Chapter 03
Ethics, Sustainable Development and New Technologies

CHAPTER 3
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3.1. Introduction

Scientific and technological progress has profoundly transformed modern societies, particularly in the fields of **energy, automation, and intelligent systems**. Electrical machines, energy conversion systems, artificial intelligence, robotics, and drones now play a central role in industry, transportation, healthcare, and everyday life. However, these advances raise **major ethical challenges**, notably in terms of **responsibility, safety, environmental impact, and respect for human beings**.

Sustainable development, based on a balance between economic progress, environmental protection, and social justice, has become an essential framework for engineers. In this context, **ethics acts as a guiding compass**, helping to orient technological choices toward solutions that are **responsible, sustainable, and socially acceptable**.

Figure 3.1 Artificial intelligence and sustainable development: ethical challenges and opportunities

This chapter aims to analyze the close relationship between **ethics and sustainable development**, to examine the role of technologies in **reducing energy consumption**, and to discuss the **ethical issues associated with emerging technologies**, particularly artificial intelligence, humanoid robots, and drones. The objective is to raise students' awareness of their **responsibility as future engineers** with regard to the societal and environmental impacts of innovation.

3.2. Relationship between Ethics and Sustainable Development
3.2.1. Definition of Sustainable Development

Sustainable development is based on a fundamental principle: **meeting the needs of the present without compromising the ability of future generations to meet their own needs**. It relies on three interdependent pillars:

- **Environmental pillar**;
- **Economic pillar**;
- **Social pillar**.

Ethics provides a framework for reflection that enables the reconciliation of these three dimensions in **technological and industrial decision-making**.
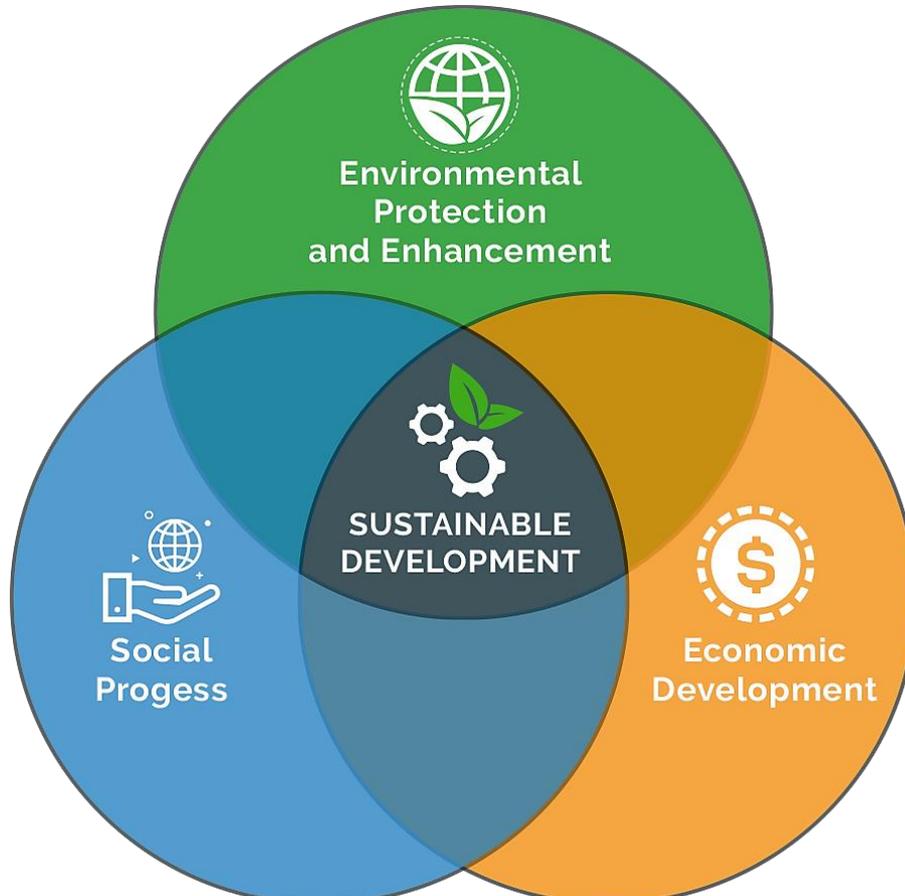

Figure 3.2 Sustainable development: ethical challenges and opportunities

3.2.2. Role of Ethics in Technological Choices

Technological ethics aims to assess the **long-term consequences** of innovation. It requires engineers to consider essential questions such as:

- Is this technology beneficial to society?
- What is its environmental impact?
- Are the risks adequately controlled?
- Are the benefits distributed fairly?

Example:

Choosing a high-efficiency motor, even if it is more expensive at the time of purchase, can be ethically justified by the **reduction of energy losses and CO_2 emissions** over the entire lifecycle of the equipment.
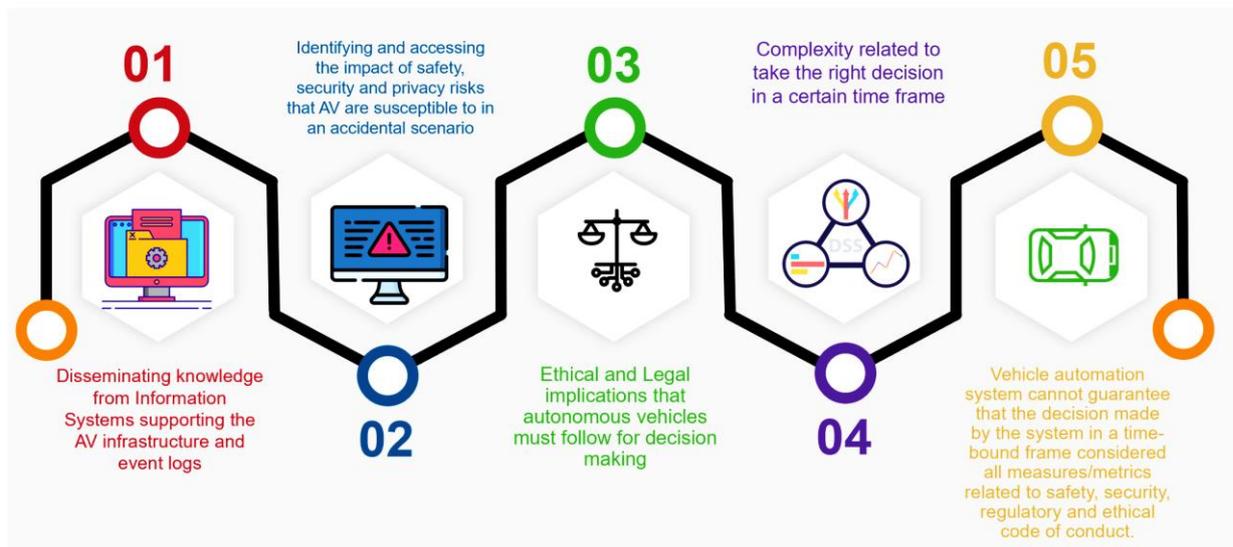

Figure 3.3 Ethical dilemmas related to AV's decision making

3.3. Ethics and Energy Efficiency

3.3.1. Global Energy Challenges

Global energy consumption is continuously increasing, leading to:

- Depletion of fossil fuel resources;
- Rising greenhouse gas emissions;
- Significant environmental and public health impacts.

In this context, **energy efficiency becomes both an ethical and a technical imperative**.

3.3.2. Role of Electrical Machines in Energy Efficiency

Electrical machines account for a substantial share of industrial electricity consumption. Engineers therefore play a key role in:

- Improving motor efficiency;
- Reducing electrical and mechanical losses;
- Optimizing control and regulation systems.

Example:

The use of **variable speed drives** allows motor power to be adapted to actual demand, thereby reducing energy consumption and equipment wear.

3.3.3. Ethical Responsibility of the Engineer

Engineers have a **moral responsibility** to prioritize solutions that are:

- Energy-efficient;
- Reliable and durable;
- Environmentally friendly.

Deliberately ignoring more efficient and sustainable solutions in favor of less responsible choices may be considered an **ethical failure**, particularly when long-term environmental and societal impacts are foreseeable.
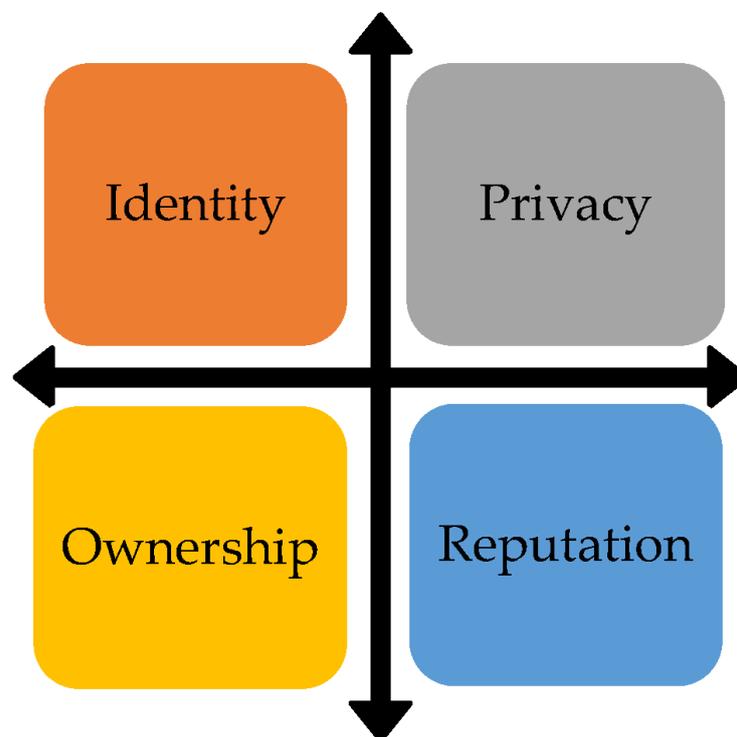

Figure 3.4 Ethical Concerns Related to Big Data and Machine Learning

3.4. Bioethics and Emerging Technologies

3.4.1. Concept of Bioethics

Bioethics is a discipline that examines the moral issues related to the life sciences and technologies that have a **direct impact on human beings**. With the increasing integration of **intelligent systems** in healthcare, assistive technologies, and robotics, bioethics has become a **central concern of modern engineering**.

Bioethics addresses questions related to **human dignity, autonomy, safety, responsibility, and social impact**, requiring engineers to anticipate the ethical consequences of technological design and deployment, particularly when technologies interact closely with individuals or vulnerable populations.

3.4.2. Artificial Intelligence and Ethics

Artificial intelligence (AI) now enables:

- Optimization of electrical power networks;
- Predictive maintenance of machines and industrial systems;
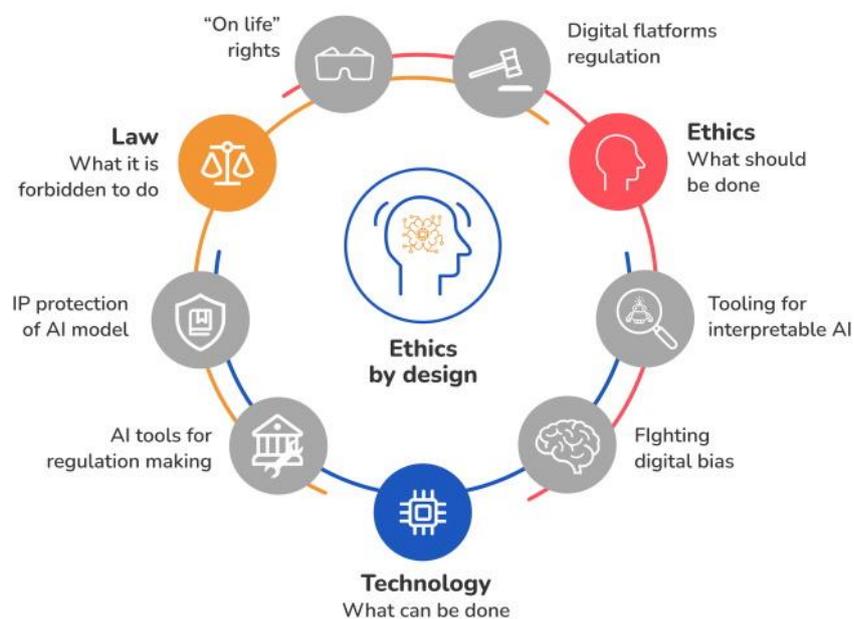- Automated decision-making in complex environments.

Figure 3.5 Artificial intelligence and ethics: transparency, accountability, and trust

However, the use of AI raises several **major ethical concerns**, including:

- **Algorithmic transparency** and explainability;
- **Bias in training data** and discriminatory outcomes;
- **Responsibility and liability** in case of errors or accidents;
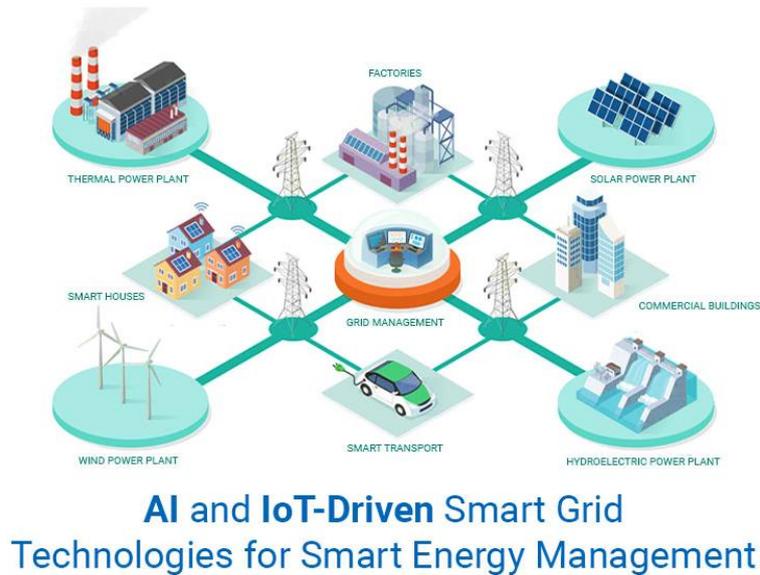- **Protection of personal and sensitive data**.

Figure 3.6 Artificial intelligence applications in smart electrical grids

Example:

An AI-based system optimizing the operation of an electrical grid must be **explainable and verifiable** in order to prevent unsafe, unfair, or discriminatory decisions that could affect consumers or critical infrastructure.

3.4.3. Humanoid Robots and Robotics

Humanoid and industrial robots are increasingly deployed in:

- Production lines;
- Service sectors;
- Assistance and support for individuals.

Figure 3.7 Humanoid and industrial robots in modern working environments

The main ethical challenges related to robotics include:

- **Safety of human–robot interaction**;
- **Replacement of human labor** and social consequences;
- **Responsibility and liability** in the event of malfunction or accident.

A poorly programmed collaborative robot may pose a **physical risk to human operators**, thereby engaging the responsibility of the **engineer, designer, or system integrator**.

Figure 3.8 Ethical and safety issues in human–robot collaboration

3.4.4. Drones and Autonomous Technologies

Drones and autonomous systems are widely used in:

- Inspection of electrical power lines;
- Industrial monitoring and surveillance;
- Logistics, security, and emergency operations.

Figure 3.9 Use of drones in electrical and industrial infrastructure inspection

Despite their benefits, drones raise significant **ethical and societal concerns**, such as:

- **Respect for privacy** and data protection;
- **Military or coercive uses**;
- **Safety and regulation of airspace**.

Figure 3.10 The five levels of autonomy in drone technologies

Example:

The use of drones for inspecting electrical networks is ethically positive when it improves worker safety and reduces accident risks. However, it becomes ethically problematic if it results in **violations of privacy** or uncontrolled surveillance.
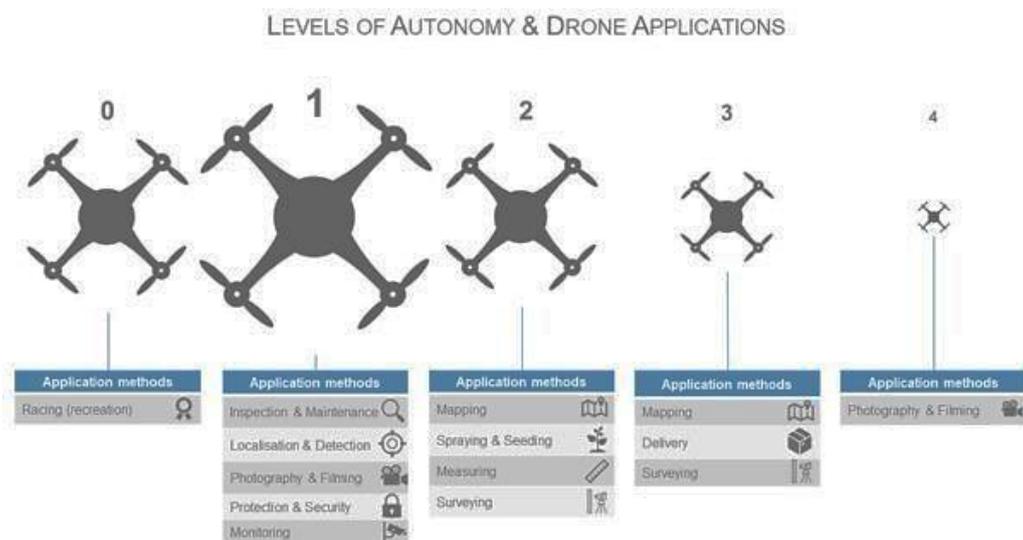

Figure 3.11 Drone application

3.4.4.1. Pedagogical Perspective

Bioethics and emerging technologies require engineers to go beyond technical performance and consider the **human, social, and environmental implications** of innovation. Ethical design, transparency, and accountability are therefore essential competencies for future engineers working with intelligent and autonomous systems.

3.5. Scientific Progress and Social Responsibility

Scientific progress should not be assessed solely in terms of **technical performance or efficiency**. It must also be evaluated according to:

- **Environmental impact**;
- **Social consequences**;
- **Ethical acceptability**.

Technological advancement that neglects these dimensions may generate unintended negative effects, including environmental degradation, social inequality, or risks to human safety.

Engineers are therefore required to adopt a **responsible and holistic approach**, integrating the principles of **sustainable development** from the earliest stages of system design. This responsibility extends beyond technical optimization to include long-term societal and environmental considerations.
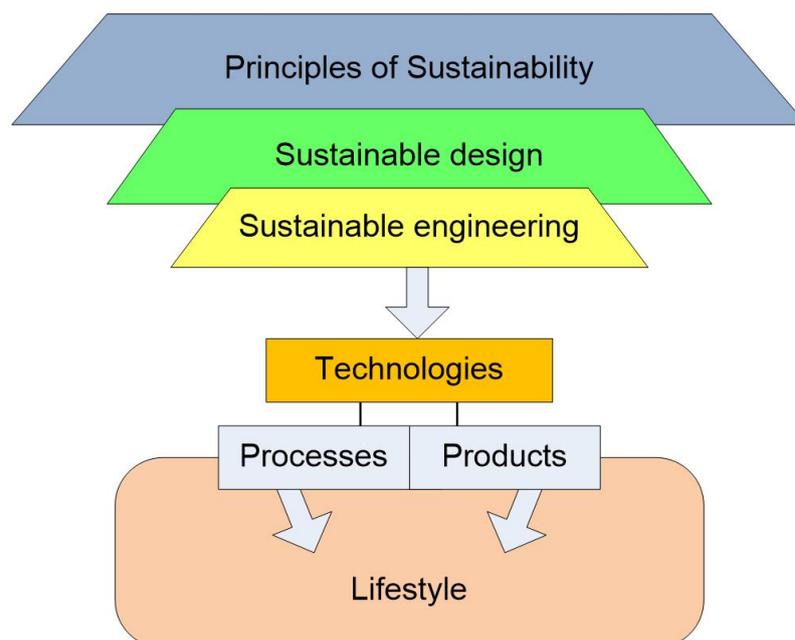

Figure 3.12 Scientific progress evaluated through environmental, social, and ethical dimensions.

Table 3.1 Dimensions of Responsible Scientific Progress

Dimension	Key Considerations	Engineering Implications
Environmental	Resource consumption, emissions	Energy-efficient design
Social	Employment, safety, equity	Human-centered systems
Ethical	Transparency, accountability	Responsible decision-making

3.5.1. Pedagogical Perspective

A responsible engineer must be capable of anticipating the **long-term impacts** of innovation and making informed decisions that balance **technical feasibility, economic viability, and societal well-being**. Integrating social responsibility into engineering practice is therefore essential for building **trustworthy, sustainable, and human-centered technologies**.
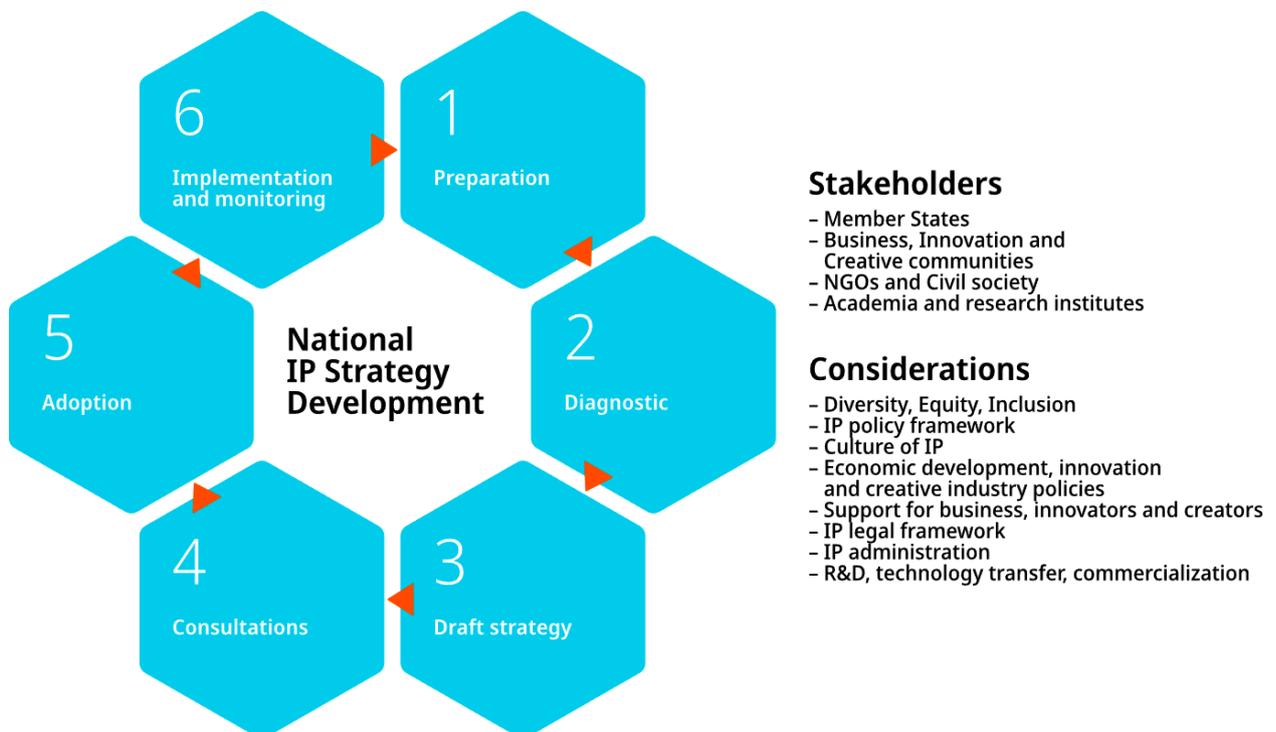

Figure 3.13 National intellectual property (IP) strategy development

3.6. Conclusion

This chapter has emphasized the **strategic importance of intellectual property (IP)** in higher education, scientific research, and industrial innovation. In a knowledge-driven economy, intellectual property represents a key mechanism for **recognizing authorship, protecting creativity, and transforming innovation into tangible value**.

Through the study of the **fundamentals of intellectual property**, this chapter clarified the distinction between **copyright** and **industrial property**, particularly patents. It highlighted that academic productions—such as Master's theses, scientific

articles, software, databases, and technical models—are not merely educational outputs but may constitute **original intellectual assets** deserving legal protection.

Special attention was given to **copyright in the digital environment**, demonstrating that digital accessibility does not eliminate legal protection. Software, databases, online content, and open-source resources remain subject to specific rights and licenses that must be respected. The chapter also underlined the crucial role of **proper citation practices**, especially through standardized formats such as **IEEE**, as a cornerstone of academic integrity and scientific credibility.

The discussion of **patents** illustrated their role in protecting technical inventions and enabling **technology transfer** from universities to industry. Understanding patentability criteria and protection strategies is essential for preventing loss of rights through premature disclosure. Furthermore, the chapter examined the **protection and valorization of intellectual property**, showing how innovation can be transformed into economic and societal value through licensing, partnerships, start-up creation, and industrial collaboration.

Finally, the overview of **intellectual property in Algeria** demonstrated its alignment with international conventions and its contribution to fostering research, innovation, and technological development at the national level.

In conclusion, mastery of intellectual property concepts is an **essential competence for future engineers and researchers**. It enables them to protect their work, respect the rights of others, and responsibly contribute to scientific and technological progress. The next chapter builds on these foundations by addressing **ethics, sustainable development, and new technologies**, focusing on the broader societal and environmental responsibilities associated with innovation.