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 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 undergo a big change: the factory “with no light” happens to be a utopian
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

Time allowed to confirm a delivery date

Order transmitted by post

Order transmitted by fax

Order transmitted via the Internet

Evolution of ICT

1970  1985  2000

Anni
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?

Product volume

Product variety

Mass industrial production (up to c.1980)

Today

Handicraft production (up to c.1850)

Tomorrow?
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

Factors
- Operators
- Equipment
- Materials
- Data

Production process

$ and €

Energy

Products and services
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
Production of cement by 2 alternative processes

Alternative process based on cyclone pre-heating of raw meal

Alternative process based on granulation of raw meal
<table>
<thead>
<tr>
<th>Descrizione</th>
<th>Simboli</th>
<th>Distanza (m)</th>
<th>Tempo (sec)</th>
<th>Quantità (kg)</th>
<th>Osservazioni</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magazzino</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Gru a ponte</td>
</tr>
<tr>
<td>da magazzino a cesoiatura</td>
<td></td>
<td>30</td>
<td>60</td>
<td>Lotti di 2.500</td>
<td></td>
</tr>
<tr>
<td>Cesoiatura</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Spazio accanto a cesoia</td>
</tr>
<tr>
<td>Deposito intermedio</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Spazio accanto alla pressa</td>
</tr>
<tr>
<td>da deposito intermedio a presso-piegatura</td>
<td></td>
<td>20</td>
<td>45</td>
<td>2.200</td>
<td></td>
</tr>
<tr>
<td>Presso-piegatura</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Spazio accanto</td>
</tr>
<tr>
<td>Deposito intermedio</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Spazio accanto alla pressa</td>
</tr>
<tr>
<td>da deposito intermedio ad assiematura</td>
<td></td>
<td>25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assiematura</td>
<td></td>
<td></td>
<td></td>
<td>240</td>
<td></td>
</tr>
<tr>
<td>Controllo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Il controllo avviene</td>
</tr>
<tr>
<td>da controllo a saldatura</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>nello stesso luogo di</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>assiematura</td>
</tr>
<tr>
<td>Saldatura</td>
<td></td>
<td>30</td>
<td>600</td>
<td></td>
<td>Spazio accanto reparto di</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>saldatura</td>
</tr>
<tr>
<td>Deposito intermedio</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Spazio accanto reparto di</td>
</tr>
<tr>
<td>da deposito intermedio a verniciatura</td>
<td></td>
<td>20</td>
<td></td>
<td></td>
<td>verniciatura</td>
</tr>
<tr>
<td>Verniciatura</td>
<td></td>
<td></td>
<td></td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>da verniciatura a magazzino</td>
<td></td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magazzino</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Job: Requisition of petty cash

Details of method

- Requisition made out by department head
- Put in “pick-up” flag
- To accounting department
- Account and signature verified
- Amount approved by treasurer
- Amount counted by cashier
- Amount recorded by bookkeeper
- Petty cash sealed in envelope
- Petty cash carried to department
- Petty cash checked against requisition
- Receipt signed
- Petty cash stored in a box

Summary

<table>
<thead>
<tr>
<th>Summary</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations</td>
<td>6</td>
</tr>
<tr>
<td>Inspections</td>
<td>2</td>
</tr>
<tr>
<td>Transport</td>
<td>2</td>
</tr>
<tr>
<td>Delays</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
</tr>
</tbody>
</table>

Distance:
- 10 m
- 5 m
- 15 m
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*
The Flow-chart