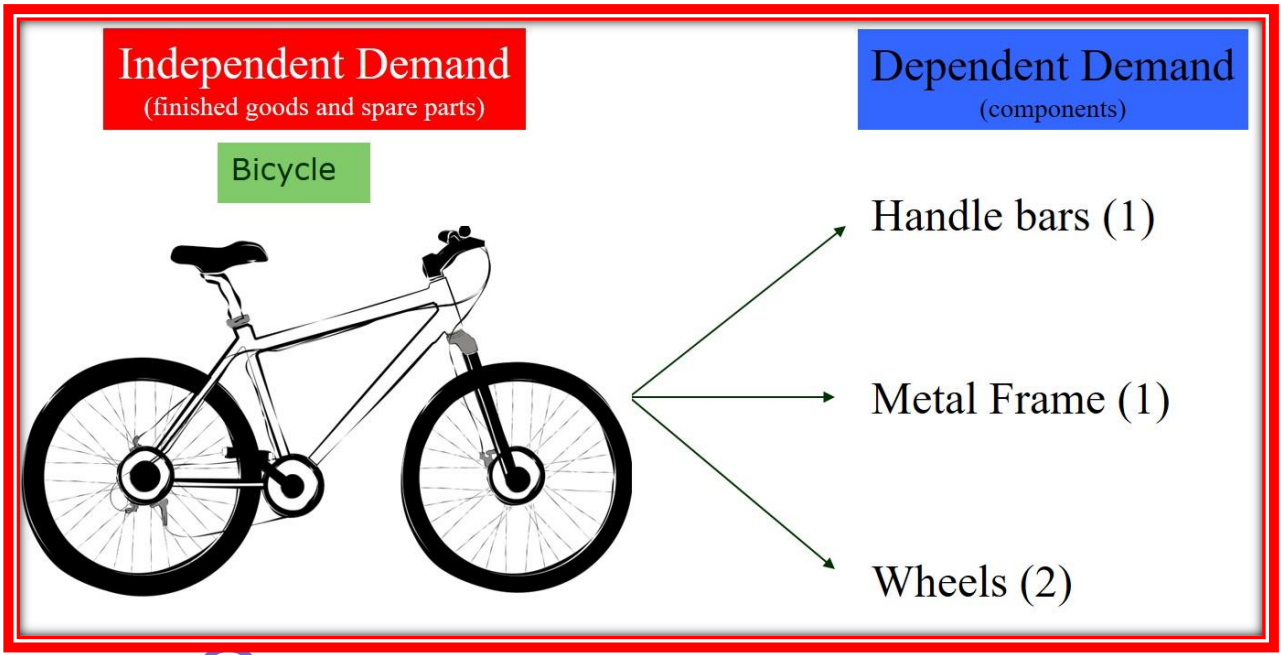


Figure 1.3: Independent and Dependent Demand

1.3 Dependent Demand

Dependent demand is the demand for goods that will be utilized to produce final goods as subassemblies or component parts. Demand for one item will influence demand for another item. The dependent demand (all parts and components) can be calculated if the independent demand (end item) is known. The following are necessary for using dependent demand inventory models effectively:

a. Master production schedule
b. Specifications or bill of material
c. Inventory availability
d. Purchase orders outstanding
e. Lead times

In order to avoid resource waste and maximize profit, operations' job is to estimate dependent demand as accurately as possible. It is more difficult to produce estimates for a product with dependent demand because the company must also consider how demand for its counterparts affects its own demand as well as how external economic factors are expected to affect both products.

Example

Example 1:

What is Material requirement Planning (MRP)?

Answer:

Material requirement planning (MRP) is the computer-based inventory management system to develop inventory requirements for component and raw materials.

Example 2:

Give the definition and differences between dependent and independent demand in MRP.

Answer:

Item	Dependent Demand	Independent Demand
Definition	The demand for goods that will be utilized to produce final goods as subassemblies or component parts	Products or components that are sent to customers as finished goods
Difference	Raw materials, sub-assemblies and component inventories.	Finish good items, which are ordered by customer.

1.4 Summary Of The Chapter

What Is Material Requirements Planning (MRP)?

Abby Jenkins | Product Marketing Manager July 20, 2022

A common supply planning system called material requirements planning (MRP) aids companies, mainly producers of goods, in understanding their inventory needs and balancing supply and demand. MRP systems, which are part of supply chain management systems, are used by businesses to effectively manage inventory, plan production, and deliver the right product—on time and at the best price (Jenkins, 2022).

1.4 Benefits of MRP

MRP systems make it possible to efficiently plan and schedule production, ensuring that materials move through the work order promptly and assisting enterprises in delivering goods and services on time.

It's simple to underestimate timing when builds are complex and call for numerous sub-assemblies inside the work order. Understanding all the parts that go into each sub-assembly and how long it takes to finish each step with the aid of an MRP helps you avoid production cycle delays and boost production yield.

https://youtu.be/eoLSZh35_LY

https://youtu.be/u3P6YMI5Ah0

Checkpoint 1

It's time to test yourself. Please choose the right answer.

1. MRP is a computerized _____ .

Answer choices:

a) trial and error schedule.

b) volume and timing of the end products to be made.

c) inventory control and production planning system.

2. the list of resources, ingredients, and component quantities needed to make a product is the _____ .

Answer choices:

a) Purchase Order.

b) Bill of Materials.

c) Master Schedule.

3. Material Requirements Planning (MRP) is understand inventory requirements while _____.

Answer choices:

a) balancing supply and supplier.

b) balancing supply and demand.

c) balancing material and demand.

CHAPTER 2

ELEMENT FOR PROCESS OF MRP

After completing this lesson, you are expected to be able to:

- identify the element for the MRP. Inputs.
- Discuss Master Production Schedule (MPS).

2.1 MRP Inputs

A timetable for completed goods is the starting point for MRP, and it is transformed into a schedule of the subassemblies, component parts, and raw materials that are required to make the final goods within the time frame given (Stevenson, 2005). MRP is made to respond to the following questions:

What is needed?

How much do you need?

How soon is it required?

The cumulative lead time, master production schedule (MPS), inventory status file (ISF) or inventory records, bill of materials (BOM) and product structure tree are the five fundamental inputs of an MRP system.

2.2.1 Master Production Schedule (MPS)

A planning schedule known as a Master Production Schedule (MPS) outlines which end items are to be produced, when, and in what quantities. It must follow the aggregate production plan. According to Figure 2.1, inputs come from engineering, supplier performance, consumer demand, and financial plans. Each phase of the process, from planning to execution, needs to be tested for feasibility.

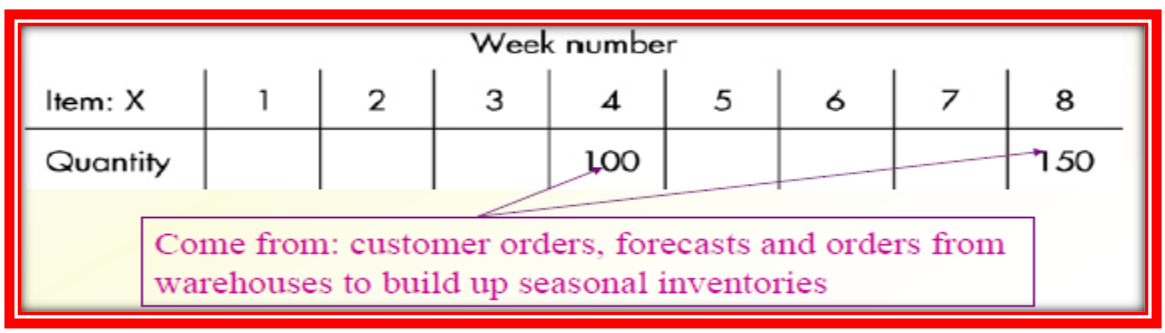


Figure 2.1: Master Production Schedule (MPS) *(Stevenson, 2005)*

For finished items, the following information as shown in Figure 2.2 is used as the demand: open production orders, forecast entries, and sales orders, whereas batch production jobs, inventory levels, and receipts are used as the supply. Immediately after manufacturing orders have been evaluated and accepted, material requirement planning can begin. Using the future batch orders predicted by MPS, MRP generates suggestions for purchase orders (Afolalu et al., 2020).

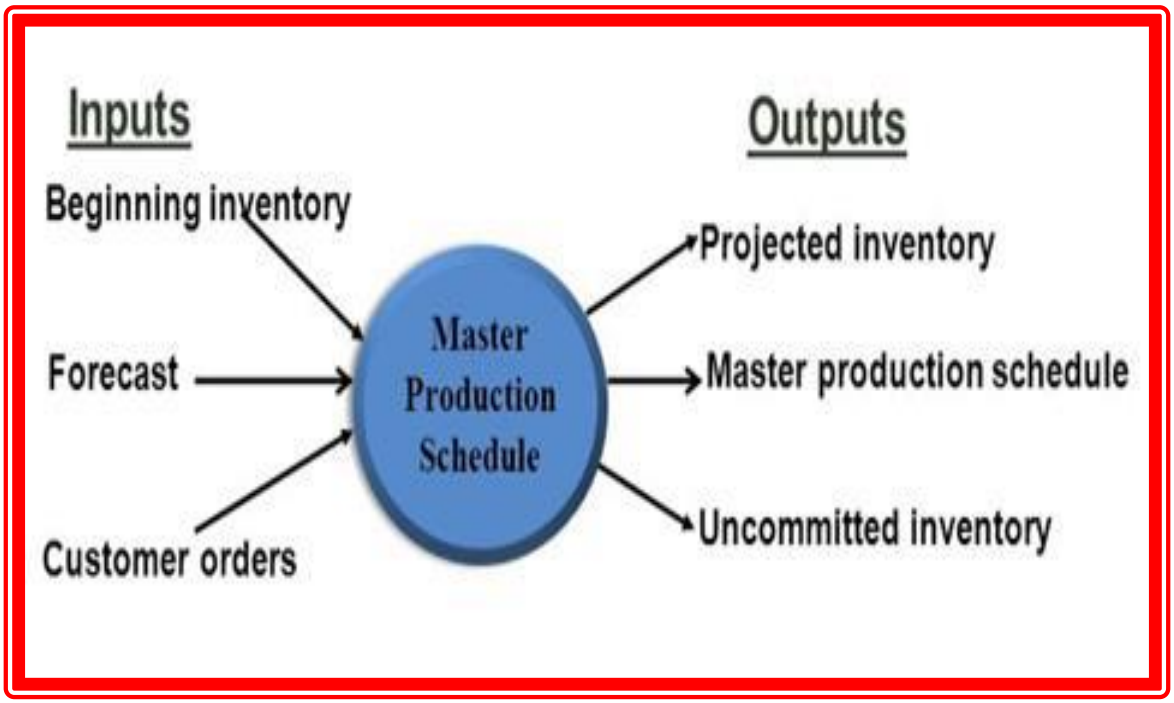


Figure 2.2: The Schematic of Master Scheduling Process (Afolalu et al., 2020)

The outcome of the production planning process is the MPS. It is firmly established in terms of specific goods. A suitable amount of time must pass while adhering to the schedule. Quite frequently, the MPS is fixed or frozen in the short-term portion of the plan. The MPS is a statement of what is to be produced, not a forecast of demand, due to its rolling schedule (Stevenson, 2005). MRP determines the materials required and when they will be needed during the manufacturing process using data from the bill of materials (BOM), inventory data, and the master production schedule as shown in Figure 2.3.

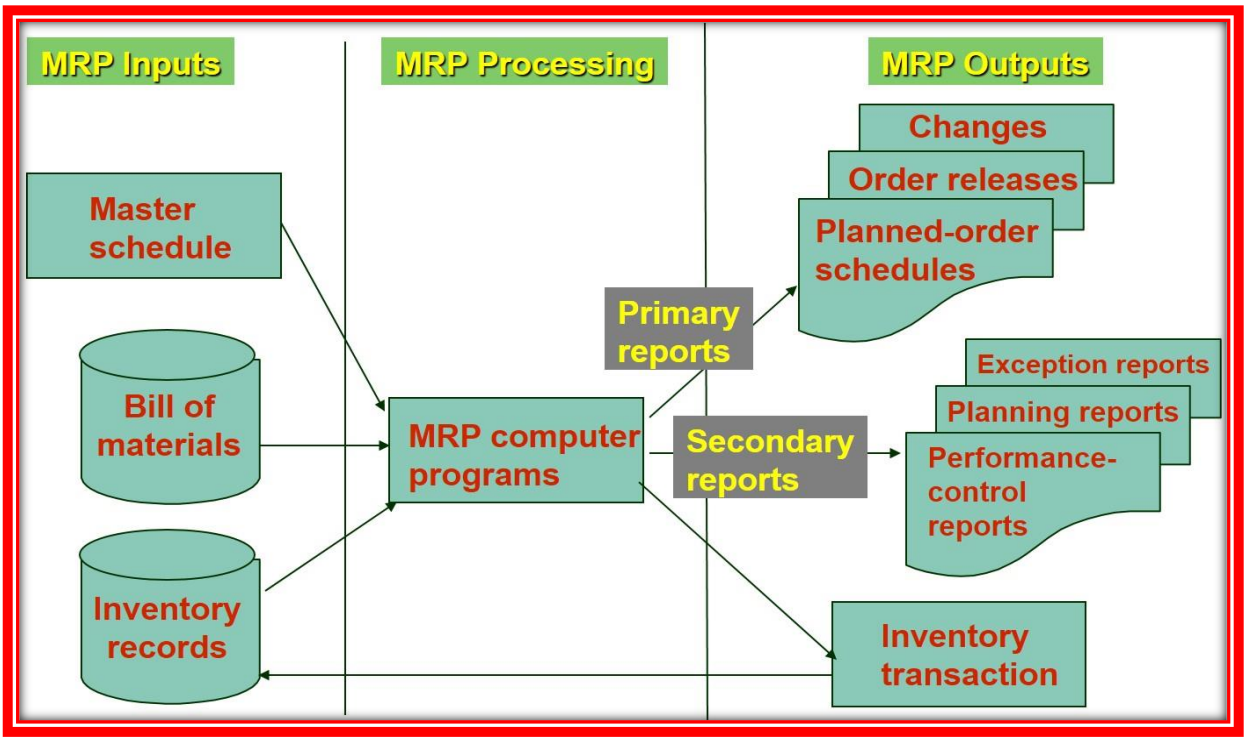


Figure 2.3: MRP Inputs *(Stevenson, 2005)*

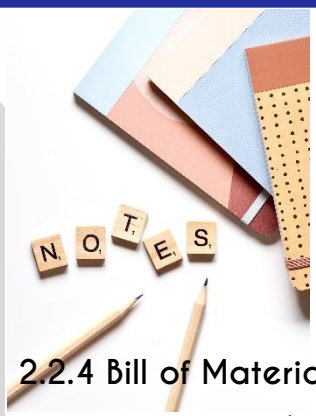
2.2.2 Lead Time

Cumulative lead time refers to the total lead time from ordering parts or raw materials to finishing the final assembly necessary for each of the process's sequential phases.

MRP works backwards from the due date using lead times and other information to determine **when** and **how much** to order. The **MPS** is just the total amount and timeliness of all final goods to be produced over a certain period. Through customer orders and demand projections, MPS is determined.

2.2.3 Inventory Records

Inventory Records are one of the three primary inputs in MRP. It contains data on an item's status over the planning horizon, such as the quantity, supplier, order lead time, lot size, etc. Important real-time data on a company's inventory can be found in the inventory record. Accurate inventory records are absolutely required for MRP to operate correctly. It provides managers with information on the status of each item by time period - Gross requirements, Scheduled receipts, Amount on hand, Lead times, Lot sizes and more.



2.2.4 Bill of Materials (BOM)

Bill of Materials (BOM) is a list of all the components, sub-assemblies, and raw materials required to make ONE unit of a product. BOM containing part numbers, part names, descriptions, quantities, measurements and more. The lowest level at which an item occurs is the level at which it is coded. One level of BOMs is processed at a time.

2.2.5 Product Structure Tree

Product structure tree is an illustration of the needs in a bill of materials, where each component is specified according to its level of importance.

- Items above given level are called ***parents***
- Items below given level are called ***components*** or ***children***

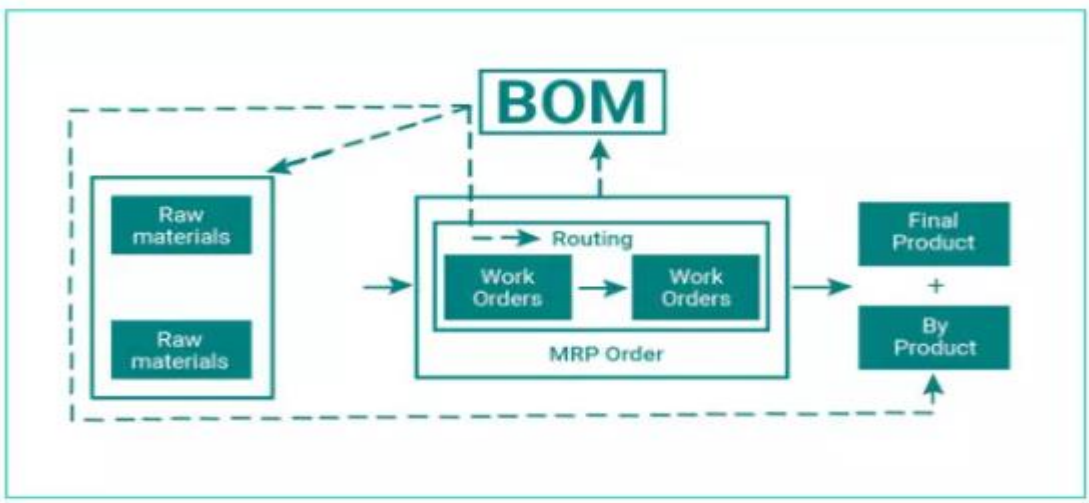


Figure 2.4: Bill of materials Structure (*James Wilson; 2020*)

Example

Example 1:

How Material Requirements Planning (MRP) works?

Answer:

For dependent-demand inventories, MRP is a piece of information technology that establishes **what, how much, and when are necessary.** Basically, dependent demand is what drives MRP. Even if neither deals with raw materials, independent and dependent demand would both be considered when calculating MRP.

MRP starts with a production schedule for completed goods and converts it into a list of the subassemblies, component components, and raw materials required to make the finished product within the specified time frame.

Example 2:

Show the steps for designing the MRP process.

Answer:

The MRP can determine with main inputs to solve the process.

a) Estimating demand and the materials required to meet it.

b) Check demand against inventory and allocate resources.

c) Known the Master Production scheduling (MPS).

d) Monitor the process with the computer system.

2.2 Summary of The Chapter

How does MRP work?

Based on demand and the bill of materials (BOM), a material requirements planning (MRP) system determines what raw materials, components, and subassemblies are required and when to assemble the finished goods (Jenkins, 2022). It accomplishes this by posing three key questions:

- **What is needed?**
- **How much do you need?**
- **When is it needed?**

The answers to these questions help to promote an effective and efficient production schedule by highlighting what materials are required, how many are required, and when to meet the necessary demand.

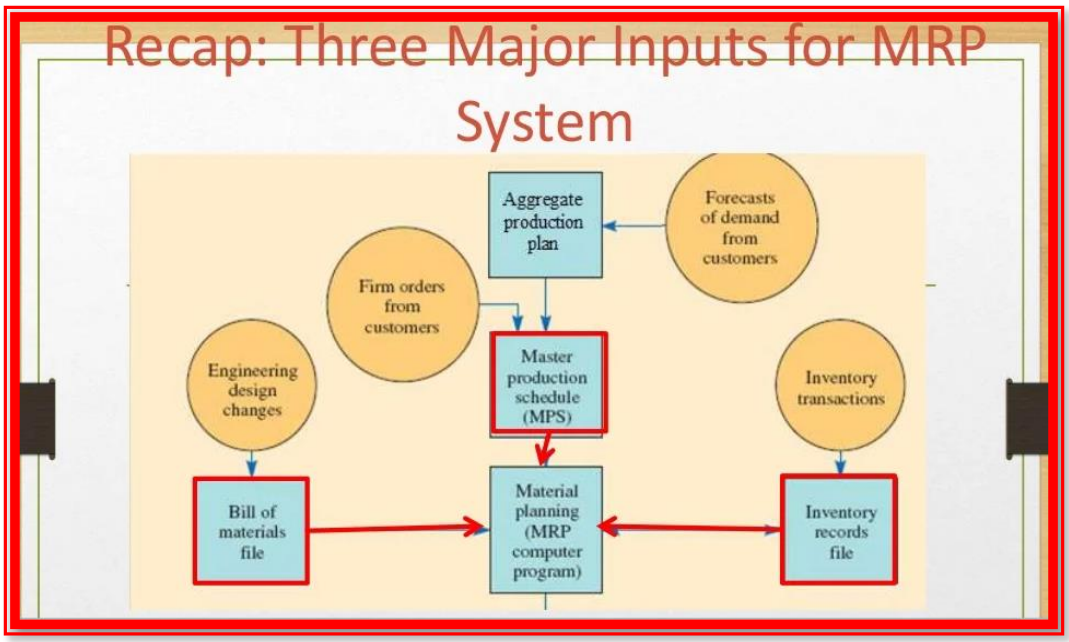


Figure 2.5: Major Inputs for MRP

https://youtu.be/6d73Y1662QQ

https://youtu.be/XiSpDVGhasQ

Checkpoint 2

It's time to test yourself. Please choose the right answer.

Q1. The primary input for materials requirement planning, which includes a declaration of the quantity and timeline of the final products to be produced is called _____.

Answer choices:

a) Master Production Schedule (MPS)

b) Material Requirement Planning (MRP)

c) Bill of Material (BOM)

Q2. Which is NOT a MRP input?

Answer choices:

a) Demand

b) Bill of materials (BOM)

c) Master production schedule (MPS)

d) Calculate needed required materials

Q3. Which of the following items DOES NOT appear in a bill of materials?

Answer choices:

a) Raw materials to be used

b) Type of demands

c) Physical dimensions

d) Number of components

CHAPTER 3

ORGANIZE INVENTORY USING MRP

After completing this lesson, you are expected to be able to:

- Organize inventory using MRP structure as follows:
  a. Tree product structure construction
  b. Time phase structure construction
  c. Bill of Material (BOM)
  d. Material Requirement Planning (MRP) table

3.1 Assembly Diagram

In manufacturing the product structure tree provides a levels of the items which form a product. With the product structure, the understanding of the components which compose a product as well as their attributes, can be represented (Project Production Institute, n.d.). A detailed description of the raw materials, parts, and instructions needed to build, manufacture or repair a product or service is known as a **bill of materials (BOM)**. The product structure shows the material, component parts subassemblies and other items in a hierarchical structure that represents the finished product at the top (Project Production Institute, n.d.) listed the grouping of items on an assembly drawing (shown in figure 3.1) that come together at a stage in the manufacturing process.

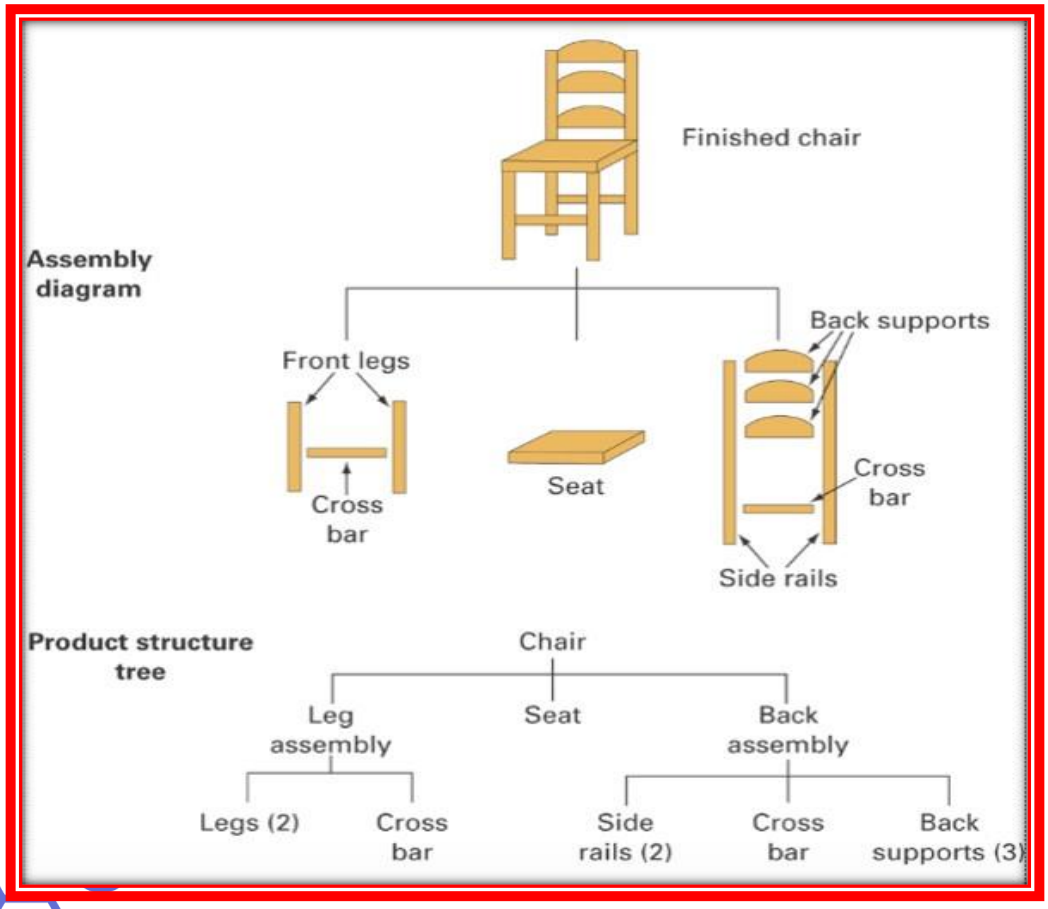


Figure 3.1: Chair Assembly diagram *(Stevenson; 2005)*

3.2 Product Structure Tree

Meanwhile, Figure 3.2 – 3.4 are exhibited few examples of product structure tree for different level of products.

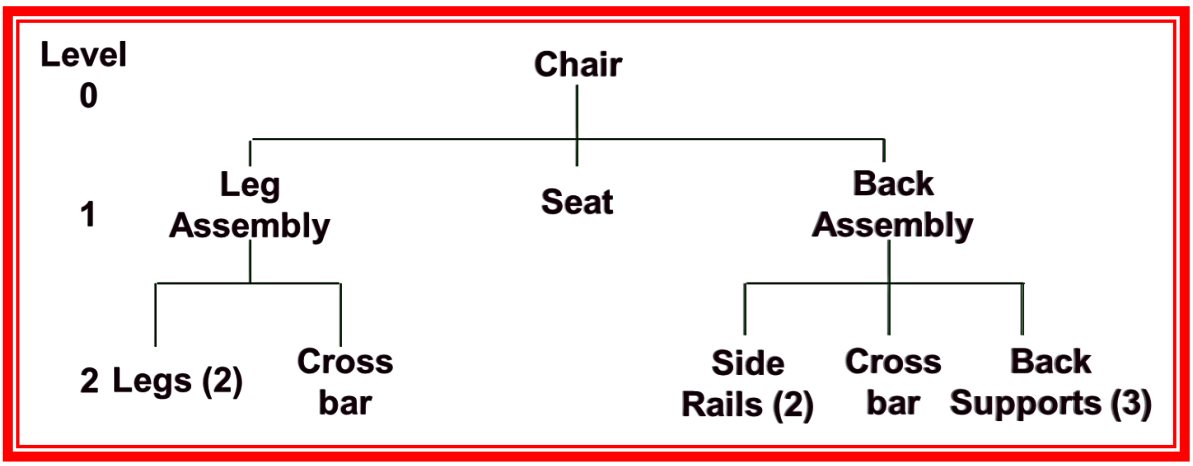


Figure 3.2: Level for Structure Tree*(Stevenson; 2005)*

If identical items exist at various levels in the BOM such as in Figures 3.3 and 3.4, the Item is coded at the lowest level at which it occurs. Let's Look at item D in Figure 3..3 . As shown in the figure, for example, **the low-level code of item D used at Level 2 and Level 3 is 3 in Product A.** The low-level code represents the lowest level of usage of material within all product structures, thus, that level will be stated for the item in BOM or product structure tree.

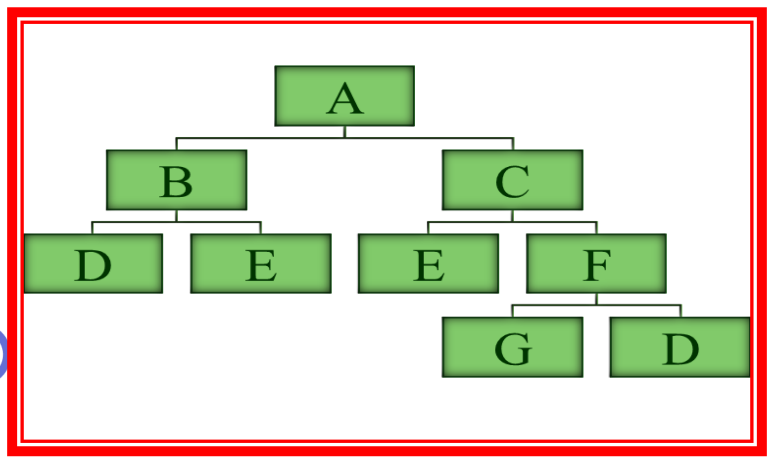


Figure 3.3: Identical item in Structure Tree

The instructions for obtaining and using the supplies are also included in BOMs. A product structure, assembly component list, or production recipe are other names for a BOM (in process manufacturing industries). **BUT product structure tree cannot be a complete BOM.**

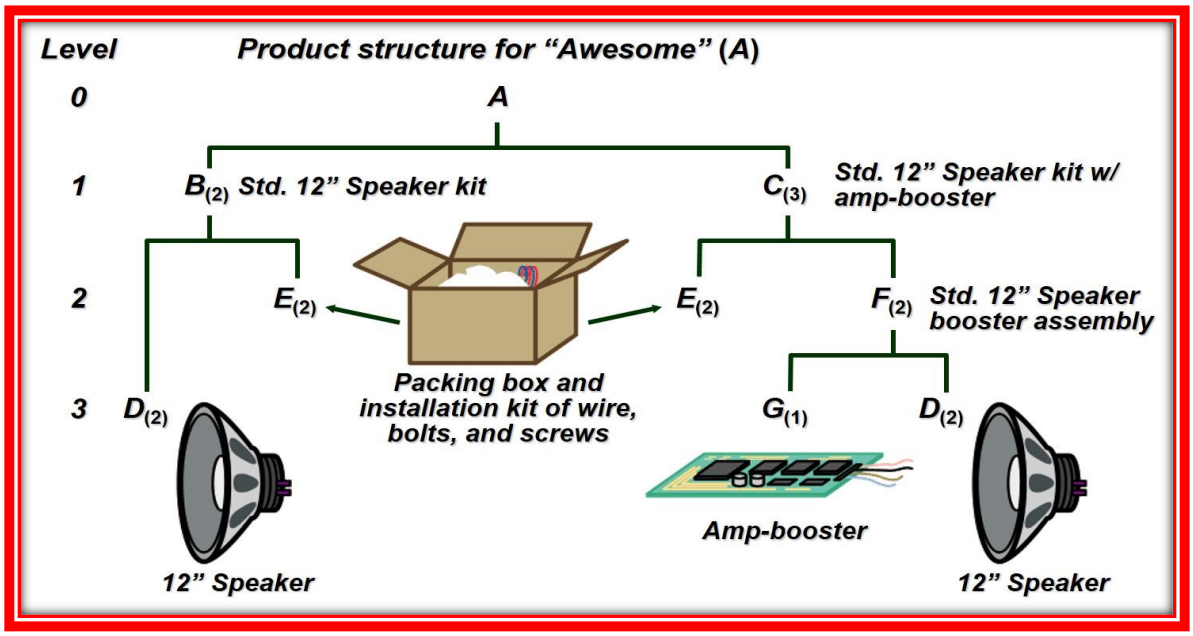


Figure 3.4: Structure Tree of Speaker (Heizer & Render, 2008)

The bill of materials will list every component needed to assemble 1,000 speakers Awesome, for instance, if a speaker company wants to make 1,000 speakers Awesome. The list would include the quantity and price of each component, along with the 12" speaker kit, 12" speaker kit amp-booster, packing box with an installation kit of wire, bolts, and screw, speaker booster assembly, amp-booster and 12" speaker. Both physical products and software-as-a-service bill of materials products can be used to build BOMs.

3.3 Bill of Material (BOM)

Usually, a BOM is organized hierarchically, with the finished product at the top. It provides product codes, descriptions of the parts, quantities, prices, and other details. The two types of BOM representation that are most frequently used are single-level and multilevel BOMs.

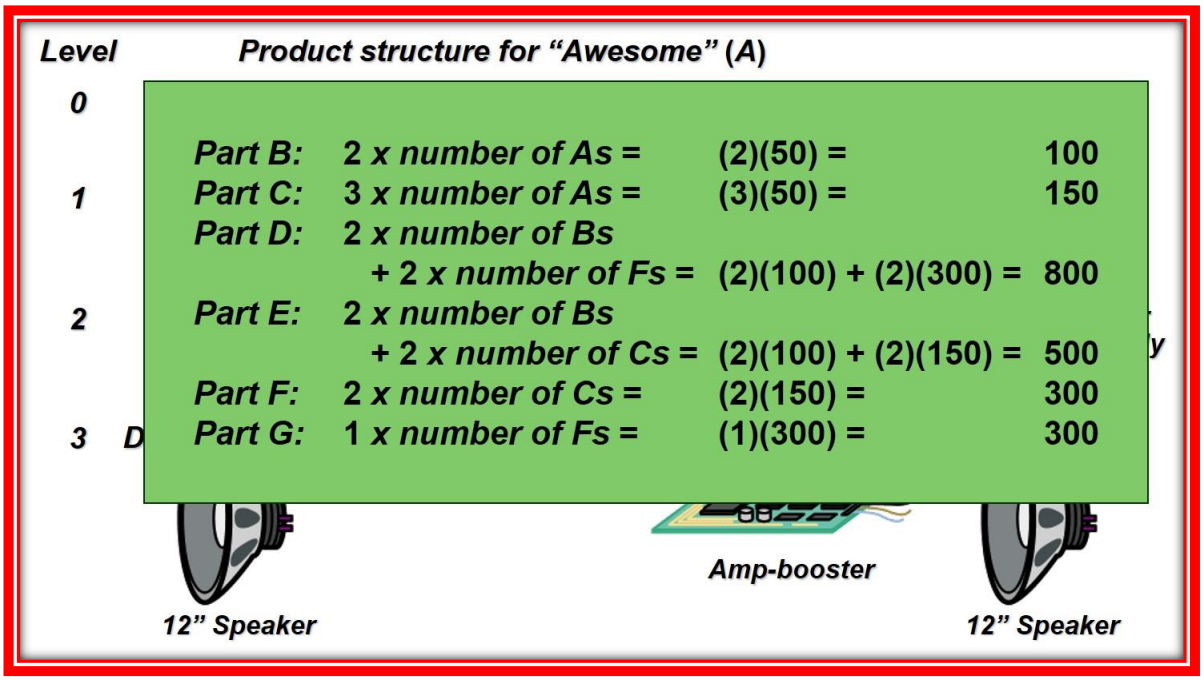
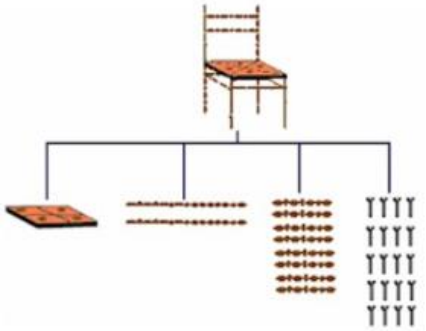


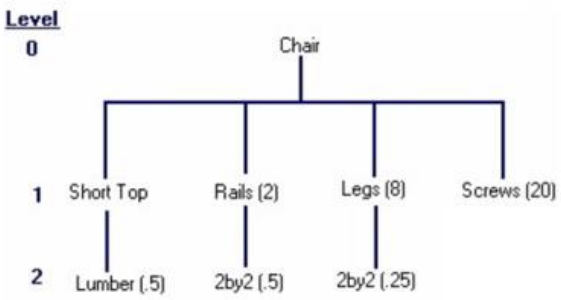
Figure 3.5: Bill of Material (Heizer & Render, 2008)

Figure 3.6 show the complete process how the chair assemble and the data from the assembly diagram can transfer to product structure tree and bill of material.

Assembly Diagram



Product Structure Tree



Bill of Materials (BOM)

Level	Item	Parent	Quantity for 1 of Parent
0	Chair	-	-
1	Short Top	Chair	1
1	Rail	Chair	2
1	Leg	Chair	8
1	Screw	Chair	20
2	Lumber	Short Top	0.5
2	2by2**	Rail, Leg	0.5, 0.25

**Each rail requires 0.5 2by2s and each leg requires 0.25 2by2s.

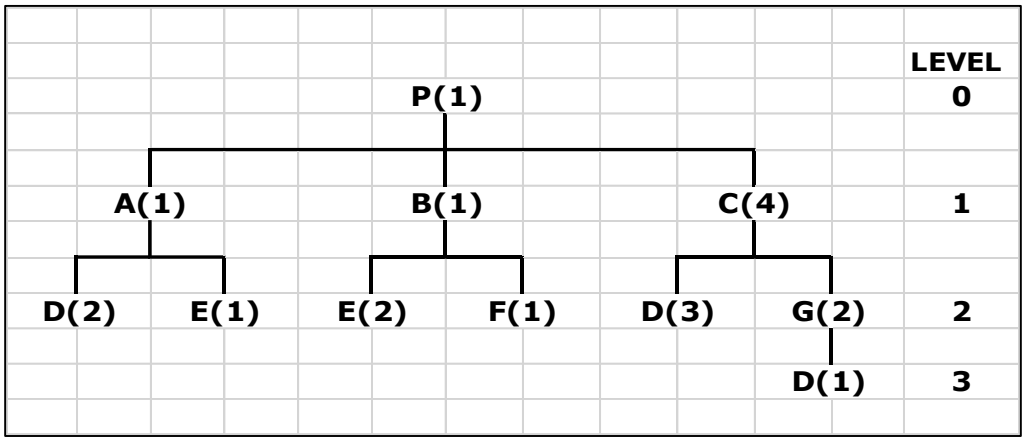
Figure 3.6: Different types of charts to present parts in a custom-made chair. (https://www.chegg.com)

Example

Product P requires 1 part A, part B and 4 parts C. Parent A requires 2 parts D and 1 part E. Meanwhile, the parent of B requires 2 parts E and 1 part F. For parent C, it requires 3 parts D and 2 parts G. At last, parent G requires 1 part D. Use the given information, present all data in the product structure tree and determine the quantities of each part needed to assemble 10 units of product P.

ANSWER:

i) Product Structure Tree



ii) Bill of Material ➔ Component D = 140 + 80 = 220

LEVEL	ITEM	UNIT OF ITEM	QUANTITY
0	P	10	10
1	A	A= 1(P)= 1(10)	10
1	B	B= 1(P)= 1(10)	10
1	C	C= 4(P)= 4(10)	40
2	D	D= 2(A)+3(C) =2(10) +3(40)	140
2	E	E= 1(A)+2(B)= 1(10)+2(10)	30
2	F	F= 1(B) = 1(10)	10
2	G	G= 2(C)= 2(40)	80
3	D	D= 1(G) = 1(80)	80

3.4 Time-Phases Product Structure

Forward scheduling works by beginning at the present and calculating the earliest date the task can be completed in three periods.

Backward scheduling means beginning with the due date and planning your workday from there. If we need to start producing clipboards by period three, we should do so right away.

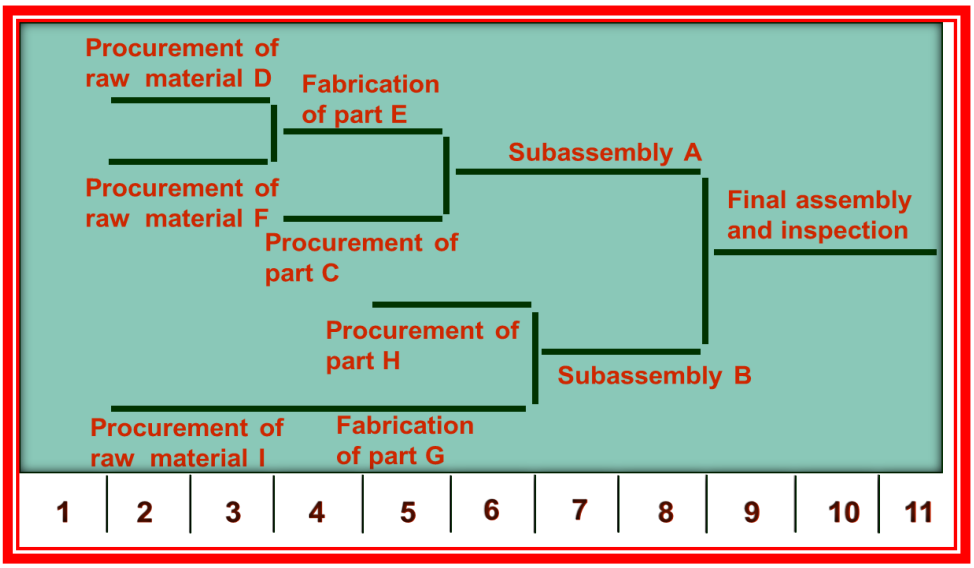


Figure 3.6: Time-Phased Product Structure (Heizer & Render, 2008)

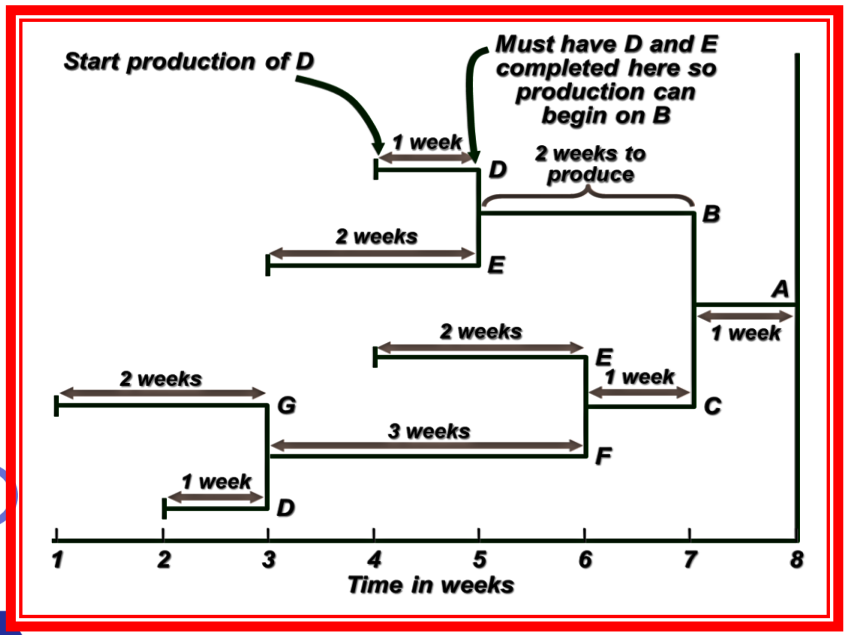


Figure 3.7: Assembly Time-Phased Product Structure (Heizer & Render, 2008)

3.5 MRP Processing

The following are some key terms related to MRP (computerized) planning forms:

3.5.1 Gross Requirements:

By the conclusion of the given time frame, these represent futuristic requirements for raw materials, component parts, subassemblies, and final goods. Either the master schedule for end goods or the sum of the requirements for other items, is used to determine these requirements (Makers, 2017).

3.5.2 Scheduled Receipts:

These are items that were ordered from a vendor or an outstanding in-house shop and will be delivered at the start of the period. MRP forms provide planned receipts as well as quantity and projected time of receipt information (Makers, 2017).

3.5.3 Projected On-hand or available balance:

The amount of a product that is expected to be on hand at the end of the given time period. This includes the amount recovered from the prior period in addition to planned collections, such as scheduled receipts and ordered receipts minus gross requirements (Makers, 2017).

(Book: Inventory balance at end of each period)

Projected On-hand = (Scheduled receipts + inventory carried forward)

3.5.4 Net requirements: These are the net requirements for a given period, which are equal to the gross requirements minus the projected inventory from the previous period along with the scheduled receipts.

Net requirements = Gross requirements – [On hand product quantity + Scheduled receipts]

3.5.5 Planned order receipt:

These indicate materials that need to be ordered from a vendor or in-house shop and will be delivered at the beginning of the period, or they resemble a scheduled receipt (Makers, 2017).

3.5.6 Planned order release:

These are the projected quantities that will be ordered during the adjusted time frame, considering the lead time offset, to ensure that the materials arrive on schedule (Makers, 2017).. The planned order releases are removed from the form when orders are released, and the receipts they produced are changed to scheduled receipts. The MRP system's gross or forecasted requirements for completed goods are determined by the MPS, which does not take inventory in-stock or on order into account.

By processing all key bills of materials on every level, the MRP computer programme then explodes the demands for finished items into requirements for part components and supplies. After that, net requirements are calculated by subtracting goods from current inventory as well as those that have been ordered and noted in the inventory status file. The detail of MRP planning forms is presented as in Figure 3.8.

3.6 MRP Output

Primary reports and secondary reports are both possible MRP output forms. Planned order schedules, order releases, and changes to planned orders are the three kinds of primary reports. Future material orders are specified in terms of timing and amount by planned order schedules. Order releases provide permission for future orders. Revisions or cancellations to the time period or number of planned orders are possible.

3.7 Other Considerations

3.7.1 Safety Stock

Safety stock is the amount of stock that is intended to be kept in stock to guard against changes in demand and/or supply. BOMs, inventory records, purchasing and production numbers could not be accurate since safety stock might be a wise decision (Heizer & Render, 2008). It must be reduced and ultimately got rid of. Usually included in the projected on-hand inventory.

3.7.2 Lead Time in MRP Systems

- The planned period given for orders to go through the manufacturing chain is represented by **lead times in MRP systems**. Setting lead times is a significant problem for MRP systems.
    - For purchased items – the period between the recognition of a requirement and the item's availability for production (Heizer & Render, 2008).
    - For production – the sum of the order, wait, move, setup, store, and run times (Heizer & Render, 2008).

3.7.3 Lot Sizing Techniques

There can be a minimum or maximum order size for items that need to be purchased or because of technical issues. It may be necessary to use more than the specified number of purchased parts or subassemblies (e.g., multiples of 50). The quantity of each order is determined by rules that alter the frequency of replenishment orders (balance holding & ordering costs to reduce total costs).

Lot sizing - item quantity that is made or purchased:

- Lot-for-lot ordering (L4L)
- Fixed period ordering
- Economic order quantity (EOQ)
- Fixed-order quantity (FOQ)

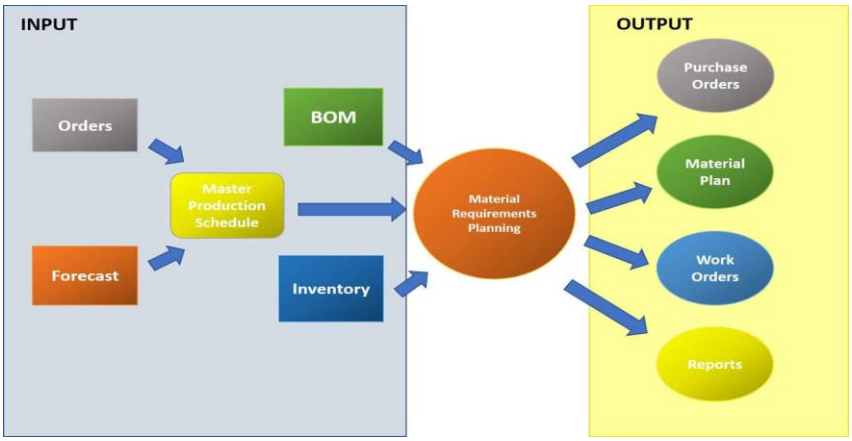
Common rules for determining lot sizing include:

- Lot-for-lot ordering policy: When you wish to obtain the correct lot size again, you arrange using lot-for-lot order quantity (L4Lor LFL). Lots as needed or intended.
- Fixed-size lot ordering policy (FOQ): If a material is only delivered, for instance, in pallets of a given number or in tanks of a certain size, choosing a fixed lot size for it is useful.
  - Minimum order quantities
  - Maximum order quantities
  - Economic order quantity
  - Periodic order quantity
  - Multiple order quantities

Week Number	0	1	2	3	4	5	6	7	8
Item:									
Gross Requirements									
Scheduled Receipts									
Projected on Hand									
Net Requirements									
Planned-order Receipts									
Planned-order Releases									

Figure 3.8: MRP Table

3.8 Summary of The Chapter



Source:
Andy Marker, 2017.
https://www.smartsheet.com/

MRP Inputs

Each input must be correct and up-to-date for an MRP system to function effectively. An MRP depends on the following inputs:

Demand: A system that relates to an enterprise-wide ERP system enables forecasting utilizing historical sales rather than just sales projections when dealing with expected demand.

Bill of Material (BOM): To accurately estimate and plan supplies, a single updated version of the bill of materials must be maintained. Version control problems and building against obsolete invoices, which cause reworks and more waste, are avoided by a system that is connected.

Inventory: To know what items you have on hand, which are in transit or have purchase orders issued, where that inventory is, and what its status is, you must have a real-time view of inventory across the entire business.

Master Production Schedule (MPS): The master production schedule accounts for all the build needs and plans the use of the machinery, people, and workstations to finish all outstanding work orders.

https://youtu.be/TXID6w2UV6s

https://youtu.be/Dis3UYcEXVw

Important terms used with MRP:

Time bucket: period, usually 1 week.

Planning horizon: the total number of periods, which are subsequently split into time fences.

Lead time offset subtracts a necessary replenishment from a planned order release.

Net requirement: the discrepancy between gross requirements and stock on hand.. **Gross Requirements minus Scheduled Receipts minus Projected on hand**.

Gross requirements: the amounts needed for each period based on the item's expected usage (or demand).

Scheduled receipts: Orders for current replenishment that are due at the start of the period.

Projected on hand: The item's anticipated inventory status at the start of each session.

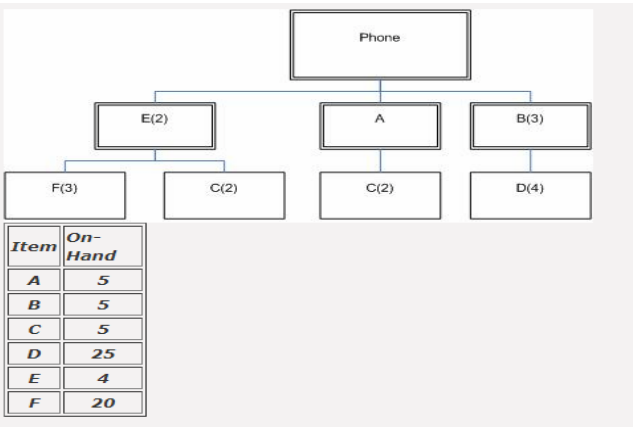
Planned order receipt: planned receipt of replenishment orders at the beginning of the period.

Planned order release: release of planned replenishment orders for the item using lead-time offset.

Checkpoint 3

It's time to test yourself. Please choose the right answer.

Q1. Calculate how many products Cs need to be ordered in order to make 20 phones using the product structure tree and inventory data shown in the accompanying figure.



Item	On-Hand
A	5
B	5
C	5
D	25
E	4
F	20

Answer choices:

a. 120
b. 97
c. 105
d. 115

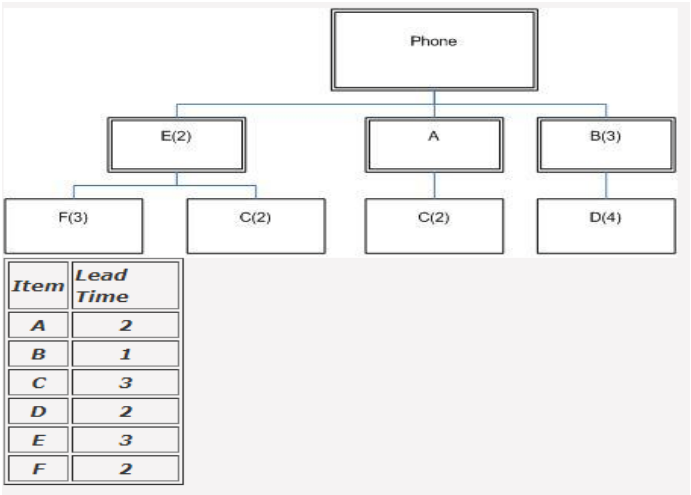
Q2. Refer to the information provided in Q1, calculate the quantity that should be ordered for items B, D and F in case to produce 20 phones.

Solution:

Item	Quantity need to order in producing 20 phones
B	
D	
F	

Checkpoint 3

Q3. If it takes two weeks to assemble the phones, use the product structure tree and the lead time data (in weeks) to determine when to place an order for Fs to deliver the phones in week 10. Assume that no component or end item has any initial inventory.



Item	Lead Time
A	2
B	1
C	3
D	2
E	3
F	2

Answer choices:

a. week 4
b. week 5
c. week 3
d. week 2

Q4. Which is not an inventory record?

Answer choices:

a. Item Master File
b. Transaction File
c. Location File
d. Available Quality

CHAPTER 4

ANALYZE THE MRP TABLE

After completing this lesson, you are expected to be able to:

- Arrange each item of MRP processing in Material Requirement Planning (MRP) table correctly.

4.1 Material Requirement Planning System

Using a master production schedule as a basis, a system for material requirements planning:

- Creates schedules identifying the specific parts and materials required to produce end items.
- Determines exact unit numbers required.
- Based on lead times, determines the dates that orders for such materials should be released (Heizer & Render, 2008).

4.2 Accurate Record

The proper operation of MRP (or any dependent demand system) depends entirely on accurate inventory records. MRP systems typically seek 99% accuracy. Quantities and scheduled receipts must be appropriately reflected in all outstanding purchase orders.

4.3 Steps in Materials Requirement Planning

The MRP process consists of these three key steps as shown in Figure 4.1:

4.3.1. Exploding

Finding the quantity of each raw material required to generate the target number of finished goods is the aim of the explosion step. The Bill of Materials (BOM) for each product is examined in this process.

4.3.2. Netting

The net needs for each raw material are established using the netting step. It considers the exploding phase as well as any current inventory levels.

4.3.3. Offsetting

A production schedule is generated using the offsetting step. The manufacturing schedule indicates the best times to create each final product and to order each raw material .It's vital to remember that these procedures can be carried out manually or computerized. Businesses utilize software to track and manage inventories in a computerized system. It can make it simpler to keep track of massive amounts of data and adjust the manufacturing schedule, as necessary.

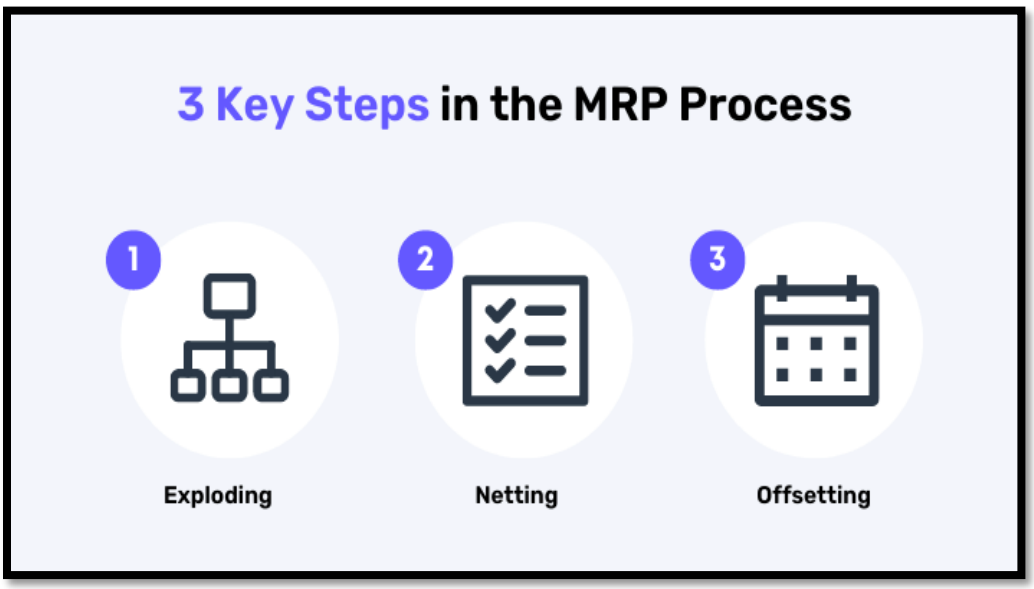
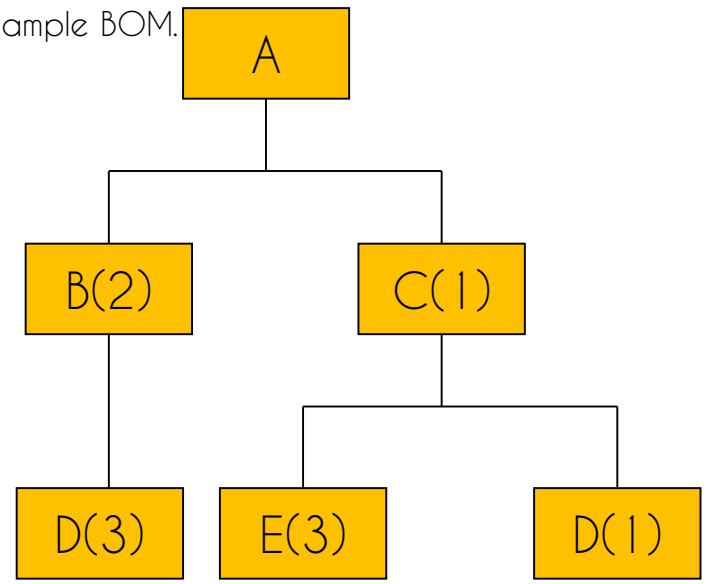


Figure 4.1: Key Steps in the MRP Process (*Rob Paredes, 2022.)*

Example

QUESTION 1

Let's look at an example BOM.

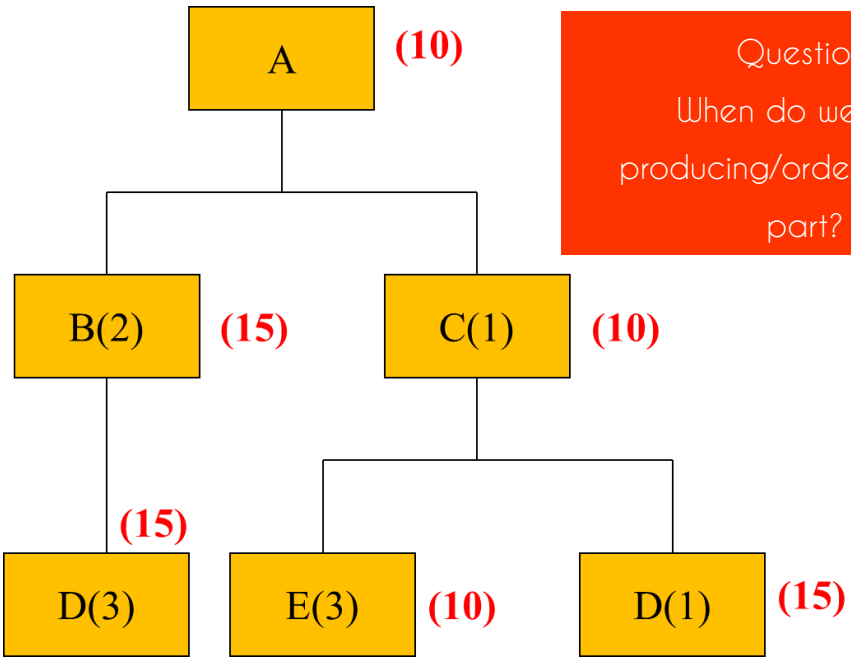


How do we manage order release?

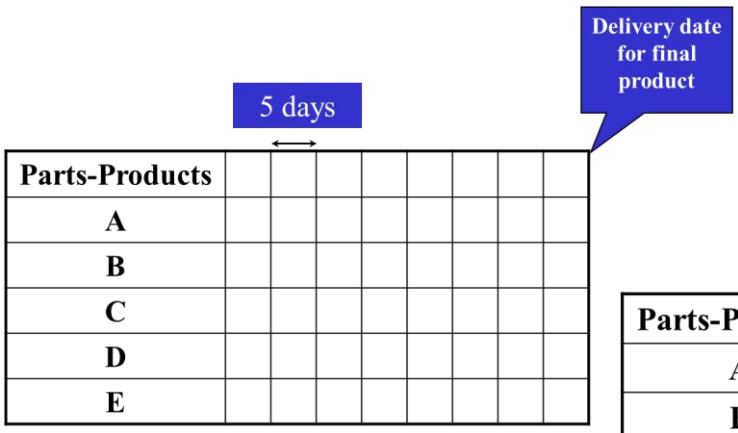
We need information on delivery times!

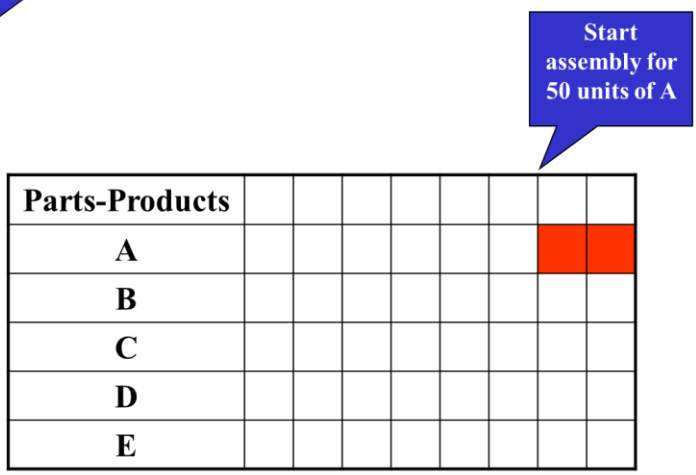
Parts-Product	Process Lead Time
A	10
B	15
C	10
D	15
E	10

Let's assume that we need 50 units of A...

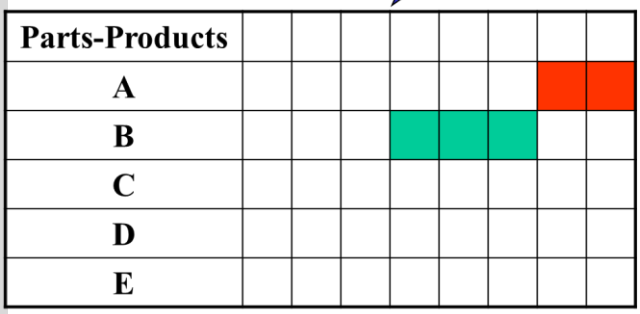


Question:
When do we start producing/ordering each part?

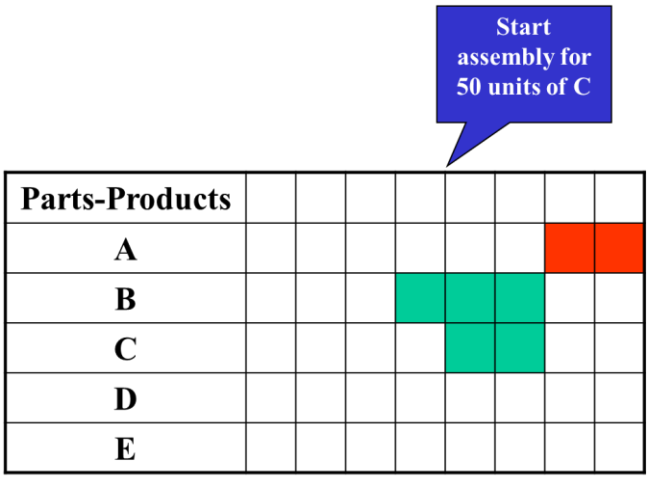




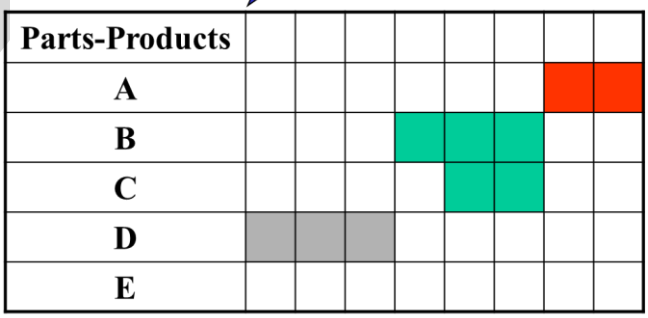
Start assembly for 100 units of B



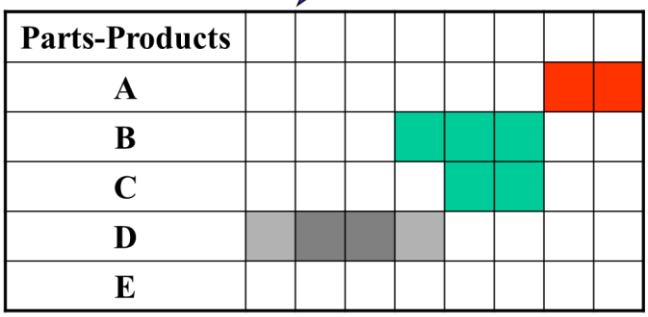
Start assembly for 50 units of C



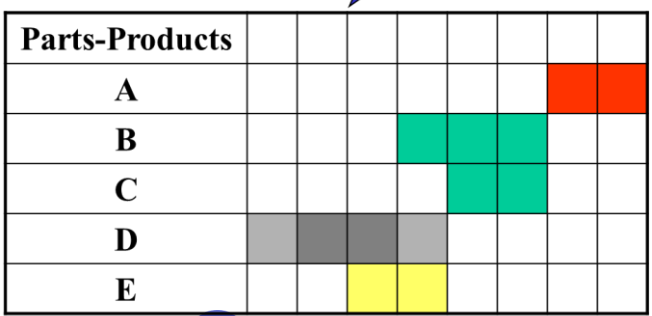
Order 300 units of D for B's process



Order 50 units of D for C's assembly

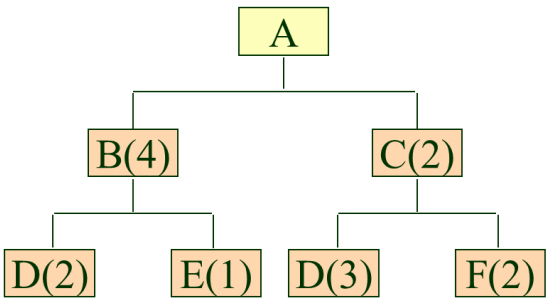


Order 150 units of E for C's assembly



QUESTION 2:

Give a materials requirements plan that specifies the quantity of each component and when it will be required based on the product structure tree for "A" and the lead time and demand information below. Product Structure Tree for Assembly A



Lead Times	
A	1 day
B	2 days
C	1 day
D	3 days
E	4 days
F	1 day

Demand	
Day 10	50 A
Day 8	20 B (Spares)
Day 6	15 D (Spares)

SOLUTION:

Give a materials requirements plan that specifies the quantity of each component and when it will be required based on the product structure tree for "A" and the lead time and demand information below.

	Day:	1	2	3	4	5	6	7	8	9	10
A	Required										50
	Order Placement									50	

LT = 1 day

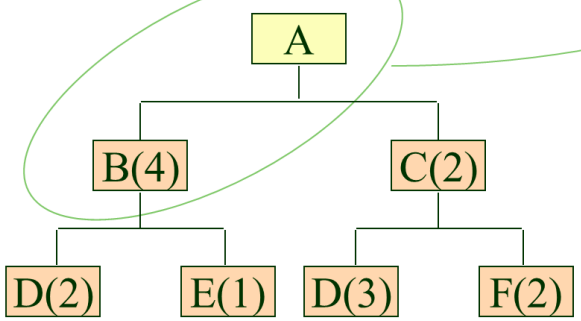
Next, we need to start scheduling the components that makeup "A". In the case of component "B", we need 4 B's for each A. Since we need 50 A's, that means 200 B's. And again, we back the schedule up for the necessary 2 days of lead time.

	Day:	1	2	3	4	5	6	7	8	9	10
A	Required										50
	Order Placement									50	
B	Required								20	200	
	Order Placement						20	200			

LT = 2

Spares

4x50=200



Finally, repeating the process for all components, we have the final materials requirements plan:

	Day:	1	2	3	4	5	6	7	8	9	10
A	Required										50
LT=1	Order Placement									50	
B	Required								20	200	
LT=2	Order Placement						20	200			
C	Required									100	
LT=1	Order Placement								100		
D	Required						55	400	300		
LT=3	Order Placement			55	400	300					
E	Required						20	200			
LT=4	Order Placement		20	200							
F	Required								200		
LT=1	Order Placement							200			

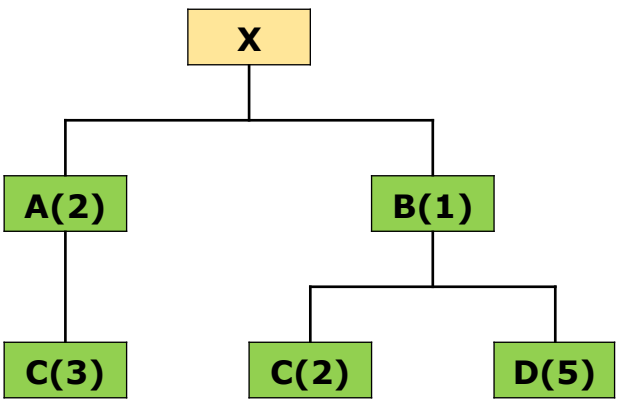
Part D: Day 6

40 + 15 spares

QUESTION 3:

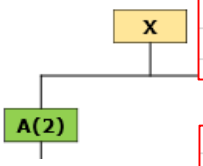
Requirements include 95 units (80 firm orders and 15 forecast) of X in week 10.

Item	On-Hand	Lead Time (Weeks)
X	50	2
A	75	3
B	25	1
C	10	2
D	20	2

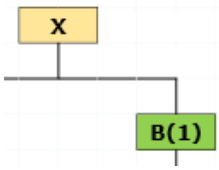


SOLUTION:

	Week Number	0	1	2	3	4	5	6	7	8	9	10
X	Gross Requirements											95
LT=2	Scheduled Receipts											
On-Hand 50	Projected on Hand	50	50	50	50	50	50	50	50	50	50	50
	Net Requirements											45
	Planned-order Receipts											45
	Planned-order Releases									45		

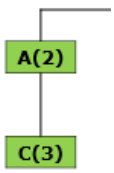


	Week Number	0	1	2	3	4	5	6	7	8	9	10
A	Gross Requirements									90		
LT=3	Scheduled Receipts											
On-Hand 75	Projected on Hand	75	75	75	75	75	75	75	75	75		
	Net Requirements									15		
	Planned-order Receipts									15		
	Planned-order Releases						15					

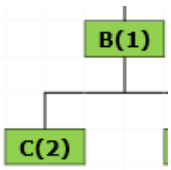


	Week Number	0	1	2	3	4	5	6	7	8	9	10
B	Gross Requirements									45		
LT=1	Scheduled Receipts											
On-Hand 25	Projected on Hand	25	25	25	25	25	25	25	25	25		
	Net Requirements									20		
	Planned-order Receipts									20		
	Planned-order Releases								20			

It takes 1B for each X

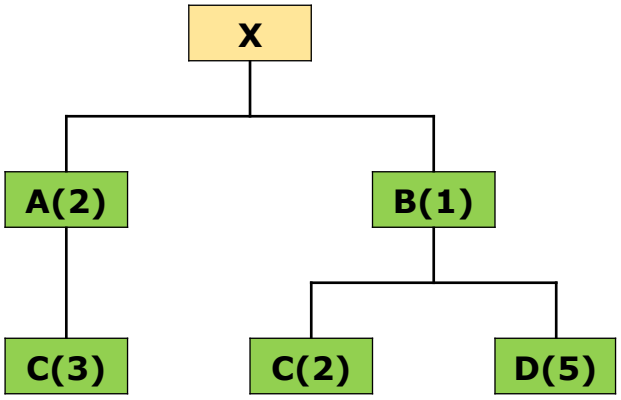


It takes 3 C's for each A



It takes 2 C's for each B

	Week Number	0	1	2	3	4	5	6	7	8	9	10
C	Gross Requirements						45		40			
LT=2	Scheduled Receipts											
On-Hand 10	Projected on Hand	10	10	10	10	10	10					
	Net Requirements						35		40			
	Planned-order Receipts						35		40			
	Planned-order Releases				35		40					



It takes 5 D's for each B

	Week Number	0	1	2	3	4	5	6	7	8	9	10
D	Gross Requirements								100			
LT=2	Scheduled Receipts											
On-Hand 20	Projected on Hand	20	20	20	20	20	20	20	20			
	Net Requirements								80			
	Planned-order Receipts								80			
	Planned-order Releases						80					

Item B is parent to item D

X5

	Week Number	0	1	2	3	4	5	6	7	8	9	10
B	Gross Requirements									45		
LT=1	Scheduled Receipts											
On-Hand 25	Projected on Hand	25	25	25	25	25	25	25	25	25		
	Net Requirements									20		
	Planned-order Receipts									20		
	Planned-order Releases								20			

4.4 Summary of The Chapter

Source: *Abby Jenkins, 2022.* https://www.netsuite.com/portal

Steps and Processes for MRP

There are four main steps that make up the MRP process:

1. Determining the needs to satisfy the demand (Jenkins, 2022).

By entering customer orders and sales predictions, the MRP process begins by determining consumer demand and the requirements necessary to satisfy it.

2. Inventory review and resource allocation(Jenkins, 2022).

You can monitor what you have in stock and where it is by using the MRP to compare demand to inventory and allocating resources accordingly. Additionally, you can view the status of items, providing visibility into both those that have been ordered but have not yet arrived at the warehouse and those that have been allocated to a different project. The MRP then directs inventory to the appropriate places and generates suggestions for reorders.

3. production planning.

The system calculates how much time and labour are needed to finish each phase of each build and when they need to happen so that production can proceed without interruption using the master production (Jenkins, 2022).

https://youtu.be/cmFsIesel8U

4. Identifying issues and offering suggestions.

Finally, because the MRP connects work orders, customer orders, and raw materials, it can automatically notify your team when items are delayed and offer suggestions for current orders, such as automatically shifting production into or out of the order, performing what-if analyses, etc (Jenkins, 2022). .

The MRP technique is made up of **four steps** that are applied to each item in ascending order of their low-level code, starting with the finished items, then moving on to the assemblies and semi-finished products, and finally moving to the purchased goods. Finding the gross requirement, which might include both independent and dependent requests, is the first step. In order to calculate the net requirement, the physical inventory, safety stock, open orders, and allocated amounts must be offset. The third step is to create batches by combining the individual net requirements. The batch sizes are transformed into order proposals in the fourth step. Scheduling determines the start date.

Source: *Abby Jenkins, 2022.* https://www.netsuite.com/portal

https://youtu.be/kK4Dd6EELtQ

Checkpoint 4

It's time to test yourself. Please choose the right answer.

Q1. MRP processes is_____

Answer choices:

A. Bill of material - Netting inventory - Lot sizing - Time requirements

B. Lot sizing - Netting inventory - Bill of material - Time requirements

C. Netting inventory - Bill of material - Lot sizing - Time requirements

Q2. There are 20 As available now in week 1. At the beginning of week 5, we require 300 As. When and how much of an order should be placed to fulfil the need for 300 As if scheduled receipts of 120 As each for weeks 3 and 4 are planned and A has a lead time of 1 week?

Answer choices:

A. Week 1, 300 As

B. Week 1, 40 As

C. Week 5, 40 As

D. Week 4, 40 As

Q3. Considering the gross material requirements plan, which of the following propositions is TRUE?

Answer choices:

A. It displays the overall demand for a product.

B. It indicates when a product must be ordered from a supplier or when production needs to begin.

C. A precise bill of materials is one of the inputs needed.

D. All the statements are true.

Checkpoint 4

Q4. There has been an order for 110 pieces of Product M. Product M is now available in 30 units. For every M, 4 units of component N are needed. N is available in 20 unit quantities. What are N's net requirements?

Answer choices:

A. 150

B. 170

C. 300

D. 320

Q5. Consider the following specifications for a certain product.

- ▶Beginning inventory = 500 units
- ▶Setup cost = $500 per setup
- ▶Lead time = 1 week
- ▶Holding cost = $3 per unit per week

Calculate the total relevant costs.

Period	1	2	3	4	5	6	7	8
Gross requirements	0	200	200	500	0	400	0	400

Answer choices:

A. 3900

B. 5400

C. 1500

D. 500

BRIEF NOTES MRP

MATERIAL REQUIREMENT PLANNING (MRP)

A computerized information system to aid in managing dependent demand inventory and scheduling replenishment orders.

1 Purposes of MRP

- ❑ Inventory – right part, quantity. Time
- ❑ Capacity – complete load
- ❑ Priority – due date

2 Inputs to MRP

- ❑ Bill of material (BOM)
- ❑ Master production schedule (MPS)
- ❑ Inventory record database

Bill of Material (BOM)

- ✓ All the components of an item
- ✓ Usage quantities (for unit parent)
- ✓ The parent-component relationships

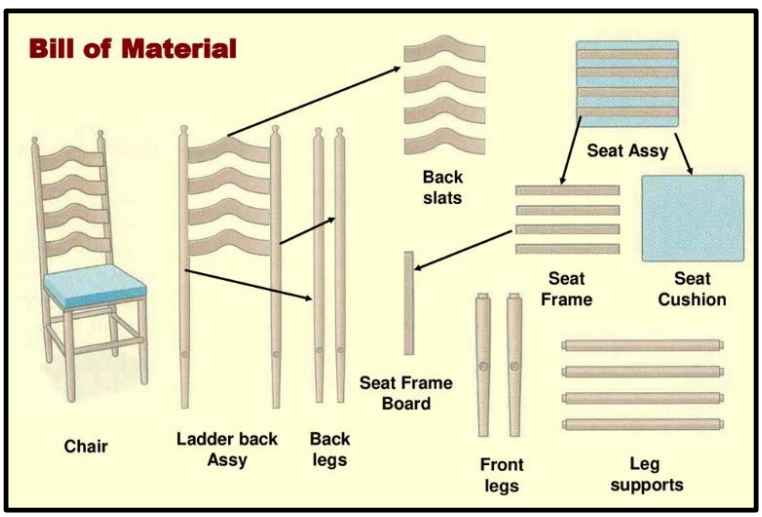


Figure 4.2: Bill of material for a chair
(Krajewski and Ritzman, 2002; https://slideplayer.com/slide/15307953/)

BRIEF NOTES MRP

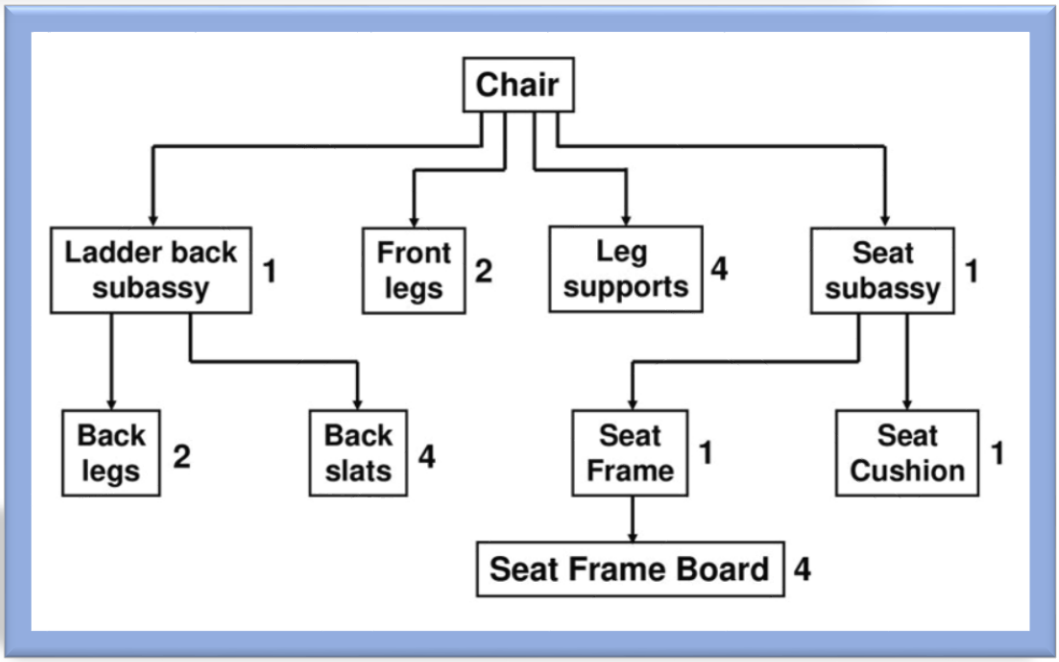


Figure 4.3: Bill of material in structure tree
(Krajewski and Ritzman, 2002; https://slideplayer.com/slide/15307953/)

Master production schedule (MPS)

✓ Details of how many end items will be produced within specified periods of time.

	APRIL				MAY			
Aggregate production plan for chair family	670				670			
Week number	1	2	3	4	5	6	7	8
Ladder-back chair	150					150		
Kitchen chair				120			120	
Desk chair		200	200		200			200

Figure 4.4: Master Production Schedule (Krajewski and Ritzman, 2002; https://slideplayer.com/slide/15307953/)

BRIEF NOTES MRP

Inventory Record

✓ A record that shows an item's lot-size policy, lead time and various time-phased data (Krajewski and Ritzman, 2002).

	Week Number	1	2	3	4	5	6	7	8
Lot size 230	Gross Requirements	150			120		150	120	
LT= 2 wks	Scheduled Receipts	230							
On-Hand 37	Projected on Hand	117	117	117	227	227	77	187	187
	Net Requirements				230			230	
	Planned-order Receipts				230			230	
	Planned-order Releases		230			230			

	Week Number	1	2	3	4	5	6	7	8
Lot size 230	Gross Requirements	150			120		150	120	
LT= 2 wks	Scheduled Receipts	230							
Safety stock	Projected on Hand	117	117	117	227	227	307	187	187
= 80 units	Net Requirements				230		230		
	Planned-order Receipts				230		230		
	Planned-order Releases		230		230				

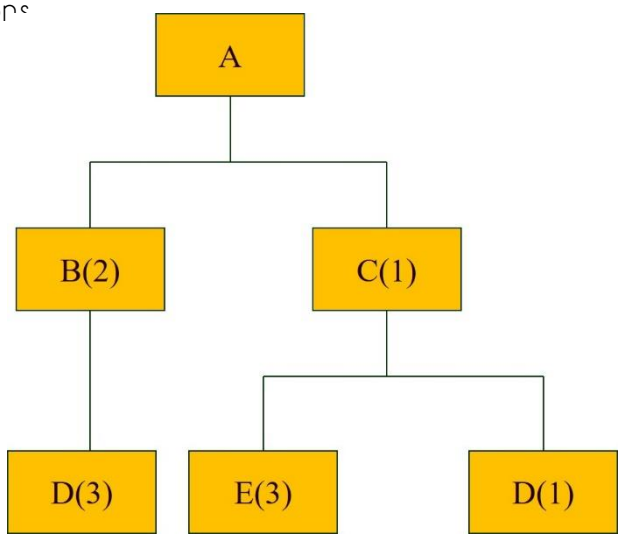
	Week Number	1	2	3	4	5	6	7	8
Lot for Lot	Gross Requirements	150			120		150	120	
LT= 2 wks	Scheduled Receipts	230							
	Projected on Hand	117	117	117	0	0	0	0	0
	Net Requirements				3		150	120	
	Planned-order Receipts				3		150	120	
	Planned-order Releases		3		150	120			

EXERCISE

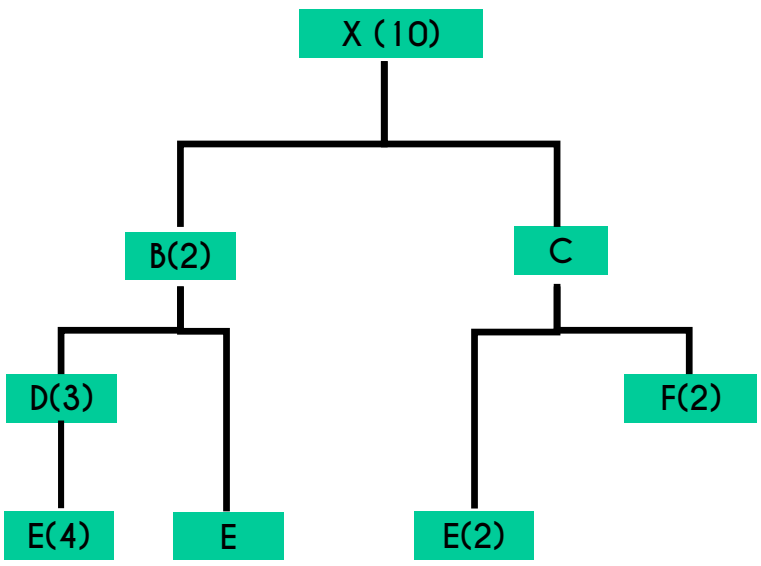
1. State **FIVE (5)** inputs to processing Material Requirement Planning (MRP).

2. Identify the specific requirements of an effective Material Requirement Planning (MRP) system.

3. Calculate the number of D's we need in order to produce 50 A's. Show all related calculations.

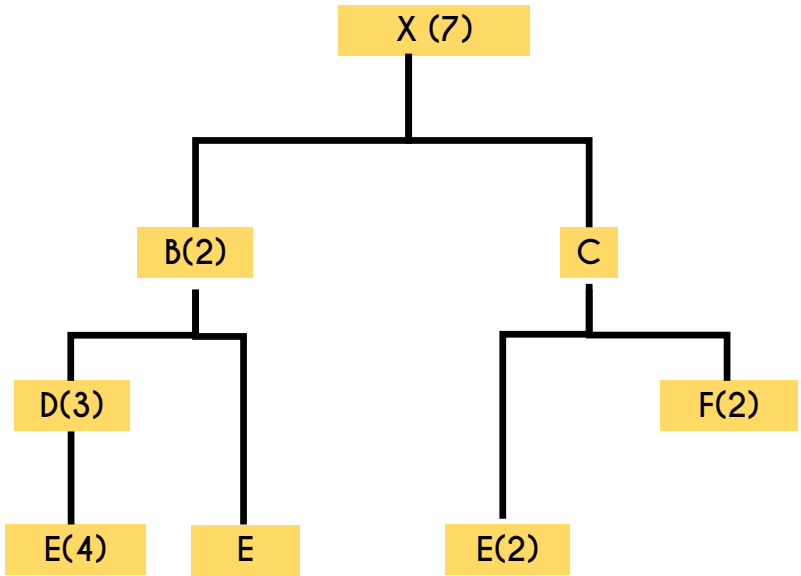


4. Calculate the number of each component needed (how many more) to make 15 X's **if there are 5 of each already in stock**. Show all related calculations.

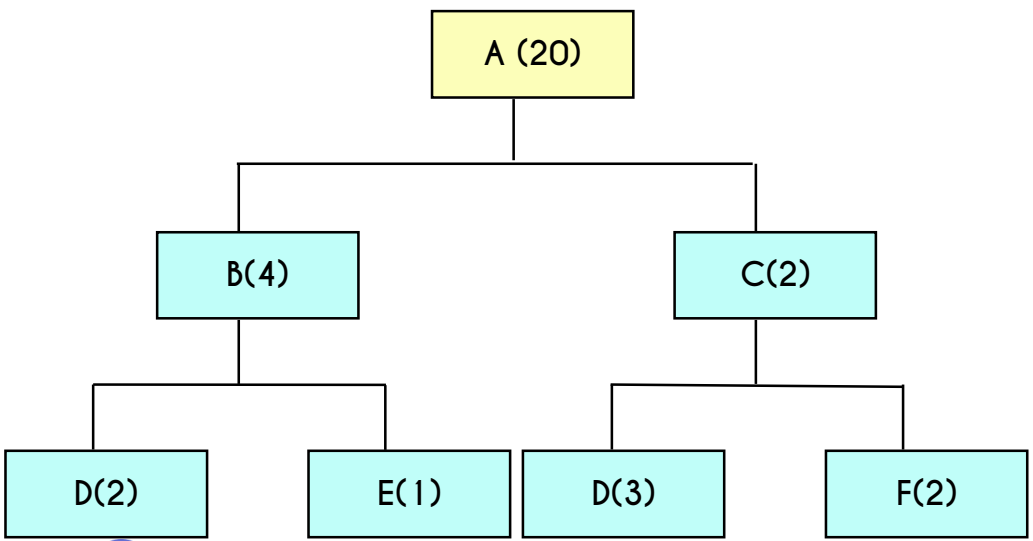


EXERCISE

5. Calculate the number of each component needed (how many more) to make 15 X's if **there are 8 of each already in stock**. Show all related calculations.



6. Calculate the number of each component needed (how many more) to make 40 A's if **there are 20 of each already in stock**. Show all related calculations.



EXERCISE

7. Given the structure tree, inventory table and MPS for each item. Solve the MRP for each item below.

Master production schedule (MPS) for item A and C

Week No.	1	2	3	4	5	6
Gross requirements of A				80		
Gross requirements of C						50

Inventory record for each item.

Item	Lead time (week)	Lot size
A	1	Lot for lot
C	1	Lot for lot
D	2	100
F	1	Lot for lot

EXERCISE

8. product A needs 1 unit B and C. Then product B needs 2 units D and 2 units C. Each unit of C needs 1 unit of E and F. Furthermore, the item of C from level 2 needs 1 unit of E and F. Given the table below for inventory record.

Item	Lead time	Quantity On Hand
A	1	10
B	2	20
C	3	0
D	1	100
E	1	10
F	1	50

Master Production Schedule for A

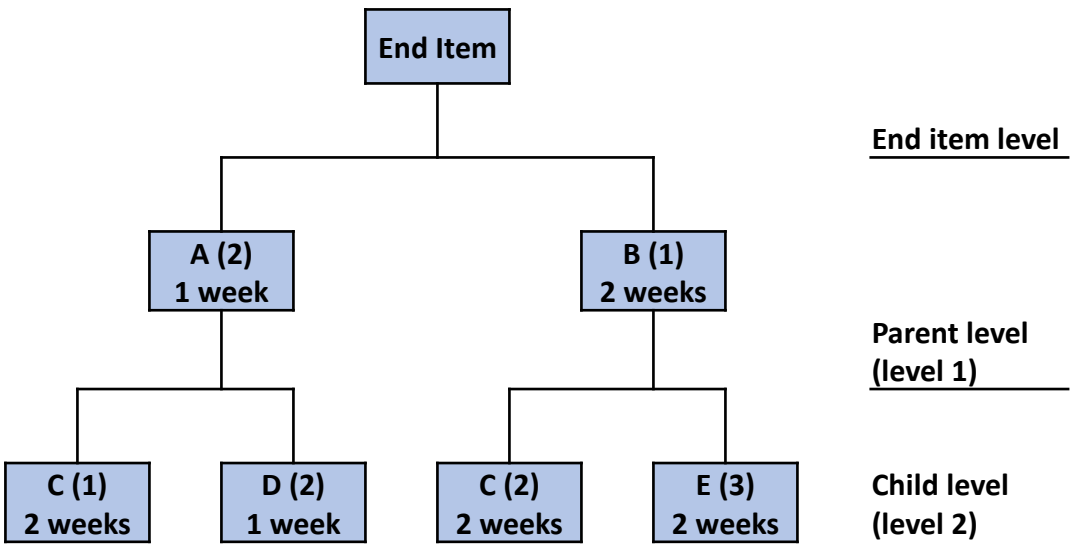
Period	1	2	3	4	5	6	7	8	9
Gross Requirement				50			50		100

a. Draw the tree structure
b. Sketch the time-phased
c. Construct the net Material Requirement Planning (MRP) for product A

9. Explain **THREE (3)** benefits of Material Requirement Planning (MRP).

EXERCISE

10. Azuma Sdn. Bhd. receives an order of 500 units for product X which have to be completed by the end of week 10. Product X needs 2A components and 1B component. Each component of B uses 2C components and 3E components. To complete A component, it needs 1C component and 2D components. The product structure diagram for product X with lead times is shown in Figure Q4 (b). Assume 1 week to assemble X and there is no on-hand inventory available for all components, calculate every component that is needed to produce 500 units of product X.



CASE STUDY RELATE TO TOPIC

INSTRUCTION:

Form a group of 3 or 4 people, set up a company or select an existing company which produces at least THREE (3) products. Explain the company and products as per format below. Submit one report and prepare a presentation as provided in presentation guideline. Please attach your presentation slide as an appendix to your report. Your report must use font "Times New Roman", size 12, and 1.5 line spacing.

Table of Content

1. Company Background
   i. Name
   ii. Organization Chart
2. Introduction to Product
   i. Product's Name
   ii. Product Description (picture/sketching, function/operation, material used, price, bill of material BOM) **The information will be used in inventory management.*
   iii. Manufacturing process of each product (show your process flow chart, the processing time for each process, and sequence of the activity) **The information will be used in MPS.*
3. Inventory Management
   i. Identify/show types of inventory in your warehouse, factory and distribution center.
   ii. Set aggregate planning, MPS & MRP for each product (monthly for one year) **The information will be used in MRP.*

PLO4: Conduct investigations of well-defined problems; locate and search relevant codes and catalogues, conduct standard tests and measurements.
CLO2: Integrate Material Requirement Planning (MRP) and inventory control for manufacturing process controlling activities.(C4, PLO4)
CLS2: Knowledge & Understanding

CASE STUDY RELATE TO TOPIC

Table of Content

3. **Inventory Management**
   iii. Select & justify the inventory model (EOQ) for each product, then determine;
   - Annual setup cost
   - Annual holding cost
   - Optimal ordering number
   - Expected numbers of orders
   - Total cost
   - Expected time between orders
4. **Material Requirement Planning (MRP)**
   i. Identify major elements in MRP and explain them.
   ii. Organize each product inventory by using MRP and show items as follows for each product your group selected.
      a. Tree product structure construction
      b. Time phase structure construction
      c. Bill of Material (BOM)
      d. Material Requirement Planning (MRP) table
5. **Conclusion**
   i. Conclusion about your products and company.
   ii. What did you learn/get from this case study.
6. **References (use APA format)**
7. **Appendix**

PLO4: Conduct investigations of well-defined problems; locate and search relevant codes and catalogues, conduct standard tests and measurements.
CLO2: Integrate Material Requirement Planning (MRP) and inventory control for manufacturing process controlling activities.(C4, PLO4)
CLS2: Knowledge & Understanding

References

1. Afolalu, S.. A., Ikumapayi, O. M., Ongbali, S. O. & Afolabi, S.O. (2020). Analysis of Production Scheduling Initiatives in the Manufacturing Systems. *International Journal of Mechanical and Production Engineering Research and Development (IJMPERD)*, 10 (3). pp.1301-1318. 10.24247/ijmperdjun2020113
2. Essex, D. (2020, Dec). *material requirements planning (MRP).* https://www.techtarget.com/searcherp/definition/material-requirements-planning-MRP
3. Heizer, J. & Render, B. (2008).*Operation Management Ninth Edition;* Pearson.
4. Jenkins, A. (2022, July 20). *What Is Material Requirements Planning (MRP)?* https://www.netsuite.com/portal/resource/articles/inventory-management/material-requirements-planning-mrp.shtml?cid=Online_NPSoc_YT_SEOMRP
5. Laureen Reed, L.. (2016, Nov 14). CHAPTER 3: PRODUCTION BILL OF MATERIALS https://silo.tips/download/chapter-3-production-bill-of-materials
6. Marker, A. (2017, April 21). *Not Just for Manufacturing, Material Requirements Planning (MRP) Is Indispensable for Any Business.* https://www.smartsheet.com/guide-to-material-requirements-planning
7. Paredes, R. (2022, 16 June). *The Basics of Materials Requirement Planning (MRP)* https://safetyculture.com/topics/material-requirements-planning/
8. Project Production Institute (n.d.). *Product Structure Tree.* https://projectproduction.org/glossary/product-structure-tree/
9. Shaw, J. (n.d.) *Material Requirement Planning (MRP).* https://slideplayer.com/slide/15307953/)
10. Stevenson, W..J. (2005). Operation Management Eight Edition; The McGraw-Hill.
11. Testbook Edu Solutions (n.d.). https://testbook.com/question-answer/the-product-structure-tree-in-the-figure-below-sho--60892e7cc1033cc9365f015a
12. Victor, R. (2019, 19 June). *The Different Types of Supply Chain Management Methods and Theories.* https://www.hollingsworthllc.com/the-different-types-of-supply-chain-management-methods-and-theories/
13. Vskills, (n.d.). *MRP Processing.* https://www.vskills.in/certification/tutorial/mrp-processing-4/
14. Watson, D. (2020, 19 Oct). *Why a Bill of Materials is Important.* https://www.theengineeringprojects.com/2020/10/why-a-bill-of-materials-is-important.html

e ISBN 978-967-2897-59-0