Technological Possibilities for Wood and Furniture VET

SHIFTVET

Digital Transformation for
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1. Introduction

1.1 Context of the project

The ShiftVET project "*Digital Transformation for Wood and Furniture VET*", responds to the need to modernize vocational training in traditional manufacturing sectors, particularly woodworking, by integrating advanced digital technologies.

The woodworking sector continues to experience significant skills shortages, particularly in digital skills. In addition, there is also a lack of trained staff to teach these technologies in their classrooms, and vocational training centres often lack the practical guidance necessary to adapt to these new demands and methodologies. That is why the ShiftVET project was created to incorporate technologies such as 3D printing, extended reality, and CNC in an educational manner.

ShiftVET has a transnational consortium of vocational training course providers, as well as a technology center that can address these shortcomings. The collaboration between the partners aims to transfer technological knowledge, improve the skills of VET instructors, create innovative teaching resources, and enhance the appeal of vocational training in the wood and furniture sector, mainly, at the European level.

1.2 Objectives of Activity 1

Activity 1, "Analysis and Implementation of Technologies in Woodworking VET Programs", forms the basis of this project, as it establishes a technological baseline and pedagogical orientation for all subsequent activities. The objectives of this activity are:

- To identify and analyse digital technologies that have potential for application in vocational training in woodworking at the three associated vocational training centres.
- Involve stakeholders to validate technological priorities and gather expert opinions for the report that we will see in the following sections.
- Develop a set of guides for trainers, each focusing on a specific technology, explaining the potential of each one and its integration for teachers in the classroom.

- Create an open-access web repository where the results of this project are disseminated and accessible to everyone.
- Implement internal workshops to train teachers and stakeholders, giving technology demonstrations and promoting the exchange of good practices with other vocational training providers.

1.3 Objectives of this report

This report, created by the ShiftVET consortium, aims to establish a sound basis for digital transformation into woodworking VET. It summarizes the technological, pedagogical, and sectoral needs identified across the consortium and provides guidance for the integration of advanced digital tools into VET programs. The specific objectives of this report are:

1. To identify digital technologies applicable to woodworking vocational training.

Conduct a systematic analysis of digital technologies such as 3D printing or mixed reality, which can improve teaching and learning processes in the furniture and wood sector.

2. Evaluate their pedagogical value and integration potential.

Assess the educational benefits, learning outcomes, and applications in the classroom and VET workshops of these technologies, considering the profiles of students and trainers.

3. Map the alignment between technology and the curriculum.

Determine which specific subjects, modules, or training units within VET programs can most effectively incorporate each technology.

4. Incorporate stakeholder opinions.

Integrate the perspectives of industry representatives, trainers, technology experts, etc. to ensure that the proposed technological applications are viable and in line with current needs.

5. Support the development of guides and exercises for trainers.

This report will be a first step in providing a basis for these technologies so that pedagogical exercises can be developed for trainers to use.

6. Contribute to a shared European vision of digital VET in woodworking.

Promote a common understanding of technological opportunities in the three participating countries (Italy, Latvia, and Spain), encouraging mutual learning and the scalability of digital teaching practices.

7. Enable informed decision-making by VET providers

Provide vocational training institutions with practical and structured information to guide investment, training planning, classroom innovation, and digital transformation within these woodworking VET programs.

2. Methodology

This report follows a structured, evidence-based methodology designed to identify the technologies best suited to vocational training in wood and furniture. The methodological approach combines documentary research, stakeholder input, and a process of analysis to ensure that the results are robust, valid, and consistent with the needs of the sector.

2.1 Desk research: review of current technological trends in the Wood and Furniture sector.

The first phase involved researching and discussing current technological advances and innovation trends in the sector.

During the drafting of the ShiftVET proposal, strategic reports from European institutions were analysed, and the results of related projects such as ALLVIEW and TwinRevolution were reviewed.

Each partner also identified the most relevant technologies mentioned for the VET course. Each partner reviewed the technologies currently gaining momentum and assessed the resources available in their own centres that could be valuable for ShiftVET and for delivering training to students and trainers.

This analysis made it possible to identify different technologies that had the potential to be integrated into VET courses on wood, such as extended reality, 3D modelling applications, scanning systems, and advanced aids for machining.

2.2 Stakeholder surveys

Another methodology that has been used, in this case to validate and refine the identified technologies, is to conduct a survey of stakeholders in the three participating countries. The survey covered the following:

- VET trainers and instructors.
- Experts in the technologies mentioned.
- Workers from companies in the furniture or wood sector.

Each organization collected comments from different stakeholders, gathering information about:

- Experience in the sector that the stakeholders have.
- Technological needs- Digital tools or technologies that should be integrated into carpentry training to improve student preparation.

- Industry trends- Current and future trends in the furniture industry that students and trainers should be aware of.
- Essential skills that graduates should have when entering the furniture and woodworking industry.
- Learning experience- Benefits of including technologies such as 3D printing or virtual reality in student learning in these VET programs.
- Challenges and priorities when integrating new technologies into training.

The survey results, presented later in this report, have enabled the validation of technological priorities and the identification of relevant opportunities and constraints.

2.3 Data analysis and technology selection process

The data collected through documentary research and surveys has been analysed using a multi-criteria approach. The technologies that have ultimately been selected for development in ShiftVET have been evaluated based on the following criteria:

- Pedagogical relevance: potential to improve student learning, support practical training, and enhance classroom safety.
- Feasibility: availability of equipment, necessary resources, and alignment with the infrastructure of participating VET centres.
- Applicability to the sector: relevance to the furniture and wood sector and increase in industry skills to improve processes.
- Transferability: the use of these technologies can be transferred later to other sectors or VET courses.
- Validation by stakeholders: level of consensus on the usefulness of the technologies and their relevance.

Following this analysis, a list of technologies has been selected for development throughout the project, in addition to the following sections of the project to define them well and see the possible applications in the sector, the necessary skills, and the ways of integrating them into woodworking VET.

3. Overview of technological trends

This section outlines the main technological trends identified by the consortium. This analysis reflects both the current level of technological integration in wood VET and broader innovation trends.

The technologies identified not only improve teaching methodologies but also respond to the growing demand to introduce digital skills and provide training in this area.

3.1 Digital Fabrication Technologies

Additive Manufacturing (3D printing)

All partners recognize that 3D printing is a very important technology for creating prototypes, validating designs, and providing practical training for students. The José Luis Castillo Puche Institute and ASLAM have different types and models of 3D printers, such as CoLiDo SR1 and Prusa XL, which are FDM printers, as well as MSLC resin system printer models such as Elegoo Saturn 8K. These types of printers are used for prototyping and also for validating precision components. They emphasize that this technology provides practical exposure to students and helps them understand manufacturing processes.

RMMT does not use 3D printing in its carpentry curriculum, but they also point out that it is a technology with growing demand and easily adaptable for woodworking training.

CNC machining and milling

CNC machining is a fundamental technology at all three institutions. RMMT uses advanced machinery and professional software such as Alphacam to train students at its center.

JLCP, on the other hand, focuses more on additive manufacturing and XR (Extended Reality), but identifies CNC and CAD/CAM as essential in professional woodworking training as they are relevant skills in the sector.

ASLAM also agrees that CNC is a growing technological trend and can be very useful for training students in woodworking modules.

Laser Cutting and Engraving

In its personal analysis, RMMT highlights CO2 laser engraving as a key technology for creating precision prototypes and templates. This technology complements CNC machining as it allows for more detailed manufacturing tasks.

3.2 Digitalization and Metrology

3D scanning and reverse engineering

Both JLCP and RMMT now use 3D scanning technologies to introduce digital metrology to students in their VET courses. JLCP uses the RangeVision NEO system, which offers high precision for digitizing electrical and wooden components.

RMMT, on the other hand, also uses the scanner to digitize decorative carvings for projects, allowing students to experience the entire digital production cycle.

3.3 Immersive Technologies (XR)

Virtual Reality (VR)

Partner JLCP reports on the advanced use of PICO 4 and PICO Neo Pro virtual reality systems, using them to validate models and for immersive learning. Virtual reality improves spatial comprehension and reduces risk in certain practical activities. It also allows for repeated practice of certain tasks with a higher degree of complexity.

Stakeholders also associate VR with higher safety and greater student confidence. Another advantage is cost savings, as it reduces the use of materials.

Currently, the Riga training center does not implement VR in its woodworking program, but they highlight that it could be potential technology to include in their training courses for tasks such as stage assembly or CNC workflow simulation.

Mixed Reality (MR)

The use of this technology allows for step-by-step guided learning, virtual superimposition of assemblies, and more interactive training in certain programs. Its potential for woodworking courses is high, as it can help with tasks such as guided machining, assembly instructions, or more complex tutorials.

This positions MR as a technology with high value for inclusion in training.

3.4 Traditional and Hybrid Woodworking Technologies

It is true that the partners' analyses and the report focus on digital technologies, but it is worth highlighting the partners' opinion on **traditional machinery**, which remains essential for these VET courses. The analyses list:

- Table saws
- Band saws
- Planers and thicknessers
- Stationary drills
- Milling machines
- Stationary grinders
- Woodworking presses

Although these are not technological machines, it is also important to continue to emphasize the idea that in the furniture and wood sector, traditional methods cannot disappear. Instead, we must know how to adapt what already exists to new technologies or see how traditional methods can be complemented by digital ones, so as not to lose the craftsmanship of this sector.

3.5 Software Ecosystem and Digital Workflows

The main software trends are also mentioned:

- CAD/CAM modelling: AutoCAD, Alphacam, Xilog Plus
- Cutting software: Cura, Orca, PrusaSlicer
- Metrology software: RV 3D Studio/ScanCenter NG
- XR software: AURORA VR, Windows Holographic

This ecosystem demonstrates a shift toward fully digital workflows, from design to prototyping and final production.

3.6 Cross-cutting Trends and Industry Drivers

All **ShiftVET** partner analysis reports highlight different technological drivers:

- **Industry 4.0 integration:** automation, digital twins, real-time monitoring
- **Precision and quality control:** 3D scanning, CNC precision
- Safety and sustainability: virtual reality simulations reduce risk and material waste
- **Skill hybridization:** emphasizing that there must be a balance between craftsmanship and digitization

- **New skill demands** programming, modelling, and problem solving are key skills that can be nurtured through the incorporation of new technologies.

Stakeholders also highlight the importance of artificial intelligence for future applications in design, maintenance, and even automation.

4. Survey results and validation

This section deals with the consolidated results of the surveys conducted among stakeholders by the four institutions participating in the project, as part of the validation process for activity 1.1. The aim of the survey was to assess the perceived relevance, usefulness, and future potential of different digital and traditional technologies in wood VET.

The results confirm an alignment between educational institutions and what is expected from industry in the future, reinforcing the technological trends identified in section 3.

4.1 Profile of Respondents

The following stakeholders were consulted in the four organizations associated with this project:

- Wood and furniture companies
- Vocational training teachers and workshop instructors in woodworking, CAD/CAM, digital manufacturing, and technical subjects
- Technical specialists in digital production
- Local industrial partners and cluster representatives.

Organization to which you belong and position you hold	Country
IES J. l Castillo Puche- head of studies	Spain
IES José Luis Castillo Puche - Teacher	Spain
ASLAM- Expert on the field	Italy
ArtWood Academy- Teacher	Italy
ArtWood Academy- Tutor	Italy
Fioretti- Expert on the field	Italy
FederlegnoArredo- Expert on the field	Italy
ArtWood Academy - Tutor	Italy
Sagone- Expert on the field	Italy
TM Leader Contract, Production and Logistic Technician	Spain
UOC, Professor	Spain
Head of department	Spain

Ies Jose Luis Castillo Puche- Vocational training teacher for the carpentry and furniture cycle	Spain
RMMT teacher	Latvia
RMMT teacher	Latvia

Table 1: Name and organization of respondents

Each institution had a minimum of three stakeholders, in accordance with the requirements of the ShiftVET methodology.

In general, the respondents contributed practical experience in the technologies described in section 3, and their comments provided reliable validation for identifying the most relevant technologies in woodworking vocational training.

4.2 Results of the survey

Age	Experience on VET sector
62	10 years
47	20 years
28	4 years
33	Brief experience in the VET sector, as a tutor and teacher
56	Experience in Internship organization
32	Experience in cad-cam, 3d printing
45	3 years
28	4 years
34	6 years
43	Teaching new workers in the company
32	I have been teaching in some VET courses apart from the university
52	20 years
55	6 years
26	have worked in a vocational education school
26	Experience as a teacher

Table 2: Age and experience of respondents

TECHNOLOGICAL NEEDS: What digital tools or technologies do you think should be integrated into woodworking training to improve student preparedness?

Scanner and 3D printing
To improve student preparedness in woodworking, training programs should integrate CNC machinery, CAD software, digital measuring tools, and Industry 4.0 concepts. These technologies enhance precision, efficiency, and real-world relevance.
Integrating CAD/CAM software, CNC simulation, 3D printing, and mixed-reality tools would best prepare woodworking students for digital manufacturing and Industry 5.0 environments.
For student training, it is important to find the right balance between CNC and traditional machines.
Specific SW for design, production en prototyping
AR to help the students learn by themselves when there aren't teachers around; LCA programs to help the students choose the best materials/technologies/shapes in order to minimize the product's impact on the environment.
AI, human-robot interaction
It depends on the profile of the woodworker, I believe a solid competence on CADCAM software usage is mandatory, and of course being able to read and understand technical drawings is important too. Another aspect to consider would be knowledge on ERP systems
Mixed Reality tools for on-field training, 3D scanning for digital models acquisition / handling, CAD software, CNC practical use / simulation
Students should learn to design and produce parts using Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM) software. Understanding how to program and operate CNC machines (Computer Numerical Control) is fundamental for efficiency, precision, and competitiveness in modern furniture production. In addition, training should include 3D modelling and rendering tools (e.g., SketchUp, Fusion 360, SolidWorks). These allow designers and technicians to visualize projects, detect design issues early, and communicate ideas effectively with clients and colleagues.

Industry 4.0 technologies such as robotics, IoT sensors, and digital twins would be valuable. AR and VR tools could enhance training by simulating woodworking processes, machine operation, and workshop safety. CNC machines are also quite important.
Virtual Simulator
In my opinion, the student should know how to operate the numerical control machine, the design programs, and be receptive to incorporating AI into their learning as much as possible.
• CAD/CAM software (Fusion 360, SketchUp, AutoCAD) for precise design and production planning. • CNC technology training, including NC programming, tool selection, and machining parameters. • 3D scanning and 3D modelling for digitalization of objects and prototype creation. • Digital measuring tools (laser levels, digital templates) to improve accuracy. • IoT and smart machinery with sensors for safety, performance, and quality monitoring. • Production management software (ERP/MES) to help students understand modern manufacturing workflows.
Augmented Reality (AR) guides to support step-by-step assembly and machining instructions. • Computer-controlled measuring systems for precise calibration and alignment. • Digital twin technology to simulate workshop processes before actual production. • Cloud-based design platforms that allow sharing projects between students and teachers. • Laser-cutting training to introduce fast prototyping alongside traditional woodworking skills.

Table 3: Answers to first question

INDUSTRY TRENDS: Based on your experience, what are the current and future trends in the woodworking industry that students and trainers should be aware of?

Numerical control, virtual reality
The woodworking industry is evolving rapidly, with key trends including digital fabrication, sustainability, hybrid materials, and a growing DIY movement. Students and trainers should embrace these shifts to stay relevant and competitive.
Key trends include automation through CNC and robotics, sustainable materials and circular design, and the growing integration of digital modelling, data analytics, and human-centric technologies in production.
Current trends in the woodworking industry are strongly linked to design and internationalization.
Integrating material, customization
sustainability, the use of ai in the design process.
Artificial Intelligence mainly
Being able to implement CNC machining and more advanced technologies such as 3D scanning or artificial intelligence for what concerns prototyping could turn out to be interesting to companies of this industry when hiring new people
The most relevant trends at the moment of technological transition of companies in our geographical area concern the training of operators in the use and programming of CNC machines, the possibility of quickly learning the use of new tools (for the continuous training of operators in the sector), the use of digital tools for the design and manufacturing of products, alternative methods for prototyping and for production with a reduction of waste materials, the design of products according to sustainability criteria throughout the life cycle.
Digitalization, smart manufacturing, customization and Ecodesign
Digital transformation, flexible production, sustainable and circular practices, new materials, ergonomics, etc.
Artificial Intelligence. Numerical control programming, virtual reality. Finishing processes.
In my opinion, it can be: Digitalization and Advanced Manufacturing: Use of CNC machines, CAD-CAM, 3D

designs, and wood-based 3D printing. Integration of digital design with production.
• Automation and robotics (CNC centres, robotic sanding, automated handling). • Return of solid wood and natural materials due to sustainability demands. • Digital manufacturing – personalized products, short production series, rapid adaptability. • 3D printing for prototypes, moulds, and custom parts. • Circular economy principles – waste reduction, material reuse, eco-friendly production. • Smart home integration – furniture with built-in lighting, sensors, and mechanical systems.
• Growing importance of sustainable forestry and certified materials (FSC, PEFC). • Smart factories adopting Industry 4.0 principles and data-driven decision making. • Increased demand for lightweight structures and hybrid materials. • Expansion of mass-customization, where unique furniture pieces are produced efficiently. • Integration of AI-assisted design tools that optimize joints, materials, and ergonomics.

Table 4: Answers to second question

ESSENTIAL SKILLS: What technical and transferable skills do you consider essential for graduates who want to join the woodworking industry in the coming years?

Numerical control and 3D printing
Graduates entering the woodworking industry must master both technical skills like CNC operation and CAD design, and transferable skills such as problem-solving, teamwork, and digital literacy. This dual competency ensures adaptability in a rapidly evolving sector.
Graduates will need strong CAD/CAM and digital manufacturing skills combined with adaptability, problem-solving, teamwork, and an understanding of sustainability and design thinking.
Versatility in using different machinery and software
design, production in prototyping

cad-cam expertise, materials knowledge; as a soft skill I'd say communication and cooperation with people of different fields and sectors.
Programming, knowledge of new materials, competences on circular transition
Technical knowledge on materials and their proper application but also fundamentals of sustainability and perhaps project management skills
CAD drawing and 3D modelling, materials technologies, sustainability, CNC programming and use.
Technical skills (CNC, programming, CAD, 3D modelling, etc.), digital skills and soft skills
Technological, digital and transversal skills
3D design software
Graduates need strong technical skills such as CNC operation, CAD design, material knowledge, assembly and finishing techniques. They must also develop transferable skills like problem-solving, teamwork, communication, and time management. Creativity, sustainability awareness, and adaptability to new technologies are key to success in the evolving woodworking industry.
Technical skills: • Ability to read technical drawings and 3D models • Basic CNC machine operation • High precision and quality control • Understanding of materials (wood, veneer, composites) • Strong knowledge of safety procedures Transferable skills: • Problem-solving and analytical thinking • Team communication • Creativity and design thinking • Time management and responsibility • Ability to adapt to new technologies
Technical competencies: • Ability to work with digital fabrication tools • Installation and maintenance basics for modern machines • Understanding of joinery systems and structural integrity • Competence in surface finishing and coating technologies

Transferable skills: • Critical thinking and troubleshooting • Project planning and documentation • Collaboration across different departments (design, production, logistics) • Adaptability and willingness to learn new tools

Table 5: Answers to third question

LEARNING EXPERIENCE: What advantages do you think 3D or virtual reality exercises could bring to the practical learning of carpentry or joinery students?

less danger for the student when performing the exercises and greater possibilities in their preparation
3D and virtual reality (VR) exercises offer carpentry and joinery students immersive, risk-free environments to practice complex tasks, visualize spatial relationships, and accelerate skill acquisition—especially before handling real tools or materials.
3D and virtual reality exercises can enhance carpentry training by allowing students to safely practice complex tasks, visualize designs in real scale, and develop spatial and technical skills in an immersive, risk-free environment.
3D or virtual reality exercises can be useful for visualizing the finished product and working on it with various software. They are also useful for collaborating with architects and designers.
More flexibility
it helps them better imagine and visualize what they are working on.
Students have the possibility to learn and test their competences and technical skills without risks. They can also train their creativity and designing skills by seeing virtually the final results of their designing activities
First of all, it would reduce material waste and give instant feedback to students, preventing mistakes without influencing their learning curve too much
Pre-prototyping in a digital environment, boosting the learning outcomes through gamification, improve the ability to convey concepts and skills to a student audience that is increasingly less accustomed to conventional forms of studying and understanding content.

Motivation, better understanding of digital workflows, practice repeatedly without material waste, visualization of different designs and processes, safety environments
Controlled learning environment, better visualization of designs, hands-on practice, better understanding
Better practical compression of content
3D and virtual reality can help carpentry students practice safely without wasting materials. They allow students to see how tools and joints work in a clear, visual way, even before touching real wood. Students can repeat exercises many times and learn from mistakes without risk. It builds confidence and improves learning, even with limited experience.
• Safe learning environment for practicing complex tasks without injury risk. • Realistic simulations of machining, CNC operation, and construction tasks. • Faster understanding of geometry, structures, and assembly processes. • Efficient error analysis, since tasks can be repeated without material waste. • Access to rare or expensive equipment and processes through virtual simulations.
• They allow students to experience a full workshop environment before entering a real one. • VR enables visualizing hidden joints or internal structures, which is difficult in real life. • 3D simulations make it possible to practice tool paths and learn how machines respond. • Students can progress at their own pace, improving motivation and engagement. • Reduces the pressure of making mistakes in front of others, supporting confident learning.

Table 6: Answers to fourth question

CHALLENGES AND PRIORITIES: What difficulties do you see in integrating digital technologies into woodworking training, and what aspects should be prioritized to overcome them?

Lack of adequate technology due to a lack of financial resources and teacher training
Integrating digital technologies into woodworking training faces challenges like teacher readiness, infrastructure gaps, and resistance to change. To overcome these, programs must prioritize pedagogical integration, equitable access, and hands-on digital literacy.
The main challenges are high equipment costs, limited staff expertise, and resistance to change, so priorities should include teacher upskilling, gradual investment in scalable technologies, and stronger collaboration with industry partners
I don't notice any particular difficulties.
Companies need to be more welcoming
digital illiteracy: younger generations often don't know well how to use computers and programs as they usually prefer working on phones and tablets.
Not all students necessarily have a good level of proficiency in using technological tools, so preparatory work could be needed to ensure that everyone reaches an adequate level. Technological tools become obsolete quick, so training institutions and companies must be willing to invest in this area.
It could be expensive to acquire all the technologies necessary, moreover teachers should be trained to use those technologies and therefore it is crucial to understand how long it could take to catch up to the technological advancement before training teachers on technologies that may become outdated or no longer supported in a short period of time (see Microsoft Hololens)
Cost of XR headsets, renewal cost for software, number of devices available to the students at the same time. Investing in human resources and using projects funding for further development tools and contents.
Limited access to modern equipment and software, teachers have not enough digital competences, curricula are not flexible to do changes

High implementation costs to integrate new digital technologies, resistance to change of trainers, lack know-how of trainers
Inversion
The main difficulties are lack of equipment, teacher training, and students' low digital skills. To overcome them, we should prioritize basic digital training, teacher support, and access to simple, practical tools.
Main challenges: • High costs of equipment and software • Insufficient digital skills among teachers • Fragmented digital environment (different formats, software versions) • Limited practical time on modern machines • Students entering with very different technical backgrounds Priority actions: • Continuous teacher training in CNC, CAD, VR, and digital manufacturing • Partnerships with industry to access modern equipment and apprenticeships • Unified digital standards and teaching resources • Smaller student groups for practical sessions • Investment in VR/3D simulations to reduce material costs and improve learning
Challenges: • Schools may lack continuous funding to keep equipment updated. • Some students struggle with the digital component and need more support. • Software licenses can be complex and time-consuming to manage. • Teachers may not have enough time to redesign traditional lessons. Priorities: • Create clear digital competency frameworks for each study year. • Ensure access to shared digital labs where students can practice independently. • Strengthen cooperation with companies providing technical support. • Develop easy-to-understand tutorials and blended learning materials.

Table 7: Answers to fifth question

If you have any other idea or suggestion, please write them here:

It is very important that teachers prepare for this and interact with each other to learn new techniques.
A pay raise is always appreciated
Encouraging co-design projects with local companies and integrating sustainability-focused digital tools could strengthen the connection between training and real industrial innovation.
Develop international internship
• Introduce mini production lines with sensors so students can understand the full workflow from design to quality control. • Include real-client project assignments for practical experience. • Create makerspace-style workshops equipped with modern digital tools and prototyping equipment.
• Include training in sustainable material choices and eco-design principles. • Encourage students to participate in international skills competitions. • Organize joint workshops with design schools to improve creativity and innovation.

Table 8: Suggestions of respondents

4.3 Barriers and opportunities identified

Main obstacles:

Stakeholders identified several common challenges:

1. High cost of technologies

CNC machines, AR/MR systems, and 3D scanners require a high investment, and many VET centres do not have that funding or are late to the process.

2. Insufficient equipment for classroom use

Many centres also lack certain machines for classroom practice, which limits learning.

3. Teacher training needs

Teachers need to improve their skills to effectively integrate technologies into the classroom.

4. Limited integration into the curriculum

Many digital tools are considered supplements rather than integral parts of VET modules.

5. Technological complexity

Some tools have steeper learning curves.

Key opportunities:

Stakeholders have also been able to identify opportunities related to greater digitization:

1. Increased safety and risk-free practices

Virtual reality simulations, for example, allow students to practice certain procedures that involve more risk in a safer way.

2. Reduction of material waste

Digital prototyping helps avoid errors and reduces costs because less material is used.

3. Increased student motivation

Immersive technologies promote engagement, curiosity, and creativity among teachers and students in VET courses.

4. Connection with modern industry

Digital tools align vocational training with the demands of today's industries.

5. Support for inclusive learning

Another advantage is that technologies such as virtual reality can help underperforming students gain confidence.

5. Selected technologies

Based on the results of the documentary research, stakeholder validation, and technology mapping carried out by the ShiftVET partners, four technologies have been selected for analysis due to their relevance, feasibility, and transformative potential for wood VET. This section provides an overview of each of the selected technologies, including a description and their application in the sector, as well as their potential use in wood VET.

5.1 Additive Manufacturing (3D Printing)

3D printing allows physical objects to be created from digital models using additive processes. In professional woodworking training, there are two main categories that may be most relevant:

- FDM (fused deposition modelling): suitable for structural prototypes, functional components, and low-cost models.
- MSLA (resin printing): allows for high-precision and highly detailed production, ideal for furniture joints, moulds, and ornamental elements.

Possible applications in the wood and furniture sector

- Rapid prototyping of furniture components.
- Validation of joint geometries before cutting the material.
- Production of templates, jigs, moulds, and ergonomic models.
- Creation of replacement parts for restoration work.
- Support for hybrid production workflows that combine wood with printed components.

Potential use in VET

- Introduction to the complete workflow, from design to digital production.
- Practical exercises with CAD modelling and cutting software.
- Prototyping exercises that reduce material consumption and costs.
- Visualization of complex geometries that would be difficult to illustrate with traditional tools.
- Integration with 3D scanning and virtual reality environments for digital twin projects.

Required skills

- Basic CAD modelling (parametric and polygonal).
- Use of cutting software (PrusaSlicer, Cura, Chitubox).
- Understanding of printing parameters (layer height, supports, temperature).
- Knowledge of post-processing techniques (cleaning, curing, sanding).
- Problem solving and process optimization.

Examples of implementation/pilot ideas

- Prototype before cutting: Students design a chair joint in CAD, print it, evaluate the fit, and then produce the final piece in wood.
- Replica of ornaments: Scan a decorative carving—print a scale model—reproduce using CNC.
- Functional prototypes: Create templates for drilling or positioning during assembly.

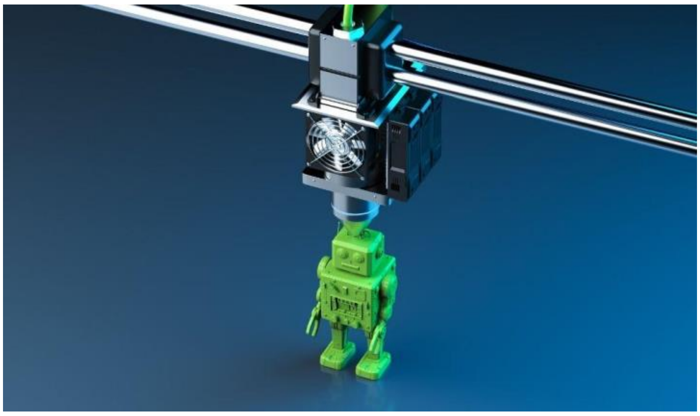

Figure 1: 3D printing [1].

5.2 Digital Metrology and Reverse Engineering (3D scanning)

3D scanning technology captures the exact geometry of physical objects and converts them into detailed digital models. Structured light scanning systems, such as those used by JLCP and RMMT, provide high accuracy suitable for furniture components.

Application in the wood and furniture sector

- Quality control and measurement validation.

- Reverse engineering of existing parts, especially in restoration or replication work.
- Creation of accurate digital twins for modification, analysis, or CNC machining.
- Digitization of handcrafted details for industrial reproduction.

Possible use in VET

- Teaching measurement accuracy, tolerance, and the fundamentals of metrology.
- Demonstrate the link between traditional craftsmanship and digital reproduction.
- Provide accurate models for virtual reality inspection exercises.
- Enable fully digital workflows: scan-model-prototype-CNC.
- Improve students' understanding of geometry, surface analysis, and digital transformation.

Required skills

- Handling structured light scanners.
- Use of scanning software (RV 3D Studio, ScanCenter NG).
- Cleaning, alignment, merging, and meshing of point cloud data.
- Exporting files for CAD/CAM integration.
- Evaluating deviations between physical and digital models.

Implementation examples / Pilot ideas

- Heritage restoration project: Scan a carved wooden ornament, repair it digitally, and reproduce it using CNC.
- Quality verification exercise: Scan is a part manufactured by a student and compares it to the original 3D model.
- Digitization of ergonomic objects: Scan handles or chair curves for human-centred design projects.

Figure 2: 3D scanner [2].

5.3 CNC Machining (Computer Numerical Control)

CNC machines automate the cutting, drilling, shaping, and milling of wood using programmed tool paths. They are essential for industrial furniture manufacturing and require strong integration with CAD/CAM software.

Application in the wood and furniture sector

- Manufacturing of structural components and complex geometries.
- Production of repetitive elements with high precision.
- Manufacture of moulds, templates, and curved surfaces.
- Optimized use of materials through nesting and digital planning.
- Integration with digital twin systems and Industry 4.0 workflows.

Possible use in VET

- Teach students the professional workflow design-CAM-machining.
- Provide experience with industrial tools such as Alphacam, AutoCAD, or Xilog.
- Enable students to carry out final projects with complex shapes.
- Development of skills directly related to employability in carpentry companies.

Required skills

- CAD design (2D and 3D).
- CAM programming and toolpath optimization.
- Machine configuration, calibration, and parameter adjustment.
- Understanding of safety, feed rates, spindle speeds, and tools.
- Post-processing and finishing of machined components.

Implementation examples/Pilot ideas

- Parametric furniture exercise: Students design a small stool in CAD and produce it on the CNC milling machine.
- Training in CAM tool paths: Compare machining strategies (adaptive, contouring, pocketing).
- Digital twin workflow: Scan—adjust the model—generate tool paths—final CNC part.

Figure 3: CNC machine [4].

6. Conclusions

This report confirms that the integration of digital technologies is essential to modernize vocational training in woodworking and furniture making. The analysis shows a strong alignment between educational institutions and industry stakeholders: CNC machining and CAD/CAM remain the core skills needed for employability, while 3D printing, 3D scanning, and VR/AR bring significant added value by improving accuracy, safety, and motivation for learning.

The selected technologies enable students to participate in the entire digital workflow, from design and simulation to prototyping and manufacturing. At the same time, stakeholders emphasize that digital tools should complement, not replace, traditional craft skills, which remain fundamental to carpentry training.

The findings also highlight key needs: stronger teacher training, strategic investment in equipment, and closer cooperation with industry to keep curricula in line with real-world practices. These insights provide a solid foundation for the next phases of the ShiftVET project and will guide the development of practical exercises, training materials, and implementation recommendations.

7. Conclusions after internal workshops (A1.3)

As part of Activity 1.3, three internal technological workshops were organised by the partner institutions in Italy (ASLAM), Spain (CETEM & IES José Luis Castillo Puche), and Latvia (RMMT). These workshops aimed to present the Technological Guides developed within ShiftVET, demonstrate the selected technologies (3D printing, 3D scanning and CNC), and gather structured feedback from teachers, technical staff, students, and industry representatives.

A total of 45 participants were involved across the three countries (14 in Italy, 19 in Spain and 12 in Latvia, including trainers, coordinators, technical staff, VET students, and external sector specialists. This diversity ensured that the validation process incorporated both pedagogical and industry perspectives.

7.1 Overall reception of the technologies and guides

Across the three workshops, the selected technologies were perceived as highly relevant for the modernization of Wood and Furniture VET.

3D printing and CNC machining were consistently identified as the most immediately applicable technologies. In Spain, participants emphasized that 3D printing is particularly accessible due to existing equipment, while CNC will become central with the arrival of new machinery.

In Italy, the technologies presented were already partially integrated into training activities, and participants expressed strong interest in further pedagogical expansion.

In Latvia, CNC-related workflows and digital design tools were considered realistic areas for gradual integration, given current infrastructure constraints.

The Technological Guides were generally regarded as useful and relevant tools to support innovation in VET. Spanish participants reported high perceived usefulness (93% rated them useful or very useful). Italian participants also highlighted their strong alignment with existing practices, while Latvian stakeholders considered them a valuable reference framework for structured and gradual digital integration.

At the same time, feedback pointed to the need for complementary materials such as visual step-by-step resources and practical implementation examples to facilitate classroom adoption.

7.2 Pedagogical value and cross-disciplinary impact

The workshops confirmed the pedagogical added value of digital fabrication and metrology technologies in woodworking training.
Participants highlighted several educational benefits:

- Safer learning environments, especially when using simulation or digital prototyping approaches
- Reduction of material waste through digital validation before physical production
- Improved student motivation and engagement
- Better understanding of complete digital workflows from design to manufacturing

In Spain, the workshop demonstrated clear cross-disciplinary interest, involving teachers from electricity and students from different vocational areas
JLCP report A1.3 workshop. This confirms that the ShiftVET approach can foster collaboration between vocational families and extend beyond the woodworking department. In Latvia, the presence of seven external sector specialists introduced a constructive critical perspective. Initial scepticism evolved into productive dialogue, reinforcing the importance of aligning digital innovation with real production environments rather than treating it as purely theoretical enhancement.

7.3 Common challenges identified

Despite the positive reception, all three workshops identified structural and organisational challenges that must be addressed to ensure sustainable implementation.
The most recurrent barriers were:

1. Limited equipment and infrastructure
   Italian participants stressed the insufficient number of technological devices. Spanish participants mentioned the need for better computers and design software. Latvian stakeholders underlined infrastructure constraints and the absence of certain advanced technologies.
2. Teacher training and professional development needs
   All centres emphasized the necessity of targeted and continuous teacher upskilling. Digital integration requires not only equipment but also pedagogical confidence and methodological adaptation.
3. Financial sustainability and investment planning
   Equipment acquisition, software renewal, and maintenance costs were highlighted as significant constraints, particularly in contexts with limited institutional funding.

4. Balance between digital innovation and craftsmanship
   Latvian participants explicitly warned against overemphasising technology at the expense of traditional skills.
   This concern aligns with earlier findings in the report and confirms that digital tools must complement, not replace, core woodworking competences.

7.4 Strategic implications for the next project phases

The internal workshops have provided practical validation of the technologies selected in Activity 1 and confirmed their relevance for European Wood and Furniture VET.
Several strategic directions emerge:

- Prioritise gradual and context-sensitive implementation rather than large-scale immediate transformation.
- Support teachers with concrete, ready-to-use pilot activities and methodological guidance.
- Encourage cross-disciplinary collaboration within VET centres.
- Strengthen dialogue with industry representatives to ensure alignment with labour market needs.
- Explore funding opportunities to progressively expand equipment and digital infrastructure.

Overall, the A1.3 workshops demonstrate that there is strong institutional interest in digital transformation across the three partner countries. While implementation conditions vary, the commitment to modernising vocational education through 3D printing, 3D scanning and CNC technologies is evident.
The feedback collected during these workshops will directly inform the refinement of training materials, the design of pilot activities, and the strategic planning of subsequent ShiftVET project actions.

8. Annexes

Survey

Technological possibilities for Wood and Furniture VET- *ShiftVET Project.*

ShiftVET is a European initiative that seeks to modernize vocational education and training (VET) in the woodworking sector by incorporating innovative technologies such as 3D printing and Extended Reality (XR).

Our goal is to bring new digital tools to VET centres to improve the skills of students and professionals in the sector.

With this form, we want to gather the opinions of different stakeholders (teachers, students, companies, associations, and training centres) on the needs, opportunities, and challenges for implementing these technologies. Your participation is very valuable: *responses will be anonymous and will only be used for research and development purposes for the project*.

The ShiftVET Project is co-founded by European Union

GENERAL INFORMATION ABOUT STAKEHOLDER
Name
Organization to which you belong and position you hold
Age
Experience on VET sector
Country: - Spain - Italy - Latvia

QUESTIONS
TECHNOLOGICAL NEEDS: What digital tools or technologies do you think should be integrated into woodworking training to improve student preparedness?
ESSENTIAL SKILLS: What technical and transferable skills do you consider essential for graduates who want to join the woodworking industry in the coming years?

LEARNING EXPERIENCE: What advantages do you think 3D or virtual reality exercises could bring to the practical learning of carpentry or joinery students?
CHALLENGES AND PRIORITIES: What difficulties do you see in integrating digital technologies into woodworking training, and what aspects should be prioritized to overcome them?
If you have any other idea or suggestion, please write it here.

Thank you!

We sincerely appreciate your time and input. Your answers will help us better understand the needs of the sector and design innovative training solutions that strengthen vocational training in woodworking with the support of 3D printing and Extended Reality. Thank you for contributing to the success of ShiftVET and for being part of this modernization process.

For more information, please write to shiftvet.project@gmail.com.

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