Chapter 5. Long and Short Term Production Planning

Basic references:

- Heizer, J. & Render, B. (2009): Operations Management. New Jersey: Pearson Prentice Hall

Chapter 5. Long and short term production planning

5.1. - Long term capacity planning

5.2. - The planning process

5.3. - Aggregate planning

5.4. - Materials requirements planning (MRP)

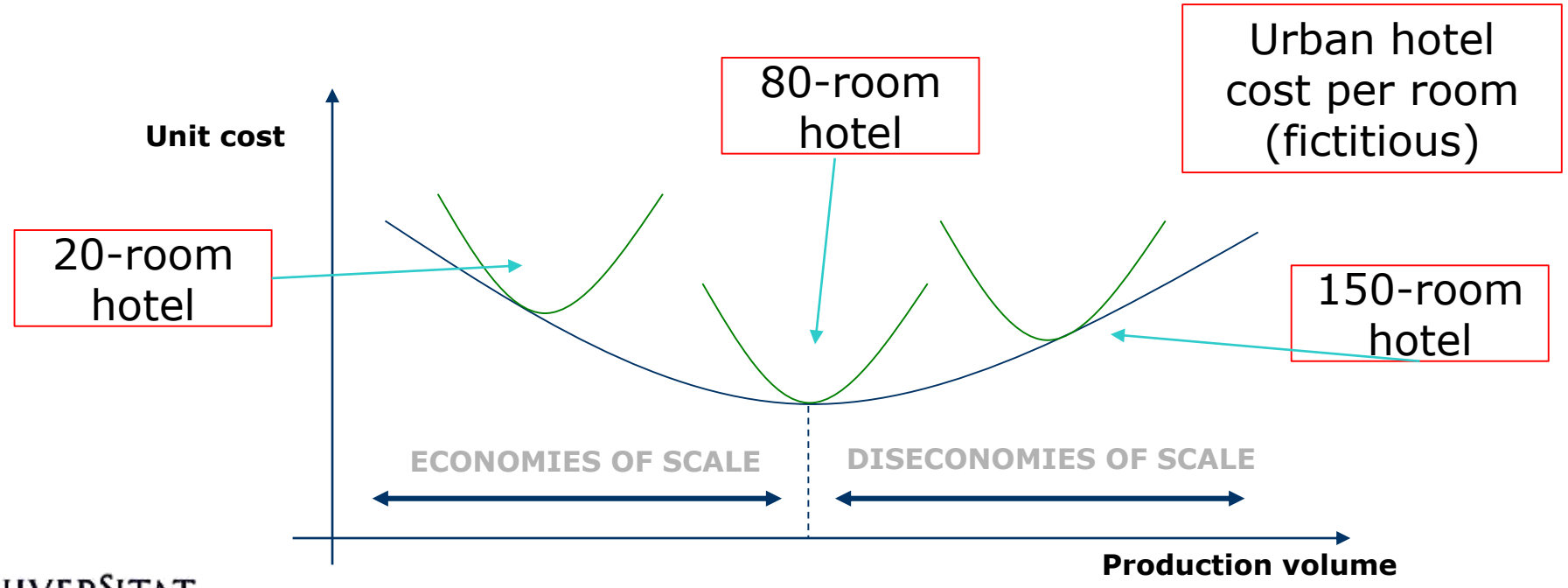
5.5. - Structure and functioning of MRP

5.1. - Long term capacity planning

- **Capacity:** maximum quantity of products or services that can be obtained in a given period from a production unit under normal functioning conditions.
- **Frequent mistakes:**
  - To use capacity measurements not related to time.
  - To confuse production capacity with production volume.
  - To confuse maximum capacity and sustainable capacity.

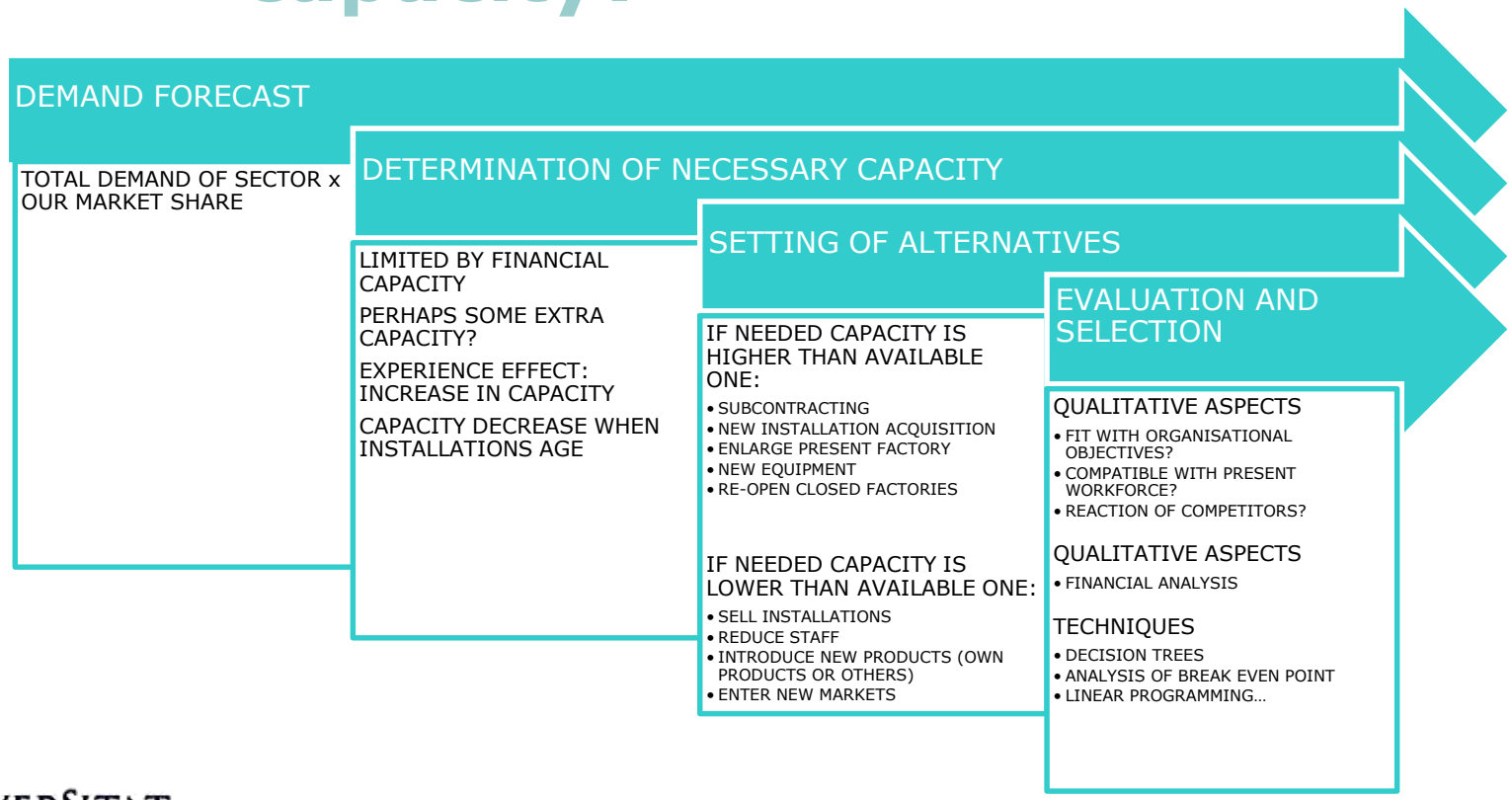
5.1. - Long term capacity planning

- **Economies and diseconomies of scale:** unit production cost diminishes when volumen increases.

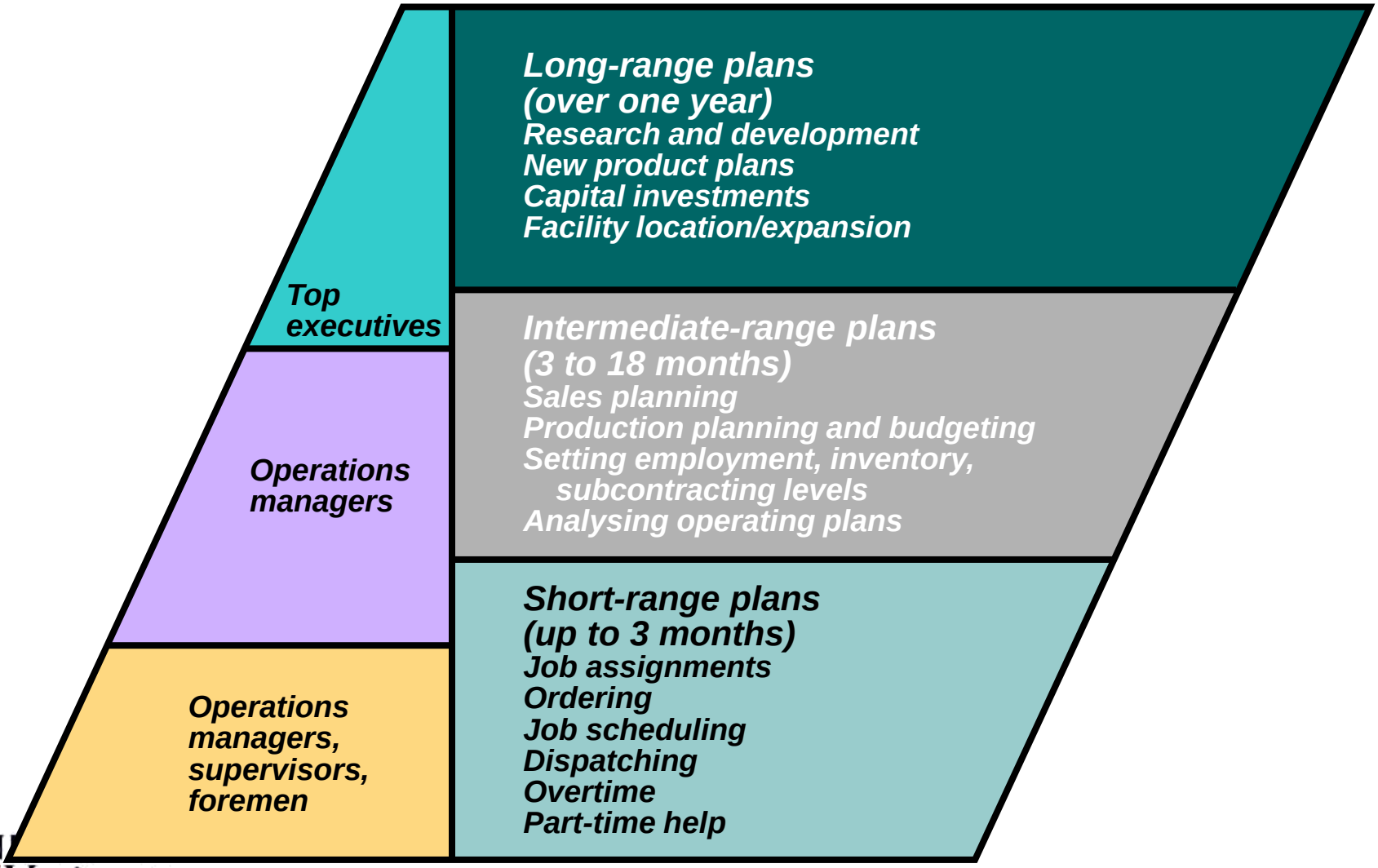


5.1. - Long term capacity planning

- **How to calculate production capacity?**



5.2. - The planning process



5.3.- Aggregate planning

Determine the quantity and timing of production for the immediate future

- ☑ Objective is to meet forecasted demand while minimising cost over the planning period by adjusting
  - ☑ Production rates
  - ☑ Labour levels
  - ☑ Inventory levels
  - ☑ Overtime work
  - ☑ Subcontracting rates
  - ☑ Other controllable variables

5.3.- Aggregate planning

Required for aggregate planning

- ☑ A logical overall unit for measuring sales and output
- ☑ A forecast of demand for an intermediate planning period in these aggregate terms
- ☑ A method for determining costs
- ☑ A model that combines forecasts and costs so that scheduling decisions can be made for the planning period

5.3.- Aggregate planning

Quarter 1		
Jan	Feb	Mar
150,000	120,000	110,000

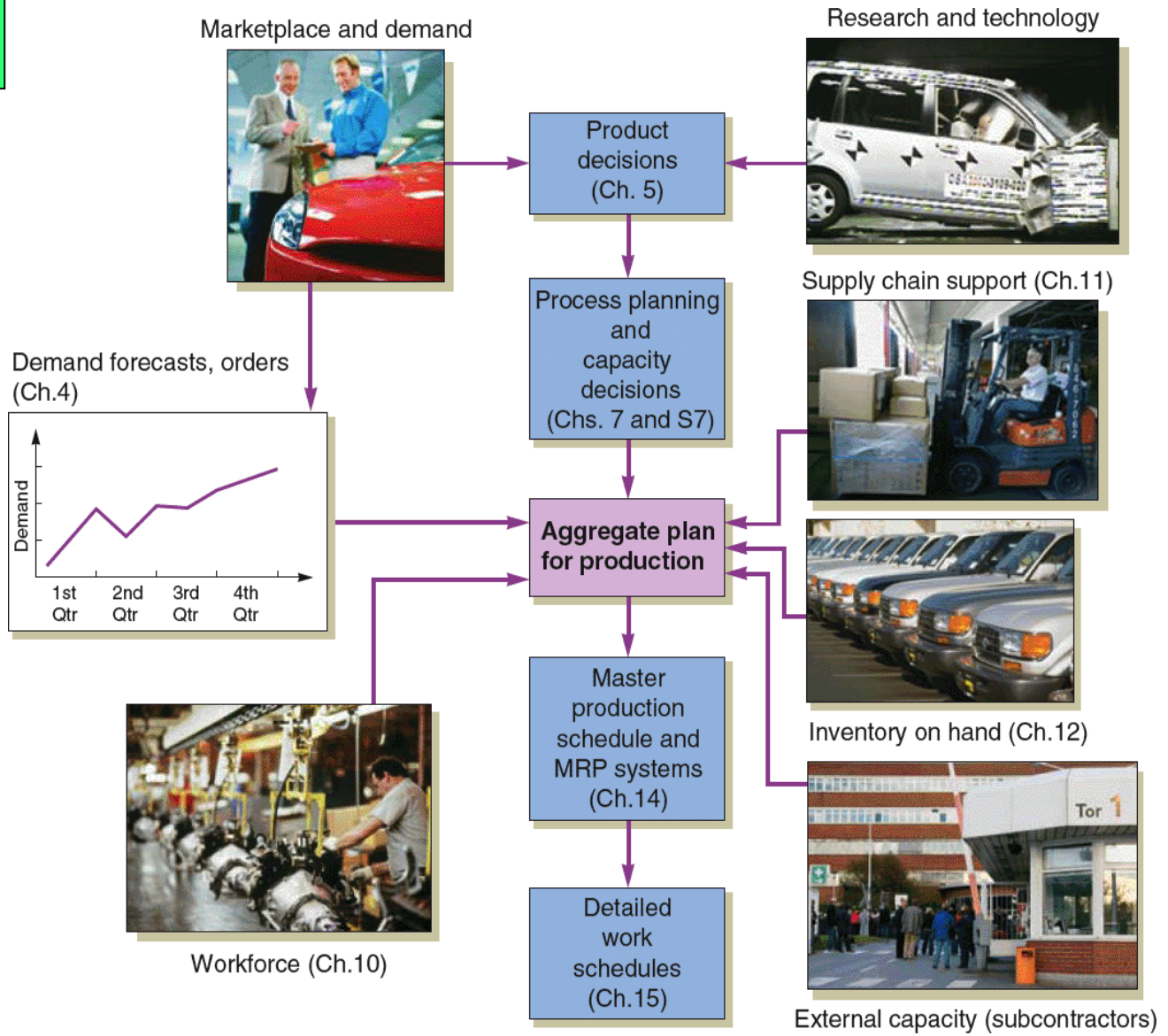
Quarter 2		
Apr	May	Jun
100,000	130,000	150,000

Quarter 3		
Jul	Aug	Sep
180,000	150,000	140,000





Aggregate planning



5.3.- Aggregate planning

- ☑ Combines appropriate resources into general terms
- ☑ Part of a larger production planning system
- ☑ Disaggregation breaks the plan down into greater detail
- ☑ Disaggregation results in a master production schedule→ MRP systems (purchase/produce)

5.3.- Aggregate planning

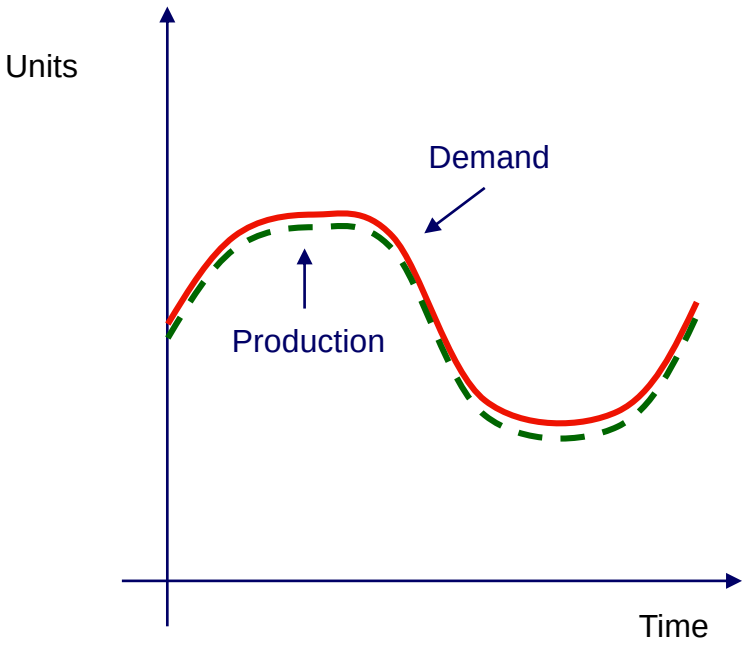
DO NOT CHANGE DEMAND

1. Use inventories to absorb changes in demand
2. Accommodate changes by varying workforce size
3. Use part-timers, overtime, or idle time to absorb changes
4. Use subcontractors and maintain a stable workforce

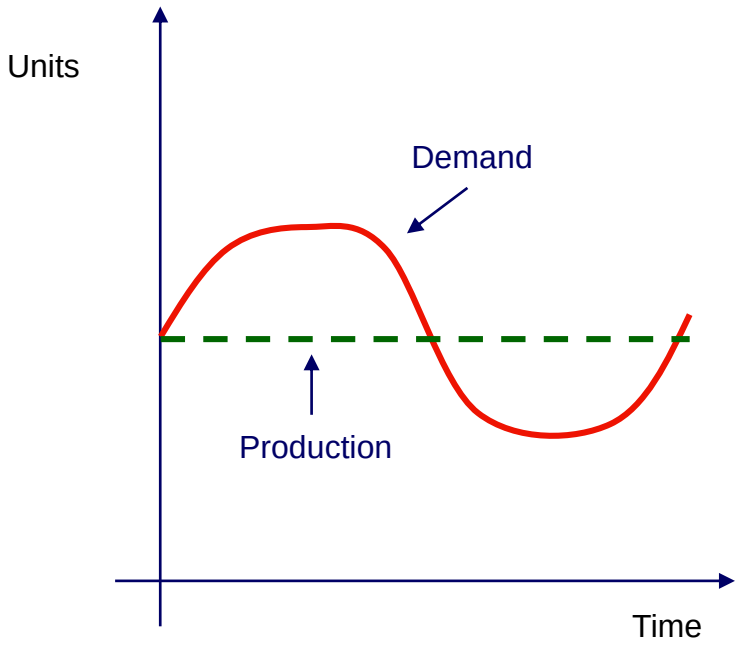
CHANGE DEMAND

5. Change prices or other factors to influence demand (yield management, counter-seasonal products)

5.3.- Aggregate planning

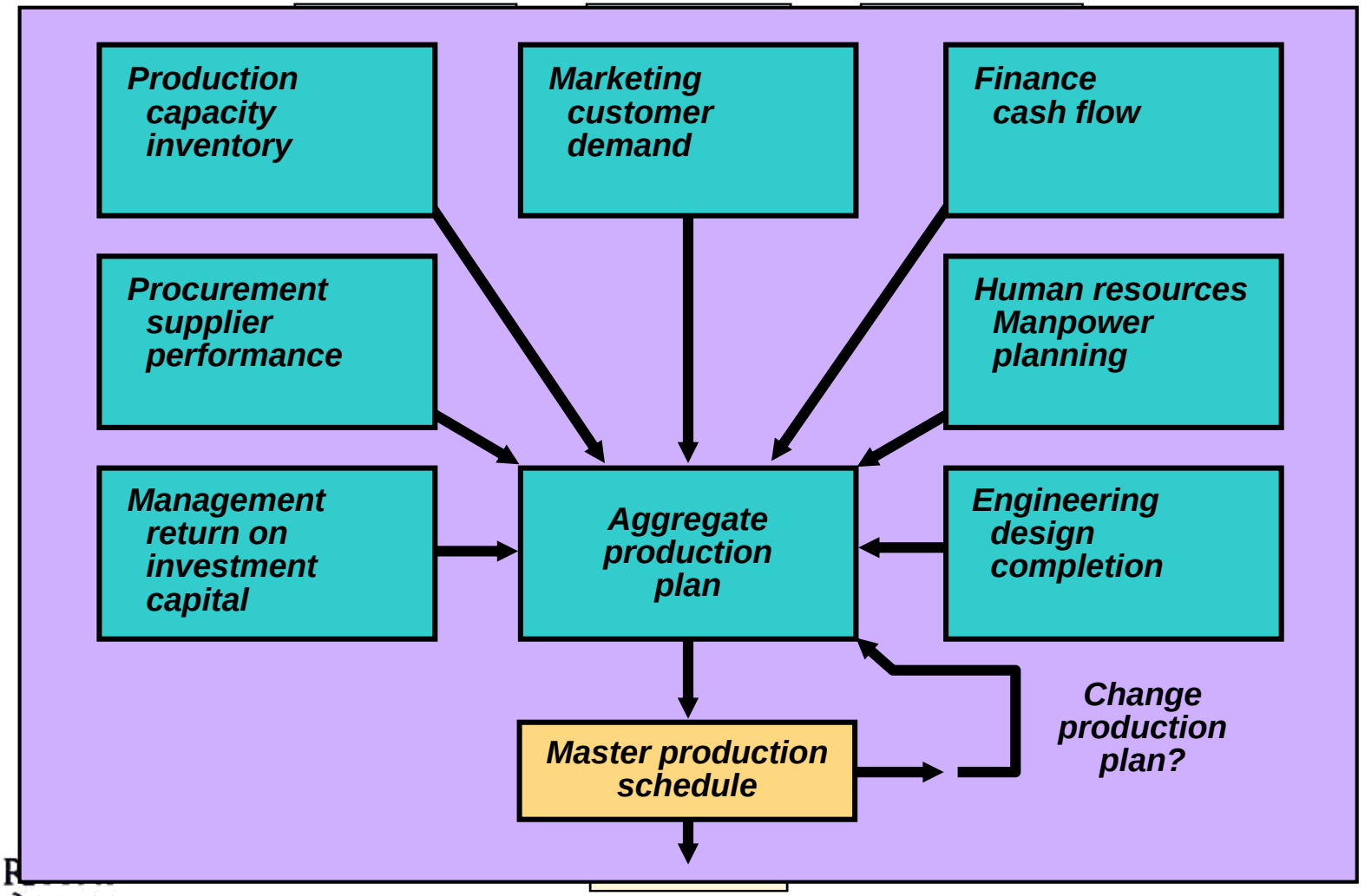


CHASE

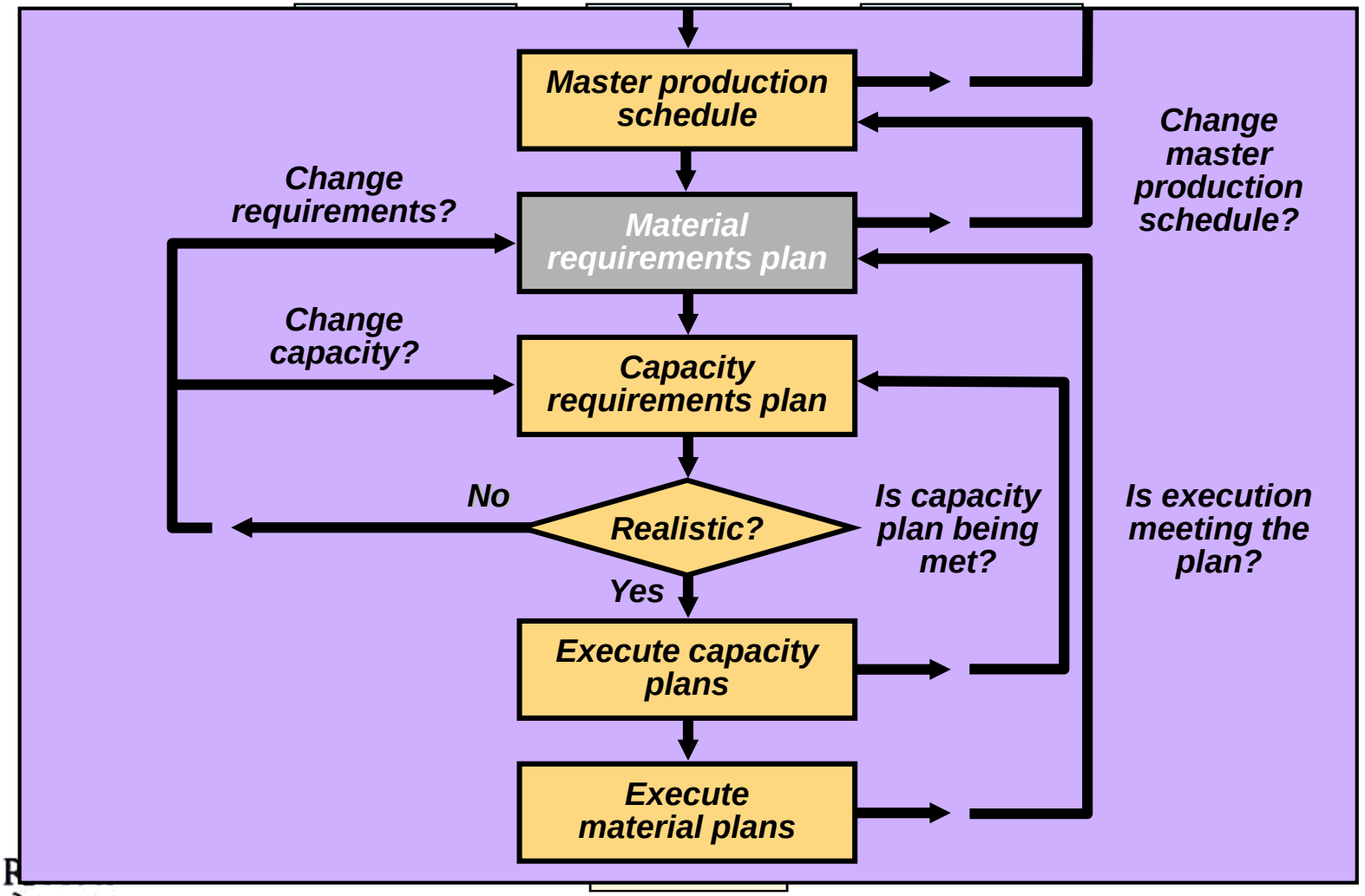


LEVEL

5.3.- Aggregate planning



5.3.- Aggregate planning



5.4.- Materials requirements planning (MRP)

Benefits of MRP

1. Better response to customer orders
2. Faster response to market changes
3. Improved utilisation of facilities and labour
4. Reduced inventory levels

5.4.- Materials requirements planning (MRP)

Dependent demand

1. The demand for one item is related to the demand for another item
2. Given a quantity for the end item, the demand for all parts and components can be calculated
3. Generally used whenever a schedule can be established for an item
4. MRP is the common technique

5.4.- Materials requirements planning (MRP)

Dependent demand

1. Effective use of dependent demand inventory models requires the following

    1. Master production schedule
    2. Specifications or bill of material
    3. Inventory availability
    4. Purchase orders outstanding
    5. Lead times

5.4.- Materials requirements planning (MRP)

Master production schedule (MPS)

- ☑ Specifies what is to be made and when
- ☑ Must be in accordance with aggregate production plan
- ☑ Inputs from financial plans, customer demand, engineering, supplier performance
- ☑ As the process moves from planning to execution, each step must be tested for feasibility
- ☑ The MPS is the result of the production planning process

5.4.- Materials requirements planning (MRP)

Master production schedule (MPS)

- ☑ MPS is established in terms of specific products
- ☑ Schedule must be followed for a reasonable length of time
- ☑ The MPS is often fixed or frozen in the near term part of the plan
- ☑ The MPS is a rolling schedule
- ☑ The MPS is a statement of what is to be produced, not a forecast of demand

5.4.- Materials requirements planning (MRP)

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	

Figure 14.2

5.4.- Materials requirements planning (MRP)

For Nancy's Specialty Foods

Gross requirements for crabmeat quiche										
Day	***6***	***7***	***8***	***9***	***10***	***11***	***12***	***13***	***14***	***and so on***
Amount	***50***		***100***	***47***	***60***		***110***	***75***		

Gross requirements for spinach quiche											
Day	***7***	***8***	***9***	***10***	***11***	***12***	***13***	***14***	***15***	***16***	***and so on***
Amount	***100***	***200***	***150***			***60***	***75***		***100***		

Table 14.1

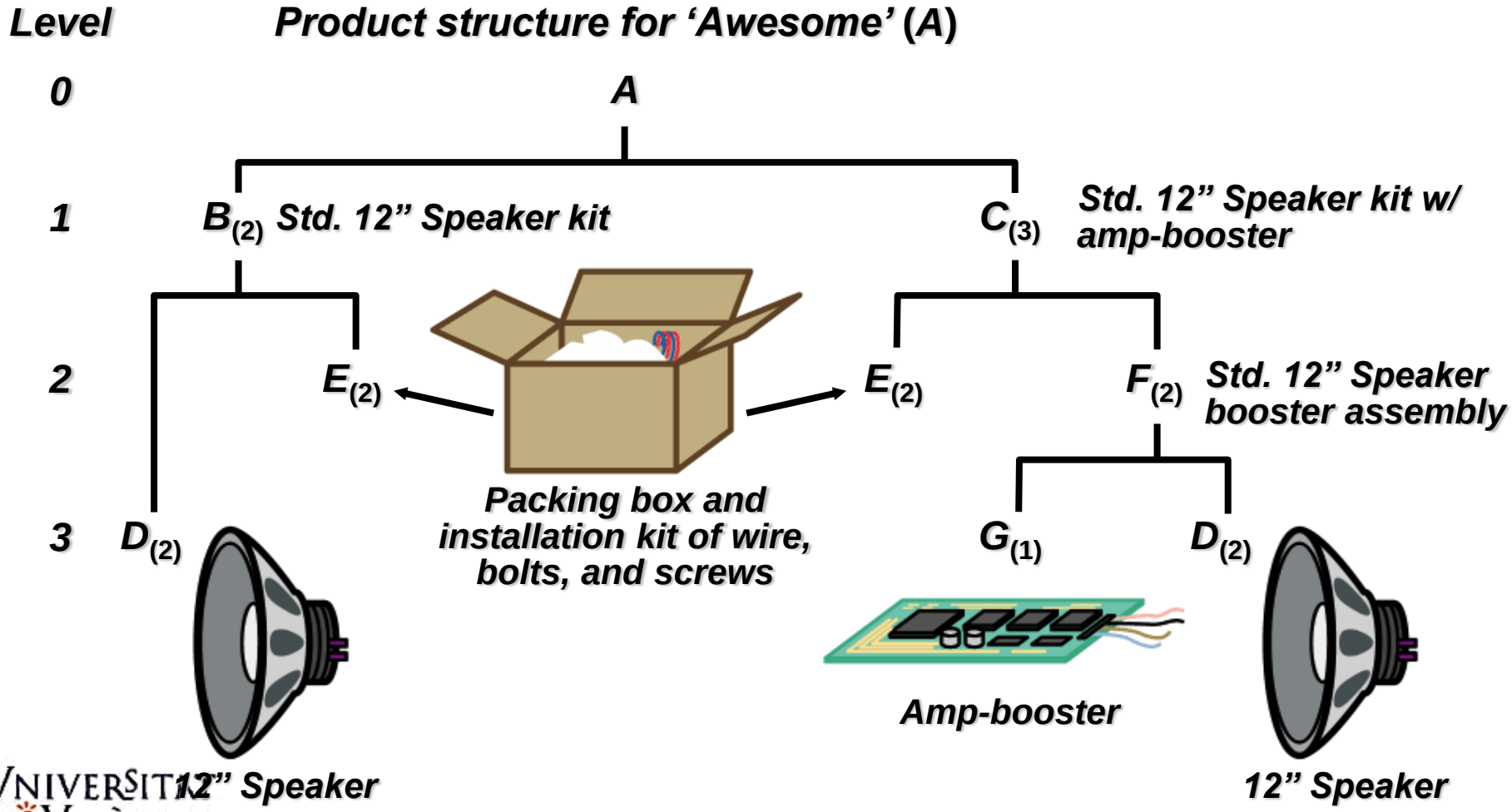
5.5.- Structure and functioning of MRP

Bill of material

- ☑ List of components, ingredients, and materials needed to make product
- ☑ Provides product structure
  - ☑ Items above given level are called parents
  - ☑ Items below given level are called children

5.5.- Structure and functioning of MRP

BOM example



5.5.-Structure and functioning of MRP

BOM example

Level	Product structure for 'Awesome' (A)			
0	Part B:	2 x number of As =	(2)(50) =	100
	Part C:	3 x number of As =	(3)(50) =	150
1	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
2	Part F:	2 x number of Cs =	(2)(150) =	300
3	Part G:	1 x number of Fs =	(1)(300) =	300

5.5.- Structure and functioning of MRP

Accurate records

- ☑ Accurate inventory records are absolutely required for MRP (or any dependent demand system) to operate correctly
- ☑ MRP systems generally require 99% accuracy
- ☑ Outstanding purchase orders must accurately reflect quantities and scheduled receipts

5.5.-Structure and functioning of MRP

Lead times

- ☑ The time required to purchase, produce, or assemble an item
  - ☑ For production – the sum of the order, wait, move, setup, store, and run times
  - ☑ For purchased items – the time between the recognition of a need and the availability of the item for production

5.5.-Structure and functioning of MRP

Time-Phased Product Structure

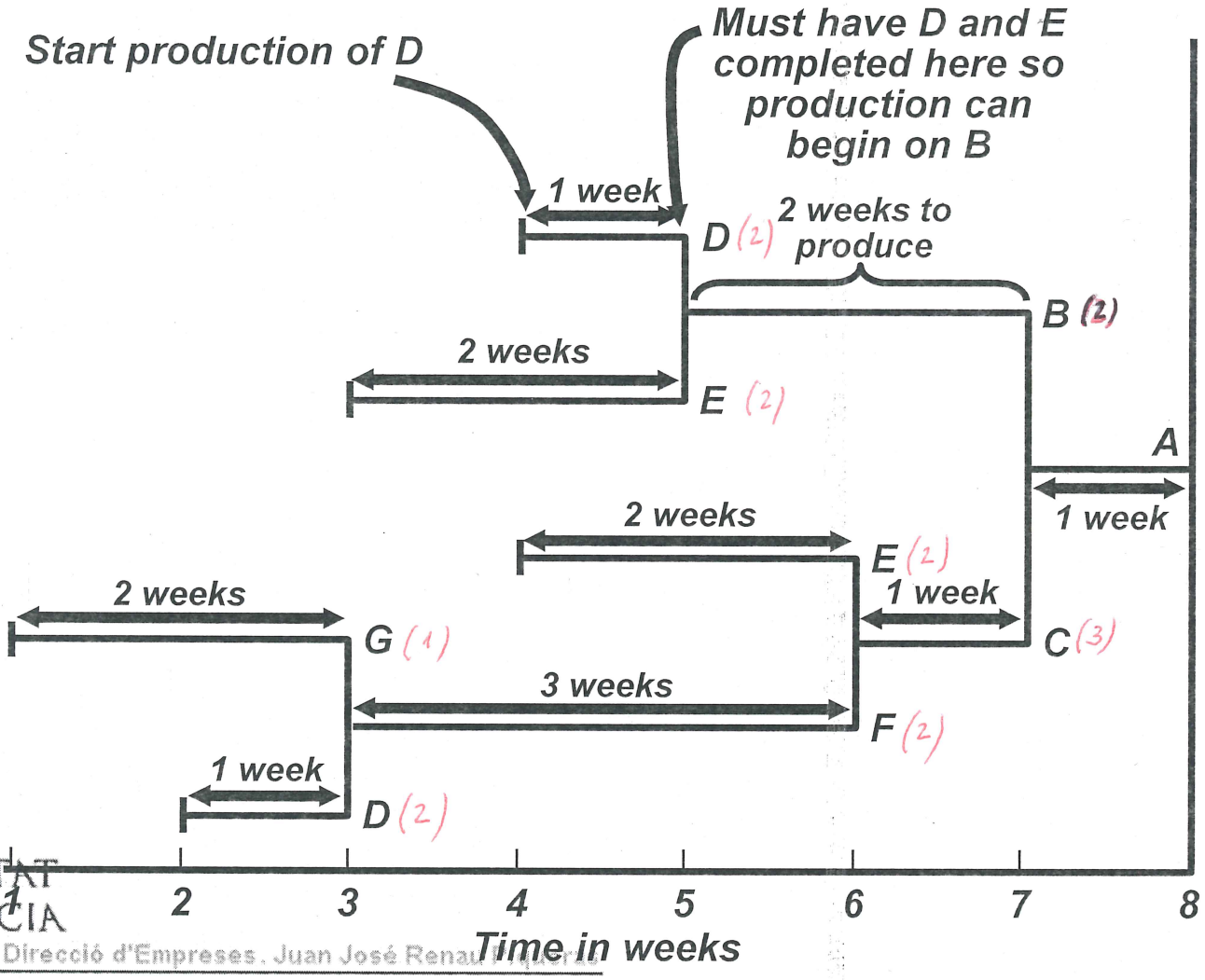


Figure 14.4

5.5.- Structure and functioning of MRP

MRP structure

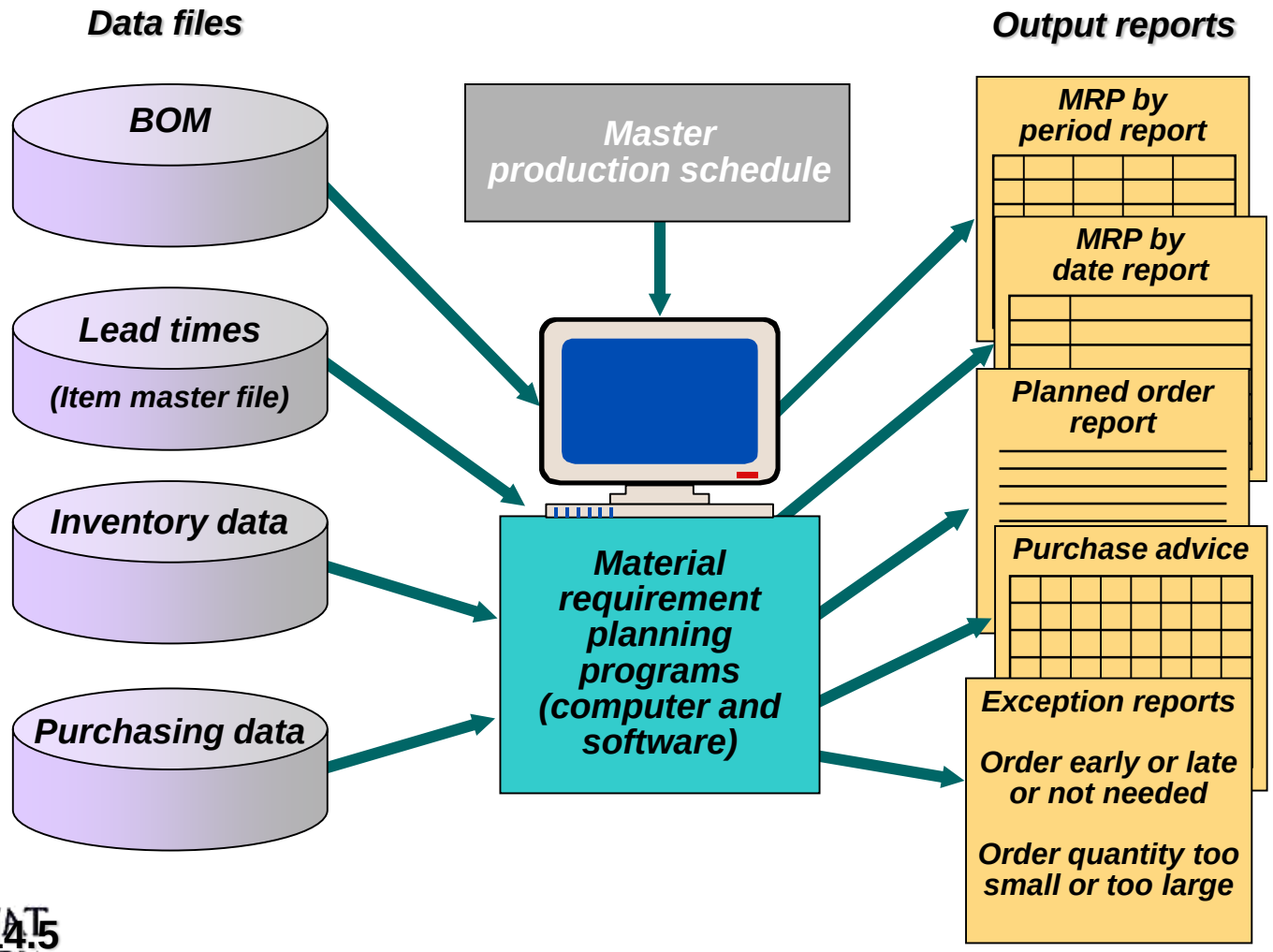


Figure 14.5

5.5.- Structure and functioning of MRP

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'

5.5.- Structure and functioning of MRP

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)

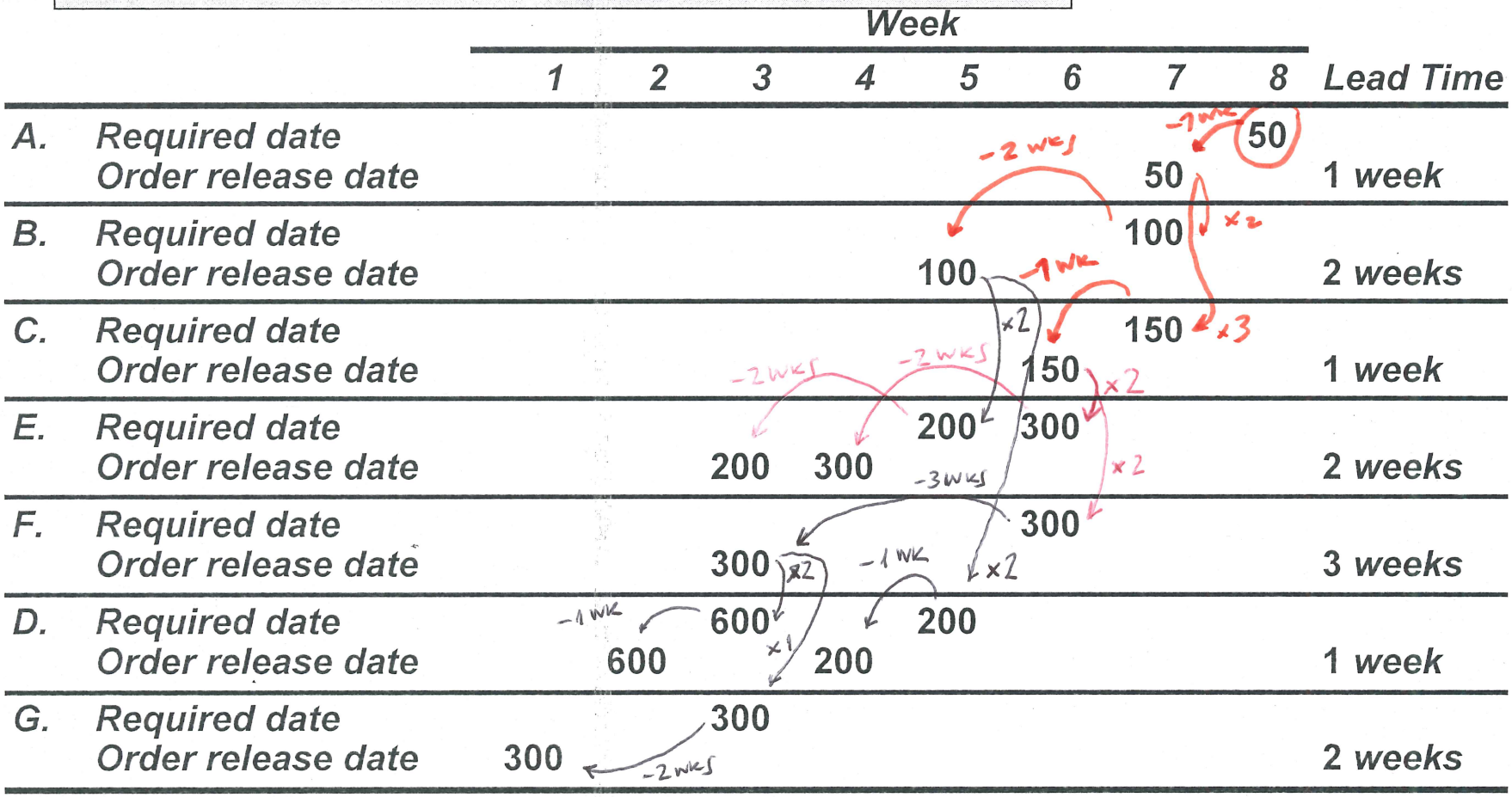
5.5.- Structure and functioning of MRP

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

5.5.-Structure and functioning of MRP

Gross Requirements Plan



5.5.- Structure and functioning of MRP

Net requirements plan

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		

5.5.- Structure and functioning of MRP

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								

5.5.- Structure and functioning of MRP

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

5.5.-Structure and functioning of MRP

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 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

5.5.- Structure and functioning of MRP

Determining net requirements

- ☑ A planned order receipt of 65 units in week 7 generates a planned order release of 65 units in week 5
- ☑ 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

5.5.- Structure and functioning of MRP

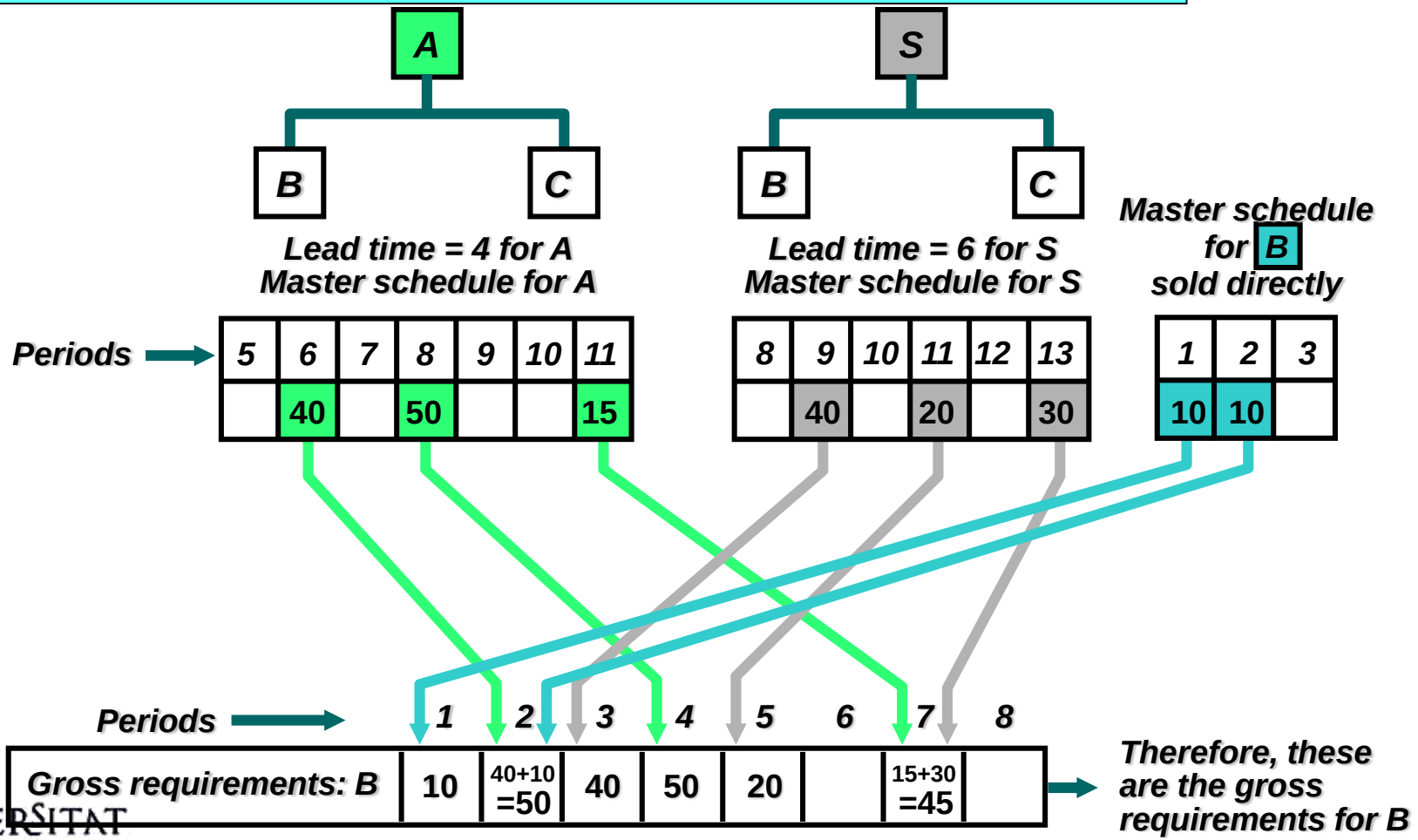
Net requirements plan

The logic of net requirements

$$\underbrace{\left[\left(\begin{array}{c}\textit{Gross}\\ \textit{requirements}\end{array}\right)+\left(\textit{Allocations}\right)\right]}_{\textit{Total requirements}}-\underbrace{\left[\left(\begin{array}{c}\textit{On}\\ \textit{hand}\end{array}\right)+\left(\begin{array}{c}\textit{Scheduled}\\ \textit{receipts}\end{array}\right)\right]}_{\textit{Available inventory}}=\textit{Net requirements}$$

5.5.- Structure and functioning of MRP

Gross requirements schedule



5.5.- Structure and functioning of MRP

MRP planning sheet

Lot Size	Lead Time	On Hand	Safety Stock	Allocated	Low-Level Code	Item ID
Lot For Lot	1	0	0	10	0	Z

		Period							
		1	2	3	4	5	6	7	8
Gross Requirements									~~80~~ 90
Scheduled Receipts									0
Projected On Hand	0	0	0	0	0	0	0	0	0
Net Requirements									90
Planned Order Receipts									90
Planned Order Releases								90	

5.5.- Structure and functioning of MRP

Safety stock

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

5.5.- Structure and functioning of MRP

MRP management

- ☑ MRP is a dynamic system
- ☑ Facilitates replanning when changes occur
- ☑ System nervousness can result from too many changes
- ☑ Time fences put limits on replanning
- ☑ Pegging links each item to its parent allowing effective analysis of changes

5.5.- Structure and functioning of MRP

MRP and JIT

- ☑ MRP is a planning system that does not do detailed scheduling
- ☑ MRP requires fixed lead times which may actually vary with batch size
- ☑ JIT excels at rapidly moving small batches of material through the system