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وزارة التعليم العالي والبحث العلمي
جامعة وهران للعلوم والتكنولوجيا محمد بوضياف
People's Democratic Republic of Algeria
Ministry of Higher Education and Scientific Research
University of Sciences and Technology Oran Mohamed BOUDIAF
Faculty of Physics
Department of Energy de Physics



COURSE HANDOUT

Professions in Science and Technology 1

PST 1

Intended for first-year undergraduate students (LMD) L1-ST:

Option: **Science and Technology ST**

Elaborated by :

Dr. **GHALEB Fatiha** Lecturer A, USTOMB

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Introduction

INTRODUCTION

This syllabus, defined by the Ministry of Higher Education and Scientific Research, will serve as the table of contents for our course handout, offered to first-year undergraduate students, entitled: Professions in Science and Technology (MST1).

Semester time: 22.5 hours; Weekly time: 1 hour 30 minutes; (1 hour 30 minutes of lectures)

Coefficient: 01; Credit: 01.

This handout is divided into five main chapters:

Chapter 1: What are engineering sciences?

The first chapter provides a detailed overview of the engineering profession, including its history, a thorough description of the main activities, and the skills required for these jobs. Additionally, we will discuss how to search for a job and how to read and interpret job advertisements.

Chapter 2: Sectors of Electronics, Telecommunications, Biomedical Engineering, Electrotechnics, Electromechanics, Optics & Precision Mechanics:

Our second chapter is focused on a range of fields, including electronics and telecommunications, biomedical engineering, as well as electrical engineering and electromechanics, and finally optics and precision mechanics. We will present the specialties of each domain.

Chapter 3: Sectors of Automation and Industrial Engineering

This chapter introduces the fields of industrial automation and robotics systems, as well as storage management and goods traffic. We will discuss the quality and the role of the specialties in these areas within the labor market.

Chapter 4: Sectors of Process Engineering, Hydrocarbons and Petrochemical Industries

In this chapter, we briefly present the various sectors of the pharmaceutical, agri-food, and textile industries, as well as biotechnology. We detail the petrochemical and plastics domain, and we also discuss the energy sector (oil and gas) in Algeria and around the world.

Introduction

Chapter 5: Sustainable development (SD)

This last course presents definitions and global challenges, climate change and demographic transitions, depletion of resources (oil, gas, coal, etc.), loss of biodiversity, etc. It includes the Sustainable Development diagram (Sustainable = Viable + Livable + Equitable), the actors of Sustainable Development (governments, citizens, the socio-economic sector, international organizations, etc.), and the global nature of Sustainable Development challenges.

We will summarize this document with additional questions (Appendix) as well as a rich bibliography.

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PREFACE

This course booklet on careers in science and technology consists of several chapters. Its primary goal is, first, to introduce students to the various fields covered by the domain of science and technology. Next, it presents a variety of careers accessible through these fields. At the same time, this course also addresses the new challenges related to sustainable development and the emerging professions that arise from it.

Many students in the common core of Science and Technology (ST) are not familiar with the meaning of this domain or the careers associated with it. Why do we study this subject? The simplest answer is that this module has several important objectives. First and foremost, it allows students to discover the different careers available in these ST fields, as well as the roles and responsibilities associated with each profession.

Additionally, this course helps develop essential skills, both technical and non-technical, such as problem-solving, critical thinking, and teamwork. It also prepares students to enter the job market by informing them about employer expectations, industry trends, and job opportunities. Furthermore, students are encouraged to innovate and think about projects that could have a positive impact on society. The course also addresses contemporary issues such as sustainable development, technological ethics, and the social responsibility of professionals in the sciences and technology.

Finally, it serves as a tool for career guidance, helping students better understand their interests and make informed choices for their future. In summary, this course on careers in science and technology prepares students not only for specific careers but also offers them a broader perspective on the impact of these professions on our society and environment.

This teaching takes place during the first semester (S1) at the Faculty of Physics, in the Department of Basic Physics Education, and is intended for first-year undergraduate students in the field of Science and Technology (ST). It allows for a deeper exploration of certain foundational concepts already presented in class sessions. These texts have been developed for the training of LMD students.

Any comments, suggestions, or constructive critiques aimed at improving and enhancing this booklet will be welcomed with great pleasure.

Chapter I: What are engineering sciences?

Contents of Chapter I

The engineering profession, history and challenges of the 21st century, Search for a profession/recruitment advertisement by keyword, develop a simple job description (job title, company, main activities, required skills (knowledge, know-how, relational.

I.1. Engineering sciences:

Engineering sciences (IS) are sciences applied to complex technological objects (phones, connected cars and planes, etc.), as opposed to more theoretical sciences such as mathematics and physics. They give pride of place to the concrete and the implementation of solutions.

Engineering sciences are aimed at scientists whose activity is centered not on fundamental research, but on the production of products meeting certain identified needs of society. They therefore require technical skills and allow you to work on concrete projects. Engineering sciences will appeal to intellectuals who also have a sense of reality and profitability. This may involve, for example, improving the energy performance of homes, working in bionics on prostheses, drones, humanoid robots, improving medical imaging solutions or the mechanical properties of a machine. Engineering science students work a lot on computers to analyze and model systems.

I.2. The profession of engineer

« Equipped not only with technical and managerial skills, the engineer must know how to demonstrate versatility and adaptation in a context that has become international ». En français

« Doté non seulement de compétences techniques et managériales, l'ingénieur doit savoir faire preuve de polyvalence et d'adaptation dans un contexte devenu international ». Par Karine Darmon

I.3.What does it mean to be an engineer?

The engineer? The very person who is responsible for solving technological problems, concrete and often complex, linked to the design, production and implementation of products, systems or services.

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Today, behind this term, there is a wide diversity of professions: computer engineer, business engineer, research and development engineers, design engineer, test engineer, sales engineer, materials engineer, design engineer, aeronautical engineer, methods engineer, structural engineer, agronomist engineer...

I.4. Why become an engineer?

Because it is the main engine of innovation! Its role **consists of designing, coordinating and implementing technical solutions** within constraints of time, resources and compliance with regulations. **An engineer must be able to take risks**, control, direct, invent, innovate, predict, decide, act and create activity.

What is the profession of engineer? All in all, **beyond the necessary scientific skills**, he also has technological, financial, commercial/purchasing, logistical, managerial, legal and social skills. Rigors, organization, precision of reasoning, method are also qualities expected by recruiters, as much as knowledge.

I.5. History and challenges of the 21st century:

The volume of knowledge doubles every 5 years. The world is changing and it is changing faster and faster, exponentially. Alongside the destruction of biodiversity, climate change and the widespread pollution of our planet, we must really realize that humanity is also threatened by the depletion of our oil, mineral, aquatic and fishery resources. It is becoming extremely urgent to develop a new vision of our relationship with the Earth because we risk seeing numerous conflicts erupt in the near future over territories, food, water and even oil.

More than ever, the world needs real engineers, people who give of themselves and are committed to creating positive change in them, in others and for the Earth.

We have entered a very particular period of history filled with challenges that are both unprecedented and colossal while, at the same time, we have at our disposal the tools to transform these perils into opportunities. As a species, the choices we make and the directions we take will be crucial. We must now take matters into our own hands, and Humanity needs a true engineer more than ever.

I.6. Who will be the engineers of tomorrow?

Almost all Western countries feel a cruel lack of engineers and fear the disappearance of the “building spirit”. Germany, Denmark and the United Kingdom are among the countries which regularly alert their opinion to the risks of the current slope. Developing countries are also

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worried. In sub-Saharan Africa, UNESCO warned in 2010, 2.5 million new engineers and technicians would be needed to achieve the “millennium goals” regarding access to water and the quality of public hygiene in 2015. . Certainly, China, India and South Korea display triumphant statistics on the progression of their population of graduates, as do certain countries in Central Europe, such as Poland. Second-tier emerging countries, such as Mexico or Turkey, are also starting to catch up. But if we consider the entire planet, the deficit of engineers seems very real.

I.7. Where does this deficit come from?

It is firstly part of a lack of attractiveness of all scientific professions, and with them studies perceived as difficult, dry and unpromising in terms of remuneration. This vocations crisis is taking on worrying proportions in developed countries. The European **ROSE (Relevance Of Science Education)** survey regularly analyzes the interest and motivations of 15-year-olds for scientific and technical careers. However, for several years, we have seen in developed countries a progressive disaffection among younger generations for these professions.

The engineering profession is particularly affected. Researchers and politicians put forward different arguments to understand this movement, starting by putting into perspective the historical exception that constituted their extraordinary development in the 20th century, linked to the phases of industrialization which preceded (the United States) and followed (Europe)). The Second World War. The apotheosis of the engineer was that of the building spirit, where the challenge was to build a country: build bridges, highways, industries, launch automobile models, launch rockets, structure and integrate savings. Today the most dynamic phase of this construction has been completed in developed countries, and industry is losing momentum in the face of the development of services, which consume a growing share of scientific graduates. The figure of the builder in the service of national development is fading in favor of other figures, more hedonistic, more mobile and cosmopolitan, more individualistic too, to whom the media make more space. Engineering professions thus suffer from competition from other sectors, such as finance, which also absorb part of the workforce leaving school.

I.8. Search for a profession/recruitment ad by keyword

Writing a relevant application requires first and foremost a good understanding of the job offer. But how to decipher an ad to provide a tailor-made response? Sending an application without having taken the time to dissect the advert is almost like throwing a bottle into the sea: your efforts will be doomed to failure and you will waste precious time. To write a relevant CV and a convincing cover letter, the fruits of an effective application, there are no

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secrets: you must carry out an in-depth analysis of the advert.

But what is the information to identify? And how can you read between the lines of the ad?

Anatomy of a job offer.

First of all...

In a job offer, each sentence carries information and nothing is written randomly. So take the time to read each of them several times and identify the keywords, that is to say the words that should appear in your application.

In terms of structure, the vast majority of advertisements are distributed as follows:

- A summary of the company and the sector in which it operates
- The working framework and the proposed missions
- The desired profile as well as the chosen skills ("You are...")

1.8.1. Analyze the business closely

The first step is to analyze the business and ask you some questions. What is the sector in which she operates? What products or services does it sell? Is she part of a group? Where is it?

Also pay attention to the size of the company. Start-ups favor flexible profiles with extensive experience, while large international groups have a preference for people from other large groups. This can allow you to make an initial selection of the information to highlight in your CV.

Next, try to identify the tone used in writing the ad. Is it classic or more offbeat? Are there any puns? By using the company codes when writing your cover letter and also during the interview, you already stand out from other candidates.

Sometimes, the announcement does not specify the name of the company to hide current recruitment from competitors or employees. But it is clearly indicated, do not hesitate to do research on social networks, the website or in media that talk about the company. The objective is to build up a pool of information about the company.

1.8.2. Zoom on the post itself

Once you have analyzed the company and what revolves around it, focus on the missions offered and the work environment. What are the tasks? Is this a job with staggered hours? Which team will you join? What services will you work with? Will you have to be mobile? What degree of responsibility will you have?

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On the one hand, this will allow you to determine if this job really corresponds to your aspirations and on the other hand, to match your previous experiences with what is expected.

1.8.3. What profile is sought?

The last part concerns the profile sought, i.e. the training, experience, know-how and interpersonal skills of the candidate. It is generally in this paragraph that the candidate will be asked to be “curious”, “versatile”, to have “a sense of organization” or an “ability to solve problems”.

Skills and knowledge must be indicated in your CV in order to pass the first filters of ATS (the software that sorts applications according to criteria determined by the recruiter, such as keywords). If, for example, the position mentions “commercial negotiation” and “sales techniques”, the words “negotiation” and “sales” must imperatively appear in your CV.

Abstract:

Finding a job is not an easy mission in a tense economic context. To be effective, know that it is not the quantity of applications sent but their quality that will make the difference. Exploration, organization and preparation: these are the three key steps to succeed in aiming correctly and convincingly.

- ✓ Target your search
- ✓ Get organized
- ✓ Prepare

Chapter II: Sectors of Electronics, Telecommunications, Biomedical Engineering, Electrotechnics, Electromechanics, Optics & Precision Mechanics:

Contents of the Chapter II

- Definitions, areas of application (home automation, embedded automotive applications, video surveillance, mobile telephony, fiber optics, advanced scientific instrumentation, medical imaging and instrumentation, giant mirrors, contact lenses, electrical energy transmission and distribution, power plants, energy efficiency, industrial equipment maintenance, elevators, wind turbines, etc.)
- Role of the specialist in these fields.

II.1. Definition of the Electronics Sector 1

Electronics is the essential industrial foundation for the production of digital equipment and systems. The electronics industry plays a central role in the industrial landscape and is at the heart of the digital transformation of our society. This sector serves other industries (defense, aerospace, automotive, telecommunications, healthcare, etc.), and its innovations significantly impact the performance and productivity of these sectors. Therefore, the growth prospects of the electronics sector are closely linked to the health of the industries it serves. Moreover, electronics is the essential support for the fields of computing and digital technologies.

The electronics sector is supported upstream by a dense network of laboratories, schools, and universities that offer expertise in areas ranging from advanced materials for micro-, nano-, and optoelectronics to the creation and development of complex tools for designing circuits and systems. The mentioned developments reveal numerous challenges for companies in the electronics sector, particularly regarding employment, training, and qualifications. The growth of the sector thus requires anticipating these challenges in order to meet the expectations and needs of the stakeholders in the electronics industry.

II.2. Definition of the Telecommunications Sector

Telecommunications is defined as the transmission of information over distances using electronic, computer, wired, optical, or electromagnetic technologies. This term has a broader meaning than its official equivalent "electronic communication." Telecommunications is distinct from postal services, which transmit information or objects in physical form.

II.3. Definition of Biomedical Engineering

Biomedical Engineering (BME) is the application of engineering principles and techniques to the medical field, aiming to control biological systems or develop devices used for the diagnosis and treatment of patients. This field is a blend of medicine, biology, engineering, and physics.

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II.4. Definition of Electrical Engineering

Electrical engineering pertains to the practical applications of electricity and the science that studies these applications. It involves, for example, the production, transport, distribution, processing, transformation, management, and use of electrical energy. Sometimes referred to as "electrical engineering," it dates back to the invention of an electrometer in 1600, which allowed for the detection of electric charges, and to the invention by William Gilbert of an electrostatic generator in 1672, which allowed for the separation of electric charges using a machine.

II.5. Definition of Electromechanics

Electromechanics is the combination of electrical and mechanical techniques.

At the dawn of electricity applications, it was often merely a source of energy for mechanical systems.

By the early 21st century, electricity and electronics often require a mechanical or microtechnical support to provide a usable service or function.

The development of home 3D printing and stereolithography favors a return to electromechanics.

In the 1990s, as micro-electromechanics developed, theoretical explorations in nanomicroelectronics began.

II.6. Definition of Optics and Precision Mechanics

The optics and precision mechanics sector is a specialty that manipulates fragile and expensive materials such as glass or silica at very small scales, providing training in optics and precision mechanics (mechanics at a small scale). **Precision mechanics** encompasses the manufacturing of parts with tight tolerances. Due to the trend towards ever-smaller products that also offer more functions, the dimensions and manufacturing tolerances are becoming increasingly narrow. These objectives are achieved through new materials and coatings, but especially through new manufacturing processes.

Certain industries, such as aerospace construction, watchmaking, and armaments, utilize parts that are complex to manufacture due to their very small sizes, complicated profiles, or strict dimensional tolerances. The design and production of such elements are entrusted to specialized workshops that employ engineers from prestigious schools, highly skilled operators, and very sophisticated machines.

II.7 Application Areas

II.7.1. Home Automation (Domotics)

Home automation is a network of hardware, communication, and electronic interfaces that work to integrate everyday devices with each other via the internet. Each device is equipped with sensors

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and connected via WiFi, allowing you to manage them from your smartphone or tablet, whether you are at home or miles away. This enables you to turn on lights, lock the front door, or even lower the heating from anywhere.

A home automation system consists of three main components: sensors, controllers, and actuators.

Sensors can monitor changes in daylight, temperature, or motion detection. Home automation systems can then adjust these parameters (and many others) according to your preferences.

Controllers refer to the devices—personal computers, tablets, or smartphones—used to send and receive messages regarding the status of automated functions in your home.

Actuators can include light switches, motors, or motorized valves that control the mechanism or function of a home automation system. They are programmed to be activated by a remote command from a controller.

II.7.2. Embedded Applications for Automotive

An embedded system is a device that performs a specific task using one or more microprocessors (black box).

- Digital electronics, microprocessors, calculators.
- Software.
- Communication protocols between calculators.



Picture 1: *Example of an Embedded System*

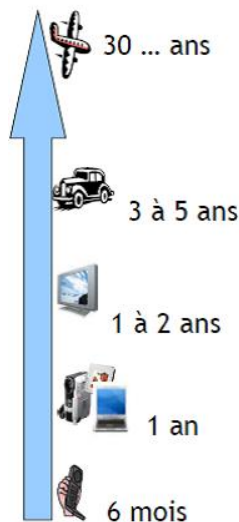
➤ **Collective Systems (Large Community of Individuals)**

- Nuclear Power Plant, Aircraft, Train.
- Volume: 1, 10, 100.
- Long Lifespans and Development Times.
- High Costs.

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➤ Personal Systems (Individuals or Small Groups)

- Automobile, Telephone, Pacemaker.
- Volume: 1,000 to 1,000,000.
- Short Lifespans and Development Times.
- Cost Accessible to Individuals.



Picture 2 : Classification of an embedded system

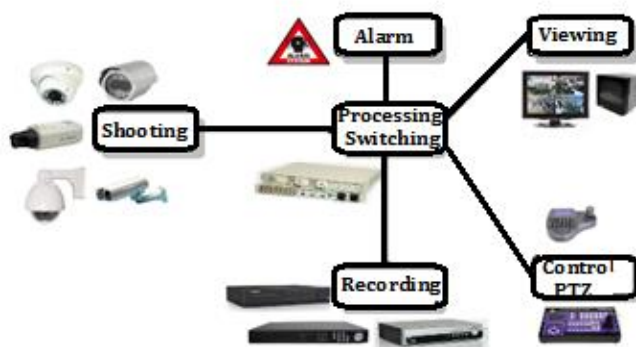
II.7.3. Video Surveillance:



What is Video Surveillance?

Video surveillance, sometimes referred to by the English acronym CCTV (Closed-Circuit Television), is a system of cameras and image transmission set up in a public or private space to monitor it. The images obtained through this system can be processed automatically and/or viewed, then archived or destroyed. The purpose of surveillance is to ensure compliance with safety, security, or the execution of a particular procedure.

Principle Diagram



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(Here, you could create a simple diagram illustrating the components of a video surveillance system. A basic example could include the following elements:)

Cameras: Capture video footage.

Transmission: Sends the video signals to a monitoring station.

Monitoring Station: Where the footage is viewed in real-time or recorded for later analysis.

Storage: Archive system for storing recorded footage (could be local or in the cloud).

Control Interface: Allows operators to manage camera angles, zoom, and settings.

The diagram might represent these components with arrows indicating the flow of information from the cameras to the monitoring station and storage.

This diagram represents the different functions of a video surveillance system. These functions can be fulfilled by one or more devices (a DVR can perform the switching and recording functions).

This diagram is an "excess" diagram, as some installations do not include as many functions.

The different functions can be described as follows:

Camera Capture: Allows the acquisition of images using cameras that are more or less sophisticated. Certain situations may require the use of cameras with specific specifications (waterproof, wide-angle, IR, etc.).

Switching / Processing: This function allows the "dispatching" of video signals to the recording and viewing functions. It also enables post-processing of the image (brightness/contrast adjustments, motion detection, monitoring of emergency exit obstructions, etc.).

Recording: Image recording is primarily done digitally. Continuous recording 24 hours a day over a rolling period is legally limited to 30 days.

PTZ Control: Allows control of the position of cameras equipped with PTZ (Pan-Tilt-Zoom) functionality. These are generally dome-type cameras.

Viewing: One or more monitors allow the viewing of video surveillance images. More or less complex installations may also allow the broadcasting of the video stream within the monitored area to deter potential offenders.

Alarm: Video surveillance systems can communicate with intrusion detection systems. For example, motion detection on a video stream can trigger a contact just like a Passive Infrared Detector (PIR). The exchange of information goes both ways: video surveillance systems can use signals from a detector to trigger a recording.

II.7.4. Mobile Telephony:

Mobile phones fall within the domain of telecommunications.

The first question we should ask is: *What is the purpose of a mobile phone?* "A phone is a communication device designed to transmit the human voice and enable conversation at a distance."

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Invention of the Landline Phone: Many inventors contributed directly or indirectly to the invention and improvement of the telephone. However, the inventor of the telephone is Alexander Graham Bell (in 1876).

How Does a Mobile Phone Work?

A mobile phone uses radio waves that travel at the speed of light. When a call is made, the voice is converted into a digital signal. This sequence of 0s and 1s is then "etched" onto an analog signal and captured by the nearest antenna. This antenna transmits the signal to a base station, which then sends it to a central office. From there, the conversations are routed to the recipient's mobile phone.

The Role of Telephone Operators

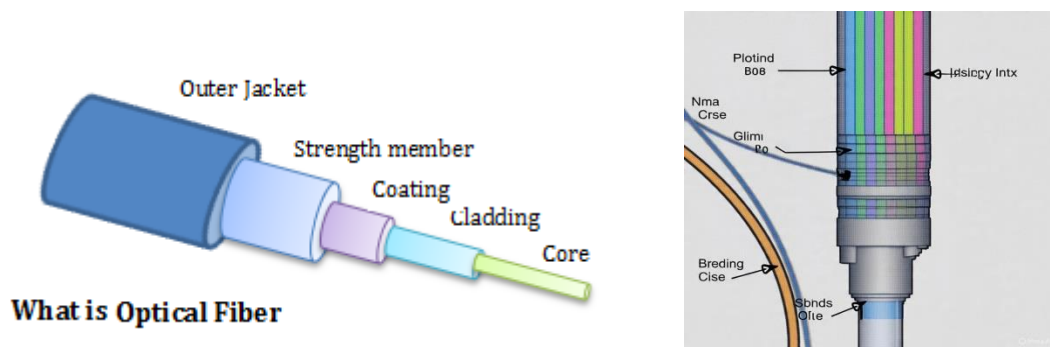
The operation of mobile phones entirely depends on telephone operators. Not only do they manage customer subscriptions, but they also handle the management of connections between callers. Finally, they are responsible for dividing the territory into cells.

The Future of Mobile Technology and Mobile Phones

A few years ago, the global network began to become saturated. New frequencies were then freed up to create the 4G network, which allows for both phone calls and the exchange of photos, videos, and internet usage up to 10 times faster than 3G+. The technology inherent in mobile phones is complex and continues to advance every day.

II.7.5. Optical Fiber:

An optical fiber is a thin thread made of glass or plastic that has the property of conducting light and is used for endoscopy, lighting, or the transmission of digital data. It offers a significantly higher information throughput than coaxial cables and can serve as a medium for a "broadband" network through which television, telephone, videoconferencing, and computer data transit. The principle of optical fiber dates back to the early 20th century, but it was not until 1970 that a usable fiber for telecommunications was developed in the laboratories of the American company Corning Glass Works (now Corning Incorporated).



Picture 3: Principle of an Optical Fiber

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II.7.6. Advanced Scientific Instrumentation:

Over the past twenty years, the conditions of scientific production have undergone profound transformations, with teams relying on more complex and costly instrumentation that structures the division of labor. Gaudillière (2000) emphasizes that the increased use of instrumentation in the life sciences is part of a historical evolution toward new instrumental logics, heavily relying on equipment, automation, and new information technologies to generate, store, analyze, and represent vast amounts of data.

II.7.7. Medical Imaging and Instrumentation:

How to Understand Medical Imaging?

Medical imaging emerged with the discovery of X-rays by Wilhelm Röntgen (a German physicist) in 1896. Soon, the interest in such a discovery for medicine grew, and Antoine Béclère, head of the department at Tenon Hospital in Paris, acquired a radioscope in 1897. The first screenings for tuberculosis were performed there using lung X-rays. Since then, medical imaging has continuously evolved, improved, and offered increasingly precise technologies.

Medical imaging is also an essential element in clinical research, the study of diseases, and the development of new treatments. There are many complementary imaging techniques. Medical imaging encompasses a wide variety of technologies developed through the exploitation of major discoveries in 20th-century physics:

Different Medical Imaging Technologies: Radiography; CT scan; Single Photon Emission Computed Tomography (SPECT); Positron Emission Tomography (PET); Ultrasound; Electroencephalography (EEG); Magnetoencephalography (MEG); Magnetic Resonance Imaging (MRI); Diffusion MRI; Functional MRI (fMRI).

II.7.8. Giant Mirrors:

A mirror in optics is a reflective surface. Mirrors, as opposed to elements referred to as "refractive" such as diopters, lenses, etc., are called "reflective" elements. A mirror is most often a glass element of a particular shape, with one of its surfaces treated to reflect incident light, but it can also be just a reflective surface. Giant mirrors are used to reflect and concentrate sunlight. Several categories of mirrors can be distinguished: metallic mirrors and glass mirrors with a metallic reflective coating or a multilayer treatment.

II.7.9. Contact Lenses:

A contact lens (also called a contact glass, lens, or simply contact) is a corrective, cosmetic, or therapeutic lens placed on the cornea of the eye.

While Leonardo da Vinci conceived the idea of contact lenses in 1508, they were not developed until 1887 by the German ophthalmologist Adolph Eugene Fick.

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There are several types of contact lenses. Soft lenses and rigid lenses are the two most common types.

II.7.10. Transport and Distribution of Electrical Energy:

How to Transport Electrical Energy?

Electricity flows from the place where it is produced to where it is consumed. The **transport** of electricity is carried out through a high-voltage transmission and interconnection network and a distribution network. The **electricity** transport is conducted through a high-voltage transmission network, which conveys the electricity produced at the output of power plants over long distances via Very High Voltage lines (between 225,000 and 400,000 volts).

The transport and distribution network of electricity is organized similarly to a road network, with its main routes, secondary routes, and interchanges:

- The transmission network acts like the highway and national road network;
- The distribution network acts like the departmental road network;
- To move from one network to another...

II.7.11. Electricity Production Plants:

An electric power plant is an industrial site dedicated to the production of electricity. Power plants supply electricity via the electrical grid to consumers, whether individuals or industries, that are located far from the plant. Electricity production is ensured by converting a primary energy source into electrical energy, which can be mechanical (wind power, water power from rivers, tides, etc.), chemical (oxidation-reduction reactions with fossil or non-fossil fuels such as biomass), nuclear, or solar.

There are three types of electricity production plants: thermal, hydroelectric, and nuclear. An electric power plant is an industrial building that produces electricity. However, depending on the type of plant, electricity is generated in different ways. It is primarily through these plants that consumers, both individuals and businesses, can benefit from an electrical grid.

II.7.12. Energy Efficiency:

In general, energy efficiency (or energy effectiveness) refers to the operating state of a system where energy consumption is minimized for the same level of service provided. It particularly concerns the building and industrial sectors. Energy efficiency is a broad concept encompassing several elements and notions.

In physics, "energy efficiency" refers to the ratio between the useful energy produced by a system and the total energy consumed to operate it.

So, what exactly do we mean by energy efficiency?

Utilizing energy efficiency means using less energy in our daily activities. It involves managing our

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electricity consumption more effectively. It also means using what has already been produced as efficiently as possible.

II.7.13. Industrial Equipment Maintenance:

Industrial maintenance is a strategic function within a company! While in the past it was solely seen as a means to ensure the proper functioning of production tools, its objectives are now much more numerous and complex.

What is the goal of industrial maintenance?

The objective of industrial maintenance jobs is to detect, anticipate, and restore the functioning of production devices. Maintenance professionals can work in industries or in workshops (service providers).

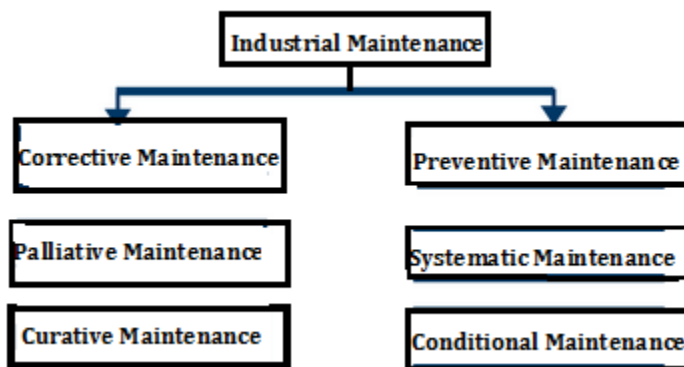


Image: The Different Types of Maintenance

II.7.14. Elevators:

Elevators, or lifting devices, transport people in a cabin moving between vertical or slightly inclined guides. A boat lift connects two areas of different water levels.

There are essentially two main types of elevators:

- ✦ Cable traction elevators,
- ✦ Hydraulic elevators.

Its operation is simple:

- ✦ The elevation of the electric elevator is ensured by an electric motor.
- ✦ The elevator cabin is suspended by metal cables and equipped with a counterweight designed to balance it.

II.7.15. Wind Turbines:

A wind turbine is a device that converts the kinetic energy of the wind into mechanical energy, known as wind energy, which is most often transformed into electrical energy. Wind turbines that produce electricity are called wind generators, while turbines that pump water directly are sometimes referred to as pumping windmills. An ancient form of a wind turbine is the windmill.

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Who Uses Wind Energy?



Wind energy is the energy of the wind, whose driving force (kinetic energy) is used in the movement of sailboats and other vehicles or transformed by a wind-generating device, such as a wind turbine or windmill, into various usable energy forms.

II.7.16. Role of the Specialist in These Fields

An economic activity sector is a grouping of manufacturing, industrial, commercial, or service companies that share the same primary activity.

Each sector of activity encompasses different professions within it.

- It would take a lot of time to describe them all.
- Therefore, we will focus only on those that require training in science and technology; this is the purpose of this course.

Chapter III: Sectors of Automation and Industrial Engineering

Contents of the third course

Definitions, areas of application (automated industrial lines, CNC machine tools, robotics, inventory management, freight management, quality) - Role of the specialist in these fields

III.1. Definition:

a. Automation: is a science that deals with the modeling, analysis, identification, and control of dynamic systems. It includes cybernetics in the etymological sense of the term, and its theoretical foundations are based on mathematics, signal theory, and theoretical computer science. Automation enables the control of a system while adhering to a set of specifications (speed, accuracy, stability, etc.).

Professionals in automation are called automation engineers. The objects that automation allows us to design for the automation of a system (such as controllers, regulators, etc.) are referred to as control systems or control-command organs of a managed system.

A simple example of automation is the speed regulator of a car: it allows the vehicle to maintain a predetermined constant speed set by the driver, regardless of disturbances (such as road inclines, wind resistance, etc.). James Clerk Maxwell, in his paper "***On Governors***" (1868), defined the regulation system he invented as follows: "A governor is a part of a machine by means of which the velocity of the machine is kept nearly uniform, notwithstanding variations in the driving-power or the resistance." This definition serves as an excellent introduction to automation.

b. Industrial Engineering:

According to the American Institute of Industrial Engineers, "Industrial engineering encompasses the design, improvement, and installation of integrated systems. It utilizes knowledge from mathematical, physical, and social sciences, as well as the principles and methods specific to 'engineering' or the art of the engineer, with the aim of specifying, predicting, and evaluating the results arising from these systems." We can summarize all the areas related to industrial engineering with the phrase: "Optimization of overall business performance." This discipline was reintroduced in France in the early 1990s.

The goal of training in industrial engineering is to provide various sectors of the economy (manufacturing production, small and medium enterprises, services, design offices, banks, etc.) with engineers capable of designing, managing, organizing, and optimizing the functioning of complex systems for producing goods or services. These systems integrate human, financial, material, and

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intangible resources, as well as the flows of materials, energies, and information. To fulfill this mission, industrial engineering training combines a solid mastery of science and technology with skills in business management and economics, thanks to a multidisciplinary approach, an open-mindedness, and a good knowledge of mathematical and computing tools that allow for understanding the different aspects and components of a project or industrial system.

III.2. Areas of Application:

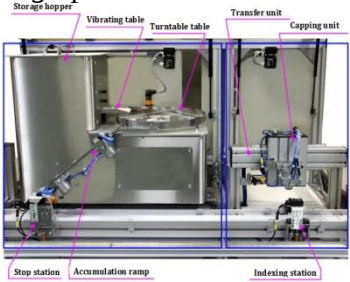
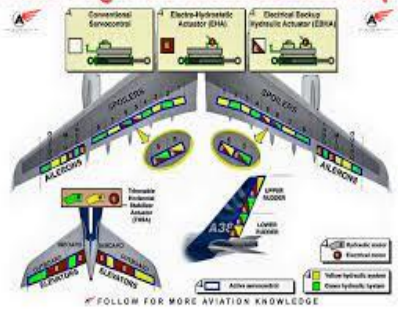
III.2.1. Automated Industrial Chains:

- a. Introduction:** "Since the dawn of time, man has sought well-being." This reflection (which relates to the notion of need) may seem far removed from a course in Industrial Sciences; however, it is the foundation of the evolution of sciences in general and automation in particular. Man began by thinking, designing, and creating. When it became necessary to multiply the number of manufactured objects and produce on a larger scale, the automation of tasks emerged to replace human effort in arduous, delicate, or repetitive actions.

Notable figures from the early developments of the industrial era in the 18th century include Watt, with his steam regulation systems, Jacquard, with his automatic looms... An exhaustive list would be quite difficult to compile! Finally, the development of knowledge and mathematical tools led to a tremendous growth of automated systems and controlled systems in the second half of the 20th century.

- b. Definition of an Automated System:** An automated or automatic system is one that performs operations in which human intervention is limited to programming the system and its adjustment.

The goals of an automated system are to carry out complex or dangerous tasks for humans, perform tedious or repetitive tasks, or gain efficiency and precision. Example:

<i>Ravoux capsule machine</i>	<i>Robot TRIBAR</i>	<i>Airbus A380 Primary Flight Controls</i>
<i>Repetitive task</i> <i>High pace</i> 	nuclear power plant pipeline inspection Dangerous task requiring precision and reliability 	<i>Precision, Reliability.</i> A380 Flight Control Actuator Map 

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c. **Definition of Automation** is the set of theories and techniques for decision-making and the control of systems. In English, this is referred to as "Automatic Control" (a false friend: "commande").

d. **Classification of Systems:**

✓ *The Different Types of Information*

As discussed in (Functional Analysis, §VII – 1.), for each functional chain of a system, there corresponds an information chain and an energy chain. Automation focuses on ***the information chain***. Automated systems are then classified based on the nature of the control or measurement information, as well as the nature of the processing of this information.

There are two types of information: ***analog*** and ***discrete (logical)***.

Definition: An analog information (signal) is one that can take any possible value within a given interval. Physical quantities, such as temperature, speed, pressure, voltage, etc., are examples of analog information. An analog signal can be represented by a curve (see next page).

Definition: A discrete information (signal) consists of a finite set of values.

✓ *Numerically Controlled Machine Tools:*

A numerically controlled machine tool (NC, or simply CNC) is a machine tool equipped with numerical control. When the numerical control is performed by a computer, it is often referred to as a CNC machine, which stands for Computer Numerical Control.

What are the application areas of numerically controlled machines?

The primary application areas for numerical control systems are as follows:

- CNC Milling;
- CNC Turning;
- CNC Machining Centers;
- CNC Grinding;
- CNC Electrical Discharge Machining;
- Robotics;
- Automated Transport Systems.

The first milling machine in history is credited to American ***Eli Whitney***. Like many inventions, it was conceived during a time of armed conflict.

Diagram of a Numerically Controlled Machine Tool:

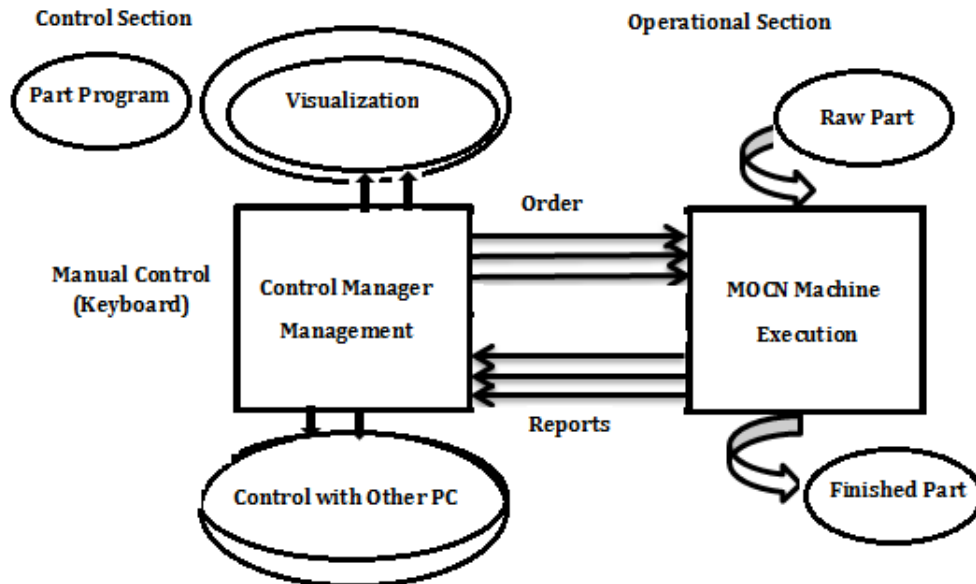
This type of machine consists of two parts:

A) ***The operative part*** is similar to conventional machines in the "machining" function but possesses superior performance. It may have multiple motorized machining heads according to

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one or more independent axis systems and also includes additional elements for controlling clamping and lubrication devices.

- B) *The control part* is the brain of the machine, referred to as the Numerical Control Unit (NCU). This unit sends command orders for rotation and movement to the movable parts of the machine based on the setpoint values described in the program for the part to be produced.



III.2.2. Robotics

Who is the inventor of robotics?



Archytas of Tarentum (4th century BC) is credited with what is considered the first **robot** in human history, long before the first clocks and automata we have physical evidence of: a wooden pigeon capable of flying, powered by steam.

a. *Three Laws of Robotics*

In the novels of Isaac Asimov, the three laws of robotics are three rules that robots must obey:

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm;
2. A robot must obey the orders given to it by human beings, except where such orders would conflict with the First Law;
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

b. *What are the different fields of robotics?*

From industrial manufacturing to the medical field, the use of robotics is multiplying across all

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significant sectors of life and society.

- ✦ Industry: ...
- ✦ Agriculture: ...
- ✦ Military: ...
- ✦ Medicine: ...
- ✦ Other Uses of **Robotics**

c. *Who is the father of robotics?*

Joseph F. Engelberger, an American engineer, pioneer, researcher, and businessman, who passed away at the age of 90 on December 1st, was the creator of the first industrial **robot**, "Unimate," which was installed in the late 1950s in a major automobile manufacturer in the United States.

d. *Which country has developed the most research in robotics?*

Only a few countries are particularly well-equipped with robots. According to studies, China, Japan, the United States, South Korea, and Germany are the best-equipped economies.

III.2.3. Inventory Management

- a. **Definition:** Inventory management is the set of measures that a company uses to determine how much to order and when, with the aim of achieving a balance between low storage costs and a high capacity to respond to customer needs.

Good **inventory management** constitutes a factor of flexibility for the company. Indeed, **inventories** represent a financial burden and a tie-up of capital. **Inventory management** within a company concerns the following items:

- **Merchandise inventory:** Reselling goods for profit, without prior transformation.
- **Raw material inventory:** Products purchased for transformation.
- **Work-in-progress inventory:** Products that are in the process of being manufactured.
- **Finished goods inventory:** Once the transformation of raw materials is complete, the product is ready to be sold.
- **Packaging inventory:** This includes empty packaging such as boxes, pallets, etc.

b. *What is the role of inventory management?*

Good inventory management will allow for meeting future needs. It constitutes a factor of flexibility for the company. Indeed, **inventories** represent a financial burden and a tie-up of capital.

c. *The 4 Methods of Inventory Management*

Based on these two constants, four combinations are possible for managing inventory. They correspond to several possible management methods:

1. Replenishment Method

Also called the "calendar method," this involves ordering a **fixed quantity** at a **fixed date**, close to

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the economic order quantity (this is Wilson's formula or EOQ).

2. Reorder Point Method

This adopts a variable order timing system but a fixed quantity, where reaching a *specific stock level* (called the reorder point) triggers the replenishment order.

3. Restocking Method

This involves ordering a *variable quantity* at a fixed date since the stock level to be replenished varies based on sales volume, while the date remains the same.

4. The Order-Based Replenishment Method

This method involves placing variable quantity orders at variable dates based on demand.

III.2.4. Traffic Management of Goods:

Goods transport, or *freight*, is an economic activity.

The individual or entity that transports goods, called a freight carrier, uses transportation means (cars, light utility vehicles, trucks, trains, cargo bikes, aircraft, ships, etc.) and infrastructure.

- This infrastructure consists of:

Communication routes (roads, railways, canals, rivers, etc.) that define the mode of transport:

- Either terrestrial: road transport and rail transport;
- Maritime;
- Inland waterway (river or canal transport);
- Aerospace (air transport and space transport);
- Combined, multimodal, or more modal;
- Facilities (parking lots, ports, airports, etc.) designed to transfer goods or vehicles, maintain vehicles, or park them, and to accommodate the drivers of vehicles;
- And civil engineering works designed to cross natural obstacles (bridges, viaducts, tunnels, locks, etc.).

III.2.5. Quality:

1. **Definition:** Today, the notion of "*quality*" is used in all sectors, including services. Maintaining quality is a significant issue for companies. Several definitions have been formulated for the concept; we have retained the following three:

The French standardization association (AFNOR) defines quality as "*the ability of a product or service to satisfy the needs of users.*"

The International Organization for Standardization (ISO) presents a similar definition: "it is the set of properties and characteristics of a product, process, or service that give it the ability to satisfy expressed or implied needs."

For *James TEBOUL*, "it is primarily conformity to specifications. It is also the appropriate

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response to the desired use at the time of purchase and in the long term.

Additionally, it involves more seduction and excellence, closer to desire than to need."

A few words to summarize these three definitions:

- 1) Conformity to standards;
- 2) The ability to satisfy users' needs;
- 3) Closer to desire than to need.

2. Forms of Quality:

In practice, it manifests in two forms: external and internal.

a) External Quality:

Corresponds to customer satisfaction. This involves providing products or services that meet customer expectations to foster loyalty and thereby increase market share. The beneficiaries of external quality are the customers of a company and its external partners. This approach requires necessary listening to customers, but it must also take into account implicit needs that are not expressed by customers.

b) Internal Quality:

Corresponds to the mastery and improvement of the company's functioning. The purpose of internal quality is to implement means to best describe the organization, identify, and limit dysfunctions. The beneficiaries include management, company personnel, shareholders, and of course, customers. It is challenging to achieve external quality without internal quality!

3. The Purpose of Quality:

The primary external goal is to:

"Serve customers better by offering them what they desire when they desire it."

This implies:

- ✦ A precise identification of potential customers;
- ✦ An attentive listening to their needs.

Chapter IV: Sectors of Process Engineering, Hydrocarbons and Petrochemical Industries

Contents of Chapter IV

Definitions: Pharmaceutical Industry, Agro-food Industry, Leather and Textile Industry, Biotechnology, Chemical and Petrochemical Industry, Plastics Industry, Energy Sector (oil, gas), ...
Role of the specialist in these fields.

IV.1. Definition of process engineering:

The term "engineering" is widely used in the field of engineering, including industrial engineering, civil engineering, and process engineering. These various titles may seem quite confusing, and it can sometimes be difficult to understand what they entail. Therefore, it is important to clarify what each of these terms represents.

Today, we will focus on one of these areas: process engineering.

Process Engineering: A Brief Explanation

Process engineering is a field of engineering that focuses on the application of physical chemistry in industry. More broadly, it is a domain whose main objective is to transform materials (through chemical or even physical processes) within the industry. Process engineering involves designing, sizing, and managing the operation of a process for various chemical and physical transformations. It is closely related to chemical engineering, and sometimes these terms are used interchangeably. A subtle difference between the two is that process engineering focuses on the overall system, while chemical engineering is concerned with the theoretical aspects, concepts, and equations that govern the studied system.

IV.2. Pharmaceutical Industry

IV.2.1. Historical Background: Before the end of the 19th century, medicines were prepared by individual pharmacists or apothecaries using various plant and even mineral substances. The modern pharmaceutical industry emerged in the late 19th century with the development of synthetic drugs derived from chemistry. Major global pharmaceutical laboratories generally trace their origins back to the advancement of chemistry. The pharmaceutical industry is an important component of healthcare systems worldwide. It encompasses numerous services and companies, both public and private, that discover, develop, manufacture, and market medicines for human and animal health (Gennaro, 1990). ***The pharmaceutical industry*** is the economic sector that includes the research, manufacturing, and marketing activities of

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medicines, primarily relying on research and development (R&D) of drugs intended to prevent or treat various ailments or disorders.

IV.2.2. Growth Factors: The demand for medications is significant due to:

- ✓ The aging population;
- ✓ Increased access to healthcare services in many countries;
- ✓ Therapeutic advancements;
- ✓ The rise of chronic diseases (such as hypertension, diabetes...);
- ✓ The emergence or identification of new diseases;
- ✓ Improved understanding of the human body.

IV.2.3. Professions in the Sector:

- ✦ Bioinformatician
- ✦ Hydrobiologist
- ✦ Chemical Engineer
- ✦ Pharmacist
- ✦ Pharmacy Technician
- ✦ Regulatory Affairs Manager
- ✦ Biomedical Analysis Technician
- ✦ Pharmaceutical Industry Technician

IV.3. Agro-food Industry

IV.3.1. Definition: *The agro-food industry* (abbreviated as IAA) encompasses all industrial activities that transform food products from agriculture or fishing into industrial foods primarily intended for human consumption (agro-food sector). This economic sector includes processors of consumer goods on a global scale. It should not be confused with agro-industry, which, in addition to agro-food, involves the transformation of products from agriculture, fishing, and forestry into non-food products, such as biofuels, biomaterials, and industrial biotechnology (often referred to as "white biotechnology").

IV.3.2. The Eight Major Families of Food Industries: This sector is composed of eight major families:

- 1) Meat industry: slaughtering of cattle, poultry, charcuterie, meat canning.
- 2) Dairy industry: production of milk, butter, yogurt, cheeses, powdered or concentrated milk, "cracking" milk for the food industry (casein, lactose, ultra-filtered proteins...), manufacture of ice creams and frozen desserts.
- 3) Sugar manufacturing, which produces sugar from plants such as sugar cane or beets; for example, the sugar refinery of the Algerian group Cevital produces 2.7 million tons of sugar

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per year, making it the largest refinery in the world.

4) Production of processed food products: fruits, vegetables, fish, ready-made meals, and jams.

5) Manufacturing of cereal-based products: flour, industrial bread and pastries, biscuits, toast, semolina, pasta, malt, starch, and derivative products, animal feed for livestock and pets.

6) The production of oils, fats, and margarines.

7) The manufacture of various food products: chocolate, confectionery, packaged coffee and tea, spices, herbs, condiments, vinegar, prepared sauces, dietary foods, baby food, diet products, breakfasts, desserts, broths, soups, yeast, etc.

8) The production of beverages and alcohol: wines, spirits, alcohol distillation, aperitifs, champagne, beer, cider, fruit and vegetable juices, other non-alcoholic beverages, mineral waters.

IV.3.3. Food Industry: Most Sought-After Professions:

The most sought-after professions in the agro-food sector fall into the following categories:

- ✓ Operation of food production equipment
- ✓ Slaughtering and cutting of meats
- ✓ Installation of equipment and industrial maintenance
- ✓ Manual operations for assembly, sorting, or packaging
- ✓ Operation of load handling machinery
- ✓ Operation of packaging equipment
- ✓ Manual handling of loads
- ✓ Warehousing and order preparation
- ✓ Pastry, confectionery, chocolate-making
- ✓ Technical intervention in industrial analysis laboratories
- ✓ Catering charcuterie

IV.4. Leather and Textile Industry

IV.4.1. Definition: The textile, clothing, leather, and footwear industry is characterized by geographically dispersed production and rapid market-driven changes, providing employment opportunities to millions of workers worldwide, particularly young women. Given the diversity and profile of the workforce, the sector has the potential to significantly contribute to economic and social development.

Leather: It is a material prepared from the skin of an animal, primarily used in clothing and decoration in a variety of forms. It typically comes from large mammals (Mammalia) such as cattle and pigs, processed industrially by tanneries. "A tannery is a workshop where tanning is performed. Animal skins (cattle, sheep, goat, pig, etc.) are treated chemically and mechanically

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for leather production," mainly to ensure its preservation even in high humidity conditions.

Textile: It is a material that can be woven or knitted. Initially, it refers to a material that can be divided into fibers or textile threads, such as cotton, hemp, linen, wool (organic textiles), or asbestos (mineral textile), and later, with the discovery of new techniques, synthetic fibers.

IV.4.2. Textile and Leather Industry in Algeria

During a meeting held at the headquarters of the Association with the organizer of the International Textile, Leather, and Clothing Exhibition (Texstyle EXPO), scheduled for February 25-27, 2020, in Algiers, and a member of the National Federation of Textile and Leather Workers (FNTTC), Mr. Boulenouar emphasized the need to encourage local production in the leather and textile industries and to support investors in this field in order to reduce the import bill.

The president of the National Association of Traders and Artisans (ANCA) stated that there are only about fifty companies operating in the leather and textile industry, highlighting the need to revitalize this sector, which has significant investment potential that remains untapped.

IV.4.3. Professions in this Field:

- Leather and Hides Buyer
- Finishing Agent for Color and Effects on Leathers and Hides
- Finishing Agent for Leathers and Hides
- Method Agent for Leathers and Hides
- Drying Frame Operator for Leathers and Hides
- Communication Officer for Leathers and Hides
- Project Officer for Research and Development in Leathers and Hides
- Product Manager for Leathers and Hides
- Hides Clipper
- Sales Representative for Leathers and Hides
- Machine Operator for Leather Transformation
- Quality Compliance Controller for Leathers and Hides
- Import Manager for Leathers and Hides
- Mechanic/Setter for Leather Transformation Machines
- Tanning Operator
- Hides Preparer
- Hides Splitter
- Colorist Manager for Leathers and Hides

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- Sales Manager for Leathers and Hides
- Production Workshop Manager for Leathers and Hides
- Production Manager for Leathers and Hides
- Environmental Manager for Leathers and Hides
- Quality Manager for Leathers and Hides

IV.5. Biotechnology

IV.5.1. Definition: The OECD (Organisation for Economic Co-operation and Development) defines **biotechnology** as "the application of science and technology to living organisms, as well as to their components, products, and models, to modify living or non-living materials for the purpose of producing knowledge, goods, and services." Biotechnology, or "bioconversion technology," results, as its name suggests, from a marriage between the science of living beings—biology—and a set of new techniques derived from other disciplines such as microbiology, biochemistry, biophysics, genetics, molecular biology, and computer science. Biotechnology offers a very promising alternative to synthetic foods and allows for improved management of plant genetic resources. Combined with other advanced agricultural technologies, it provides a means to contribute to the development of sustainable production and responsible consumption.

IV.5.2. Themes in Biotechnology: Today, the field of contemporary biotechnology encompasses numerous specialties that address different themes. Notably, we can mention:

- ✓ **Green biotechnology**, which focuses on agriculture
- ✓ **Red biotechnology**, which focuses on medicine
- ✓ **White biotechnology**, which focuses on energy, such as biofuels and biogas
- ✓ **Yellow biotechnology**, which addresses pollution issues
- ✓ **Blue biotechnology**, which focuses on the qualities of marine genetic diversity and their exploitation

IV.5.3. Which Biotechnology Profession to Choose?

The professions in biotechnology are numerous and depend on the sector in which they are practiced.

Non-exhaustively, the following professions can be found in the field of biotechnology:

- ✓ Hydrobiologist
- ✓ Astrobiologist
- ✓ Neurobiologist
- ✓ Biological Technician
- ✓ Biomedical Equipment Technician

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- ✓ Biomedical Analysis Technician
- ✓ Microbiology Technician
- ✓ Technical Sales Manager
- ✓ Biological Engineer
- ✓ Sales Engineer
- ✓ Process Engineer
- ✓ Research Engineer
- ✓ Study Engineer
- ✓ Biostatistician
- ✓ Quality Manager
- ✓ Quality Manager in Agro-food Industry
- ✓ Regulatory Affairs Officer
- ✓ Product Manager
- ✓ Scientific Director
- ✓ Consultant

IV.5.4. What education is required to work in Biotechnology?

To pursue a career in biotechnology, you will need to enroll in a biotechnology program. This can be done at a university or an engineering school.

Bachelor's degree programs (bac+3) include:

- Professional Bachelor's degree in Biotechnology
- Bachelor's degree in Biotechnology

Master's degree programs (bac+5 and longer) include:

- Master's degree in Biotechnology
- Specialized Master's degree in Biotechnology

IV.6. Chemical and Petrochemical Industry

IV.6.1. Definition:

a. The chemical industry is the industrial sector that involves the production of products through controlled chemical synthesis. This sector includes, among others, petrochemicals, phytochemical chemistry, pharmaceuticals, the production of polymers, paints, and oleochemistry (from the Latin "oleum," meaning "olive oil," which is the science of physicochemical transformations applied to animal and vegetable oils and fats). This industry is process-oriented. The chemical industry produces basic chemicals, intermediate chemicals, and finished products.

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b. Petrochemicals are, within the framework of carbon chemistry, all technologies that study or use oil or natural gas (mainly composed of methane and ethane) to produce synthetic chemical compounds (whether they exist in nature or not; in the latter case, these compounds are referred to as "artificial"). These techniques rely on chemical reactions, often catalyzed. Natural distillates and shale gas are also related raw materials used.

IV.6.2. Why the Chemical Industry?

The chemical industry plays a major role in controlling climate change through the innovations it brings in terms of "energy transition," which will soon be complemented by "material transition," utilizing plant resources in place of fossil resources.

IV.6.3. The Main Sectors of This Industry Include:

- **Plastics** (packaging, toys, computer and electronic equipment, containers, decorative accessories, office supplies, bags, automotive parts, aircraft parts, etc.)
- **Rubber** (tires, shoes, belts, vehicle parts, machine parts, plumbing items, electrical insulators, flooring, tubes and pipes, etc.)
- **Plastic foam** (upholstery for furniture and mattresses, car seats, packaging)
- **Composites** (parts for aircraft, automobile parts, boat parts, certain computer components, etc.)

Household Products: (detergents, all-purpose cleaners, hand cleaners, floor cleaners, carpet cleaners, waxes, soaps, bleach, solvents, degreasers, pool and spa maintenance products, automotive cleaning products, etc.)

Beauty and Personal Care Products: (cosmetics, perfumes, shampoos, deodorants, creams, lotions, conditioners, hair dyes, etc.)

Chemical Fertilizers: (fertilizers and manures, pesticides, germicides, herbicides, insecticides, etc.)

Coating Products: (paints, varnishes, stains, strippers, lacquers, primers, etc.)

Paper Products: (colored papers, specialty papers, newsprint, glossy papers, cardboard, hygienic paper, etc.)

Textile Fibers: (nylon, cellulose, acetate, or polyester fibers and filaments)

Adhesives and Protective Products: (adhesives, glues, sealants, adhesive putty, adhesive tapes, protective coatings)

Vinyls: (vertical blinds, acetates, interior decoration accessories, etc.)

Printing Inks: (inkjet inks, laser printer powders and photocopier inks, specialized inks for printing presses, other types of inks)

High-Density Polyethylene: (pipes, cables, molded products)

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Industrial Chemicals: (industrial coatings, industrial cleaners, industrial degreasers, chemical preparations for food industries, chemical preparations for pharmaceutical and cosmetic industries, chemical preparations for metallurgical industries, chemical preparations for textile industries, chemical preparations for paper industries, chemical preparations for petroleum industries, chemical preparations for wood processing industries, chemical preparations for plastics industries, chemical preparations for rubber industries, chemical preparations for water treatment plants, etc.)

Inorganic Chemicals: (chlorine, caustic soda, sodium carbonate, sulfuric acid, etc.)

Organic Chemicals: (ethylene, methanol, benzene, etc.)

Primary Petrochemicals: (lubricants, greases, etc.)

Industrial Gases: (oxygen, argon, hydrogen, helium, etc.)

Asphalts: (asphalt, tar, bituminous concrete, etc.)

Pharmaceutical Products: (medications, vaccines, biomedical products, medical gases, etc.)

Explosives: (powder, TNT explosives, dynamite, explosive smoke, detonators and fuses, pyrotechnic devices, etc.)

Tobacco Products: (cigarettes, cigars, cigarette tobacco, etc.)

Others: (plasticizers, rust inhibitors, photographic films, textile dyes, food colorants, etc.)

IV.6.4. What Are the Advantages of Petrochemicals?

The long list of uses

Plastics, textile fibers, adhesives, detergents, cosmetics, medicines, food packaging, pipes, bottles... All these everyday objects come from **petrochemicals**. They enable the production of many products found in our daily environment.

IV.7. Plastics Industry

IV.7.1. Definition:

The plastics industry refers to all companies that transform plastic into numerous everyday objects using various polymer processing techniques (extrusion, injection, 3D printing, thermoforming, etc.). The term is derived from the word “plastic,” combined with the suffix “-urgy” (from the Greek -ourgos, meaning work or production): literally, the plastics industry is the work of plastic.

IV.7.2. Techniques Used in the Plastics Industry:

There are two types of plastic materials: thermoplastics and thermosets.

a. Thermoplastic Polymers: The polymerization of a thermoplastic material is said to be reversible. Thermoplastic materials are processed without chemical reaction, unlike

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thermosetting polymers. A thermoplastic material is thus potentially recyclable after grinding.

b. Thermosetting Polymers: The transformation of a thermosetting material involves polymerization, which is irreversible and leads to a solid finished product, typically rigid. This product is infusible and cannot be reshaped, preventing its recycling.

IV.7.3. Why Choose the Plastics Industry?

- ✓ Join companies with a human touch
- ✓ A sector that offers numerous job opportunities
- ✓ Every employee in this sector contributes to the creation of tangible products that surround us daily
- ✓ Ensure a secure future

IV.7.4. Professions in the Plastics Industry:

- ✓ Materials Engineer
- ✓ Production Technician
- ✓ Quality Technician
- ✓ QHSE (Quality, Hygiene, Safety, Environment) Manager
- ✓ Assembler-Setter
- ✓ R&D (Research and Development) Manager
- ✓ Technical Sales Representative
- ✓ Toolmaker
- ✓ Team Leader/Coordinator

IV.8. Energy Sector (Oil, Gas)

IV.8.1. Definition of Energy (Oil, Gas)

a. The energy sector is a crucial economic sector that includes the production, transportation, transformation, distribution, and marketing of various energy sources. The extraction of primary energy sources is followed by their potential transformation into secondary energy: production of petroleum products through refining, production of electricity and heat. This energy is then stored (with the major exception of electricity) and transported before being distributed to the end consumer. This is referred to as final energy.

b. Oil (from Latin *petroleum*, from Greek *petra*, meaning "rock," and Latin *oleum*, meaning "oil"), also known as naphtha in ancient times, is a naturally occurring mineral oil composed of a multitude of organic compounds, primarily hydrocarbons, trapped in particular geological formations.

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c. Gas: Natural gas, or fossil gas, is a gaseous mixture of hydrocarbons primarily composed of methane, but generally containing a certain amount of other higher alkanes, and sometimes a small percentage of carbon dioxide, nitrogen, hydrogen sulfide, or helium.

IV.8.2. Major Energy Resources: The energy sources used by humans are either renewable or non-renewable:

- 1) **Fossil Fuels (Natural Gas, Coal, Oil):** Non-renewable energy sources are raw materials whose stocks do not replenish on a human timescale. Fossil fuels, which result from the accumulation of organic materials in geological layers, mainly include natural gas, oil, and coal, which are used by automobiles, airplanes, ships, thermal power plants, and heating equipment. Non-renewable energies also include nuclear energy obtained from nuclear fission, while nuclear fusion is under research for potential future industrial implementation on a very long-term scale.
- 2) **Renewable Energies:** Renewable energies correspond to energy sources that can renew their stocks within a few years or a few decades. This includes solar energy, wind energy, and hydro energy, whose flow varies only based on climatic factors, independent of consumption (stranded energy).

a. Renewable energies encompass a variety of energy forms:

- Energy from biomass (dry biomass, wet biomass, and biofuels);
- Hydraulic energy from rivers, harnessed through dams, penstocks, and turbines to produce mechanical power or electricity;
- Wind energy;
- Solar energy by converting light energy into heat (solar thermal; thermodynamic solar) or directly into electricity (photovoltaic);
- Wave energy, which is the kinetic and potential energy associated with the movement of the sea's surface under the influence of swells;
- Geothermal energy;
- Tidal energy;
- Ocean thermal energy;
- Animal energy, originating from muscle power (conversion of sugars and/or lipids and/or starches into heat and movement).

IV.8.3. These Different Energies Come, Through Successive Transformations, from Three Main Sources:

- **The Sun:** This energy is used directly (photovoltaic, solar thermal) or indirectly: wind energy produced by thermal differences in the atmosphere, hydroelectric energy

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resulting from evaporation (the water cycle), biomass energy that depends on photosynthesis, and hydrocarbon energy that originates from fossil biomass.

- **The Subsoil:** Nuclear energy (uranium, thorium) and deep geothermal energy.
- **Gravitation:** The gravitational pull of the Earth and the Moon (tidal energy).

IV.8.4. The Algerian Energy Sector: The Algerian mining sector holds the third-largest oil reserves in Africa, accounting for 2.37% of the world's proven natural gas reserves. However, this fossil energy is not merely a set of aggregates; it represents a complex issue intertwining domestic affairs and the power dynamics that Algeria maintains with the rest of the world.

Chapter V: Sustainable development (SD)

Contents of Chapter V

This last course presents definitions and global challenges, climate change and demographic transitions, depletion of resources (oil, gas, coal, etc.), loss of biodiversity, etc. It includes the Sustainable Development diagram (Sustainable = Viable + Livable + Equitable), the actors of Sustainable Development (governments, citizens, the socio-economic sector, international organizations, etc.), and the global nature of Sustainable Development challenges.

V.1. Definition of Sustainable Development (SD)

Sustainable development is a concept of development that is oriented towards the long term, integrating ecological and social constraints into the economy. According to the definition provided in the report of the World Commission on Environment and Development of the United Nations, known as the Brundtland Report, where this term first appeared in 1987, "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

V.2. History of the Term SD:

The term "sustainable development" first appeared in scientific literature in the early 1980s (see, for example, articles by Vinogradov or Clausen from 1981), and for the first time in a publication aimed at the general public in 1987 in the report titled "Our Common Future" by the World Commission on Environment and Development of the United Nations, written by Norwegian Gro Harlem Brundtland.

V.3. The Three Pillars of Sustainable Development

Unlike economic development, sustainable development considers three dimensions: economic, environmental, and social. The three pillars of sustainable development that are traditionally used to define it are therefore: economy, society, and environment. The uniqueness of sustainable development lies in its position at the intersection of these three pillars.

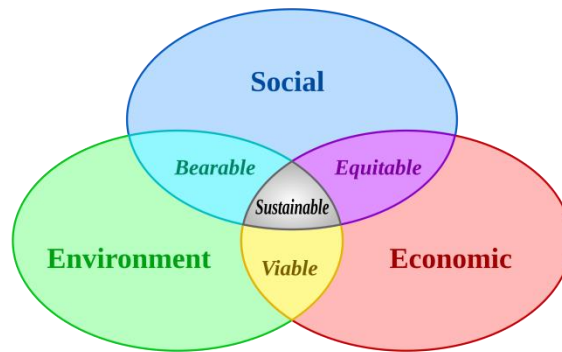


Figure 1. Diagram of Sustainable Development (SD)

V.4. Global Challenges

The creation of protected areas is currently justified by the loss of biodiversity and the services provided by ecosystems. A global awareness and reflection have begun. Nevertheless, biodiversity continues to decline.

V.4.1. Biodiversity: The Neologism That Spanned the Globe

Used during the 1986 forum on biological diversity by scientist Walter Rosen, this neologism refers to the variety and diversity of living organisms. It represents biological wealth, the diversity of living organisms, and the relationships these organisms maintain with their environments. It is generally subdivided into three levels: *genetic diversity* within a species, *species diversity* among living beings, and *ecosystem diversity* on a planetary scale. Considered more impact ful than the term "*biological diversity*," it aimed to draw strong attention to the erosion of living diversity and the acceleration of species extinction processes at that time.

V.4.2. Geodiversity

Geological heritage (rocks, minerals, fossils), geomorphology (landform shapes), and pedology (soils) form geodiversity, along with all the dynamic processes that generate them (Gray, 2004). As an essential support for biodiversity, it can be threatened with disappearance or irreversible degradation by numerous human activities: quarry exploitation, fossil looting, oil, gas, or hydrocarbon extraction, water pollution, and the sand market.

V.5. A List of Sustainable Development Challenges

Among these challenges, the following are perhaps the most important:

- Climate and atmospheric changes
- Biodiversity and ecosystems
- Agricultural and food transition
- Energy transition
- Sustainable mobility

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- Sustainable and responsible innovations
- Health preservation
- Well-being and quality of life
- Equality and human rights
- Combating poverty and exclusion
- Wealth distribution
- Transparency and democracy
- Responsible consumption
- Waste and excess reduction
- Alternative economic models
- If you need further translations or adjustments, feel free to ask!

V.6. Sustainable Development: The Ecological and Solidarity Transition of Societies

Among the concrete examples of sustainable development policies implemented in France, we can notably mention:

- ✓ **Energy Transition:** This aims to transform the way we produce energy to make it more sustainable, particularly by using renewable energies.
- ✓ **Biodiversity Protection Policy:** This aims to protect certain species and areas to prevent the extinction of endangered species, for example.
- ✓ **Circular Economy Policy:** This aims to maximize the recycling of materials and optimize resource use while minimizing waste.
- ✓ **Large Housing Renovation and Energy Efficiency Plan:** This aims to better insulate French homes in order to reduce our energy consumption.
- ✓ **Various Plans Regulating the Use of Pesticides and Chemical Substances:** These aim to reduce pollution and phenomena such as ocean acidification.

V.7. Depletion of Resources (Oil, Gas, Coal)

Between 1970 and 2000, global energy consumption doubled. It is expected to double again by 2050. However, energy use is uneven, with electricity consumption at 83 kilowatt-hours in the least developed countries compared to an average of 8,053 kWh in OECD countries. The planet's energy supply relies 80% on fossil fuels (oil, gas, coal).

Reserves of oil, natural gas, and nuclear energy will be largely depleted before the end of the 21st century, and coal within two or three centuries: oil, 50 to 100 years; gas, 60 to 70 years; coal, 200 years; nuclear with slow neutrons, 12 to 60 years depending on global consumption. Thus, there is an increasing shift towards renewable energies, such as solar, wind, hydro, geothermal, or biomass. However, extraction techniques are still very costly, more expensive than those for fossil fuels.

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Among the false good ideas, one must mention agrobiofuels, which once held great promise, but it is now realized that too much agricultural land may be diverted from food production to provide energy...

V.8. Anticipating the Depletion of Global Reserves

Energy efficiency is the primary lever for reducing the consumption of natural resources by:

- Increasing the efficiency of installations and limiting losses during production, transport, and distribution, through more efficient technologies. For example :
 - Replacing old coal-fired power plants with next-generation coal plants (supercritical) or combined cycle gas plants;
 - Developing combined heat and power production (cogeneration).
- Using more efficient fossil fuels (coal, oil, gas) and fissile materials (uranium);
- Increasing uranium yield through recycling (from plutonium through fuel) or breeding (the ability of certain nuclear reactors to produce more fissile materials than they consume).

V.9. The 17 Sustainable Development Goals Established by the UN

The Sustainable Development Goals (SDGs) were adopted by the United Nations (UN):

- ✓ SDG No. 1 - No Poverty
- ✓ SDG No. 2 - Zero Hunger
- ✓ SDG No. 3 - Good Health and Well-Being
- ✓ SDG No. 4 - Quality Education
- ✓ SDG No. 5 - Gender Equality
- ✓ SDG No. 6 - Clean Water and Sanitation
- ✓ SDG No. 7 - Affordable and Clean Energy
- ✓ SDG No. 8 - Decent Work and Economic Growth
- ✓ SDG No. 9 - Industry, Innovation, and Infrastructure
- ✓ SDG No. 10 - Reduced Inequalities
- ✓ SDG No. 11 - Sustainable Cities and Communities
- ✓ SDG No. 12 - Responsible Consumption and Production
- ✓ SDG No. 13 - Climate Action
- ✓ SDG No. 14 - Life Below Water
- ✓ SDG No. 15 - Life on Land
- ✓ SDG No. 16 - Peace, Justice, and Strong Institutions
- ✓ SDG No. 17 - Partnerships for the Goals

Comprehension Questions

Comprehension Questions

Questions : Mark all the correct answers with an X?

1. What will be required for an automation specification?

- ☐ Commande, execution
- ☐ Speed, precision, stability
- ☐ No reponse

2. How many goals have been set by the United Nations (UN) for sustainable development (SD)?

- ☐ 20 goals
- ☐ 17 goals
- ☐ No goals

3. How many engineers alerted UNESCO in 2010 ?

- ☐ 2,5 million
- ☐ 1 million
- ☐ No réponse

4. Electronics is a sector that serves other industries such as

- ☐ Aeronautics
- ☐ Telecom
- ☐ Philosophy

5. Electrical engineering refers to

- ☐ Practical applications of electricity
- ☐ Practical applications of electronics
- ☐ Practical applications of physics

6. Who invented an electrostatic generator, and in what year?

- ☐ Otto Von Guericke en 1700
- ☐ Alessandro Volta en 1799
- ☐ No reponse

7. The 3 pillars of sustainable development SD

- ☐ Agriculture, defense, and energy
- ☐ Business, politics, and science
- ☐ Economics, social affairs, and the environment

8. Engineering professions are thus suffering from competition from other sectors which also absorb a portion of the number of students leaving school. What is this sector ?

- ☐ Architecture
- ☐ Finance
- ☐ Chemistry

9. To write a relevant CV and a convincing cover letter, the fruits of an effective application, there are no secrets, except that

- ☐ You must write in Times New Roman
- ☐ You must conduct a thorough analysis of the announcement
- ☐ You must conduct a salary analysis

10. What materials are used in optics and precision mechanics?

- ☐ Glass or silica
- ☐ Glass or material
- ☐ Silica or copper

Comprehension Questions

11. How many main elements make up a home automation system?

- ☐ Four main elements
- ☐ Two main elements
- ☐ Three main elements

12. Who is the father of robotics?

- ☐ George C. Devol
- ☐ Joseph F. Engelberger
- ☐ Isaac Asimov

13. How many types of information exist in automated systems?

- ☐ One type of information
- ☐ Two type d'information
- ☐ Three type d'information

14. Control point management is to adopt a control system at

- ☐ Variable date and fixed quantity
- ☐ Fixed date and variable quantity
- ☐ Variable date and variable quantity

15. What are the main energy resources?

- ☐ Fossil fuels
- ☐ Electrical energy
- ☐ Renewable energy

16. What are the different embedded systems?

- ☐ Community systems
- ☐ Computer systems
- ☐ Personal systems

17. How many large families are there in the food industry

- ☐ Seven families
- ☐ Eight families
- ☐ Two families

Answers to Comprehension Questions

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