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.

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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?

OUR MARKET SHARE	LIMITED BY FINANCIAL CAPACITY PERHAPS SOME EXTRA CAPACITY? EXPERIENCE EFFECT:	SETTING OF ALTERNAT	TIVES EVALUATION AND SELECTION
	EXPERIENCE EFFECT: INCREASE IN CAPACITY CAPACITY DECREASE WHEN INSTALLATIONS AGE	ONE: • SUBCONTRACTING • NEW INSTALLATION ACQUISITION • ENLARGE PRESENT FACTORY • NEW EQUIPMENT • RE-OPEN CLOSED FACTORIES	QUALITATIVE ASPECTS • FIT WITH ORGANISATIONAL OBJECTIVES? • COMPATIBLE WITH PRESENT WORKFORCE? • REACTION OF COMPETITORS?
		IF NEEDED CAPACITY IS LOWER THAN AVAILABLE ONE: • SELL INSTALLATIONS • REDUCE STAFF	QUALITATIVE ASPECTS • FINANCIAL ANALYSIS TECHNIQUES
		INTRODUCE NEW PRODUCTS (OWN PRODUCTS OR OTHERS) ENTER NEW MARKETS	ANALYSIS OF BREAK EVEN POINT LINEAR PROGRAMMING

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5.2. - The planning process



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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

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Required for aggregate planning

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

		Quarter 1	
	Jan	Feb	Mar
	150,000	120,000	110,000
		Quarter 2	
	Apr	Мау	Jun
	100,000	130,000	150,000
		Quarter 3	
	Jul	Aug	Sep
	180,000	150,000	140,000
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Demand

- 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)

- 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

DO NOT CHANGE DEMAND

> Change prices or other factors to influence demand (yield management, counterseasonal products)



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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

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

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Dependent demand

- 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

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Master production schedule (MPS)

- \square 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

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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

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Months		Jan	uary		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		

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Figure 14.2

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				
		Gro	ss req	uiren	nents	for s	pinac	h qu	iche			
Day	7	8	9	10	11	12	13	14	15	16	and so on	
Amount	100	200	150			60	75		100			

Table 14.1



Bill of material

- ☑ List of components, ingredients, and materials needed to make product
- \square 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 Product structure for 'Awesome' (A) Level 0 Std. 12" Speaker kit w/ **C**(3) 1 B₍₂₎ Std. 12" Speaker kit amp-booster **E**(2) 2 **E**(2) **F**(2) Std. 12" Speaker booster assembly Packing box and **D**(2) **D**(2) 3 installation kit of wire, **G**₍₁₎ bolts, and screws Amp-booster VNIVERSIT12" Speaker 12" Speaker **DÖVALÈNCIA**

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BOM example

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Leve	Ι.	Produ	<u>ct structure for 'Awesome'</u>	'(A)	
0		Part B:	2 x number of As =	(2)(50) =	100
U		Part C:	3 x number of As =	(3)(50) =	150
		Part D:	2 x number of Bs		
1			+ 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	D	Part G:	1 <i>x number</i> of Fs =	(1)(300) =	300
				Amp-booster	
VALUE	יוצת	Tári Speaker			nookor
TENTVE	ÊN	Inz Speaker		12. 3	peaker
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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

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

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MRP structure

Data files

Output reports



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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 VNIV offset' or `time phasing'

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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)

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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

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Gross Requirements Plan

		2		N	/eek			· ·	
	1	2	3	4	5	6	7	8	Lead Time
<i>Required date Order release date</i>						2 wes	50	50	1 week
<i>Required date Order release date</i>					100	1 WR	100	*2	2 weeks
<i>Required date Order release date</i>			-24	ik S	-ZWKS	×2) 150	150 ₽, ×2	13	1 week
<i>Required date Order release date</i>			200	300	200 ² -3WKS	300	×2		2 weeks
Required date Order release date			300	KZ) -1	WK K	×2 300 ⊭			3 weeks
<i>Required date Order release date</i>	-1.	600	600 ⁷	200	200				1 week
Required date Order release date	300 -	-2	300 wies						2 weeks
	Required date Order release date Required date Order release date	1Required date Order release dateRequired date Order release date300	12Required date Order release dateRequired date Order release date0rder release date300	123Required date Order release date7Required date Order release date7Required date Order release date7Required date Order release date7Required date Order release date200Required date Order release date300Required date 	1234Required date Order release date $Required date$ Order release date $Required date$ Order release date 200 Required date Order release date 200 300 Required date Order release date 200 300 Required date Order release date 300 x^2 <	1 2 3 4 5 Required date Order release date 100, Required date 100, Required date 100, Required date 200, Order release date 200, Required date 200, Order release date 200, Required date 200, Order release date 200, Required date 200, Order release date 300, Required date 600, Order release date 300, Required date 300, Order release date 300,	123456Required date Order release date 2^{wel} 2^{wel} 2^{wel} Required date Order release date 100^{-1} 100^{-1} Required date Order release date 100^{-1} 100^{-1} Required date Order release date 200^{-1} 300^{-1} Required date Order release date 200^{-1} 300^{-1} Required date Order release date 300^{-1} 200^{-1} Required date Order release date 300^{-1} 300^{-1} <td>1234567Required date Order release date$2^{west}$$50^{west}$$100^{west}$$100^{west}$Required date Order release date$100^{west}$$100^{west}$$100^{west}$$100^{west}$Required date Order release date$200^{west}$$150^{west}$$150^{west}$$120^{west}$Required date Order release date$200^{west}$$300^{west}$$x^2$Required date Order release date$300^{west}$$x^2$$300^{west}$Required date Order release date$-1^{west}$$600^{west}$$200^{west}$Required date Order release date$-1^{west}$$600^{west}$$200^{west}$Required date Order release date$300^{west}$$200^{west}$$300^{west}$Required date Order release date$300^{west}$$200^{west}$$200^{west}$Required date Order release date$300^{west}$$300^{west}$$300^{west}$</td> <td>12345678Required date Order release date$2^{Wel}$$50^{0}$$50^{0}$$50^{0}$$50^{0}$Required date Order release date$100^{0}$$100^{0}$$100^{0}$$100^{0}$$100^{0}$$100^{0}$Required date Order release date$100^{0}$$100^{0}$$100^{0}$$100^{0}$$100^{0}$$100^{0}$Required date Order release date$200^{1}$$300^{1}$$200^{1}$$300^{1}$$150^{0}$$12^{0}$Required date Order release date$300^{1}$$100^{1}$$100^{1}$$100^{1}$$100^{1}$$100^{1}$Required date Order release date$200^{1}$$300^{1}$$100^{1}$$100^{1}$$100^{1}$Required date Order release date$300^{1}$$100^{1}$$100^{1}$$100^{1}$$100^{1}$Required date Order release date$300^{1}$$200^{1}$$200^{1}$$300^{1}$Required date Order release date$300^{1}$$100^{1}$$100^{1}$$100^{1}$Required date Order release date$100^{1}$$100^{1}$$100^{1}$$100^{1}$<</td>	1234567Required date Order release date 2^{west} 50^{west} 100^{west} 100^{west} Required date Order release date 100^{west} 100^{west} 100^{west} 100^{west} Required date Order release date 200^{west} 150^{west} 150^{west} 120^{west} Required date Order release date 200^{west} 300^{west} x^2 Required date Order release date 300^{west} x^2 300^{west} Required date Order release date -1^{west} 600^{west} 200^{west} Required date Order release date -1^{west} 600^{west} 200^{west} Required date Order release date 300^{west} 200^{west} 300^{west} Required date Order release date 300^{west} 200^{west} 200^{west} Required date Order release date 300^{west} 300^{west} 300^{west}	12345678Required date Order release date 2^{Wel} 50^{0} 50^{0} 50^{0} 50^{0} Required date Order release date 100^{0} 100^{0} 100^{0} 100^{0} 100^{0} 100^{0} Required date Order release date 100^{0} 100^{0} 100^{0} 100^{0} 100^{0} 100^{0} Required date Order release date 200^{1} 300^{1} 200^{1} 300^{1} 150^{0} 12^{0} Required date Order release date 300^{1} 100^{1} 100^{1} 100^{1} 100^{1} 100^{1} Required date Order release date 200^{1} 300^{1} 100^{1} 100^{1} 100^{1} Required date Order release date 300^{1} 100^{1} 100^{1} 100^{1} 100^{1} Required date Order release date 300^{1} 200^{1} 200^{1} 300^{1} Required date Order release date 300^{1} 100^{1} 100^{1} 100^{1} Required date Order release date 100^{1} 100^{1} 100^{1} 100^{1} <

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Net requirements plan

Lot	Lead Time	On	Safety	Allo-	Low-	Item					We	ek			
Size	(weeks)	Hand	Stock	cated	Code	fication		1	2	3	4	5	6	7	8
Lot-	1	10	—	—	0	Α	Gross Requirements								50
for-							Scheduled Receipts								
Lot							Projected On Hand 10	10	10	10	10	10	10	10	10
							Net Requirements								40
							Planned Order Receipts								_40
							Planned Order Releases							40 🖌	
Lot-	2	15	_	_	1	в	Gross Requirements							80 ^A	
for-	-	10					Scheduled Receipts								
Lot							Projected On Hand 15	15	15	15	15	15	15	15	
							Net Requirements							65	
							Planned Order Receipts							-65	
							Planned Order Releases					65 🗲			
Lat	4	20			4	0	Grass Beguirements							100A	
for-	'	20	_	_	'	C C	Cross Requirements							1201	
Lot							Scrieduled Receipts	20	20	20	20	20	20	20	
LOI							Not Deguirements	20	20	20	20	20	20	100	
							Net Requirements							100	
							Planned Order Receipts						100	2100	
VAL	NCU						Fianned Order Neleases						100		

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Net requirements plan

ſ	Lot-	2	10	—	—	2	E	Gross Requirements					130 ^B	200 ^C	
	for-							Scheduled Receipts							
	Lot							Projected On Hand 10	10	10	10	10	10		
								Net Requirements					120	200	
								Planned Order Receipts				/	-120	- 200	
								Planned Order Releases			120	200			
- r		-					-							0000	
	Lot-	3	5	—	—	2	F	Gross Requirements						200~	
	for-							Scheduled Receipts							
	Lot							Projected On Hand 5	5	5	5	5	5	5	
								Net Requirements						195	
								Planned Order Receipts						-195	
								Planned Order Releases			195 -				
Г	Lot	4	10			2	D	Grass Bequirements			annE		120B		
	for-	'	10	_	_	3	U	Cobedulad Respireta			390		130		
	lot							Scheduled Receipts	10	10	10				
	LOI							Projected On Hand 10	10	10	10		100		
								Net Requirements			380		130		
								Planned Order Receipts			,380		_130		
l								Planned Order Releases		380″		1301			
ſ	Lot-	2	0	_	_	3	G	Gross Requirements			195 ^F				
	for-	_	_					Scheduled Receipts							
	Lot							Projected On Hand			0				
VA								Net Requirements			195				
VI								Planned Order Receipts			-195				
ÐQ								Planned Order Releases	1054	\sim	150				 25
Depa	rtament	ue Dire	CCIO O E	Inpreses	Juan	USE NEI	Iau Fiqu	rianned Order heleases	195						32

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 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

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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
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Available inventory

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MRP planning sheet

Lot	Lead	On Hand	Safety	Allocated	Low- Level	Item					Pei	riod			
OIZE	Time	Tianu	Olock		Code			1	2	3	4	5	6	7	8
1 ot	1	0	0	10	0	Z	Gross Requirements								80 90
Eap		_				-	Scheduled Receipts								0
TON							Projected On Hand 0	0	0	0	0	0	0	0	0
LOI							Net Requirements								90
							Planned Order Receipts								90
							Planned Order Releases							90	

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

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

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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