UNIT 1: The digital Factory as an answer to the fourth industrial revolution

MODULE 4: Fundamentals of enabling technology applications

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Quality Control

Training Unit 1: The digital factory as an answer to the fourth industrial revolution

AFTER COMPLETION OF THIS UNIT, YOU WILL KNOW OR YOU WILL CAPABLE TO DO

Knowledge	Skill	Competence
• Provide an update state of the art of enabling technologies • Basic information for implementing an innovation process in a furniture company	• Good reading comprehension skills of the topic of Fundamentals of enabling technology applicationsf • Flexible attitude towards changing circumstances (sectoral, design, production, innovation, history etc.) and acknowledgement of the constant need to learn new skills and new concepts in a changing environment; • Problem identification, creative search for solutions, ability to follow logical inferences	• Knowledge of new technologies for furniture sector; • Design and plan a strategy for application of new technologies in a company; • Capacity to identify the best solution in terms of new technologies;

1.1:Introduction Context

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TOPICS 1.

1. Introduction Context

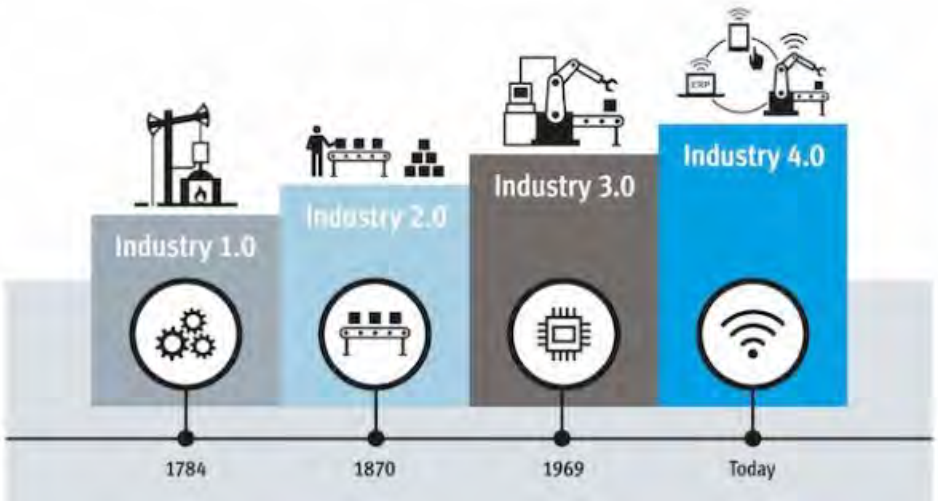
2. The component of Digital Factory

3.Man in the digital Factory

4. Risks of The Industry 4.0

The fourth industrial

revolution is defining new production needs that every company must consider as such in order to remain competitive in the markets.



- Innovation
- Light organizations
- Disjointed organizations
- Economies of personalization
- Services
- Connectivity

1.2: *The digital Factory and Industry 4.0*

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The digital Factory

Automated Systems

Digitalization of the decentralized factory system/supply chains

Differentiated utility for functions and competences

1.2: *The digital Factory and Industry 4.0*

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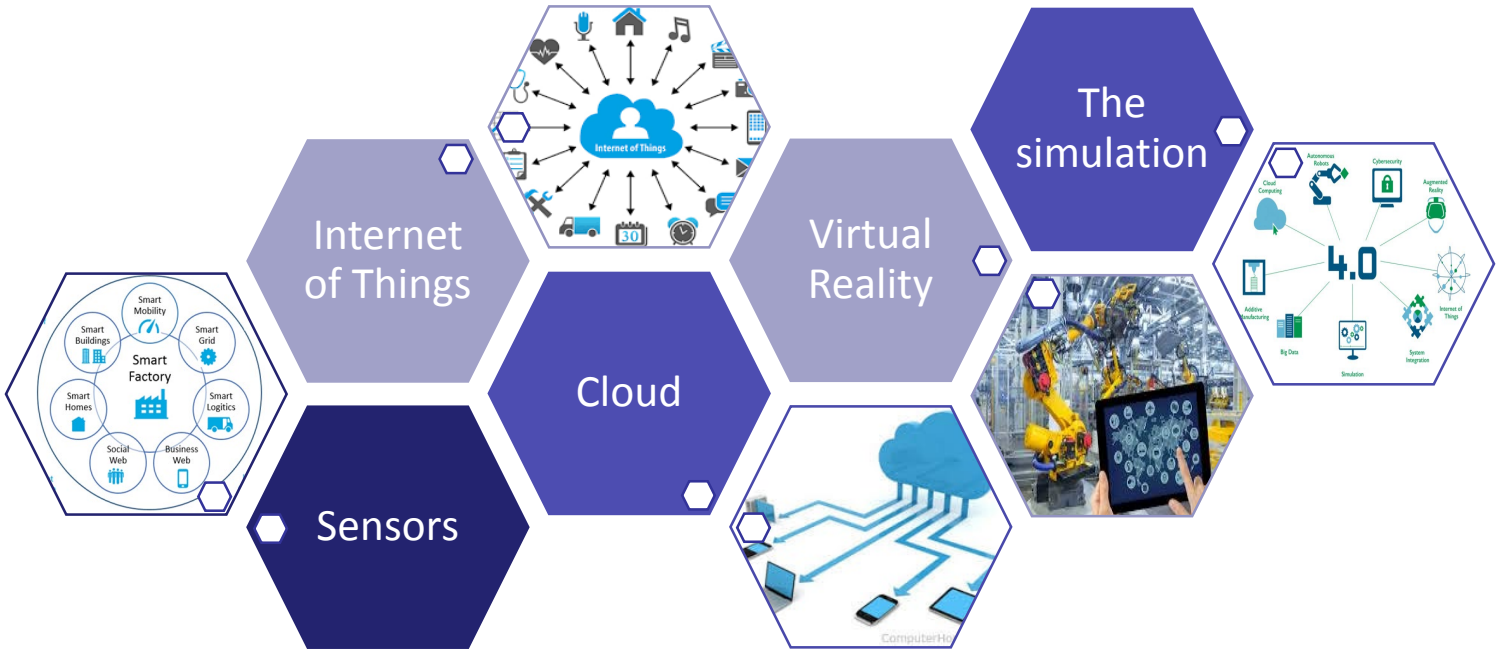
The components of the digital Factory



Characteristics of Digital Factory:

- Interoperability
- Decentralization
- Data as a company asset
- Development of new business models

1.3:Risks and Critical issued of The Industry 4.0

Training Unit 1: Principles of Total Quality Management

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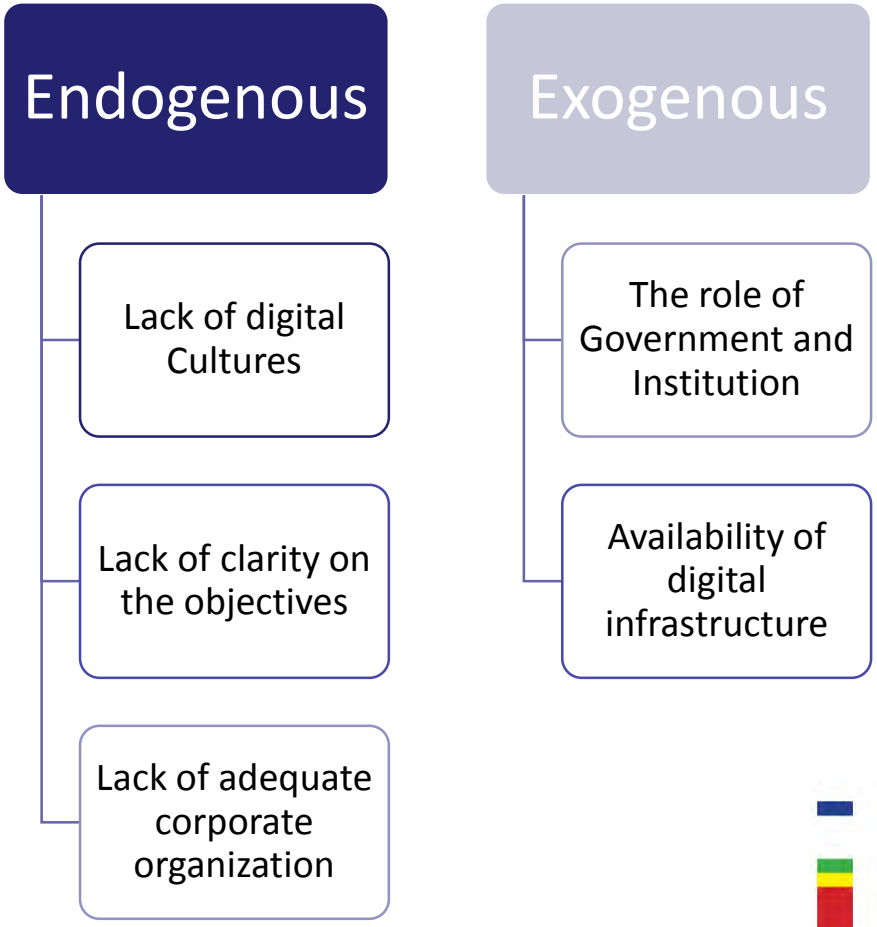
Risks of Industry 4.0



UNIT 2:Enabling Technologies of Industry 4.0

MODULE 4: Fundamentals of enabling rechnology applications

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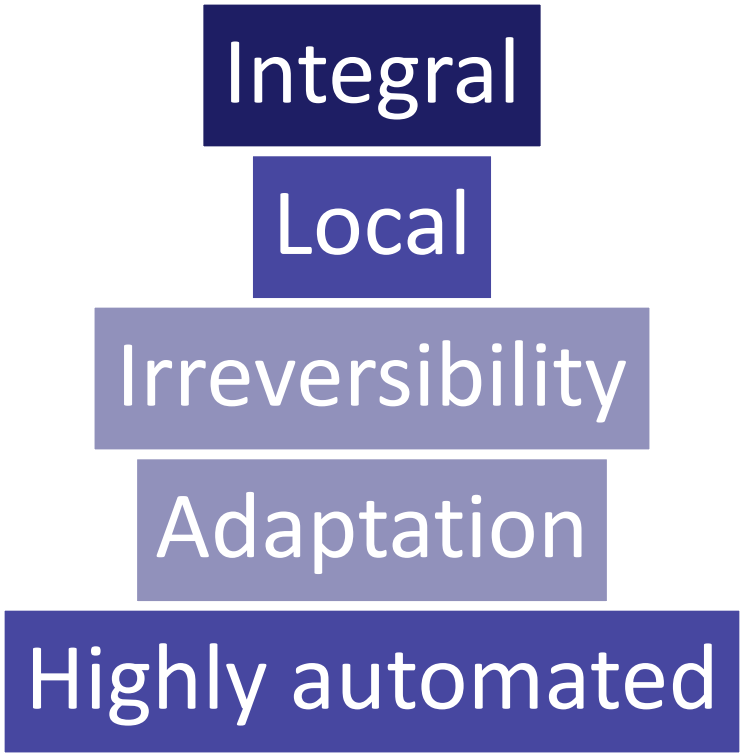
TOPICS 2.

1. Cyber physical system
2. Enabling technologies of Industry 4.0

Cyber physical system

Systems where sensors, machines, work pieces and IT are connected along the value chain, beyond the single company.

Characteristics:



Company Capabilities:

- Smart Connection
- Data-to-Information conversion
- Digital Twin
- Cognition
- Configuration

Enabling Technologies of Industry 4.0

Data Analysis Technologies	Big data and Analytics: analysis of a large volume of data in order to optimize products and production processes
	Internet of Things: the set of equipment and devices, other than computers, connected to Internet.
	Cloud: management of large volume of data on open systems
	Cyber-security: safety during network operations and on open systems
Manufacturing Technologies	Advanced automation: Collaborative interconnected robot
	Additive manufacturing: (3D visualization, 3D prototypes)
	Augmented reality: augmented reality supporting productive processes
	Simulation: between interconnected machines in order to optimize processes
	Computer aided designed: simplify the manufacturing process by transferring detailed diagrams of a product's materials, processes, tolerances and dimensions with specific conventions for the product in question
Smart factory	Smart integration: integrated production organism, WMS, ERP
	Smart Planning: Inventory management, production and distribution planning

Unit 3. Big Data

MODULE 4: Fundamentals of enabling rechnology applications

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TOPICS 3.

1. Big data definition
2. Characteristics
3. Applications

Big Data

refers to a large volume of data that daily flood a company

Volume

- Availability of data

Variety

- Different types

Velocity

- Continuous availability of data

Variability

- Changes in data structure

Value

- Data are business values that offer organization advantages

Unit 4.1 The technologies of Internet of Things

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TOPICS 4.

1. Internet of Things
2. Characteristics
3. Advantages of IoT

The Internet of Things

"A mega network in which all the objects that surround us are connected to the network and interconnected, thus taking the name of smart objects, i.e. intelligent objects"

These allow the collection and exchange of data in real time, providing information that we did not have access to before

Main advantages

- Improvement of the Overall Equipment Effectiveness
- Improvement of Factory Logistics
- New potential for automation and control
- Cost Reduction
- Improvement of the remote control methods

4.1:Cybersecurity

MODULE 4: Enabling technologies

Training Unit 1:The digital Factory as an answer to the fourth industrial revolution

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With industry 4.0, companies and public bodies must invest more and more on the protection of cyber physical systems

Damages deriving from its omission :

- damage to production (including sabotage);
- damage to intellectual property;
- damage to industrial infrastructure;
- damages to natural persons (including employees and customers);
- damage of reputation and image.

It is necessary to design the system, the plant and the infrastructure, keeping in mind the issues related **to cyber security**

Learnint Unit 5. Cloud Systems

MODULE 4: Fundamentals of enabling technology applications

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TOPICS 5.

1. Cloud Computing
2. Characteristics
3. Service models and distribution models
4. Vertical and horizontal integration

Cloud

Cloud computing
is a model to enable access ubiquitous, convenient and
on-demand to the network, to a shared sea of configurable
computing resources (e.g. Networks, servers, storage, applications and services) that
can be provided and released quickly with minimal management effort or interaction
with the service provider.

- Self service
- Global accessibility
- Grouping of resources
- Immediate elasticity
- Measurability of services

Service and Distribution Models

Service models

- Software as a Service (SaaS)
- Platform as a Service (PaaS)
- Infrastructure as a Service (IaaS)

Distribution models

- Private Cloud
- Community Cloud
- Public Cloud
- Hybrid Cloud

Vertical and Horizontal Integration

The key features of Industry 4.0 include horizontal integration through valuable networks to facilitate collaboration between companies, vertical integration of hierarchical subsystems within a factory to create a flexible and reconfigurable production system.

.

Horizontal integration
refers to the integration between a resource and a network of information within the value chain, in order to obtain perfect cooperation between companies and provide a product and a service in real time.

Vertical integration
refers to networked production systems within the intelligent factories of the future and to customized production as an alternative to traditional fixed production processes, such as the production of assembly lines

Learning Unit 6. Manufacturing technologies. Autonomous Robot

MODULE 4: Fundamentals of enabling technology applications

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TOPICS 6.

1. Autonomous Robot
2. Simulation
3. Augmented Reality
4. Additive manufacturing
5. The maker-movement

Autonomous Robots

An **autonomous robot** is a **robot** that performs behaviors or tasks with a high degree of **autonomy**.

In the Industry 4.0 paradigm, robots collaborate with human operators for the execution of production processes can already be and will be a fundamental resource .

The man-robot cooperation technologies aim to offer operators natural methods of use and a high level of confidence in machine functions such as reliability and safety.

Simulation

The simulation
is a very important **analysis tool**, thanks to which it is possible to overcome the difficulties or the impossibility that are faced in a real laboratory.

Advantages:

- reduce time and costs associated with planning;
- manage company know-how, using simulation to gain experience and manage results so that they become a reusable asset;
- maintain a sustainable competitive advantage over time by constantly innovating and at the same time reducing the risks related to innovation.

In order To accelerate the development of increasingly smart products, the extension of the use of simulations to the entire product life cycle has become strategic. In this way it is possible to obtain useful information digitally to make the best engineering choices at every stage of the process.

Augmented reality

It refers to the enrichment of the human sensory perception by means of information, typically manipulated and conveyed electronically, which would not be perceivable by the five senses.

It can be applied:

Production

- Installation, assembly, equipment change on machine tools are just some of the processes in which AR can make the difference by making the factory truly intelligent.

Remote maintenance and assistance

- AR is extremely effective in reducing execution times, minimizing human error and sending relevant statistics to maintenance managers.

Training

- The benefits are appreciable both on new staff to be trained and on expert technicians to be trained on new operations.

Quality Control

- With the support of the AR in quality control processes, it is possible to check whether the produced objects respect the best production standards or not.

Safety Management

- Augmented reality makes available the tools necessary for the management of risks and safety of operators and goods within companies.

Design and Visualization

- Augmented reality comes into play providing tools that can improve design and prototyping.

Logistic

- AR tools can improve the efficiency in the management of warehouses, especially large ones, during loading and withdrawal operations.

Additive manufacturing

Additive Manufacturing
is the name of a whole series of manufacturing techniques and technologies in which the finished product is formed without the need to melt the material into moulds or to remove it from a raw form.

Additive manufacturing can be used to:

- Improve Quality
- Increase Flexibility
- Reduce costs

It is a process of joining materials to create objects starting from a 3D (virtual) model and then printing layers of materials in succession,

The maker-movement

From mass production logics to

Mass customization logics

The final consumers become protagonists of the manufacturing taking on the role of product designers, but also of designers and producers, being recognized as prosumer.

The customer becomes a co-designer, using the company's ability to create a unique individualized solution

“Maker" describes each of us, no matter how we live our lives or what our goals may be.

Today's makers enjoy a level of **interconnectedness** that has helped to build an entire movement, recognized as "**Maker Movement**.

Learning Unit 7 Computer aided design

MODULE 4: Fundamentals of enabling technology applications

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TOPICS 7.

1. Computer Aided Design
2. Main advantages
3. 3D Visualization

Computer aided design (CAD)

Computer-aided design (CAD) refers to the use of computer programs for creating graphical representations in two or three dimensions (2D or 3D) of physical objects.

CAD is also used throughout the engineering process, from conceptual design and product set-up to dynamic assemblies and assembly resistance to the definition of production methods

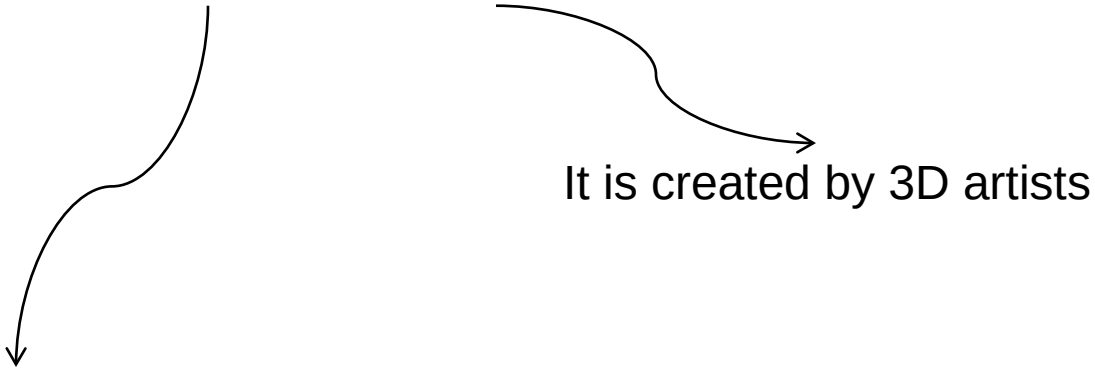
The main advantages of using CAD software are:

- reducing product development costs, increasing productivity, improving product quality and accelerating time-to-market;
- the accurate visualization of the final product, the sub-assemblies and components within a cad system optimize the design process;
- CAD software offers the maximum precision, contributing to minimize the errors;
- It allows easy re-use of the design and best practice data.

3D visualization

The term 3D visualization is used synonymously with 3D graphics, 3D rendering, computer generated imagery (CGI), and other terms.

They all basically refer to the process by which graphical content is created using 3D software



It is created by 3D artists

3D visualization enables users to understand projects and data better and take the guesswork out of the analyses of 2D images

Learning Unit 8. Computer aided Manufacture (CAM) and cutting optimization system

MODULE 4: Fundamentals of enabling technology applications

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TOPICS 8.

1. Computer Aided Manufacture (CAM)
2. Advantages
3. Cutting optimization systems

Computer aided Manufacture (CAM)

Computer-Aided Manufacturing (CAM)
is commonly understood as the use of numerical control software applications (NC) for the creation of detailed instructions (G code) required for CNC machine tools for machining parts/pieces

The definition of CAM includes the use of computer applications to define a plan for the design of equipment, the preparation of the CAD model, the programming of the numerical control, the programming of the measurements with CMM machines, the simulation of the machine tool or post-processing.

Main advantages:

- Optimization of the production equipment
- A support to creation, verification and optimization of CNC programs
- Provide data production management
- Generate the machine tool instructions
- A graphic simulation of the generated tool path
- It is capable to send data to the numerical control of the machine tool.

Cutting optimization of materials and parts

Cutting optimization of all materials and parts	Cutting optimization of processes and technologies
• Flat cutting of materials in sheets or plates: sheet metal (steel, aluminium), wood panel, plastic panel, textile width; • Tri –dimensional cutting of formed and folded metallic parts; • Tube cutting (linear or tri-dimensional); • Bar and profile cutting (linear or tri-dimensional); • Cutting of parallelepiped materials: foam, polystyrene, marble, wood.	• Linear cutting (for example sawing of bars and profiles) • Edge-to-edge rectangular cutting (for example sheet-metal shearing, wood-panel cutting for woodwork • Flat cutting following contours and fluid jet cutting of parts of any shape (laser, plasma, water jet cutting of parts of any shape • Punching-nibbling. • Multi-Layer cutting following contours in 2D or 2.5D • Milling or routing of tender materials (wood, plastic, aluminium) • Cutting with hot wire or blade of parallelepiped blocks.

Learning Unit 9. 3D printing

MODULE 4: Fundamentals of enabling technology applications

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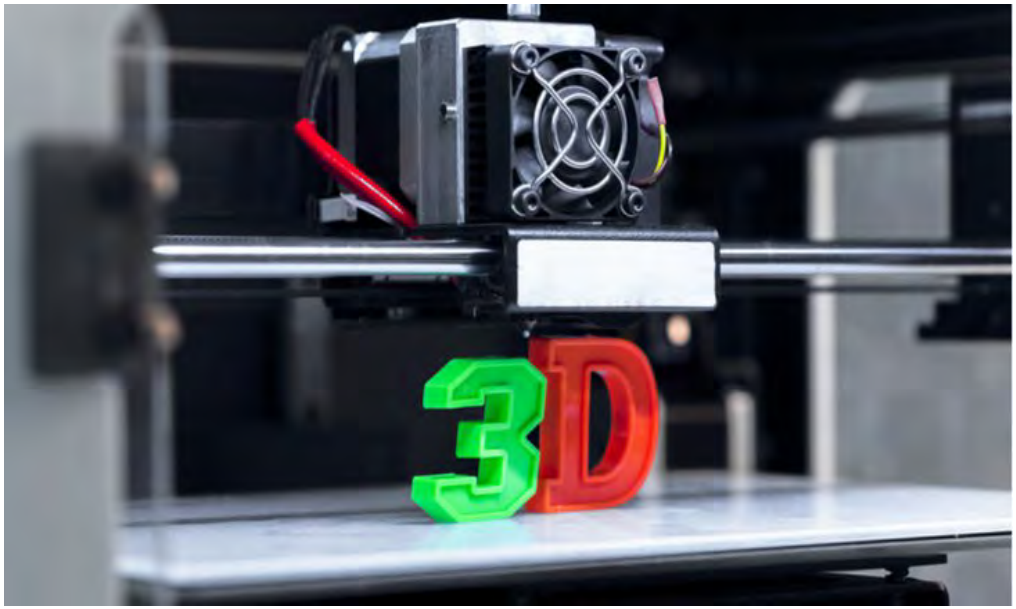
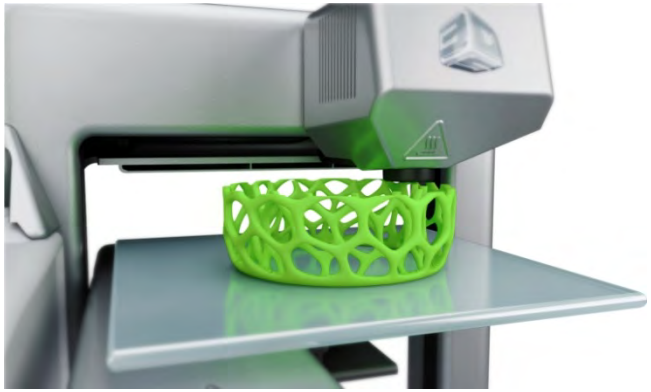
TOPICS 9.

1. 3D printing
2. Advantages and disadvantages
3. Application fields of 3D printing

3D printing

3D printing
is a production method which, using very different technologies, allows the creation of objects (component parts, semi-finished or finished products) generating and adding successive layers of material, thus classifying itself as an additive manufacturing; this contrasts with what happens in many traditional production techniques in which one proceeds by subtraction of material.





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3D printing

Main advantages

- Speed
- Single phase production
- Custom
- Easy Access
- Storage and Transportation
- Sustainability
- Cost Reduction (Labor and Transportation)

Main disadvantages

- High costs of Material
- High costs of Machines
- Limited material
- Questionable accuracy
- Complexity and Freedom of design
- Risk migration

Main application fields:

- Prototype
- Aerospace
- Automotive
- Medicine
- Architecture
- Buildings

Learning Unit 10. Manufactoring and production information system

MODULE 4: Fundamentals of enabling technology applications

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TOPICS 10

1. Production
2. MES
3. PLM
4. Types of manufacturing and production information system

Manufactoring and Production information system

Manufacturing Execution Systems (MES): it is important to monitor all stages of production., (including production orders, distinct of picking, work cards, preventive verification of pick-up, work progress, detection times, management of testing and approval areas), both at the company and at external suppliers level.

PLM (Product Lifecycle Management), a too
made up of software capable of managing th
mass of data related to a product throughou
its cycle of life.

With the PLM it is possible to manage and visualize the three-dimensional virtual prototypes of the factory, and in this way, who is called to decide is put in a position to see what will be and the indications to reach the desired result, avoiding costs and times much longer than the classic systems.

Manufacturing and Production information system

Some types of manufacturing and production system are:

- **Production scheduling**. This system schedules the use of manufacturing facilities to produce products most efficiently.
- **Material requirements planning (MRP)**
- **Manufacturing resource planning (MRP II)**
- **Just-in-time (JIT**) inventory management

Learning Unit 11. Material requirements planning (MRP) and Manufacturing resource planning

MODULE 4: Fundamentals of enabling technology applications

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TOPICS 11

1. MRP
2. Components
3. MRP II

MRP

Materials requirements planning
is a computer-based inventory management system designed to assist production managers in scheduling and placing orders for items of dependent demand.

The purpose of this system is to determine what parts and materials will be needed during the manufacturing process and when they will be needed.

Bill of materials

Production scheduling system

Inventory Records file

The main benefits are:

- helping production managers to minimize inventory levels and the associated carrying costs, track material requirements,
- determine the most economical lot sizes for orders, compute quantities needed as safety stock,
- optimise production time among various products, and plan for future capacity needs

MRP II

Its combines MRP with production scheduling and other functions in comprehensive manufacturing information system

MRP II is a computer-based system that can create detail production schedules using real-time data to coordinate the arrival of component materials with machine and labour availability.

Both MRP and MRP II are seen as predecessors to Enterprise resource planning (ERP), which is a process whereby a company, often a manufacturer, manages and integrates the important parts of its business.

Learning Unit 12. Inventory control Systems

MODULE 4: Fundamentals of enabling technology applications

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TOPICS 12

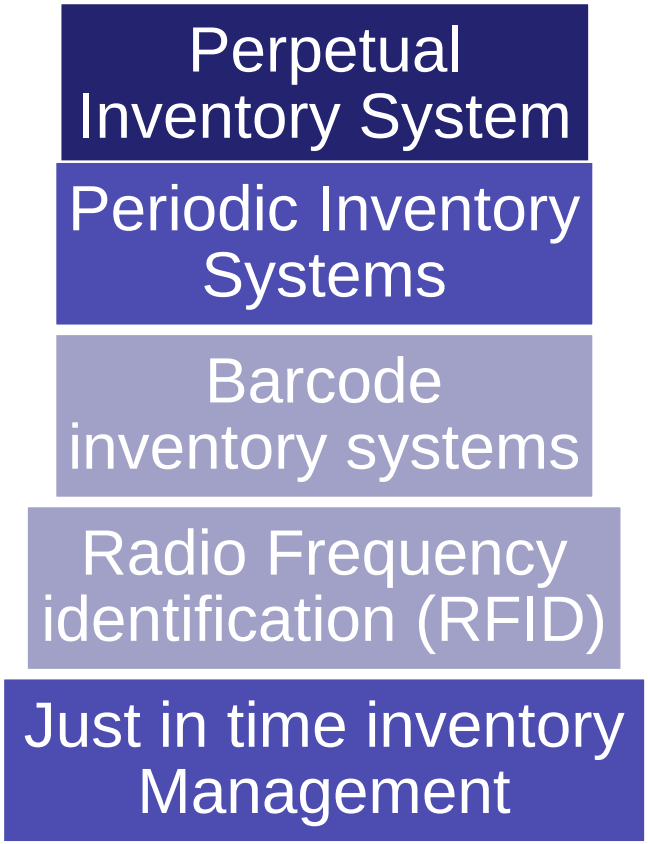
1. Inventory control systems Components
2. Main components
3. Typology of inventory systems

Inventory Systems

Inventory control systems
are technology solutions that integrate all aspects of an organization's inventory tasks, including shipping, purchasing, receiving, warehouse storage, turnover, tracking, and reordering

The main components of Inventory Control System are:

- A systems for identifying inventory items and their information including barcode labels;
- Hardware tools for scanning barcode labels
- A central database for all inventory in addition to the ability to analyze data, generate repost and forecast demand
- Reporting Inventory with a proven methodology like just-in-time, ABC analysis, first I, or first out (FIFO), or last-in-first-out (LIFO).



Learning Unit 13. The Sales Order Processing System

MODULE 4: Fundamentals of enabling technology applications

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TOPICS 13.

1. Sales order processing system
2. Main Advantages

The Sales Order Processing System

It is a comprehensive System
covering and supporting the selling needs
throughout its entire life cycle from Proposals,
Orders, Deliveries, Invoices, Returns and Point of
Sales, and the whole system can be monitored
live

The main advantages are:

- Flexibility
- Simply to use
- Customize Reporting
- Integrated
- Multichannel
- Error Free
- Visibility of the complete sales process
- Real time tracking of orders
- Promote better customer relations and cross-sell

Learning Unit 14. Warehousing and Distribution System

MODULE 4: Fundamentals of enabling technology applications

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TOPICS 14

1. Logistic 4.0
2. Warehouse Management system
3. Main advantages

Warehousing and Distribution System

The logistics 4.0 should meet the needs of the market or highly customization of products, able to "communicate" with the customer providing the most information possible, and that are delivered in the shortest time always respecting the delivery times.

Main advantages of the introduction of the WMS are:

- the optimization of goods handling times (and the possibility of managing goods with a specific logic, identified a priori, LIFO, FIFO, FEFO etc.);
- the reduction in order processing times (e.g. through the determination and the suggestion to the operator of the withdrawal round to be carried out);
- the rationalization of spaces, thanks to the possibility of storing any item in any location without the risk of forgetting where the goods have been stored;
- the reduction of recourse to the historical memory of the operators, in fact, at any moment it is known exactly where the goods are located or where the goods are located
- the reduction of paper supports (e.g. the picking lists are displayed directly at the terminal without needing to print them);
- the possibility of consulting stock data in real-time;
- the possibility of having updated statistics on the operation of the warehouse
- the reduction of errors due to manual management, thanks to the confirmation of the operation, and therefore a reduction of the related
- hidden costs (e.g. the non-fulfilment, partial or total, of the order

Example: Kanban System

Learning Unit 15. Enterprise resource planning

MODULE 4: Fundamentals of enabling technology applications

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TOPICS 15.

1. ERP systems
2. Advantages

Enterprise resource planning

It is an application system that is well-poised to help drive the success of these emerging technologies

The ERP system allows to:

- Automate and integrate most of the business processes
- Share information and practices across the entire enterprise
- Produce and use information in real time.

Learning Unit 16. Customer Relationship Management

MODULE 4: Fundamentals of enabling technology applications

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TOPICS 16

1. CRM
2. Main advantages

CRM

The CRM system is a tool that helps managing contacts and sales, productivity and much more

- CRM system allows companies to manage the business relationships, data and information associated with them.
- CRM systems connect information about customers from various sources, including e-mails, websites, physical stores, events, call centres, mobile sales and online marketing and advertising efforts, etc.

The main advantages are:

- An easier research of all the contacts that work for the same company and all the interactions (like messages) that have been activated about your work with this one

- Getting a larger picture of your contacts and you'll know exactly what to talk the next time you meet or email any of the contacts in the application.
- Any CRM system is built around people and embraces their relationships

- A CRM system is an internal marketing and sales network that helps you understand your current customers and your future customers.
- A CRM helps companies stay in touch with customers in a systematic way, simplifies and makes processes efficient and improves profitability.
- CRM solutions are open and can be integrated with other business tools, such as document signing, accounting and billing, so that information can give you a true 360-degree view of your customer.

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