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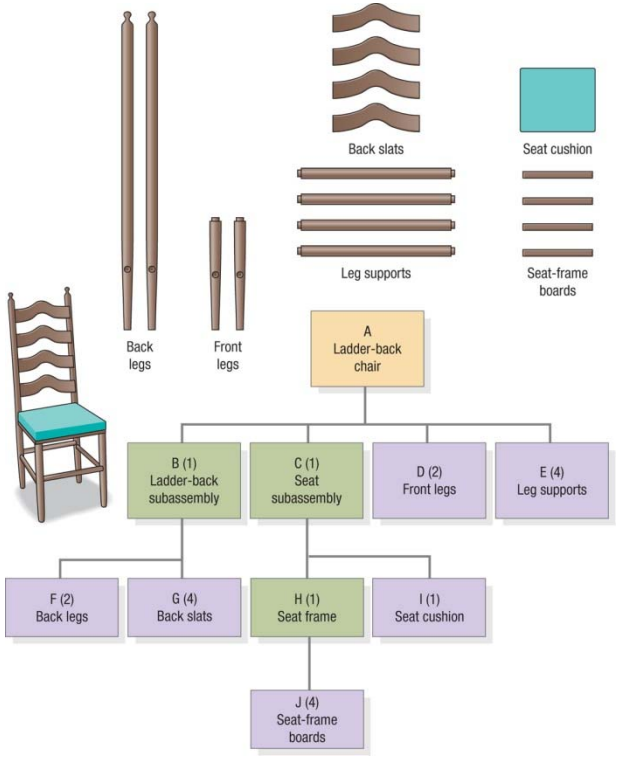
MPS, MRP & JIT

Yuji Yamamoto

PPU426



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Today's topic

- What is MPS and MRP
- Developing MPS
- How to make MRP
- Enterprise Resource Planning
- Kanban system

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Production planning and scheduling

Demand

1,400pcs/m
for coming
months

Production
planning

How many to make?
How much to work?

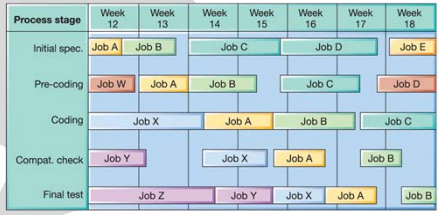
Lets make 1,200pcs/m
with overtime!

Resource
planning

MPS
MRP

What model/part to
make until when?

Scheduling



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What is Master Production Schedule (MPS)?

A schedule showing how many end items need to be produced within specified period of time

	April				May			
	1	2	3	4	5	6	7	8
Model A	500					500		
Model B				300			300	
Model C		200	200		200			200
Volume per month	1200				1200			

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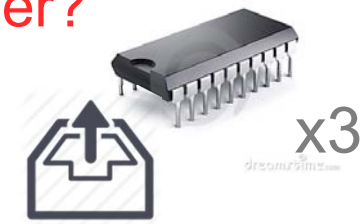
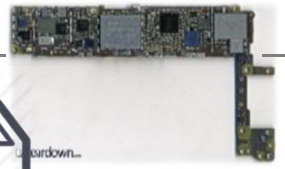
What is Material Resource Planning (MRP)?

Translate MPS into the requirement of what parts are needed when, in order to make the end item

When to order?
How many?
=1500pcs
Week n-4



x3



x10

(2w to get purchased parts)

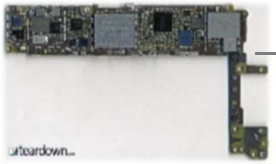
1w

1w

500 pcs
at week n!

MPR is for dependent demand

x3



x10

Independent demand

Market demand

Dependent demand

(Dependent on the constitute of the product)

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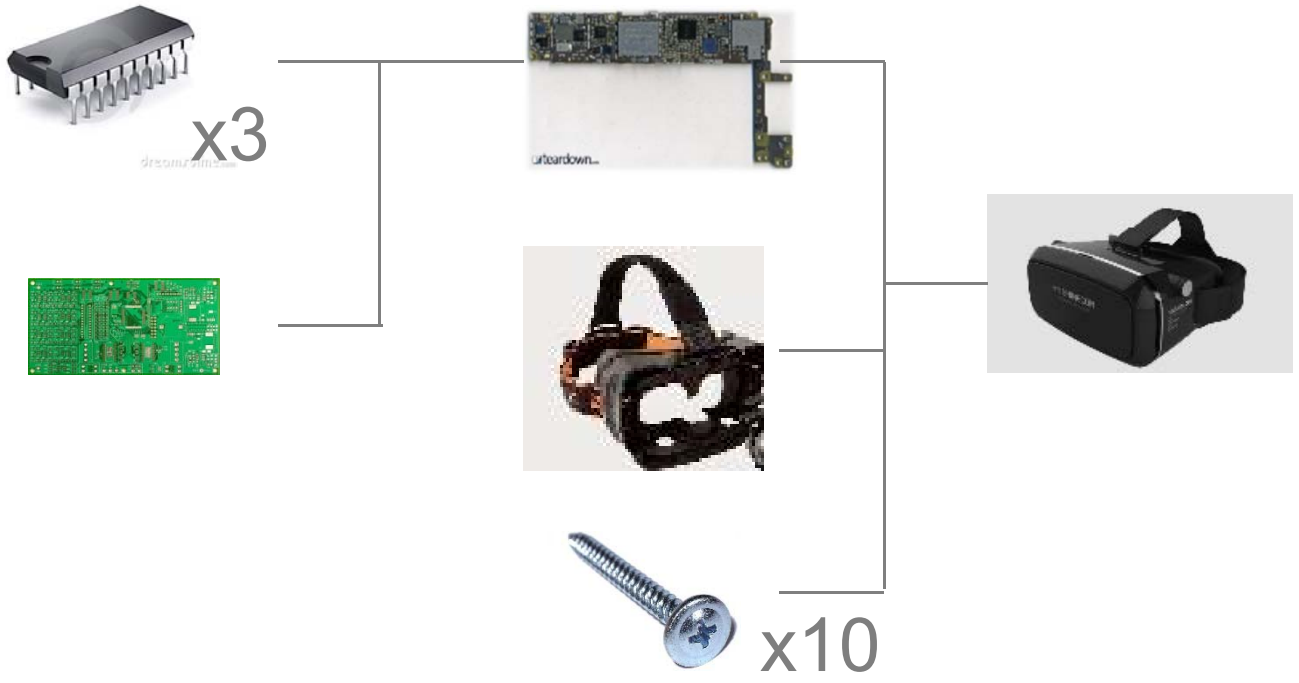
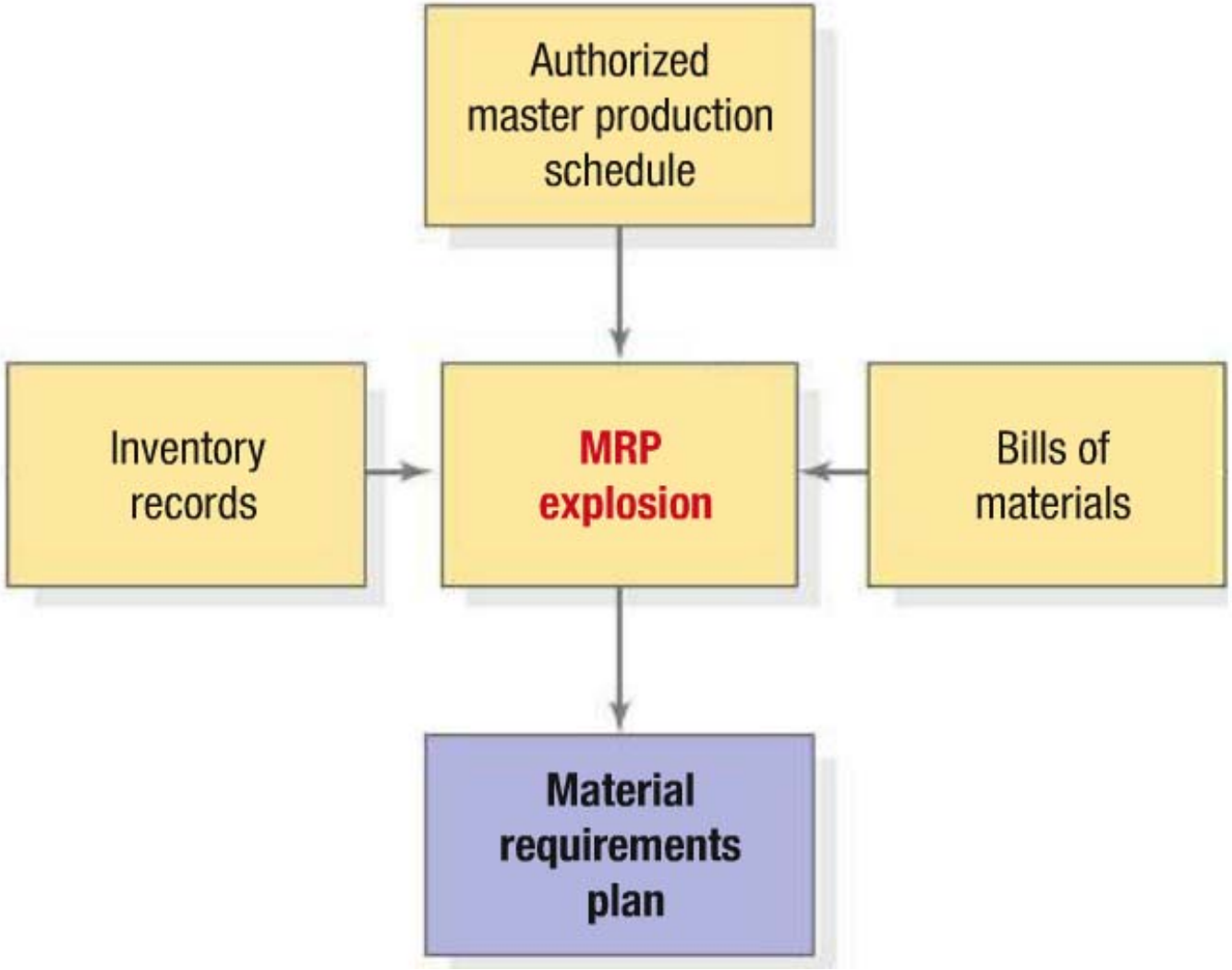
Bill of Material (BOM)

Information of parent-component relationship



Bill of Material (BOM)

MRP exploration



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Developing MPS

Item: Ladder-back chair

Lot size 150 units, Lead time 1w

		April				May			
Quantity on Hand:	55	1	2	3	4	5	6	7	8
Forecast							35	35	35
Booked orders							0	0	0
Projected on-hand inventory		17	137						87
MPS quantity			150					150	
MPS Start		150					150		

How many items left at the end of the week?

How many items to be completed in this week?

I week lead time

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Developing MPS

Item: Ladder-back chair

Lot size 150 units, Lead time 1w

		April							
Quantity on Hand:	55	1	2	3					
Forecast		30	30	30					
Booked orders		38	27	24					
Projected on-hand inventory		17	137	107	77	42	7	122	87
MPS quantity			150					150	
MPS Start		150					150		

Development of MPS

- Calculate product on-hand inventory
- Decide MPS quantity and MPS start

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Calculation of Projected on-hand inventory

$$\left(\begin{array}{c}\text{Projected on-hand}\\ \text{inventory at end}\\ \text{of this week}\end{array}\right) = \left(\begin{array}{c}\text{On-hand}\\ \text{inventory at}\\ \text{end of last week}\end{array}\right) + \left(\begin{array}{c}\text{MPS quantity}\\ \text{due at start}\\ \text{of this week}\end{array}\right) - \left(\begin{array}{c}\text{Projected}\\ \text{requirements}\\ \text{this week}\end{array}\right)$$

where:

Projected requirements = max(Forecast, Customer orders booked)

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Calculation of Projected on-hand inventory

Item: Ladder-back chair

Lot size 150 units, Lead time 1w

		April				May			
Quantity on Hand:	55	1	2						8
Forecast		30	30						35
Booked orders		38	27	24	8	0	0	0	0
Projected on-hand inventory		17	137	107	77	42	7	122	87
MPS quantity			150						
MPS Start		150					150		

= 55 + 0 - 38

= 17 + 150 - 30

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If we do not produce anything….

Item: Ladder-back chair

Lot size 150 units, Lead time 1w

		April				May			
Quantity on Hand:	55	1	2	3	4	5	6	7	8
Forecast		30	30	30	30	35	35	35	35
Booked orders		38	27	24	8	0	0	0	0
Projected on-hand inventory		17	-13	-43	-73	-108	-143	-178	-….
MPS quantity			150					150	
MPS Start		150					150		

Add lot size to avoid out of stock

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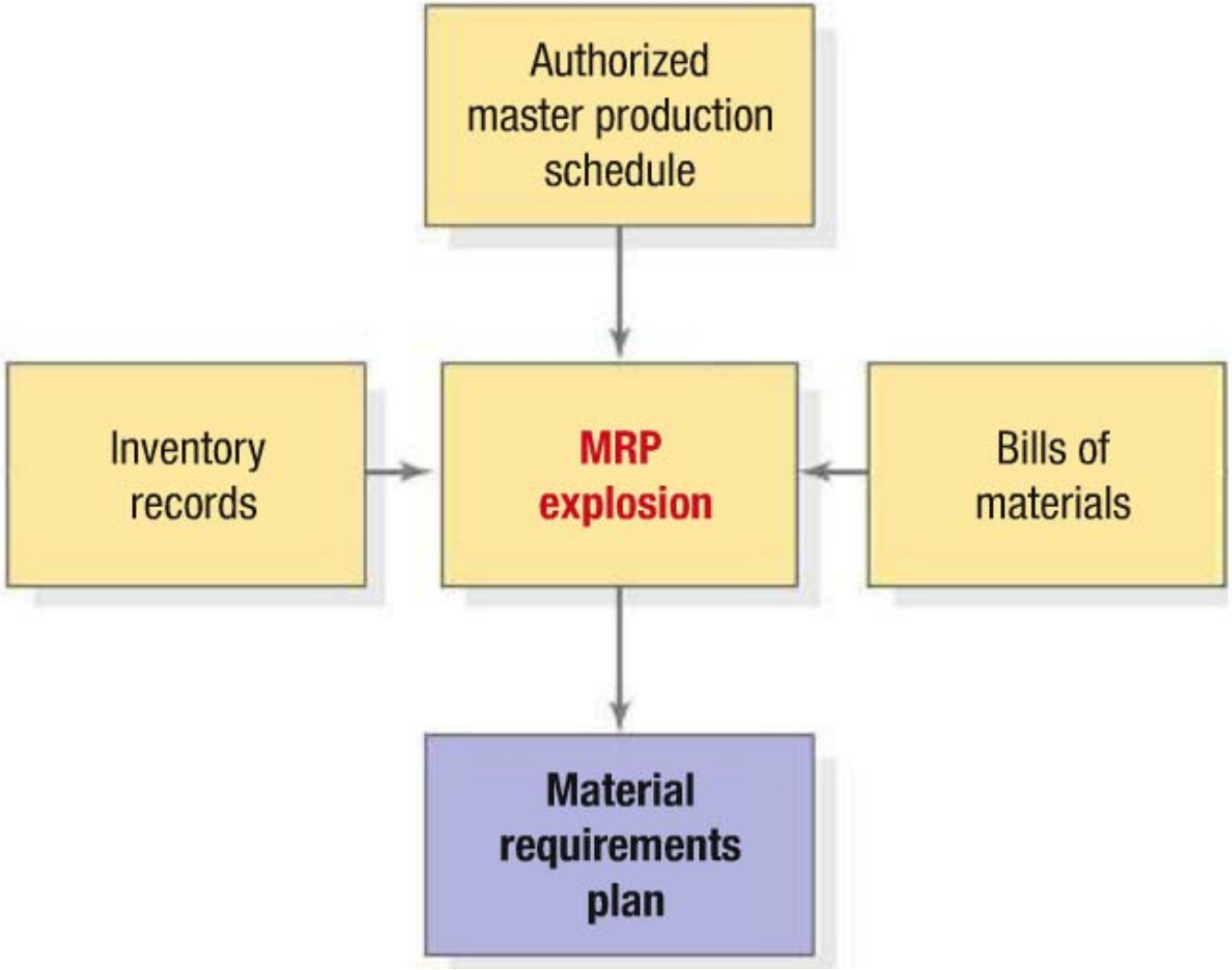
Developing MPS

Item: Ladder-back chair

Lot size 150 units, Lead time 1w

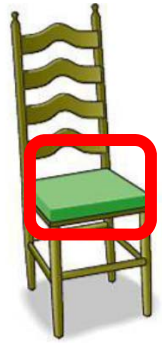
		April				May			
Quantity on Hand:	55	1	2	3	4	5	6	7	8
Forecast		30	30	30	30	35	35	35	35
Booked orders		38	27	24	8	0	0	0	0
Projected on-hand inventory		17	137	107	77	42	7	122	87
MPS quantity			150					150	
MPS Start		150					150		

Making MRP


Authorized master production schedule
Inventory records
MRP explosion
Bills of materials
Material requirements plan

Making MRP

BOM



Lot Size: 230 units
Lead Time: 2 weeks

	Week							
	1	2	3	4	5	6	7	8
Gross requirements	150	0	0	120	0	150	120	0
Scheduled receipts	230	0	0	0	0	0	0	0
Projected on-hand inventory 37	117	117	117	227	227	77	187	187
Planned receipts				230			230	
Planned order releases		230			230			

Inventory record

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Inventory record

bassembly

Lot size 230 units, Lead time 2w

Total demand from parent's MPS

Order actually placed and to be completed this week

The amount should be completed to avoid out of stock

	1	2	3	4	5	6	7	8
Gross requirement	150	0						
Scheduled receipts	230	0	0					
Projected on-hand inventory 37	117	117	117	227		77	187	187
Planned receipts				230			230	
Planned order release		230			230			

Calculation of Projected on-hand inventory

Lot size 230 units, Lead time 2w

= 37 + 230 - 150

= 117 + 230 - 120

	Week							
	1	2	3	4	5	6	7	8
Gross requirement	150	0	0	120	0	150	120	0
Scheduled receipts	230	0	0	0				
Projected on-hand inventory 37	117	117	117	227	227	77	187	187
Planned receipts				230			230	
Planned order release		230			230			

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Lot size rules

- Fixed order quantity (FOQ)
- Periodic order quantity
- Lot for Lot

As shown in the previous slides.
Lot size can be decided by…

- Discount
- Truckload capacity
- Minimum purchased quantity
- EOQ
- etc.

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Periodic order quantity

: subassembly

TBO (P) = 3, Lead time 2w

		Week							
		1	2	3	4	5	6	7	8
Gross requirement		150	0	0	120	0	150	120	0
Scheduled receipts		230	0	0					
Projected on-hand inventory	37	117	117	117	–3	–3	–153	–273	–273
Planned receipts									
Planned order release									

We know when but how many to order?

Calculation of Periodic order quantity

$$\left(\begin{array}{c}\text{POQ lot size}\\ \text{to arrive in}\\ \text{week } t\end{array}\right) = \left(\begin{array}{c}\text{Total gross requirements}\\ \text{for } P \text{ week, including}\\ \text{week } t\end{array}\right) - \left(\begin{array}{c}\text{Projected on-hand}\\ \text{inventory balance at}\\ \text{end of week } t\text{–}1\end{array}\right)$$

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Calculation of POQ

subassembly

TBO (P) = 3, Lead time 2w

		Week							
		1	2	3	4	5	6	7	8
Gross requirement		150	0	0	120	0	150	120	0
Scheduled receipts		230	0						
Projected on-hand inventory	37	117	117	117	150	150	0	0	0
Planned receipts					153			120	
Planned order release									

0

Need to make sure we do not get out of stock until the next fill-up

= 120 + 0 + 150 -117

= 120 + 0 + 0 - 0

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Lot for Lot

: subassembly

Order any week, Lead time 2w

		Week							
		1	2	3	4	5	6	7	8
Gross requirement		150	0	0	120	0	150	120	0
Scheduled receipts		230	0	0	0	0	0	0	0
Projected on-hand inventory	37	117	117	117	–3	–3	–153	–273	–273
Planned receipts									
Planned order release									

Order any week so that inventory will not be below zero

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Lot for Lot

: subassembly

Order any week, Lead time 2w

		Week							
		1	2	3	4	5	6	7	8
Gross requirement		150	0	0	120	0	150	120	0
Scheduled receipts		230	0	0	0	0	0	0	0
Projected on-hand inventory	37	117	117	117	0	0	0	0	0
Planned receipts					3		150	120	
Planned order release			3		150	120			

Comparison of Lot-sizing rules

Average inventory from week 4 to 8:

$$\text{FOQ: } \frac{227 + 227 + 77 + 187 + 187}{5} = 181 \text{ units}$$

$$\text{POQ: } \frac{150 + 150 + 0 + 0 + 0}{5} = 60 \text{ units}$$

$$\text{L4L: } \frac{0 + 0 + 0 + 0 + 0}{5} = 0 \text{ units}$$

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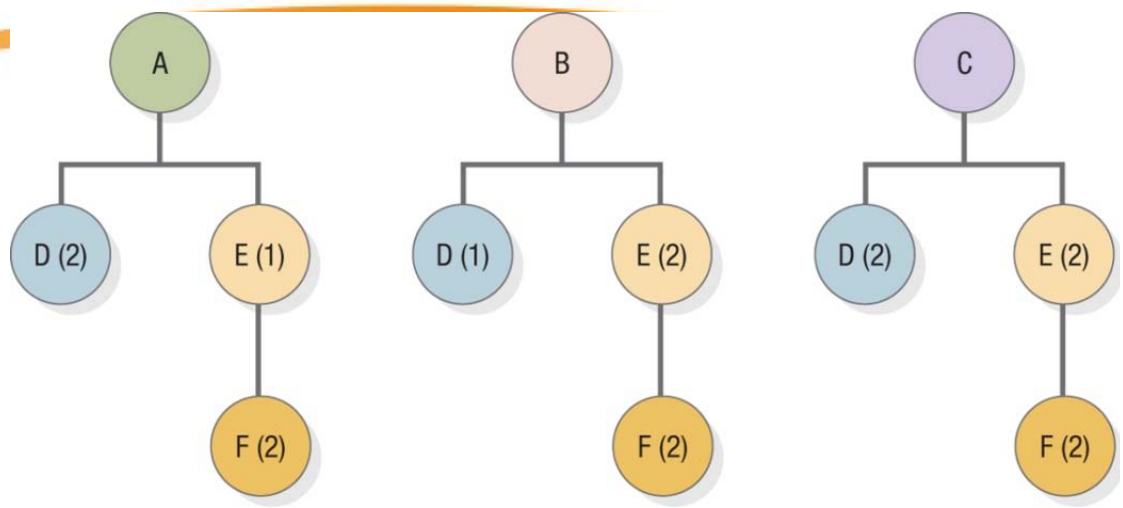
EXAMPLE 5

MRP explosion

MPS

Item	Qty	Due (week)	Lead time
A	80	4	1
A	55	7	1
B	125	7	2
C	60	7	3

BOM



Inventory record

	D	E	F
Lot size rule	FOQ =150	Lot for Lot	POQ, P=2
Lead time	3 w	1 w	2 w
Safety stock	40	0	30
Scheduled receipts	250 (week 1)	120 (week 2)	None
Beginning inventory	150	0	100

Question: Develop MRP for D, E, F for the next 8 weeks

Solution

Item: A	Week	1	2	3	4	5	6	7	8
MPS Quantity (due)					80			55	
MPS Quantity (release)				80			55		

Item: B	Week	1	2	3	4	5	6	7	8
MPS Quantity (due)								125	
MPS Quantity (release)						125			

Item: C	Week	1	2	3	4	5	6	7	8
MPS Quantity (due)								60	
MPS Quantity (release)					60				

Solution

Item: A | Week	1	2	3	4	5	6	7	8
MPS Quantity (due)				80			55	
MPS Quantity (release)			80			55		

80x2 55x2

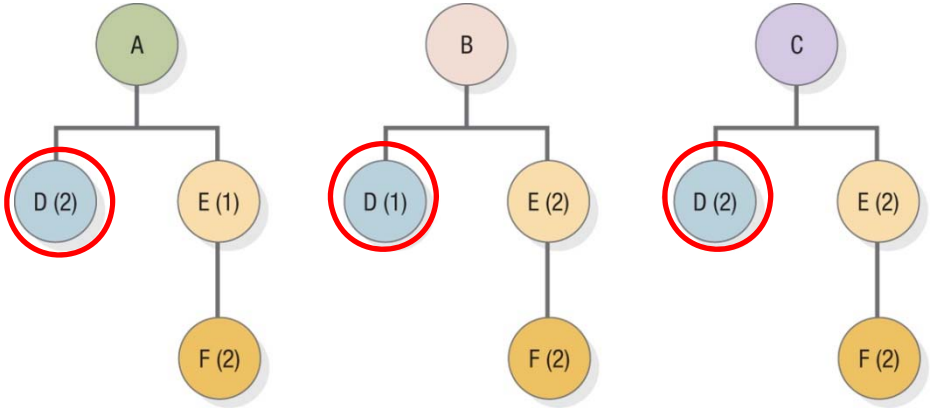
Item: B | Week	1	2	3	4	5	6	7	8
MPS Quantity (due)							125	
MPS Quantity (release)					125			

125

Item: C | Week	1	2	3	4	5	6	7	8
MPS Quantity (due)							60	
MPS Quantity (release)				60				

60x2

Gross requirement for D



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Inventory beginning 150

FOQ = 150, LT= 3, Safety stock = 40

Scheduled receipts 250 at w1

ITEM D 150	1	2	3	4	5	6	7	8
Gross requirement			160	120	125	110		
Scheduled receipts	250							
Projected on-hand inventory	400	400	240	120	145	185	185	185
Planned receipts					150	150		
Planned order release		150	150					

Order when lower than 40

Solution

Item: A | Week	1	2	3	4	5	6	7	8
MPS Quantity (due)				80			55	
MPS Quantity (release)			80			55		

80 55

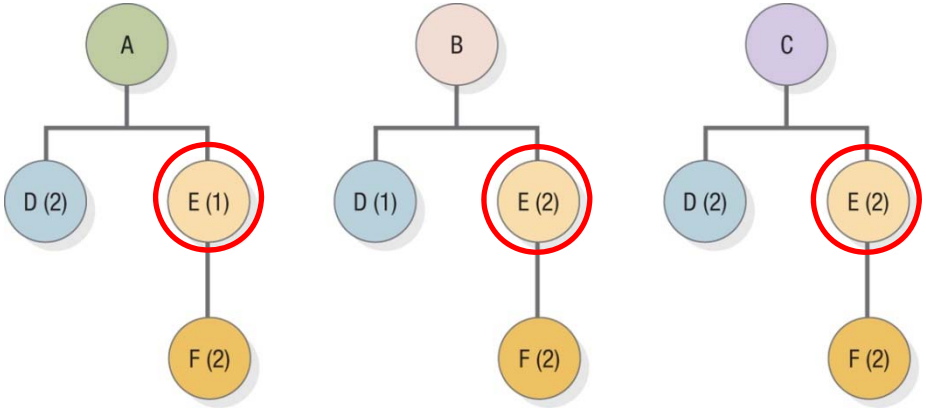
Item: B | Week	1	2	3	4	5	6	7	8
MPS Quantity (due)							125	
MPS Quantity (release)					125			

125x2

Item: C | Week	1	2	3	4	5	6	7	8
MPS Quantity (due)							60	
MPS Quantity (release)				60				

60x2

Gross requirement for E



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Inventory beginning 0

Lot for Lot, LT= 1, Safety stock = 0

Scheduled receipts 120 at w2

ITEM E 0	1	2	3	4	5	6	7	8
Gross requirement			80	120	250	55		
Scheduled receipts		120						
Projected on-hand inventory	0	120	40	0	0	0	0	0
Planned receipts				80	250	55		
Planned order release			80	250	55			

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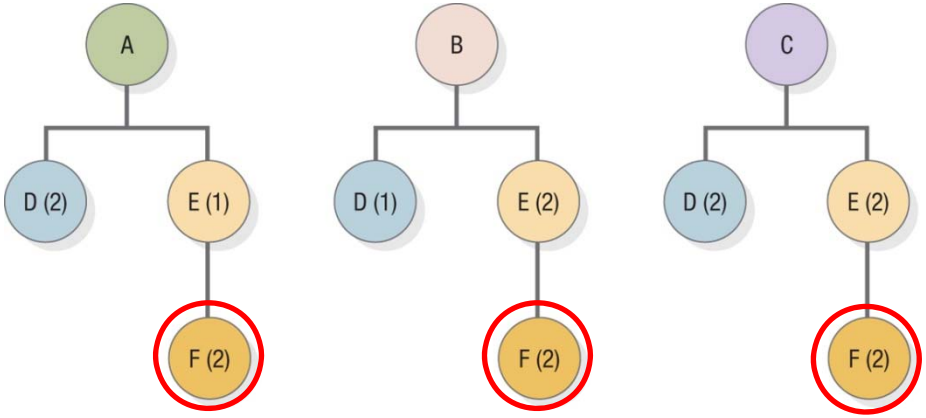
Solution

ITEM E 0	1	2	3	4	5	6	7	8
Planned order release			80	250	55			

80x2 250x2 55x2

Gross requirement for F



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Inventory beginning 100

POQ P=2, LT= 2, Safety stock = 30

Scheduled receipts none

ITEM F 100	1	2	3	4	5	6	7	8
Gross requirement			160	500	110			
Scheduled receipts								
Projected on-hand inventory	100	100	530	30	30	30	30	30
Planned receipts			590		110			
Planned order release	590		110					

110+0+30-30

Make sure no out of stock until the next fill-up + Safety stock 30

160+500+30-100

Item: D					Lot Size:	FOQ = 150		
Description:					Lead Time:	3 weeks		
					Safety Stock:	40 units		
Week	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Gross requirements			160	120	125	110		
Scheduled receipts	250							
Projected on hand | 150	400	400	240	120	145	185	185	185
Planned receipts					150	150		
Planned order releases		150	150					

Item: E					Lot Size:	L4L		
Description:					Lead Time:	1 week		
					Safety Stock:	0 units		
Week	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Gross requirements			80	120	250	55		
Scheduled receipts		120						
Projected on hand | 0	0	120	40	0	0	0	0	0
Planned receipts				80	250	55		
Planned order releases			80	250	55			

Item: F					Lot Size:	POQ = 2		
Description:					Lead Time:	2 weeks		
					Safety Stock:	30 units		
Week	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Gross requirements			160	500	110			
Scheduled receipts								
Projected on hand | 100	100	100	530	30	30	30	30	30
Planned receipts			590		110			
Planned order releases	590		110					

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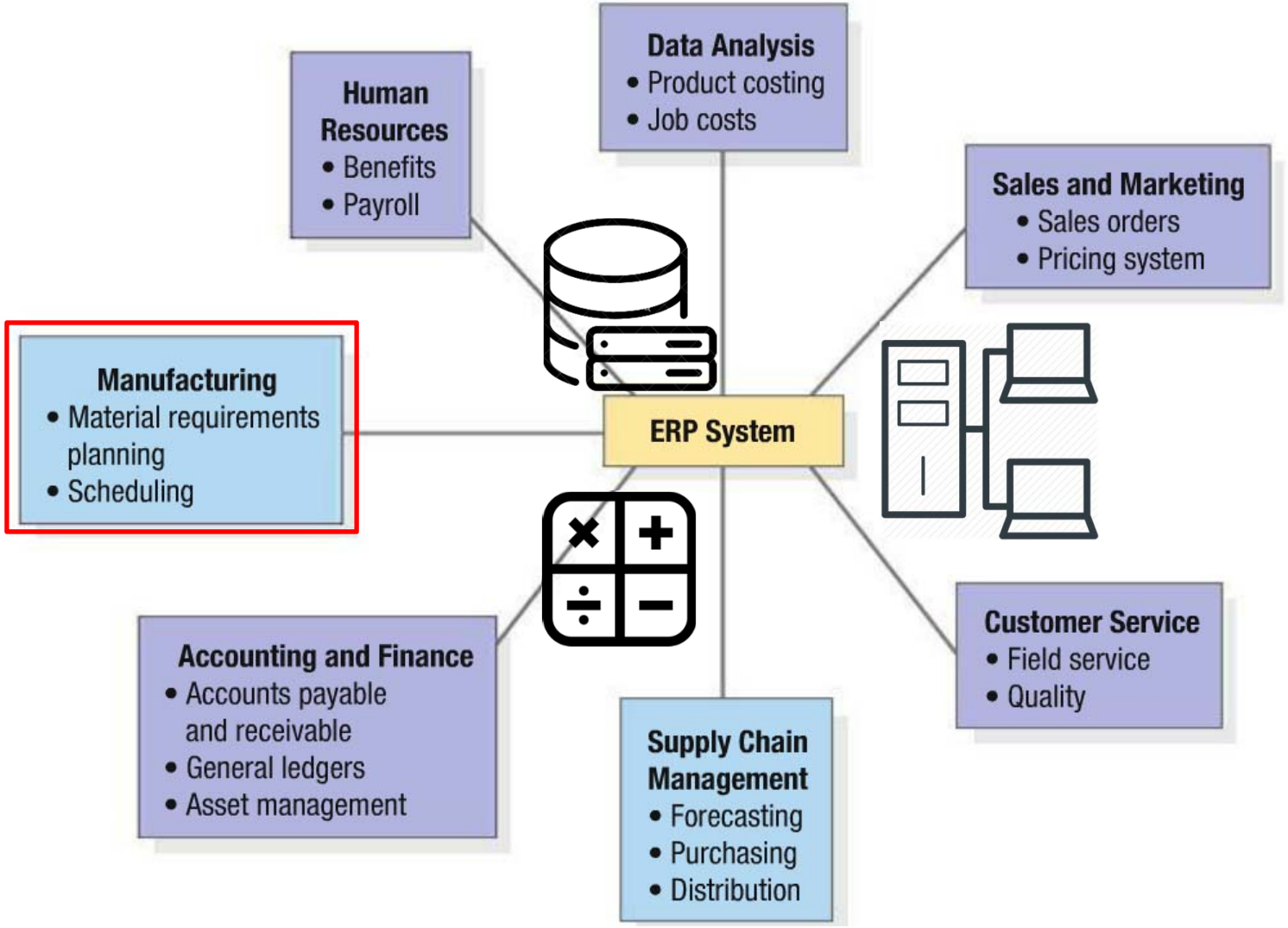
Today's topic

- What is MPS and MRP
- Developing MPS
- How to make MRP
- Enterprise Resource Planning
- Kanban system

What is Enterprise Resource Planning (ERP)?

A large integrated information system. It supports operations processes through data processing and storage.



Problems with MRP

- MPR works only when everything goes as planned
- Otherwise it often makes situation worse!

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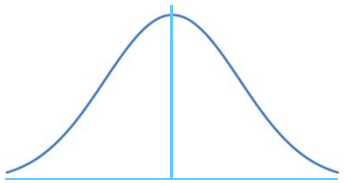
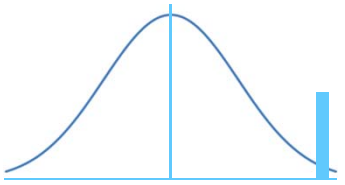
Problems with MRP: examples

MRP

LT is fixed in MPR



LT in reality



Set LT worst scenario

Not possible to update all the LT data

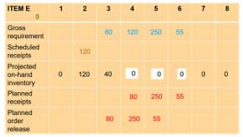


Table is not reliable

Run with own adjustment

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Problems with MRP: examples

MRP

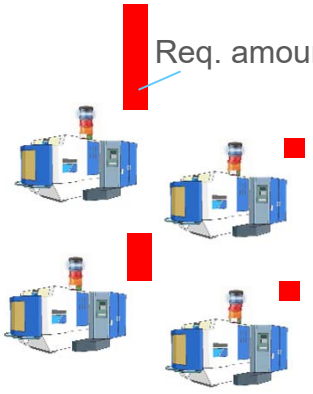
Inventory /Q/when

Can tell out of stock (delay) but not tell when ready

No recovery plan until we know when ready

Planner running around the factory

Not consider capacity



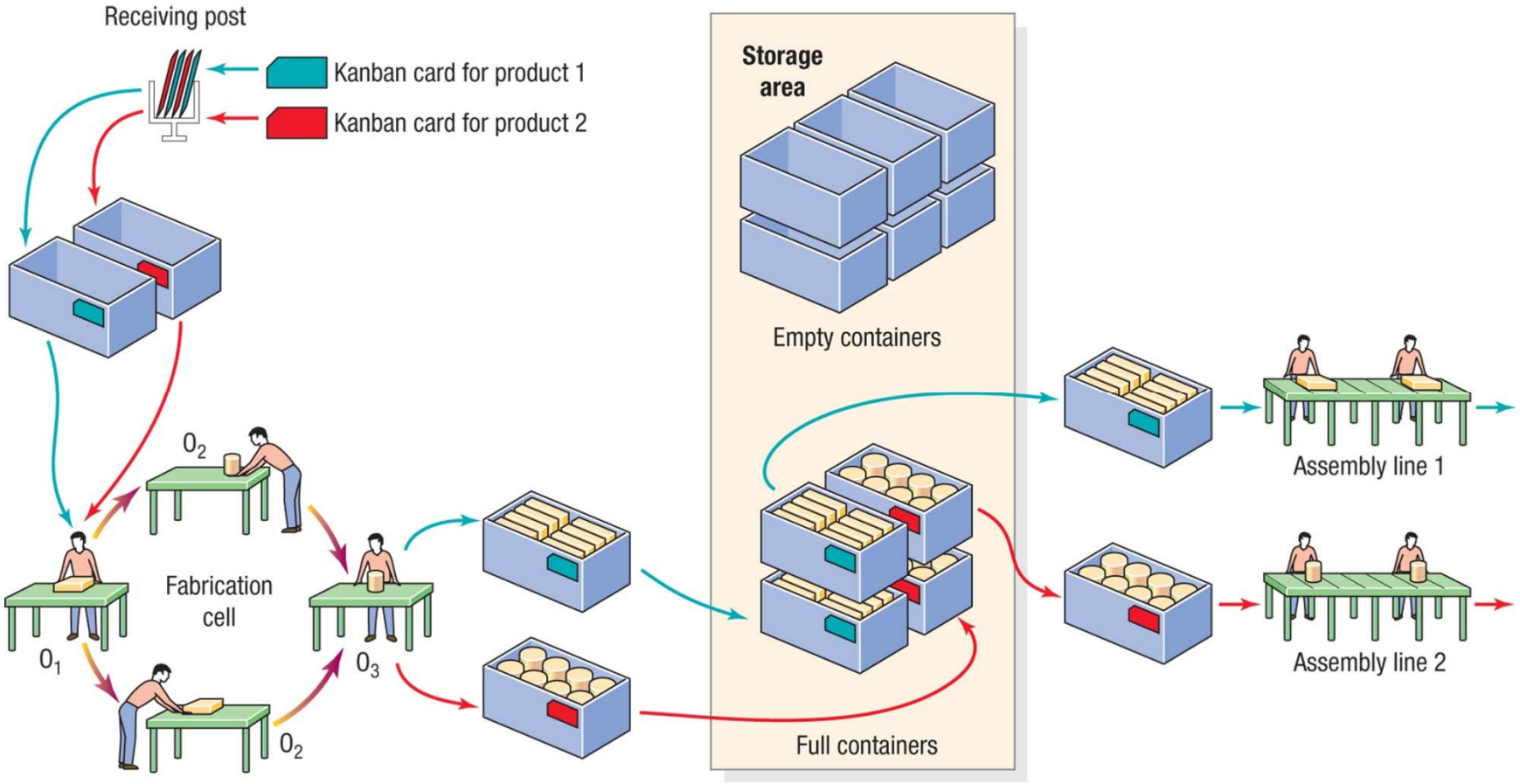
Run with own adjustment, Changing LT

Problems with MRP

- MPR works only when everything goes as planned
- Otherwise it often makes situation worse!

It's like planning an efficient trip with

Kanban system



Kanban system

Prerequisite of using Kanban system

- Flow production
- Small batch production
- Pull production
- Leveling production
- Relatively steady demand on end item
- Frequent internal transport (mizusumashi)
- Small standardized containers
- Fixed address for containers

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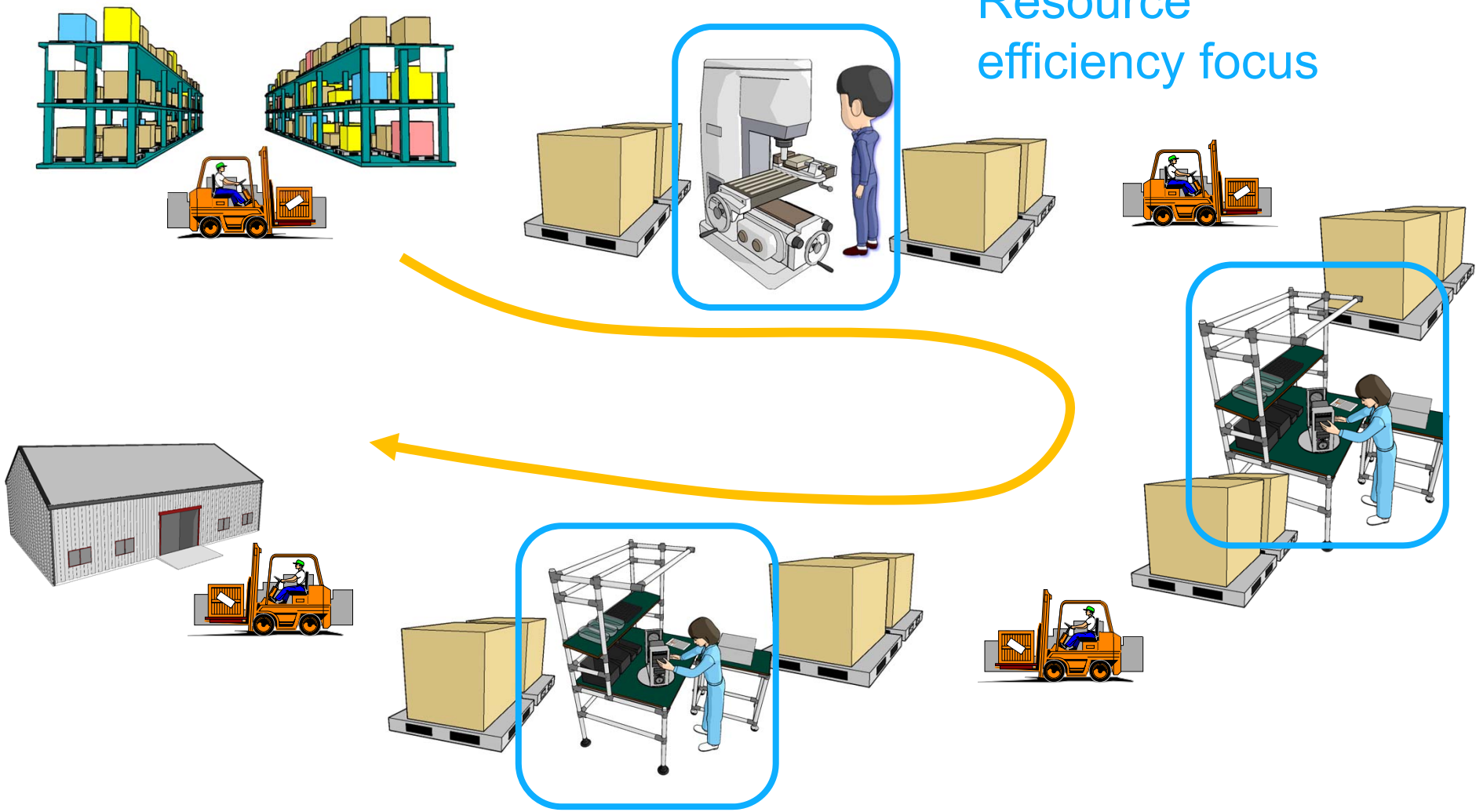
Conventional production (mass production)

Resource
efficiency focus



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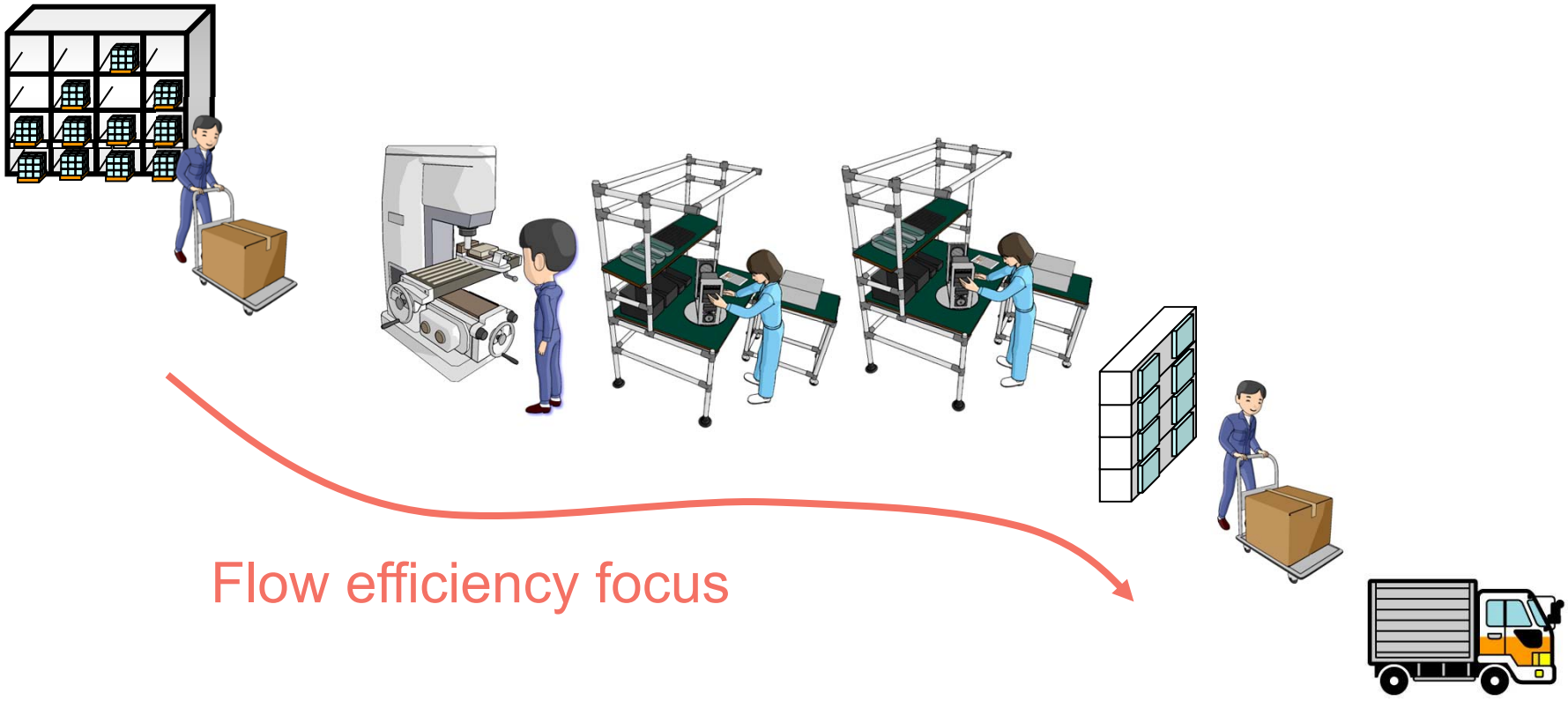
Flow production



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Flow production requires stability

- Stability in machines and equipment
- Stability in quality
- Stability in man power
- Stability of material supply from suppliers

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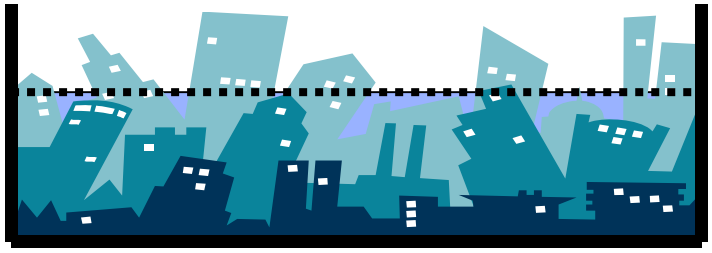
Sensitiveness till disturbances is an improvement opportunity

High inventory level (work-in-process) can hide problems

Defects

Lack of parts

Machine break down



With low inventory level, you can easily identify problems

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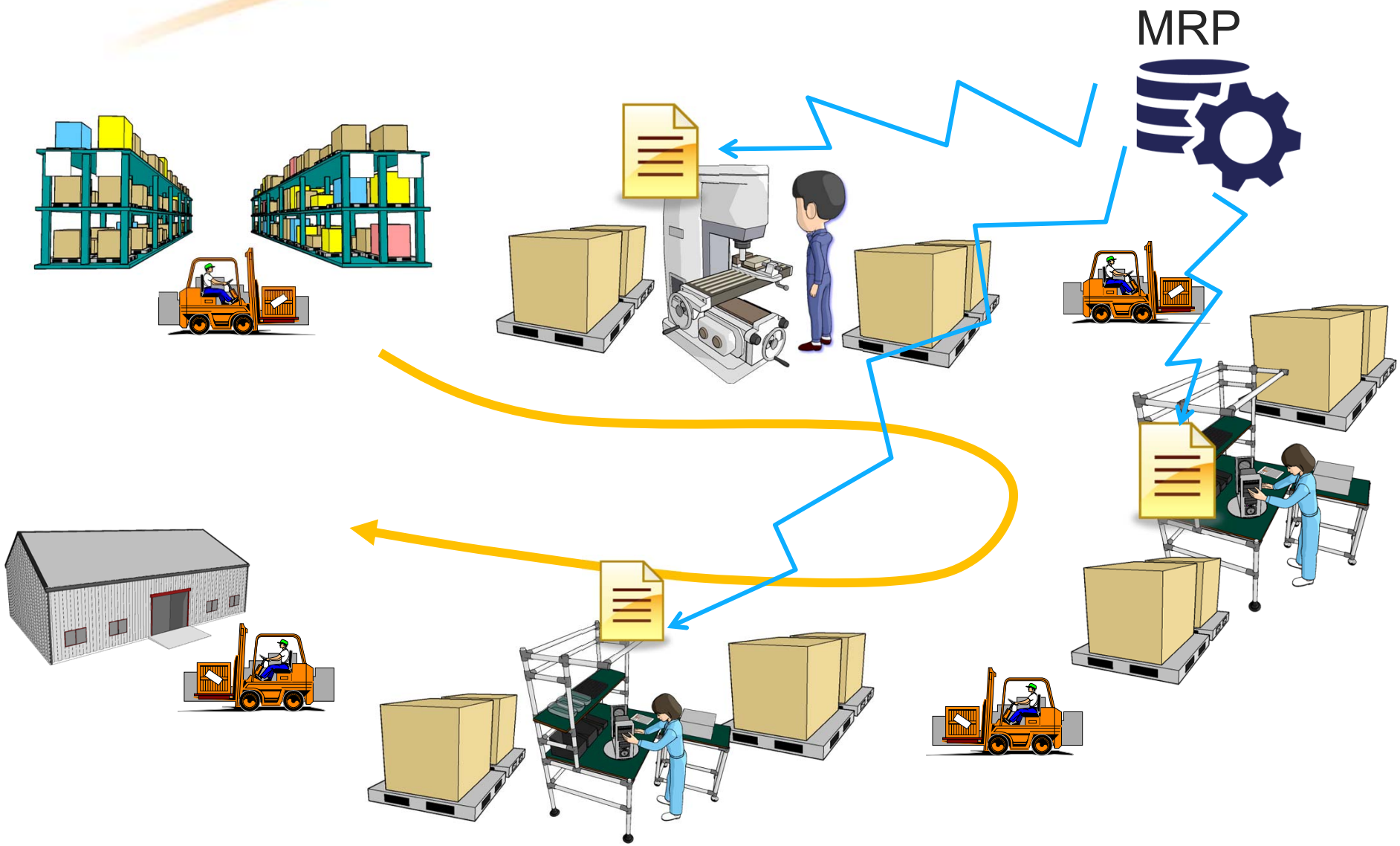
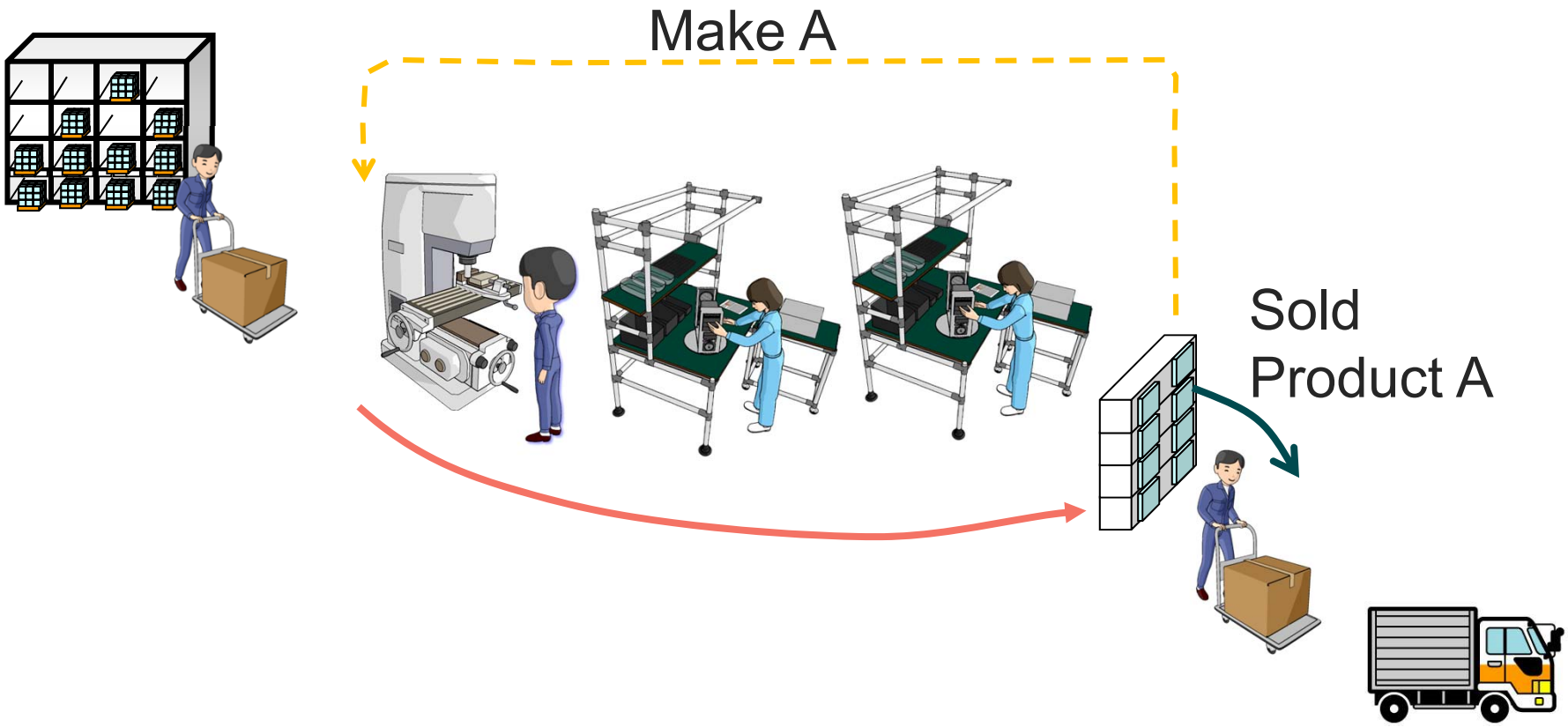
Push production



Flow production + Pull production



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Leveling production

To meet demand and keep inventories low, a "level" schedule is developed so that the same mix of products is made every day in small quantities.

Weekly production Requirements by Product

A: 10 units/week
B: 20 units/week
C: 5 units/week
D: 5 units/week
E: 10 units/week

Traditional Production Plan

Monday	Tuesday	Wednesday	Thursday	Friday
AAAAA	BBBBB	BBBBB	DDDDD	EEEEE
AAAAA	BBBBB	BBBBB	CCCCC	EEEEE

JIT Production Plan

Monday	Tuesday	Wednesday	Thursday	Friday
AABBBB	AABBBB	AABBBB	AABBBB	AABBBB
CDEE	CDEE	CDEE	CDEE	CDEE

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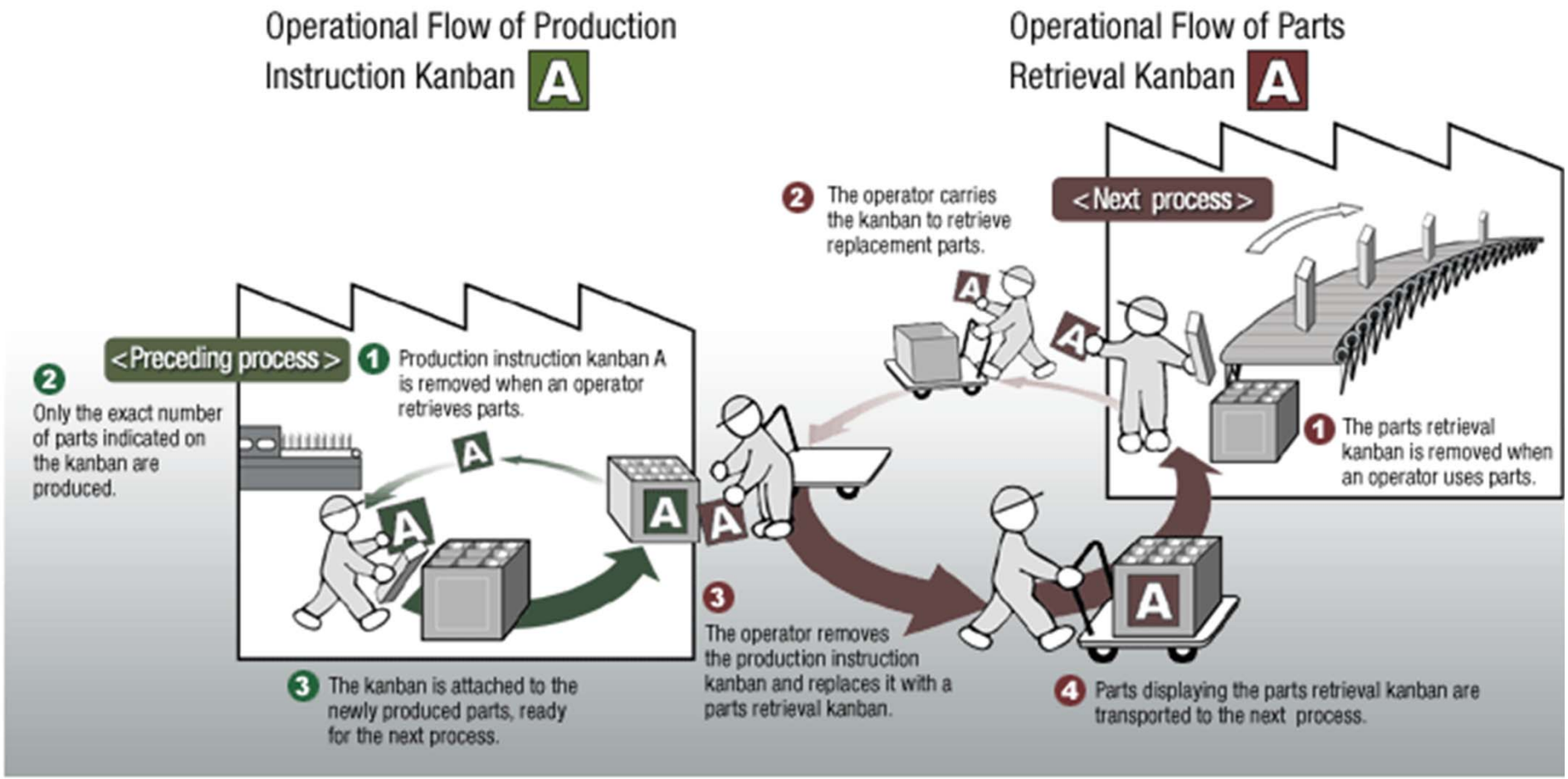
Kanban system

Conceptual diagram of the Kanban System



Kanban system

Advantage:

- Prevent overproduction
- Prevent mismatch between information and actual things
- Visualize information flow
- etc.

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Relevant book chapters

- Chapter: “Planning sufficient resources”
- Chapter: “Designing and managing processes”:
  - *The Kanban system.*