



**UNIVERSITÀ
DEGLI STUDI
DI TRIESTE**

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INDUSTRIAL PLANTS II

Chapter one ó part 1:

Lean manufacturing

DOUBLE DEGREE MASTER IN

öPRODUCTION ENGINEERING AND MANAGEMENTö

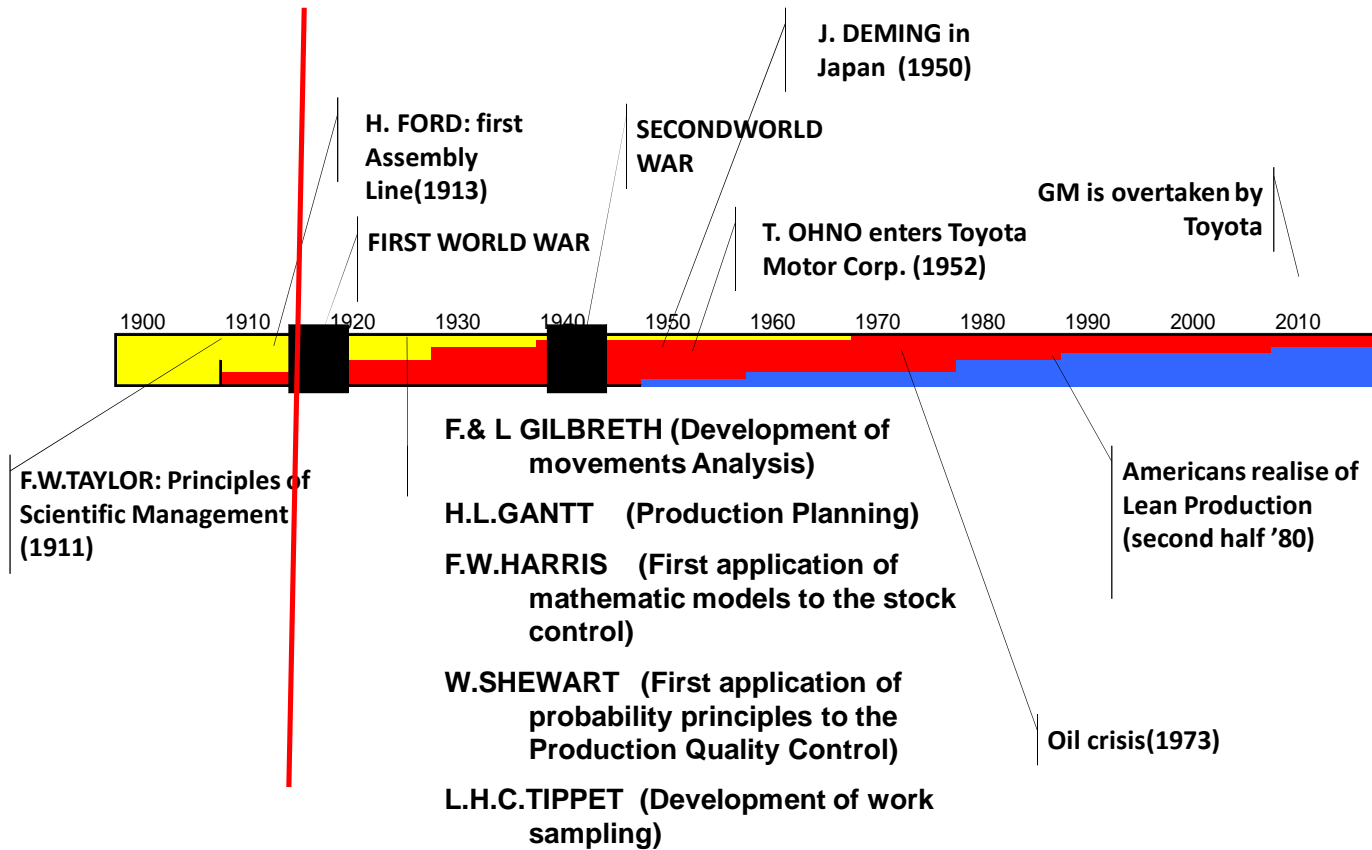
CAMPUS OF PORDENONE

UNIVERSITY OF TRIESTE

A. Y. 2021 - 2022

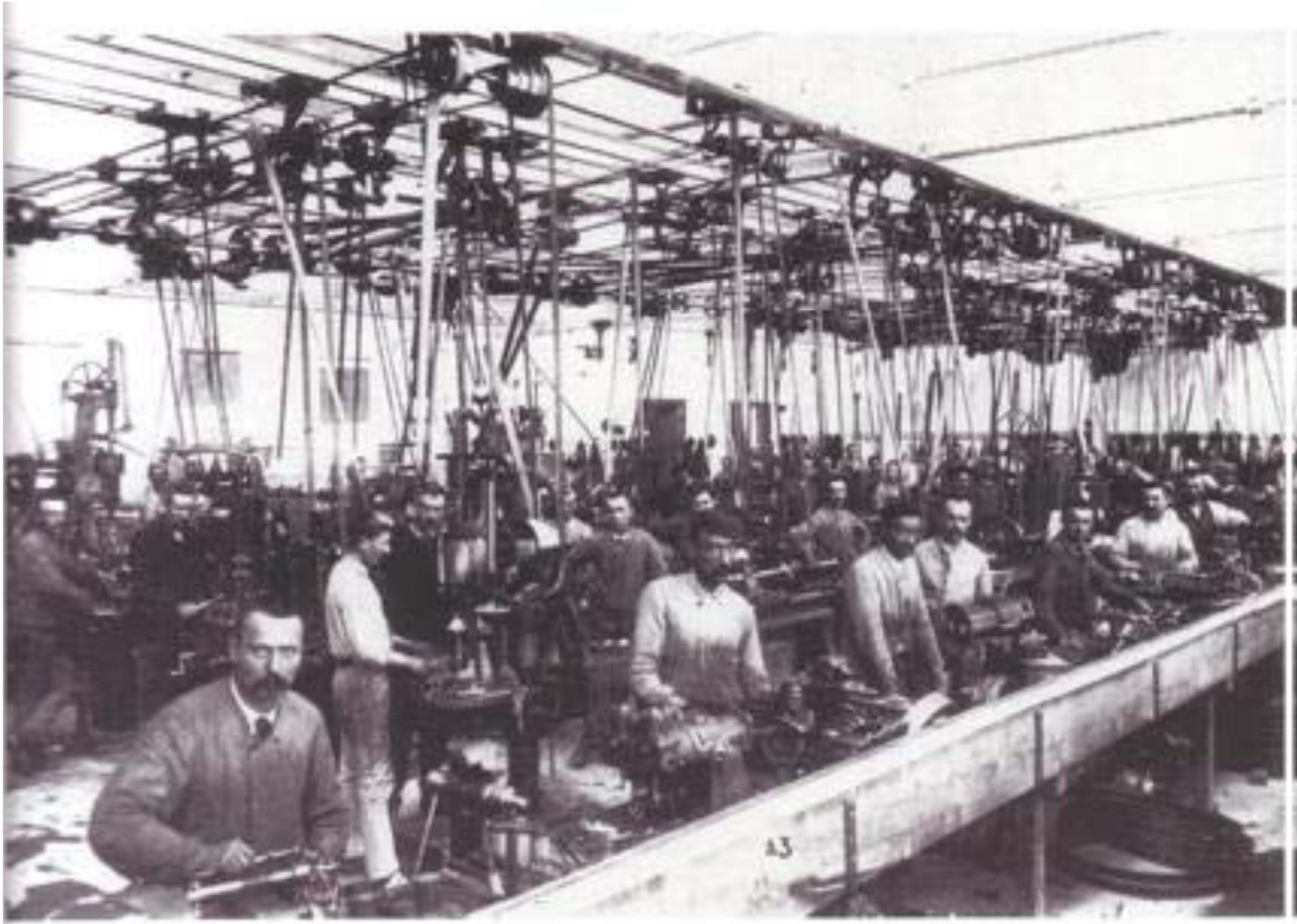


PRODUCTION PHILOSOPHY EVOLUTION





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Materiale riservato
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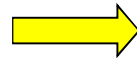
FREDERICK W. TAYLOR

THE CHANGE

**Methods and
tools chosen by
the workers**

**Lack of knowledge
for product cost
calculation**

**Worktime losses
uncontrolled**



- 1) **Rational method for each human work element (TIME AND METHODS STUDY - STANDARD)**
- 2) **Selection, training and information of the personnel on scientific basis (PERSONNEL RESPONSIBILITY)**
- 3) **Cooperation among workers and staff/managers (PERSONNEL RESPONSIBILITY)**
- 4) **Fair job division among blue collars and between blue collars and managers (TOP MANAGEMENT - FUNCTIONS)**



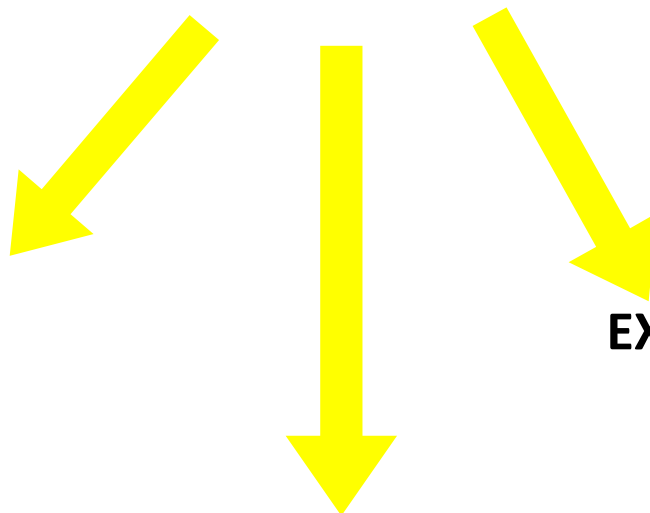
FREDERICK W. TAYLOR

PRINCIPLES

STANDARDIZATION

EXCEPTION

ONLY ONE CHIEF



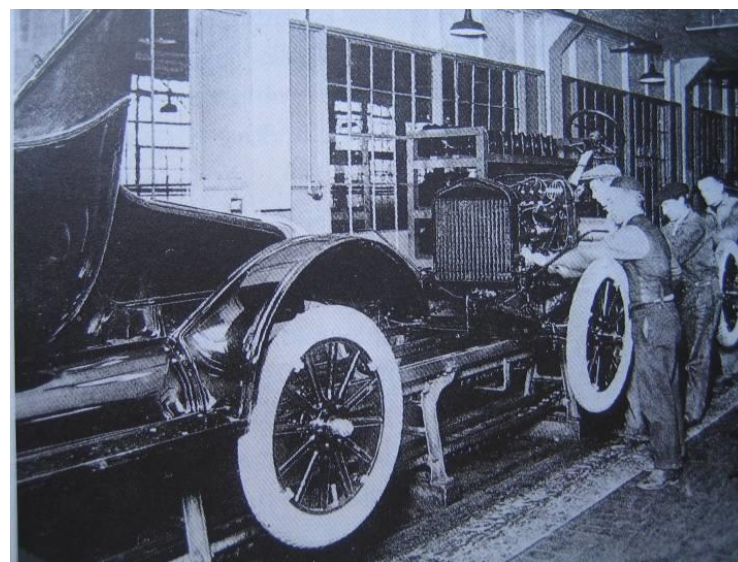


Henry Ford



1903: A Model

1908: T Model



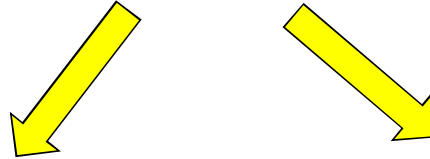


Henry Ford

Years	cars	price (\$)	notes
" 1909	10.000	825	ab. 3 months/salary
" 1910	19.000		
" 1912	78.000	575	ab. 2 months/salary
" 1914	260.000		
" 1915			manufactured the first 1.000.000
" 1921			manufactured the 5.000.000th
" 1924		290	manufactured the 10.000.000th
" 1927			end of the Model T production at a little more than 15.000.000 cars



Henry Ford



VERTICAL COMPANY

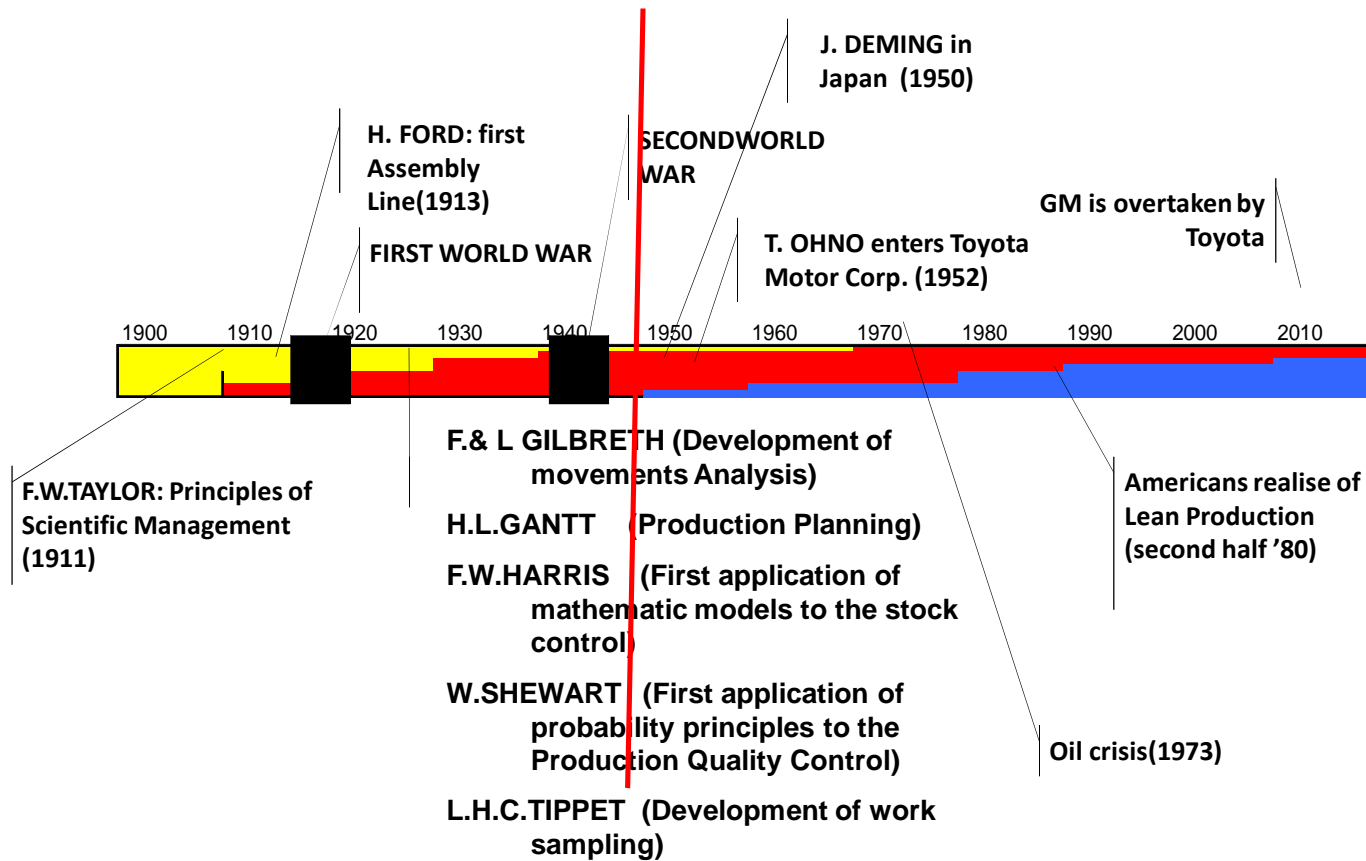
- “ Strong trust in himself
- “ Few and not specialised suppliers
- “ Quality always under control;
- “ Production capacity able to satisfy the customer requests (assembly lines)

MASS PRODUCTION

- “ High production volumes and not much diversified
- “ The flow is possible along the assembly line but not somewhere else
- “ The production process is segmented into subprocesses
- “ Difficult coordination with the Assembly lines
- “ Material stock, buffers, Wip, etc increase
- “ Difficult coordination among depts (mainly for the product development)
- “ Workers utilized only for their hands and arms (not brain)

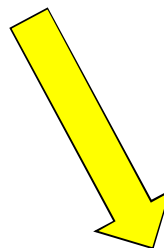
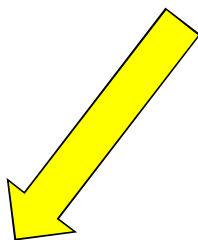


PRODUCTION PHILOSOPHY EVOLUTION





AMERICAN CAPITAL EVENTS



THE SECOND WORLD WAR

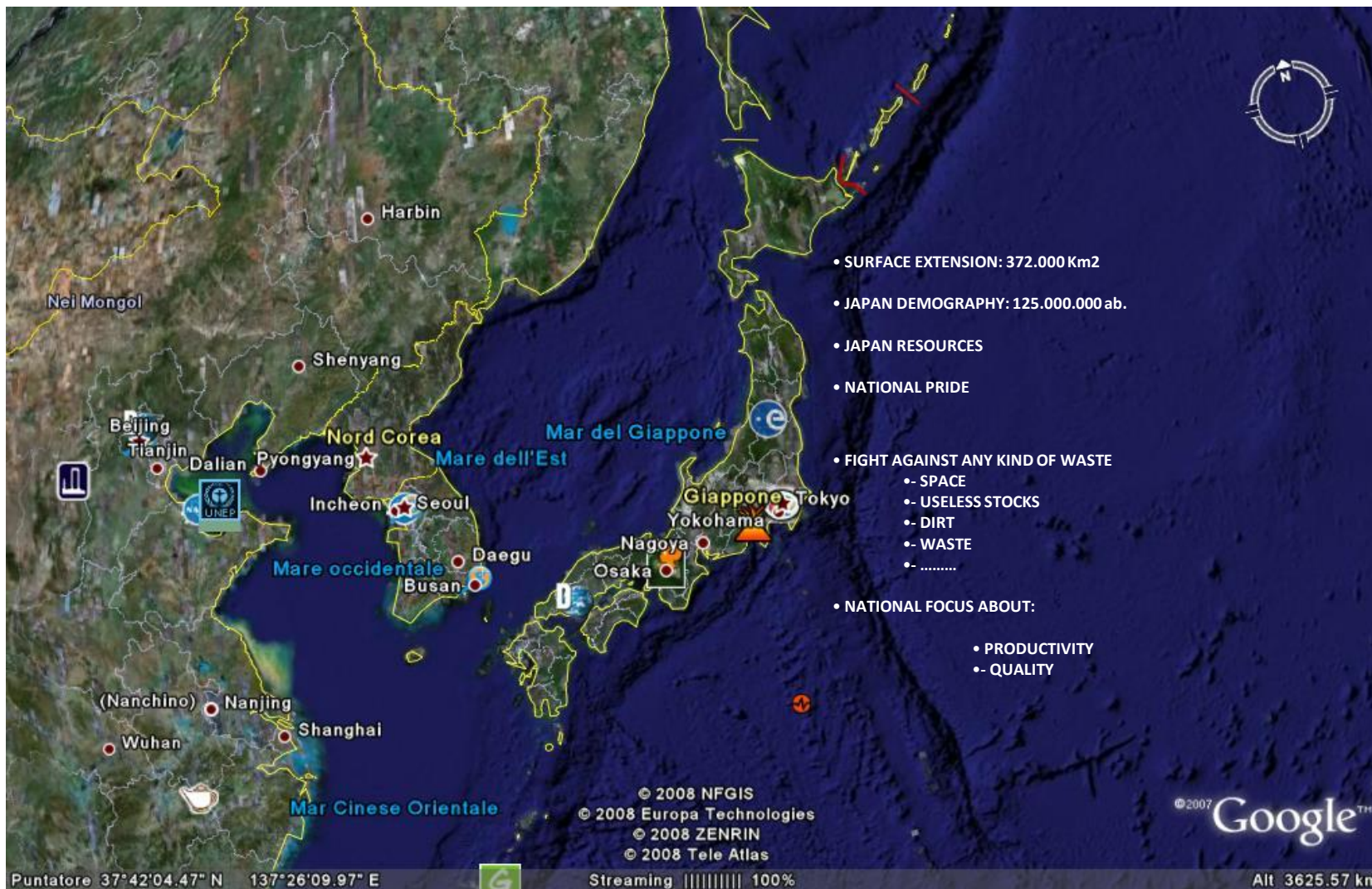
- “ Accelerated change of production process
- “ Sophisticated warfare → High production volumes
- “ Introduction of statistic control techniques
- “ Improvement of production planning
- “ Quality Control development

AFTERWAR

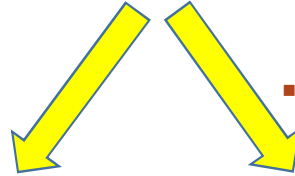
- “ Fast reconstruction
- “ Sales booming
- “ Prevalence of American methodologies (mathematical models, simulation ...)
- “ Scientific approach, rationalization, optimization
- “ Computer Era starting



JAPAN



JAPANESE CAPITAL EVENTS



- In 1945, August, Japan surrenders and close the II WW
- Taiichi Ohno moves to Toyota Motor Company (1008 car in 1949)
- Japanese market is characterised by small quantity and many models
- After 1950 (Korean war), sales volumes increase
- Japan starts using american mass production

▪ Toyota faces a big crisis due to high volumes

- . Half month they collect parts and the other half of the month they assembly
- . The PUSH system provokes high and disomogeneous stock, with a lot of time waste
- . The production system is rigid (vs the flexible request)
- . small quantity production with high mix makes stocks due to set-up time very long.
- . Overproduction increases manufacturing costs



Kiichiro Toyoda
fondatore Toyota Motor Co.



Taiichi Ohno
fondatore TPS



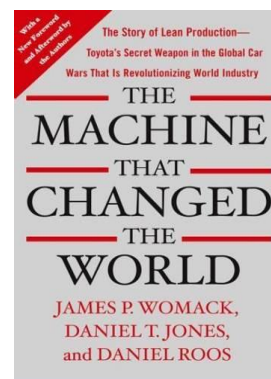
JAPANESE CAPITAL EVENTS

- “ **1952-1956: Tough years to set up the new production system (TPS)**
 - JIT
 - First application of kanban
 - Jidoka
 - standard definition
 - Kaizen implementation
- “ **Trip in the USA - SUPERMARKETS (1956)**
- “ **Full application of kanban in Toyota (1962)**
- “ **Suppliers' first involvement about kanban (1963)**
- “ **Workers full involvement (Quality Circles -Suggestions) (first years 60)**
- “ **Kaizen full implementation (ab. 60)**

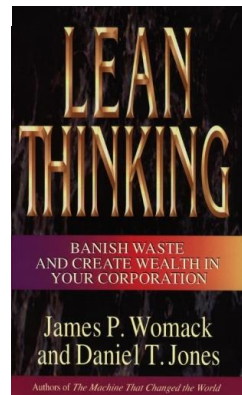


OTHER CAPITAL EVENTS

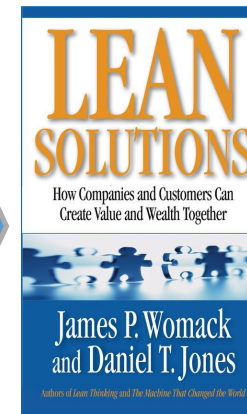
- Oil crisis in 1973
- Car Market drops
- World recession
- Zero Growth
- Toyota shows very limited losses even earnings
- Americans start understanding (1985)



1990



1996



2005



Í Japanes Production is lean because uses less resources in comparison with the mass production È half of the workforce, half of production space, half of investment for toolsÅ

Besides, TPS requires much less than half of material stock and generates much less defects Å Î

John Krafcik (First american engineer working for Toyota in the States), International Motor Vehicle Program, 1985



Rank	1950	1970	2009	2014	2017	million
1	GM	GM	Toyota	Toyota	VW	10,40
2	Ford	Ford	VW	VW	Toyota	10,16
3	Chrysler	Chrysler	GM	GM	Renault-Nissan-Mitsubishi	10,11
4	Studebaker	VW	Renault ¹	Renault-Nissan	Hyundai-Kia	7,28
5	Nash	Fiat	Hyundai	Hyundai	GM	6,87
6	Kaiser - Fra.	Toyota	Ford	Ford	Ford	6,25
7	Morris	Nissan	Honda	Fiat-Chrysler	Honda	5,35
8	Hudson	Renault	PSA	Honda	Fiat-Chrysler	4,86
9	Austin	BL	Fiat	PSA	PSA	4,16
10	Renault	Peugeot	Suzuki	Suzuki	Suzuki	3,14

D **Toyota**

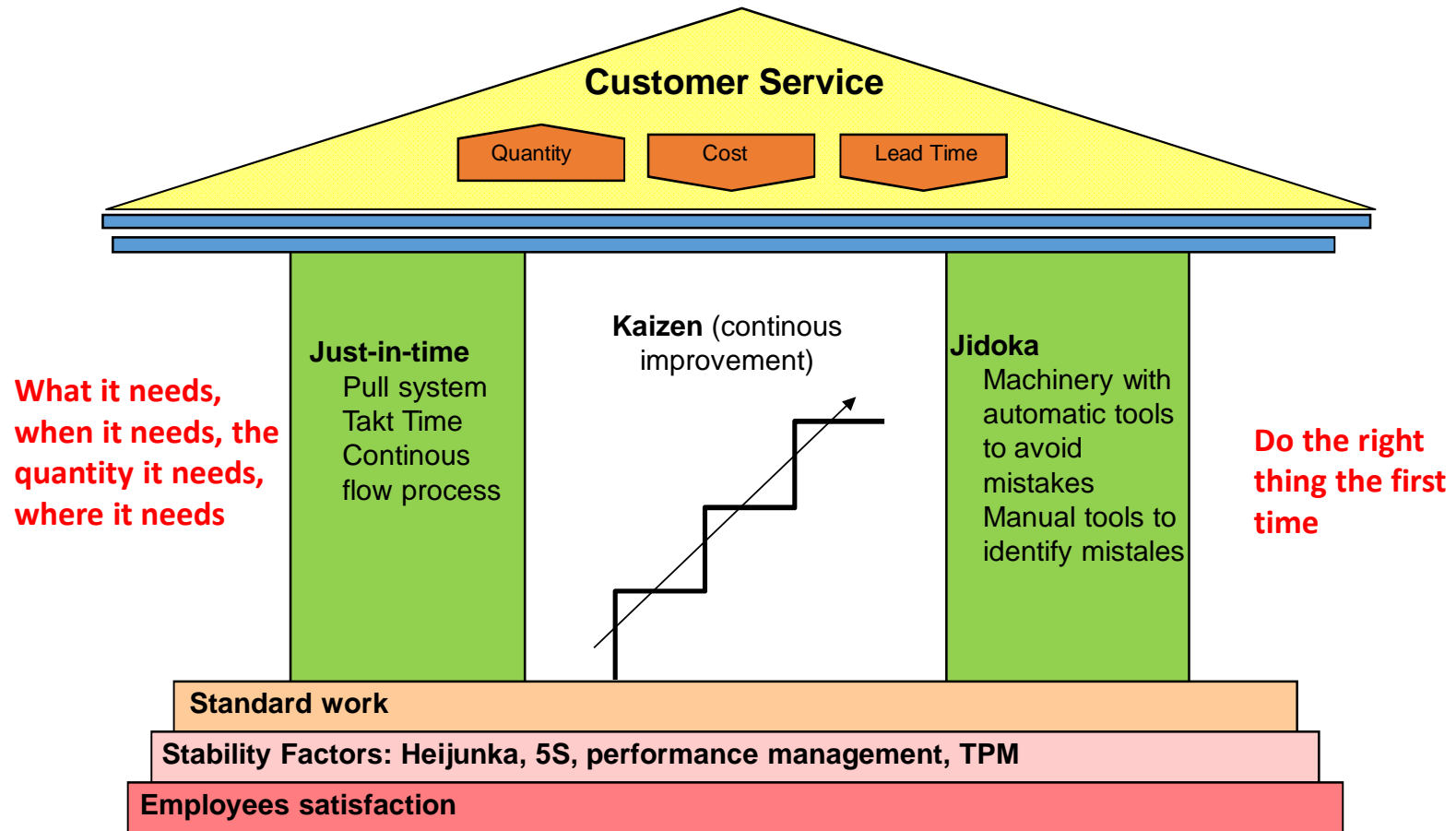


COMPARISON TABLE

	MASS PRODUCTION	LEAN PRODUCTION
MARKET	High volumes, Low variability	Low volumes, High variability
FLOW	push logic	pull logic + JIT
JOB DIVISION	Workers rigid know-how collected into categories (es: welders millers, assemblers...) Individual work	Workers flexibility towards different operations to make easy the continuous flow + kaizen Workgroups
PRODUCTION PLANNING	Local optimization, scheduling (es. economic lot, \bar{o})	Global optimization by kanban, one piece flow, \bar{o} (manufacture only what is sold)
QUALITY APPROACH	Sustainable by stocks Controlled	Jidoka + problem solving +5S+Kaizen Built-in



Il Toyota Production System





TECHNIQUES AND TOOLS				7 TOOLS	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	

THE PRINCIPLES

- “ DEFINE THE VALUE
- “ IDENTIFY THE VALUE FLOW
- “ MANUFACTURE ACCORDING TO *ípullî* SYSTEM
- “ SET UP ACTIVITIES BY *íflowî* .
- “ PURSUE THE PERFECTION

DEFINE THE VALUE

WHAT IS VALUE?

As “Value” we mean everything the Customer can see, touch, perceive, appreciate, admire...and make him/her willing to remunerate.

Everything that the Customer does not perceive is waste (muda).

DEFINE THE VALUE

Í TO GET THE UNIVERSITY CAMPUS FROM PORDENONE RAILWAY STATION

- “ TO GO WALKING
- “ TO USE A BIKE
- “ TO USE A MOTORBYKE
- “ TO USE A CAR
- “ TO GET A TAXI
- “ TO TAKE A BUS
- “ TO HITCH-HICKING



DEFINE THE VALUE

example:

- “ **The welding of two metallic parts is surely a value-added operation because you add functions to the initial part**

- “ **To assembly the door to the refrigerator is surely a value-added operation because it closes the space to be refrigerated**





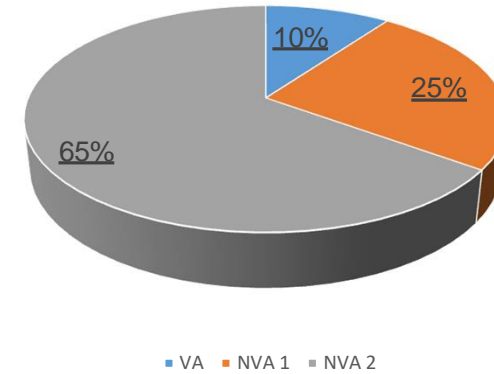
DEFINE THE VALUE

example:

- “ **À .but protecting the surface of a stainless steel sheet by a plastic film to avoid scratches during the manufacturing process, cannot be considered at the Customer's eye a value-added operation because it has to be applied, then removed and finally dispose**



IDENTIFY THE VALUE FLOW

















- ACTIVITIES CREATING VALUE (VA)

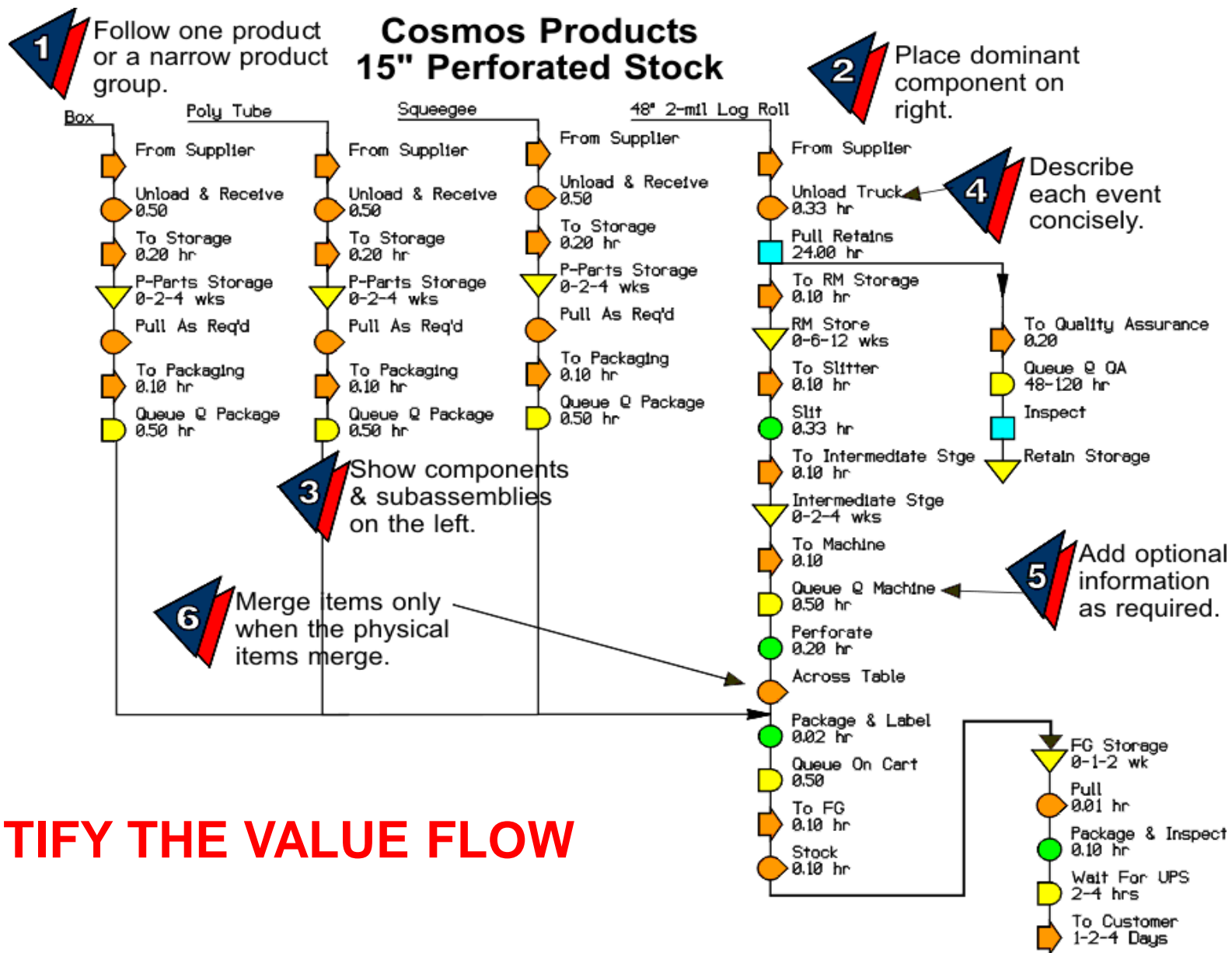
- ACTIVITIES NOT CREATING VALUE BUT NOT REMOVABLE AT THE MOMENT

- ACTIVITIES NOT CREATING VALUE AND EASILY REMOVABLE

IDENTIFY THE VALUE FLOW

Process Chart Symbols

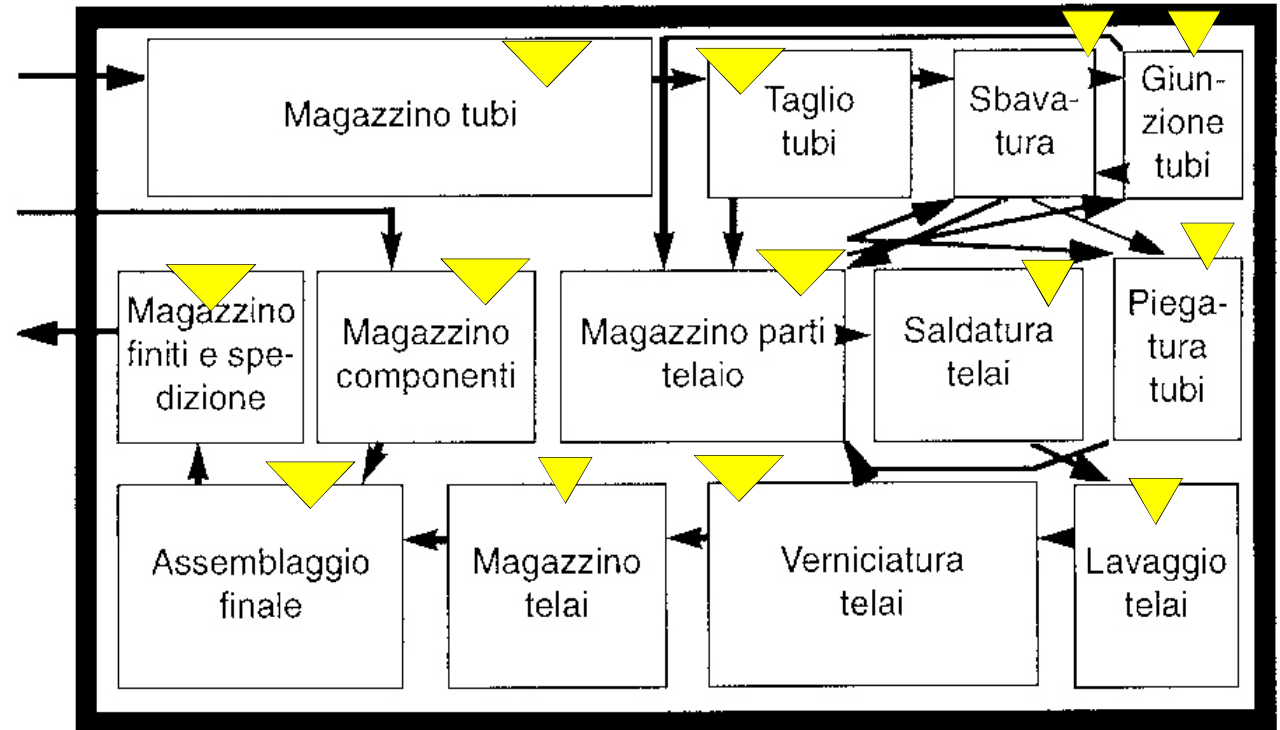
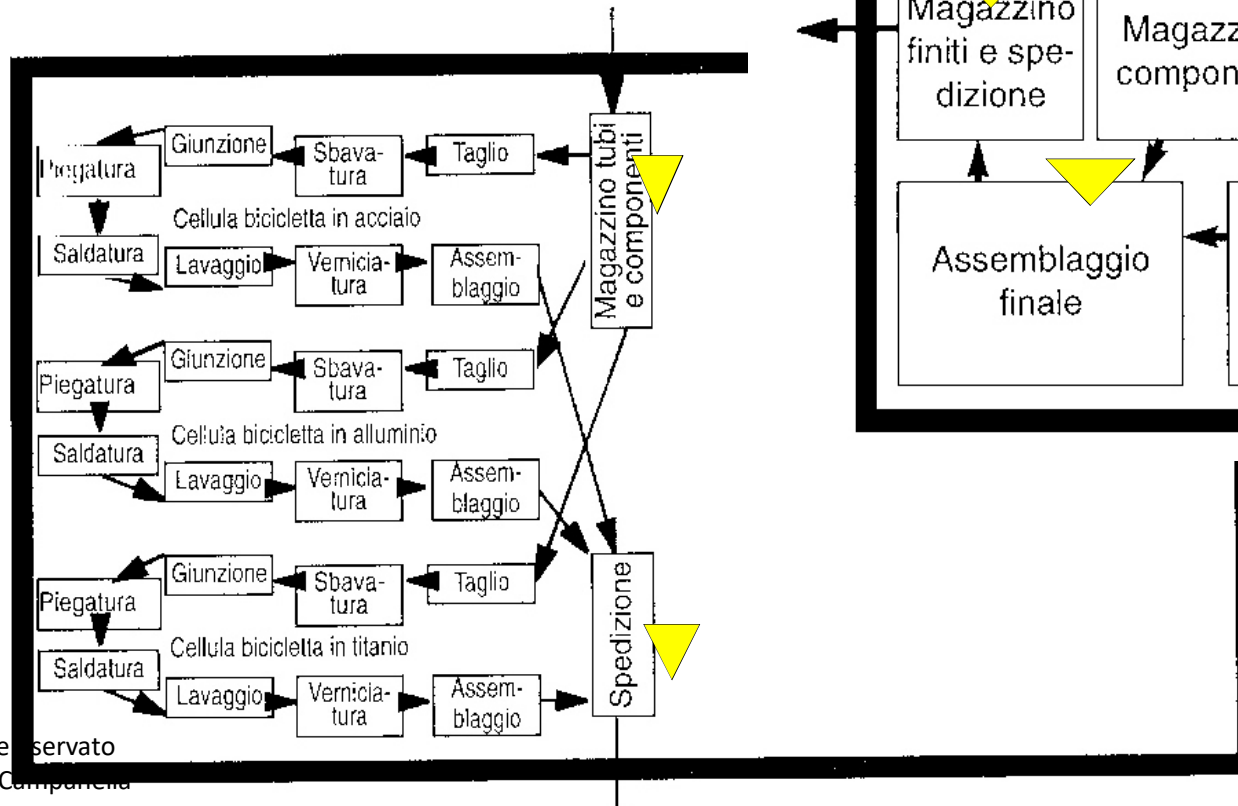
Sym	Name	Action		Examples
	Operation	Adds Value		Saw, Cut, Paint, Solder, Package
	Transport	Moves Some Distance		Convey, Fork Truck, OTR Truck
	Inspect	Check For Defects		Visual Inspect, Dimension Inspect
	Delay	Temporary Delay/Hold		WIP Hold, Queue
	Storage	Formal Warehousing		Warehouse or Tracked Storage Location
	Handle	Transfer Or Sort		Re-Package, Transfer To Conveyor
	Decide	Make A Decision		Approve/Deny Purchase



IDENTIFY THE VALUE FLOW



MANUFACTURE ACCORDING TO *Ípullí* SYSTEM





PULL PROCESS ORGANIZATION MEANS ALLOWING THE CUSTOMER TO PULL THE PRODUCTION

THIS IS THE FOURTH PRINCIPLE OF LEAN THINKING

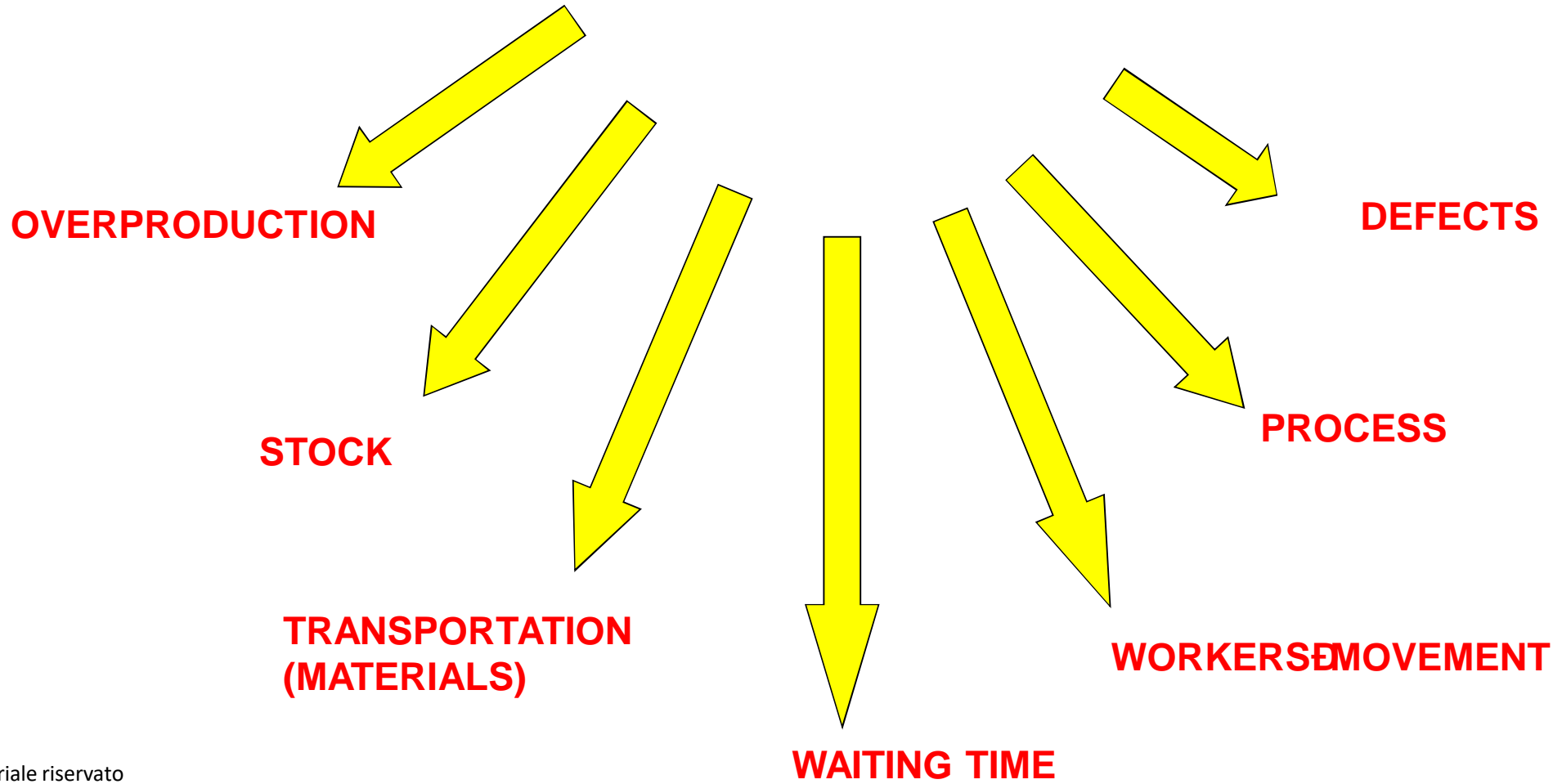
**YOU HAVE TO MANUFACTURE
WHAT YOU NEED, WHEN YOU NEED,
WHERE YOU NEED, THE QUANTITY YOU NEED**

**THE RESEARCH OF THE PERFECTION
IS
THE FIFTH PRINCIPLE OF LEAN THINKING**

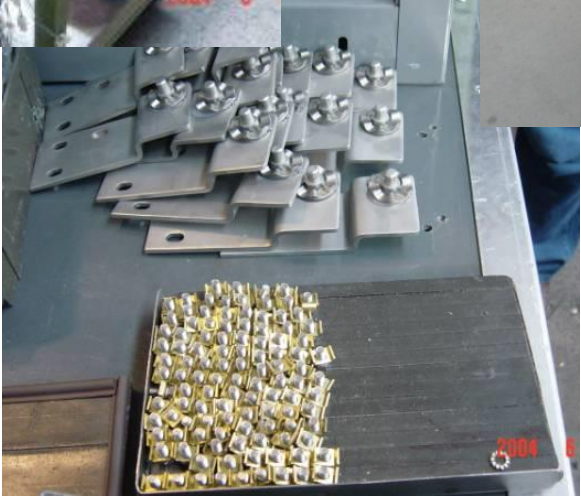
ZERO DEFECTS

DO THE RIGHT THING THE FIRST TIME

WASTES - MUDA



OVERPRODUCTION



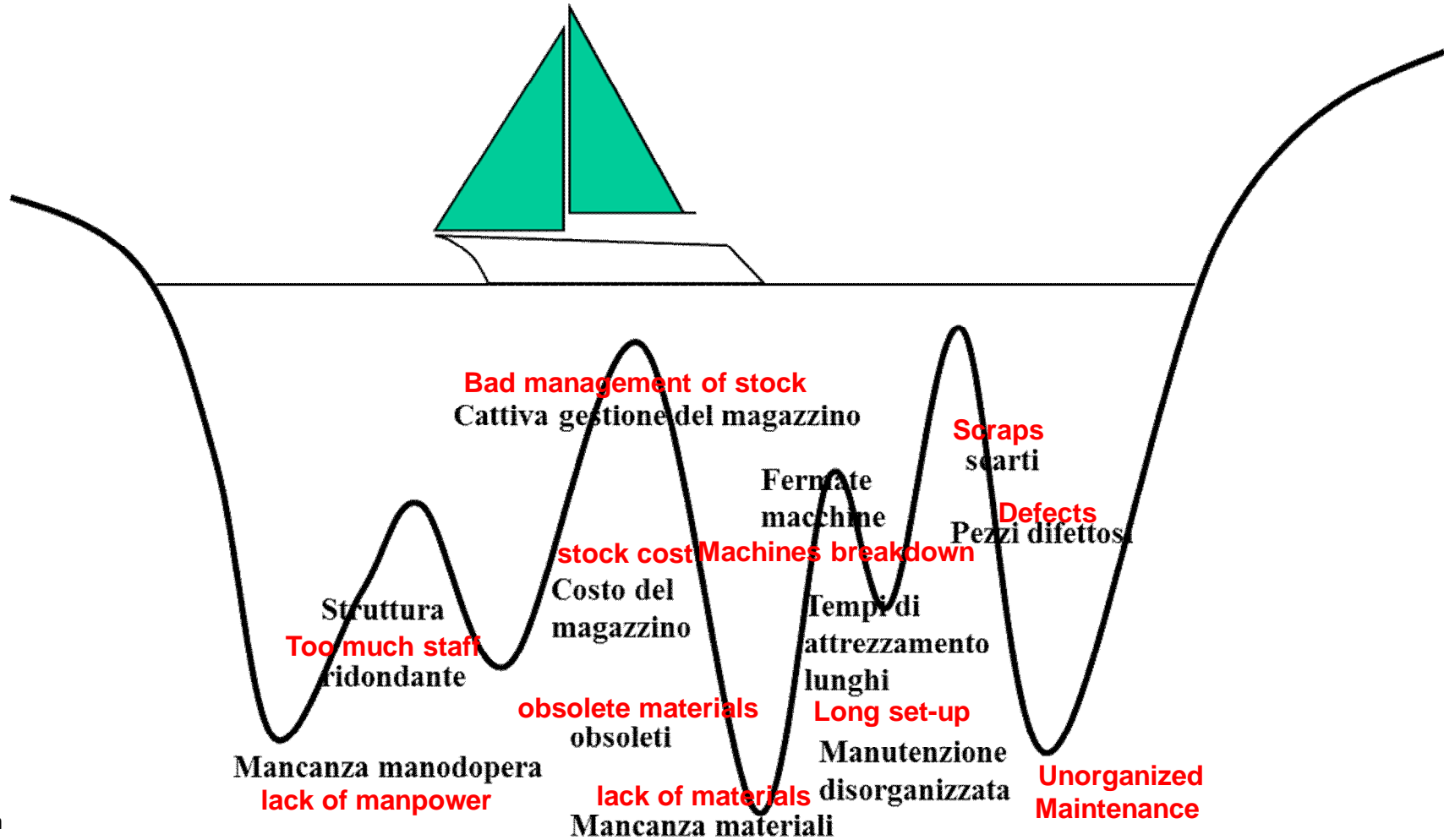
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STOCK



Materiale riservato
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STOCK



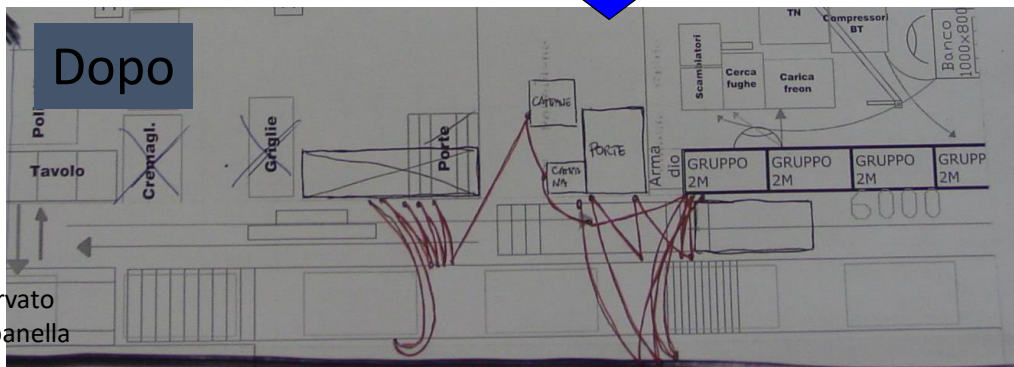
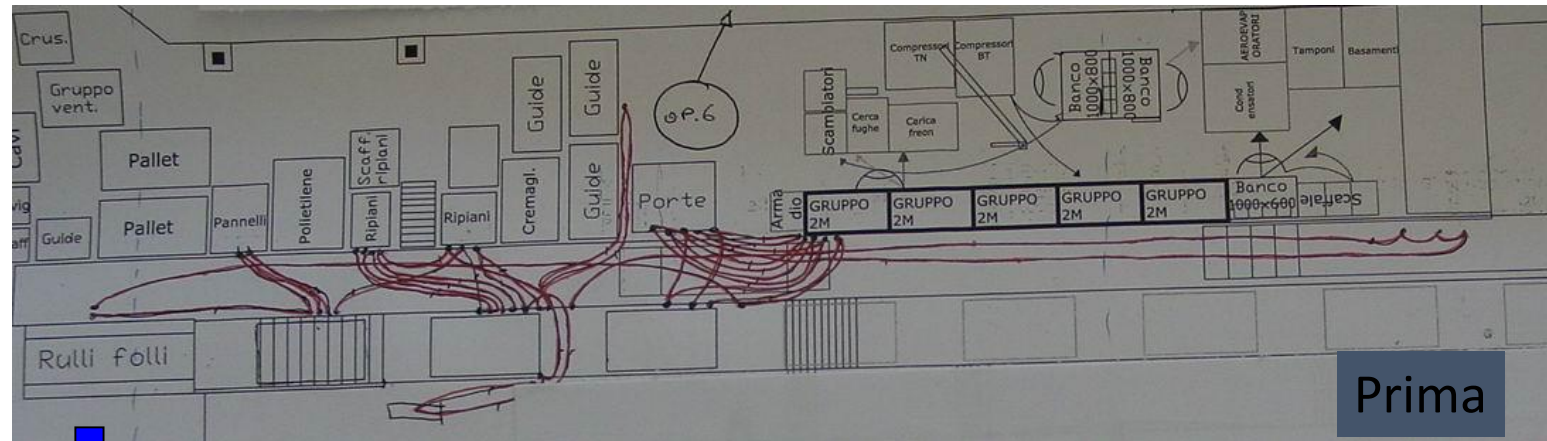
TRANSPORTATION



WAITING TIME



WORKER MOVEMENTS



Movements
reduced from 2 to
1,2 Km/day

PROCESS



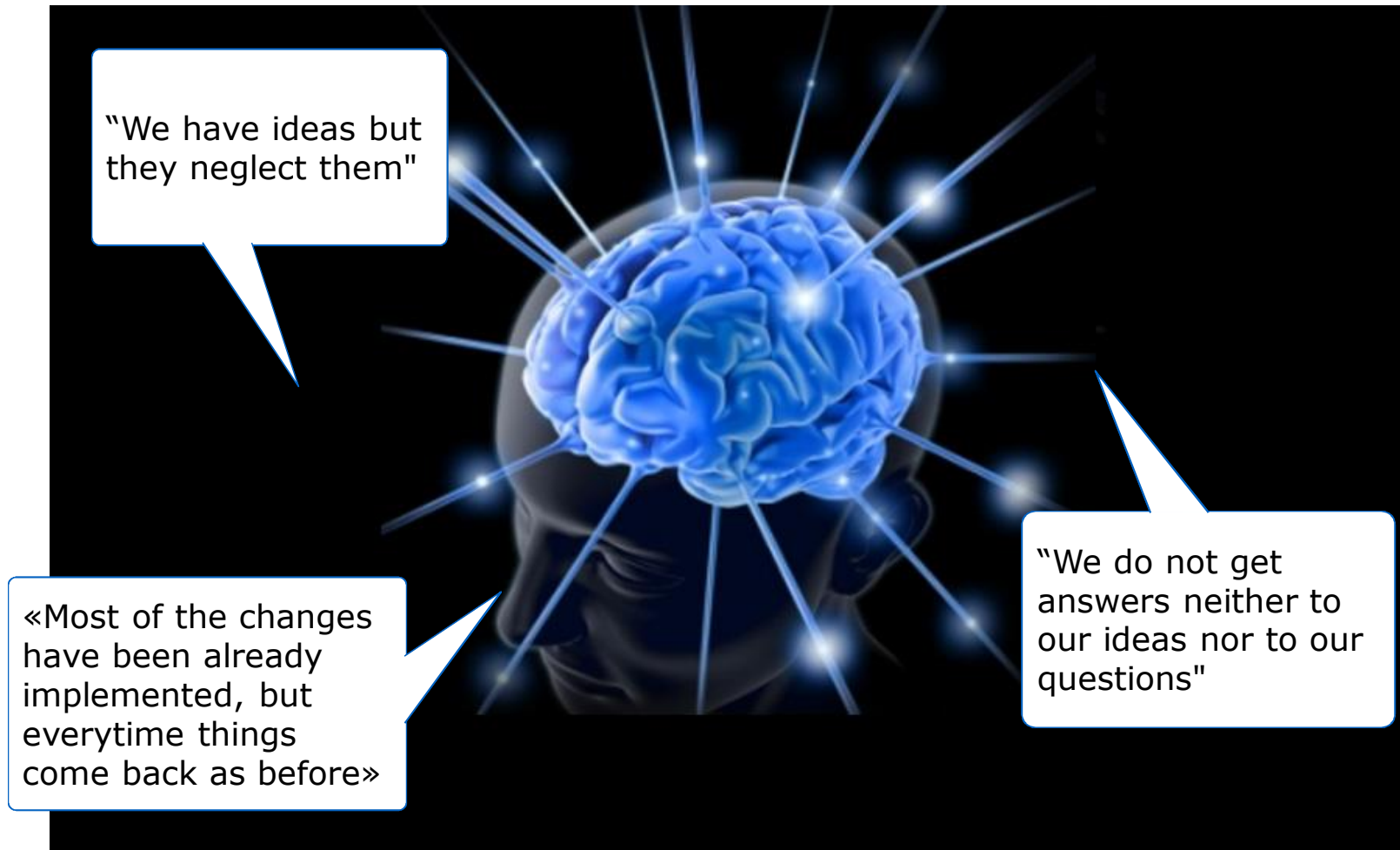
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- " Lack of standardization
- " Heating, cooling, drying times Å too long
- " Instruments and Machinery too big and not coherent with the production
- " Rifining, deburring, grinding Å
- " Protect and then uncover Å
- " Å ..

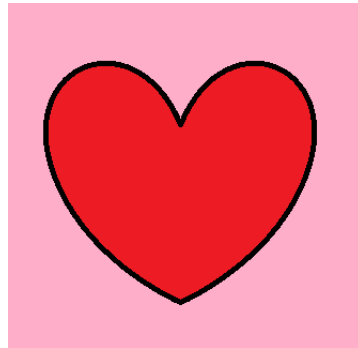
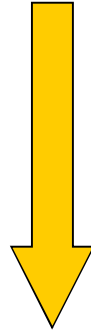
DEFECTS



The eighth waste is to neglect people potential



THE 9° WASTE!



**PERSONS' HEART:
PASSION TO DO THINGS**



TECHNIQUES
AND TOOLS

				7 TOOLS	CORRELATION	
					PARETO'S DIAGRAM	
					ISTOGRAMS	
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