UNIVERSITÀ DEGLI STUDI DI TRIESTE

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335 211609

INDUSTRIAL PLANTS II

Chapter one ï part 7:

Lean manufacturing

JUST IN TIME

DOUBLE DEGREE MASTER IN

ñPRODUCTION ENGINEERING AND MANAGEMENTò

CAMPUS OF PORDENONE

UNIVERSITY OF TRIESTE

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TECHNIQUES AND TOOLS					7 TOOLS	DATA COLLECTION SHEETS	
						STRATIFICATION	
						CORRELATION	
						PARETO'S DIAGRAM	
						ISTOGRAMS	
						CONTROL CHARTS	
						ISHIKAWA DIAGRAM	
					ONE POINT LESSON		
					A3	5 WHYS	
					KEY PERFORMANCE INDICATORS		
					5 S		
				YAMAZUMI	ANDON		FLASH MEETINGS
				TAKT TIME	VISUAL MANAGEMENT		GROUP WORK
			ERGONOMY	KANBAN	STANDARDIZATION		EMPOWERMENT
			TPM	KAIKAKU	PDCA		INVOLVEMENT
			SMED	JIT	POKAYOKE		AGREEMENT
		SPAGHETTI CHART	OEE	HEIJUNKA	KAIZEN		INFORMATION
	WASTES	LABOUR TIMES STUDY	ONE PIECE FLOW	FROM PUSH TO PULL	SIX SIGMA		COMMUNICATION
	HOSHIN KANRI	CURRENT VMS	FUTURE VSM	PULL	JIDOKA		MOTIVATION RESEARCH
PRINCIPLES	DEFINE THE VALUE	IDENTIFY THE VALUE FLOW	SET UP FLOW ACTIVITIES	MANUFACTURE PULLING THE PRODUCTION	RESEARCH PERFECTION		ATTENTION TO PEOPLE
FOCUS	CUSTOMER				QUALITY		EMPLOYEES

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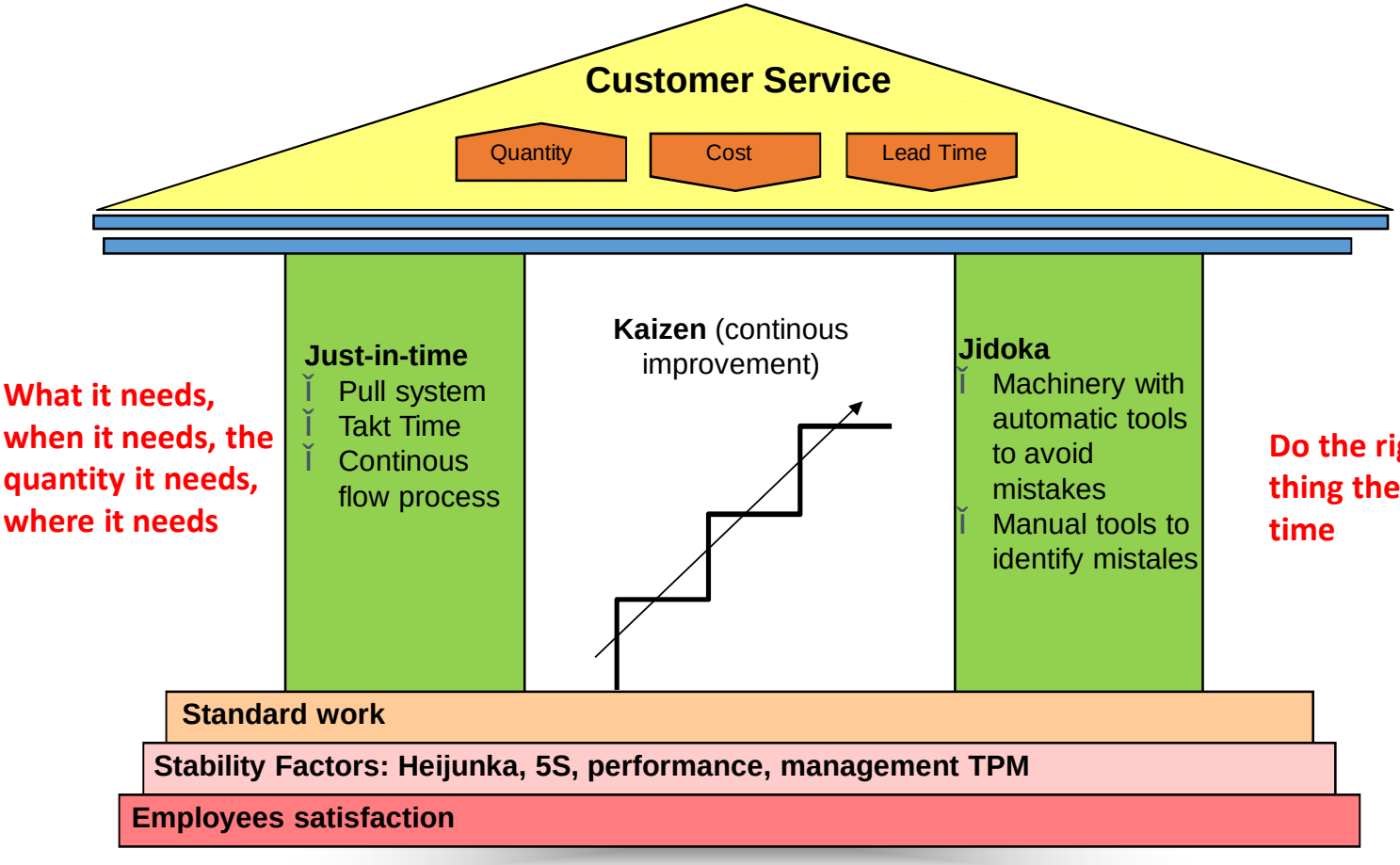
ñToyota Production Systemò



What it needs, when it needs, the quantity it needs, where it needs

Do the right thing the first time

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WHAT IS JUST IN TIME?

- **Just in Time (JIT) is an integrated set of activities designed to get the expected production volumes, with the use of stocks (raw materials, WIP - work in progress - and finished products) at the minimum value necessary to ensure correct flow of the flow.**
- **The main focus is on inventories, which are one of the largest sources of cost in companies**

What it needs, when it needs, the quantity it needs, where it needs

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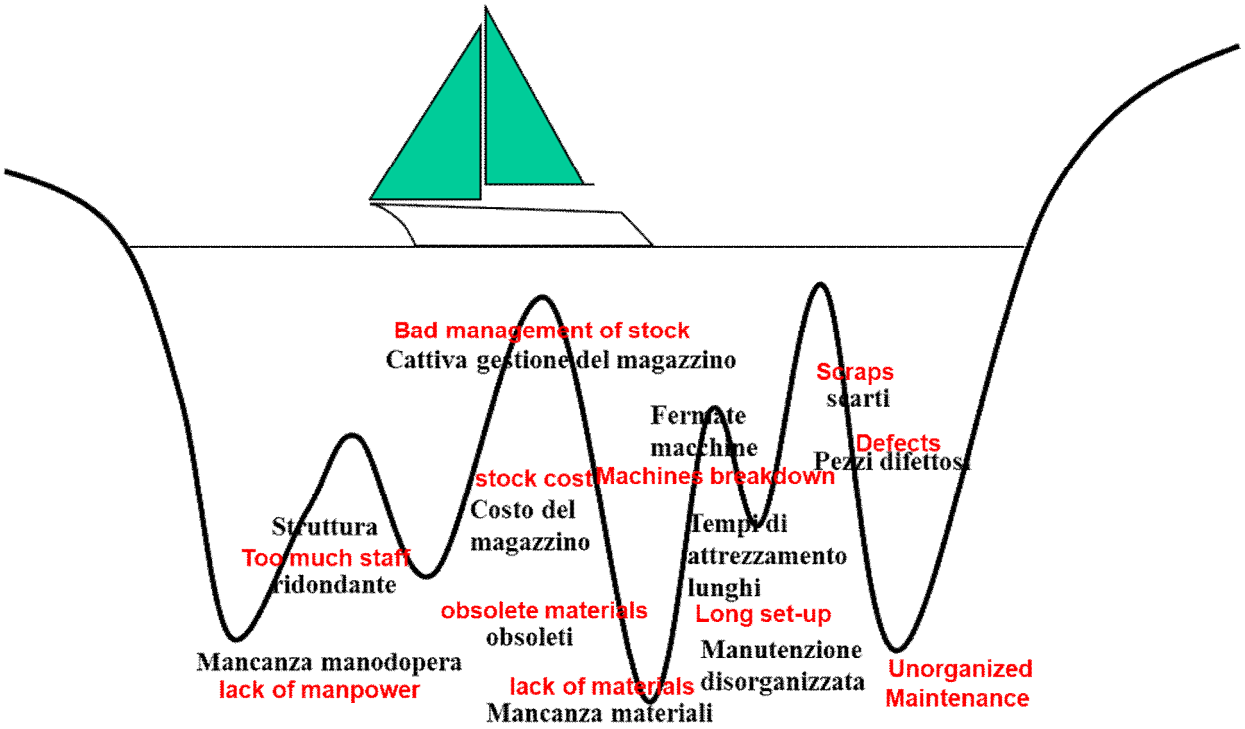
WHY DO WE NEED STOCKS?

The stocks are therefore necessary to allow an imperfect production system working, because they compensate for the problems that afflict the company.

Stocks are represented as a sea that is deep enough to cover a bottom with several rocks and therefore allow the boat to navigate.

The obstacles are the Company's malfunctions and are wastes that undermine its competitiveness and that must be eliminated.



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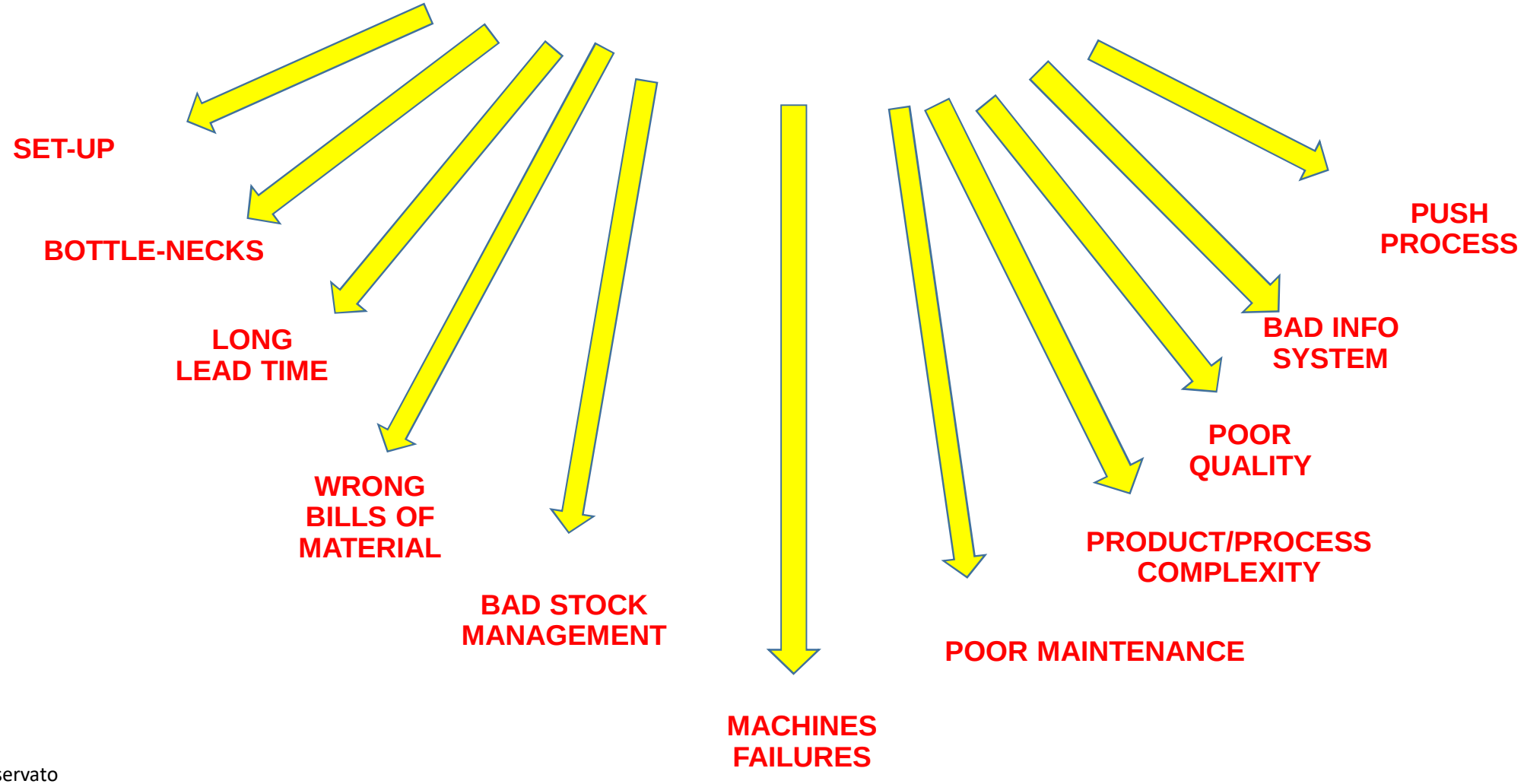
WHY DO WE NEED STOCKS?



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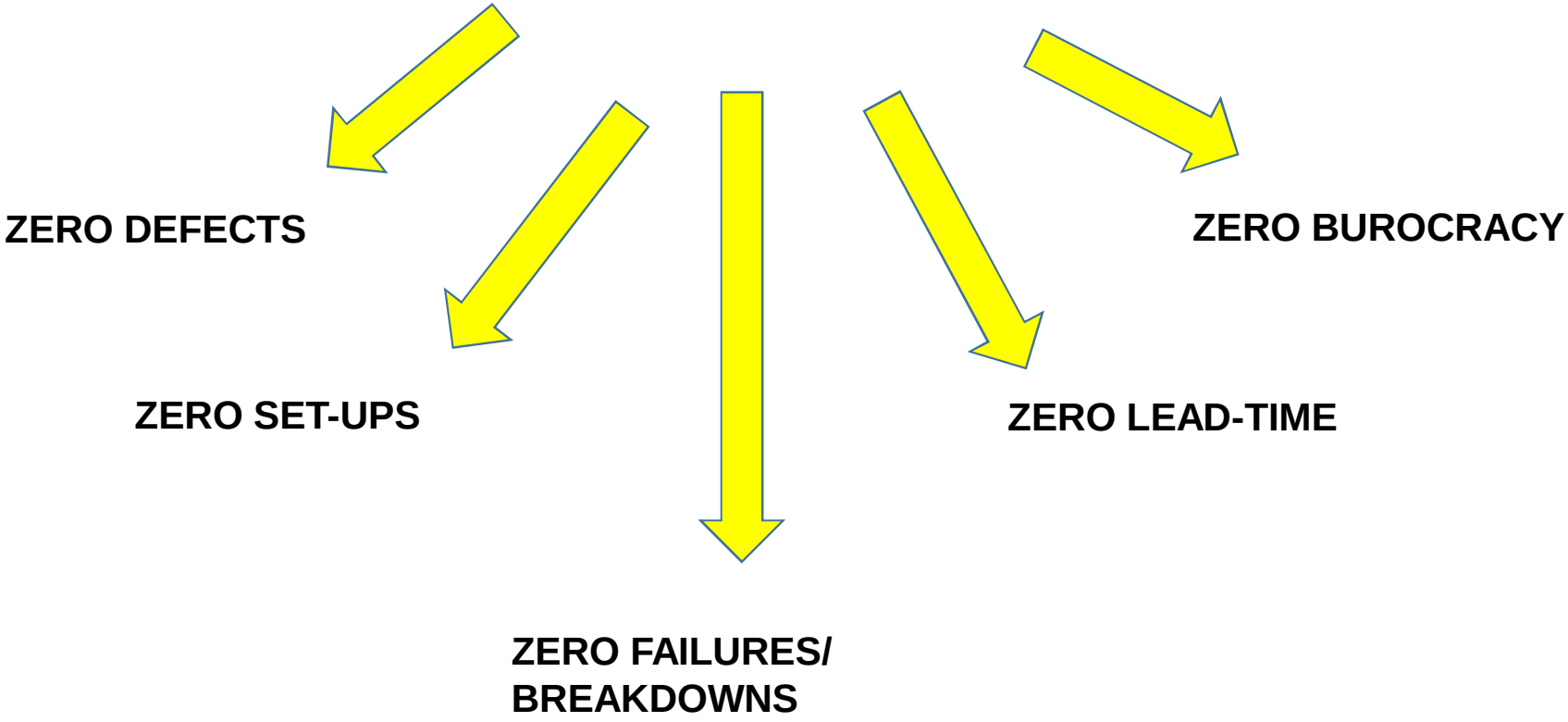
CONSEQUENCE: ZERO STOCK!



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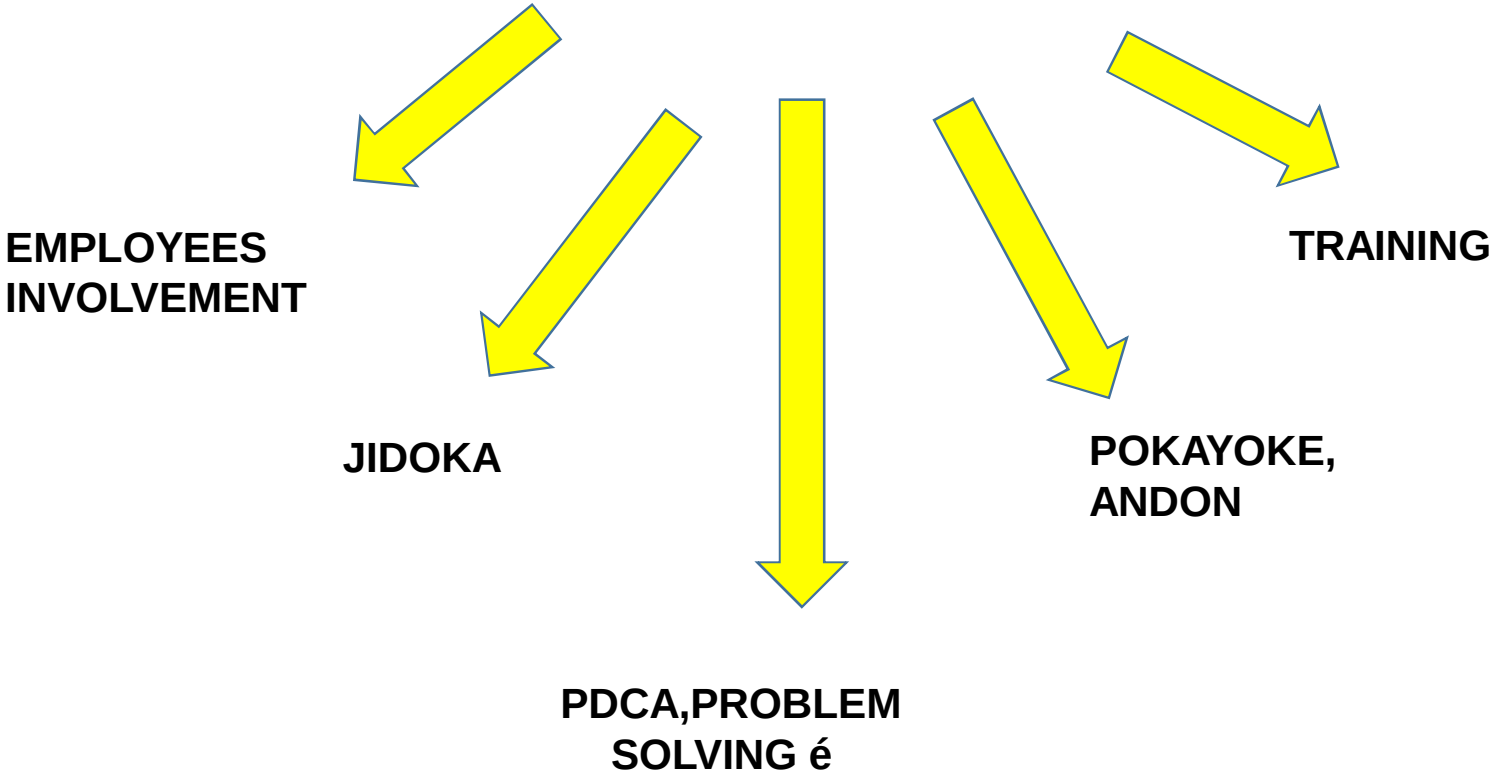
ZERO DEFECTS



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ZERO SET-UPS

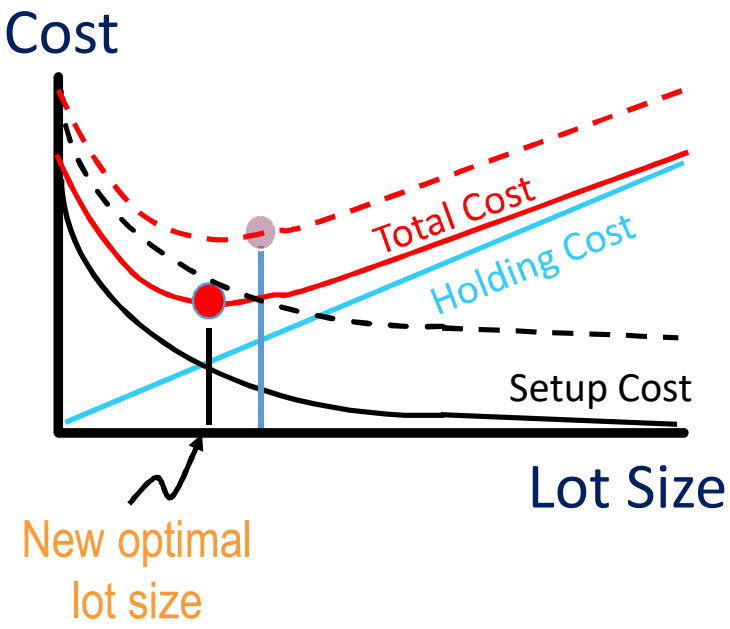
EMPLOYEES INVOLVEMENT,

SMED, OTED

TPM

OEE

TRAINING



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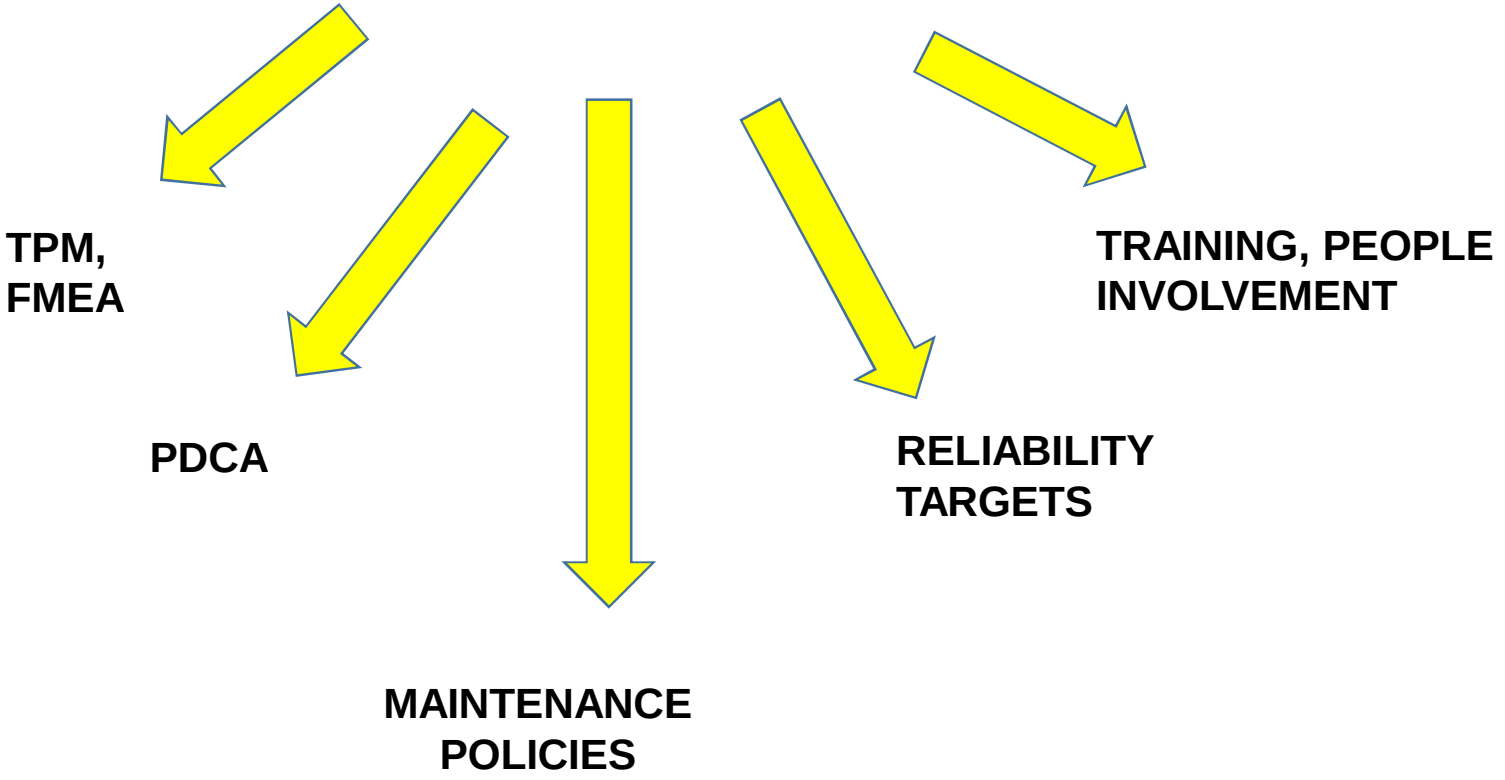
ZERO FAILURES



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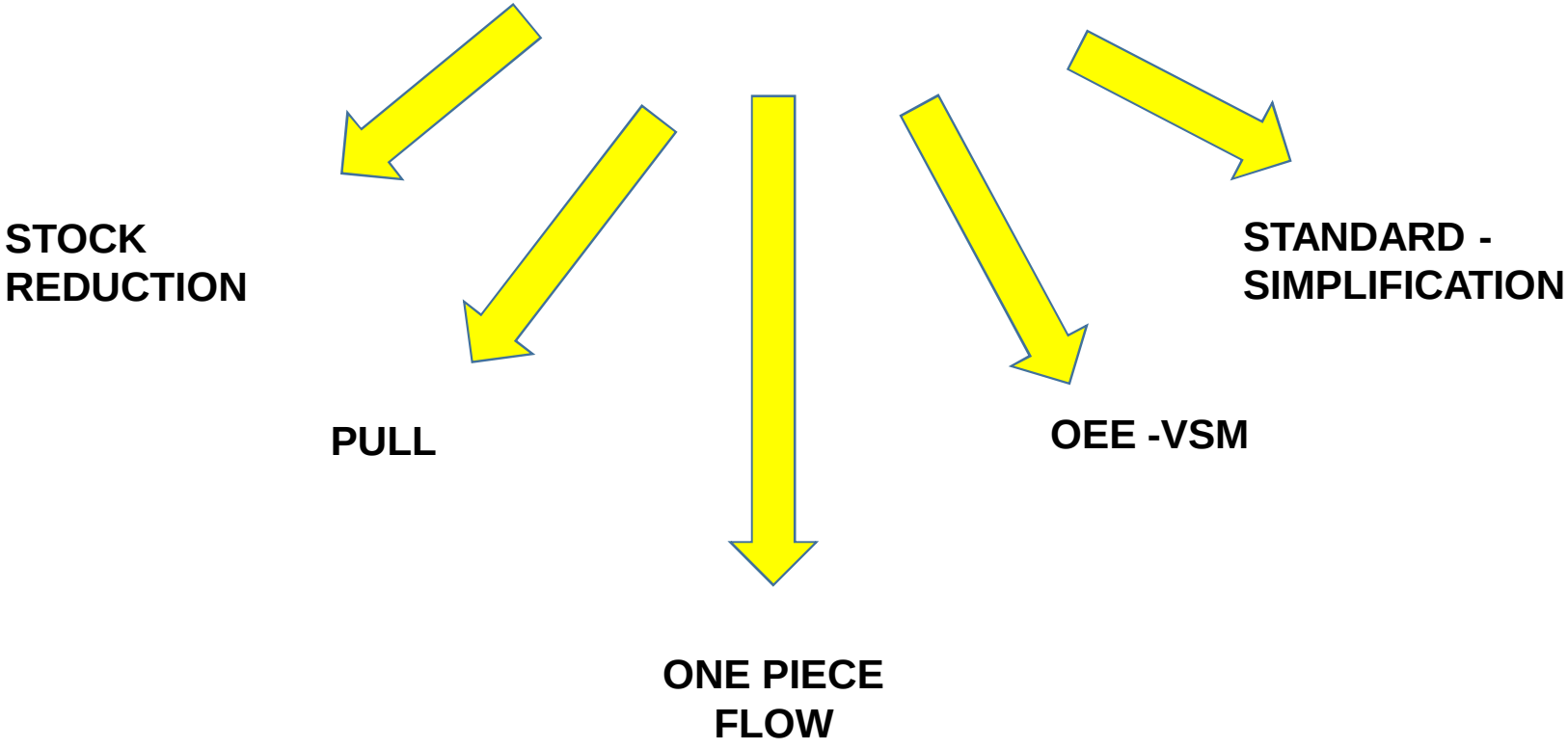
ZERO LEAD-TIME



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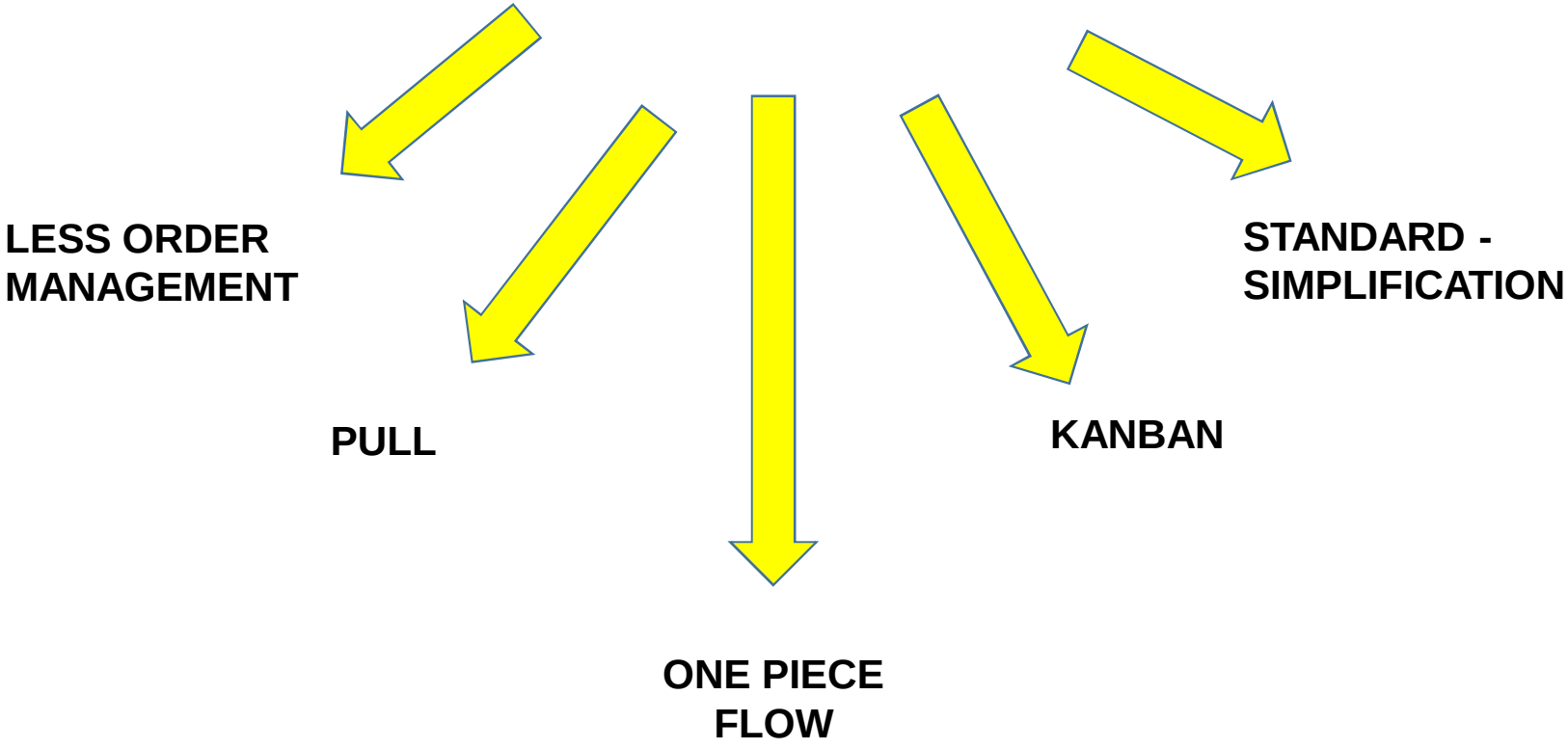
ZERO BUROCRACY



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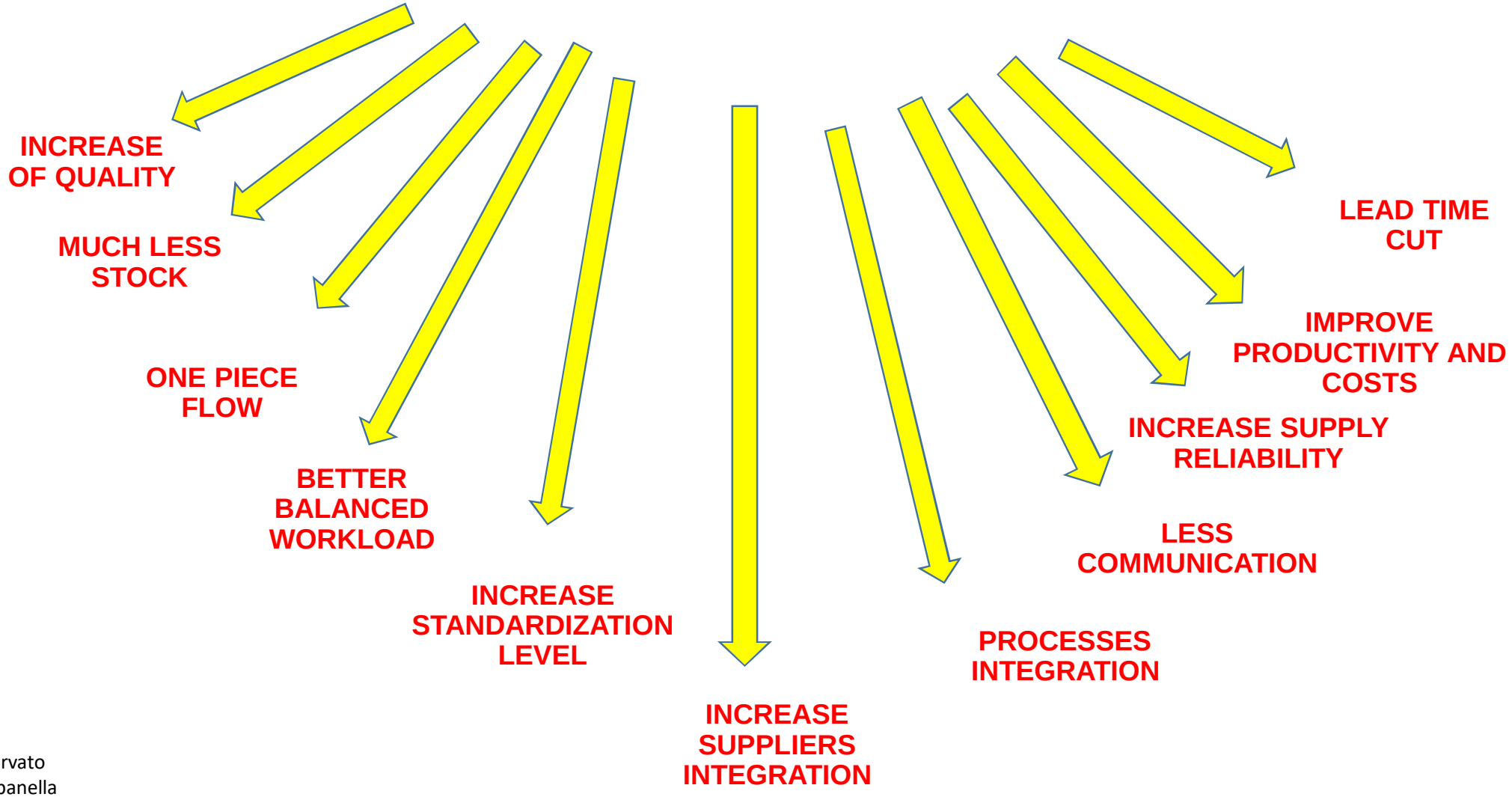
CONSEQUENCES



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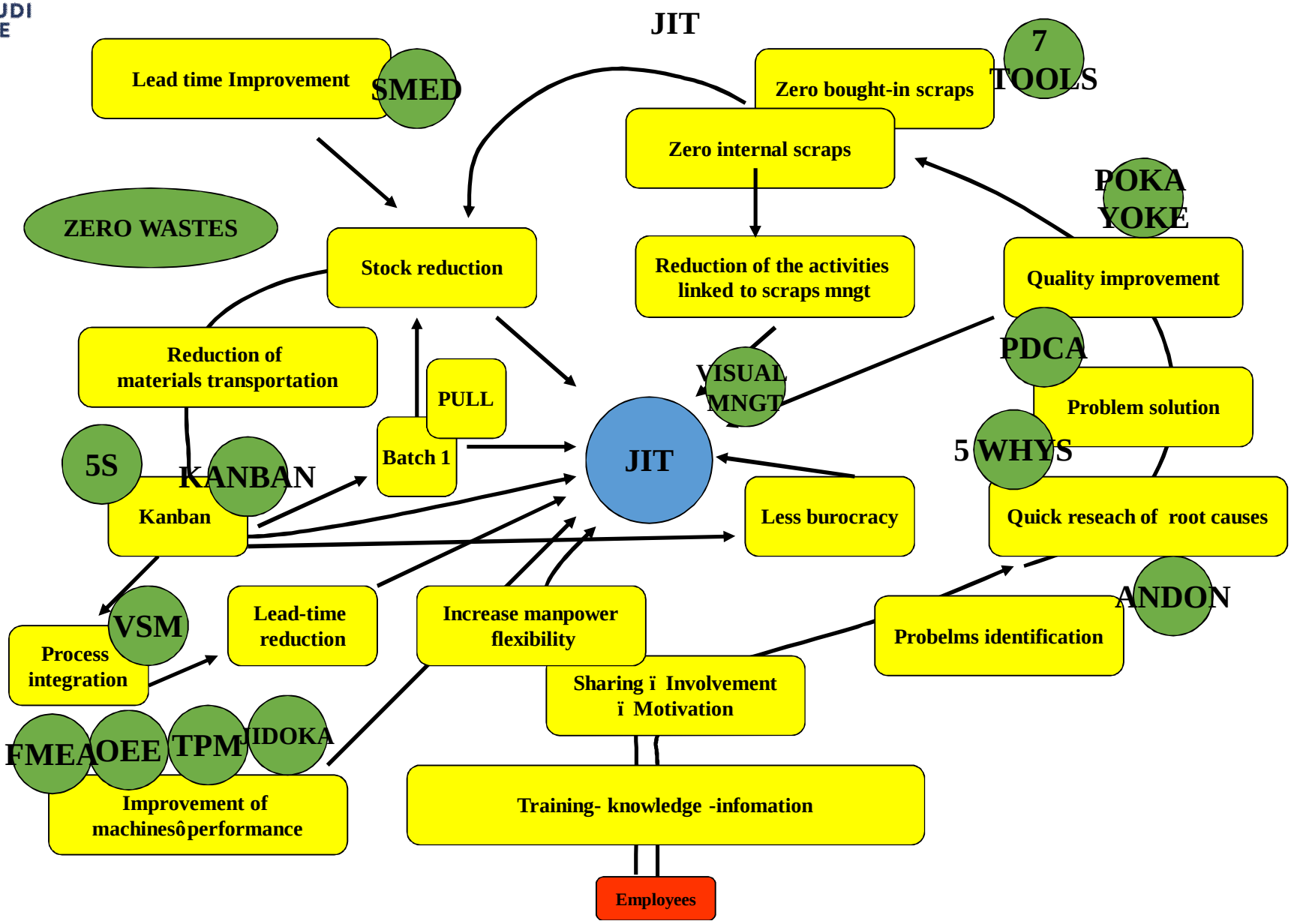
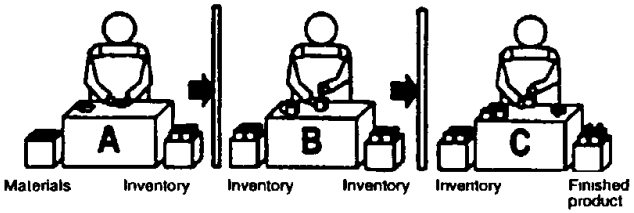


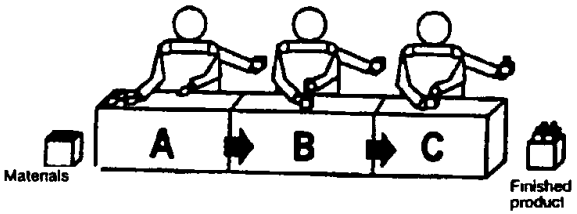
CONTINOUS FLOW

Traditional Flow



- The production steps are separate and the operators are located far each other
- Typically, the "A, B, C" depts. are organized by defined by type of processing (eg all the molding, all the turning, drilling)
- The production requires complex planning and a complex flow of materials
- It is very usual to have high level of waiting, (even if the efficiency of the individual processing phases is high) with a long lead-time
- There is a high level of working capital (especially, "work-in-process")
- The defects are discovered when the become statistically visible

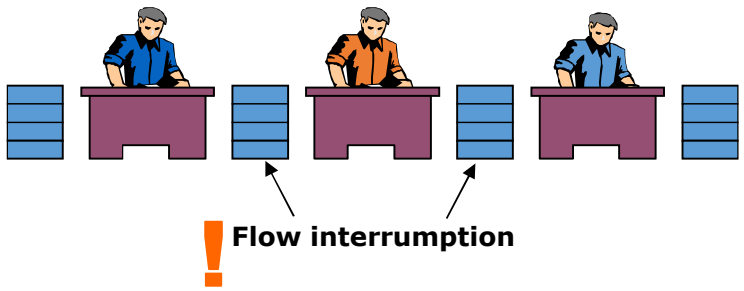
Continous Flow

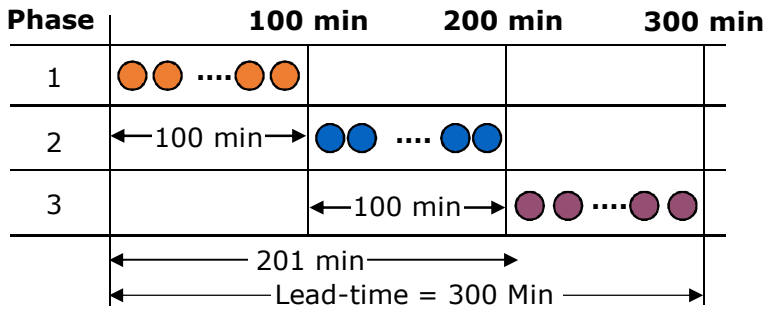


- Communication between operators and flexibility is easy because they are close
- Operators with multifunctional capabilities can be used efficiently
- The lead time is faster thanks to simplified production flows
- The standardization of set-up activities allows you to easily change the configuration of the line (flexibility)
- There is a low level of working capital (especially, "work-in-process")
- The defect is discovered at one
- The point of origin of the defects is more easily identifiable

CONTINOUS FLOW

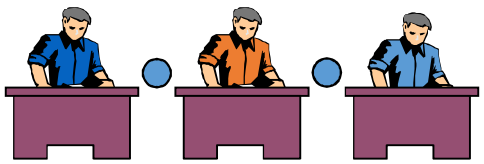
Batch Production

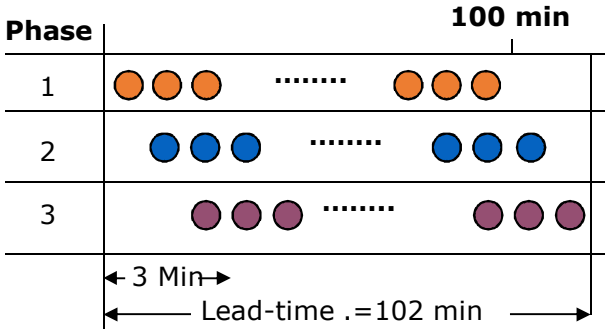




The first piece is ready to be delivered after 201 min, while the complete batch is ready after 300 min

One piece flow





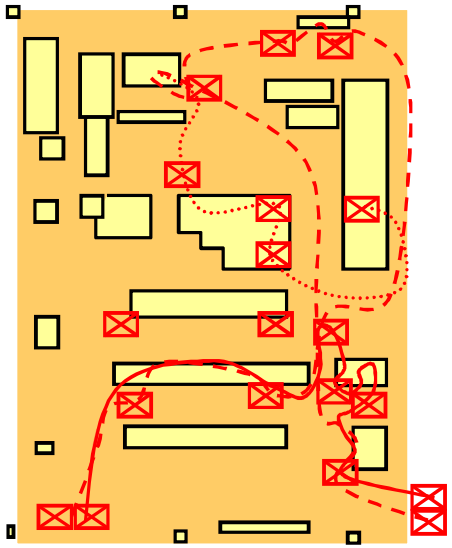
The first piece is ready to be delivered after 3 min, while the complete batch is ready after 102 min

FONTE: McKinsey

CONTINOUS FLOW
PRATICALLYé

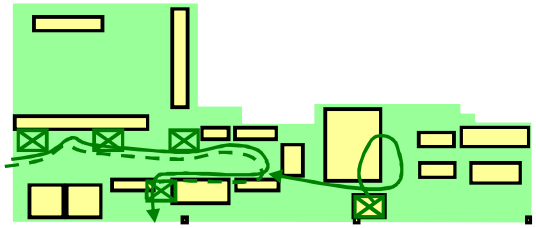
ESEMPIO

BEFORE



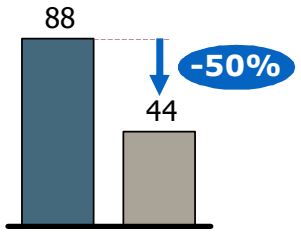
- Big batches production
- Complicated flow and longlead-time
- Long time for set-ups
- Low productivity level

AFTER

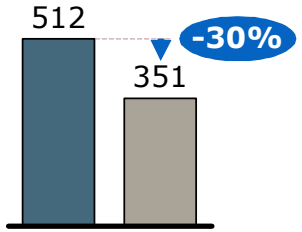


- Onepieceflow
- Low lead-time
- Reduced timefor set-ups
- High productivity level

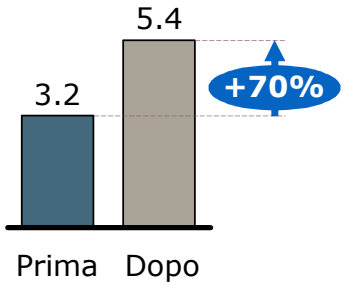
Material movement(m)



Occupied Area(m^2)

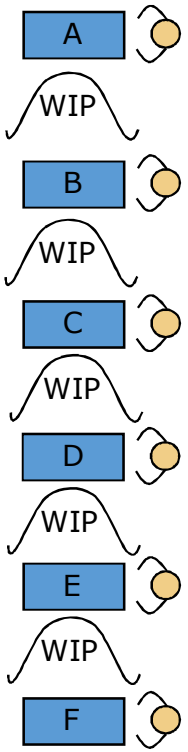
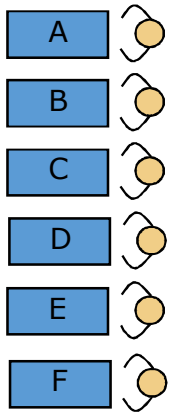
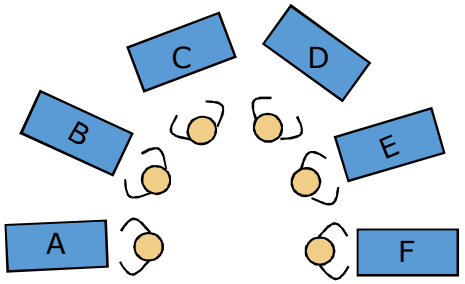
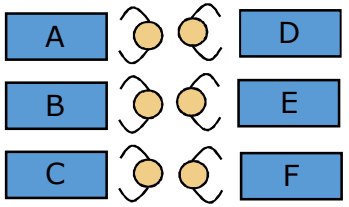


Productivity (parts/h)



FONTE: McKinsey

EXAMPLES OF FLEXIBLE PRODUCTION SYSTEM

Traditional solution	Straight flow	"U" shaped flow	Parallel configuration flow
			
	▪ Immediate feedback Low level of WIP ▪ Very low occupied area	▪ Immediate visual management on the whole flow ▪ Flexible work places	▪ Very low occupied area ▪ The best solution in case of production of simmetric parts
Batch production	**Continous flow**	**Flexible line (with optimized movements)**	

FONTE: McKinsey

JIT SUPPLIERSôPARTNERSHIP
CHARACTERISTICS

- Few
- Nearby
- Repeat business
- Analysis and support to enable desirable suppliers to become or stay price competitive
- Competitive bidding mostly limited to new purchases
- Buyer resists vertical integration and subsequent wipeout of supplier business
- Suppliers encouraged to extend JIT to their suppliers (2^{nd} and 3^{rd} tier suppliers)

JIT SUPPLIERSôPARTNERSHIP
QUANTITY CHARACTERISTICS

- Steady output rate
- Frequent deliveries in small-lot quantities
- Long-term contract agreements
- Minimal or no paperwork (use EDI or internet)
- Delivery quantities fixed for whole contract term
- Precise deliveries (quantities, time)
- Suppliers package in exact quantities
- Suppliers reduce their production lot sizes

JIT SUPPLIERSôPARTNERSHIP
QUALITY CHARACTERISTICS

- Minimal product specifications imposed on suppliers
- Help suppliers meet quality requirements
- Close relationship between buyers and suppliers quality assurance people
- Suppliers use poka-yoke and process control charts instead of lot-sampling techniques

JIT SUPPLIERSôPARTNERSHIP
SHIPPING CHARACTERISTICS

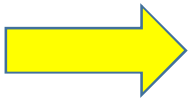
- Scheduling of inbound freight
- Gain control by use of company-owned or contract shipping and warehousing
- Use of Advanced Shipping Notice (ASN)

Work instructions		Workflow				working cycle		
	Activity	Operator	Warehouse supervisor	Forklift driver		Operator	Warehouse supervisor	Forklift driver
1	pick-up 10 paper sheets + 10 envelops + glue +stamps + tool+ input of the download in the info system							
2	transport 10 paper sheets + 10 envelops + glue +stamps + tool to the workshop							
3	assembly completely 10 full envelopes							
4	transport 10 full envelopes to the warehouse							
5	insert 10 complete envelopes in the warehouse and input of the upload in the info system							

Work instructions		Workflow				working cycle		
	Activity	Operator	Warehouse supervisor	Forklift driver		Operator	Warehouse supervisor	Forklift driver
1	pick-up 10 paper sheets + input of the download in the info system							
2	transport 10 paper sheets to the workshop							
3	fold 10 paper sheets							
4	transport 10 folded sheets to the warehouse							
5	insert 10 folded paper sheets in the warehouse and input of the upload in the info system							
6	pick-up 10 folded paper sheets + 10 envelopes + input of the download in the info system							
7	transport 10 folded sheets + 10 envelopes to the workshop							
8	insert the 10 folded sheets in 10 envelopes							
9	transport 10 full envelopes to the warehouse							
10	insert 10 full envelopes in the warehouse and input of the upload in the info system							
11	pick-up 10 full envelopes + stamps, glue and tool + input of the download in the info system							
12	transport of 10 full envelopes + stamps, glue and tool + input of the download in the info system from warehouse to the workshop							
13	glue 10 envelopes							
14	glue 10 stamps							
15	use the tool for 10 stamps							
16	transport of 10 complete envelopes + stamps, glue and tool + input of the upload in the info system							
17	insert 10 complete envelopes in the warehouse and input of the upload in the info system							

KANBAN

Kanban is the main tool to communicate in the factory to start a production or to move a material between processes in a pull system.



Kanban Benefits

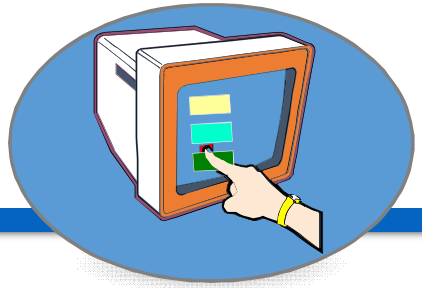
- **Avoids overproduction –**
- **no Kanban, no production**
- **Allows a self-regulated production**
- **Allows an easy and visual identification of what to manufacture**
- **Allows to standardise the operations but overall to strongly simplfy the order management**

KANBAN
type of signals

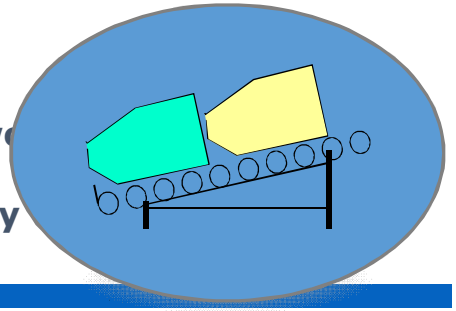
Fill-up pull

Kanban Cards

Electronic Kanban

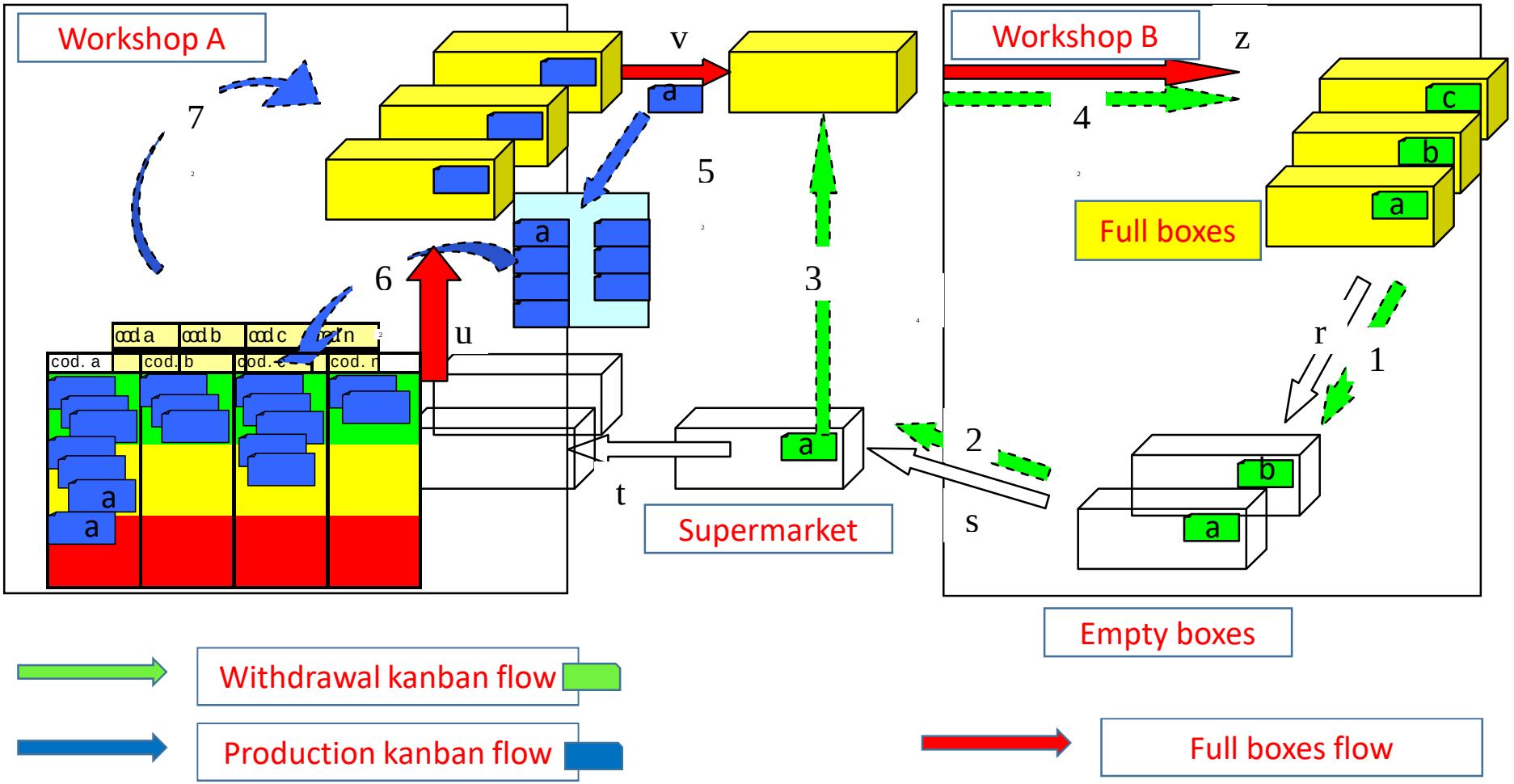


Containers Scatole (es., Principle of two containers- refill the empty one



FONTE: McKinsey

TWO KANBAN CARDS



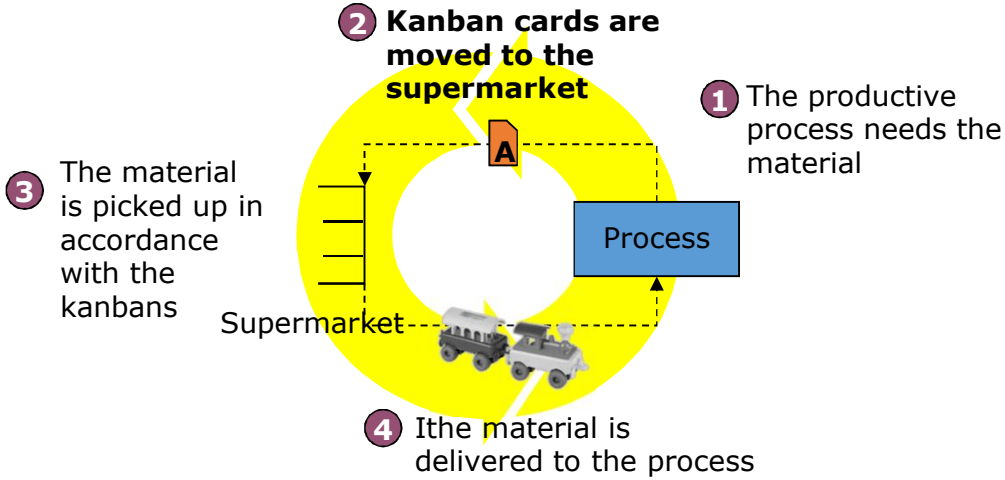
TWO KANBAN CARDS

HOW TO CALCULATE THE NUMBER OF KANBAN CARDS

This method, very common in the relationship with suppliers where the compliance with the delivery time is essential, the quantities withdrawn are variable at constant time intervals. Considering:

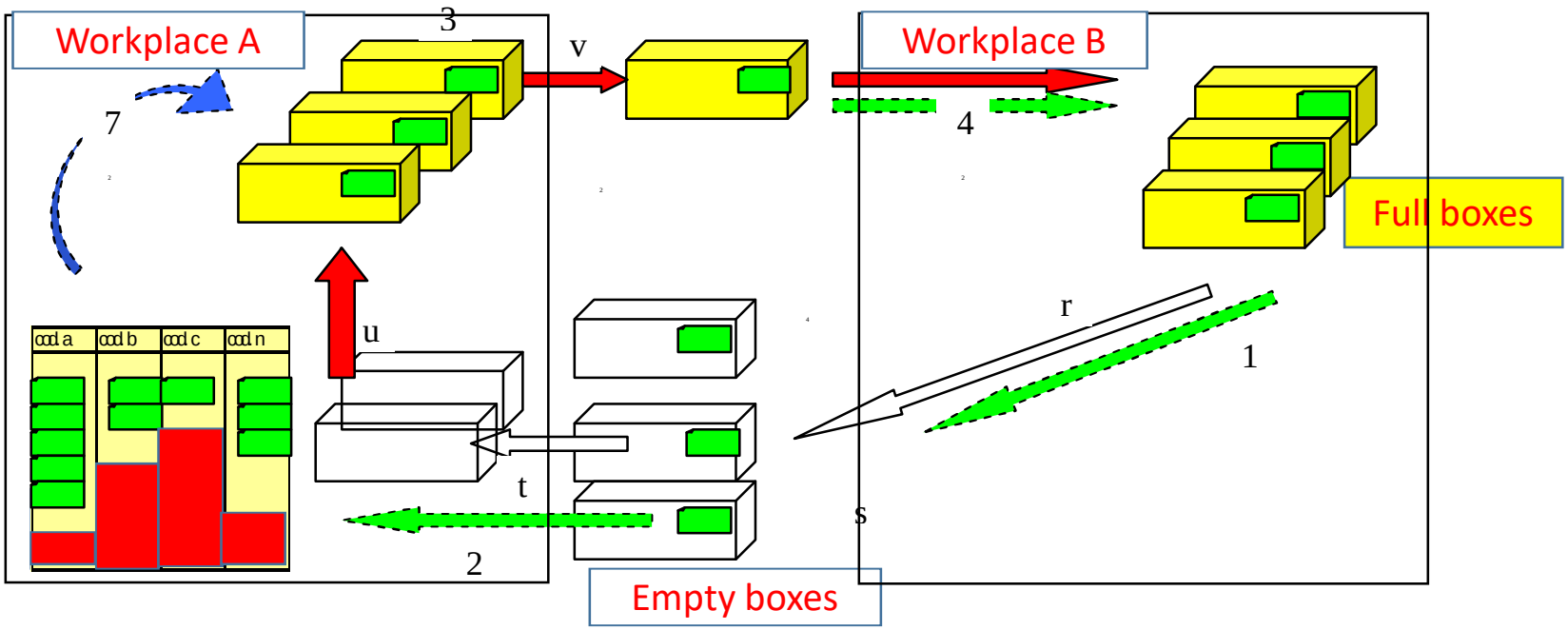
D = average daily consumption
LT = parts production lead time
RT = replenishment time
SS = safety stock
C = capacity of the container

N = number of kanbans is defined by the relation:



$$N = \frac{D \cdot (LT + RT + SS)}{C}$$

ONE KANBAN CARD



ONE KANBAN CARD

HOW TO CALCULATE THE NUMBER OF KANBAN CARDS

$$N_k = \frac{(D_M \cdot LT) + SS}{C}$$

where:

Nk = number of kanbans or containers

DM = average demand/h

LT = lead time to produce the parts

SS = safety stock

C = container capacity.

For example, if the average request is DM = 150 pieces / hour and the lead time is LT = 30 minutes = 0.5 hours, with a safety stock equal to 10% of the quantity of pieces required in the replenishment time:

$$SS = 0{,}1 \times (150 \times 0{,}5) = 7{,}5$$

and if the capacity of the container is C = 25 pieces, it follows that:

$$N_k = \frac{(150 \cdot 0{,}5) + 7{,}5}{25} = 3{,}3 \ \ kanban\ o\ contenitori$$

The number obtained can be rounded to 4 if some inefficiency is allowed, or it can be rounded to 3 if it pushes towards improvement.

ONE KANBAN CARD

HOW TO CALCULATE THE NUMBER OF KANBAN CARDS

$$N_k = \frac{(D_M \cdot LT) + SS}{C}$$

where:

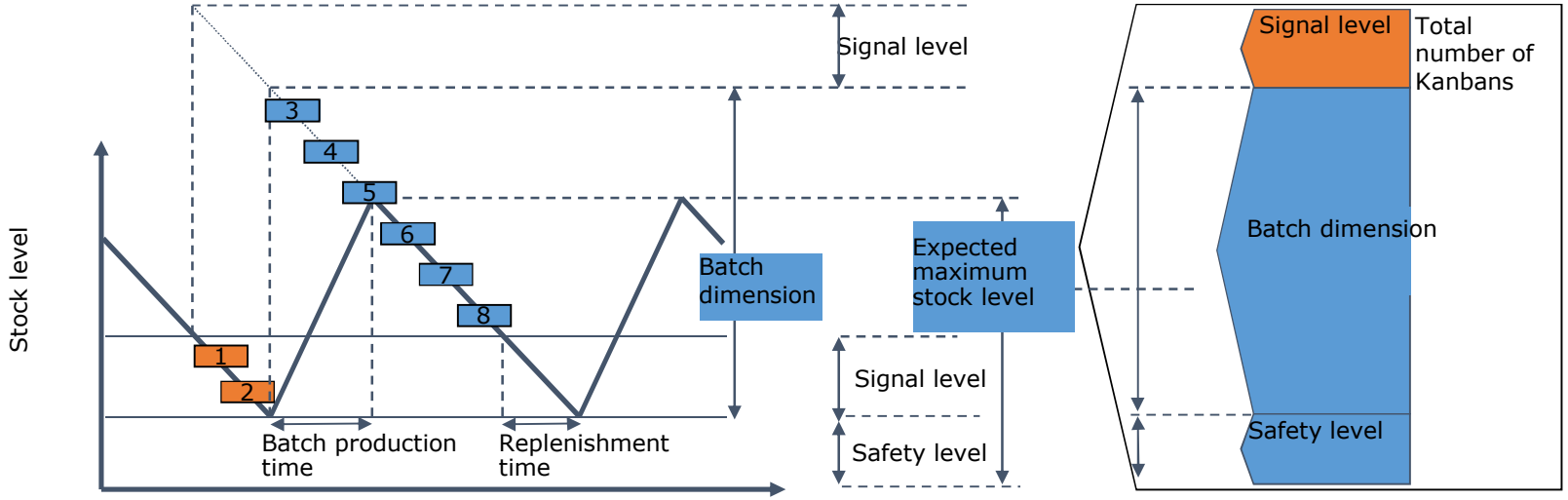
Nk = number of kanbans or containers

LT = lead time to produce the parts

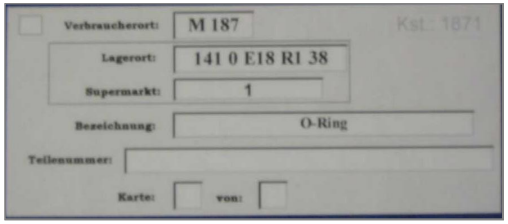
C = container capacity.

DM = average demand/h

SS = safety stock



KANBAN EXAMPLES



KANBAN EXAMPLES

Da Reparto Presse	A Reparto Assemblaggio
Material code	*4712*
Description	Electric motor support
Container type B	Container capacity : 25 pcs
Transport type A car	Warehouse position : Q1234
Card Number 3/5	Die n. 9876
Machine n. 5678	

Rule 1: Don't send defective parts to the next process

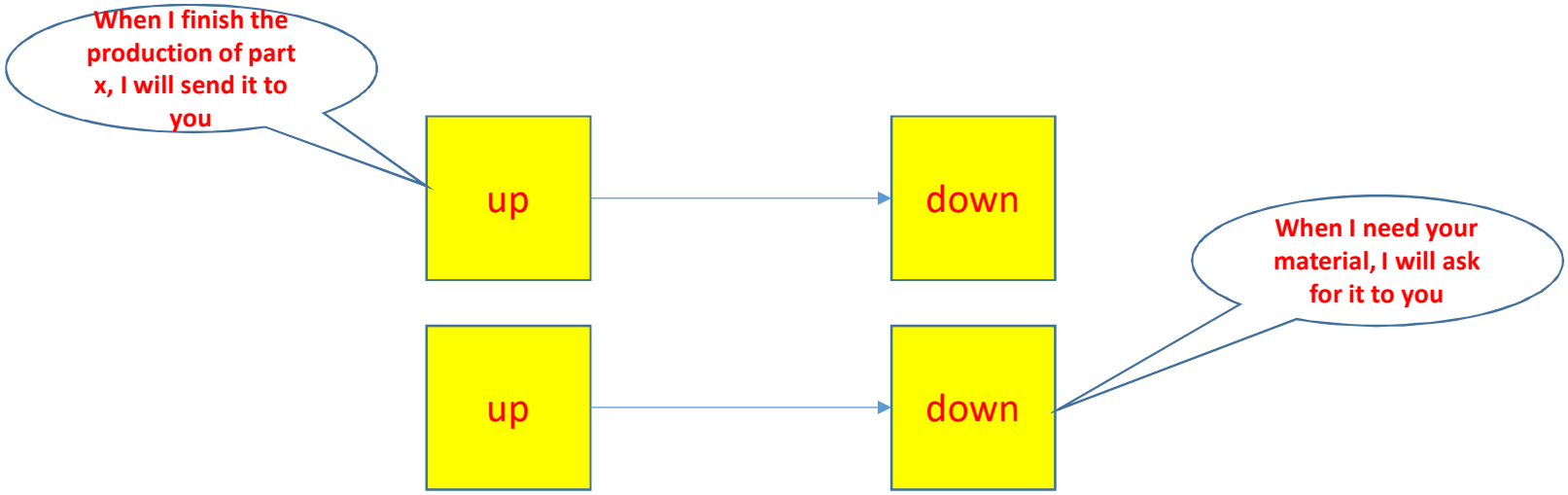
Producing defective parts means using materials, machinery and labor to obtain something that cannot be sold, that is, wasting the resources used. Compliance with this rule means that:

- **the phase that produced a defective piece must be immediately identified;**
- **the problem of that process can / must be brought to everyone's attention in order to be solved as soon as possible.**

To strictly comply with this rule, machinery must be able to stop automatically (JIDOKA) as soon as a defective item is produced and if by chance defective products are mixed with valid products, it must be possible to identify and replace them immediately.

Rule 2: The next steps should only take what is needed

The second rule says that the downstream department collects the materials at the established time and quantity (and only those): in this way we avoid producing unnecessary components, without using the production capacity of the process. This rule also determines the inversion of the "historical" concept of "supply of the downstream process by the upstream one" (push) with that of "withdrawal of the downstream process from the upstream one" (pull) over time and in the amount due.



Rule 3: produce only the exact quantity that will be collected by the next process

This is the natural consequence of the second rule: each process must produce only the exact quantity required by the downstream department and exclusively in the sequence in which the kanbans are received. Only in this way will stocks be reduced to a minimum

Rule 4: evenly distribute the production

To meet the third rule, which is to produce exactly what is ordered, the workstation may need additional manpower and machinery. For this it is necessary to distribute the production as evenly as possible in the processing cell, so that it is possible to pass from one product to another without particular upsets. In practice, since the quantities of the various codes processed are variable and the processing times are different, the balance of assets and people must be particularly calibrated, using the mobility of the personnel, the flexibility of the assets and their over-capacity.

Rule 5: Kanban is a precise and automatic planning system

The kanban allows a precise planning of production, because, in the context of a leveled production, it allows to respond to requests variations, simply by producing more or less than planned, without the need to reprogram the processes in all the workplaces.

It contains all the information necessary for processing the necessary material and allows you to avoid a large amount of paper documentation.

A single tag becomes the source of information for production, storage, picking and transport. Obviously, the information on the tag must be exact and scrupulously respected as well as the procedures for use.

The loss of a single card risks undermining the system. The enormous simplification of the control activities and the knowledge of the key operating parameters are also evident.

On the contrary, in traditional systems, information regarding "what, when and how much" is transmitted to the workplace with multiple documents issued by the scheduling office (for example, start-up plans, transport plans, reminders, internal work orders, etc.)

Rule 6: the number of suppliers must be limited as their distance

Due to stocks decrease, relationships with suppliers become more and more important in case of possible production problems.

The suppliers are no longer a mere source of supply, but become essential part of the success keys of the Companys and they must therefore be integrated into the enlarged Supply Chain.

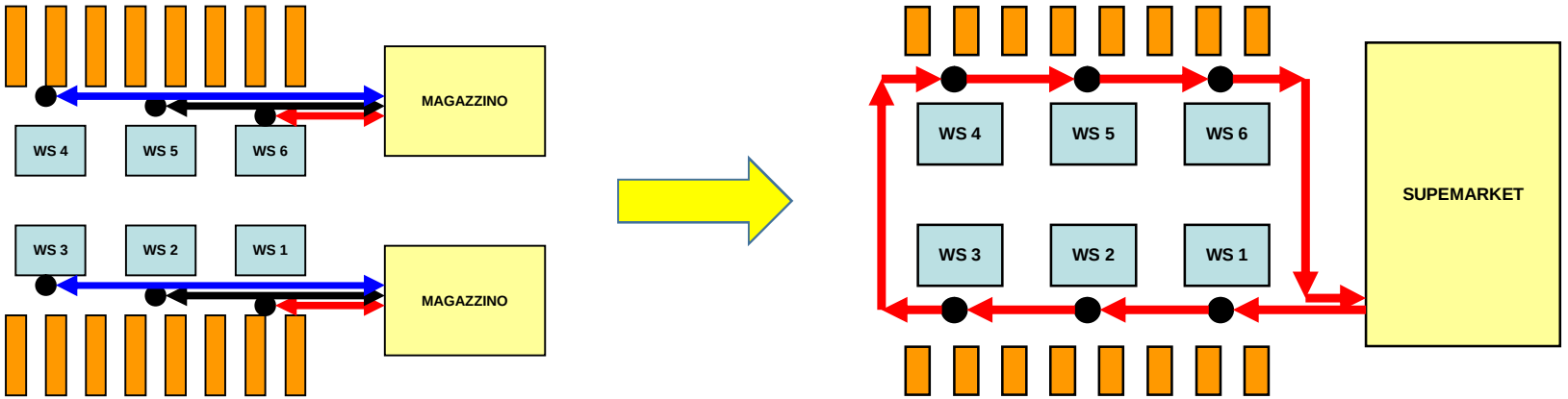
First of all it is necessary to reduce their number, after a careful selection of them. These new relationships are characterized by the deep involvement in product development and in the management of the material transformation process.

The kanban is one of the most important element for a long-term organizational and motivational involvement. For this reason, the distance of suppliers have to be obviously be contained within few tens of kilometers around the factory.

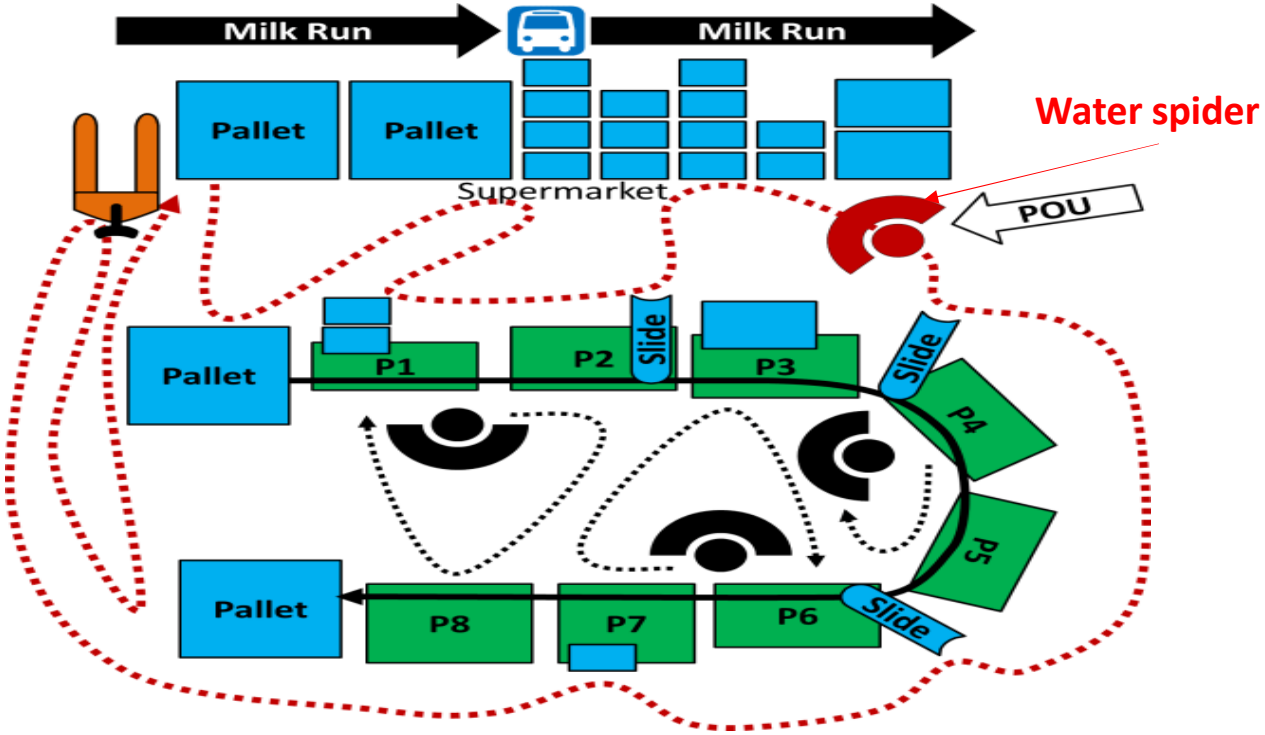
Rule 7: Transports must be short and frequent

This is the direct consequence of the activity carried out with suppliers. In fact, if they have been appropriately involved and accepted the lean philosophy, they too are able to produce in small batches as required by their customers.

They have to be able to make frequent deliveries, in small exact quantities in standard containers, facilitated by the fact of being logistically close to the Customers who request it. In these cases, many logistics systems organize themselves with the so-called "milk run" (the door-to-door delivery tour of the milk van) which starts in the morning and goes around the suppliers whose materials are needed during the same day or the next. .



Rule 7: Transports must be short and frequent
Milk-run



Water spider = Mizusumashi

Rule 8: the workforce must be flexible and motivated

We have seen how human input is fully important for system performances.

it is based on employees sharing completely the new production philosophy. If this motivation is lacking, the system will not work.

Therefore, all the constraints that prevent workers from carrying out tasks other than the usual ones must be removed, with a strong work of information, training and involvement.

KEY MESSAGES

- **Kanban is the main communication tool in the factory for initiating the production and movement of parts between processes in a pull system**

  - **The main benefits of Kanban are:**
  - **Prevents overproduction: no Kanban, no production**
  - **It allows the production to self-regulate**
  - **It allows you to identify delays visually and simply**
  - **It makes standardization in the management (and transport) of the material simple**

- **The 8 rules to follow to use kanban are:**
  - **Defective parts are never sent to the next process**
  - **The next steps should only take what is needed**
  - **produce only the exact quantity that will be collected by the next process**
  - **evenly distribute the production**
  - **Kanban is a precise and automatic planning system**
  - **the number of suppliers must be limited as their distance**
  - **Transports must be short and frequent**
  - **the workforce must be flexible and motivated**

HEIJUNKA

Leveling the type and quantity of production over a fixed period of time. This enables production to efficiently meet customer demands while avoiding batching and results in minimum inventories, capital costs, manpower, and production lead time through the whole value stream.

Example:

Quantity: suppose that a producer routinely received orders for 500 pieces per week, but with significant variation by day: 200 arrive on Monday, 100 on Tuesday, 50 on Wednesday, 100 on Thursday, and 50 on Friday. To level production, the producer might place a small buffer of finished goods near shipping, to respond to Mondayôs high level of demand, and level production at 100 units per day through the week. By keeping a small stock of finished goods at the very end of the value stream, this producer can level demand to its plant and to its suppliers, making for more efficient utilization of assets along the entire value stream while meeting customer requirements.

HEIJUNKA

Pieces types: as illustrated on the next page, suppose that a shirt company offers Models A, B, C, and D to the market and that weekly demand for shirts is:

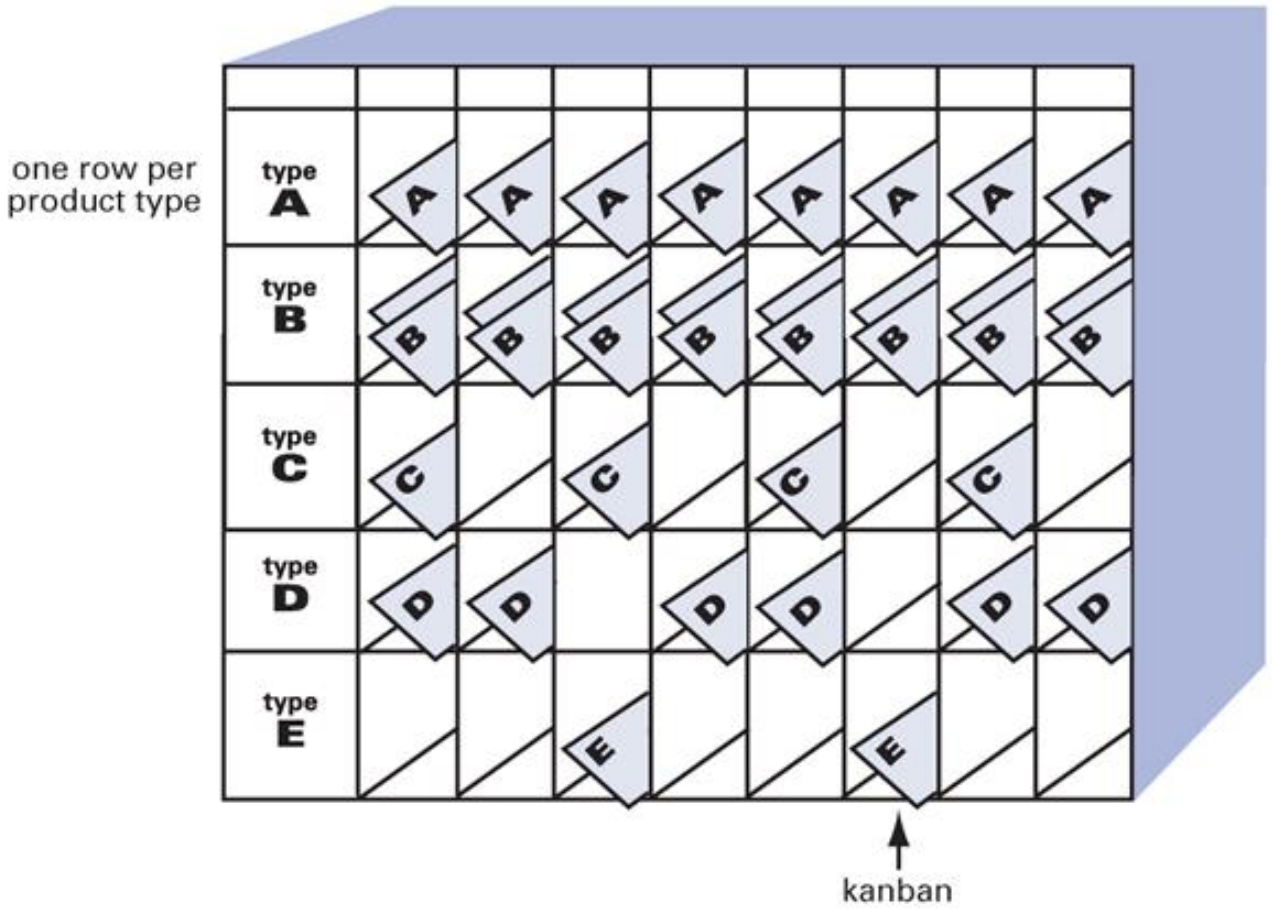
Model A: 500
Model B: 300
Model C: 200
Model D: 200

A mass producer, seeking economies of scale and wishing to minimize changeovers between products, would probably build these products in the weekly sequence A A A A A B B B C C D D.

A lean producer would strive to build in the repeating sequence A A B C D A A B C D A B, making appropriate production system improvements, such as reducing changeover times. This sequence would be adjusted periodically according to changing customer orders.

In Japanese, the word heijunka means, roughly, ñleveling ò.

HEIJUNKA


one row per product type
type A
type B
type C
type D
type E
kanban

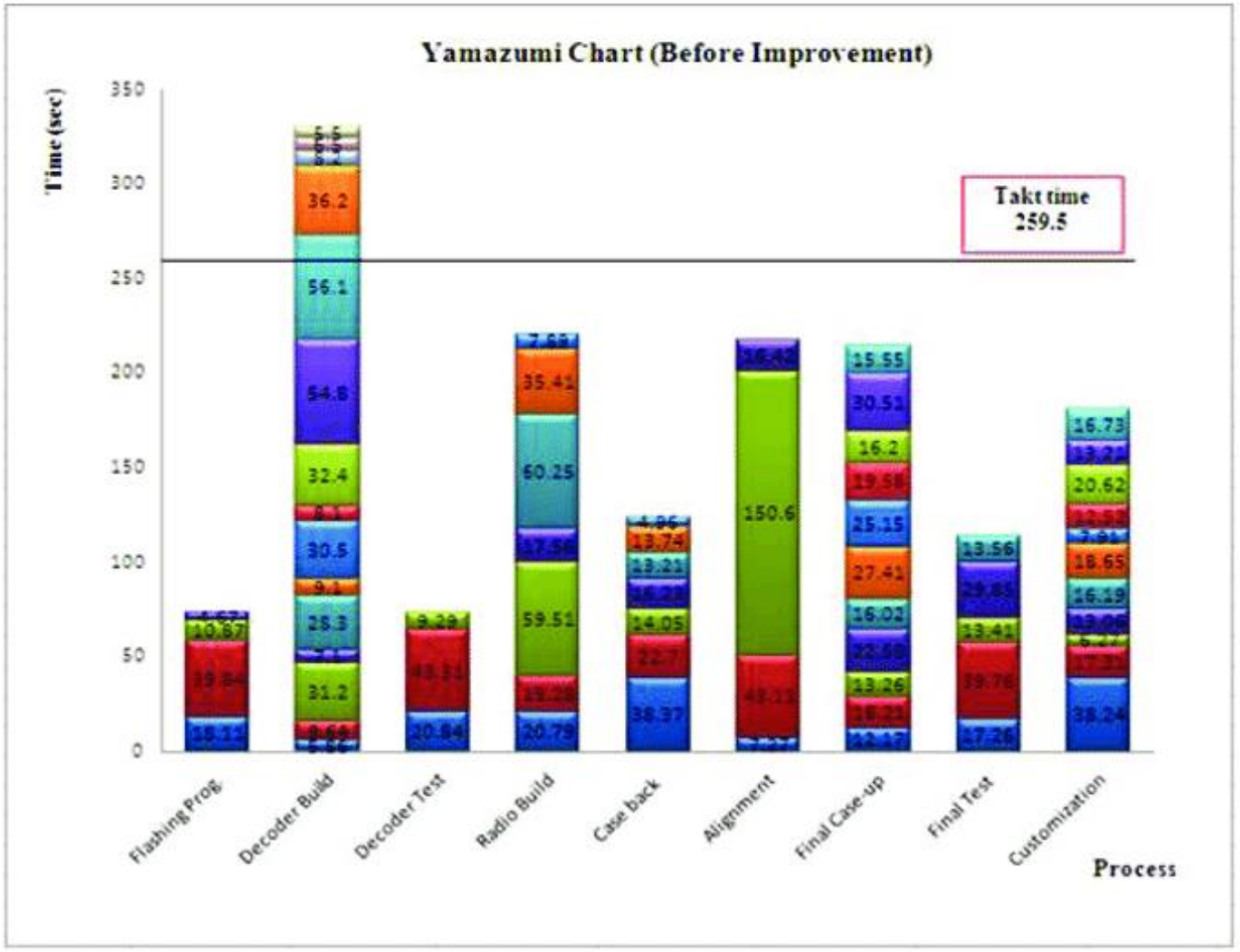
YAMAZUMI

A Yamazumi diagram is a bar diagram that is used in companies that apply Lean manufacturing to show the workloads divided between a certain number of operators, typically of an assembly line or a production cell.

The Japanese term "yamazumi" literally means "to stack", "to put one thing on top of the other".

This tool has been brought to the fore by Toyota which uses it to visualize the workload of its men and to facilitate the attribution of new tasks and the identification and removal of any non-value-added tasks.

YAMAZUMI


Yamazumi Chart (Before Improvement)
Time (sec)
350
300
250
200
150
100
50
0
Takt time
259.5
36.2
56.1
54.8
32.4
30.5
28.3
31.2
35.41
60.25
59.51
150.6
15.55
30.51
16.2
27.41
16.02
13.26
16.73
20.62
18.65
16.19
Flashing Prog
Decoder Build
Decoder Test
Radio Build
Case back
Alignment
Final Case-up
Final Test
Customization
Process

KEY MESSAGES

- **JUST IN TIME: in order to get the target of : What it needs, when it needs, the quantity it needs, where it needs, a set of actions have to be done**
- **Continous flow has to be merged with Heijunka and Yamazumi**
- **Kanban is the most powerful system to reduce complexity in scheduling the production. Simplify and the products will flow like water!**
- **There are basically two types of kanban: with one card and with two cards.**
- **Kanban works if the logistic is suitable to it. Therefore adopt milk-run and waterspider.**

UNIVERSITÀ DEGLI STUDI DI TRIESTE

TECHNIQUES AND TOOLS					7 TOOLS	DATA COLLECTION SHEETS	
						STRATIFICATION	
						CORRELATION	
						PARETO'S DIAGRAM	
						ISTOGRAMS	
						CONTROL CHARTS	
						ISHIKAWA DIAGRAM	
					ONE POINT LESSON		
					A3	5 WHYS	
					KEY PERFORMANCE INDICATORS		
					5 S		
				YAMAZUMI	ANDON		FLASH MEETINGS
				TAKT TIME	VISUAL MANAGEMENT		GROUP WORK
			ERGONOMY	KANBAN	STANDARDIZATION		EMPOWERMENT
			TPM	KAIKAKU	PDCA		INVOLVEMENT
			SMED	JIT	POKAYOKE		AGREEMENT
		SPAGHETTI CHART	OEE	HEIJUNKA	KAIZEN		INFORMATION
	WASTES	LABOUR TIMES STUDY	ONE PIECE FLOW	FROM PUSH TO PULL	SIX SIGMA		COMMUNICATION
	HOSHIN KANRI	CURRENT VMS	FUTURE VSM	PULL	JIDOKA		MOTIVATION RESEARCH
PRINCIPLES	DEFINE THE VALUE	IDENTIFY THE VALUE FLOW	SET UP FLOW ACTIVITIES	MANUFACTURE PULLING THE PRODUCTION	RESEARCH PERFECTION		ATTENTION TO PEOPLE
FOCUS	CUSTOMER				QUALITY		EMPLOYEES