



Scenarios and development trends of Production Systems



A bit of history

■ Variables of study

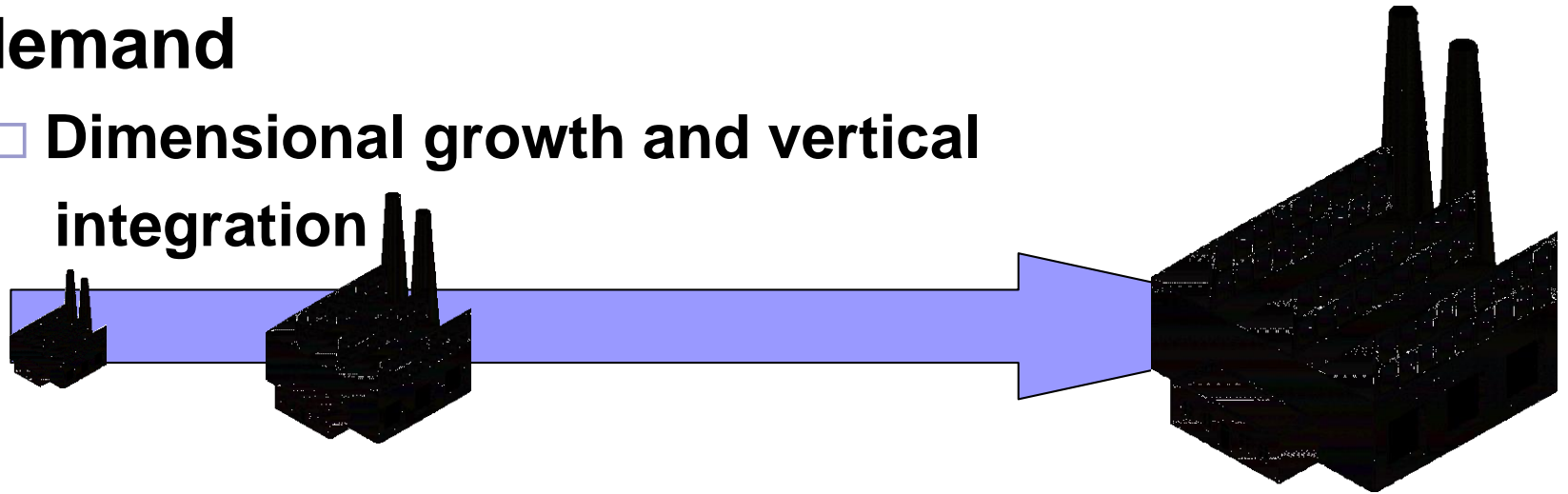
- ☐ Social context evolution
- ☐ Technology evolution
- ☐ Competitive variables relative importance evolution

■ Consequently, how does the industrial model change?

The industrial model until the 60s

- Volume growth to cope with an exuberant demand

- Dimensional growth and vertical integration



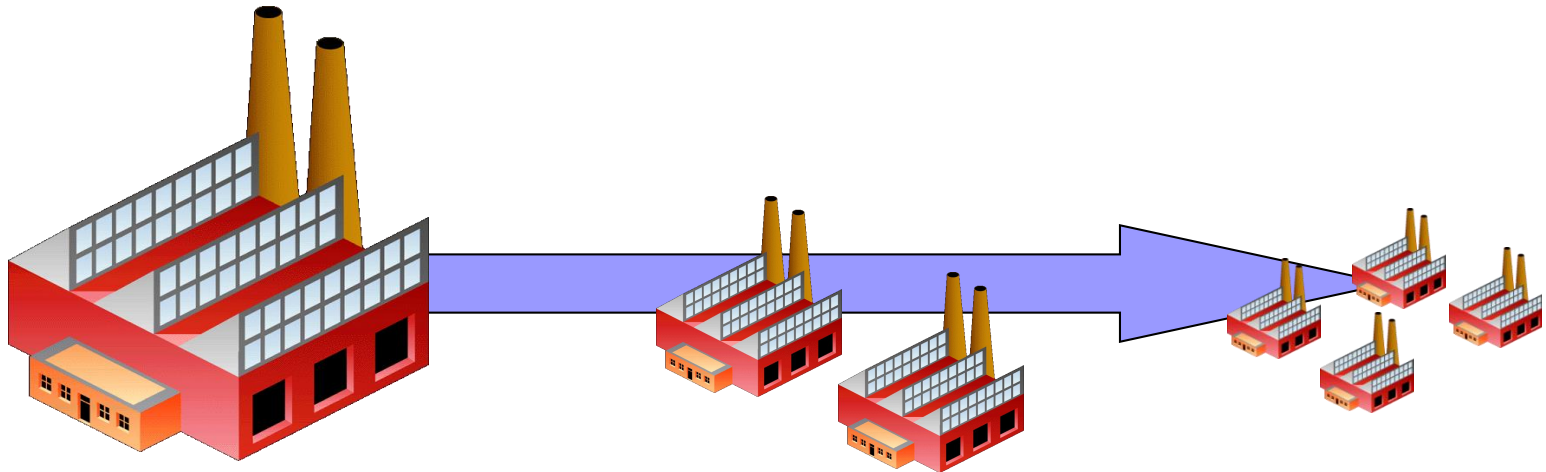
- Evaluation criteria: turnover and consumption of production factors
- Service and residual Quality: the important thing is to make the product available

The industrial model until the 60s

- **Increasing pressures after the 1960s**
 - **Increased competition**
 - It is no longer enough to “produce”, you must “sell”
 - **Containment of industrial costs**
 - Oil and economic crisis
 - Factories must "make efficiency" internally
 - **Increase of conflicts potential in industrial relations**
 - Social crisis

The reactions of the 70s

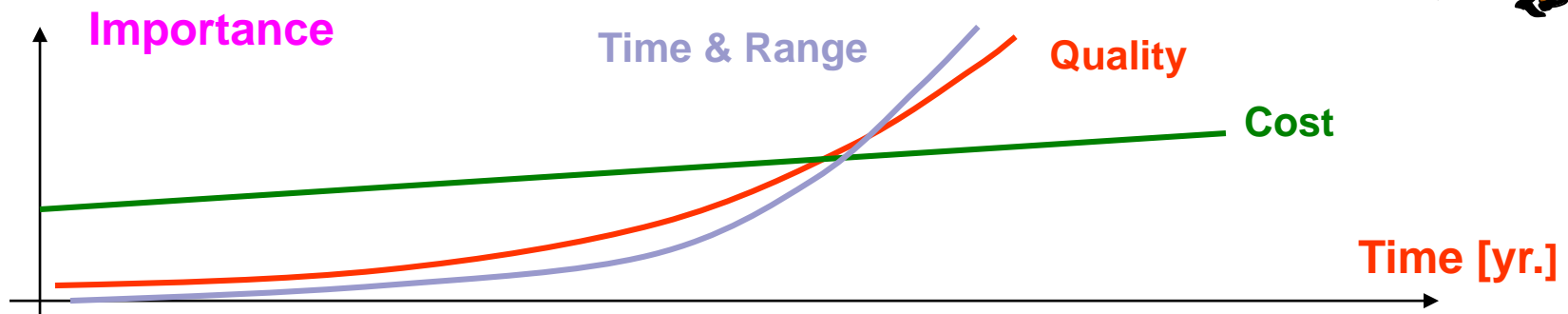
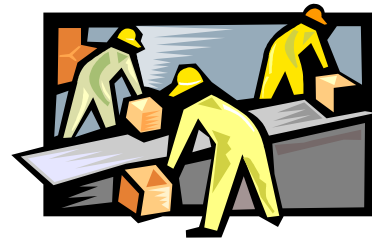
- The outsourcing phenomenon is born, focus on critical technologies and access to specialized supply sources



- Factory automation: replacement of costs with investments
- Evaluation criteria are still oriented towards cost reduction
- Service and quality are still residual: the important thing is that the product costs remains low

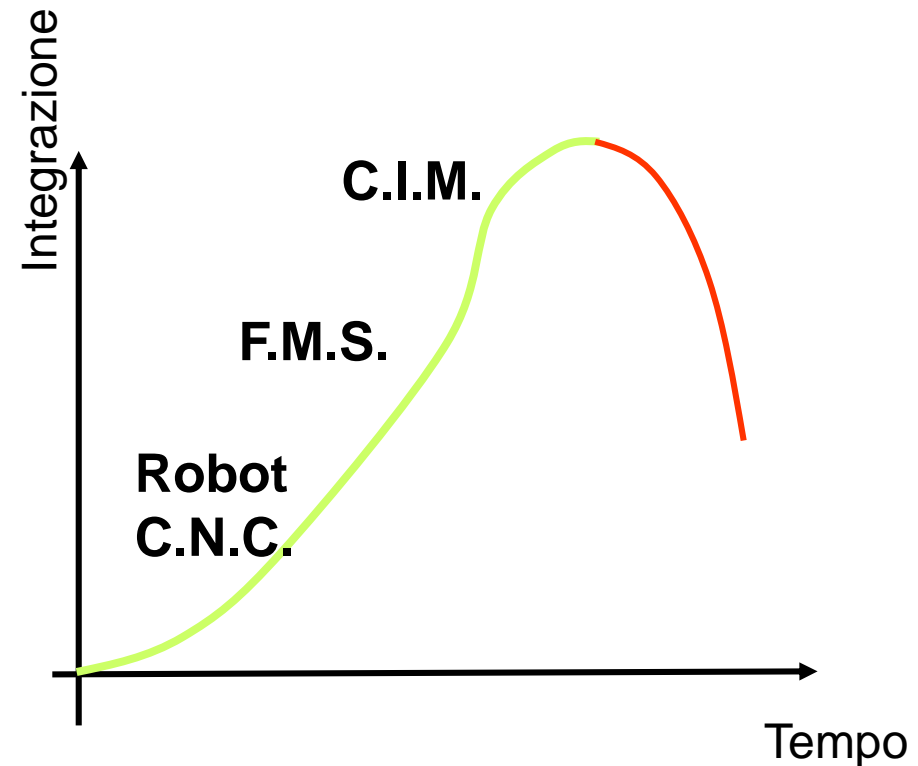
In the 80s

- The relative importance of the "competitive variables" changes significantly
 - From the internal efficiency point of view
To that of external effectiveness



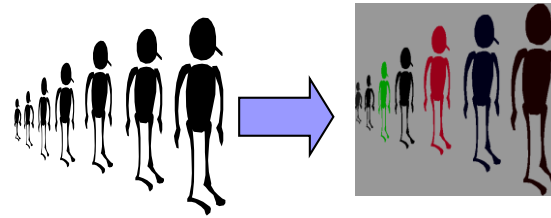
In the 80s

- Driven by the evolution of electronics, automation levels increase
- Nevertheless during mid 80s they undercome a big change: the factory “with no light” happens to be a utopia



Until the 90s

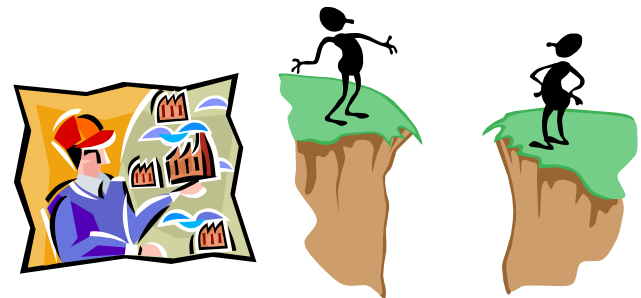
**EXPLOSIVE RATES OF
GROWTH OF THE RANGE**



**SPEED OF PROCESSES
INCREASE REQUESTS**

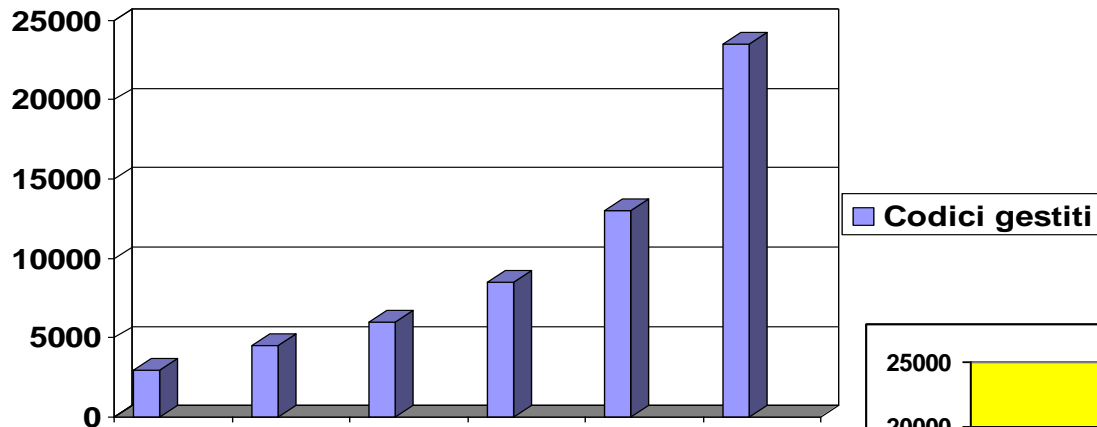


**INTERNATIONALIZATION AND
GLOBALIZATION OF MARKETS
AND INDUSTRIAL STRUCTURE**

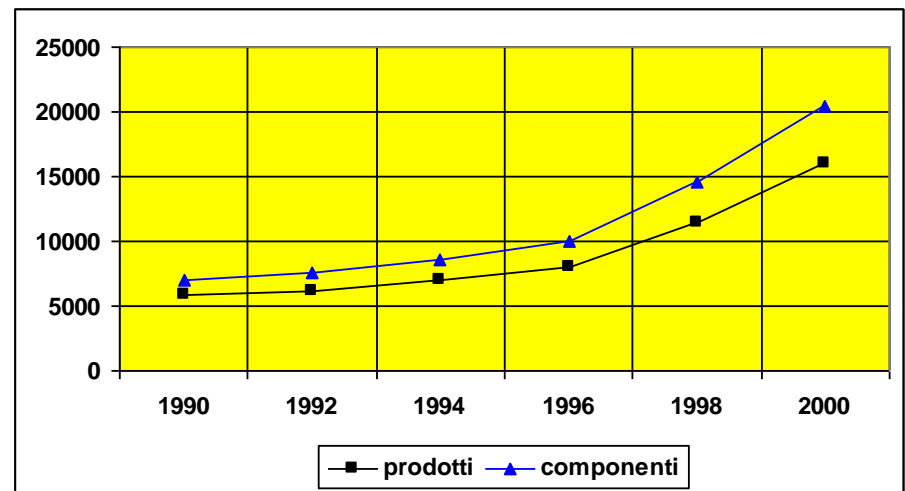


Until the 90s

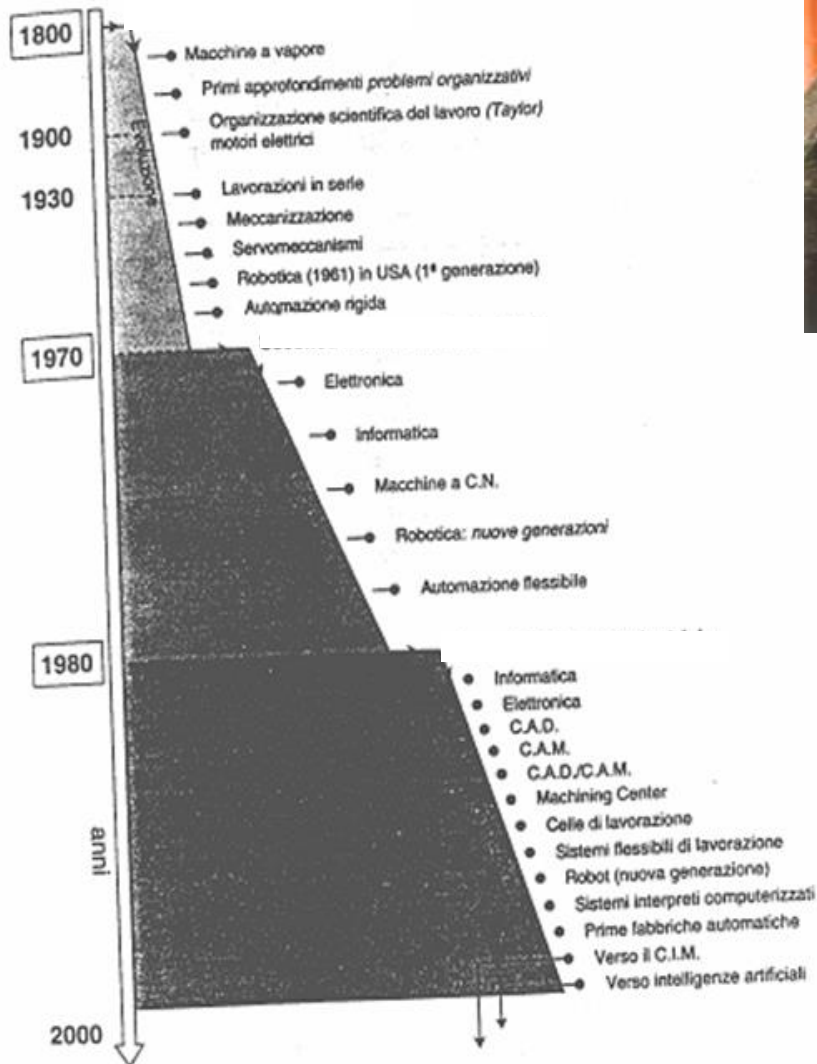
The range has impressive growth derivatives



(Source: data from an electromechanical company)



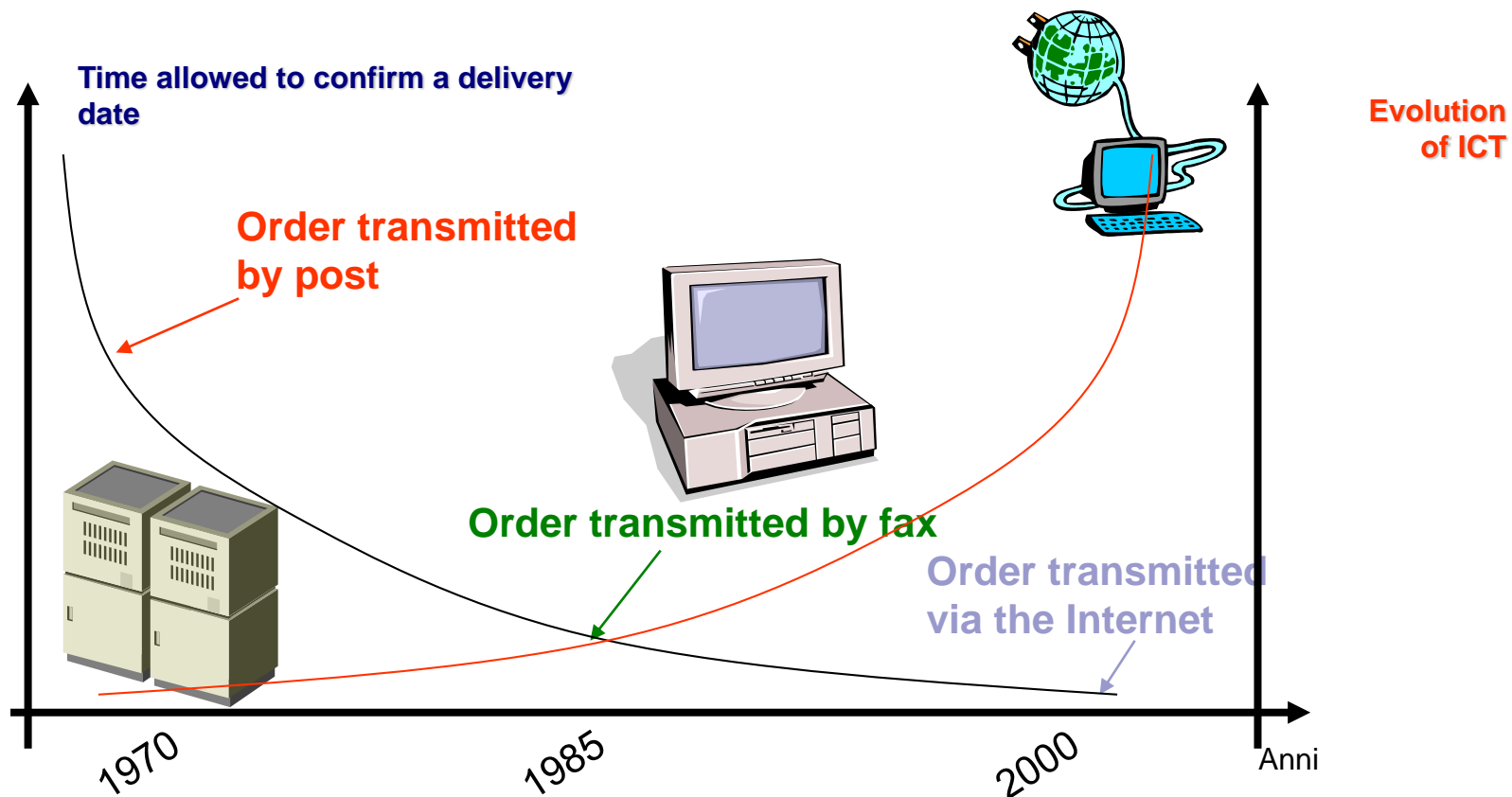
The role of technology



Today

- **Competitive variables are now "multivariate"**
 - You can not afford not being efficient (cost reduction)
 - Cost reduction is no longer a target in itself
 - It's necessary to free up resources to be more effective
 - Better quality
 - Best service
 - More punctuality and timeliness
 - ...

Today





The world has changed

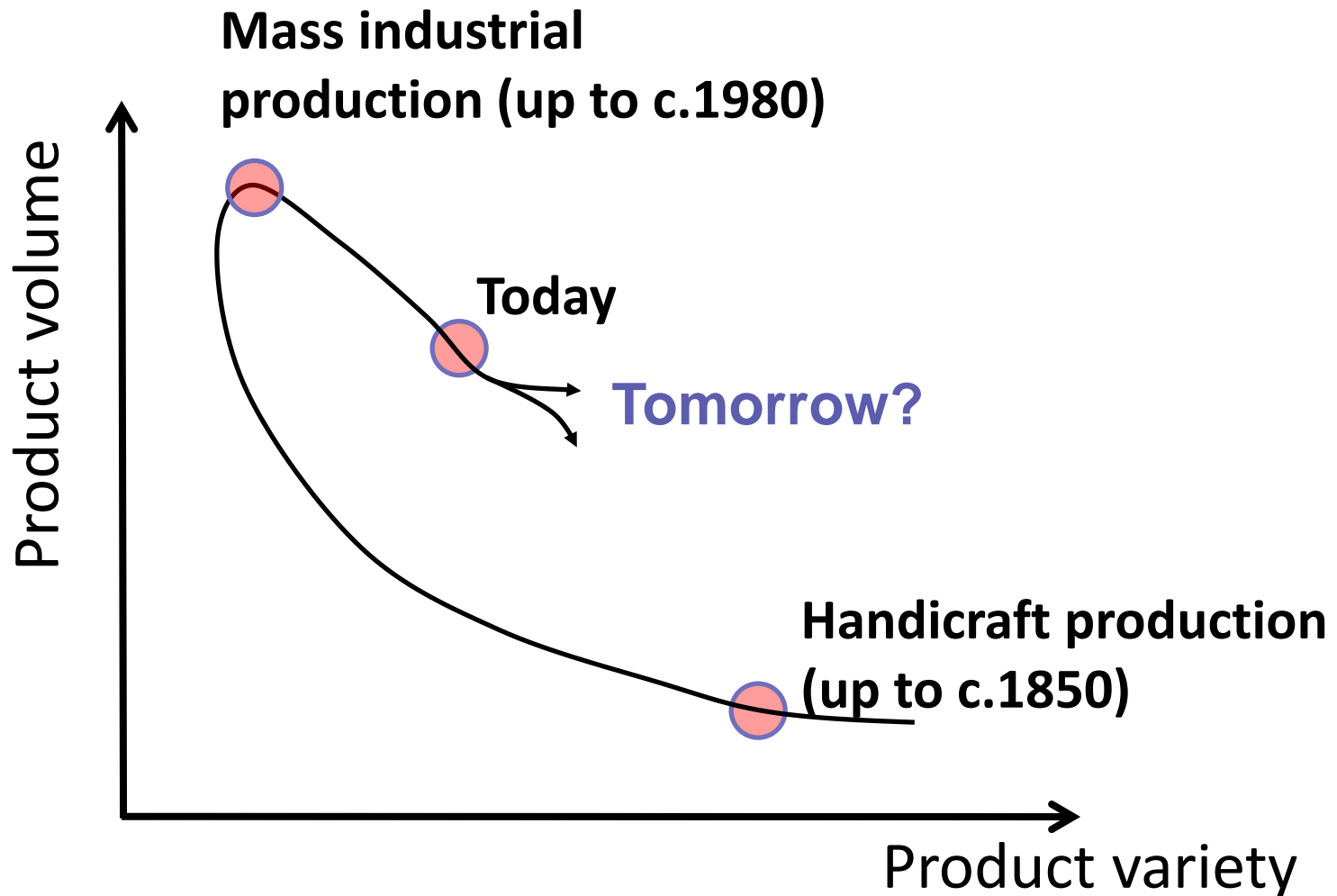
- **The product has changed, from “manufactured” products to "extended products"**
 - More efficient and effective, more reliable and cheaper ...
 - Customizable, supportable, maintainable, eco-friendly ...
- **The way to create value has changed**
 - Not only functionality, but also intangible elements
 - Not just a physical asset, but also a service
 - Addressing more complex and multi-functional problems
 - Integrating more skills
 - Formalizing and making transferable the knowledge and innovation



The world has changed

- **Markets show new trends, challenges and needs that companies must respond to**
 - From mass production to mass customization
 - Transition to a product-service system
 - Network system, intra and extra business collaboration
 - Time To Market compression
 - Sustainable development and energy efficiency

Where will the world go?





How to face the new challenges?

- **As in the past, technology, with its development trends, offers new opportunities and responses to the needs of the industrial world**
 - **Integration of multiple technologies**
 - **Pervasiveness of Information & Communication Technologies (ICT)**



How to face the new challenges?

- **ICT increasingly pervasive in the production system**
 - **Miniaturization of electronic systems with microprocessors (embedded systems) and increased performance**
 - **Increase of data transmission speed**
 - **Efficient and reliable wireless communication**
 - **Miniaturization of sensors and actuators**
 - **Standardization and orientation to the "service" of software components (eg Web Service Technologies)**



The new role of ICT at the factory

■ Virtual Engineering

- Reduce the gap between design and production with a more efficient exchange of information

■ Real Time Factory

- Reduce the time between the occurrence of an event in the production system (e.g. failure) and the subsequent reporting to the manager, increasing the company's responsiveness

■ Plant intelligence

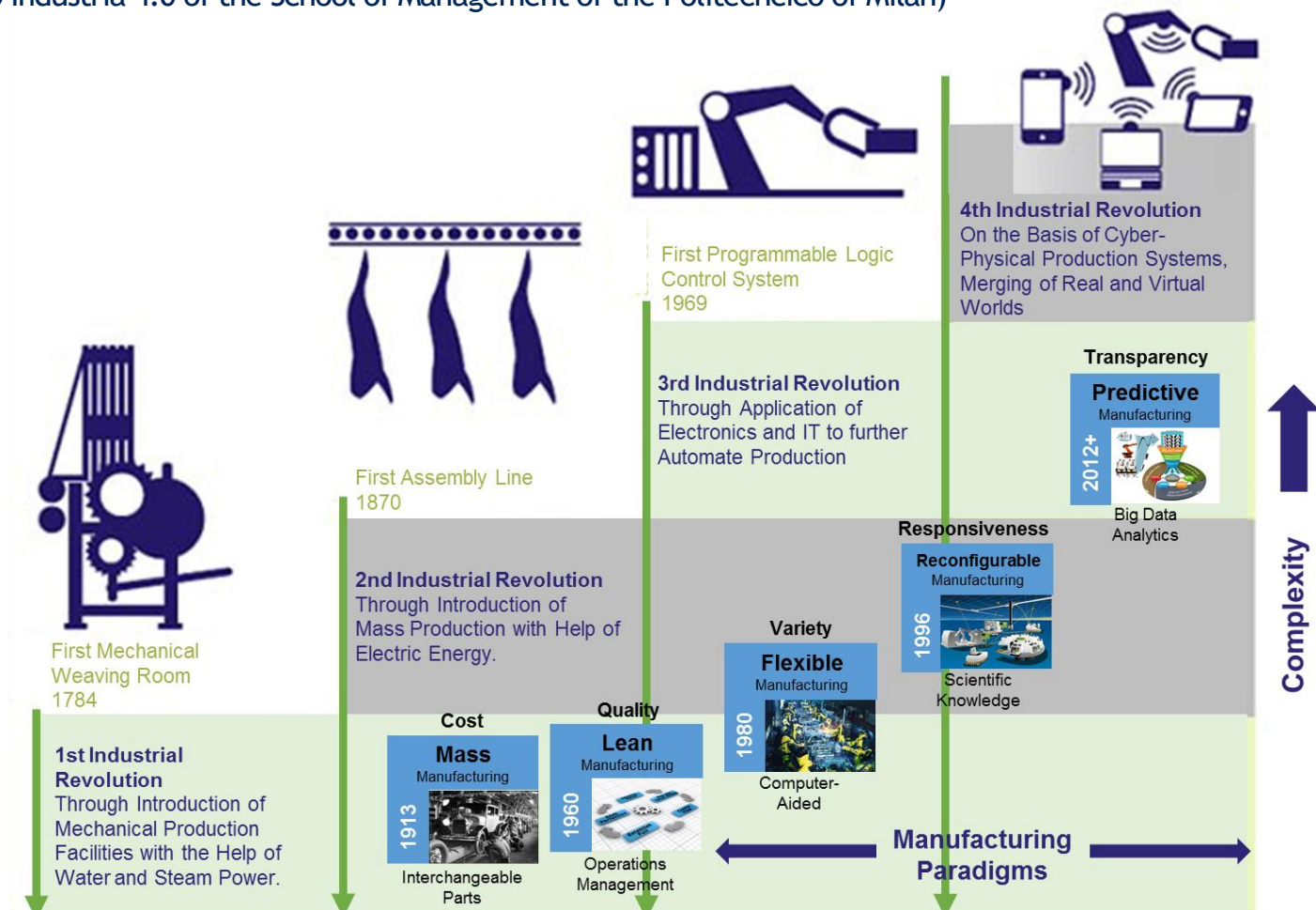
- Use business intelligence tools to identify areas of improvement in the performance of production systems, enabling the collection of more and more information of high granularity

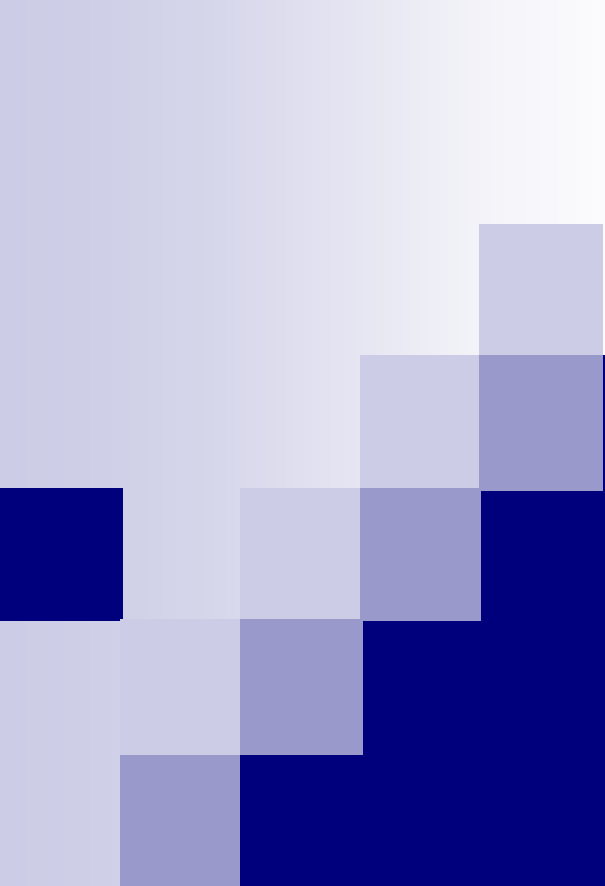


INDUSTRY 4.0

The fourth industrial revolution

Industry 4.0 states a **vision** of the future according to which industrial and manufacturing companies, thanks to **digital** technologies, will increase their **competitiveness** thanks to the greater **interconnection** of their resources (**plants, people, information**), both inside the Factory and distributed along the value chain (ref. Osservatorio Industria 4.0 of the School of Management of the Politecnico of Milan)





Manufacturing systems



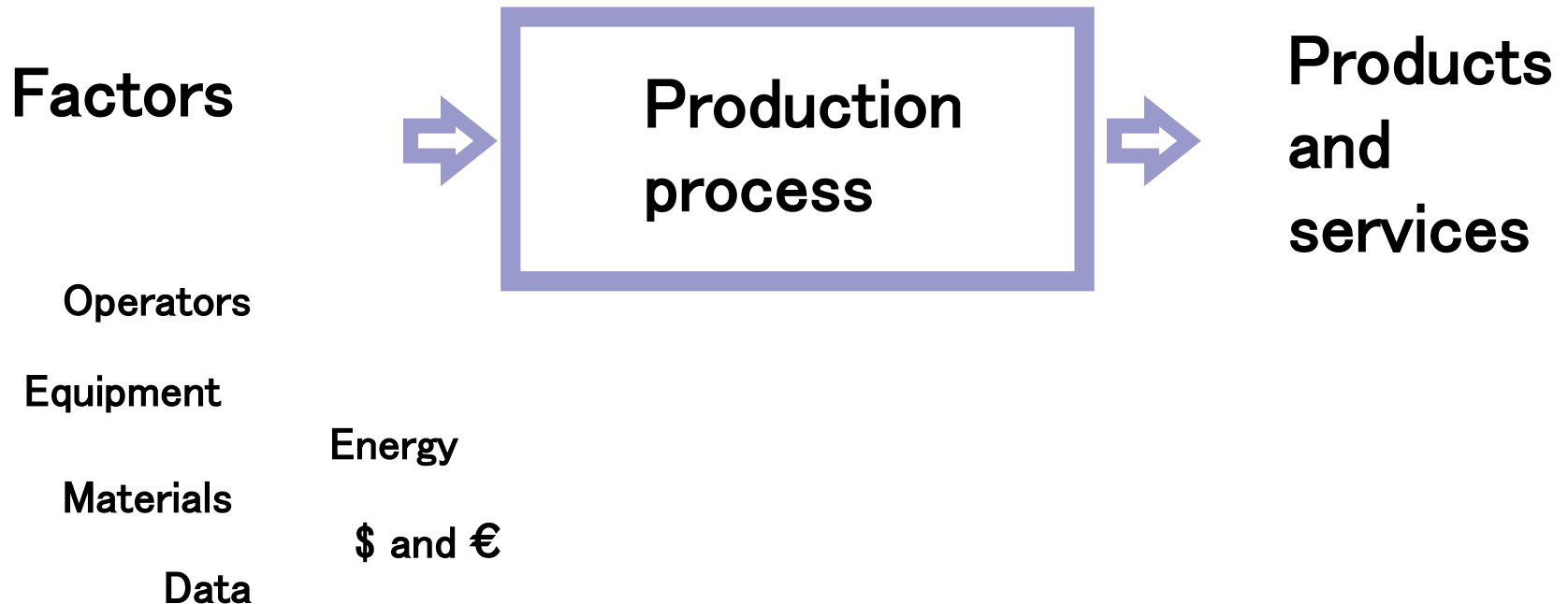
Introduction to production systems

Production (process) = set of activities (process) required to produce goods or services delivered to the market by a company

Production system = a subsystem of the company. It uses resources as inputs – raw materials, semi-finished goods, energy, information, knowledge, etc. – to provide products and services in order to satisfy the customer needs and the objectives established by the company's strategy

Production plant = physical plant where the production system is established

Production factors





Production process

- **Material acquisition, data and information retrieval**
- **Transformation**
 - ☐ Raw materials in components and parts
 - ☐ Components and parts in final products
- **Distribution**

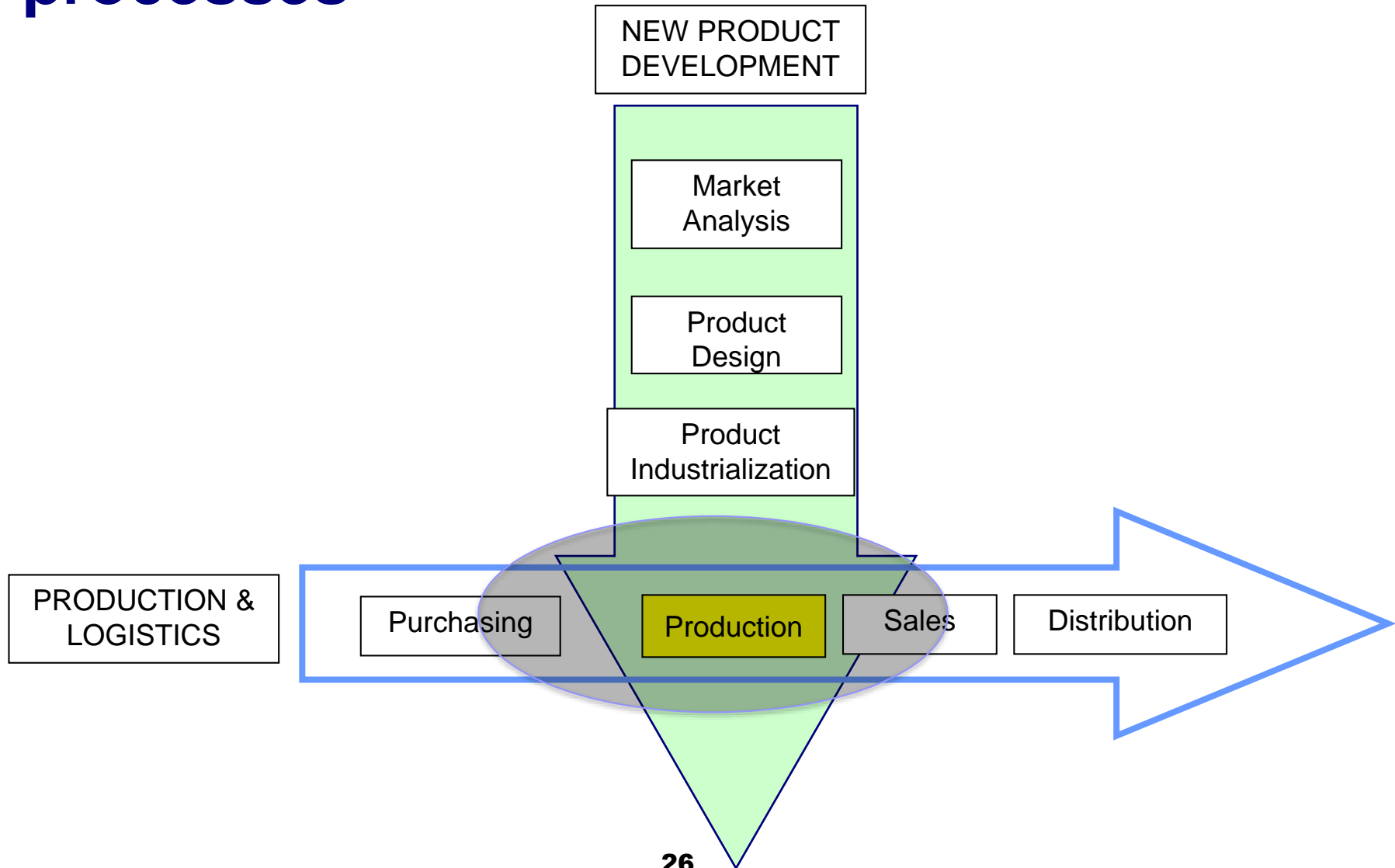
Production and Logistics

**OUTBOUND
LOGISTIC
PROCUREMENT**

**INBOUND
LOGISTIC
PRODUCTION**

**OUTBOUND
LOGISTIC
DISTRIBUTION**

Production and others industrial processes



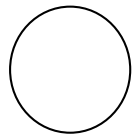


How to define a production system

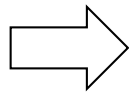
- **Production process – ASME Diagram**
- **Flow sheet**
- **Layout**
- **Procedure**

Production process

↖ ASME – American Society of Manufacturing Engineering



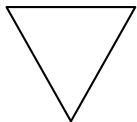
Production



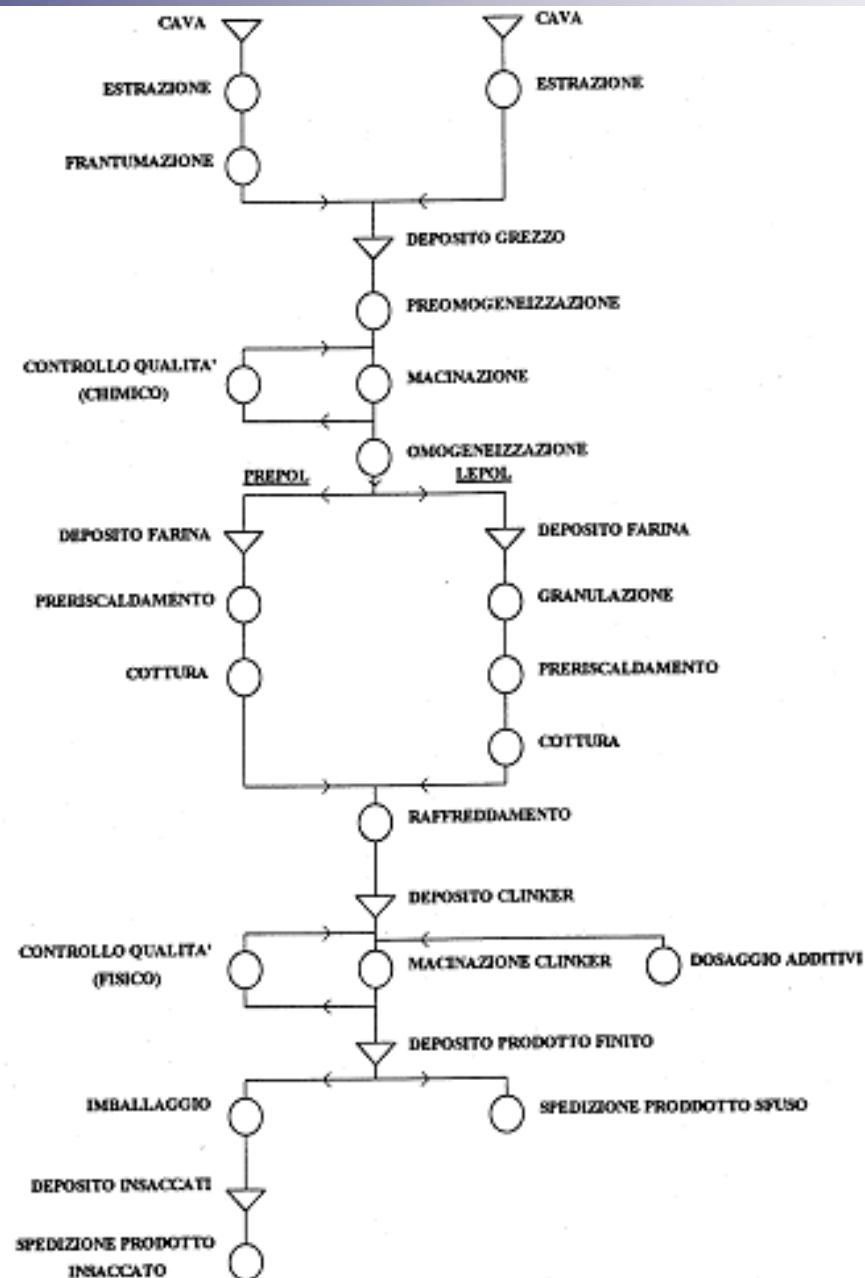
Flow, movement



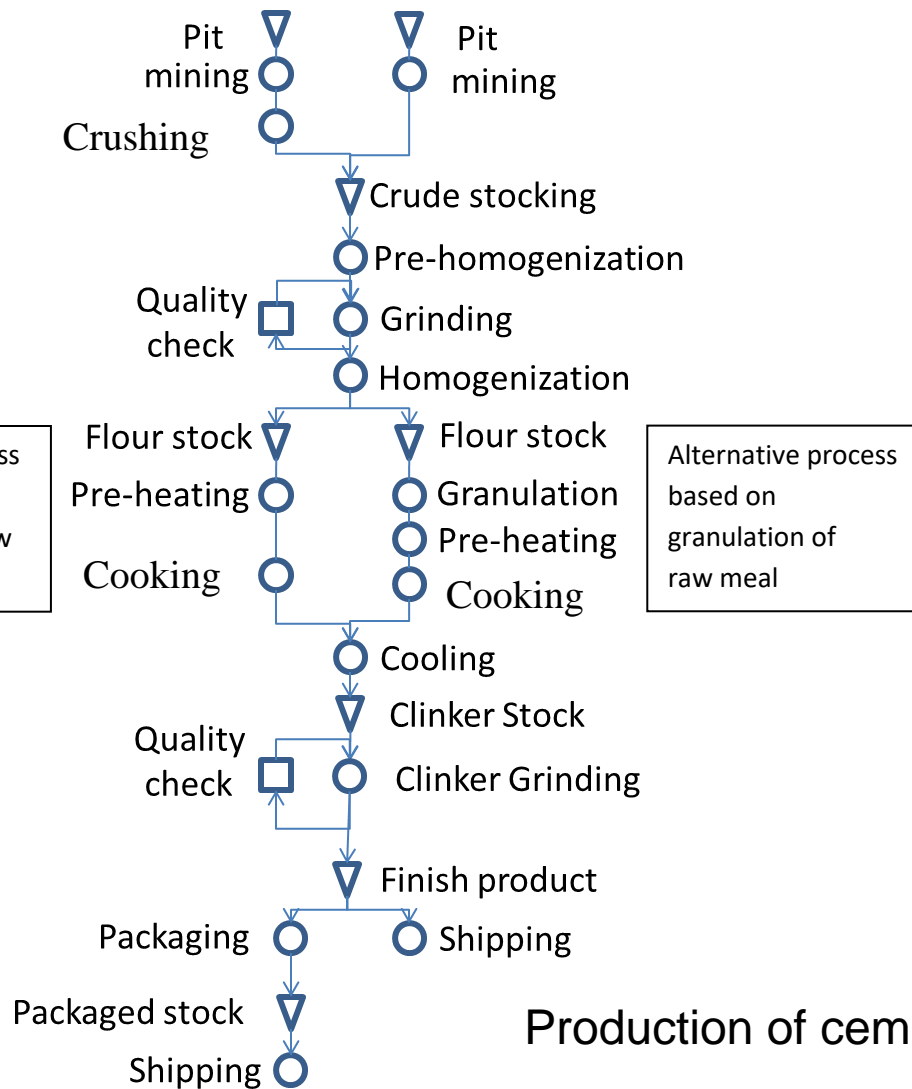
Control



Waiting



Example of a process diagram



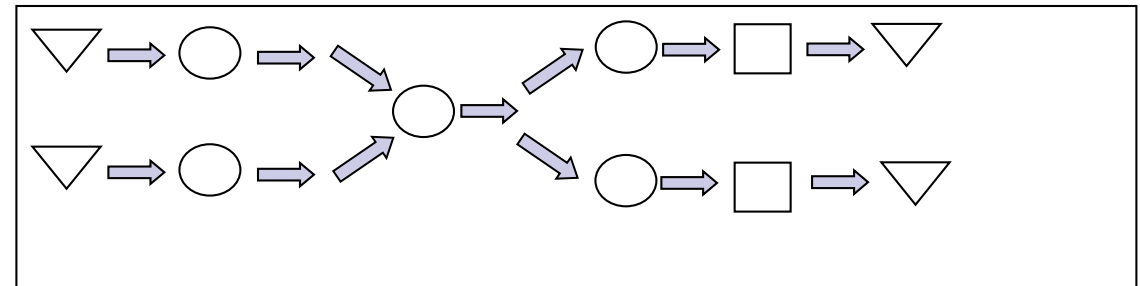
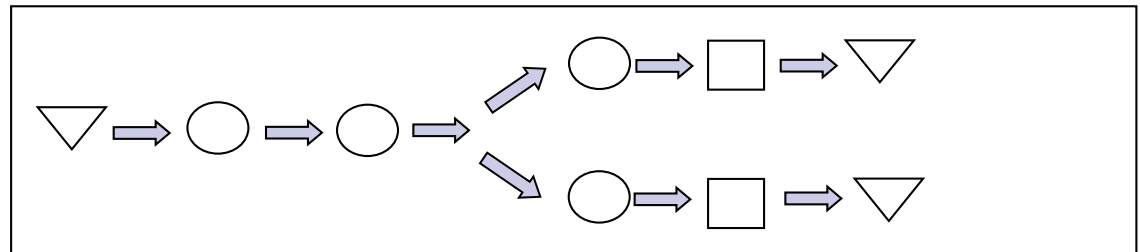
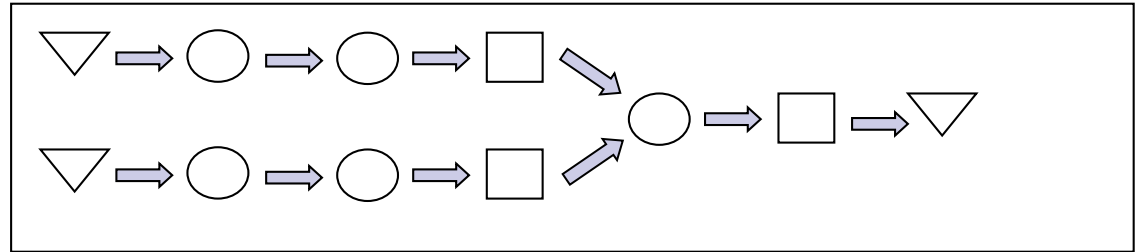
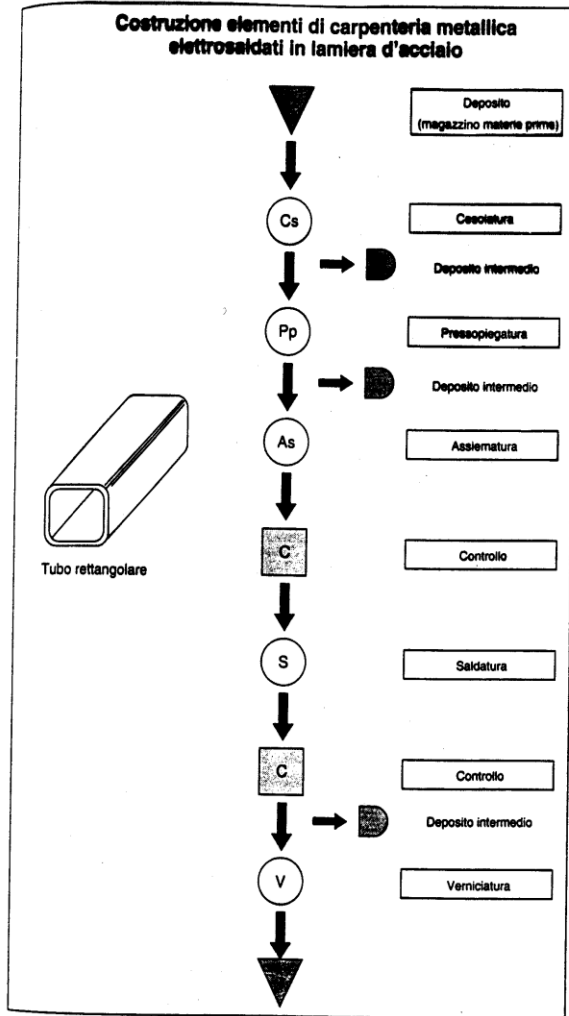
Production of cement by 2 alternative processes

Costruzioni metalliche

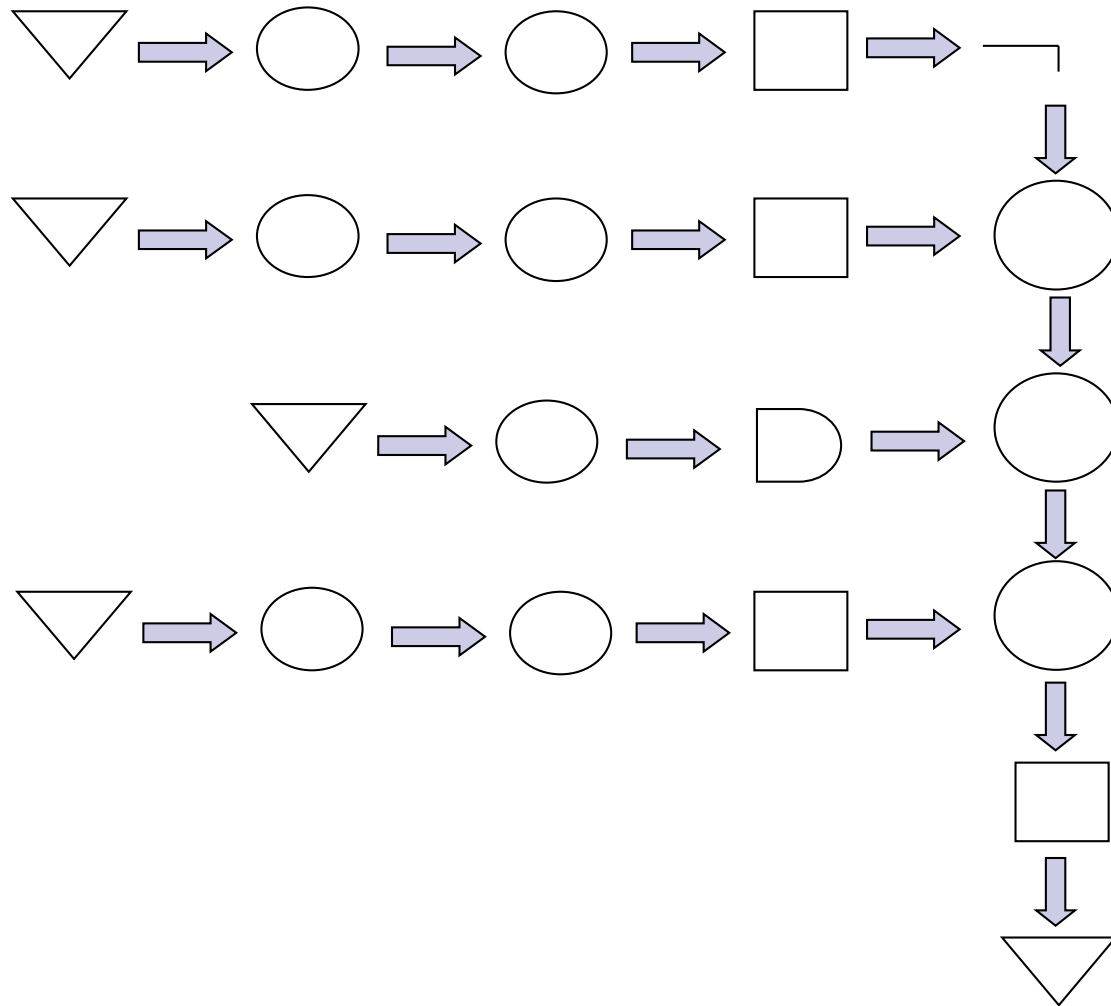
Descrizione	Simboli					distanza (m)	tempo (sec)	quantità (kg)	Osservazioni
Magazzino	○	→	D	■	▼				Gru a ponte
da magazzino a cesoiatura	○	→	D	■	▼	30	60	Lotti di 2.500	
Cesoiatura	○	→	D	■	▼		80 pezzo		
Deposito intermedio	○	→	D	■	▼				Spazio accanto alla cesoia
da deposito intermedio a presso-piegatura	○	→	D	■	▼	20		2.200	
Presso-piegatura	○	→	D	■	▼		45 pezzo		
Deposito intermedio	○	→	D	■	▼				Spazio accanto alla pressa
da deposito intermedio ad assiematura	○	→	D	■	▼	25			
Assiematura	○	→	D	■	▼		240		
Controllo	○	→	D	■	▼				Il controllo avviene nello stesso luogo di assiematura
da controllo a saldatura	○	→	D	■	▼				
Saldatura	○	→	D	■	▼	30	600		
Deposito intermedio	○	→	D	■	▼				Spazio accanto reparto di saldatura
da deposito intermedio a verniciatura	○	→	D	■	▼	20			
Verniciatura	○	→	D	■	▼		500		
da verniciatura a magazzino	○	→	D	■	▼	20			
Magazzino	○	→	D	■	▼				

Flow Process Chart Job : Requisition of petty cash	Analyst ABC	Page 1 of 2	Operation	Movement	Inspection	Delay	Storage	Distance
Details of method								
Requisition made out by department head			●	⇒	□	D	▽	10 m
Put in "pick-up" flag			○	⇒	□		▽	
To accounting department			○	■	□	D	▽	
Account and signature verified			○	⇒	■	D	▽	
Amount approved by treasurer			●	⇒	□	D	▽	5 m
Amount counted by cashier			●	⇒	□	D	▽	
Amount recorded by bookkeeper			●	⇒	□	D	▽	
Petty cash sealed in envelope			●	⇒	□	D	▽	
Petty cash carried to department			○	■	□	D	▽	
Petty cash checked against requisition			○	⇒	■	D	▽	
Receipt signed			●	⇒	□	D	▽	
Petty cash stored in a box			○	⇒	□	D	▼	
			○	⇒	□	D	▽	
			○	⇒	□	D	▽	
			○	⇒	□	D	▽	15 m
			○	⇒	□	D	▽	
			○	⇒	□	D	▽	
			○	⇒	□	D	▽	
			○	⇒	□	D	▽	
			○	⇒	□	D	▽	
			○	⇒	□	D	▽	
			○	⇒	□	D	▽	
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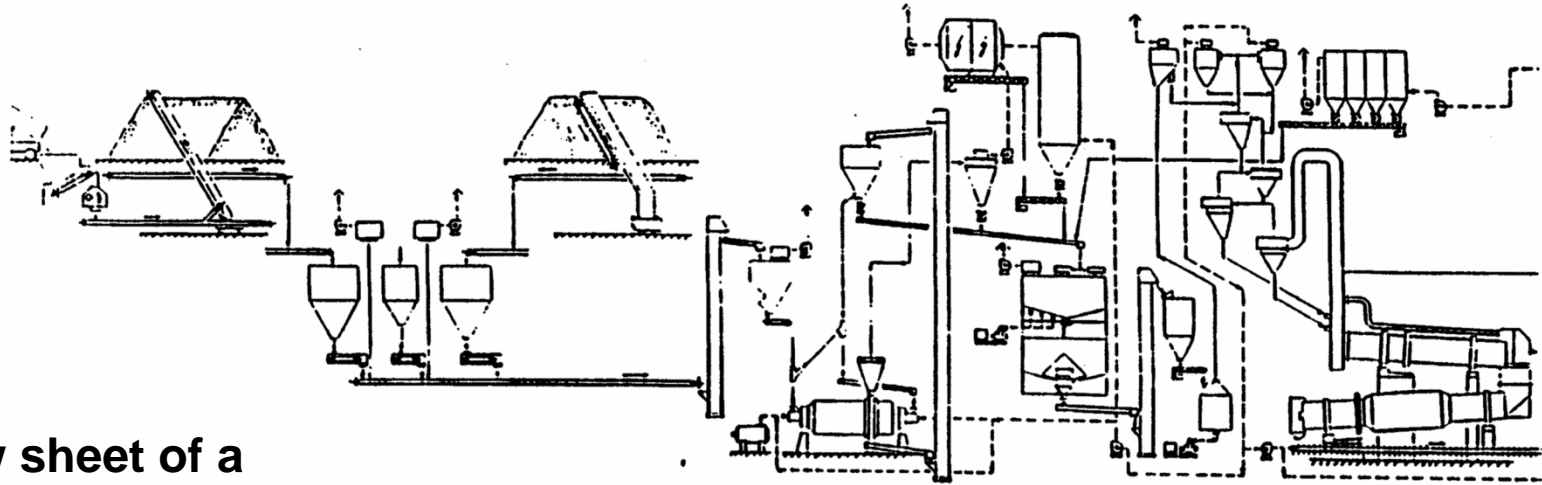
Different types of production flows



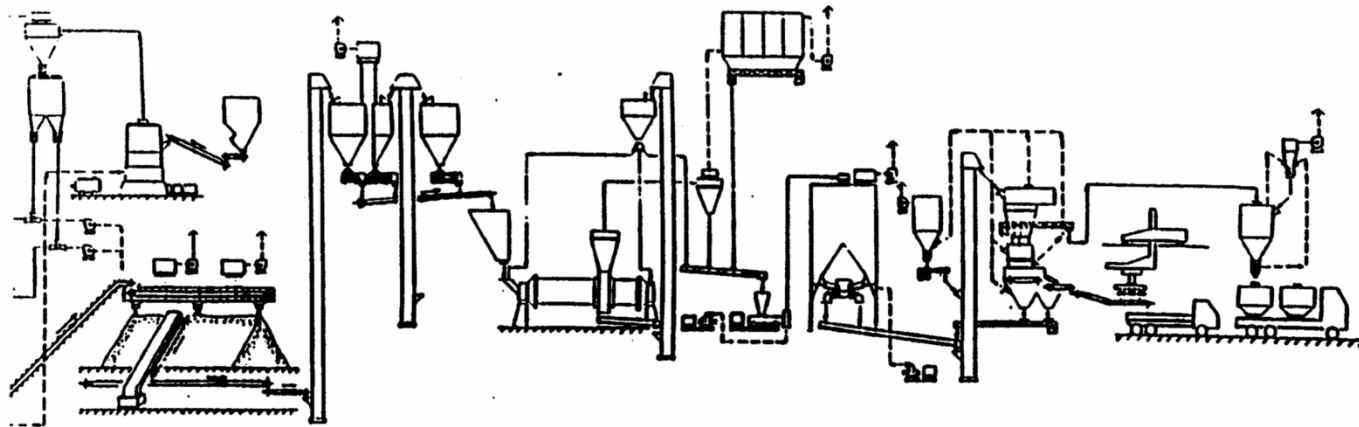
Different types of production flows



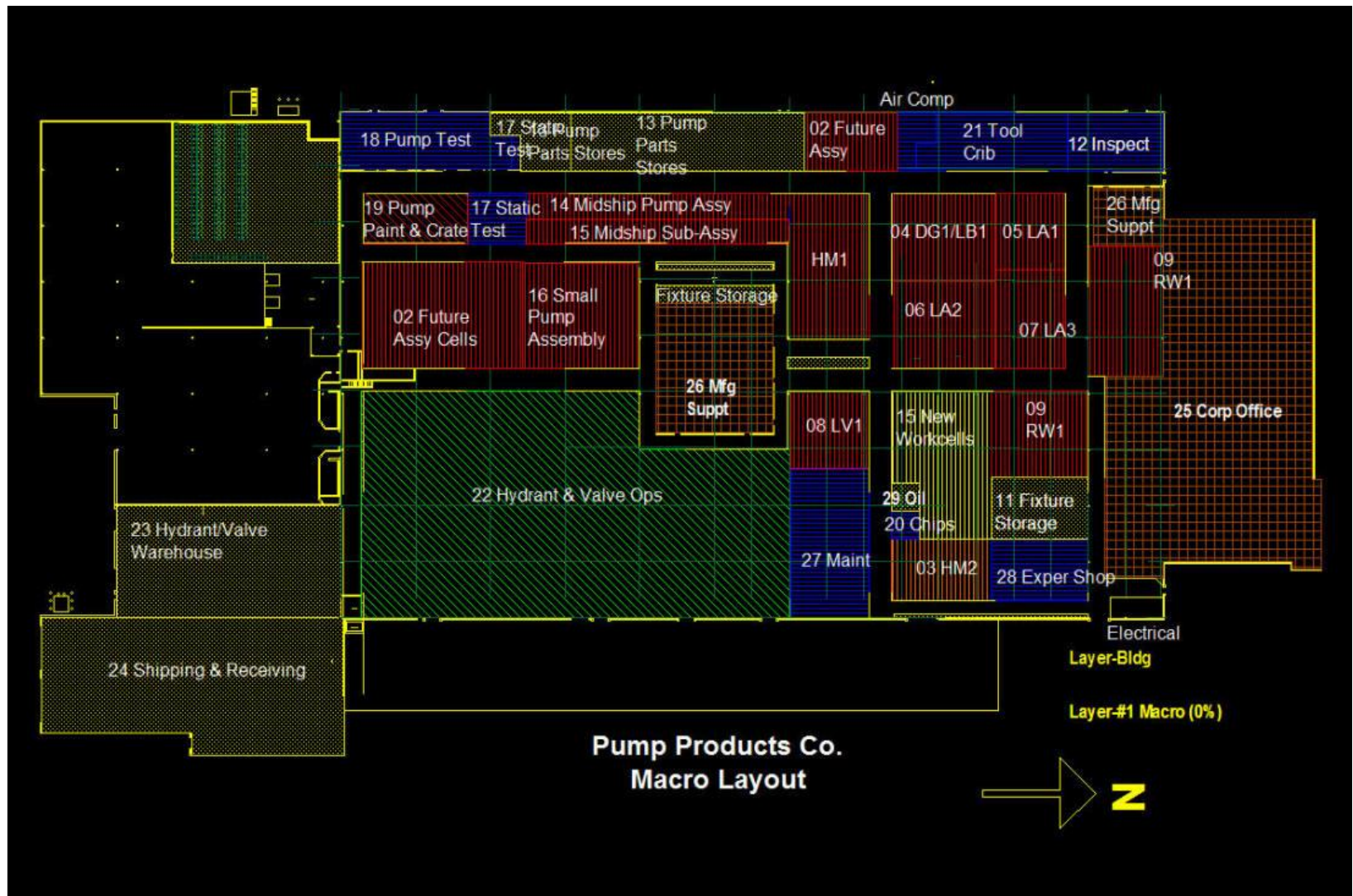
Flow sheet of a production plant



Flow sheet of a
cement plant



Layout of a production plant



Layout of a production plant

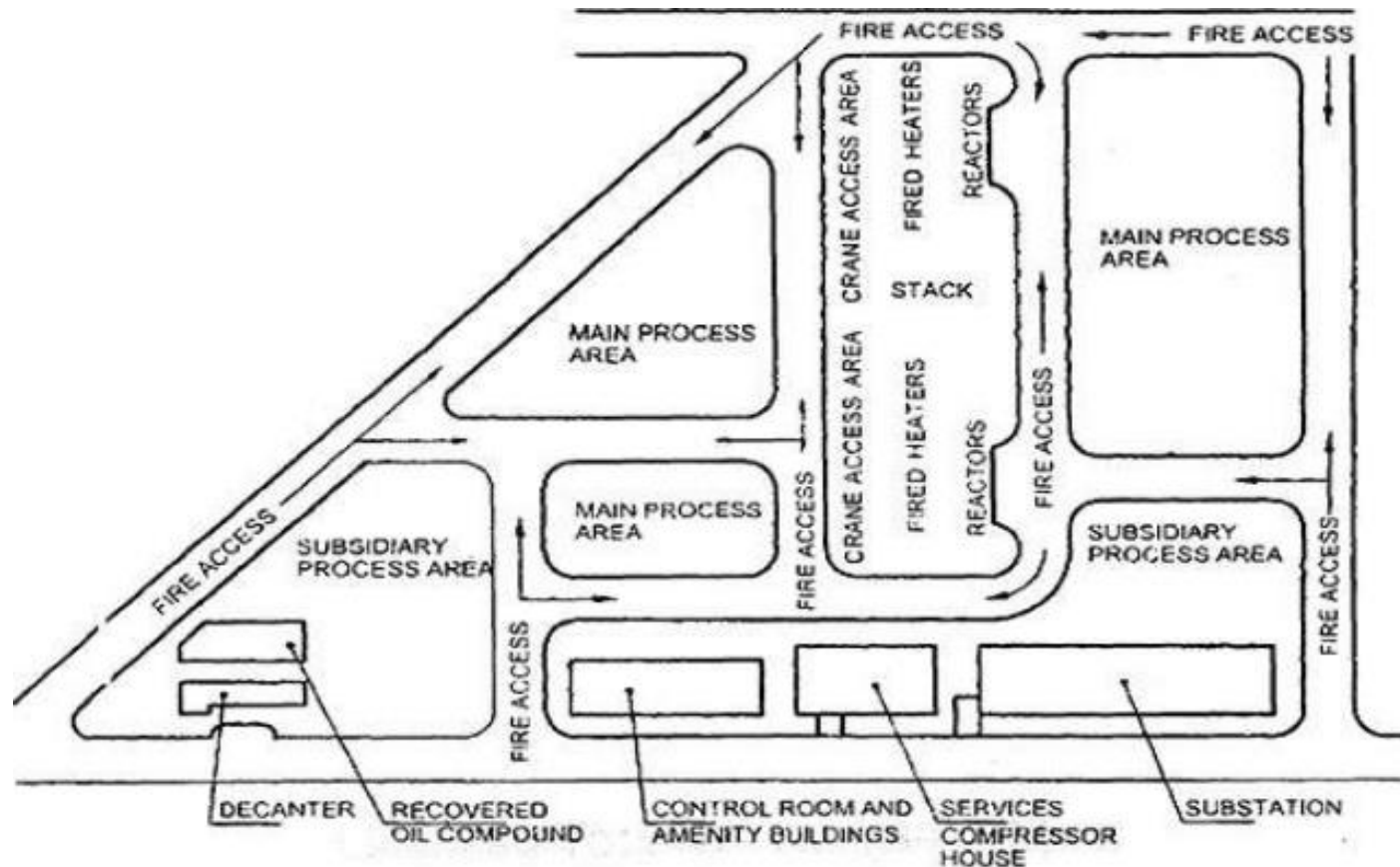
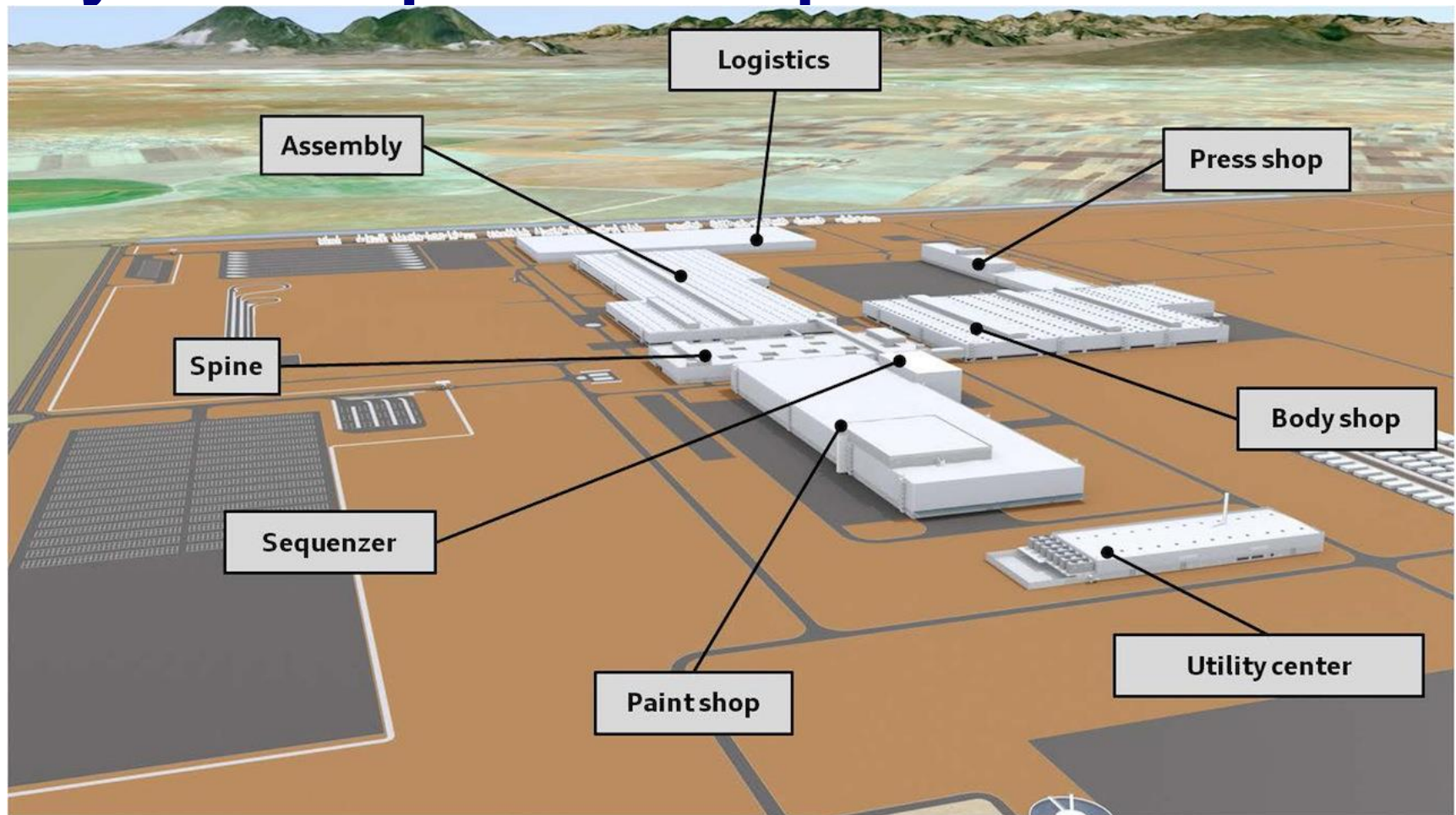
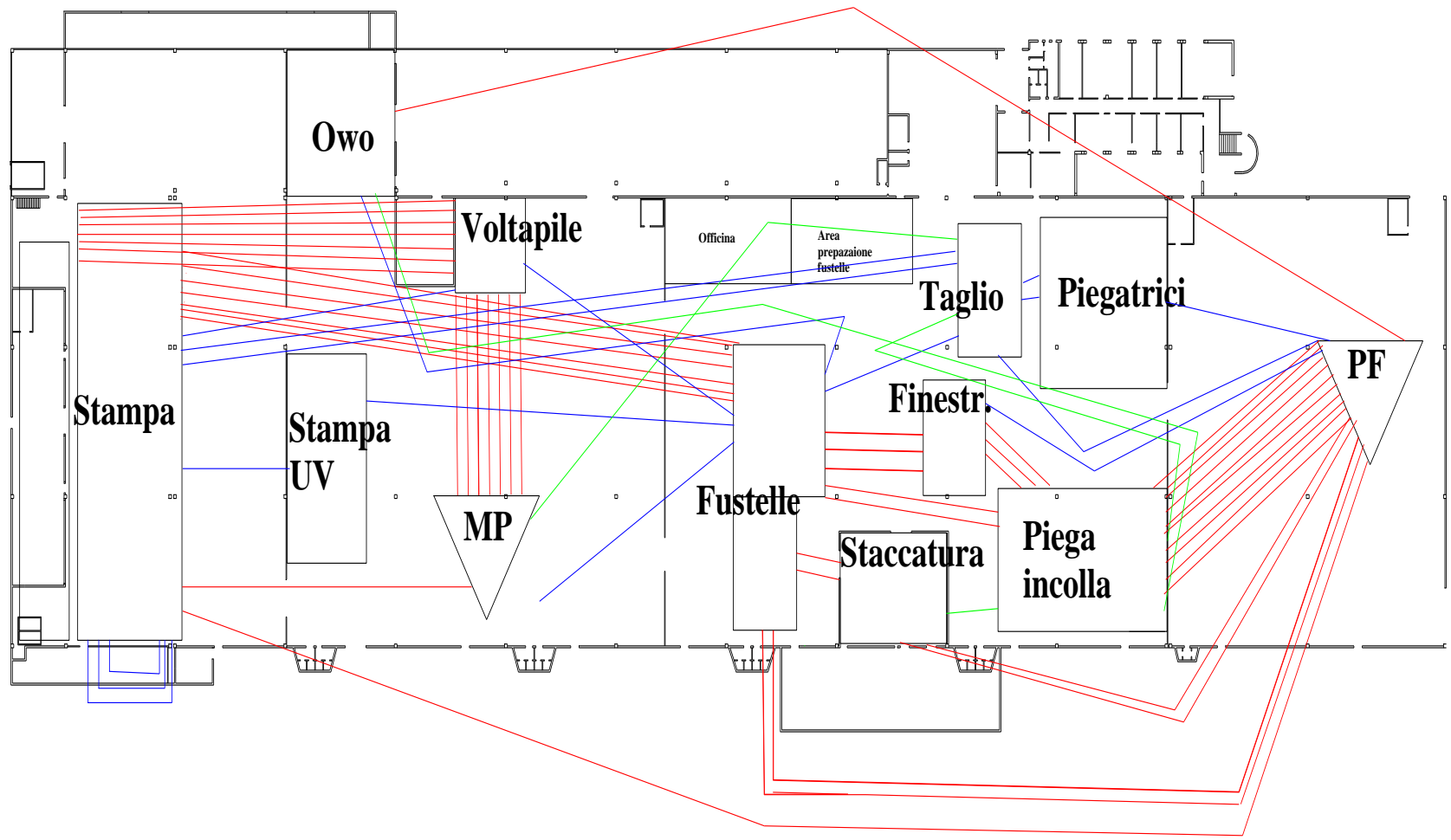


Fig. Layout System in the Process Area of a Petrochemical Plant

Layout of a production plant



Layout of a production plant



Procedural aspects

- It shows the operational aspects of a production process, by describing the different phases that constitute the operational procedure of production management.
- It includes the following phases:
 - ☐ (Aggregate) production planning
 - ☐ Material requirements planning
 - ☐ Production scheduling
 - ☐ Production control
- The typical tool is the *flow-chart*

