LEARNING FACTORIES for VET

2. LABOUR CONTEXT OF THE ADVANCED MANUFACTURING SECTOR IN THE AUVERGNE-RHÔNE-ALPES REGION IN FRANCE

WP2 PEDAGOGY OF THE LERNING FACTORIES FOR VET

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1. GLOSSARY AND/OR ACRONYMS

AR Augmented Reality

AGV - Automated Guided Vehicles

AR - Augmented Reality

ARI - Automation and Industrial Robotics

BI - Business Intelligence

CBL - Challenged-Based Learning

CLF - Collaborative Learning Factory

CNC - Computer Numerical Control

CoVE – Centres of Vocational Excellence

ERP - Enterprise resource planning

ESCO European Skills, Competences, Qualifications and Occupations

ENSAM - Ecole Nationale Superieure D'arts Et Metiers

EQF – European Qualification fFamework

FHJ – FH Joanneum

HC-R-S - Human-centred, Resilience, and Sustainable

HVET High Vocational Education and Training

I4.0 - Industry 4.0

I5.0- Industry 5.0

IALF - International Association of Learning Factories

IoT - Internet of Things

IT - Information Technologies

LF - Learning Factory

SAT - Self Assessment Tool

SOP Standard Operating Procedures

SWOT – Strengths, Weaknesses, Opportunities, and Threats

TFCC – Teaching Factory Competence Center

VET - Vocational Education and Training

VR - Virtual Reality

WP - Work Package

WS - Workstation

CONTENT TABLE

1. EXECUTIVE SUMMARY

The document outlines the socio-economic and labour market context of the advanced manufacturing sector in the Auvergne-Rhône-Alpes region, one of the most important industrial regions in France and Europe

The text also analyses developments in the industrial labour market, which have been shaped by major technological transformations (robotisation, digitalisation, artificial intelligence) and by the energy and environmental transitions. of vocational training schemes that are tailored to and grounded in the realities of the workplace.

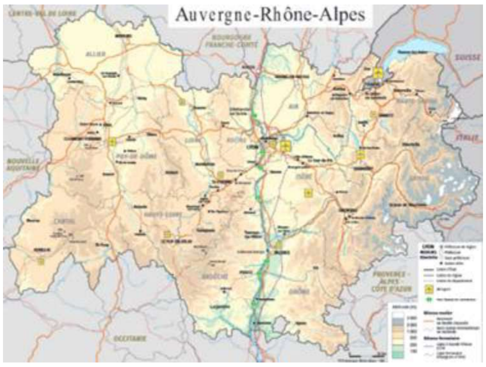
Finally, the document highlights the central role played by the École Nationale Supérieure d'Arts et Métiers, and more specifically its Chambéry campus, in addressing these challenges. Through the development of Evolutive Learning Factories, the institution offers an innovative teaching approach based on real-world work scenarios, encompassing the entire product lifecycle, from design to recycling. The training programmes examined, ranging from bachelor's degrees to engineering courses, aim to equip learners with technical, organisational and environmental skills directly linked to regional industrial needs. This approach strengthens the links between vocational training, technological innovation and sustainable transition, thereby contributing to the attractiveness and competitiveness of the manufacturing sector in Auvergne-Rhône-Alpes.

2. REGIONAL SOCIOECONOMIC CONTEXT OF THE AUVERGNE RHONE-ALPES REGION IN FRANCE

2.1 GENERAL CHARACTERISTICS OF THE AUVERGNE-RHÔNE-ALPES REGION

With 8 million inhabitants, an area of approximately 70,000 km², equivalent to the size of Ireland, or 12.8% of France's total area and a GDP equivalent to that of Denmark, the Auvergne-Rhône-Alpes region is one of the largest in Europe (Chambre de Commerce et de l'industrie, 2025). It comprises 12 departments, including Savoie, where the city of Chambéry is located, and four urban areas (Lyon, Grenoble, Saint-Etienne and Clermont-Ferrand). AURA is considered the leading region in France in terms of industrial jobs: 490,000 out of a total of 3.3 million jobs.

From a geographical point of view, the natural heritage is diverse (high mountains, plains, large lakes) and the territory is made up of areas with significant disparities and specific sustainable development challenges: on the one hand, rural areas corresponding to one third of the territory, some of which are located in the mountains, and on the other hand, large urban areas.



2.1.1. DEMOGRAPHIC COMPOSITION: A GROWING REGION

Auvergne Rhône Alpes is the second most populous region in France. Its population grew by an average of 0.6% per year between 2012 and 2017, which is above the national average. Its population is also younger than the national population. Its economic dynamism attracts executives and middle-level professionals from other French regions (INSEE, 2021). Four multidisciplinary university clusters structure higher education in the region (Lyon, Clermont-Ferrand, Grenoble and Savoie Mont-Blanc) and attract and retain students: 300,000 are enrolled in one of the region's institutions. These areas also offer a full range of local training courses (INSEE, 2021).

By 2050, population growth is expected to be between 8% and 16%, due to the region's attractiveness to young people (which would have an impact on the birth rate) and positive net migration.

2.1.2. AUVERGNE-RHÔNE-ALPES: A LEADING INDUSTRIAL REGION IN FRANCE

Today, Auvergne-Rhône-Alpes is France's second largest economic hub after Île-de-France. Its gross domestic product (GDP) exceeds €300 billion, representing 11.6% of France's GDP.

Auvergne-Rhône-Alpes is France's leading industrial region in terms of employment. With more than 533,000 industrial jobs out of a total of 3.3 million, the region's industrial system is mainly composed of small and medium-sized companies. Only 2% of these companies have more than 200 employees (Panorama Régional, 2025).

Industrial activity is structured around eight main sectors: machinery and equipment, metallurgy (and manufacture of metal products), rubber and plastics, electrical and electronic products, textiles and leather, and chemicals. The importance of the metallurgical industry in AURA compared to other French regions makes it a major industrial subcontracting region.

Training programmes for senior technicians specialising in production are connected to industrial areas (Maurienne, Arve Valley, Oyonnax). Research and development activities, mainly carried out by R&D teams in companies, are significant in the region in terms of GDP (2.7%).

Positions associated with industrial activity have been declining since the 1990s. This regional phenomenon is part of a national trend of deindustrialisation that has been ongoing since the 1980s, coinciding with the development of the tertiary sector. The position share in manufacturing has decreased in France from 21% to 11% since 1990 and from 26% to 14% in the AURA region.

Reindustrialisation is being encouraged since 2016, with the result of an increase in industrial jobs, twice as fast as in France (+6% compared to +3.2%) (INSEE,2020). Between 2016 and 2026, for example, six new factories have been created in the region. Electronics, medical equipment, jewellery, waste collection and treatment, and the pharmaceutical industry are among the most promising sectors (Panorama Régional, 2025).

2.1.3. THE REGION'S STRATEGY FOR 2028: STRENGTHENING INDUSTRIAL SOVEREIGNITY TROUGH TRAINING AND INNOVATION

The Auvergne-Rhône-Alpes region's strategy for 2028 (La Région Auvergne-Rhône-Alpes, 2022) focuses on strengthening industrial sovereignty, spreading innovation among businesses, and rolling out tailor-made offerings that adapt to businesses' needs. In this context, vocational education and training plays an essential role: training more engineers (EQF level 7), senior technicians (EQF level 5) and scientists by creating training programmes, increasing the visibility of careers in industry along with students and jobseekers' guidance.

Considering that the economy, the labour structure, the training system and innovation are related, the Auvergne-Rhône-Alpes development plan outlines five major strategic priorities:

1- Relocate production and strengthen industry with the major objective of creating 30,000 industrial positions and supporting 700 business relocation projects by 2028.

2- Accelerate the digitalisation and decarbonisation of businesses with the objective of supporting 50,000 micro-businesses and SMEs in their digital transformation by 2028 and supporting relocation projects, 50% of which must have a positive impact in terms of reducing CO_2 emissions.

3- Provide guidance and training by anticipating skills needs and adapting vocational training programmes so that by 2028, 30,000 people will be enrolled in training programmes for industrial careers.

4- Make Auvergne-Rhône-Alpes an attractive region for engineers, senior technicians and scientists by providing more VET courses whose curricula matches the skills needs of manufacturers. The aim is to strengthen the connection between businesses and schools with the goal of training 2,000 additional engineers in the region by 2028.

5- Rely on research and higher education to strengthen innovation by developing public-private partnerships and promoting technology transfer to businesses. Among other things, the region has set itself the goal for 2028 of supporting 200 multi-partner public/private research and innovation projects and having 12 projects carried out by local higher education institutions (recognised and high-performing higher education in the region).

Finally, the region's development plan is based on several sectors of excellence that constitute regional competitive advantages: the health industries, sustainable materials, microelectronics and artificial intelligence, and hydrogen.

2.1.4.THE SAVOIE DEPARTMENT

Covering an area of 6,028 km², Savoie has a population of around 431,000 (Panorama régional, 2025) and saw its population grow by 0.5% per year between 2012 and 2017. Its main activity is linked to tourism, particularly mountain tourism (15%). However, 11% of positions are industry sector related, mainly in metallurgy, metalworking and machining, and the agri-food industry.

In Savoie, 47.1% of the working population aged 25 to 54 hold a higher education qualification (a rate close to that of the Auvergne-Rhône-Alpes region, at 48.7%). The department counts nearly 15,000 students spread across various establishments in Bourget du Lac, Jacob-Bellecombette and Chambéry.

2.2. JOB MARKET AND ITS EVOLUTIONS

The manufacturing industry, the economic sector targeted by the LF4VET project, covers metallurgy and metal products; rubber and plastic products and other non-metallic mineral products; agri-food; textiles, clothing, leather and footwear; wood, paper and printing; transport equipment; machinery and equipment in Auvergne-Rhône-Alpes.

Between 2016 and 2023, jobs were mostly created in nine sectors: agri-food industry (+8,029 jobs); other manufacturing industries, repair and installation of machinery (+5,031 jobs); textiles, leather and leather goods (+2,470 jobs); IT, electronic and optical products (+2,168 jobs); the chemical industry (+1,392 jobs); the pharmaceutical industry (+1,331 jobs); transport equipment (+791 jobs) and electrical equipment (+122 jobs) (Panorama Régional, 2025).

Luxury leather goods, luxury jewellery, medical technology, electronics and optics are the sectors that have seen the highest net job creation since 2016.

Four factors will have a significant impact on the labour market between now and 2030:

- The acceleration of the ecological and energy transitions
- The transformation of professions through robotisation, digitalisation and artificial intelligence
- Lifestyles changes and consumption patterns: the rise of e-commerce and the growth of the collaborative economy will have an impact on skills requirements. Sustainable mobility advisers and circular economy specialists are emerging professions.
- The ageing population and retirements

In general, job creation will mainly target higher education graduates (47% of jobs in 2030). In the industrial sector, there will be a significant decline in the number of positions held by people with a secondary or lower diploma.

Recruitment needs will amount to 1.1 million jobs by 2030, mainly due to retirements (83%) and, to a lesser extent, net job creation (17%) (Via Compétences, 2024). Strong growth in research and development activities is expected, as well as continued reindustrialisation. These vacancies would be filled partly by young people entering the labour market and partly by workers from other regions.

However, the balance between needs and recruitment would be negative, with 5% of positions remaining unfilled.

In the industrial sector, the positions that would be most difficult to recruit for and that would recruit the most are:

- Skilled warehouse worker. This is a low-skilled job that could benefit from upward mobility.
- Textile and leather worker: this is a job that is deeply rooted in the region's culture.

The occupations that would create the most jobs and recruit the most:

- Industrial engineers and managers: the region's industrial diversity, the importance of high-tech industry and the presence of European factories make this one of the occupations that creates the most jobs. The requirement for advanced technical skills should be met through specific training.
- Research and development personnel would be one of the sectors creating the most jobs in the region, but due to its attractiveness, recruitment needs would be met.

Industrial companies have identified four short-term priorities:

- Increasing the performance of production facilities
- Innovating: developing new products and services and innovating on existing products
- Improve quality of life at work and the company's image
- Improve the environmental impact of the production process, design and develop more sustainable products, and improve the energy impact of the production process.

These priorities face with mismatch between the training system and the needs of businesses. Businesses are increasingly looking for employees with LQF 3 and 4, whereas the LQF provided is 5. Furthermore, school-based training is generalist and not particularly geared towards work challenges. The geographical dispersion of specific profiles constitutes also a difficulty (L'observatoire compétences industries 2i, 2025).

2.2.1. PROSPECTIVE ANALYSIS OF THREE INTER-INDUSTRY PROFESSIONS COVERED BY LF4VET

The report published in 2025 by the Observatoire des compétences Industries features a prospective analyse of inter-industry families of professions by 2030. Amongst the professions and French training programs covered by LF4VET, three families were identified:

1. Design, research and development: design office technician, renewable energy research and development engineer

This family of professions will see a significant evolution in skills over the next three years. This is particularly true with regard to the integration of digital technology and artificial intelligence into research and design processes: digital simulation and biostatistics. In terms of ecological and environmental transitions: changes in mobility (batteries, new materials to make vehicles lighter, hydrogen, new engines, etc.), recycling (textiles, composites, batteries, etc.), innovation by suppliers of materials (wood, aluminium, PVC, glass, etc.) and equipment (heating, paints, etc.) will evolve to offer high-performance solutions in line with regulatory changes.

2. In connection with digital transition: integration of embedded software and systems, smart cities, telemedicine, automation and robotisation.

- Design office technician: reviews specifications and documents provided by the client, analysing the technical file for the project and its constraints, and developing proposals to ensure their feasibility, taking into account environmental constraints; producing models, drawings, plans and diagrams in 2D or 3D, using CAD/DA tools in particular.
- Renewable energy research and development engineer: translates functional requirements into technological hypotheses, carrying out technical and economic feasibility studies for projects, participating in the monitoring of the manufacturing and assembly phase of renewable energy installation projects.

3. Planning and QHSE: methods technician, industrialisation engineer, HSE engineer

- Methods technician: Studies and determines the procedures to be followed for each manufacturing process; formalises the processes and procedures necessary for the organisation to function; compiles manufacturing files; establishes provisional production schedules.
- Industrialisation engineer: Analyses technical data for the implementation of industrial methods; centralises and analyses issues in order to optimise industrialisation; defines the manufacturing phases and the distribution of tasks; proposes corrections to procedures or improvements to production performance.
- HSE Engineer: Develops and implements HSE policy; assesses and manages occupational and environmental risks; coordinates relations with authorities, professional organisations and regulatory bodies to ensure regulatory compliance; monitors regulations.

The evolution foreseen for these three families of inter-industry professions conveys the idea that training and learning factories conception should take into account modifications resulting from digital and ecological evolution.

3. ORGANISATIONAL CONTEXT

3.1. THE ECOLE NATIONALE SUPERIEURE DES ARTS ET METIERS

The École Nationale Supérieure des Arts et Métiers, founded in 1780, is one of the oldest engineering schools in France. Arts et Métiers has 14 sites, 13 in France and 1 in Morocco, hosting 15 research laboratories, which train 6,000 students per year, including 331 doctoral students and 2,000 continuing education students in 11 engineering programmes (1 generalist, 10 apprenticeship programmes), two bachelor's degree in technology and one in science, 20 research master's degrees, and 17 specialised master's degrees. The entire spectrum of technological training in higher education, from bachelor's to master's degrees, is thus covered. The scientific teams are engaged in five major strategic areas, corresponding to five economic sectors: transport, energy, health, housing, and production. These fields are divided into 20 areas of research, such as digital engineering, biomechanical design, thermal energy and collaborative robotics. Researchers and students focus on the entire life cycle of a product: from design to production and recycling.

3.1.1. THE CHAMBÉRY INSTITUTE AT SAVOIE TECHNOLAC

Located in Le Bourget du Lac in the Savoie department and covering a total area of 150 hectares, Savoie Technolac is an ecosystem of companies, research centres and higher education institutions. This business park is home to 230 innovative companies, half of which are in the energy sector, providing 3,500 jobs and offering an incubator and growth accelerator for innovative companies in the region. The hub also hosts 1,000 researchers and 5,000 students. The Institut des Arts et Métiers de Chambéry has been based on this site since 1995. It is a design, mechanical engineering and environmental institute, pioneer in sustainable design. Its aim is to train future engineers and senior technicians, but also to support the industrial system in its transformation towards sustainability and robustness at the local level in order to cope with socio-ecological fluctuations.

The Chambéry institute specialises in the circular economy, eco-innovation, sustainable design, recycling and recovery channels, regional sustainability, sustainable value assessment and low-tech solutions.

Sustainable design is the main approach: design of goods and services, life cycle engineering, environmental impacts, reuse and eco-innovation. A circular economy approach is also targeted with the environmental assessment of products and services.

The Chambéry Institute offers training programmes ranging from EQF 6 to 8:

- Bachelor's degree in Science and Technology, sustainable design. EQF5
- General engineering programme. Third-year expertise: Eco-design of goods and services.
- Specialised engineering programme: Environment and risk management. EQF7

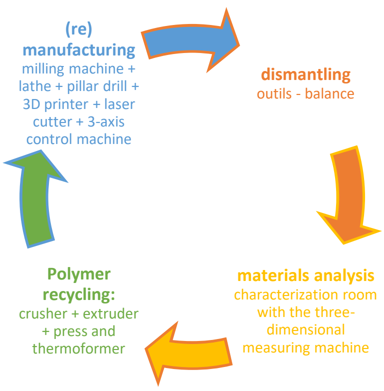
These programs are aimed at careers in health, safety and environmental engineering, environmental and sustainable development engineering, design engineering, risk management and prevention consulting and auditing, and product and process eco-design engineering.

- Specialised Master's degree: Expert in sustainable construction and housing. Change management and sustainable innovation EQF7
- PhD - EQF8

3.1.2. LEARNING FACTORY HISTORY AND DESCRIPTION

In its ambition to be the engineering school of tomorrow's industry, Arts et Métiers has undertaken a process of renewing its educational and technological approach by proposing the concept of the Evolutive Learning Factory (ELF). The aim is to bring together in one place and in a comprehensive approach the equipment, processes and methods encountered during the stages of an industrial product's life cycle: ideation, design, modelling, prototyping, production and 'end of life'. The facilities will aim to integrate different industrial processes, digital tools, and individual and collective spaces.

In Chambéry, the ELF comprises various machine tools adapted to different training programmes, and to research and innovation linked to companies' characteristics. The following cycle is therefore used as a process and training guide, with the equipment associated with each stage:



The existing equipment includes a milling machine, a lathe, a pillar drill, a 3D printer, a laser cutter, a three-dimensional measuring machine, a crusher, an extruder.

Besides, a press, a thermoformer, a 3D printer, a three-dimensional measuring machine, a 3-axis control machine are currently being acquired.

Educational renewal and spin-offs

The main objective of the ELF program is to renew the training of industrial transition engineers and manufacturing professionals (in the three areas of design, manufacturing and management). These professionals will need to integrate technological innovations, particularly those related to Industry 4.0 and 5.0, and to support companies in their digital and sustainable transformation. Supported by state-of-the-art technical platforms representative of Industry 4.0, the teaching methods developed will reduce the gap between VET situations and real work situations, thus facilitating the transfer of knowledge and skills. The definition of training goals using a skills framework, in particular the CDIO (Conceive Design

Implement Operate) approach, is aimed to strengthen the links between the training context and the work context.

The national Evolutive Learning Factories (ELF) program is strategic for Arts et Métiers. As such, its progress is systematically assessed by the School's governing bodies: the Territorial Council, the Scientific Council, the Council for Studies and Student Life, the Management Committee, the Executive Committee and the Board of Directors.

To ensure the effective deployment and monitoring of the ELF program, the management has set up specific bodies such as the School's Deputy General Management: its mission is to make the ELF project operational and to liaise with the school's management bodies. The ELF committee on each campus: implements the national strategy by integrating the national ecosystem.

4. VET PROGRAMMES

As part of the LF4VET project, two training programs will be studied in depth, particularly in regards both to connections with the labour market needs and its evolution and Learning factories conception.

1. *The Bachelor's degree in Science and Technology, sustainable design sector*. This EQF level 5 degree, targets high school graduates with a work-study approach. The study plan is structured in three years with periods in school and long period internships. Students are recruited by a company who finances their studies.

- Year 1:
    - Scientific and technological knowledge on the design and production of innovative technological products (3DEXPERIENCE CAD software, machining and rapid prototyping machines)
    - Case studies and project-based activities (simulation of an electric battery production line)
    - Practical training in industrial environments
- Year 2:
    - Product, process and energy engineering (Ansys Granta software)
    - Eco-design tools to reduce the environmental impact of products and processes (SIMAPRO and Open LCA environmental assessment software)
    - Projects related to battery life cycles with industrial partners
- Year 3:
    - Scientific and technical skills
    - Eco-innovation, sustainable development and the circular economy
    - Project leadership and management

In addition to the study plan, a hierarchy of skills has been identified to facilitate links with workplace situations:

- SKILL SET 1: Designing and manufacturing innovative products
    - Skill 1: Develop specific specifications to meet stakeholder needs
    - Skill 2: Select materials and manufacturing methods to meet specifications
    - Skill 3: Design parts and assemblies to meet specifications
    - Skill 4: Manufacture parts and assemblies to meet specifications
- SKILL SET 2: Implementing and optimizing the operation of an industrial system
    - Skill 1: Implementing an industrial system to enable the production, management in use and end-of-life recovery of products and their raw materials
    - Skill 2: Ensure the continuous improvement of production methods and processes to guarantee production quality, operator safety, cost and deadline compliance, and consideration of socio-environmental issues
- SKILL SET 3: Deploy tools and approaches aimed at reducing the socio-environmental impacts of products and services throughout their life cycle from a systemic perspective

    - Skill 1: Integrate systemic socio-environmental issues when framing a project to meet current and future challenges
    - Skill 2: Analyze the entire life cycle of a product or service in order to improve its socio-environmental impacts
- SKILL SET 4: Integrating into a technical industrial project within a multidisciplinary team
    - Skill 1: Supporting an engineer in managing a multidisciplinary team to achieve the objectives set
    - Skill 2: Supporting an engineer in steering an industrial project to meet customer needs

Scope of application: All stages of designing and manufacturing innovative products; setting up and optimising the operation of an industrial system; deploying tools and approaches aimed at reducing socio-environmental impacts; integration into a technical industrial project within a multidisciplinary team.

Bachelor's degree graduates will be able to apply to intermediate management positions as: production or maintenance team leader; eco-design project manager; industrial technician; production technician; maintenance technician; design office technician.

Target sectors: All companies designing or manufacturing products, or design offices.

2. *The Eco-design of Goods and Services programme*, third-year expertise of the general engineering degree (Programme Grande Ecole) is an EQF level 7 diploma, and the target audience is engineering students already enrolled in the general diploma at Arts et Métiers. The program this 3rd year includes four modules :

- Module 1 - Overview of environmental issues and resources in our modern societies. Interactions between the economy, the environment and society. Consequences and prospects for economic actors in product development models.
- Module 2 - Environmental assessment of products and services: Develop a carbon footprint (CF) and/or life cycle assessment (LCA) for a product or service, assess the impacts in order to improve the company's environmental performance.
- Module 3 - Eco-innovation and eco-design methods and tools: Acquire methods and tools for integrating environmental parameters into the different phases of product design in order to reduce its environmental impact throughout its life cycle.
- Module 4 - The different levers of eco-design: Reflect on the management of the materials that make up the product in order to optimise production through sustainable processes and anticipate end-of-life (recycling, recovery, etc.). Low-tech approach. New business models.

The targeted skills of engineers who choose the 'EcoBS' option have the following specific skills:

• Selecting and implementing methods for assessing the environmental impact of products and services in order to take into account, from the design stage onwards,

• Reduce these impacts throughout the entire life cycle,

• Integrate tools into a company and its design process that enable the sustainable application of eco-innovation and eco-design approaches,

• Lead an eco-innovation and eco-design initiative,

• Implement the concepts of functional economy and circular economy.

• Create and develop eco-innovative companies.

Engineers with an Eco-design specialisation are able to apply to positions as: eco-design engineer; sustainable innovation engineer; sustainable product development engineer; industrial strategy consultant; environmental analysis consultant.

Scope of application: All stages of design, production, development and deployment of goods and services.

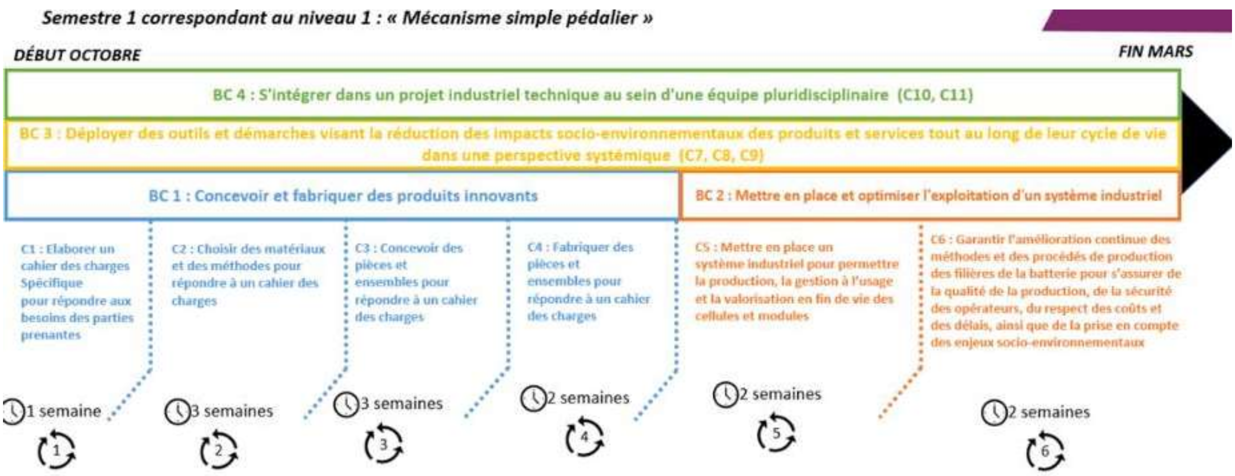
Target sectors: All companies that design or produce products and services. Research organisations, technical centres, chambers of commerce, organisations.

4. WORKPLACE SITUATIONS

4.1. BACHELOR'S DEGREE IN SCIENCE ET TECHNOLOGY, SUSTAINABLE DESIGN

Each semester corresponds to an object to be created from scratch by students using the machines in the learning factory (laser cutting, 3D printer, etc.) and in line with the knowledge they acquired, the skills targeted and taking into account the different degrees of difficulty.

This diagram summarises this authentic learning situation over a semester:



To create this pedal set, students will need to use skills appropriate to the level of difficulty required and make use of tools and machines. These skills will be assessed using assessment grids. If the required level is not achieved for one or more skills, it will be possible to re-validate the semester the following semester, as the cycle starts again but with a new, more complex object.

4.2. GENERAL ENGENEER PROGRAM ECOBS 3RD YEAR TRAINING AS PART OF THE CORE PROJECT: DISMANTELING

During a practical class entitled “Travail pratique de démantèlement” (“Dismantling practical class”), students will dismantle an end-of-life stage product and will thus use the various machines and tools available to them in the training factory, depending on the chosen product and mobilise several skills across different disciplines (multidisciplinarity).

The activities students will carry are oriented towards the acquisition of a main skill that is in the case of a Waste Electrical and Electronic Equipment (WEEE), to analyse the potential circularity of end-of-life waste electrical and electronic equipment (WEEE) by dismantling it, creating a dismantling tree and a parts list, in order to assess its current and potential recycling rates and their regulatory compliance, and to suggest ways to improve the barriers to circularity.

To develop this main skill, students will first dismantle an end-of-life product from A to Z (using the necessary tools and machines in the training factory) and then produce data for more in-depth studies. Three deliverables are associated to these activities:

Deliverable 1: Dismantling tree (link to the eco-design course)

Deliverable 2: Parts list (link to the life cycle analysis course)

Deliverable 3: End-of-life sector diagram (link to the course on product end-of-life)

Then, students will identify barriers to circularity and recyclability and propose areas for improvement and development in design.

The targeted learning outcomes include:

- Dismantle waste electrical and electronic equipment (WEEE) in accordance with safety instructions (wearing PPE, using appropriate tools, behaving responsibly) to separate it into sub-assemblies, then single-piece and single-material parts
- Collect data useful to end-of-life and recycling stakeholders, such as dismantling time, types of connections (removable, non-removable, destructive), the functions of sub-assemblies and the identification of materials
- Create a dismantling tree that summarises this data in a clear and structured manner, in order to identify the variety of materials and connections, as well as the obstacles to circularity that could be addressed through eco-design
- Create a nomenclature (parts, materials, masses, processes) that will be used as the basis for a complete life cycle analysis
- Calculate the different recycling rates for the current product (collection, treatment, reuse) using literature from eco-organisations and ADEME, and compare them with potential recycling rates using improved dismantling scenarios
- Explain and justify current and potential end-of-life scenarios by verifying their compliance with regulations
- Identify the main pollutants and critical materials (flame retardants, Critical Raw Materials Act, etc.) to study their possible targeted extraction

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