UNIVERSITÀ DEGLI STUDI DI TRIESTE

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335 211609

INDUSTRIAL PLANTS II

Chapter one ï part 2:

Lean manufacturing

KAIZEN

DOUBLE DEGREE MASTER IN

ñPRODUCTION ENGINEERING AND MANAGEMENTò

CAMPUS OF PORDENONE

UNIVERSITY OF TRIESTE

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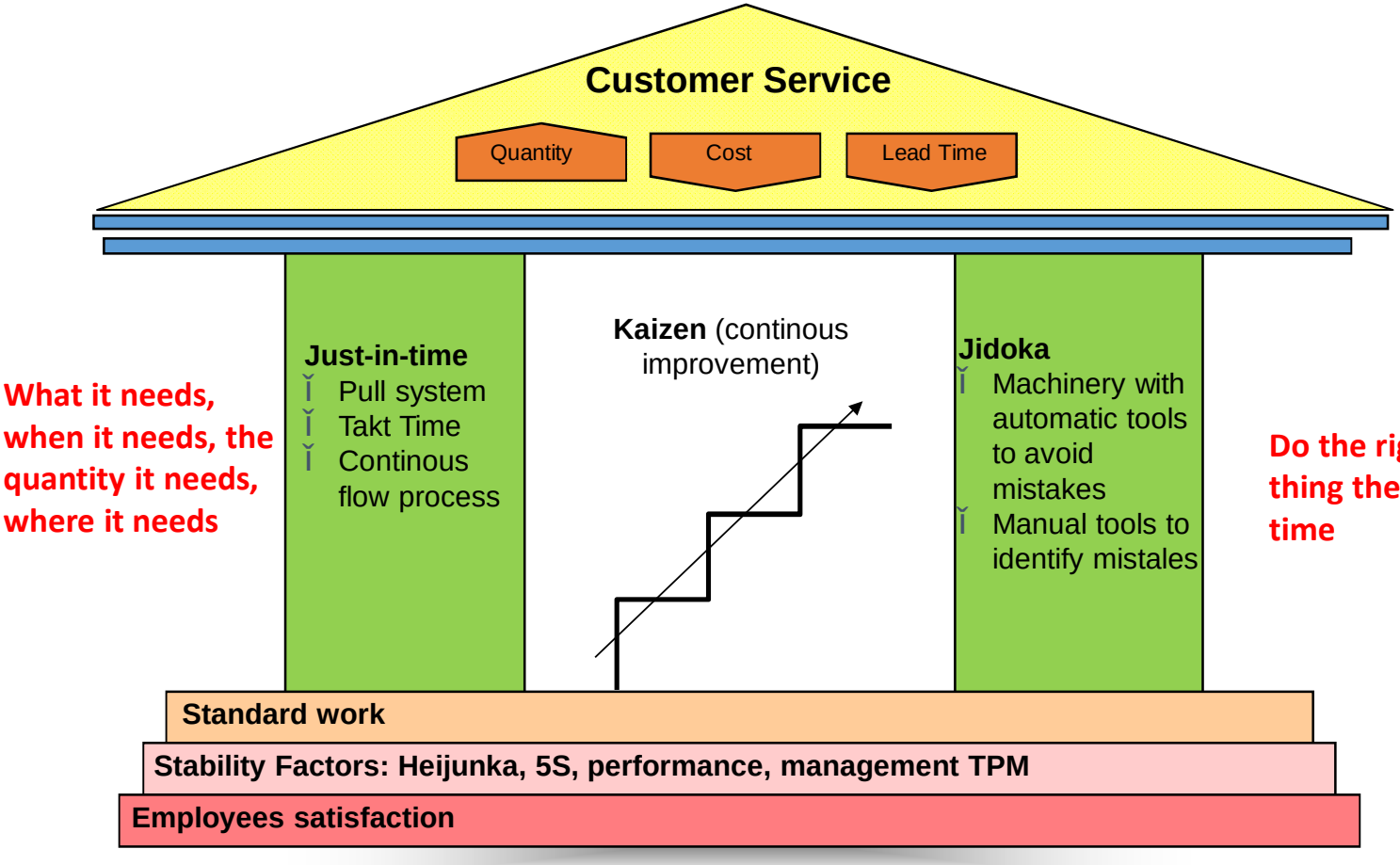
ñToyota Production Systemò



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

Do the right thing the first time

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TECHNIQUES AND TOOLS					7 TOOLS	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
	QUALITY FUNCTION DEPLOYMENT	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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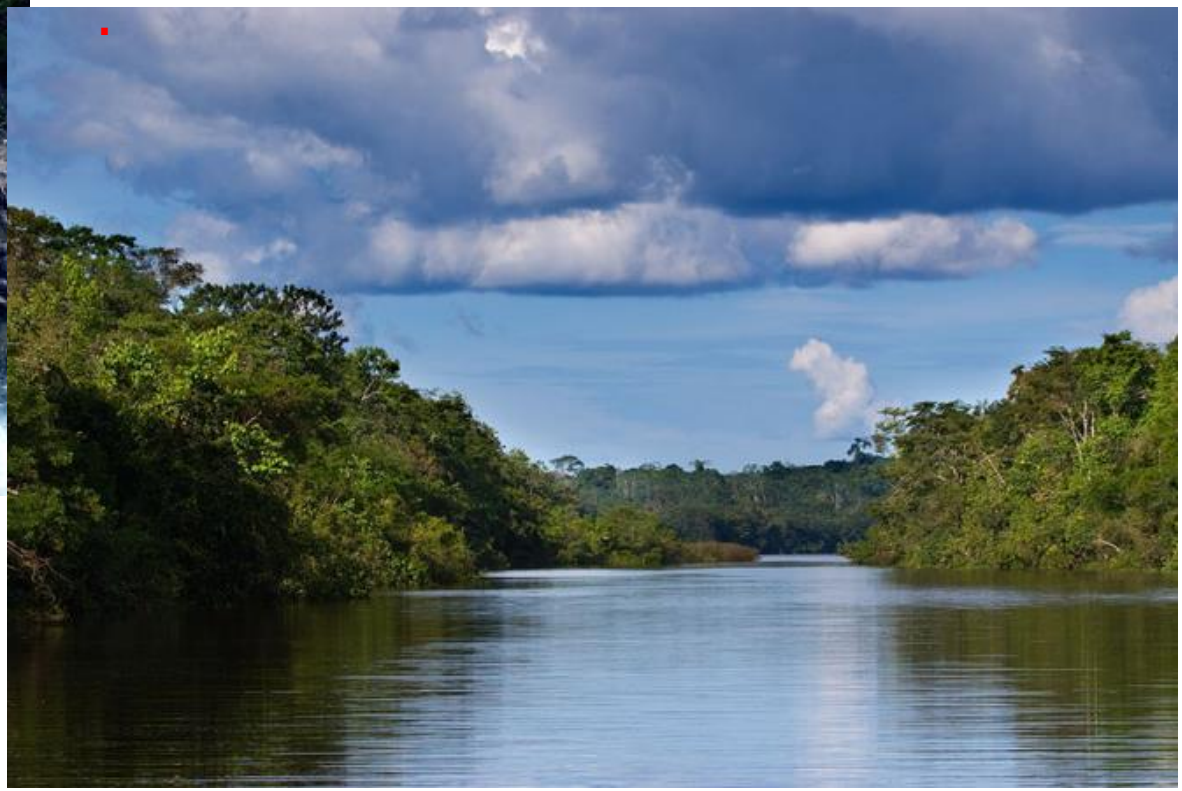
FLOW

It is the set of activities / information related to the transformation of materials that are necessary to get the final products, in the way that the company decide suitable for achieving its goals.



ñSimplify, and the products will flow like water"

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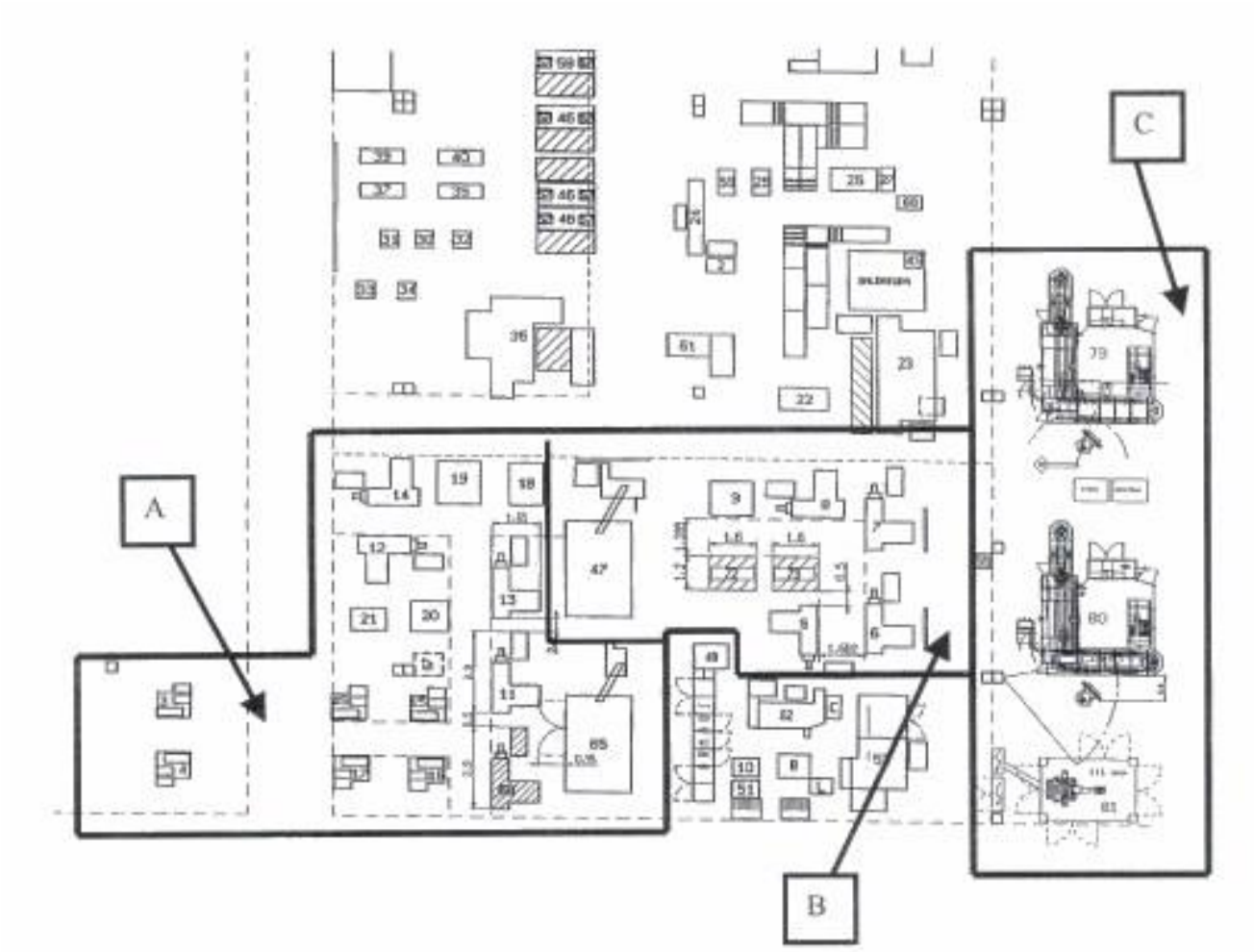
LAY-OUT TYPE A



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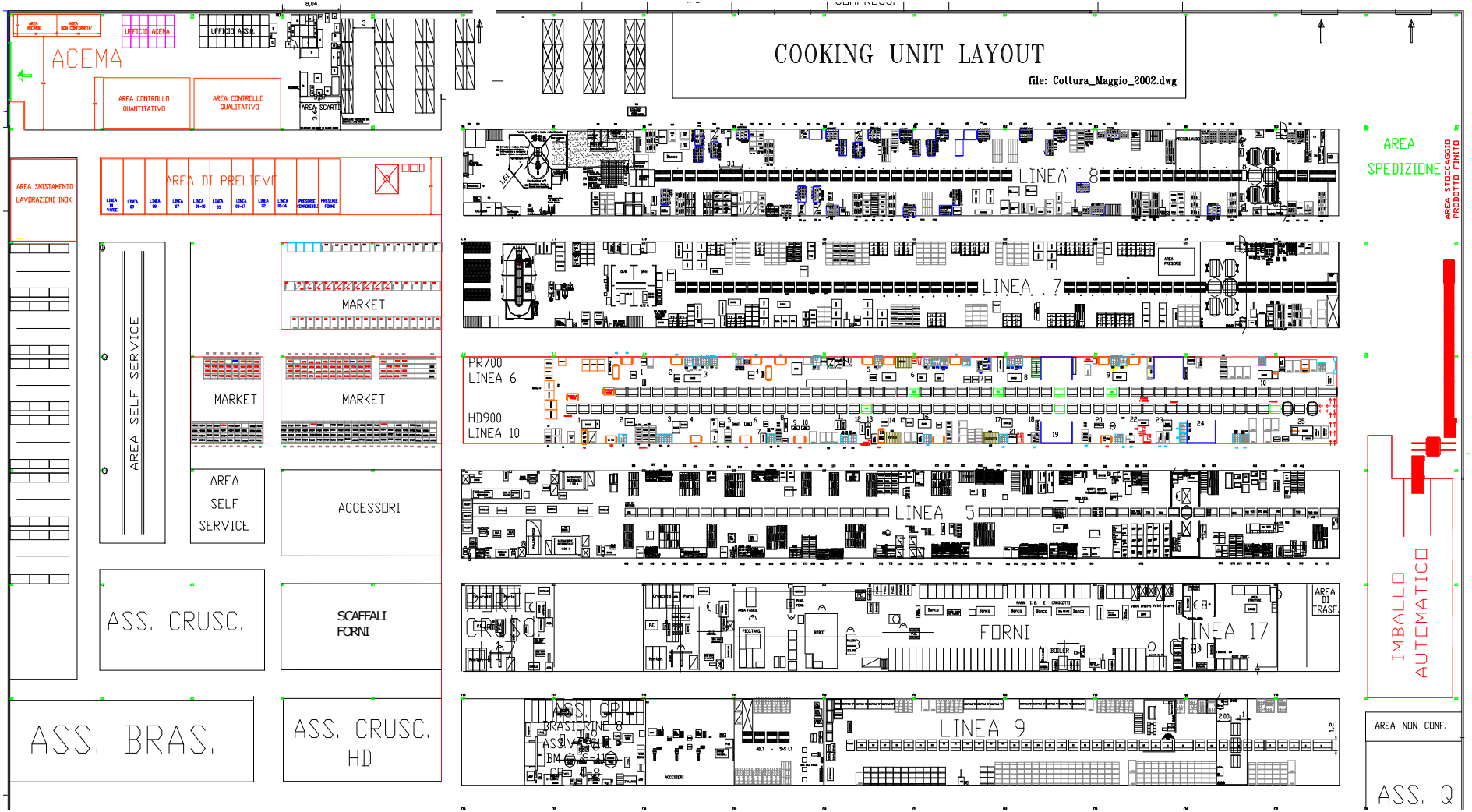
LAY-OUT TYPE B



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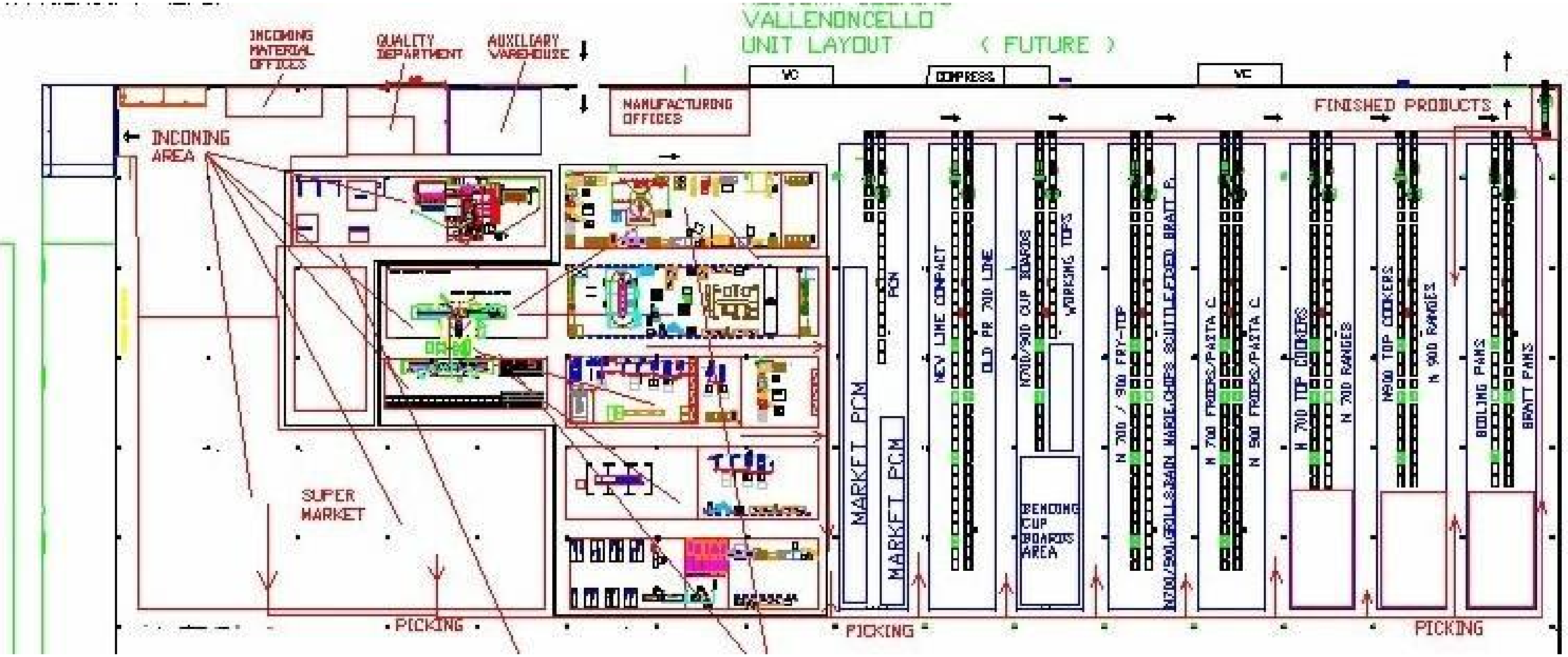
LAY-OUT TYPE B



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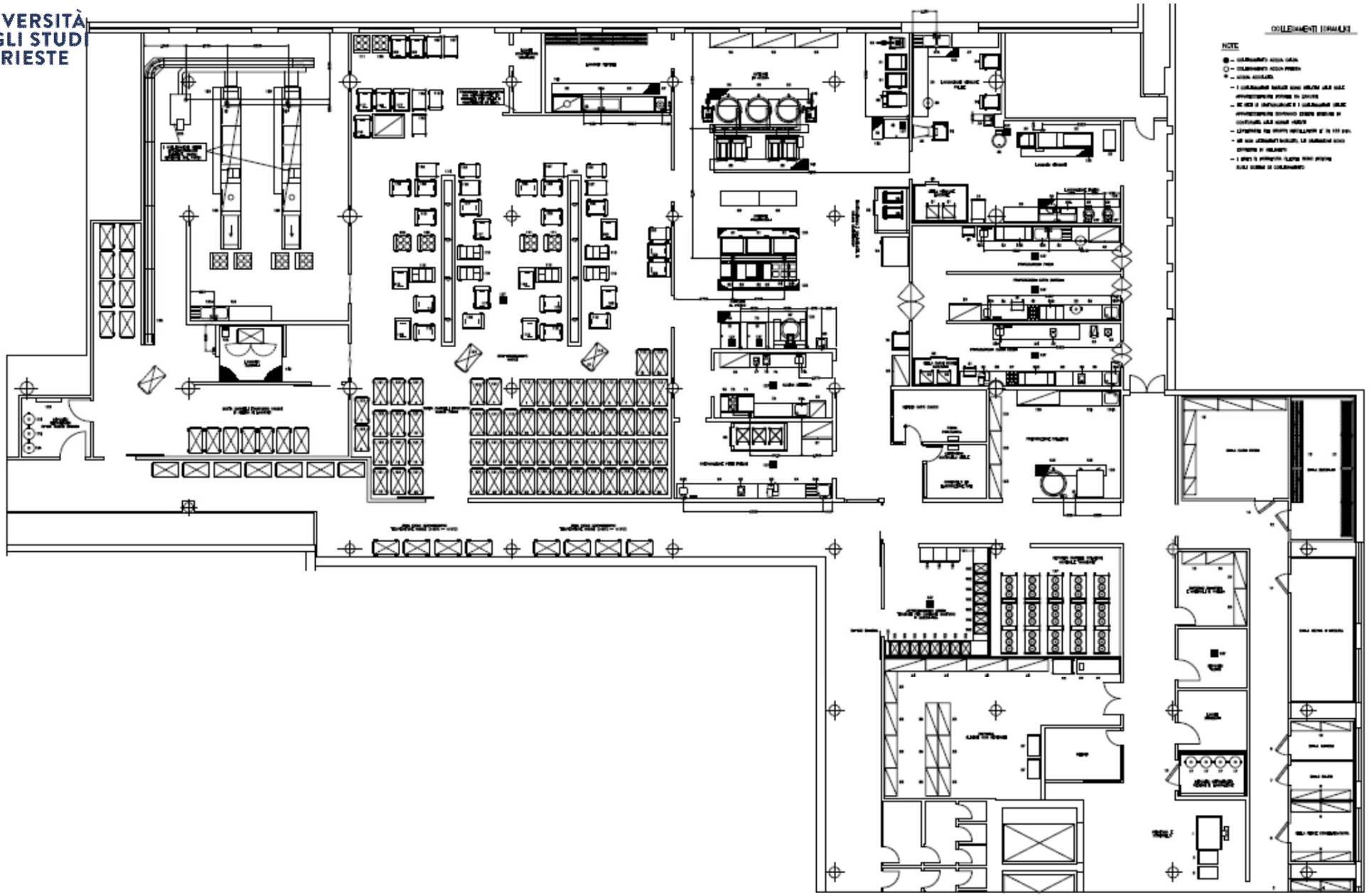

Materiale
Raffaele C

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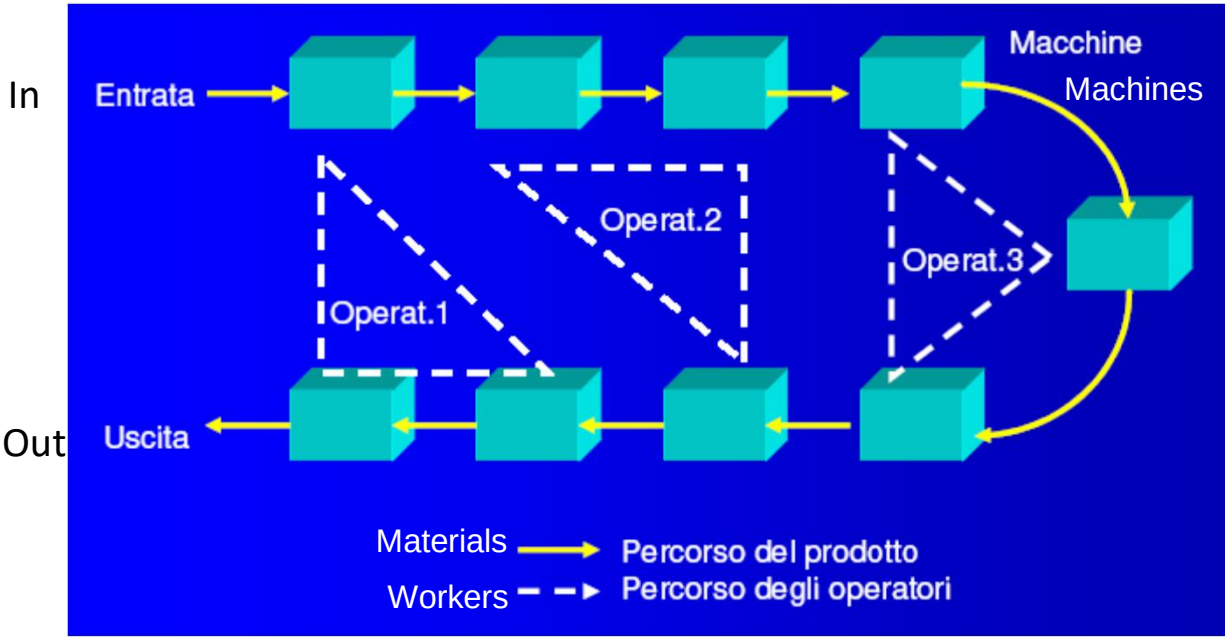
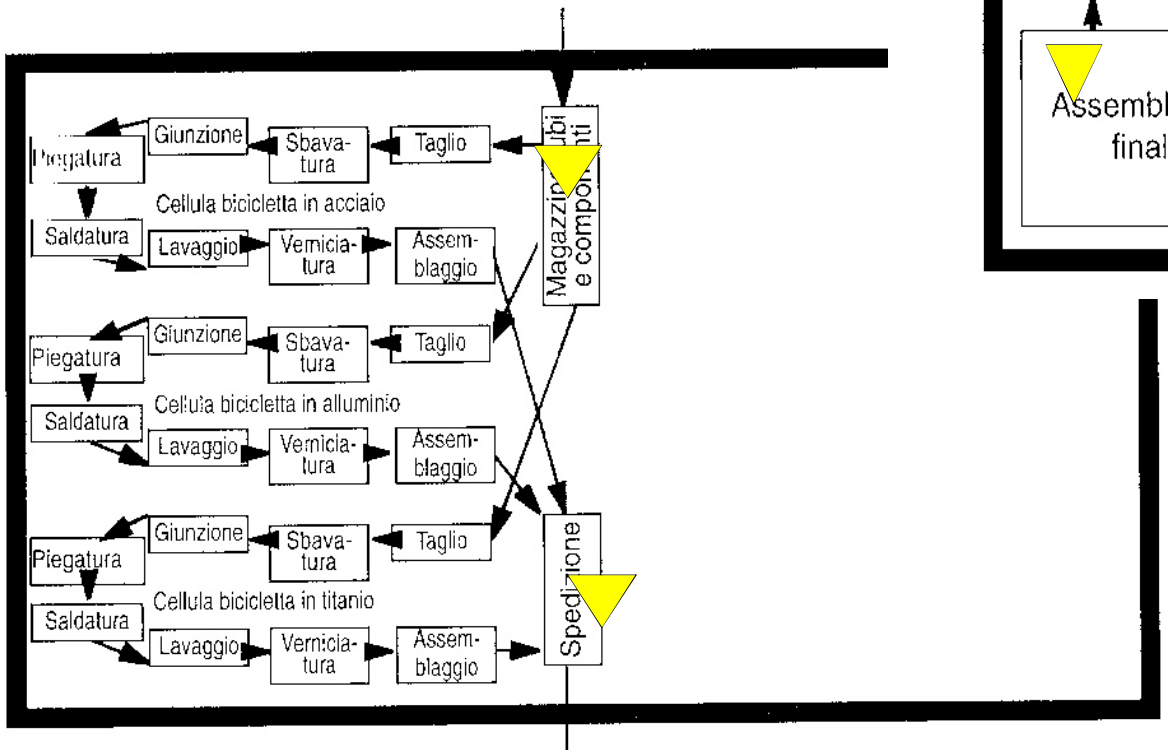
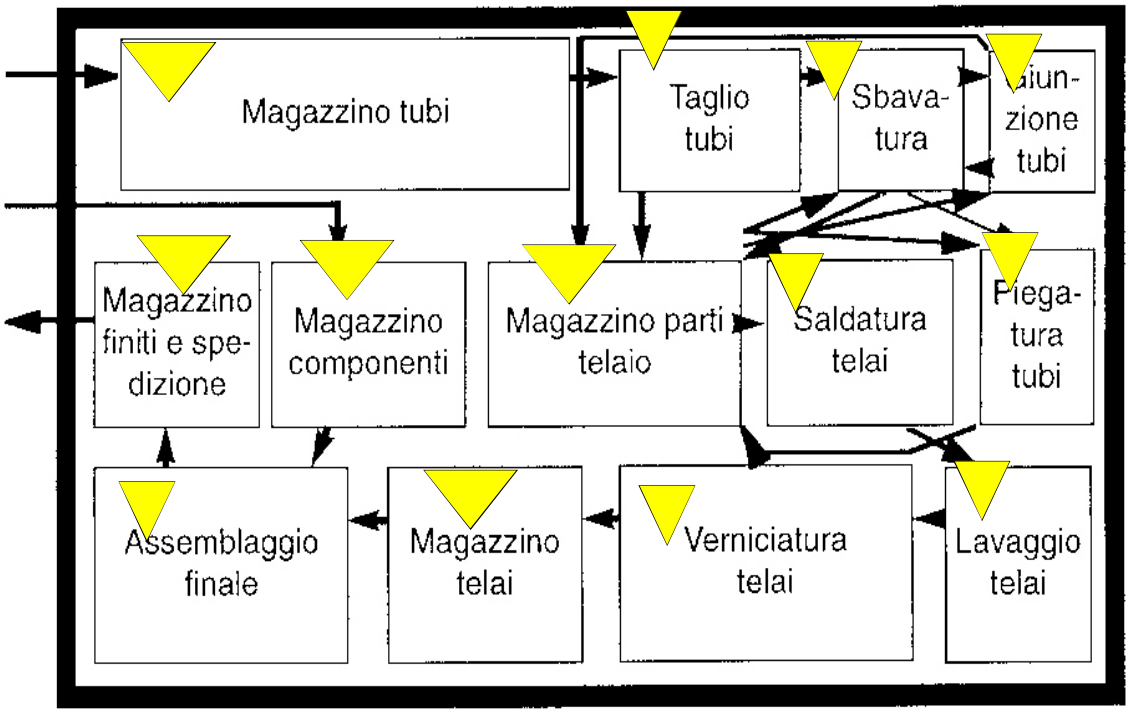
Flow line or U-shaped







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VALUE STREAM MAPPING

- VSM is a graphical tool ideal for complete process mapping
- It is used to identify and mark the processes, material flows and information of certain products
- The VSM is very useful in gathering information and viewing problems and possible improvements
- The **VSM of the Current State** is used to provide an overall representation of the process as it is and to identify possible improvements
- The **VSM of the Future State** helps to understand what the target final state should be and how to implement it
- The VSM is a diagram represented on a single page
- The VSM is made by using standard symbols

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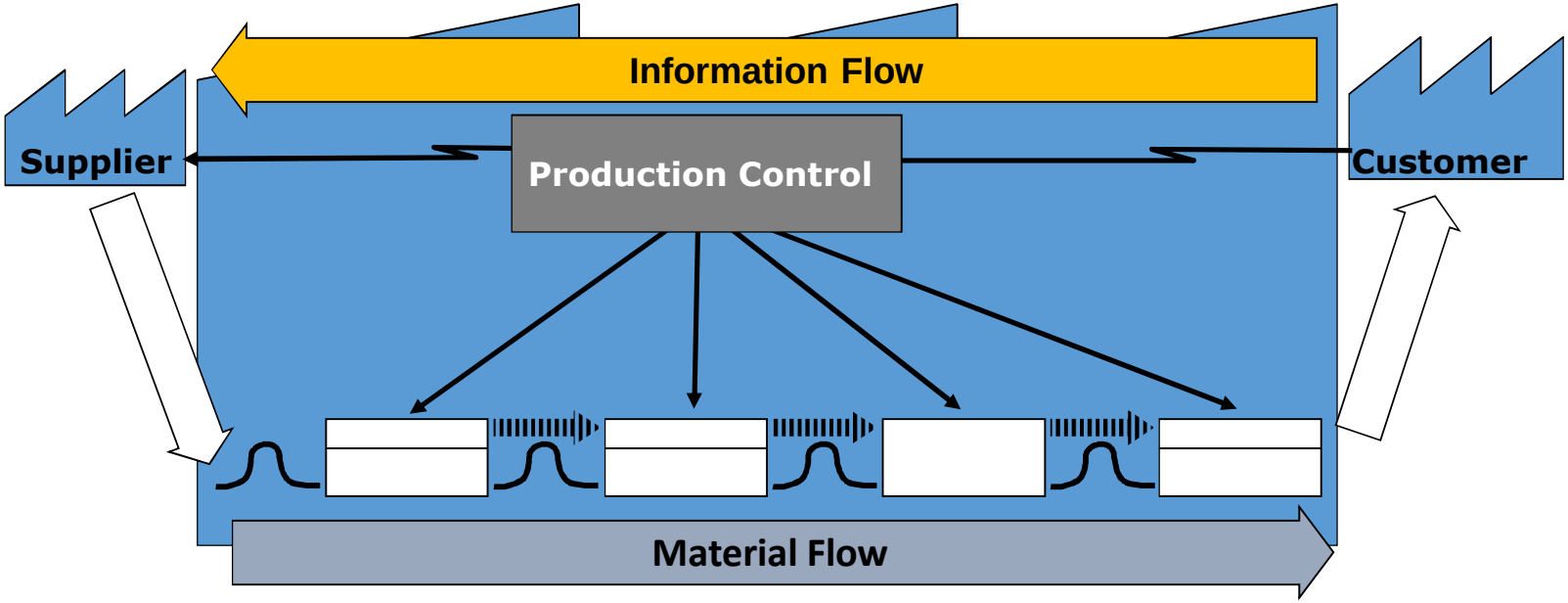
VALUE STREAM MAPPING



It provide a representation of the present process «from the beginning to the end» and its performance levels

- A set of symbols are used to represent all the element ofthe present process

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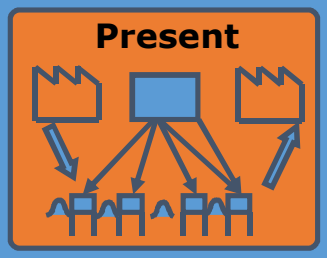
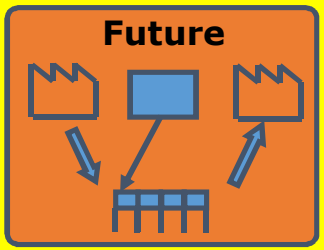
VALUE STREAM MAP: PRESENT AND FUTURE

	Present state: AS IT IS (value stream analysis)	Future State: AS TO BE (value stream design)
	Analysis thorough and fact-based 	**Design** creative and synthetic 
Reason	▪ It provides a visual description of the present value stream	▪ It provides a visual description of the future redesigned value stream
Objectives	▪ Show the current system as a whole ▪ Highlight wastes and their sources throughout the process ▪ Identify opportunities for improvement ▪ Provide a common picture to discuss problems and changes	▪ Push for the use of best practices to create the vision of the ideal value flow in "Lean" terms ▪ Be helpful in quantifying the potential improvement ▪ Be used as a communication tool of the Future Situation

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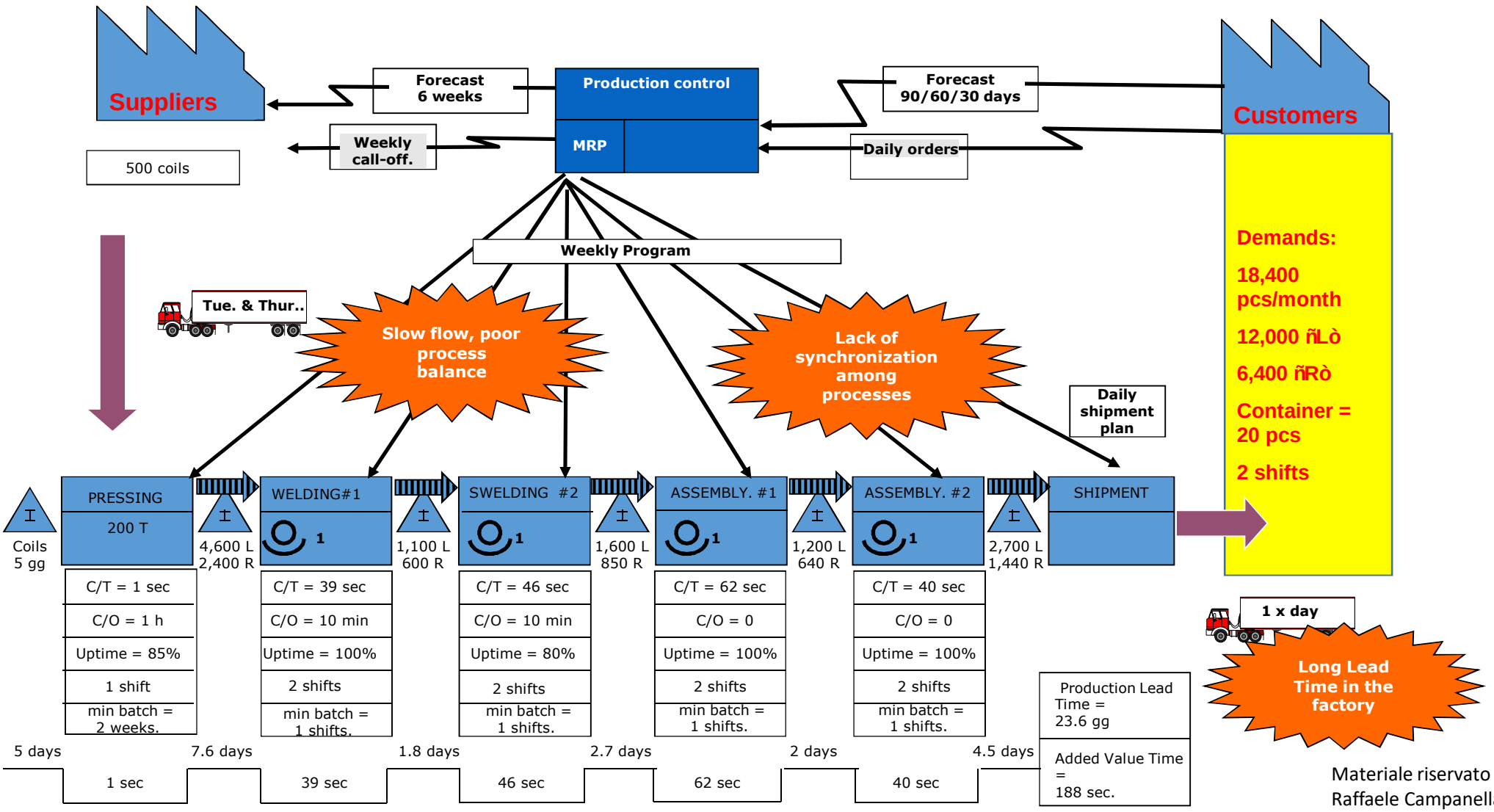
CURRENT VALUE STREAM MAPPING



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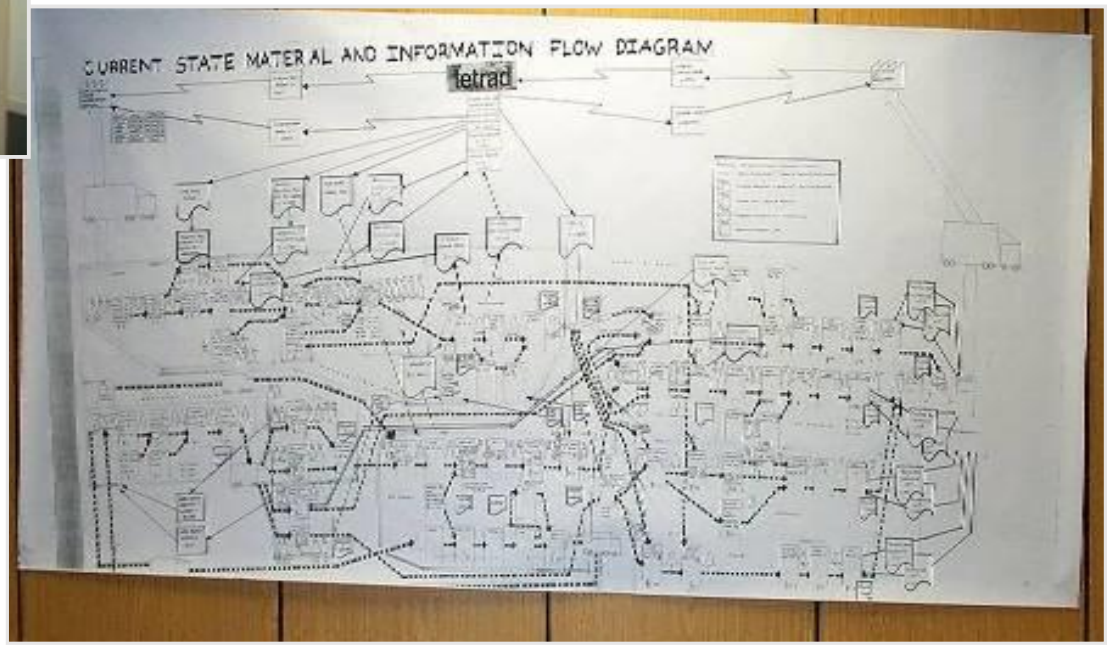
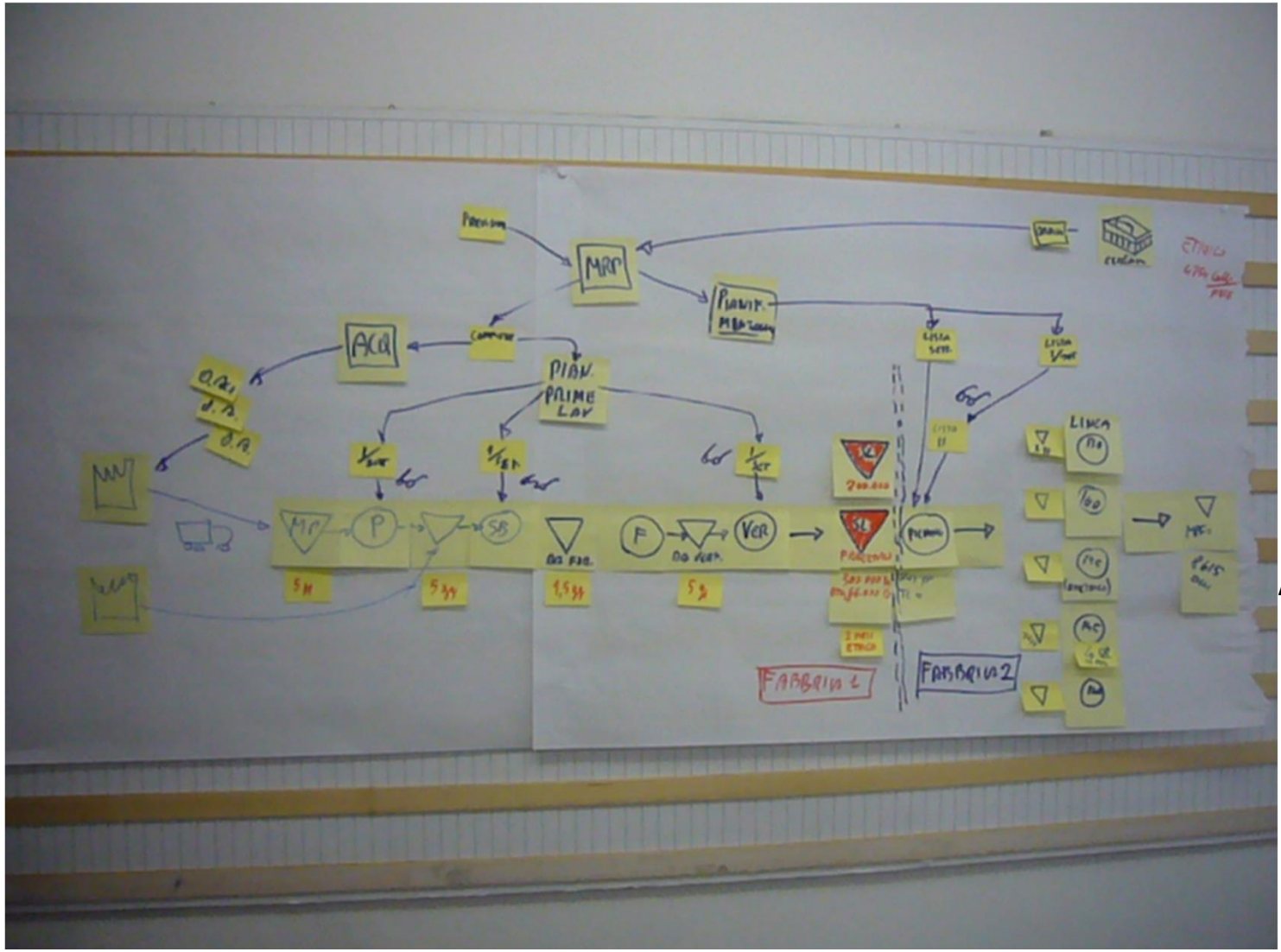
VALUE STREAM MAPPING



IDENTIFY THE VALUE STREAM



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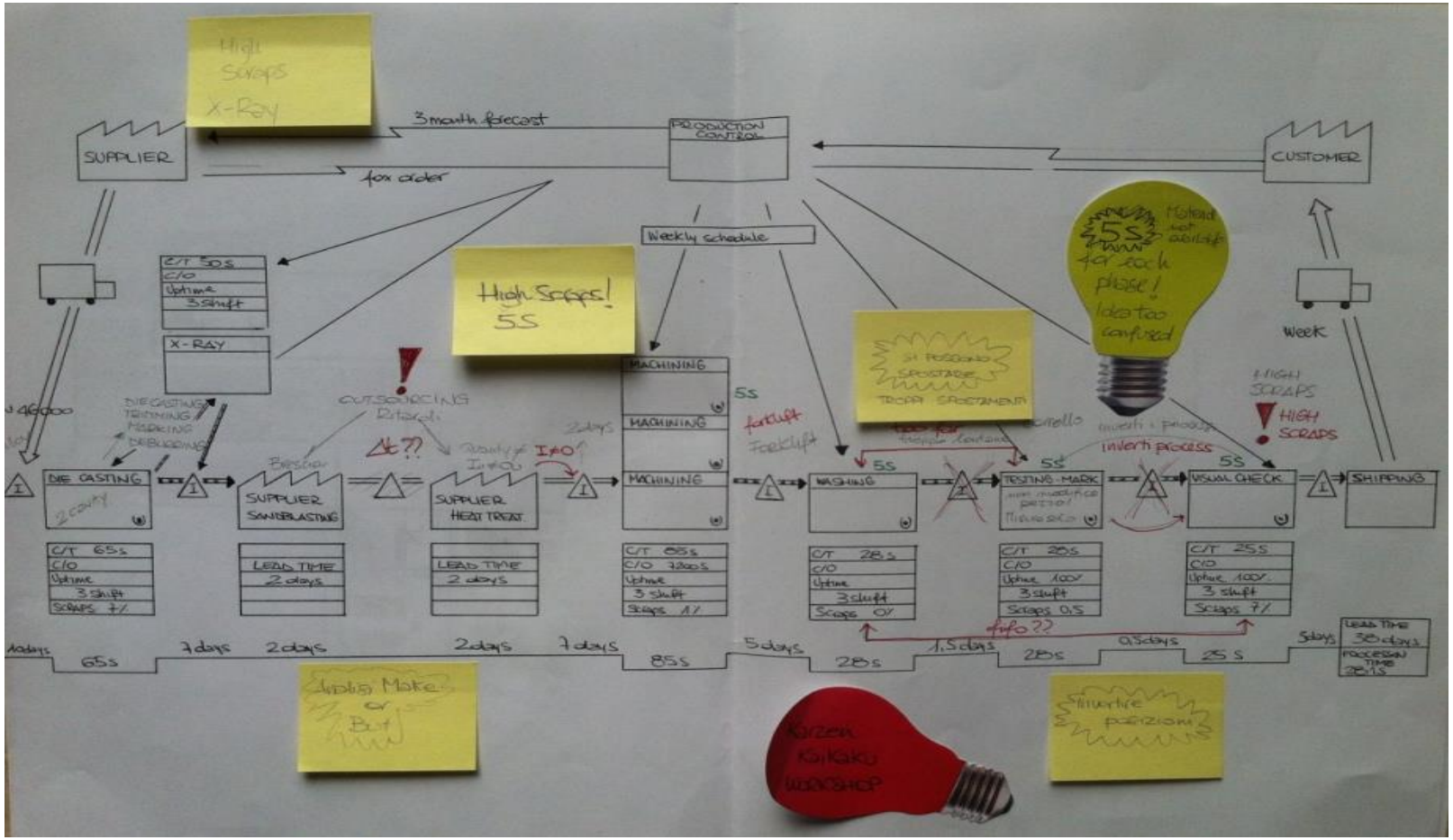
EXAMPLES OF VSM



Costampress - Padova

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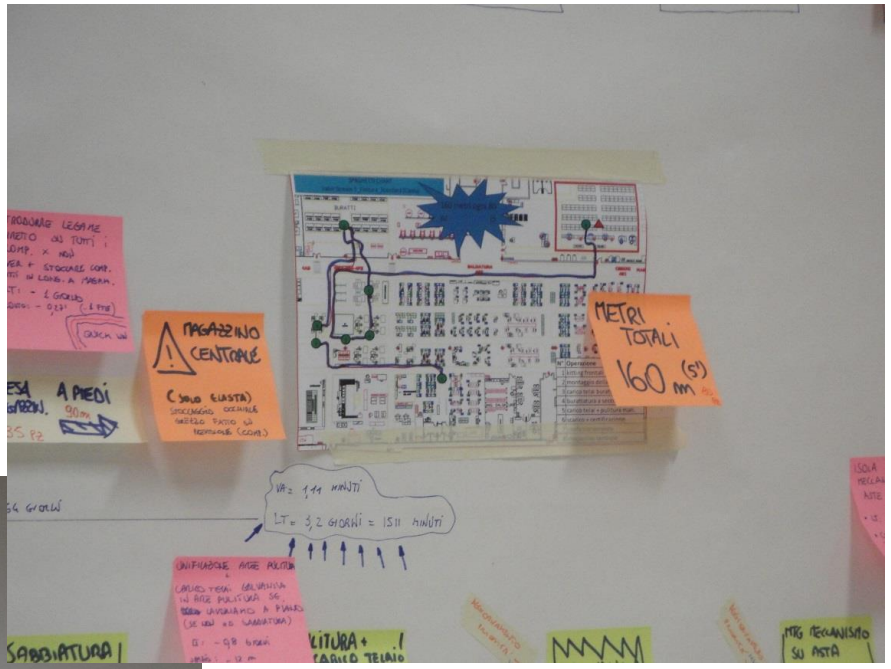
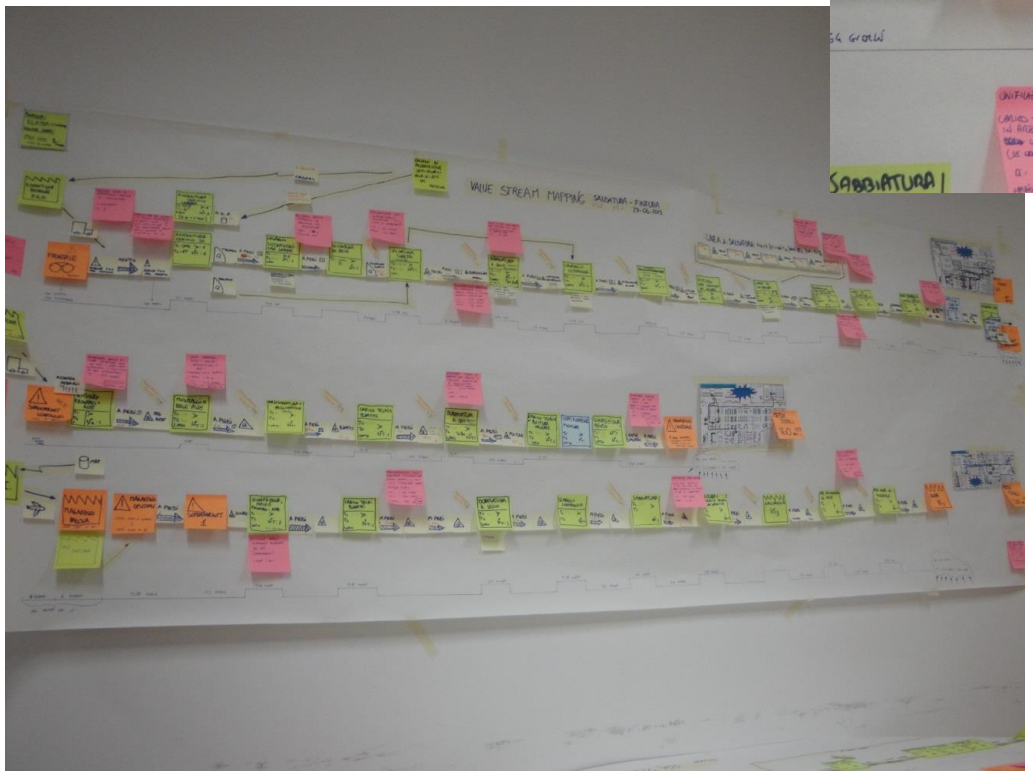
EXAMPLES OF VSM





Safilo - Longarone

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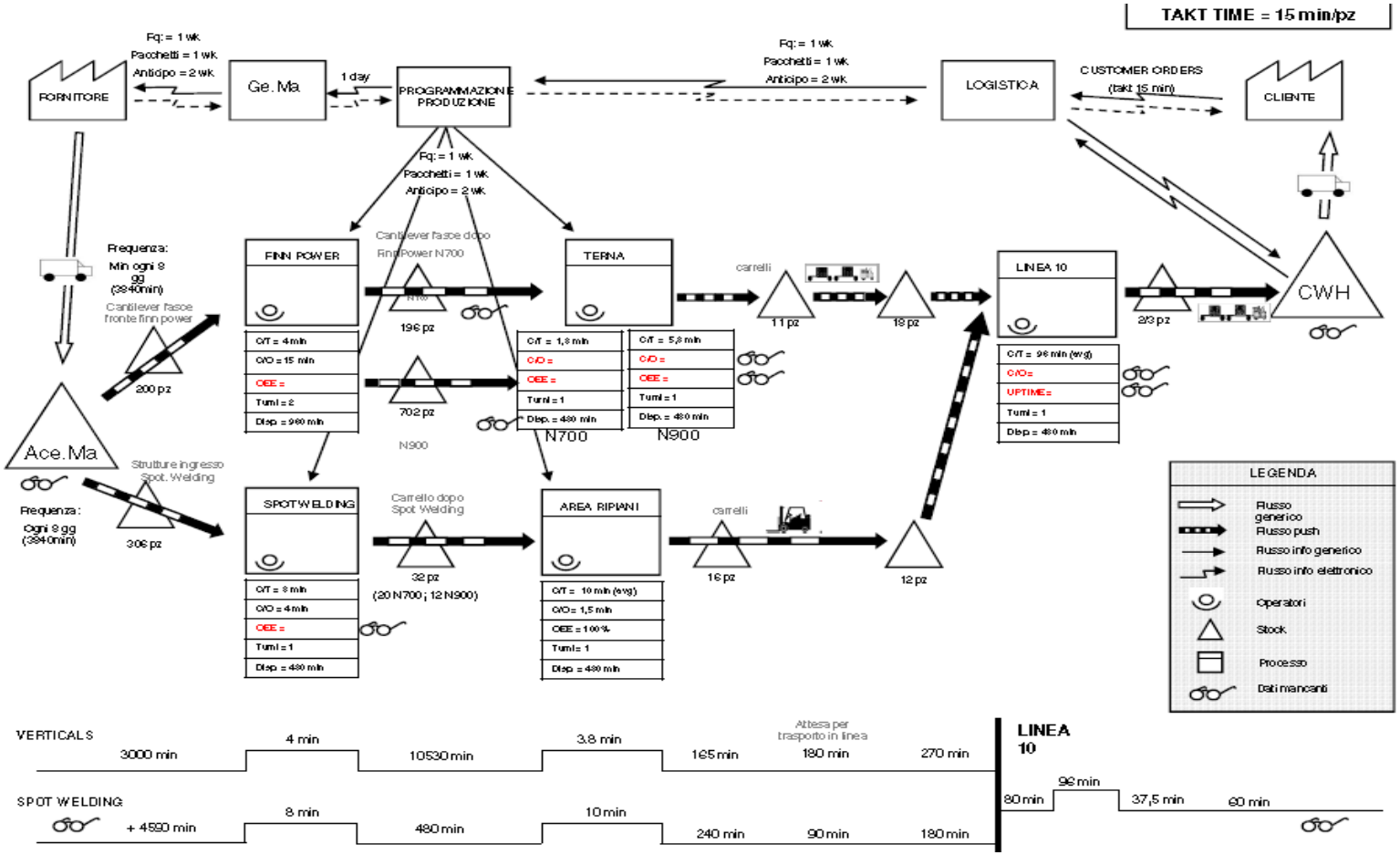
EXAMPLES OF VSM



Electrolux Prof. – Modular Cooking

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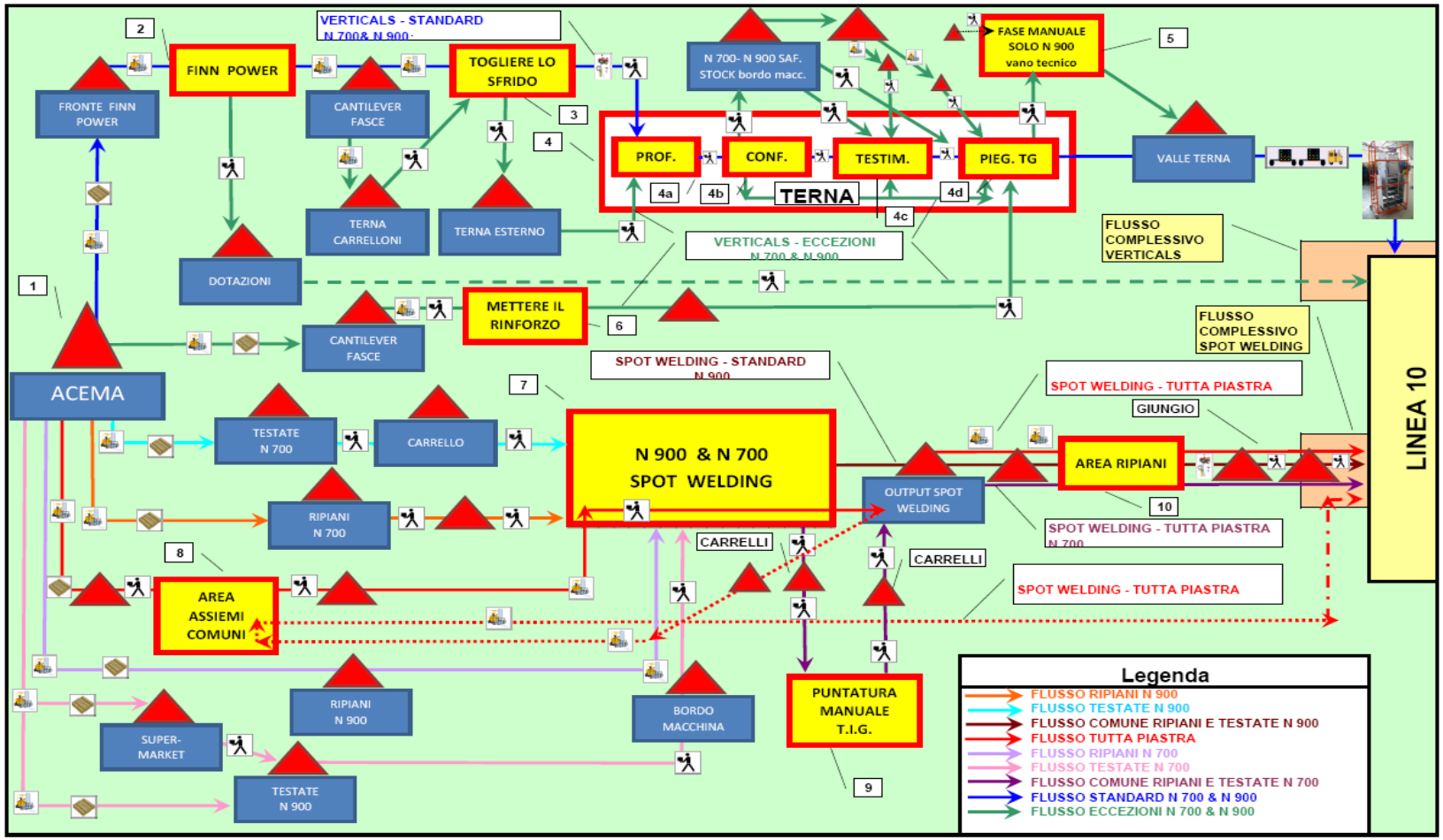
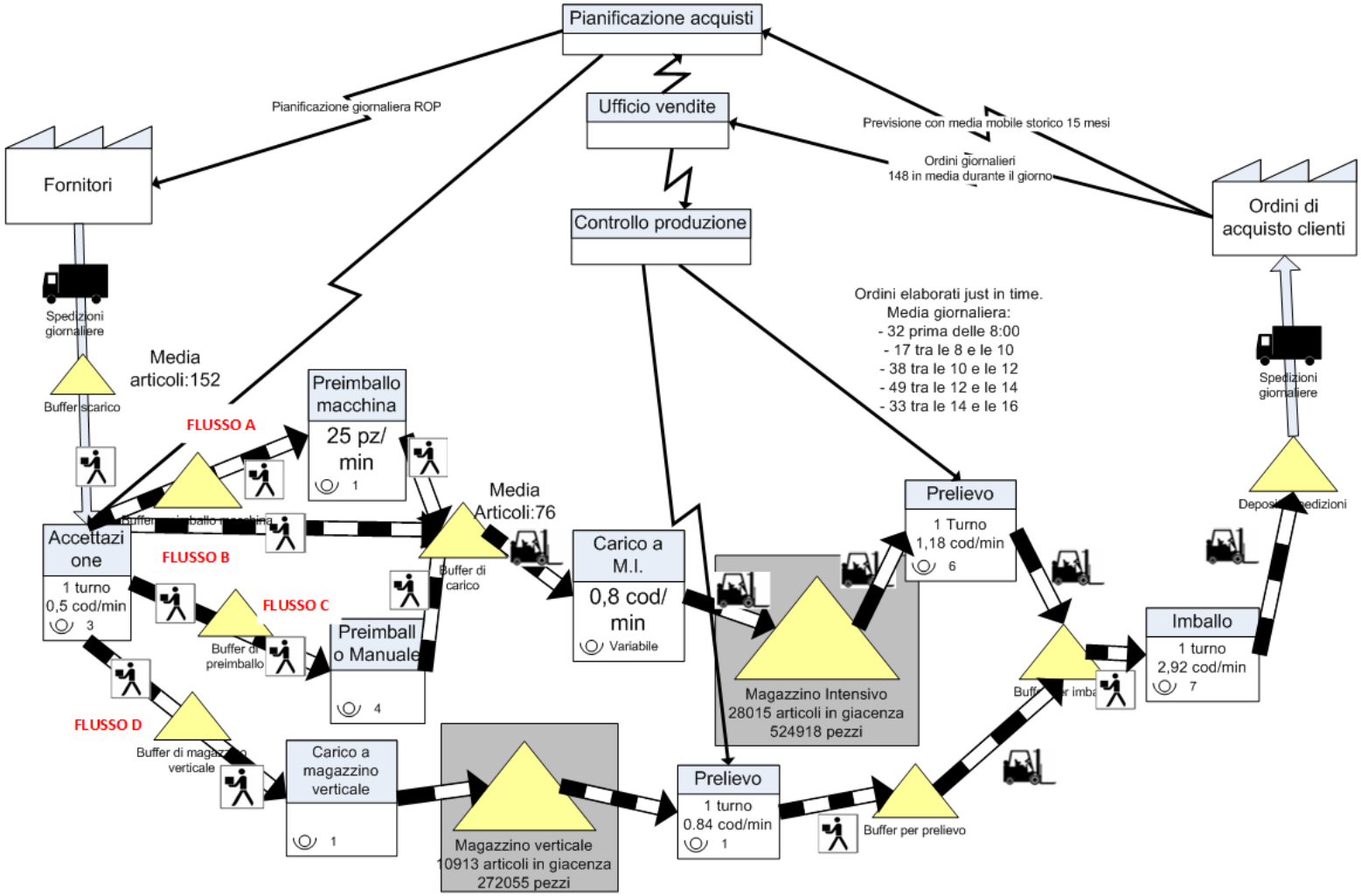
EXAMPLES OF VSM



Electrolux Prof. – Modular Cooking

EXAMPLES OF VSM



Electrolux Prof. – After Sales Service

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IMPORTANCE OF THE VALUE STREAM MAPPING

- It allows to develop a "consistent" picture of the production system, "from start to end"
- It allows to consider the complete supply chain

- It allows to analytically link system-level performance to the adopted layout choices
- It is an effective tool:
  - for promoting open dialogue between staff and for aligning on the solutions to strive for
  - for tracking continuous improvement over time and prioritizing areas for further improvement
- It pushes to frequent and do problem solving activity (PDCA), sharing the results
- It make familiar work as a cross-functional teams
- It makes easy to rotate the task among the team members

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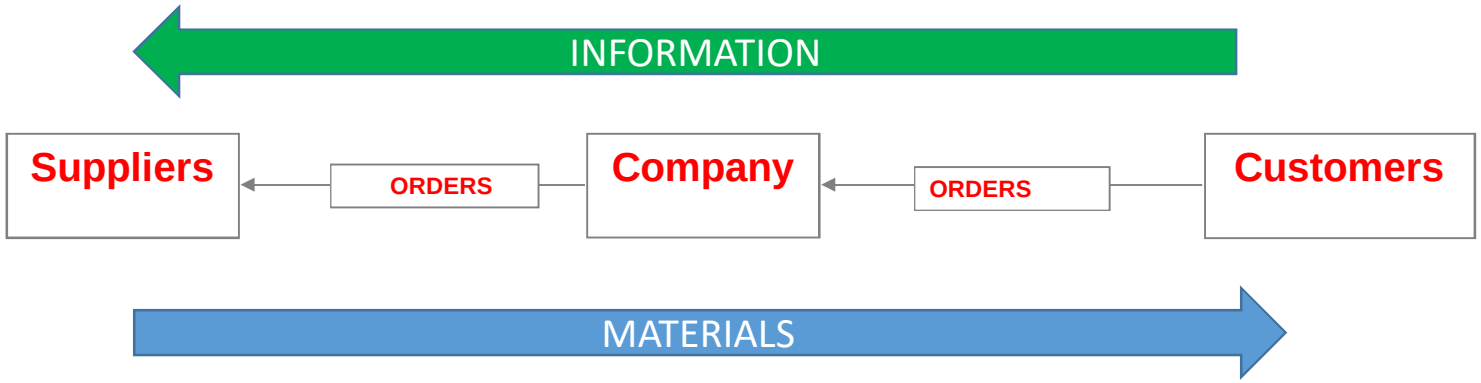
BEFORE STARTING VSMé

- IDENTITY A PRODUCT FAMILY (GROUP)
- IDENTIFY A UNIQUE RESPONSIBLE FOR THE VALUE STREAM (VALUE STREAM MANAGER)
- DEFINE THE TEAM
- START BY MAPPING ONLY THE INTERNAL PROCESSES (WITHIN OUR FACTORY)
- CONSIDER BOTH MATERIAL AND INFORMATION FLOWS



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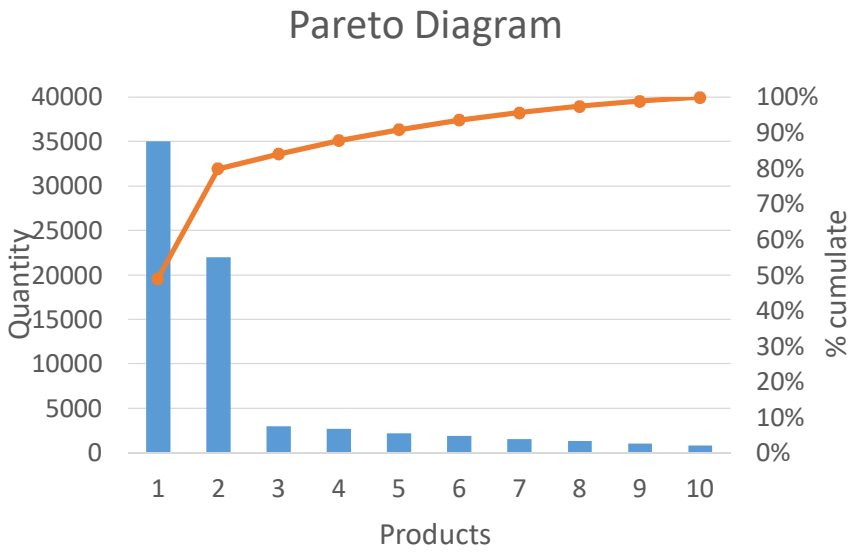
BEFORE STARTING VSMé

Å IDENTIFY A PRODUCT FAMILY (GROUP)

Å The PQ (Product-Quantity) analysis is based on the assumption that the first production processes to be analyzed are those related to products made in large quantities.

Å The PQ analysis requires that the production mix of the plant has to be reported on a Pareto diagram.

Product	Q	Q. Cumulate	%	% Cumulate
#1	35000	35000	49,02%	49,02%
#2	22000	57000	30,81%	79,83%
#3	3000	60000	4,20%	84,03%
#4	2700	62700	3,78%	87,82%
#5	2200	64900	3,08%	90,90%
#6	1900	66800	2,66%	93,56%
#7	1500	68300	2,10%	95,66%
#8	1300	69600	1,82%	97,48%
#9	1000	70600	1,40%	98,88%
#10	800	71400	1,12%	100,00%



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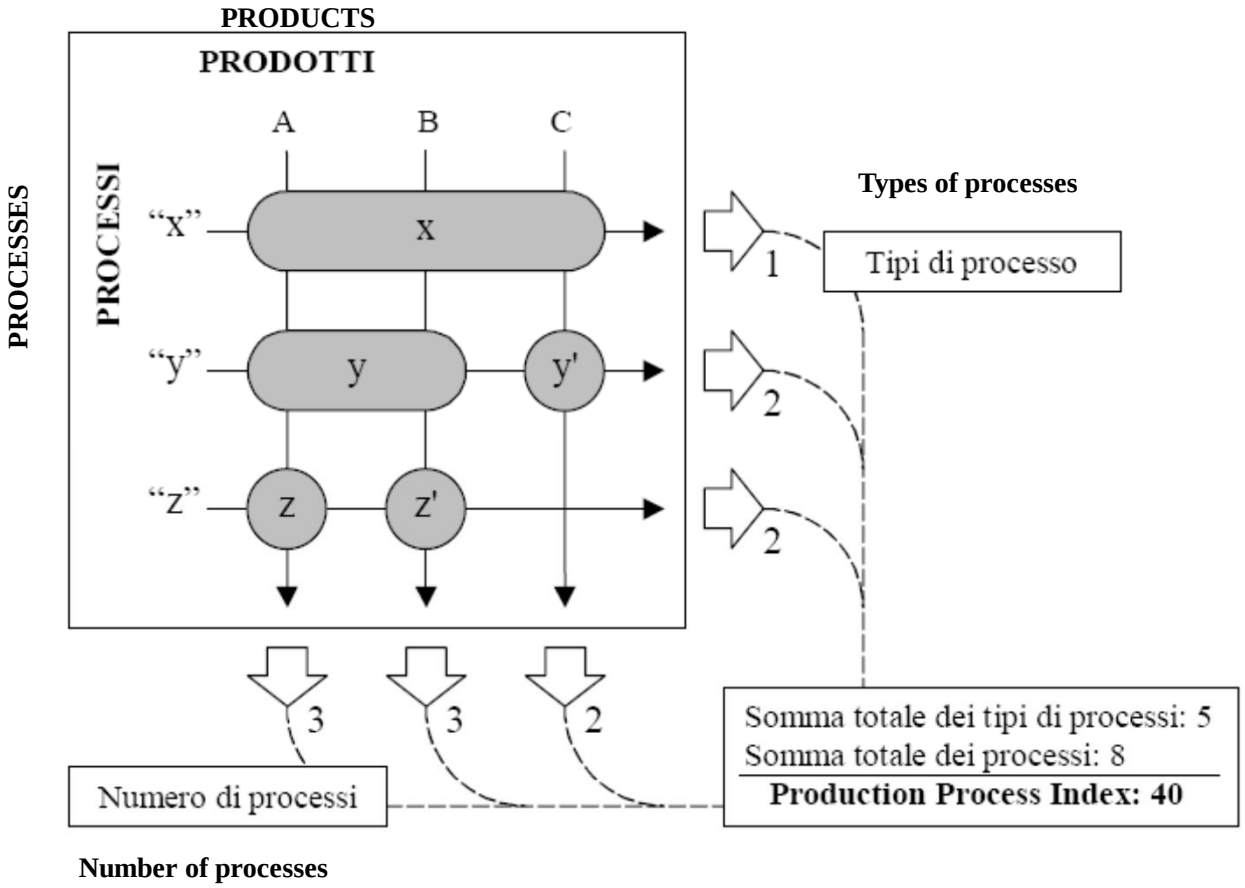
IDENTITY A PRODUCT FAMILY (GROUP): PRODUCT-PROCESS ANALYSIS

			Macchine							
Prodotti e Quantità			**M#1**	**M#2**	**M#3**	**M#4**	**M#5**	**M#6**	**M#7**	**M#8**
	1500	**P#1**	x	x	x		x	x		
	12000	**P#2**		x		x		x		x
	10000	**P#3**		x		x		x		x
	5400	**P#4**	x	x	x	x	x	x		
	3000	**P#5**			x		x	x	x	x
	2800	**P#6**	x	x	x		x	x	x	
	2700	**P#7**	x		x			x	x	x
	1500	**P#8**	x		x			x	x	x

Famiglia	**Prodotti**	**Quantità totale**
F#1	P#1,P#4,P#6	9700
F#2	P#2,P#3	22000
F#3	P#5,P#7,P#8	7200

QUANTITYô PIECES OR HOURS OR EUROS?

IDENTITY A PRODUCT FAMILY (GROUP): PRODUCT-PROCESS ANALYSIS (indexes)



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IDENTITY A PRODUCT FAMILY (GROUP): PRODUCT-PROCESS ANALYSIS

PROCESSES

PRODUCTSôFAMILIES

	East Inox	Lavorazione Esterna	10	11	14	15	18	19	21	22	23	31	32	33	41	42	43	44	45	46	51	52	53	61	62	63	66	67	68	69	71	72	73	76	77
Brasiere	X	X		X								X		X	X	X				X		X													X
Brasiere Becco	X	X		X								X		X	X	X				X		X			X										X
Coperchi 1300pz									X						X																				
Coperchi C.B. 500pz				X		X			X					X	X																				
Cuocipasta				X		X						X			X	X	X					X			X	X		X						X	X
Lavatoi		X		X			X								X	X		X	X		X							X		X		X			
Pentole																																			
Sanitari																																			
Sanitari LAVAMANI				X										X	X	X	X					X			X										
Sanitari PIATTODOCC				X									X		X							X		X											
Sanitari TURCA						X						X			X		X			X	X														
Sanitari BUSTOILETTE		X		X											X										X								X		X
Sanitari WC+TAV				X		X								X	X	X				X		X	X	X	X	X									X
Tavoli -1-			X	X		X	X					X				X				X		X													
Tavoli -2-			X	X		X						X		X		X				X		X			X										X

	78	80	81	82	83	88	89	90	91	93	94	95	96	98	101	102	103	104	106	111	112	113	114	115	116	117	118	119	120	121	122	123	131	132	133	135	136	140	141	142	143	144	145	200
Brasiere														X																				X										
Brasiere Becco																																		X										
Coperchi 1300pz			X																																									
Coperchi C.B. 500pz			X															X						X																				
Cuocipasta								X									X										X							X					X					
Lavatoi								X																																				
Pentole																																												
Sanitari																																												
Sanitari LAVAMANI						X		X																																				
Sanitari PIATTODOCC								X																X	X																			
Sanitari TURCA								X																X					X															
Sanitari BUSTOILETTE																																												
Sanitari WC+TAV								X																X			X		X															
Tavoli -1-								X								X				X				X	X		X		X															
Tavoli -2-								X												X							X		X															

COMPLEXITY INDEX: 141 x 20 = 1820

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SUGGESTIONS FOR MAPPING

- COLLECT INFORMATION BY WALKING THE REAL FLOW OF MATERIALS AND INFORMATION (GEMBA)
- START FIRST WITH A QUICK WALK ALONG THE ENTIRE STREAM TO GET AN IDEA OF THE SEQUENCE OF THE PROCESSES
- START THE REAL MAPPING FROM THE CUSTOMER AND HIS REQUESTS BACKWARDS
- ALWAYS HAVE A STOPWATCH AND CAMERA AVAILABLE (CONSIDER BUT PLS DON'T TRUST COMPLETELY STANDARD TIMES, MAYBE OBSOLETE)
- MAP THE ENTIRE CHAIN PERSONALLY (LET THE TEAM PARTICIPATE)
- USE AN A4 PAPER, A PENCIL AND AN ERASER
- CARRY OVER ON A BILLBOARD AND DISCUSS WITHIN YOUR GROUP
- USE THE VSM SYMBOLS

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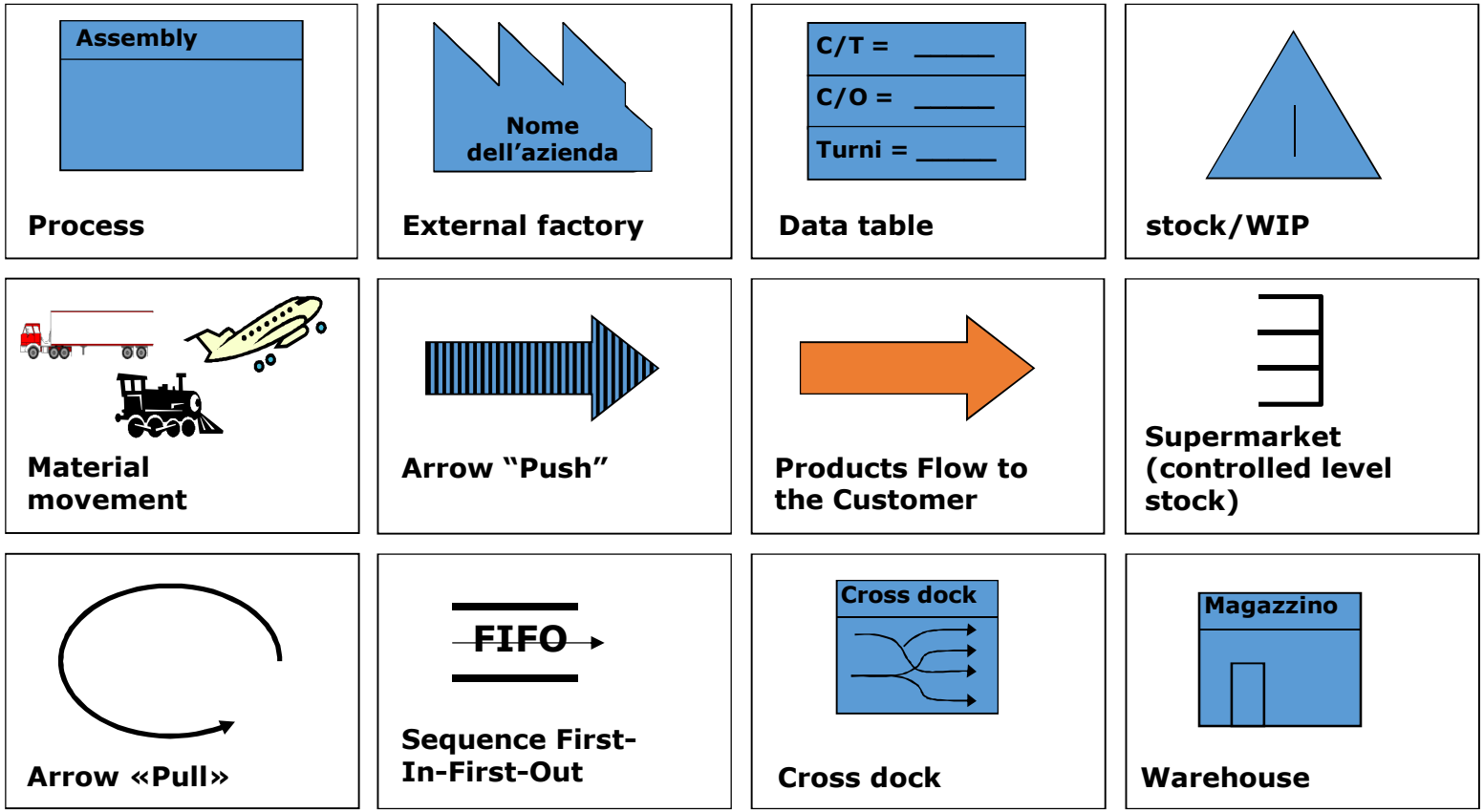
SIMBOLI PER LA MAPPATURA



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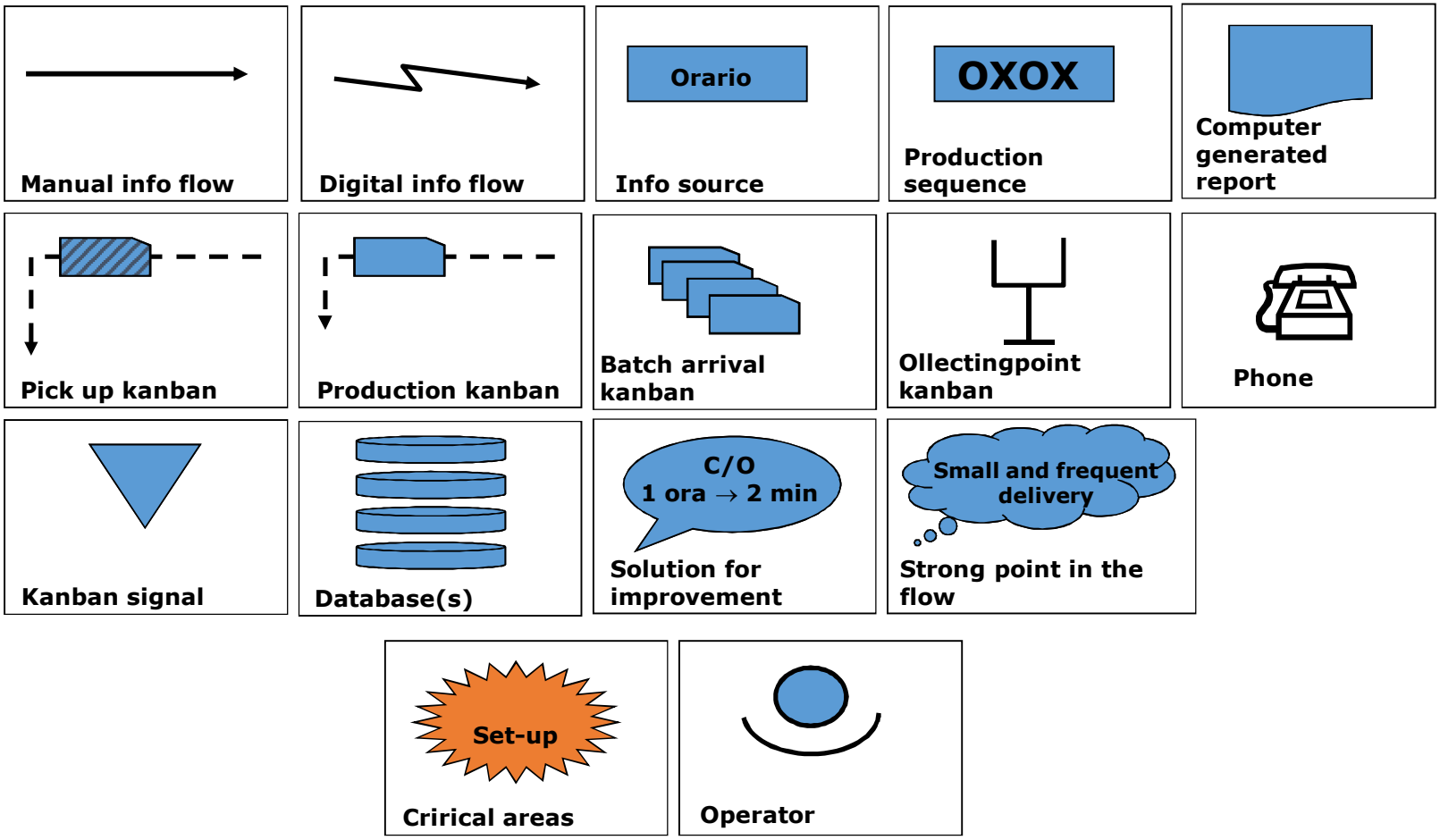
SIMBOLI PER LA MAPPATURA



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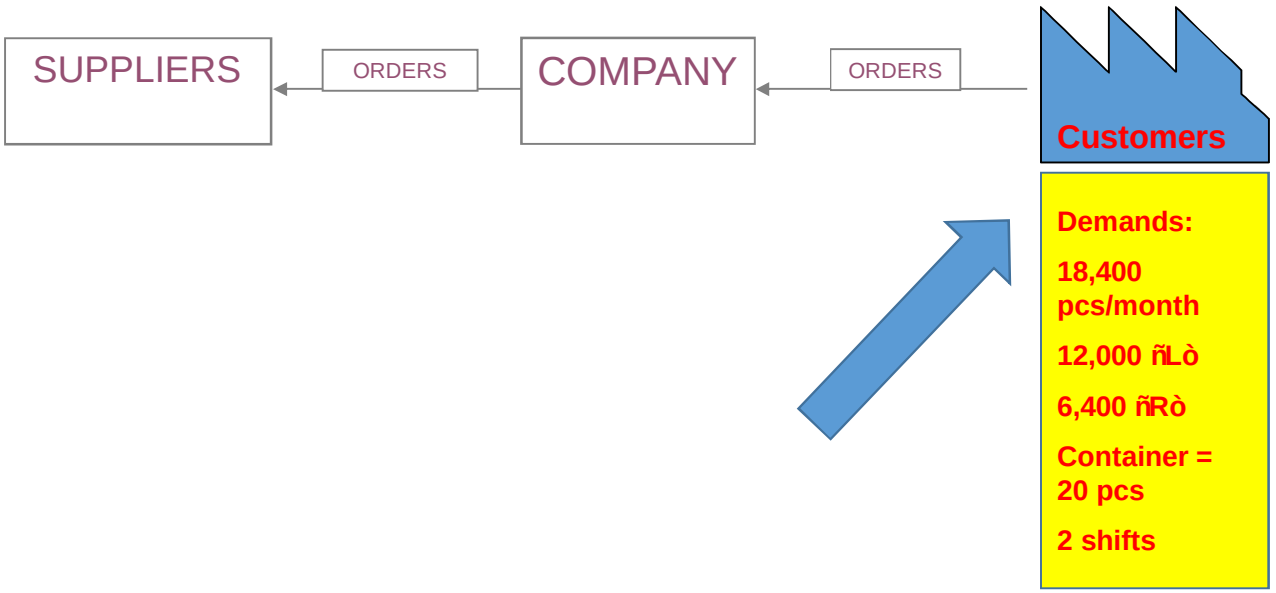
1) FIRST STEP FOR VSM



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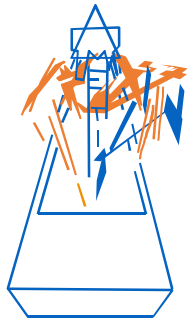
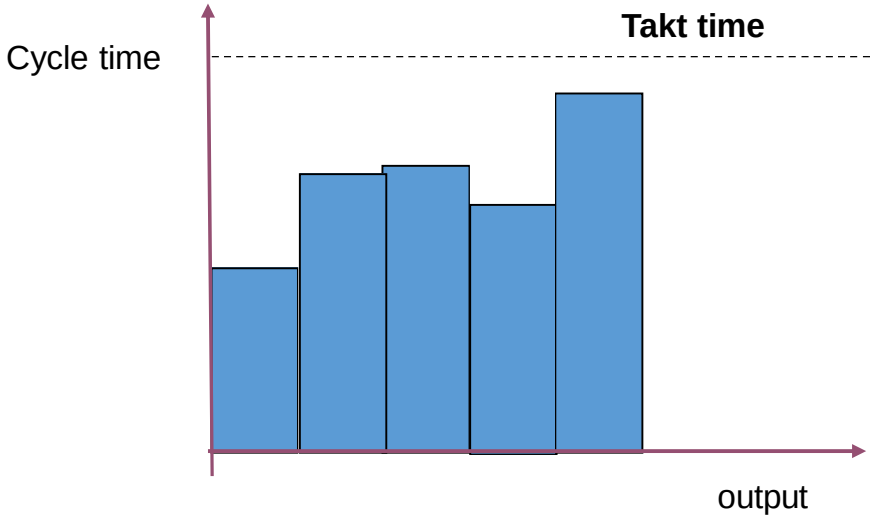
TAKT TIME

$$\text{Takt time} = \frac{\text{Hours planned for production}}{\text{Customer's demand}}$$





In the considered example:

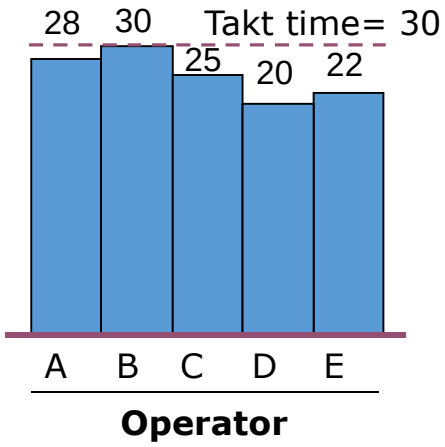
18400 pcs/months
4600 pcs/week
450 min/day=2250 min/week
2250/4600= 0,49 min/pc
Takt time= 0,49 min/pc

CABCACC CABCACC …

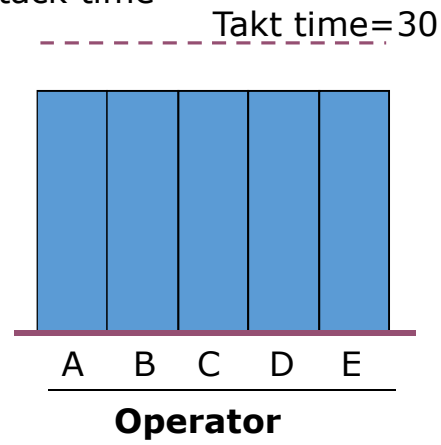
An assembly line inside a Messerschmitt factory in Germany just before the WWII.

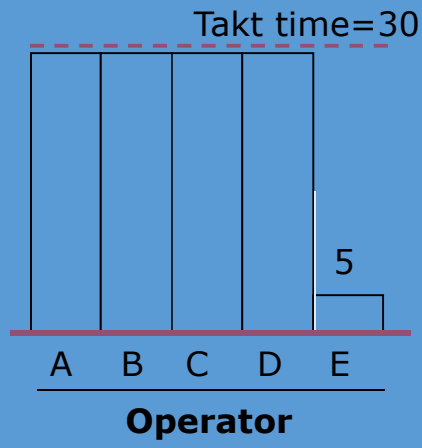
TAKT TIME:
BALANCE AMONG OPERATORS

Normally the work activities are not equally distributed among the operators



In some cases, the work activities are equally distributed among the operators
but with a time levelling significantly lower that tack time





How many workers wiil be necessary?

$$\text{Number of operators} = \frac{\text{Total workload}}{\text{“Takt time”}}$$

Example

$$\text{Number of operators} = \frac{125\text{s}}{30\text{s (TT)}} = 4.1$$

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TAKT TIME: IF VARIABLEé

If the Customersô demand increase the ñTakt timeò decrease

If the Customersô demand decrease the ñTakt timeò increase

Cycle time s have to be reduced eg by:

- **Increasing the number of work places**
- **Introducing overtime**
- **Outsourcing**
- **Utilising all the available time**
- **……..**

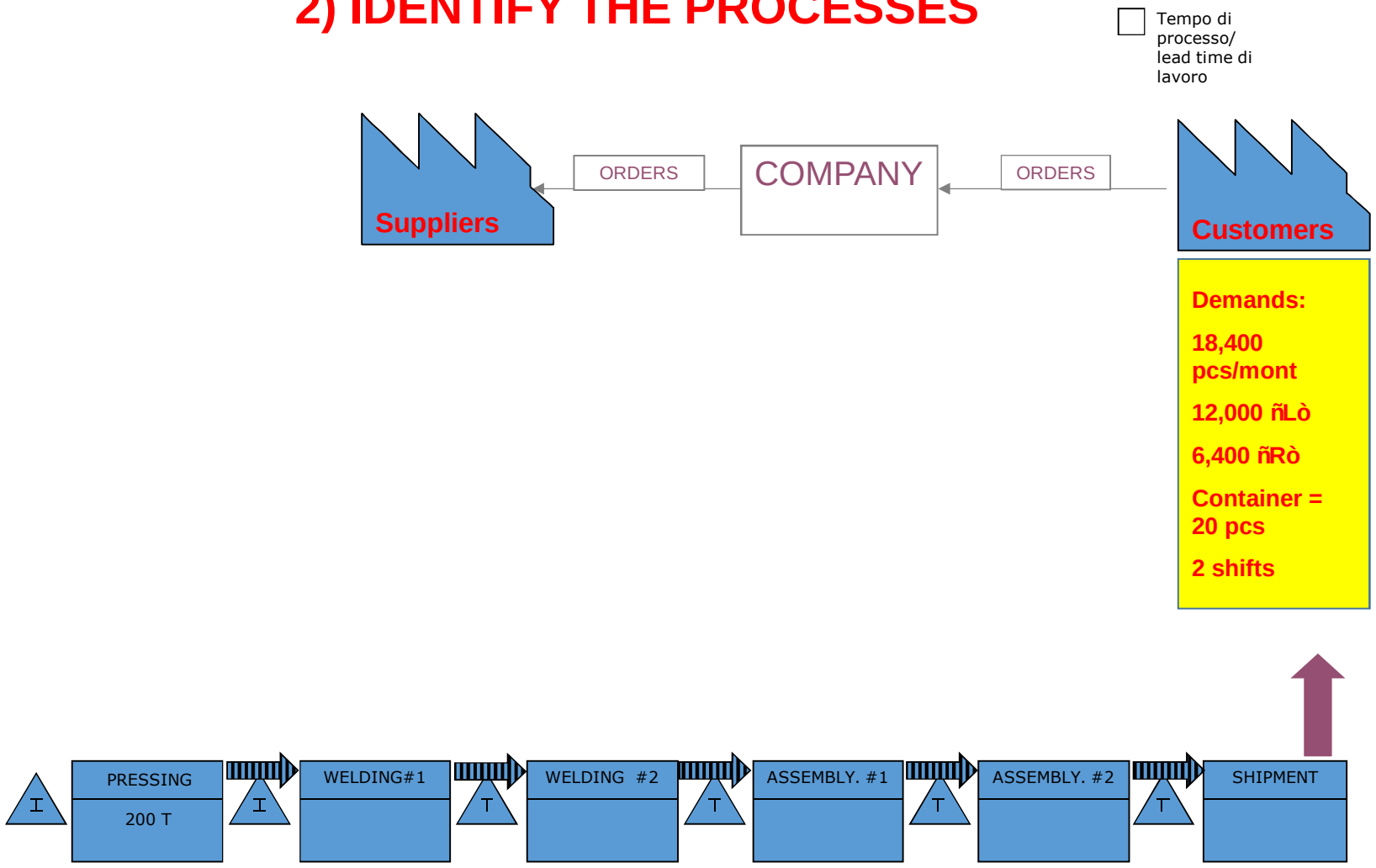
Competences and flexibility of the operators

Cycle times have to be increased eg, by:

- **Decreasing the number of operators**
- **insourcing external activities**
- **Utilising the workers in diferent activities**
- **Permissions, holidays**
- **…….**

Kaizen activities in order to reduce movements o machinery times have to be done in all the cases

2) IDENTIFY THE PROCESSES



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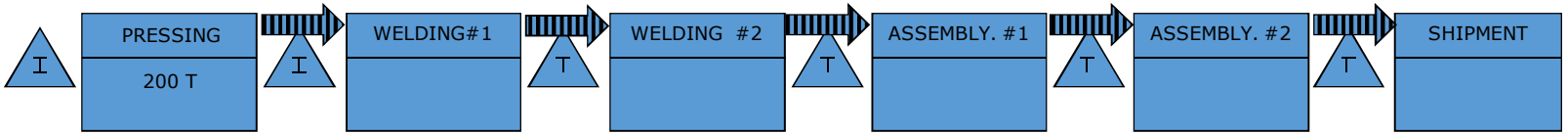
PROCESSES TYPICAL DATA



- **C/T: Cycle Time VA: Time with Add Value L/T Lead Time (sec)**
- **C/O: Set-up time Time to change model (sec/h)**
- **UPTIME: Availability of the Machinery when necessary (%)**
- **EPE (Every Part Every): Dimension of the production batch**
- **Number of operator in the specific process**
- **Number of variants produced**
- **Number of scraps (%)**
- **é ..**

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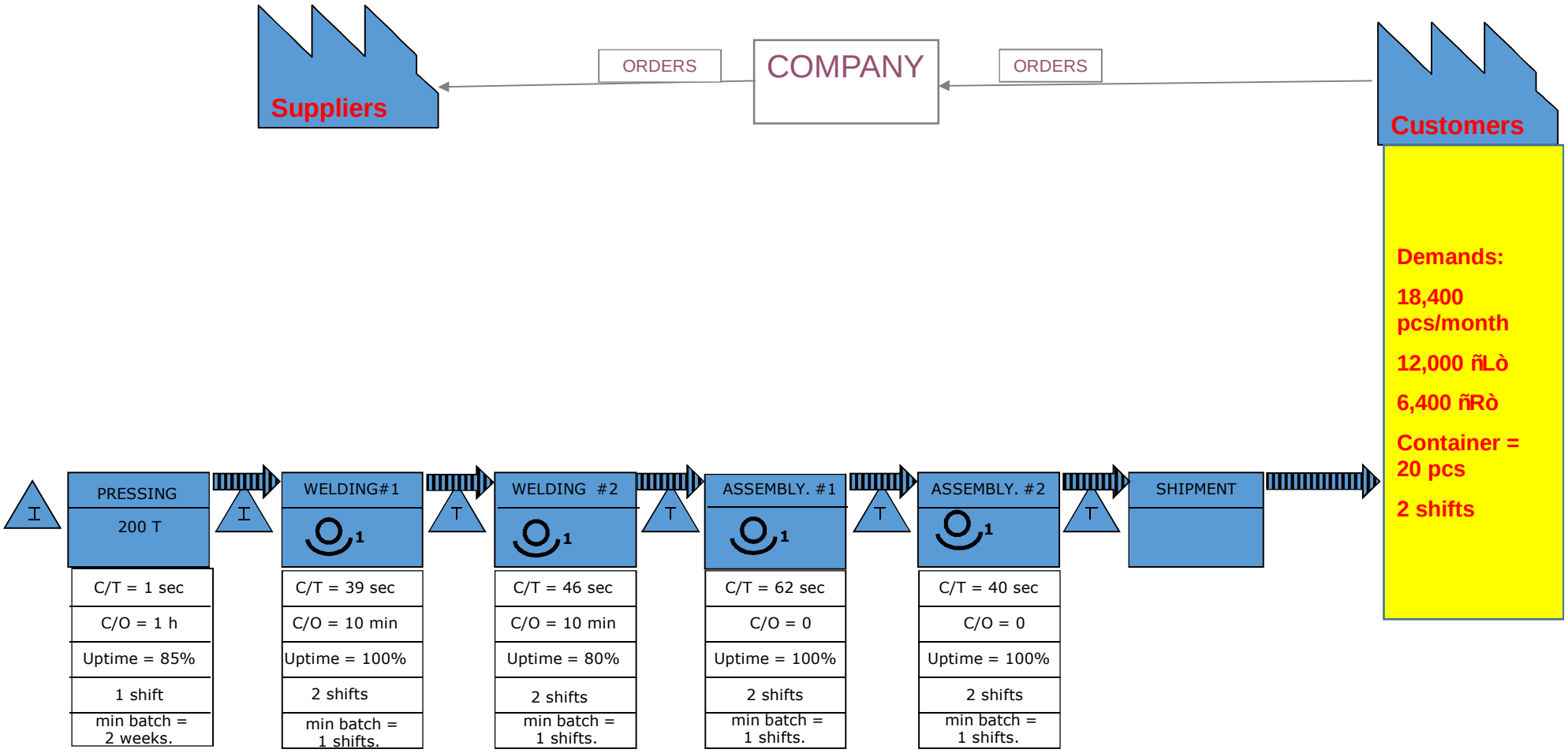
3) COLLECT PROCESS DATA



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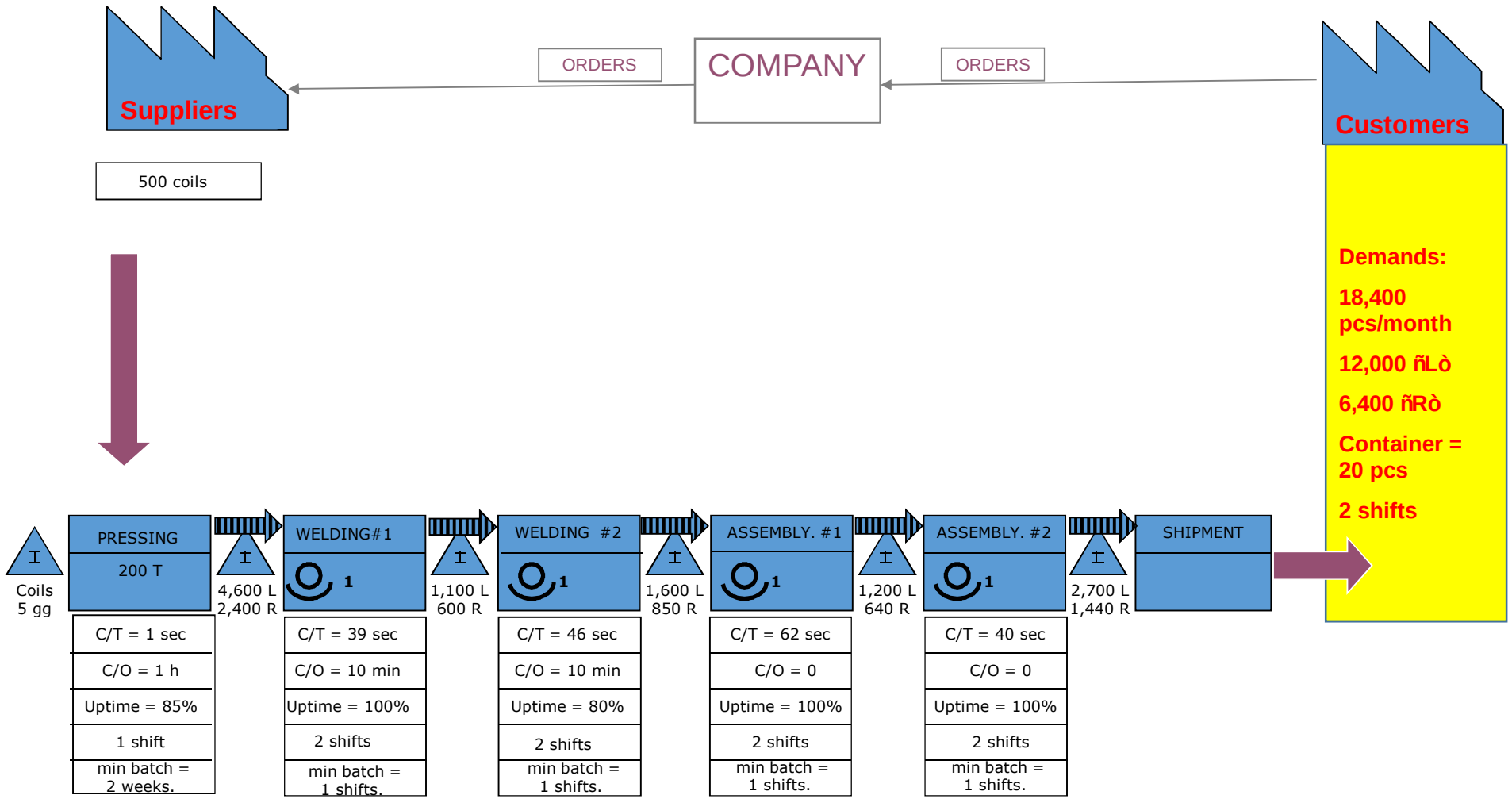
4) COLLECT STOCK DATA



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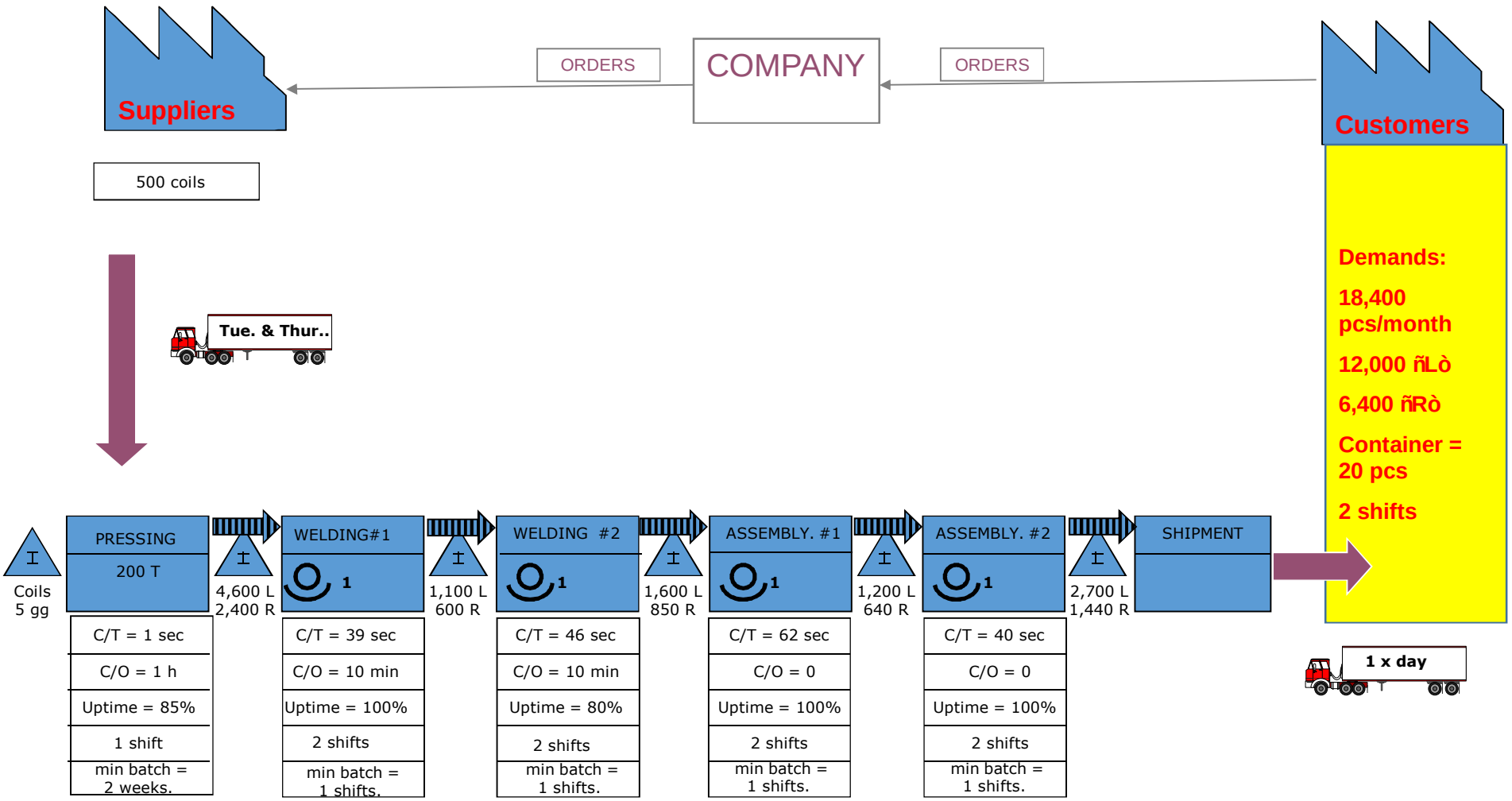
5) COLLECT DATA ON MATERIALS FLOW



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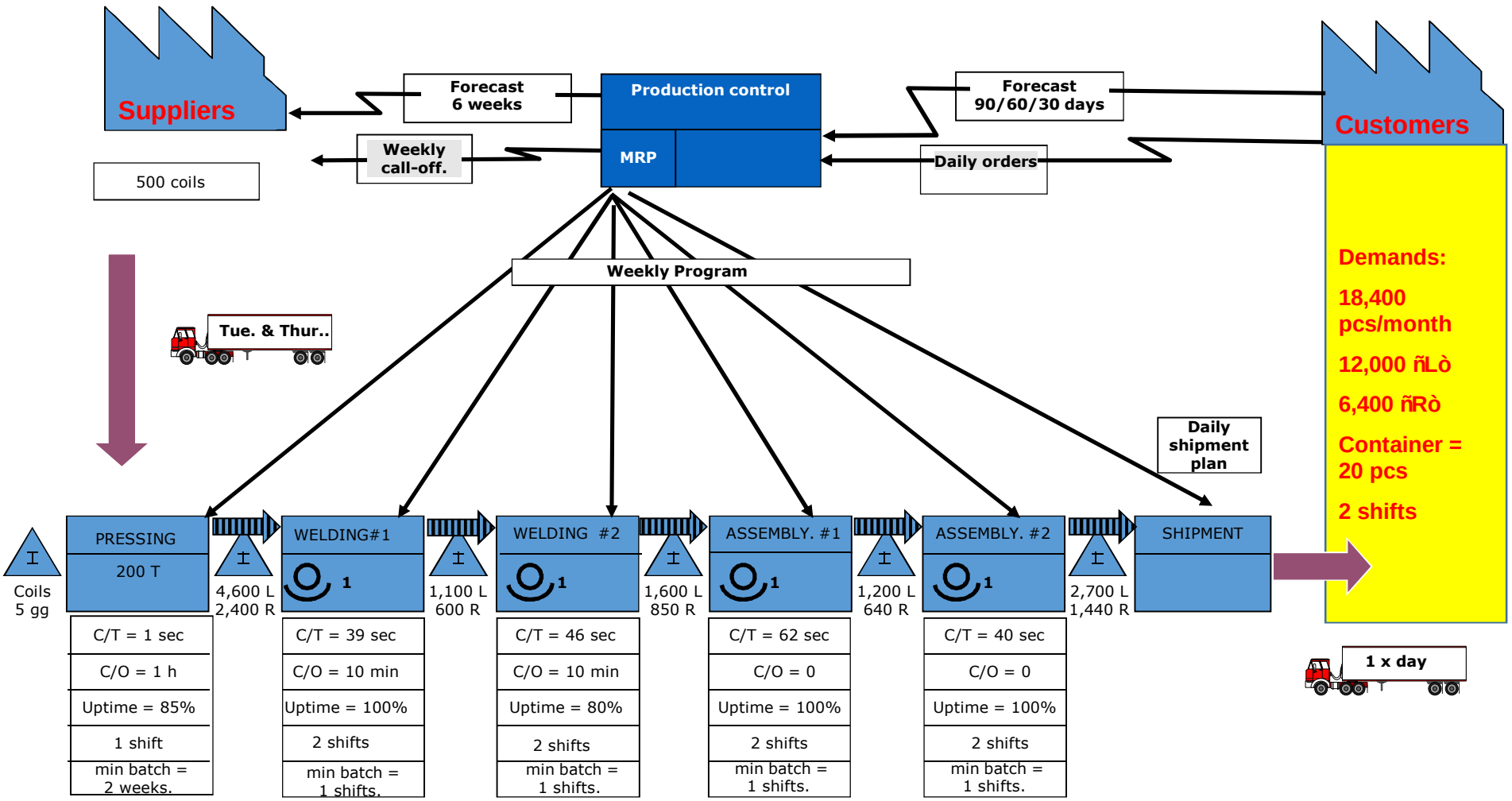
6) COLLECT DATA ON INFORMATION FLOW



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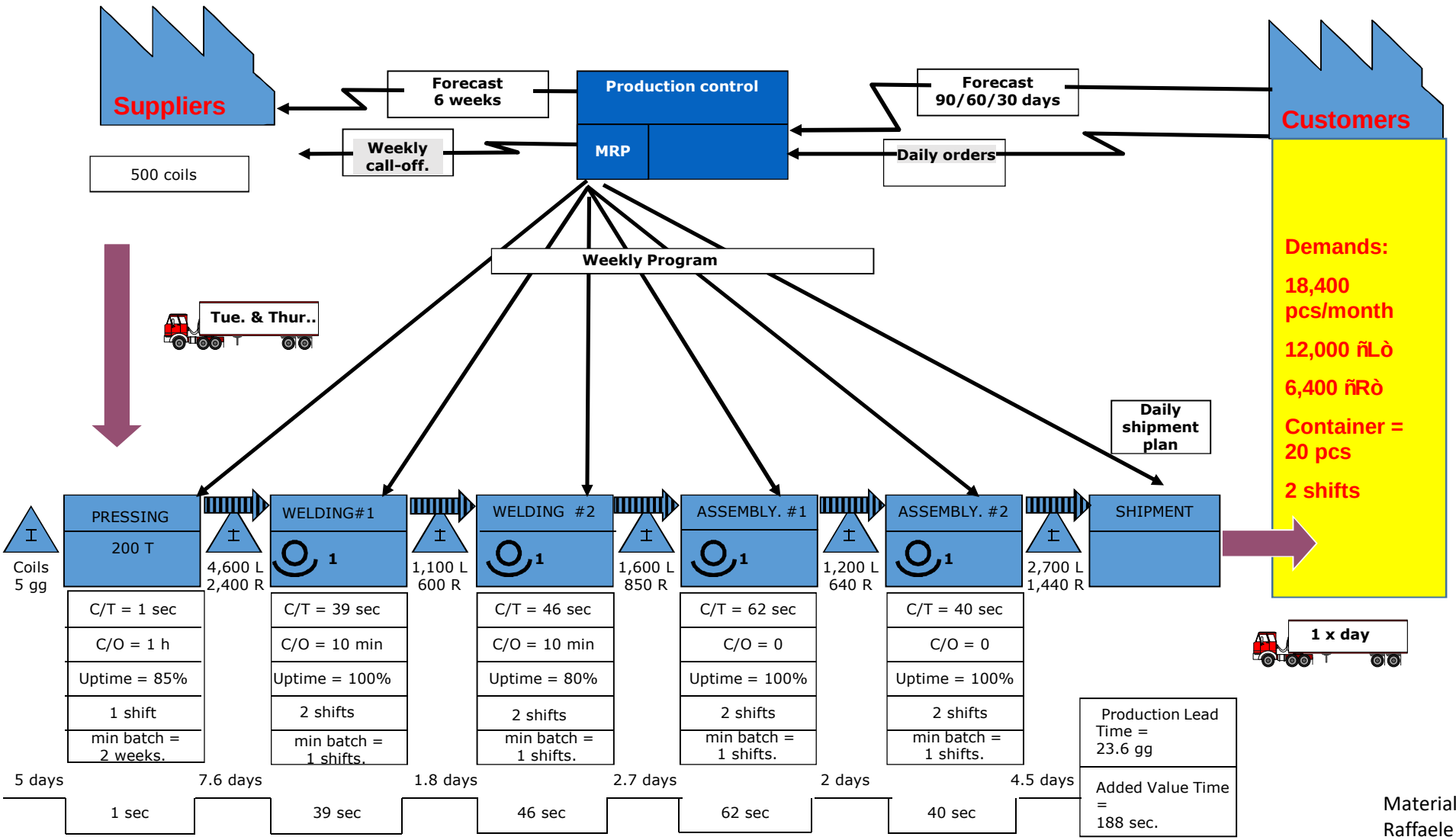
7) LEAD TIME CALCULATION



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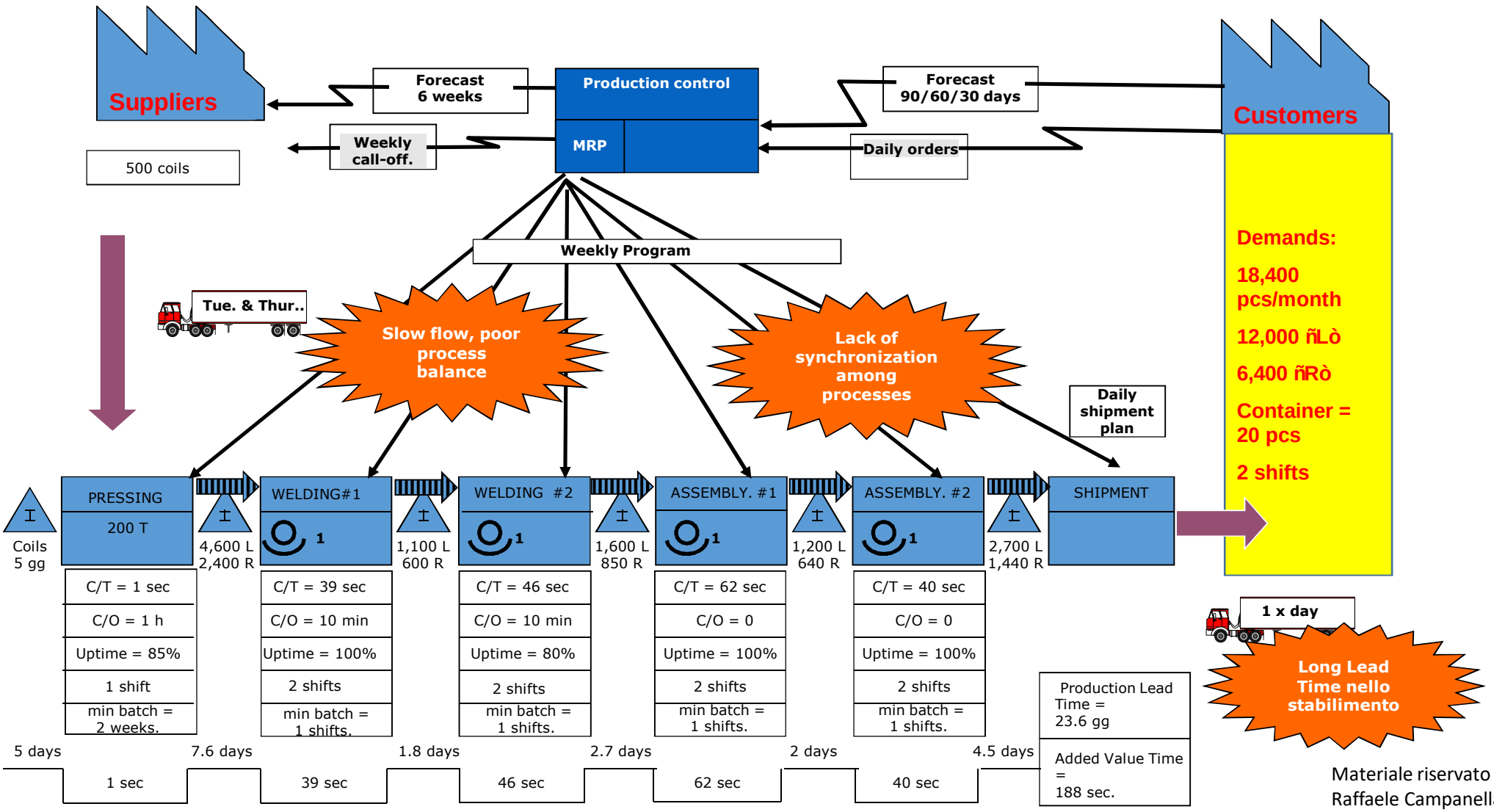
CURRENT VALUE STREAM MAPPING



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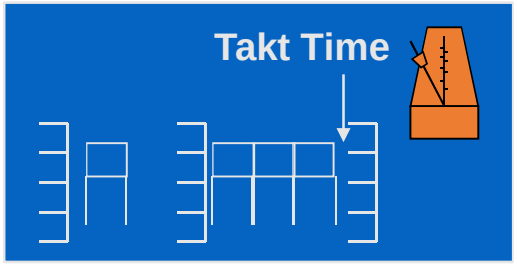
6) COLLECT DATA ON INFORMATION FLOW

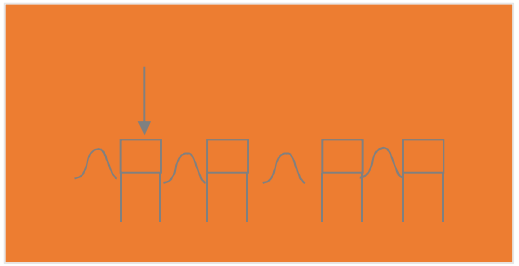
Considerations on pull vs. push

Pull System



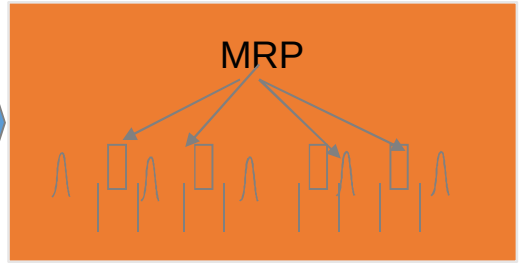
Pull System works when the production information (based on Customer's orders) is sent to the process upstream

Push System



The most common push system is the one where takt time in not known and the materials are pushed by upstream processes

MRP System



When MRP System is used, the system remains "push" type, gives its own inputs to all the processes. The result is production with different rythm due to uncertainess of the assumptions

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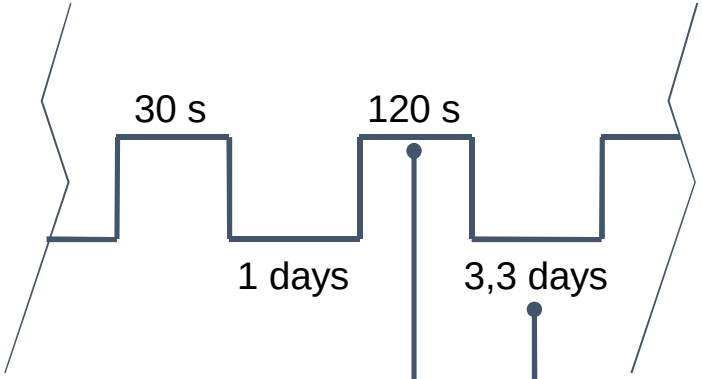
7) LEAD TIME CALCULATION
Considerations on the time line



- The upper part of the line is the average ot the present working times of the process
- Process time is defined as the sum of workers and machine cycle times
- The labour times are referred to the present job organization (actual efficiency and losses)

- The low part of the line show the waiting time between two consecutive processes
- This time is linked to the average WIP between two consecutive processes
- Cases related to specific orders are not considered

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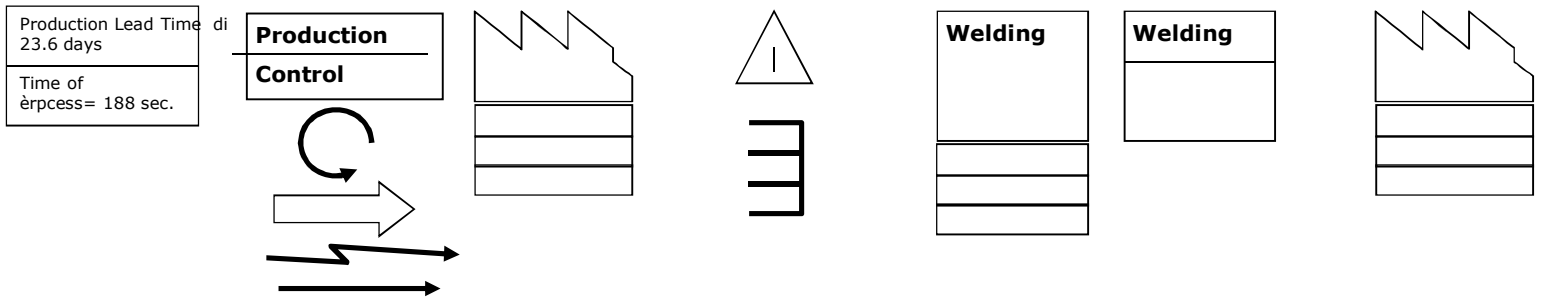
SYNTHESIS OF THE 7 STEPS FOR VSM

7	6	5	4	3	2	1
Lead Time Calculation and process times	**Determine internal material and info flows**	**Determine external material flows**	**Collection od stock data**	**Collection of process data**	**Design of the process phases**	**Customers' needs**
Calcolate Lead-Time Process time	Determine if the flow is push or pull Draw arrow pull o push if necessary Add info of production control from/to customers/suppliers Plan the production	Draw the symbol of supplier Add data Delivery "expedite" orde frequency Air freight Ispection on arrival	Draw graphics, use FIFO system or the super market for the stock Do the estimation about the stock amount evaluated in days Stock turnover	Collect and write process data Cycle time OEE Scraps Batch dimension No. ofworkers No. of shift (labour time)	Draw every process and describe the sequence of the process flow	Start from the Customer symbol Add data and ifno Demand of each period Shipment calendar Etc.



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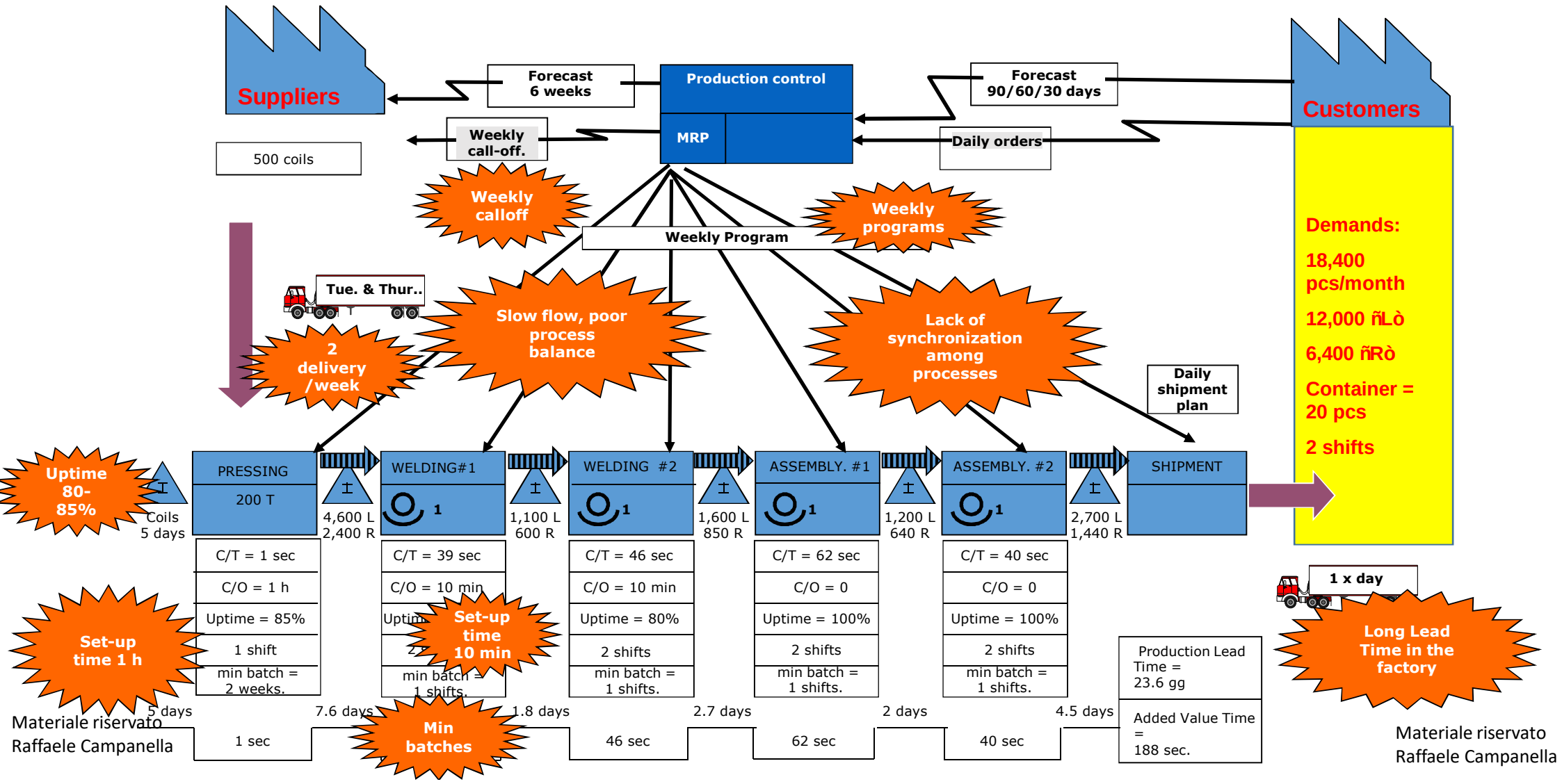
CURRENT VALUE STREAM MAPPING



Materiale riservato
Raffaele Campanella

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ORGANIZE ACTIVITIES ACCORDING PULL SYSTEM

- The value added activities have to flow without interruption, like the water.

- **The interruptions of the productive activities are:**
  - **A warehouse**
  - **A buffer**
  - **A waiting time**
  - **é é .**

- The concept of flow is not familiar with our way of thinking, that instead prefers working by batches. It is easier to approach the production completing the first operation for all the available pieces, then completing the second operation for all the pieces and so on. Very often this is due to the fact that the passage from the first to the second operation is linked to a machine (and brain) set-up that takes time.

ENVELOPES GAME

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POSSIBLE ACTIONS

Long Lead Time in the factory

- **See the difference between lead time and value added time:**

Production Lead Time = 23.6 gg
Added Value Time = 188 sec.

- **Why this so huge difference?**
- **What are the reasons?**

- **The long lead time is due to the stock along the processes**
- **The processes are too many and separate**
- **The processes production capacities are unbalanced**
- **The production organization is «push»**

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POSSIBLE ACTIONS

- The long lead time is due to the stock along the processes
- The processes are too many and separate
- The processes production capacities are unbalanced
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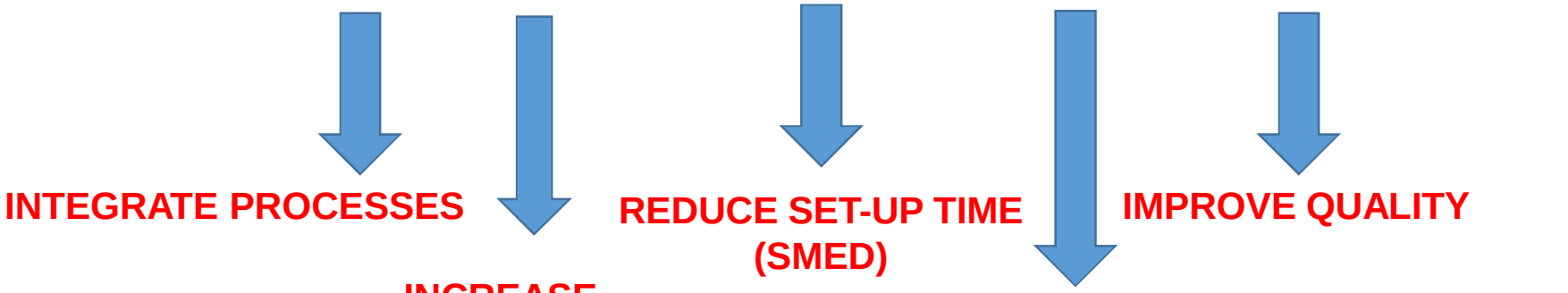

HUGE REDUCTION OF STOCKS (JIT)

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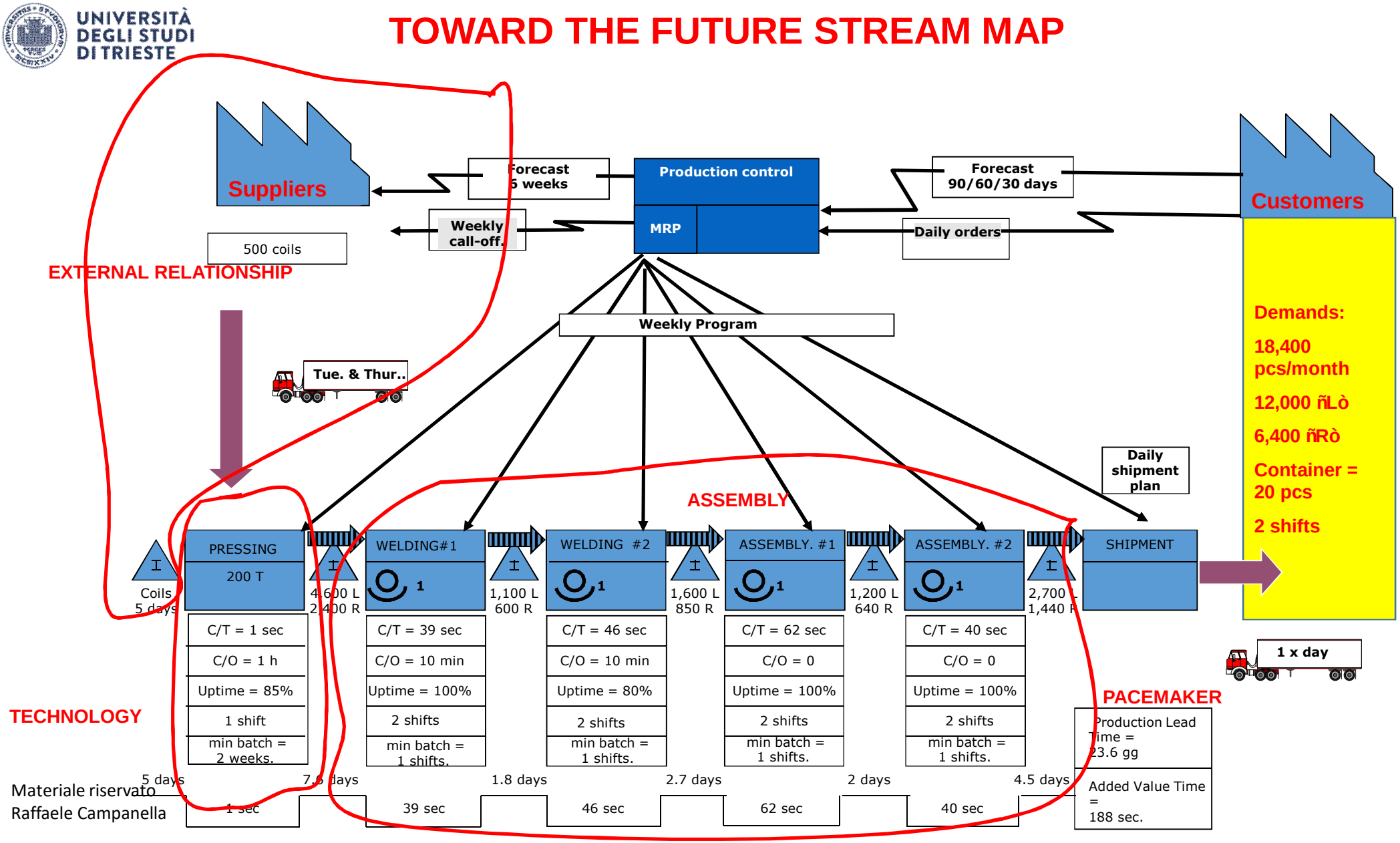
TOWARD THE FUTURE STREAM MAP



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TOWARD THE FUTURE STREAM MAP

OBJECTIVES

ASSEMBLY = PACEMAKER

- ONLY A UNIQUE CELL FOR WELDING AND ASSEMBLY
- KAIZEN WORK TO REDUCE TOTAL CYCLE TIME TO 168 SEC OR LESS
- ELIMINATE CHANGE-OVER (SET-UP) TIME
- IMPROVE UPTIME WELDER UO TO 100%
- PULL SYSTEM WITH KANBAN CARDS IN THE ASSEMBLY AREA

TECHNOLOGY:

- PULL SYSTEM WITH STAMPED PARTS SUPERMARKET
- REDUCE BATCHES SIZE TO 300 (LH) AND 160 (RH)
- REDUCE STAMPINGCHANGE-OVER TO LESS THAN 10 MIN.

EXTERNAL RELATIONSHIP:

- AGREEMENT WITH COIL SUPPLIER
- PULL SYSTEM WITH STEEL COILS SUPERMARKET
- DAILY COIL DELIVERY

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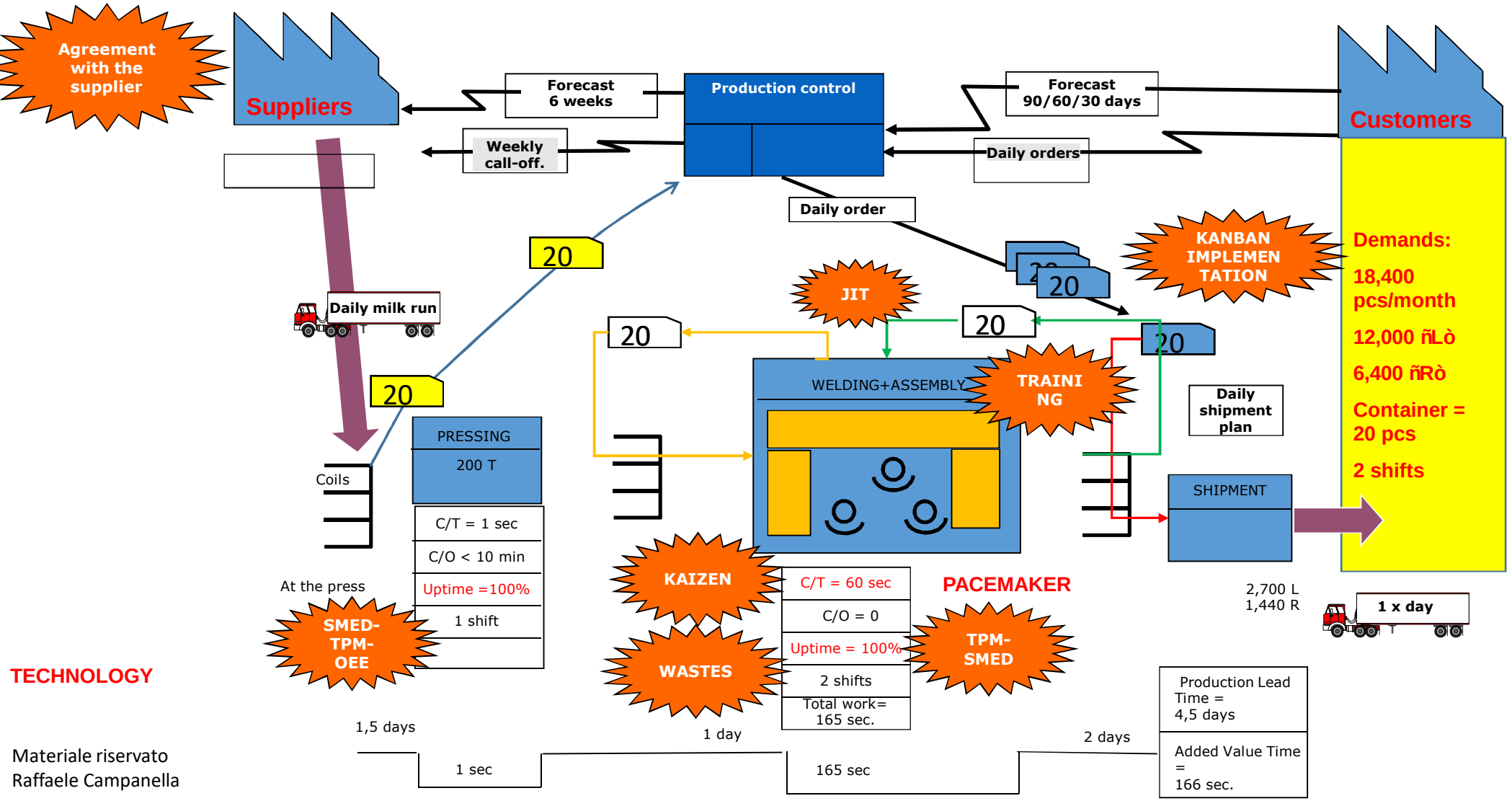
TOWARD THE FUTURE STREAM MAP



TECHNOLOGY

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KEY MESSAGES

- **VSM is the olistic map of the production system and show grafically (visually) processes, material and information flows**
- **It is used to describe the present status of the production system in order to develop its future status**
- **It is built according a solid method (eg. Process phases, symbols,…)**
- **It is built by skilled technicians able to identify correctly the working logics of the system**
- **It is a fondamental tool to support the transformation of the Productive System and the pertinent organization**

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THE LABOUR TIMES STUDY

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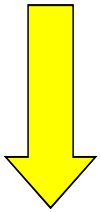
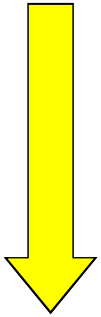
LABOUR TIMES STUDY



MEASURE THE WORK QUANTITY



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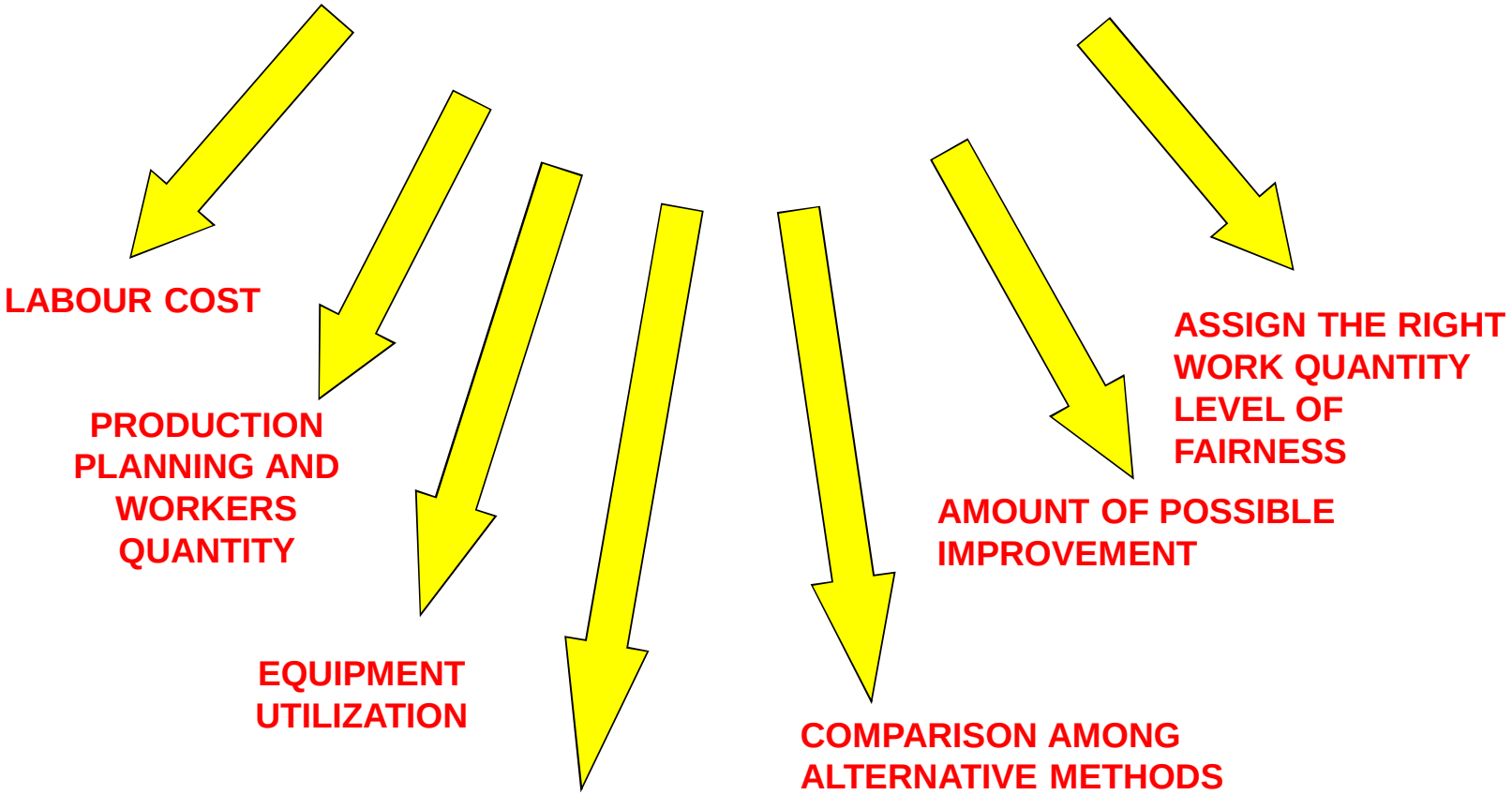
LABOUR TIME

WHY DO WE HAVE TO MEASURE IT?



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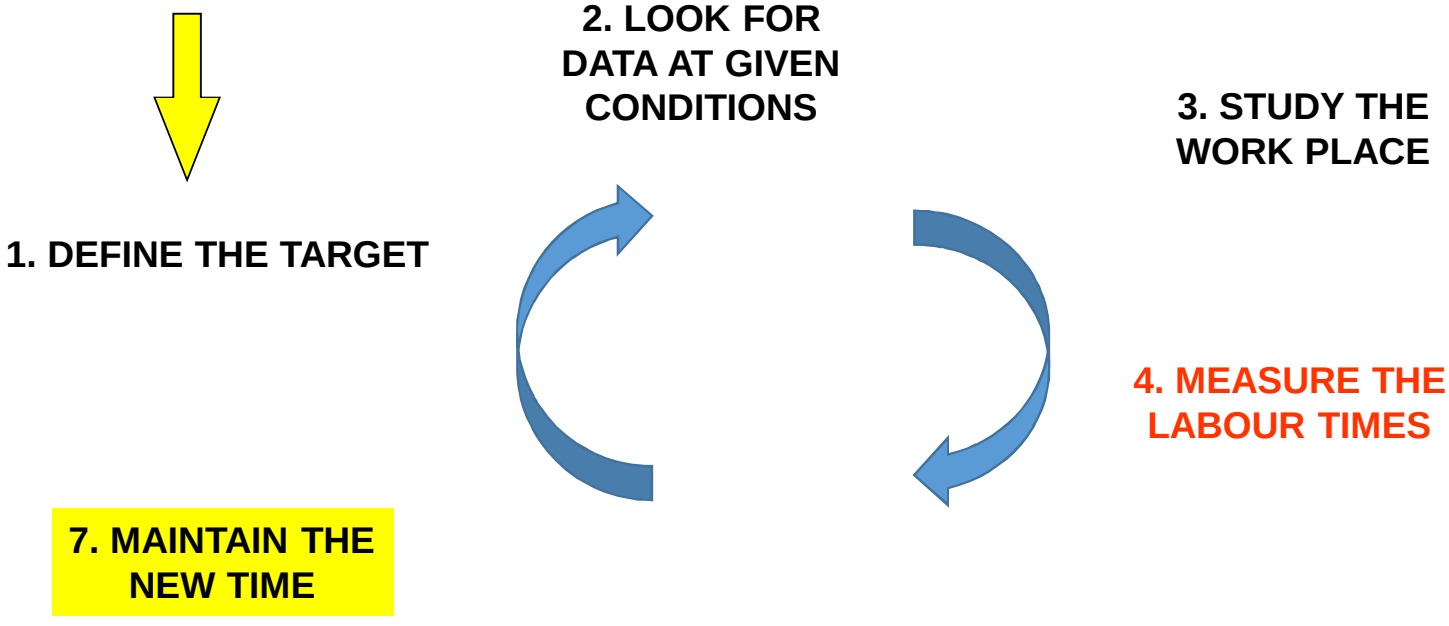
LABOUR TIME

PROCEDURE



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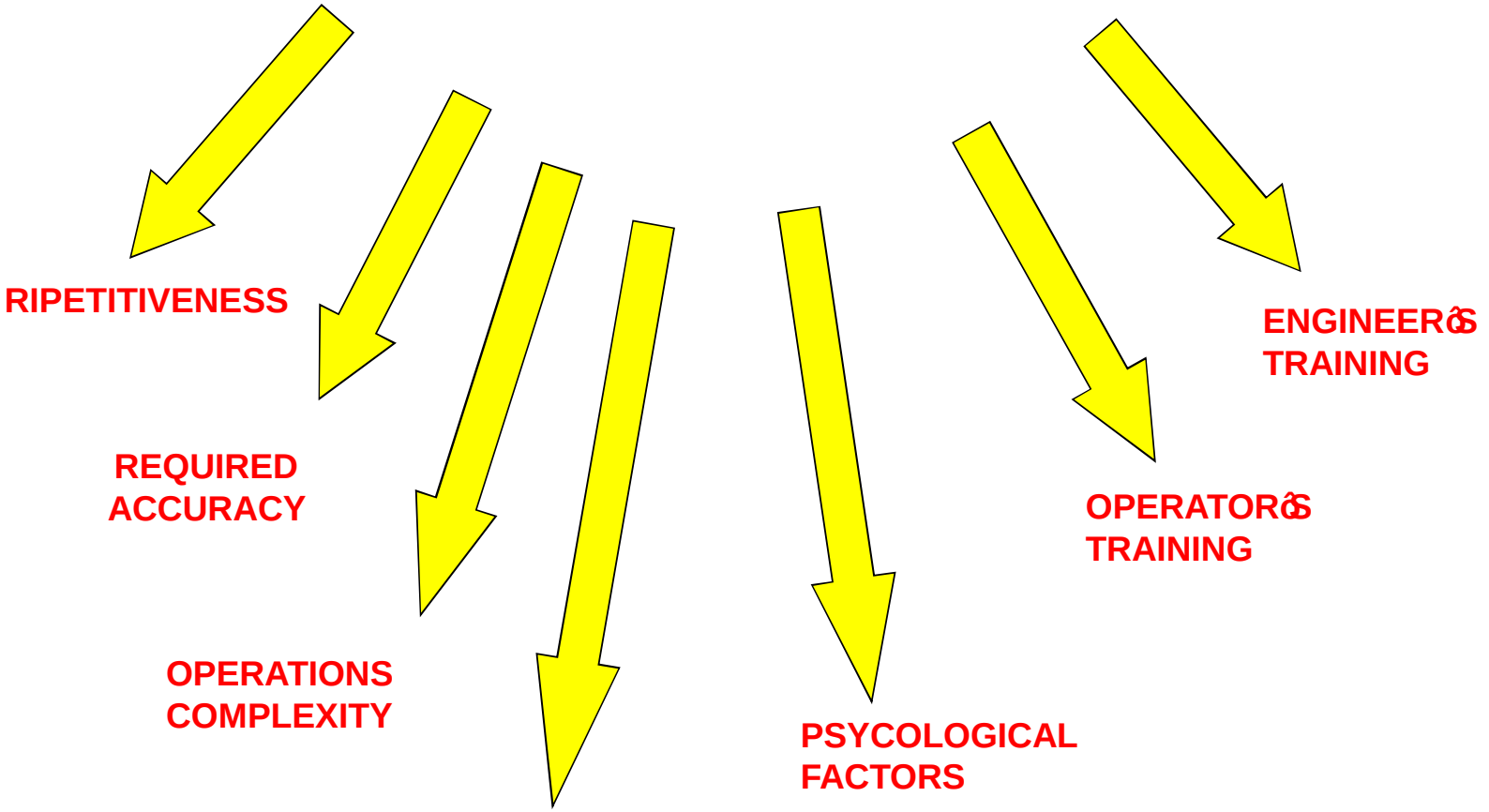
LABOUR TIME

INFLUENCING FACTORS



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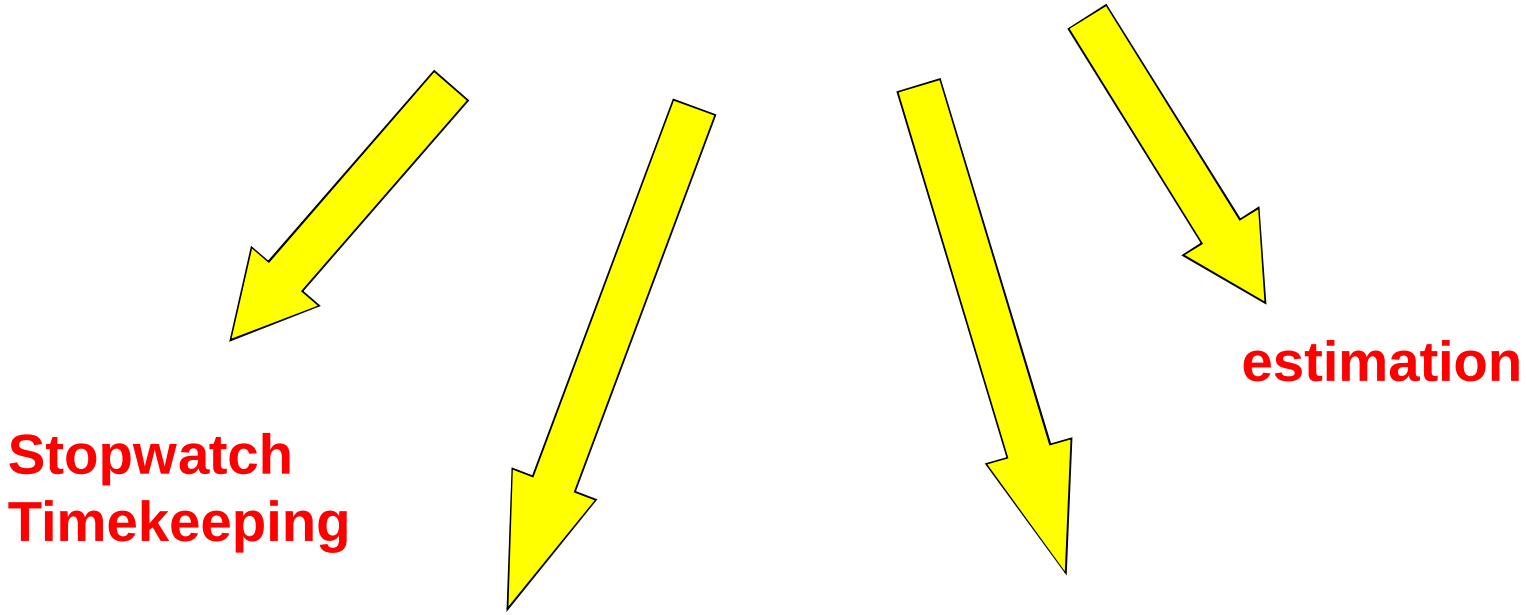
HOW TO ASSIGN LABOUR TIME



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LABOUR TIME

TIME-KEEPING

Working Cycle: It is the rational sequence, according with a pre-assigned method, of the work activities, in order to get a certain material transformation.

Operation : It is a part of a working cycle grouping together the activities done by the operator, by the machine separately or together in the same working place.

Phase: They are the parts which compose an operation.

Elementary movements: they are the fondamental activities that compose each phase

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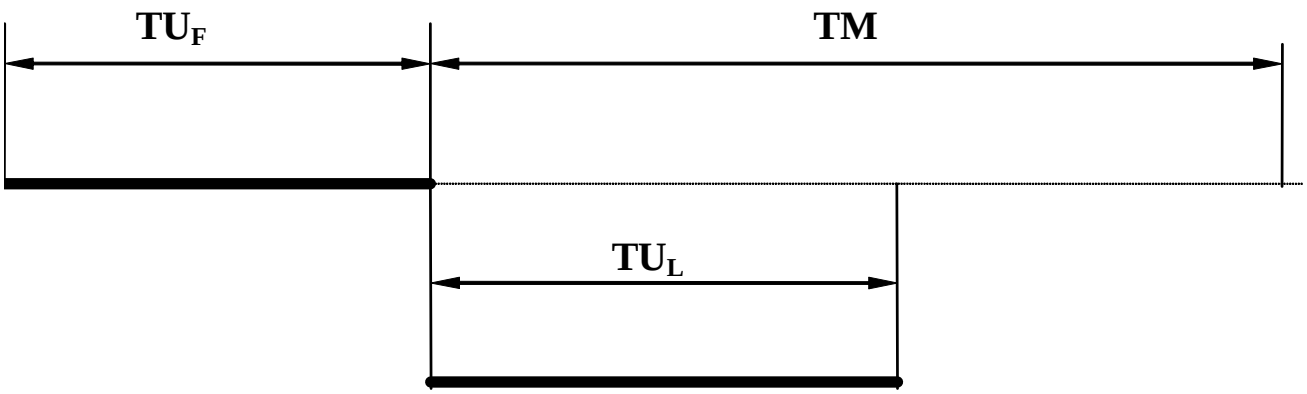
LABOUR TIME



TU_F = ELEMENTO DI MACCHINA FERMA OPERATOR TIME WITH IDLE MACHINE
TM = ELEMENTO DI TEMPO MACCHINA OPERATING MACHINE TIME
TU_L = ELEMENTI DI MACCHINA LAVORA OPERATOR TIME DURING MACHINE OPERATION TIME

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LABOUR TIME

Video tramezzino: Tesi Bianchetti MVI 1133 Video clip
ALF 195 Foto production systems
ALF 201

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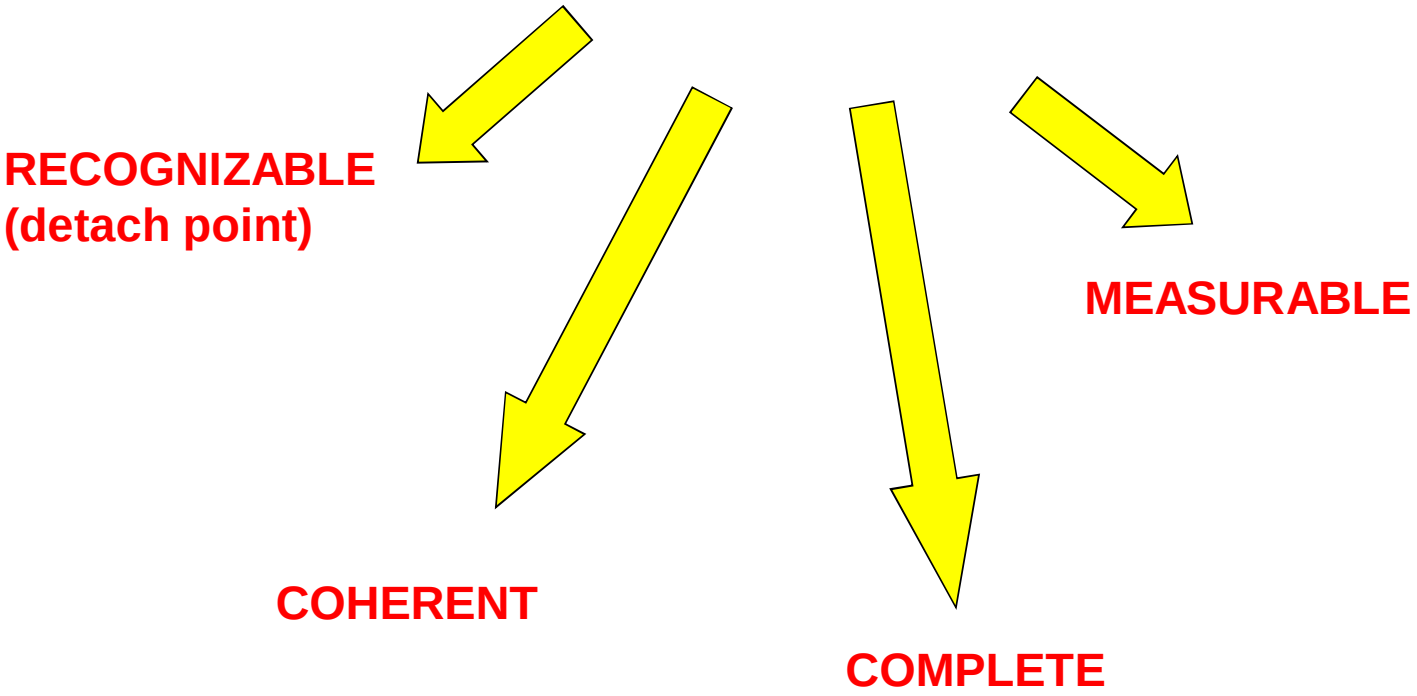
LABOUR TIME

PHASES



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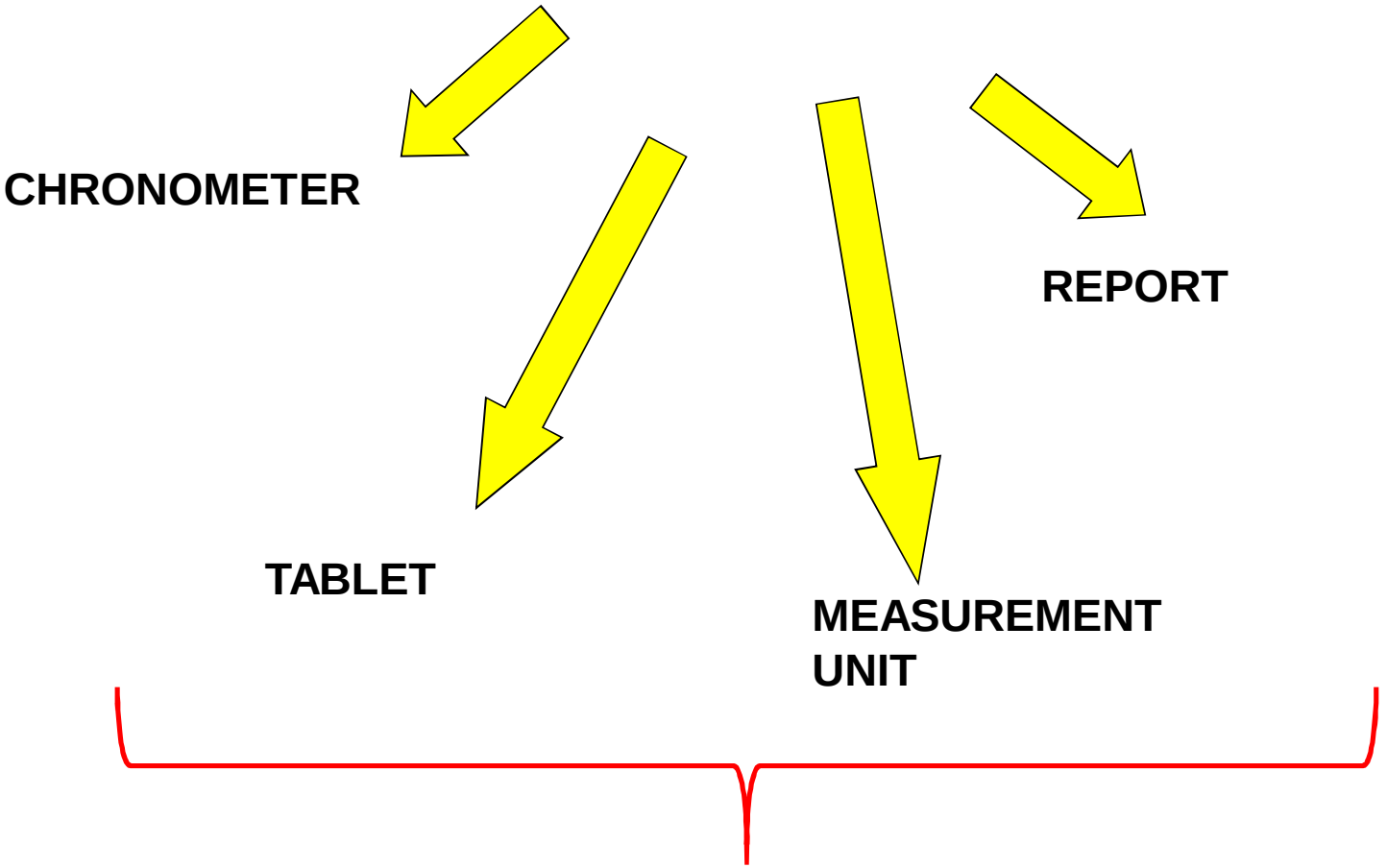
LABOUR TIME

TIME KEEPING



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LABOUR TIME

TIME KEEPING FORM

	CRONOMETRAGGIO	Data	Giro N.
Particolare			
Operazione N. ☐ di ☐	Descrizione		

Stabilimento	Sezione	C. di costo	Reparto	Linea-Gruppo	Codice N.	Modello

Cronometrista	Ora inizio: / Ora fine:	Esecutore	Matricola	uomo ☐	donna ☐	IP ☐	S ☐

N.	Fasi	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	F / S	TR / G	TN

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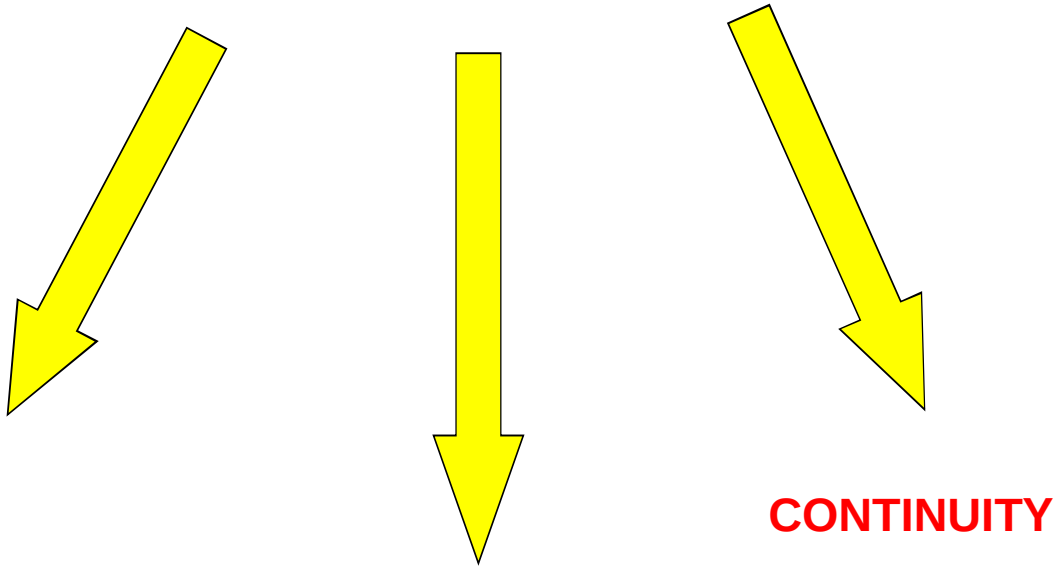
LABOUR TIME

RITHM EVALUATION



Video productions systems -foto -Alf P1200195 ï testa linea P1200201 - cassetti

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LABOUR TIME

RITHM EVALUATION
(INTERNATIONAL LABOUR OFFICE)

Normal pace: **it is the rithm of a normal operator when he works under a good supervision without incentive. This pace can be easily kept day by day without particular mental and phisical stress, and it is characterized by a reasonable level of effort.**

The normal performance generally accepted is equivalent to the speed of a man normally built, when he walk without weights and along a straight and plan line at 3 miles/hour (4, 8 Km/h) .

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LABOUR TIME

RITHM EVALUATION

(INTERNATIONAL LABOUR OFFICE)

Rythm 100/133	Description		compared speed at miles/h
67	Low performance	Very slow, clumsy, lazy movements. The operator looks half asleep, does not show interest in the job.	2
100	Medium performance	Constant performance deliberate, unhurried, a worker who does not work with an incentive, but under good supervision. It seems slow, but the time is not wasted intentionally	3
133	High performance	Performance fast, active, well-trained average worker, who works with incentive. The required standard of quality and precision is achieved without effort.	4
167	Over the average performance	The operator is very fast and reveals a high degree of self-control, skill and coordination of movements much more than an average well-trained operator.	5
200		Operator exceptionally fast, with a capacity of intense concentration and effort. It is unlikely that this rate should be retained for a long time: a "virtuous" performance, reachable only by a few workers champion.	6

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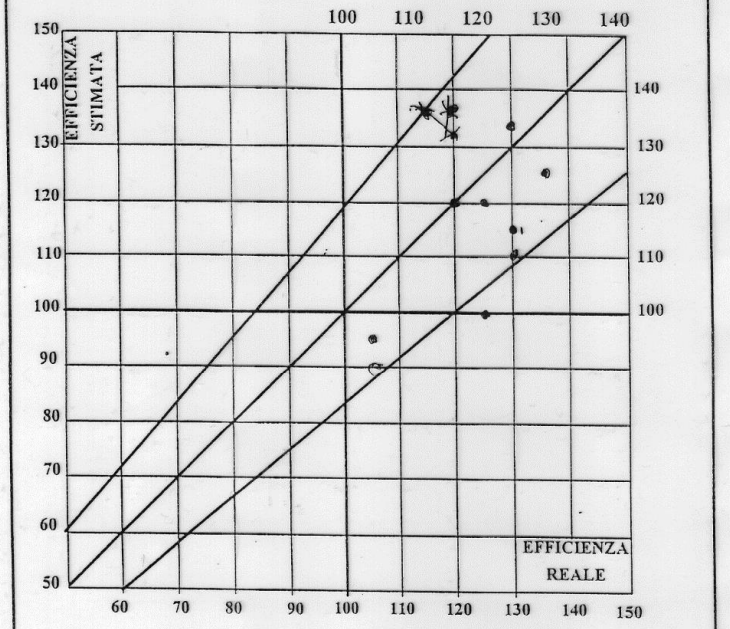
TARATURA DEL GIUDIZIO DI EFFICIENZA

SOCIETA':	Consulting Group
DATA	
UNITA'	



	N° PROGRESSIVO	1	2	3	4	5	6	7	8	9	10	11	12
A	EFFICIENZA STIMATA IN %	110	120	115	115	110	120	125	115	125	100	95	90
B	EFFICIENZA REALE IN%	120	125	130	130	130	133	135	125	155	125	105	105
C	DIFFERENZA (d) C=A-B dm - 14 ΣC/12	—	-5	-15	-15	-20	-13	-10	-10	-30	-25	-10	-15
D	SCARTO (d-dm) D=C-dm ΣD/12	-14	11	1	1	6	1	-4	4	16	11	4	1
	dm= ± 2	NOTE:											
	D=≤ 5 6.4												

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LABOUR TIME STUDY

NORMAL TIME

Measured Time T_M

measured keeping into account all the correct executions, not considering those where the operator for any reason could not work with the forecasted method

Judgement on the medium pace G

weighted by the judgements noted for that phase during the time keeping

$$T_N = T_M \times G$$

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LABOUR TIME STUDY

NORMAL TIME

$$T_N = \frac{\sum_{1}^{n} T_{Mi} \times Gi}{n}$$

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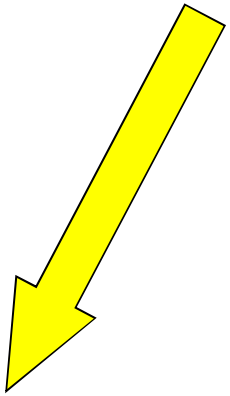
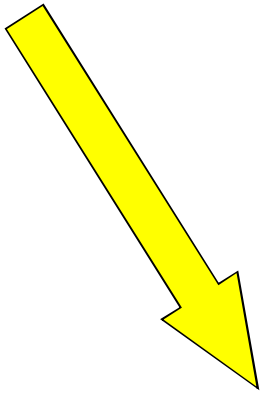
LABOUR TIME STUDY

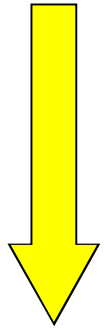
TIME INCREASE





Physiological factors

Stress factors



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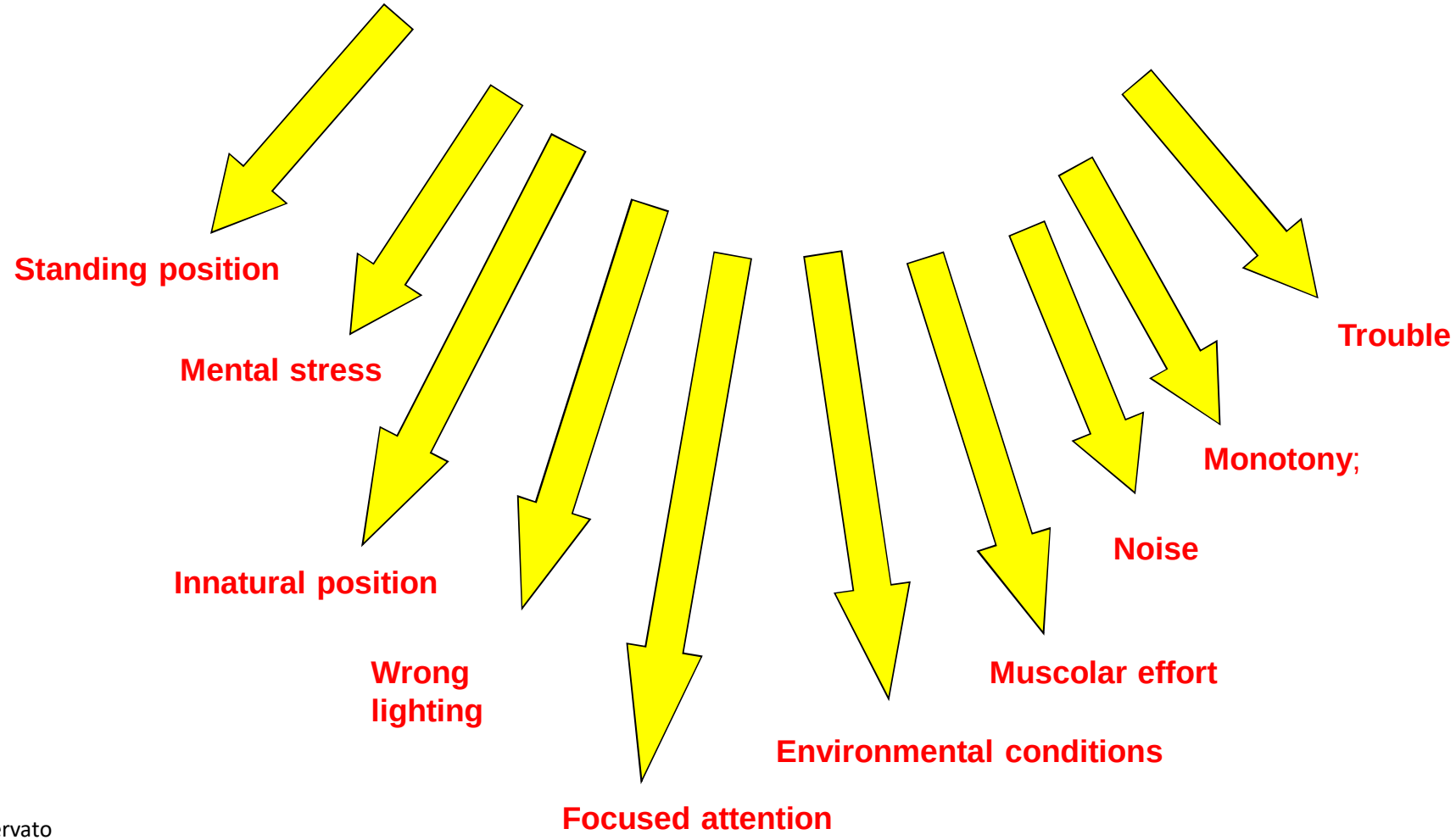
LABOUR TIMES STUDY

TIME INCREASE ï IMPORTANT FACTORS



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LABOUR TIMES STUDY

TIME INCREASE ï IMPORTANT FACTORS

WEIGHT: 2-25% DEPENDING OF THE KGS

EYE STRESS: 1-6% DEPENDING OF DIMENSIONS

MENTAL STRESS: 1-2% DEPENDING ON COMPLEXITY

MONOTONY: 1-5% DEPENDING OF THE WORKING CYCLE

NOISE: 1-3% DEPENDING ON THE LEVEL

HEATING: 1-3% DEPENDING ON THE TEMPERATURE AND HUMIDITY

SMOKES, DUSTé : 1-3% DEPENDING TO THE QUANTITY

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LABOUR TIME STUDY

ASSIGNED TIME

***Normal Time* :** $T_N = T_M \times G$

***Assigned Time* (pace = 100):** $T_A = T_N \times (1 + M)$

***Assigned Time* (pace = 133):** $T_A = (T_N \times (1 + M))/1.33$

where M is the increase factor

***Production per hour* :** $$P_h = \frac{60}{T_{A(133)}}$$

CRONOMETRAGGIO

Data: 11.05.1994 — Giro N.: 1

Particolare: ASSIEME MOBILE

Operazione N.: 1 di 20 — Descrizione: SALDARE SQUADRETTA ANTIGOCCE TUBO CARICO

E DISCO PER FORO A SCHIENALE - ASSIEME MOBILE -

Stabilimento	Sezione LB	C. di costo	Reparto	Linea-Gruppo	Codice N.	Modello
DISTA/PN	186.00	186.03	186.03.03	03	37068.5530	LAVABIANCHERIA CO 210

Cronometrista	Ora inizio: 10:20	Esecutore	Matricola	uomo	donna	IP	S
	Ora fine: 10:50		10642	X		X	

N.	Fasi	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Pz/Gg	TR G	TN
1	Prelevare schienale da cont. dist. mt.5 e deporre vicino al banco di lavoro.			306/60						270/40						170/20						1/40	2.487	0,870
					105						120						110						112	
2	Prelevare schienali in prossimità banco di lav. e posizionare su bancale saldatrice.	9	7	7	7	7	8	7	7	8	8	8	9	7	8	8	7	9	9	8	7		0.078	0,163
		130	140	140	140	140	140	140	140	130	130	130	130	135	130	130	135	125	125	125	135		134	
3	Prelevare da cont. pratic-sistem 1 disco per foro, posizionare e saldare allo schienale con 2 punti.	12	12	15"	11	13	10	10	16	12	15"	10	15	11	11	14	13	12	14	15"	13		0.124	0,155
		125	125	125	125	120	135	135		125	125	135	120	125	125	120	125	125	120	120	120		125	
4	Prelevare da cont. pratic-sistem 1 sq. antigocce, posizionare e saldare allo schienale con 3 punti.	18	18	19	16	15	16	17	15	17	18	18	17	17	18	19	18	17	15	16	15		0.171	0,225
		130	130	130	135	135	130	130	135	130	130	130	130	130	130	130	130	135	135	135	135		132	
5	Togliere schienale da bancale e deporre su carrello destante mt 1	15	17	18	18	17	19	22	19	16	19	15	16	14	15	15	15	19	18	19	18		0.172	0,194
		120	110	110	110	110	110	100	105	115	105	120	120	125	120	120	120	110	110	110	110		113	
6	Rifornimento sq. antigocce distanti mt.5, deporre in cont. pratic-sistem su banco di lavoro.		80/60					60/40						90/50				80/50				1/50	0.782	0,018
				120					120					105				115					115	
7	Rifornimento dischi per for. distanti mt.5, deporre in cont. pratic-sistem su banco di lavoro			40/150						62/300						90/600						1/350	0.640	0,002
					120						125						115						120	
8	Con lima togliere bave da punte elettrodi.									170/350												1/350	0.170	0,001
											120												120	

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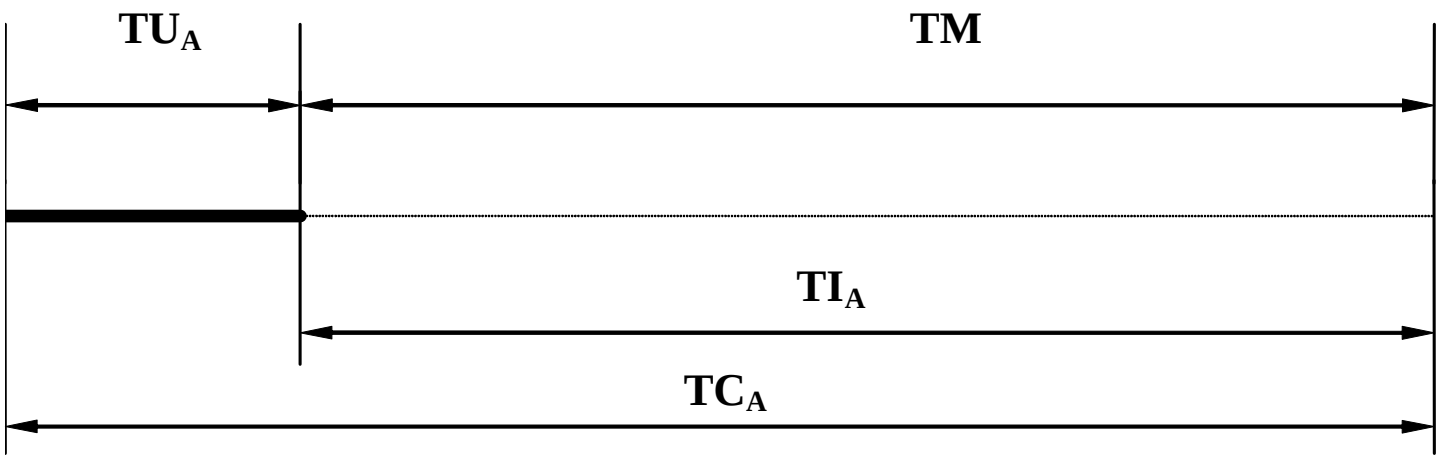
LABOUR TIME STUDY



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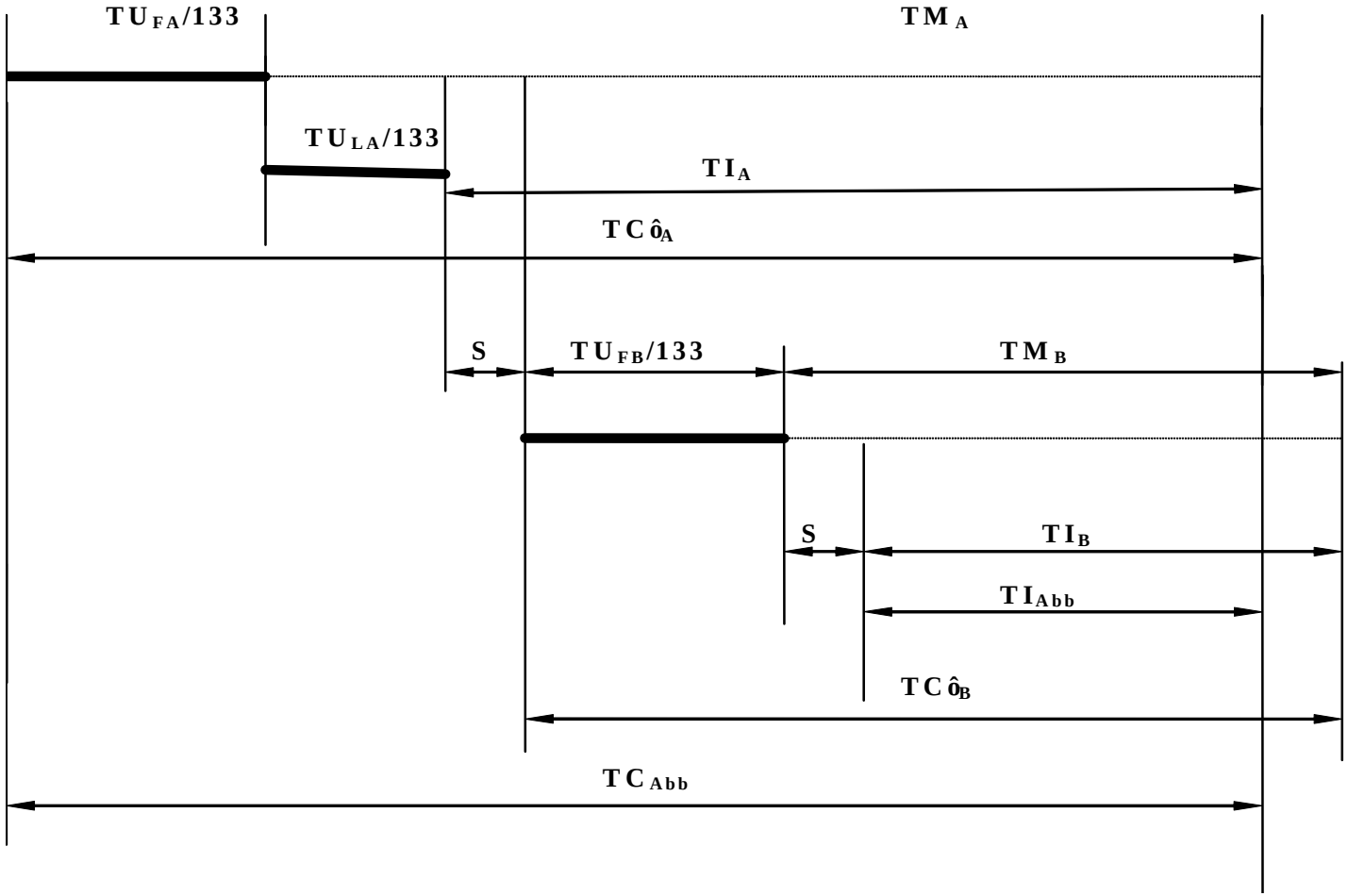
LABOUR TIME STUDY



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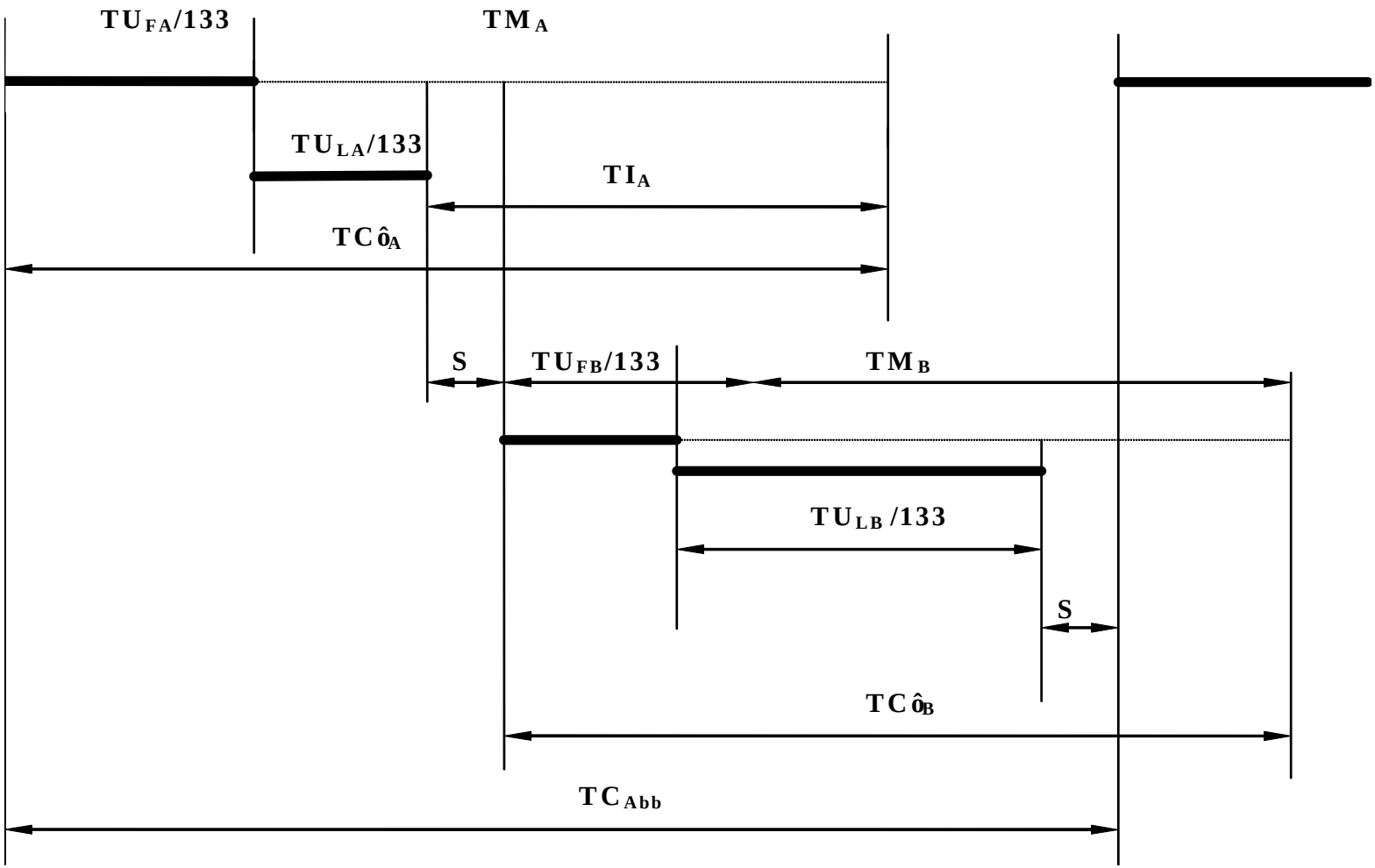
LABOUR TIME STUDY



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LABOUR TIME STUDY

ASSEMBLY LINE

Leveling: it is the activity of distribution of the labour times between the various operators in an assembly line or product flow, in order to assign to each one approximately the same amount of work content

Pilot Time: it is the longest time assigned among the different operators of an assembly line. It corresponds to the time interval between a product and another.

Individual Assigned Time : it is the time strictly necessary to perform the assigned operations

Percentage of leveling: it is the ratio between the sum of individual assigned times and the product of the pilot time and the number of operatos along the line.

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LABOUR TIME STUDY

ASSEMBLY LINE

Percentage of leveling: it is the ratio between the sum of individual assigned times and the product of the pilot time and the number of operatos along the line..

$$L = \frac{\sum_{1}^{n} Ta_i}{Tp \times n} \times 100$$

Dove:

L	=	percentuale di livellamento	Percentage of leveling
Tai	=	Tempo assegnato dellôoperazione i-esima	Assigned time to the i-operation
Tp	=	Tempo pilota della linea	Pilot time of the assembly line
n	=	numero di operatori	Number of operators along the assembly line

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LABOUR TIME STUDY

ASSEMBLY LINE

Number of Workers calculation:

$$W = \frac{Ta_{TOT} \times n}{T_P \times (1 - i)}$$

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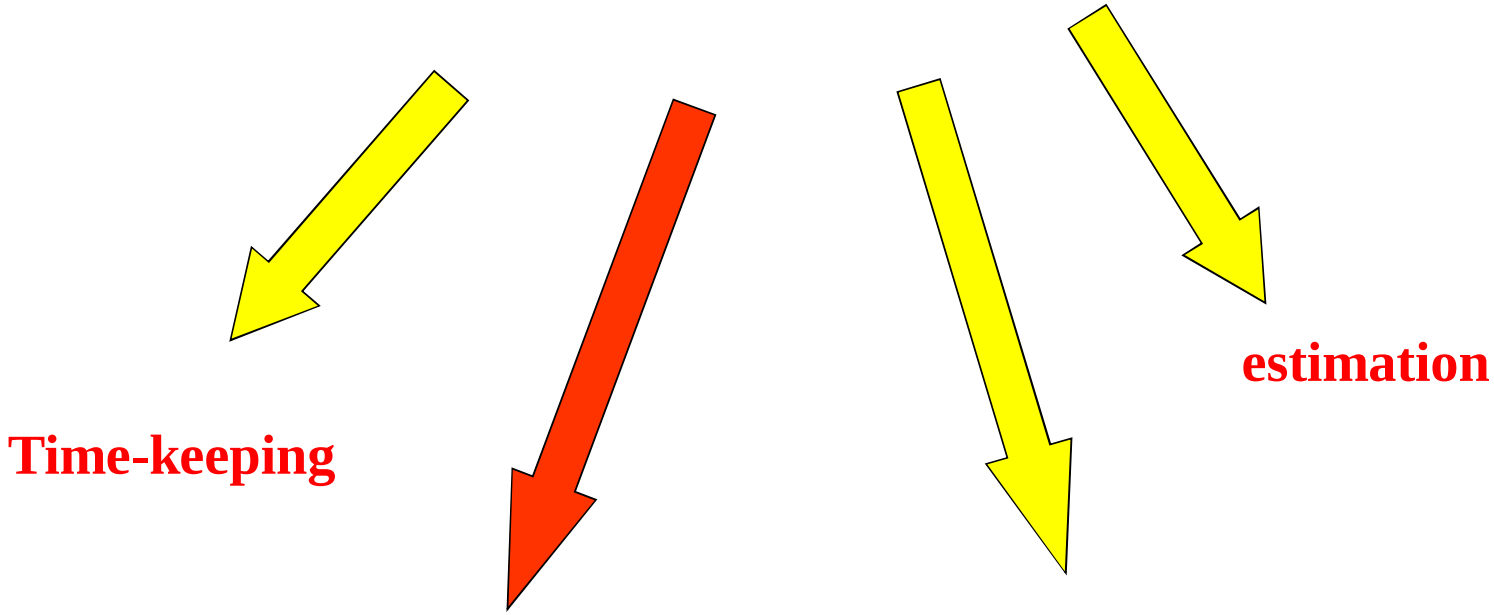
WAYS TO DEFINE THE LABOUR TIMES



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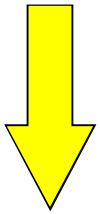
LABOUE TIMES

MICRO-MOVEMENTS

FRANK & LILIAN GILBRETH (1920)



THERBLIGS: 17 ELEMENTARY MOVEMENTS

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THERBLIGS

1) Movements allowing an efficient work:

Prendere	Grasp	G
Sostenere	Hold	H
Lasciare	Release Load	RL
Accoppiare	Assemble	A
Usare	Use	U
Disaccoppiare	Disassemble	DA
Posizionare	Position	P
Esaminare	Inspect	I

2) Movements limiting an efficient work:

Raggiungere	Transport Empty	TE
Trasportare	Transport Load	TL
Cercare	Search	Sh
Scegliere	Select	St
Preposizionare	Preposition	PP
Decidere	Plan	Pn

3) Movements that are not generating any work:

Riposo per affaticamento	Rest	R
Attesa evitabile	Avoidable delay	AD
Attesa non evitabile	Unavoidable delay	UD

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METHODS TIME MEASUREMENT - MTM

- Maynard, Stegermertens e Schwab,
- Westinghouse 1940 - 1948
- MTM 1
- MTM 2
- MTM 3

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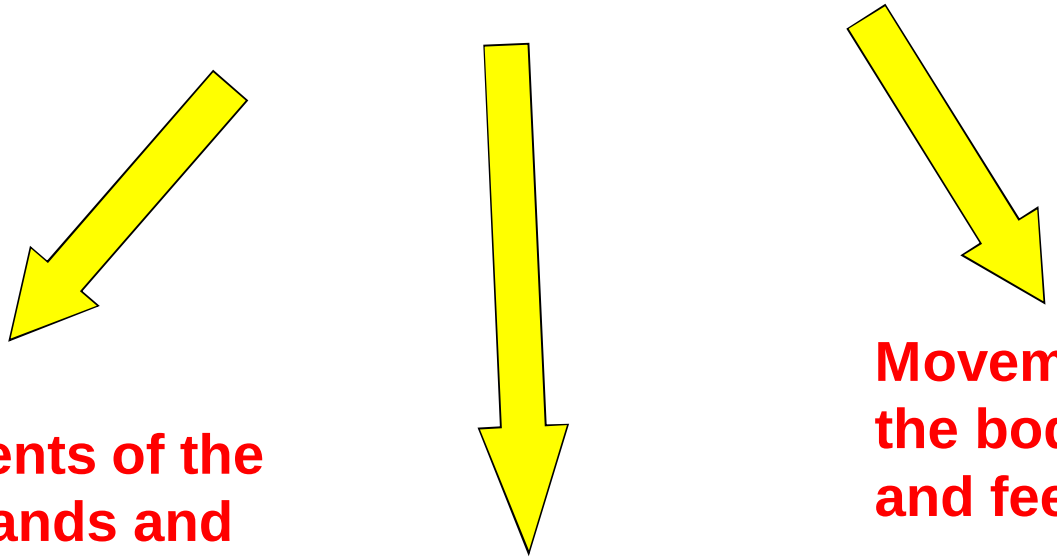
M T M 1



Movements of the arms, hands and fingers

Movements of the eyes

Movements of the body, legs and feet

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M T M 1

1) Movements of the arms, hands and fingers

Movements	symbol	meaning
Raggiungere	R	Reach
Muovere	M	Move
Ruotare	T	Turn
Girare volantino	C	Crank
Applicare Press.	AP	Apply pressure
Prendere	G	Grasp

2) Movements of the eyes:

Movements	symbol	meaning
Fissare lo sguardo	EF	Eye focus
Muovere gli occhi	ET	Eye turn

3) Movements of the body, legs and feet:

Movements	symbol	meaning
Muovere il piede	FM	foot motion
Muovere la gamba	LM	leg motion
Passo laterale	SS	side step
Ruotare il corpo	TB	turn body
Abbasssarsi	B	Bend
Inginocchiarsi	K	Kneel
Sedersi	SIT	Sit
Alzarsi da seduto	STD	Stand
Camminare	W	Walk

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MTM Units

1 TMU = 1/100.000 h
= 6/10.000 minute
= 36/1000 second
= 0.06 hundredth of minute

100.000 TMU	to have	1 hour
1.666 TMU	to have	1 minute
28 TMU	to have	1 second
16.7 TMU	to have	1 hundredth of minute

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MTM 1 - R

Distance Moved (in.)	Time TMU				Wt. Allowance			Case and Description
	A	B	C	Hand in Motion B	Wt. (lb) Up to	Dynamic Factor	Static Constant (TMU)	
¾ or less	2.0	2.0	2.0	1.7				
1	2.5	2.9	3.4	2.3	2.5	1.00	0	
2	3.6	4.6	5.2	2.9				
3	4.9	5.7	6.7	3.6	7.5	1.06	2.2	A Move object to other hand or against stop.
4	6.1	6.9	8.0	4.3				
5	7.3	8.0	9.2	5.0	12.5	1.11	3.9	
6	8.1	8.9	10.3	5.7				
7	8.9	9.7	11.1	6.5	17.5	1.17	5.6	
8	9.7	10.6	11.8	7.2				
9	10.5	11.5	12.7	7.9	22.5	1.22	7.4	
10	11.3	12.2	13.5	8.6				B Move object to approximate or indefinite location.
12	12.9	13.4	15.2	10.0	27.5	1.28	9.1	
14	14.4	14.6	16.9	11.4				
16	16.0	15.8	18.7	12.8	32.5	1.33	10.8	
18	17.6	17.0	20.4	14.2				
20	19.2	18.2	22.1	15.6	37.5	1.39	12.5	
22	20.8	19.4	23.8	17.0				
24	22.4	20.6	25.5	18.4	42.5	1.44	14.3	C Move object to exact location.
26	24.0	21.8	27.3	19.8				
28	25.5	23.1	29.0	21.2	47.5	1.50	16.0	
30	27.1	24.3	30.7	22.7				
Additional	0.8	0.6	0.85		TMU per inch over 30 inches			

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MTM 1

Left hand description	F	Left hand movement	TMU	Right hand movement	F	Right hand description
SCREW 2 BOLTS						
Reach the bolt		R24C	12.5	R24C		Reach the bolt
Grasp		G4B	9.1	-		
		-	9.1	G4B		Grasp
Bolt to assembly		M24C	13.0	M24C		Bolt to assembly
Position 1st bolt		P2SE	16.2	-		
Search thread	2	M2B	4.0	-		
		-	16.2	P2SE		Position 1st bolt
		-	4.0	M2B	2	Search thread
Release		RL1	2.0	RL1		Release
fastening cycle	8	R2A	16.0	R2A	8	fastening cycle
	8	G1A	16.0	G1A	8	
	8	M2B	16.0	M2B	8	
	8	RL1	16.0	RL1	8	
		Total	**150.1**			
TIGHTEN 2 BOLTS WITH A WRENCH						
Reach the assembly		R-A	12.8	R30B		Reach the wrench
Grasp		G1A	3.5	G1B		Grasp
			15.1	M30C		Wrench to assembly
			14.7	P1SSD		Position
			1.6	SC2		Static component
			10.9	M20B2		Screw
			11.7	M20C		Recovery with wrench
			14.7	P1SSD		Reposition wrench
			1.6	SC2		Static component
			9.6	M16B2		Screw
			10.6	APA		Tighten
			13.3	M30B		Recovery with wrench
			2.0	RL1		Release
		Total	**122.1**			

MTM - 2

DATI MTM SEMPLIFICATI

Movimenti delle mani e braccia

Raggiungere R e Muovere M

Distanza in cm.	TMU
< 5	4
5	5
10	7
15	9
20	11
25	13
30	15
35	17
40	19
45	21
50	23
60	27
70	31
80	35

Maggiorazione per peso:
> 2 Kg. = 1 TMU/Kg.
Formule per R o M:
Tipo 1 t = 3 + 0,4 L
Tipo 2 o 3 t = 0,4 L
L = Lunghezza del movimento

Ruotare T - Appl. Press. AP

	TMU
T	8
AP	15

Afferrare G - Rilasciare RL

Gf - facile	3
Gr - riafferrare	6
Gd - difficile	10
RL	2

Posizionare P

P1S	10
P2S	20
P3S	50
P1NS	15
P2NS	25
P3NS	55

Disaccoppiare D

D1	5
D2	10
D3	30

Occhio - Piede - Gamba Movimenti del corpo

	TMU
E	10
FM	10
FMP	20
LM	10
SS1	20
SS2	40
TB1	20
TB2	45
B, S, KOK	35
AB, AS, AKOK	35
KBK	90
SIT	40
STD	50
W-P	17

R	M	T	AP	G	RL	P	D	Movimento
	×		×	×		×	×	R
			×	×		×	×	M
							×	T
				■		■		AP
				×		■	■	G
								RL
						■	■	P
								D

☐ Sempre facile

☒ Con allenamento

■ Difficile assegnare entrambi i tempi

1 TMU = 0,00001 ora
= 0,0006 minuti
= 0,036 secondi
= 0,06 centesimi di minuto

Occorrono: 100.000 TMU per fare 1 ora
Circa 1.666 TMU per fare 1 minuto
" 28 TMU per fare 1 secondo
" 16,7 TMU per fare 1 centes. di minuto

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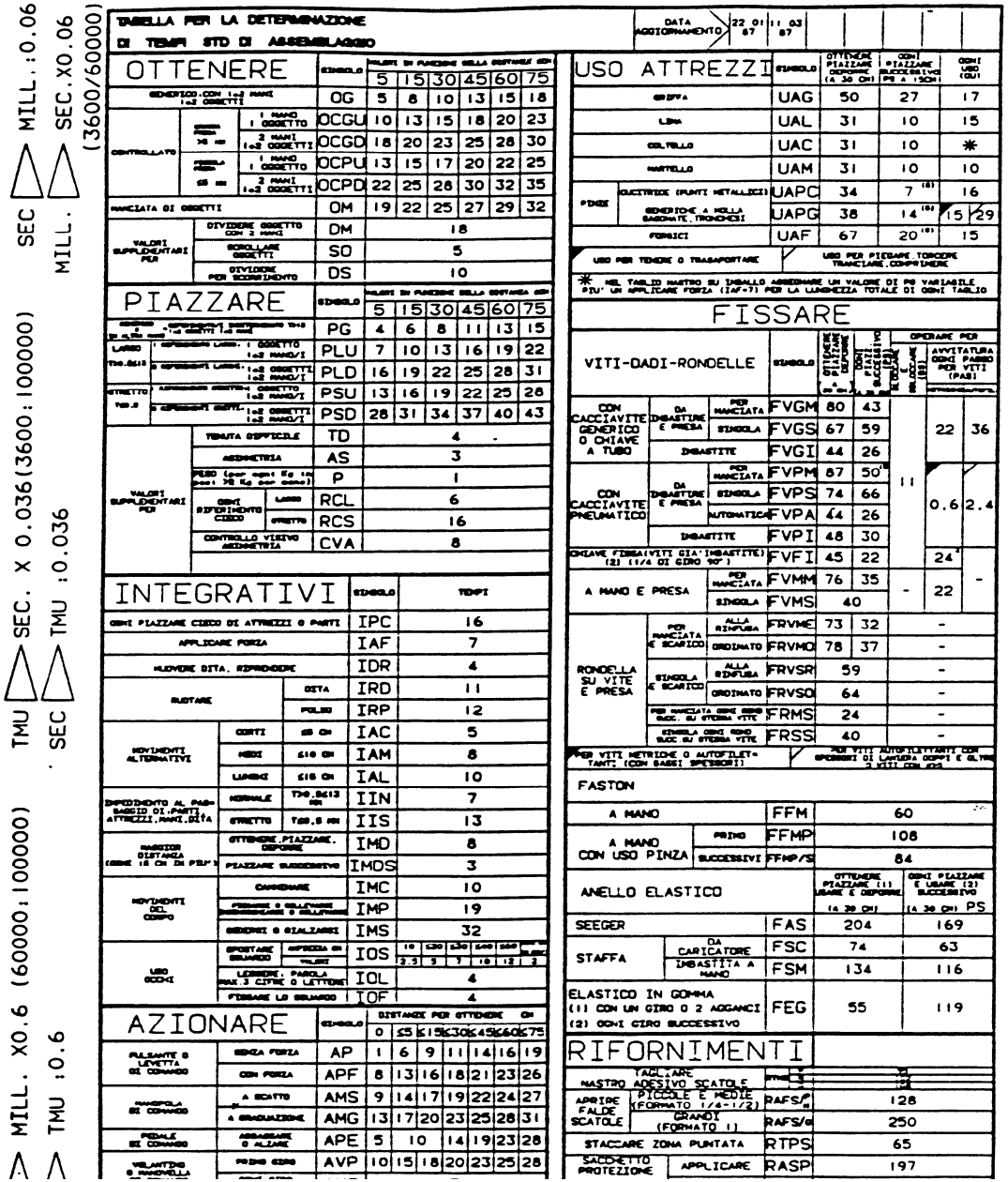
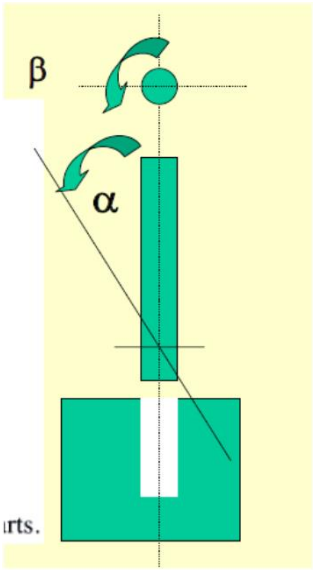
MTM - 3

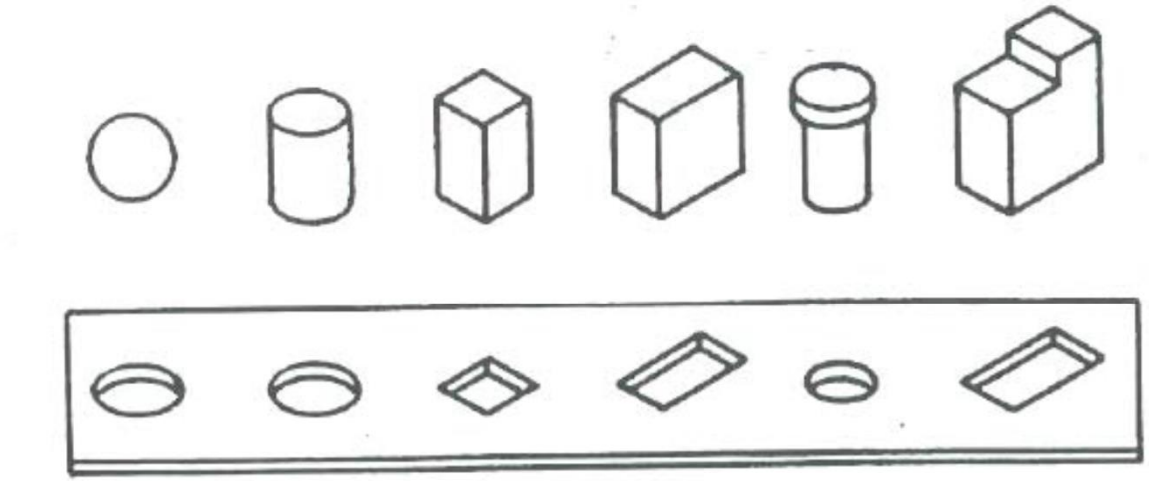


Materiale riservato
Raffaele Campanella

BOOTHROYD-DEWHURST METHOD



Experience shows there are two distinct operations in this:
1. Alignment of the axis of the part that corresponds to the axis of insertion
- called alpha rotation, Ŭ.
2. Rotation of the part about its axis of insertion
- called beta rotation, ƀ.



α	0	180	180	90	360	360
β	0	0	90	180	0	360

Source: Motorola

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Estimated Handling Time Table

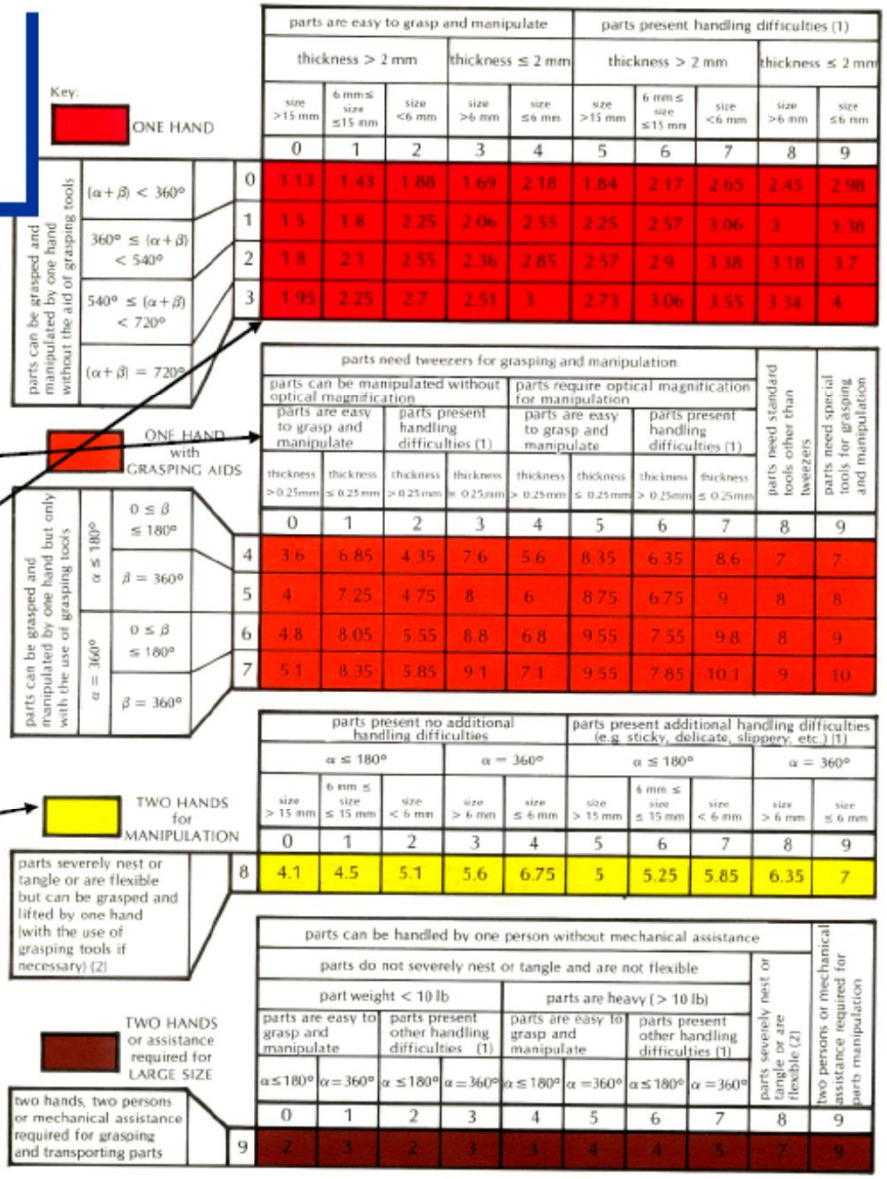
Total axis of symmetry

Size of Part

Time used later

How handled

Source: Design for Assembly, © Boothroyd & Dewhurst 1983



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Further system using predetermined labour times

MOST
Maynard Operations Sequence Technique
(Ziell Zandin -1980)

PTS ï Predetermined times system (Cegos 1990)

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MOST
Maynard Operations Sequence Technique

Activity	Sequence model	Parameter
General Move	ABG ABP A	A- Action distance
		B- Body Motion
		C - Gain control
		P - Placement
Controlled Move	ABG MXI A	M - Move controlled
		X - Process Time
		I - Aligment
Tool use	ABG ABP*ABP A	F7L - fasten/loosen
		C- cut
		S - surface treat
		M - measure
		R - Record
		T - Think

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MOST
Maynard Operations Sequence Technique

General Move. The General Move sequence is applicable when an object is moved through the air from one location to another. There are four parameters (actions) in the General Move, symbolized by letters of the alphabet:

A — Action distance, usually horizontal. This parameter is used to describe movements of the fingers, hands, or feet (e.g., walking). The movement can be per formed either loaded or unloaded.

B — Body motion, usually vertical. This parameter defines vertical body motions and actions (e.g., sitting, standing up).

G — Gain control. This parameter is used for any manual actions involving the fingers, hands, or feet to gain physical control of one or more objects. It is closely related to the grasp motion element in MTM (e.g., grasp the object).

P — Placement. The placement parameter is used to describe the action involved to lay aside, position, orient, or align an object after it has been moved to the new location (e.g., position the object).

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MOST
Maynard Operations Sequence Technique

TABLE 14.6 MOST Parameters and Index Values for the General Move Activity Sequence Model

General Move activity sequence model = **A B G A B P A**				
Index	**A** = Action distance	**B** = Body motion	**G** = Gain control	**P** = Placement
0	Close ≤ 5 cm (2 in.)			Hold, Toss
1	Within reach (but > 2 in.)		Grasp light object using one or two hands	Lay aside Loose fit
3	1 or 2 steps	Bend and arise with 50% occurrence	Grasp object that is heavy, or obstructed, or hidden, or interlocked	Adjustments, light pressure, double placement
6	3 or 4 steps	Bend and arise with 100% occurrence		Position with care, or precision, of blind, or obstructed, or heavy pressure
10	5, 6, or 7 steps	Sit or stand		
16	8, 9, or 10 steps	Through door, or Climb on or off, or Stand and bend, or Bend and sit		

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MOST
Maynard Operations Sequence Technique

Example: General Move **Develop the activity sequence model and determine the normal time for the following work activity: A worker walks 5 steps, picks up a small part from the floor, returns to his original position, and places the part on his worktable.**

Solution: Referring to Table 14.6, the indexed activity sequence model for this work activity would be the following:

$$A_{10}\ B_6\ G_1\ A_{10}\ B_0\ P_1\ A_0$$

where A_{10} = walk 5 steps, B_6 = bend and arise, G_1 = control of small part, A_{10} = walk back to original position, B_0 = no body motion, P_1 = lay aside part on table, and A_0 = no motion. The sum of the index values is 28. Multiplying by 10, we have 280 TMUs (about 17 sec).

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Analysis Time of one standard hour

PTS : **1 hour**

MOST: **5 hours**

TIME-KEEPING: **15 hours**

MTM: **40 hours**

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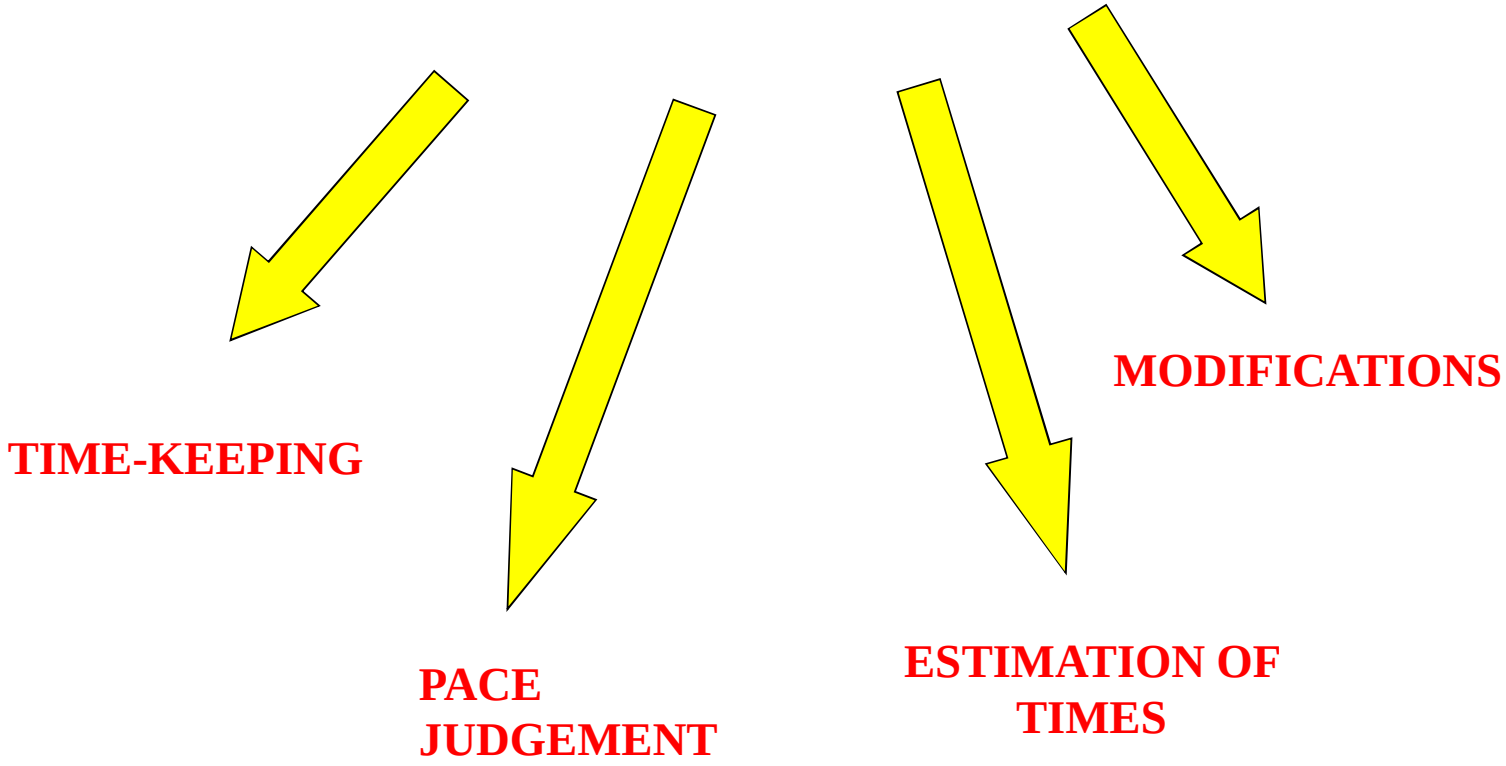
MTM - ADVANTAGES



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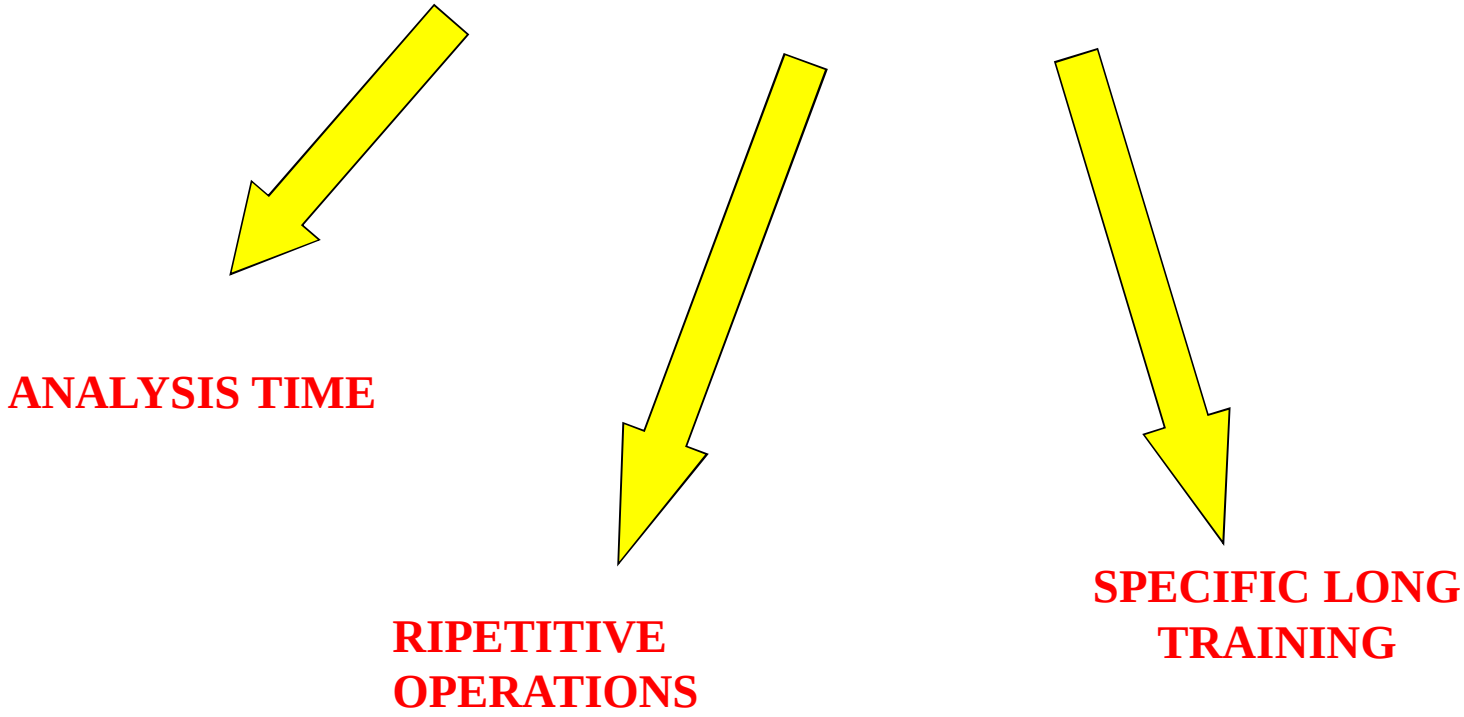
MTM - DISADVANTAGES



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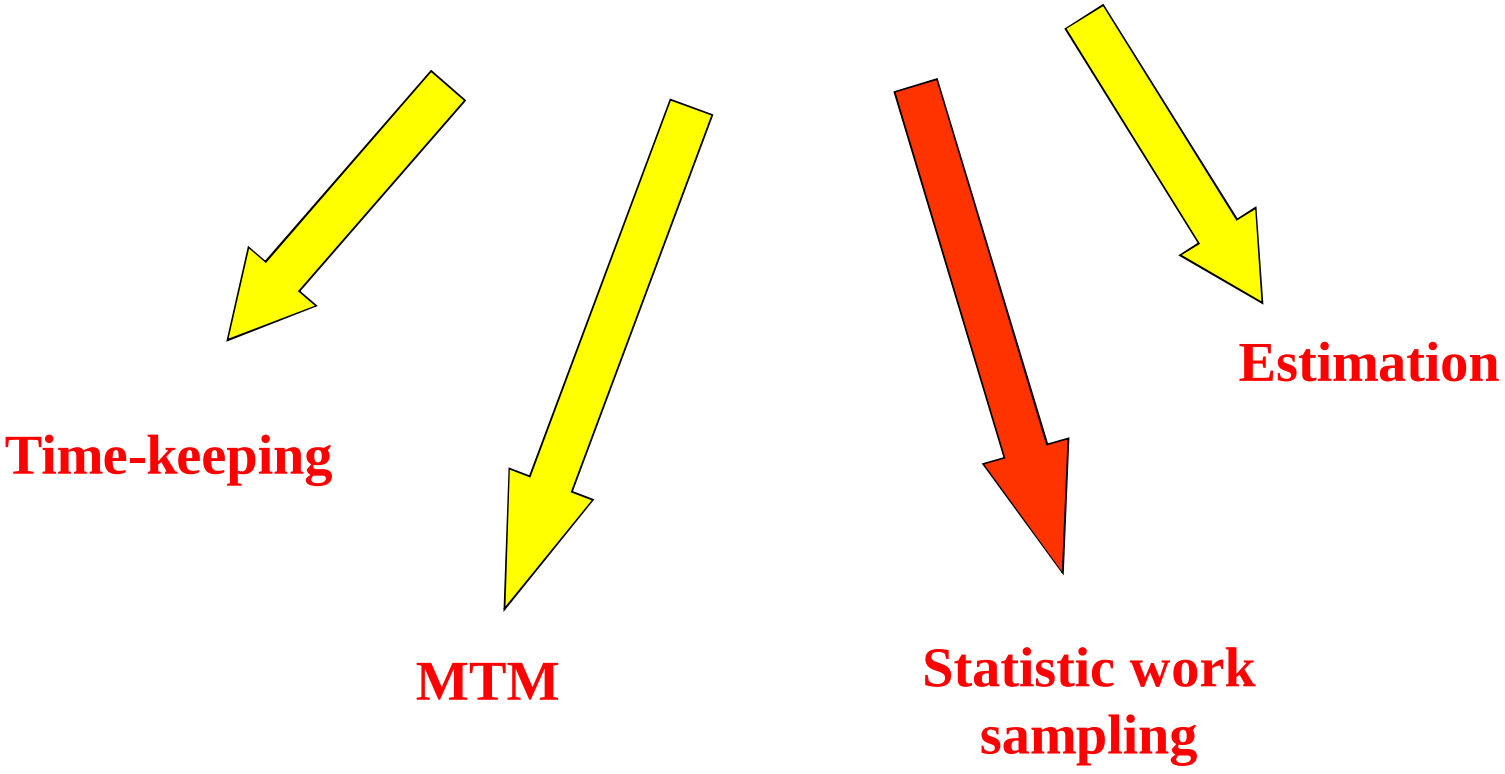
WAY TO ASSIGN LABOUR TIMES



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STATISTICAL WORK SAMPLING

- **L.H.C. Tippett**
- **1935**
- **Textile industry**

the number of observations recorded over the entire field of investigation is related to the number of observations to each work as the total time of the analysis is related to the time necessary to perform each of them.

$$N : n = T : t$$

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STATISTICAL WORK SAMPLING

- **Statistical technique for determining the proportions of time spent by subjects in various defined categories of activity**
  - **Subjects = workers – labour, machines**
  - **Categories of activity = setting up a machine, producing parts, wasted times, etc.**
- **For statistical accuracy:**
  - **Observations must be taken at random times**
  - **Period of the study must be representative of the types of activities performed by the subjects**

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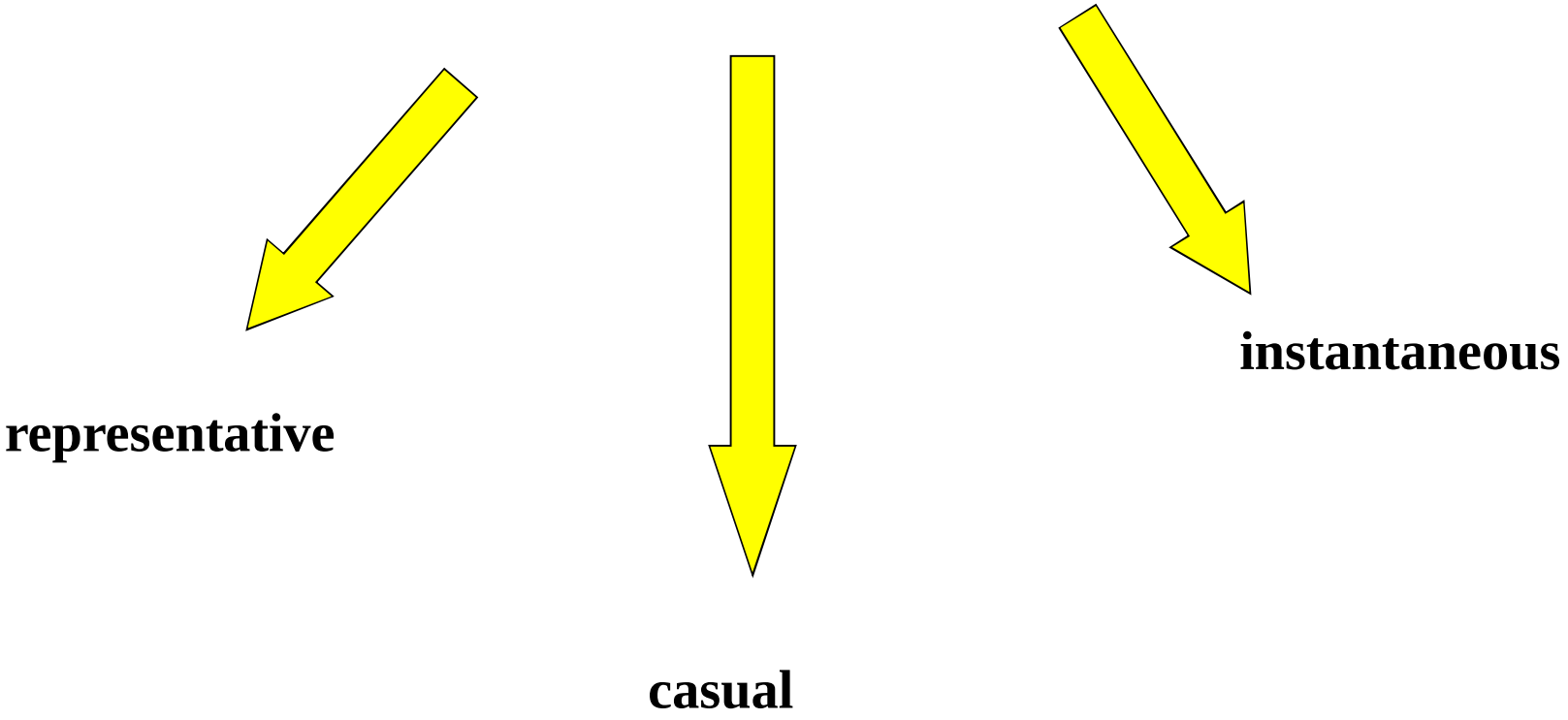
OBSERVATIONS



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WHEN IS WORK SAMPLING APPROPRIATE?

- **Sufficient time should be available to perform the study. Eg.several weeks usually required for a work sampling study**
- **Multiple subjects**
- **Long cycle times for the jobs covered by the study**
- **Non-repetitive work cycles (Jobs consist of various tasks rather than a single repetitive task)**

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Example: How Work Sampling Works?

A total of 500 observations taken at random times during a one-week period (40 hours) on 10 machines with results shown below.

Category	No. of observations
(1) set up:	75
(2) Running production:	300
(3) Machine idle:	125
TOTAL	500

How many hours per week did an average machine spend in each category?

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Example: Solution

Proportions of time determined as number of observations in each category divided by 500

Time in each category determined by multiplying proportion by total weekly hours (40 hr)

Hrs per category

(1) Set up 75/500 = 0.15	**0.15 x 40 = 6**
(2) Running production 300/500 = 0.60	**0.60 x 40 = 24**
(3) Machine idle 125/500 = 0.25	**0.25 x 40 = 10**
	1.00 40

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Work Sampling Applications

- **Machine utilization: how much time is spent by machines in various categories of activity**
- **Worker utilization: how workers spend their time**
- **Allowances for time standards**
- **Average unit time: determining an average time on each work unit**
- **Time standards: limited statistical accuracy when standards set by work sampling**

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Work sampling conditions

1. The moment and the time extention should be valid for all the observations
2. the number of observations is sufficient
3. activities are qualified clearly
4. the time between two sequential observations is not too short
5. the observer follows strictly the procedures
6. the operators under observation work in a normal way

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Procedure

1) Define the area to be investigated
2) Define how much time cumulatively you need
3) Define the categories to be studied
4) Define the statistical parameters of the sampling :
    a) max. error accepted for our categories (eg. 2%).
    b) probability which reality should statistically represented with (eg. 95,5%).
6) Calculate the number of observation
7) define the numer of observations per day
8) define the number of technicians performing the study

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Procedure

9) Prepare the report where the data will be collected
10) Inform the responsibles and the workers
11) Do some brief tests
12) Do the work sampling
15) Analyse the collected datas
16) define the direct times, the indirect times, the workers losses

73735	45963	78134	63873
02965	58303	90708	20025
98859	23851	27965	62394
33666	62570	64775	78428
81666	26440	20422	05720
15838	47174	76866	14330
89793	34378	08730	56522
78155	22466	81978	57323
16381	66207	11698	99314
75002	80827	53867	37797
99982	27601	62686	44711
84543	87442	50033	14021
77757	54043	46176	42391
80871	32792	87989	72248
30500	28220	12444	71840

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SAMPLE DIMENSION

IT DEPENDS ON THE PROBABILITY OF THE FIGURE YOU ARE LOOKING FOR.

EG.: IF THE BATCH SIZES ARE VERY BIG, THE PROBABILITY TO ASSIST TO A PRESS SET-UP IS VERY LOW.

EG.: IF THE WORKSHOP HAS TO CHANGE CODE TO BE PRODUCED EVERY 30ǫ THE PROBABILITY TO ASSIST TO A SET-UP IS VERY HIGH.

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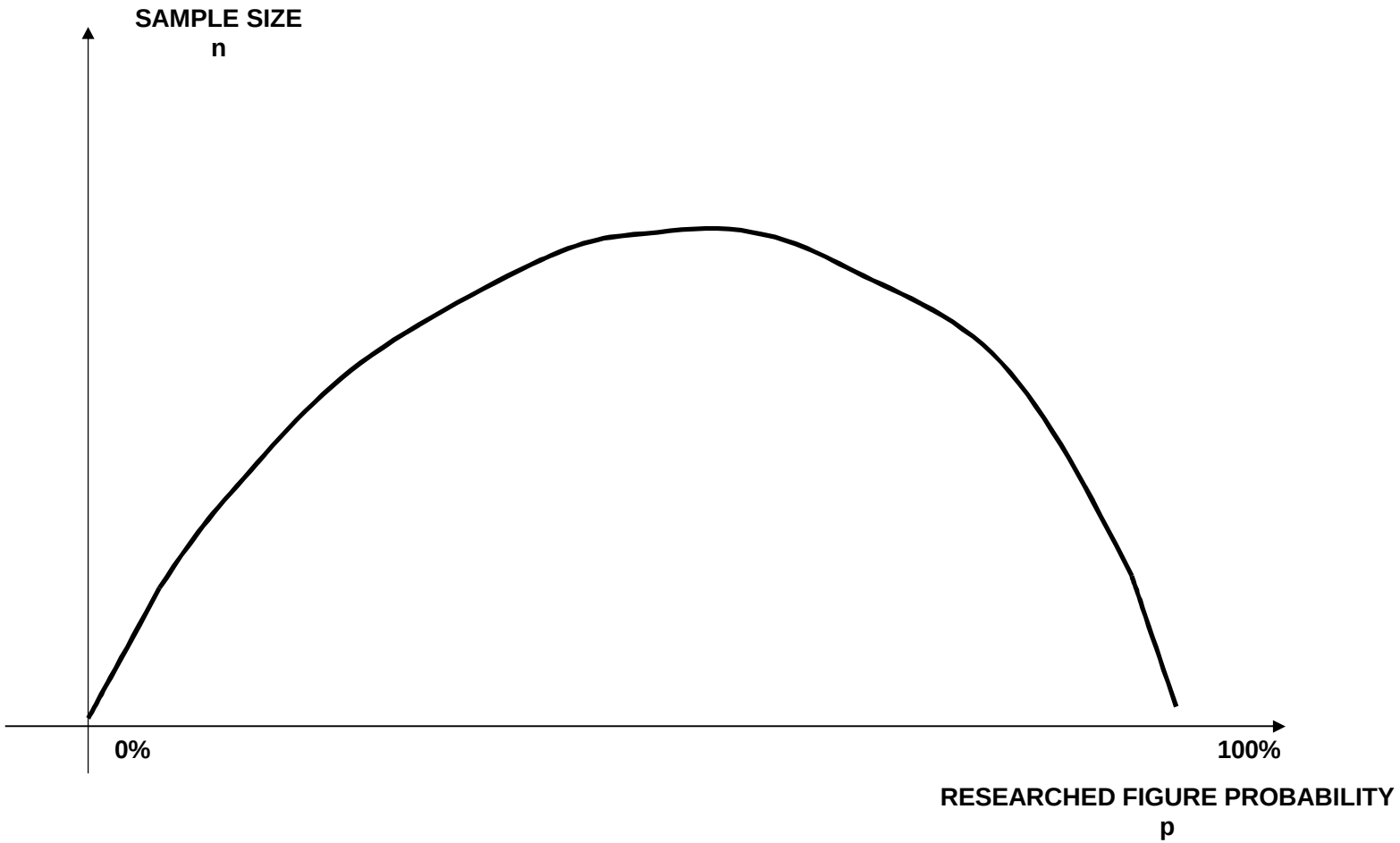
SAMPLE DIMENSION



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SAMPLE DIMENSION

$$n = \frac{a^2 * p\,(100 - p)}{Z^2}$$

a: is the confidence level that the actual value of p probability is included in the range p+/- Z

- **Åa = 1 means that there are 68% of probability that the researched figure is included in the range p+/- Z**
- **Åa = 2 means that there are 95,5% of probability that the researched figure is included in the range p+/- Z**
- **Åa = 3 means that there are 99,5% of probability that the researched figure is included in the range p+/- Z**

Z = relative error accepted for the phenomenon knowledge
p = percentage of the phenomenon to be studied
n = number of observations

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SAMPLE DIMENSION

$$n = \frac{a^2 * p\,(100 - p)}{Z^2}$$

p%	25
a	2
Z%	2
n	1875

p%	25
a	2
Z%	5
n	300

p%	20
a	2
Z%	10
n	64

p%	10
a	2
Z%	15
n	16

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Date	**Work Sampling Data Collection Form**											Page of
Period of Study							Activity Category (AC)					
Observer							1. Keypunch			5. Walking		
Department							2. Writing			6. Conversation		
Notes:							3. Filing			7. Personal		
							4. Telephone			8. Away		
	Subjects											
Observation Date and Time	Smith		Jones		Wang		Schneider		Kim		Kowalski	
	AC	PR	AC	PR	AC	PR	AC	PR	AC	PR	AC	PR

Key: AC = activity category, PR = performance rating.

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Example

	CAMPIONAMENTO STATISTICO DEL LAVORO Foglio raccolta dati	Data: Ora inizio: Ora fine:		Macchina: Saldatrice Ore tot. pres.: 8		Caso: 1 Turno: primo	
	MACCHINA O POSTO DI LAVORO	1	2	3	4	5	Oss.
	OPERATORE	A	B	C	D	E	Totali
TEMPI DIRETTI PRODUTTIVI	Deporre i pezzi da banco a contenitore						12
	Riforn. Pezzi da contenitore a banco						12
	prendere e posizionare pezzo in attrezzo						22
	Smontare pezzo da attrezzo e deporre						19
	Puntare						
	Saldare continuo						58
	Lavori manuali diversi						35
	Attesa durante TM						28
	Attività durante TM						23
	Pulire pezzi						9
	SOMMA TEMPI DIRETTI PRODUTTIVI	36	45	44	43	50	218
TEMPI PREPARAZIONE	Tempi diretti						11
	Tempi perduti necessari						12
	Attese diverse						13
	Tempi perduti personali e diversi						19
	SOMMA TEMPI PREPARAZIONE	12	9	13	10	11	55
TEMPI PERDUTI NECESSARI	Affilatura e sostituzione utensili						8
	Cambio contenitore						8
	Attese per cambio contenitori						17
	Trasporto materiali						4
	Ricerca materiali e contenitori						4
	Attesa per rifornimento materiali						11
	Dare, ricevere istruzioni...						
	Ricerca attrezzature e utensili						3
	Pulizia posti di lavoro						9
	Controlli dimensionali e visivi						
	Registrazioni scritte						2
	Spostamento a vuoto						8
	SOMMA TEMPI PERDUTI NECESSARI	15	16	13	19	11	74
TEMPI PERDUTI PERSONALI	Inattività personali varie						3
	Necessità fisiologiche						15
	Inizio ritardato/fine anticipata						7
	SOMMA TEMPI PERDUTI PERSONALI	9	5	5	3	3	25
	Operatore fuori reparto						3
TOTALE		75	75	75	75	75	375
	Giudizio del passo di lavoro	60 70	80 90	100 110	120 130	140 150	
Note							

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Esempio

	SEGRETERIA COMMERCIALE	A	B	C	D	E	F	G	TOTALE
Lavori specifici della funzione	Controllo fatture Segr. Commerc.								30
	Controllo fatture Vendite Industr..								21
	Controllo ordini Segr. Commerc.								20
	Controllo ordini Vendite Industr..								13
	Registrazione fatture-ordini								24
	Archiviazione fatture-ordini								13
	Pratiche di addebito								23
	Pratiche di accredito								42
Lavori vari	Versamento IVA								103
	Archiviazione bolle di consegna								57
	Attività varie di commessa								53
Tempi perduti necessari	Dare-ricevere istruzioni								116
	Dare-ricevere aiuto/assistenza								116
	Personali								139
TOTALE		110	110	110	110	110	110	110	770

Caso: 1

Analista:

CAMPIONAMENTO STATISTICO DEL LAVORO

Foglio raccolta dati

Data:

Ora inizio :

Ora fine:

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Example

Data		15/1	16/1	17/1	18/1	19/1	22/1	23/1	24/1		totali	Al 95%			
Ore parziali di presenza		48	48	48	48	48	48	48	48						
Ore progress. di presenza		48	96	144	192	240	288	336	384			p	+/- Z	+/- Y	
Tempi diretti	Oss. parz.	169	218	195	238	176	182	184	187						
	Oss. progress	169	387	582	820	996	1178	1362	1549	a	1549	62,6	1,9	3,0	
Tempi prepar. Lavor.	Oss. parz.	89	0	0	0	0	0	0	0						
	Oss. progress	89	89	89	89	89	89	89	89	b	89	3,6	0,8	2,2	
Tempi perduti necessari	Oss. parz.	46	74	78	87	86	48	94	51						
	Oss. progress	46	120	198	285	371	419	513	564	c	564	22,8	1,7	7,5	
Tempi personali	Oss. parz.	8	5	40	27	21	7	20	2						
	Oss. progress	8	13	53	80	101	108	128	130	d	130	5,3	0,9	17,3	
Tempi perduti non necess.	Oss. parz.	6	3	0	0	0	0	0	0						
	Oss. progress	6	9	9	9	9	9	9	9	e	9	0,4	0,1	33,3	
Operatore ad altro centro	Oss. parz.	0	0	47	8	17	63	0	0						
	Oss. progress	0	0	47	55	72	135	135	135	f	135	5,5	1,0	18,2	
N° Osserv. totali	PARZIALI	318	300	360	360	300	300	298	240						
	PROGRESSIVI	318	618	978	1338	1638	1938	2236	2476	TOT.	2476	100,0			

Curva di stabilità

%

90

80

70

60

50

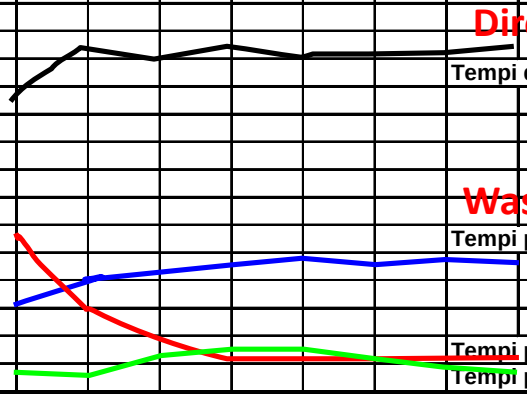
40

30

20

10

0



Note:

Data:

Campionamento statistico del Lavoro
Analisi impiego manodopera

Reparto:

Analista:

Visto:

Caso:

Centro di costo:

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Example

Data		15/1	16/1	17/1	18/1	19/1	22/1	23/1	24/1		totali	Al 95%		
Ore parziali di presenza		48	48	48	48	48	48	48	48					
Ore progress. di		48	96	144	192	240	288	336	384			p	+/- Z	+/- Y
Cambio lavorazione	Oss. parz.	89	0	0	0	0	0	0	0					
	Oss. prog	89	89	89	89	89	89	89	89	a	89	3,6	0,8	22,2
Attesa servomezzi e materiali	Oss. parz.	0	0	0	0	0	0	0	0					
	Oss. prog	0	0	0	0	0	0	0	0					
Riparazioni	Oss. parz.	0	0	0	0	0	0	0	0					
	Oss. prog	0	0	0	0	0	0	0	0					
Inattività diverse	Oss. parz.	60	82	165	122	124	118	114	53					
	Oss. prog	60	142	307	429	553	671	785	838	b	838	33,8	1,9	5,6
Macchina inattiva	Oss. parz.	149	82	165	122	124	118	114	53					
	Oss. prog	149	231	396	518	642	760	874	927	c	927	37,4	1,8	4,8
Macchina attiva	Oss. parz.	169	218	195	238	176	182	184	187					
	Oss. prog	169	387	582	820	996	1178	1362	1549	d	1549	62,6	2,0	3,2
N° Osserv. totali	PARZIALI	318	300	360	360	300	300	298	240					
	PROGRES	318	618	978	1338	1638	1938	2236	2476	TOT.	2476	100,0		

Curva di stabilità

%

90

80

70

60

50

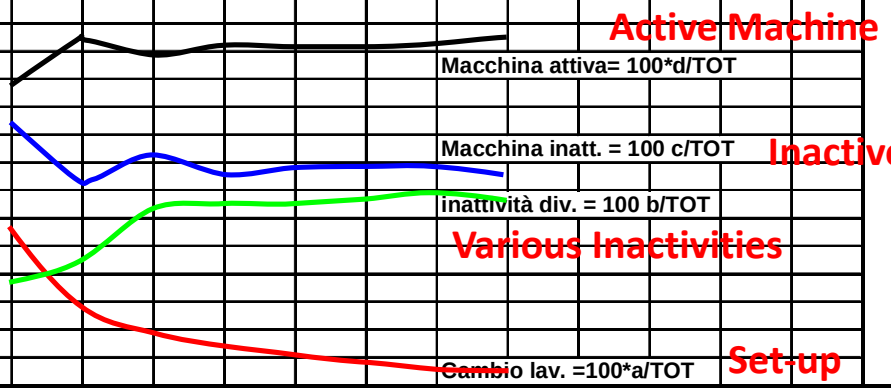
40

30

20

10

0



Note:

Data:

Campionamento statistico del Lavoro
Analisi impiego macchina

Reparto:

Analista:

Visto:

Centro di costo:

Caso:

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STATISTICAL WORK SAMPLING

ADVANTAGES

Can be used to measure activities that are very difficult to measure by direct observation

ÅMultiple subjects can be studied in the same time

ÅRequires less time and lower cost than continuous direct Observation

ÅTraining requirements less than Time keeping and MTM

ÅLess tiresome and tedious on observer than continuous Observation

ÅFewer mistakes than short-run observations

ÅBeing a subject in work sampling is more acceptable than being watched continuously for a long time

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STATISTICAL WORK SAMPLING
DISADVANTAGES & LIMITATIONS

- **Not as accurate for setting time standards as other work measurement techniques**
- **Work sampling provides less detailed information about work elements than TK and MTM**
- **Not proper to set standards for incentive pay systems**
- **Usually not practical to study a single subject doing repetitive work**
- **Since work sampling deals with multiple subjects, individual differences will be missed**
- **Workers may be suspicious because they do not understand the statistical basis of work sampling**
- **Behavior of subjects may be influenced by the act of observing them**

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LESSON LEARNT

- LABOUR TIMES HAVE TO BE MEASURED
- ALL THE WORK TYPES CAN BE MEASURED
- THERE ARE MANY METHODS TO MEASURE LABOUR TIMES
- THEY ARE SUITABLE TO THE DIFFERENT SITUATIONS

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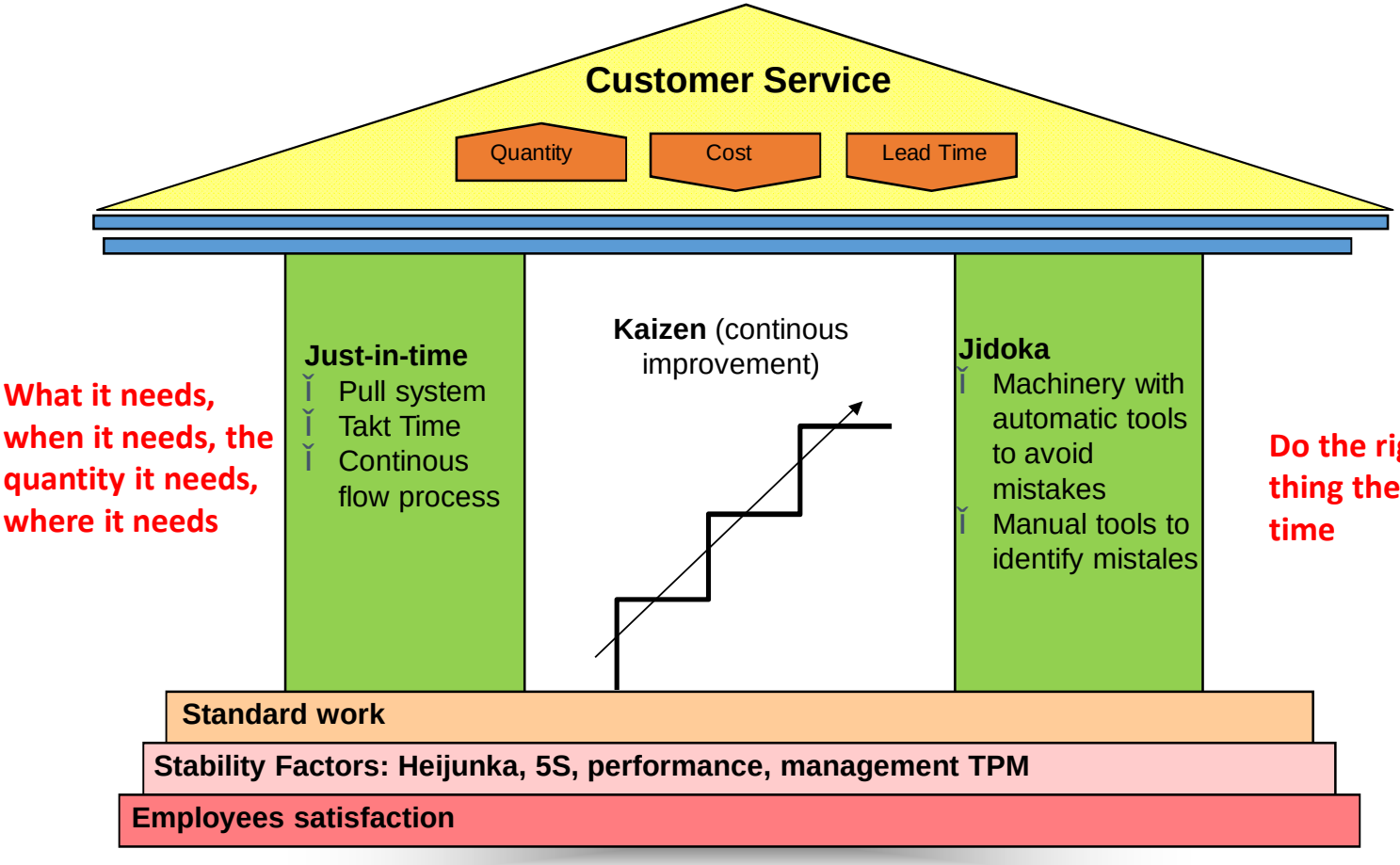
ñToyota Production Systemò



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

Do the right thing the first time

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TECHNIQUES AND TOOLS					7 TOOLS	CORRELATION
						PARETO'S DIAGRAM
						ISTOGRAMS
						CONTROL CHARTS
						ISHIKAWA DIAGRAM
					ONE POINT LESSON	
					A3	5 WHYS
					KEY PERFORMANCE INDICATORS	
					5 S	
				YAMAZUMI	ANDON	FLAS
				TAKT TIME	VISUAL MANAGEMENT	GRO
			ERGONOMY	KANBAN	STANDARDIZATION	EMP
			TPM	KAIKAKU	PDCA	IN
			SMED	JIT	POKAYOKE	AGR
	QUALITY FUNCTION DEPLOYMENT	SPAGHETTI CHART	OEE	HEIJUNKA	KAIZEN	INFO
	WASTES	LABOUR TIMES STUDY	ONE PIECE FLOW	FROM PUSH TO PULL	SIX SIGMA	COM
	HOSHIN KANRI	CURRENT VSM	FUTURE VSM	PULL	JIDOKA	MOT RESE
PRINCIPLES	DEFINE THE	IDENTIFY THE	SET UP FLOW	MANUFACTURE PULLING THE		ATTE