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CRAFT3D

Enhancing traditional craft practices

3D printing and technology through innovation

MENTORSHIP PROGRAM

Project N°: 2023-1-IT01-KA220-VET-000154806

Contents

1. Introduction

1.1. Overview of the CRAFT3D project and its objectives.

The CRAFT3D project aims to modernize the wood manufacturing sector by integrating 3D printing technology into traditional craftsmanship. It focuses on upskilling woodcraft artisans, carpenters, enthusiasts and interested individuals through a MOOC-based curriculum, a digital assessment tool, and a mentorship program to ensure hands-on learning. The goal is to equip professionals with specialized 3D printing skills, fostering innovation and adaptability in the industry.

1.2. Purpose of the Mentorship Programme.

The Mentorship Programme is designed to create a mutual learning exchange between traditional woodcraft artisans and 3D printing experts. It provides hands-on experience for artisans to apply 3D printing techniques while allowing experts to learn traditional woodworking methods, ensuring a balanced knowledge transfer.

1.3. Target audience: woodcraft artisans, carpenters, and 3D printing experts.

The target audience includes woodcraft artisans, carpenters, enthusiasts and interested individuals seeking to integrate modern technology into their craft, as well as 3D printing experts looking to enhance their understanding of traditional woodworking techniques.

1.4. Expected benefits for both mentors and trainees.

The expected benefits for trainees (artisans and carpenters) include enhanced digital skills, improved job opportunities, and innovative craftsmanship. Mentors (3D printing experts) will gain a deeper appreciation of traditional techniques, enabling them to develop better wood-compatible 3D models, fostering collaborative growth and industry innovation with the aim to realize a total of 60 Mentorship Programmes successfully implemented.

2. Objectives of the Mentorship Programme - Enhancing the understanding of woodcraft traditions and their applicability in 3D modeling and printing.

Woodcraft traditions have been passed down through generations, emphasizing precision, durability, and aesthetics. Traditional woodworking techniques such as intricate joinery, detailed carving, and expert finishing define the craftsmanship behind handcrafted wooden products. Understanding these methods is essential when integrating them into modern 3D modeling and printing, as it allows artisans to retain the authenticity and quality of traditional woodcraft while embracing new technological possibilities.

One of the most significant ways to bridge the gap between tradition and technology is by digitally replicating traditional woodworking techniques. Through advanced 3D modeling software such as Fusion 360, Rhino, or Blender, artisans can design complex joinery, interlocking structures, and ornate carvings that would be challenging to execute manually. These digital models can then be optimized for 3D printing, ensuring that they maintain both structural integrity and aesthetic value. In addition, material properties play a crucial role in achieving an authentic wood-like appearance. By using wood-infused filaments, which

contain real wood fibers mixed with polymers, artisans can create 3D-printed components that can be sanded, stained, and finished like natural wood.

2.1. Facilitating hands-on learning through Work-Based Learning (WBL).

Work-based learning is a popular approach to professional development where students or employees learn in the workplace rather than in a classroom or traditional training environment. These approaches to learning offer opportunities for students to gain qualifications while they work and for employees to develop new skills that can help them in their career progression.

2.2. Creating a reciprocal mentorship relationship between carpenters and 3D printing experts.

Beyond replication, 3D printing also enables innovation in woodcraft by allowing artisans to experiment with hybrid design approaches. By combining handcrafted wooden elements with 3D-printed parts, new possibilities emerge in furniture making, decorative arts, and architectural details. Artisans can integrate printed components for custom inlays, precision fittings, or even lightweight lattice structures that reduce material waste while maintaining strength. The ability to rapidly prototype designs before full-scale production further enhances creativity and efficiency, ensuring that time and resources are used effectively.

Applying traditional woodcraft knowledge to 3D modeling and printing not only preserves cultural heritage but also opens new avenues for artisans to modernize their craft. With the right balance of tradition and technology, woodworkers can expand their creative potential, refine their production processes, and develop unique, innovative products that merge the best of both worlds.

2.3. Supporting the transition from theoretical knowledge (MOOC) to practical application.

After completing the MOOC training, learners apply their theoretical knowledge in a practical setting. This phase reinforces learning and ensures that artisans effectively integrate 3D printing into their craft.

2.4. Strengthening networking and peer learning among participants.

The programme creates opportunities for collaboration, networking, and peer-learning among artisans, carpenters, and 3D printing professionals. This enhances knowledge sharing, fosters innovation, and helps build a strong professional community in the woodcraft sector.

3. Programme Structure

3.1. Participant Selection & Matching Process

- Eligibility criteria for trainees (woodcraft artisans, carpenters, enthusiasts and interested individuals from the MOOC).

Target Audience: The programme is tailored for woodcraft artisans, carpenters, enthusiasts and interested individuals who have completed the CRAFT3D MOOC on 3D printing.

Motivation: Candidates should demonstrate a strong desire to integrate 3D printing technologies into traditional woodcraft practices.

Inclusivity: Emphasis is placed on selecting individuals from disadvantaged backgrounds, such as those residing in remote areas, to promote equal opportunities.

- Selection process for hosting organizations.

Stakeholder Mapping: An initial identification of 40 potential hosting organizations per partner is conducted, focusing on entities experienced in 3D printing and/or woodcraft.

Engagement and Commitment: Out of these, 20 organizations are selected to enter into a Memorandum of Understanding (MOU), affirming their dedication to mentor trainees and participate in mutual learning exchanges. (4 for partner)

Selection Criteria:

    - *Expertise* - Proven experience in 3D printing technologies and/or traditional woodcraft.
    - *Mentorship Capability* - Ability to provide effective mentorship and facilitate a 30-day period Work-Based Learning (WBL) experience, during which the mentor will be at the disposal of the trainee, in case questions or suggestions arise. It's not required for the trainees to visit every day, it can be of physical, online or hybrid style.
    - *Resource Availability* - Access to necessary tools, equipment, and facilities to support hands-on training.
- Assignment of trainees to hosting organizations.

Matching Considerations:

    - *Interests and Skills* - Aligning trainee interests and proficiency levels with the specific expertise of hosting organizations.
    - *Geographical Factors* - Considering location and logistical aspects to ensure accessibility and convenience for both parties.

Mentorship Structure: Each hosting organization designates a tutor-mentor for the trainees, maintaining a maximum ratio of 1 tutor to 3 trainees to ensure personalized guidance.

- Establishment of Mutual Learning Agreements (MLAs).

The MLA serves as an informal agreement outlining the expectations and responsibilities of both trainees and hosting organizations:

- Learning objectives:
    - *For Trainees:* Application of 3D printing techniques in woodcraft to innovate and enhance traditional practices.
    - *For Hosting Organizations:* Gaining insights into traditional woodcraft methods and exploring the integration of digital technologies to foster innovation.
- Expected outcomes:

- *Innovative Products:* Creation of new or improved woodcraft items utilizing 3D printing.
- *Skill Enhancement:* Elevated technical competencies for both trainees and mentors.
- *Networking:* Establishment of connections between traditional artisans and digital manufacturing experts, promoting collaborative opportunities.

- Roles and responsibilities of both trainees and hosting organizations:
  - *Trainees:* Engage actively in practical learning, document their progress, and collaborate effectively with mentors.
  - *Hosting Organizations:* Offer mentorship, provide access to necessary facilities, and guide trainees through hands-on projects.
  - CRAFT3D Project Partners: Oversee the programme's implementation, gather feedback, and evaluate its impact through tools like Programme Diaries.

3.2. Work-Based Learning (WBL) Experience

The WBL Experience within the CRAFT3D Mentorship Programme is meticulously designed to bridge theoretical knowledge with practical application, fostering a comprehensive understanding of integrating 3D printing technologies into traditional woodcraft.

- Duration: 30 days of remote practical experience with trainer support

Over a period of 30 days, trainees will engage remotely with their designated hosting organizations. Although this experience will not involve direct, hands-on participation at the organization's premises, trainees will still have ample opportunity to practically apply knowledge gained from the CRAFT3D MOOC to relevant, real-world scenarios within the woodcraft sector. Throughout this period, trainers from the hosting organizations will remain accessible to provide guidance, answer questions, and assist with any challenges trainees might encounter. This approach ensures trainees receive targeted support, facilitating a comprehensive understanding of industry practices, challenges, and innovations.

- Responsibilities of trainees:
  - *Active Participation in Daily Operations:* Trainees are expected to integrate seamlessly into the hosting organization's workflow, engaging in routine tasks and special projects. This involvement offers a holistic view of operational dynamics and the application of 3D printing in various contexts.
  - *Application of MOOC-Acquired Skills:* Building upon the foundational knowledge from the CRAFT3D MOOC, trainees will employ advanced 3D modeling and printing techniques to develop prototypes, optimize production processes, and innovate product designs. This practical application reinforces learning and showcases the versatility of 3D printing in woodcraft.
  - *Collaborative Engagement:* Emphasizing teamwork, trainees will collaborate with mentors, peers, and other departments to foster a multidisciplinary approach to problem-solving. This collaboration enhances communication skills and encourages the exchange of diverse ideas, enriching the learning experience.

- Role of the mentor-tutor:
    - *Continuous Guidance and Supervision:* Mentors play a pivotal role in the WBL experience, offering consistent oversight and support. They assist trainees in navigating complex projects, ensuring adherence to best practices, and providing insights drawn from their professional expertise. Mentors will be available during this 30 day period to help guide and collaborate with the trainees.
    - *Alignment with Learning Objectives:* To maintain a focused training trajectory, mentors ensure that assigned tasks and projects are in harmony with the predefined learning objectives outlined in the Mentorship Programme. This alignment guarantees that the WBL experience remains purposeful and goal-oriented.
    - *Constructive Feedback and Support:* Recognizing the importance of growth through reflection, mentors provide regular, constructive feedback. This feedback addresses both technical competencies and soft skills, guiding trainees toward continuous improvement and professional development.

3.3. Reciprocal Mentorship Component

The Reciprocal Mentorship Component of the CRAFT3D Mentorship Programme is designed to facilitate a bidirectional exchange of knowledge between traditional wood artisans and 3D printing experts. This collaborative approach enriches both disciplines, fostering innovation and preserving the essence of traditional craftsmanship.

- For carpenters/wood artisans:
    - *Integrating 3D Modeling and Printing into Traditional Craft:* Artisans are introduced to digital design tools and 3D printing technologies, enabling them to enhance their traditional methods. This integration allows for the creation of intricate designs and the reproduction of complex patterns that were previously challenging to achieve manually.
    - *Exploring Innovative Approaches to Product Design:* By embracing 3D printing, artisans can experiment with new materials and design concepts, leading to the development of unique products that blend traditional aesthetics with modern functionality. This exploration opens new markets and opportunities for customized creations.
- For 3D printing experts:
    - *Understanding Traditional Woodcraft Techniques:* Experts in digital fabrication gain hands-on experience with time-honored woodworking methods, such as hand coiling and basket weaving. This understanding enables them to incorporate organic forms and textures into their digital designs, resulting in more authentic and culturally resonant products.
    - *Gaining Insight into Material Properties, Aesthetics, and Functional Aspects of Woodcraft:* Exposure to the tactile qualities of wood and traditional construction techniques informs 3D printing professionals about the limitations and possibilities of working with natural materials. This knowledge leads to

the development of hybrid products that respect the integrity of wood while leveraging the precision of 3D printing.

3. The mentoring program

3.1. The role of the tutor

The role of the tutor in an online course such as the one dedicated to 3D printing goes far beyond mere technical assistance. It is not just a matter of solving practical problems or clarifying operational doubts, but of becoming a true facilitator of learning. This means guiding students through the process of exploring content, encouraging them not to limit themselves to a superficial understanding, but to connect concepts, examples, and concrete applications. Tutors must be able to stimulate curiosity, encouraging questions and critical thinking, while at the same time nurturing creativity by suggesting ideas for personal experiments or group projects. It is also essential to be able to guide students in the use of digital tools and design software, providing practical tips, best practices, and additional resources that make learning more fluid and less hindered by technological barriers. At the same time, tutors must be able to maintain a positive, collaborative, and inclusive learning environment, where every participant feels valued and free to express ideas or share difficulties without fear of judgment. This requires interpersonal skills, intercultural sensitivity, and careful management of group dynamics, especially in an online context where the risk of isolation is greater. In short, tutors act as a bridge between the course content and the students' personal experience: they not only impart knowledge, but also create the conditions for it to be internalized, applied, and transformed into real and lasting skills.

3.2. Before the lesson

Before a training course begins, the tutor's work starts behind the scenes, at a delicate but crucial moment: preparation. The tutor does not simply welcome students when they first access the platform, but creates the conditions for their learning journey to develop smoothly and effectively. The first step is to carefully study the training module, from which a personalized support plan is developed: a calendar of checkpoints, moments dedicated to discussion, and clear and stable availability times. This preliminary organization is not just logistical, but also signals that the tutor is a reliable reference figure, capable of offering continuity and support. At the same time, a quick guide is prepared to help students find their way around the platform: a small handbook, enriched with answers to frequently asked questions, which reduces technical anxiety and leaves room for curiosity about the content. Finally, it is time to establish direct contact with the participants. A motivational welcome message is not a mere formality, but a real engagement tool: words that create closeness, that invite people to feel part of a common journey, that spark enthusiasm and reassure those who fear they do not have the necessary skills. In that initial greeting, the tutor lays the foundations for an educational relationship based on trust and listening, reminding everyone that they will never be alone in front of the screen. So, when the course really begins, students find not only materials and activities, but a welcoming, organized, and stimulating environment, ready to transform their commitment into concrete growth.

3.3. During the lesson

During the course, the tutor takes on the role of a discreet but constant guide, accompanying students step by step and transforming theoretical content into concrete learning experiences. Their voice should not overwhelm that of the participants, but rather create a context in which each concept can be understood, internalized, and connected to personal experience. For this reason, at the end of each unit, the tutor takes a few minutes to summarize the key points with

brief practical summaries: a compass that guides those who may have lost their way in the details and helps everyone to focus on what really matters. Each time, they enrich their explanations with examples from the real world, because theory, without concrete anchors, risks remaining abstract. Thus, a concept such as rapid prototyping becomes immediately understandable when explained through the case of a fashion company that manages to test an accessory in a few hours thanks to 3D printing.

At the same time, the tutor encourages practical activities that get students involved: building a visual timeline of the main stages of technology, critically comparing PLA and ABS in a discussion forum, and researching applications of 3D printing in their own field of interest. These are not exercises for their own sake, but opportunities for exploration that transform the virtual classroom into a collective laboratory.

The online community thus becomes an integral part of the course: the tutor responds to questions promptly, ideally within 24 hours, and encourages dialogue among students, acknowledging contributions and inviting others to supplement them with their own experience. Small tools such as surveys or targeted discussions serve to give rhythm and liveliness to interactions, maintaining interest and strengthening the sense of belonging to the group. In this balance of support, stimulation, and presence, learning takes shape not as a unidirectional flow, but as a living network of connections and exchanges.

3.4. After the lesson

The conclusion of the course is a valuable moment, not only to take stock but also to leave students with the feeling that they have completed a real journey of growth. The tutor accompanies this phase with attention and care, organizing a final question and answer session that becomes an opportunity for open discussion: students can clarify any remaining doubts, share impressions, and, above all, reflect together on how the skills they have acquired can find a place in their professional or creative lives. At the same time, the tutor invites them to collect their work in a small digital portfolio: CAD files, photographs of the prints they have made, personal notes, and critical reflections. This is not just an exercise in synthesis, but a tool that helps students recognize their progress and visualize the path they have traveled. Finally, the most delicate and motivating moment arrives: personalized feedback. Generic phrases are not enough; targeted observations are needed, capable of highlighting strengths and offering concrete ideas for further study. Telling a student, “You have a good understanding of the principles of slicing, now try your hand at advanced software such as Fusion360,” means recognizing their commitment, boosting their self-esteem, and opening up new learning opportunities. In this way, the end of the course does not mark a conclusion, but becomes a springboard for future developments.

3.5. Tips for online interaction

In an online course, successful learning depends not only on the quality of the content, but also on the ability to keep participation alive. In this sense, the tutor becomes the driving force behind interaction. Asking stimulating questions is a simple but powerful strategy: it is not just a matter of asking “do you understand?”, but of setting challenges that force students to connect theory to their concrete experience. Asking, for example, what technology they would use to prototype an everyday object encourages them to think critically and personally. Gamification can add a playful element that reinforces motivation: badges and points, even if

symbolic, create a sense of recognition and make individual commitment visible. Sharing up-to-date resources is equally crucial: articles, videos, and tutorials not only broaden the horizon of knowledge, but also show students that 3D printing is a living, constantly evolving field. Finally, working groups allow the virtual classroom to be transformed into a real community: collaborating on a mini-project means learning to communicate, negotiate ideas, and confront different visions. In these dynamics, the tutor is not a spectator but a facilitator: they encourage, moderate, and stimulate sharing. In this way, online interaction becomes much more than a complement, becoming an integral part of the training process.

3.6. Inclusion and Support

In an online course, inclusion is not an accessory aspect but the very heart of the training process. The tutor must remember that each student arrives with a different background of knowledge, experience, and even emotions with regard to technology. Some move confidently between software and printers, while others approach it for the first time with fear and uncertainty. For this reason, the language used makes all the difference: explaining concepts in simple terms, avoiding unnecessary technicalities, allows everyone to feel involved and not left behind. At the same time, offering alternative materials—an infographic for those who prefer visual impact, a video tutorial for those who learn by watching, a simplified glossary for those who need clear reference points—provides the opportunity to adapt the course to different learning styles. But inclusion is not limited to tools: it is above all about the atmosphere that is created. The tutor has the task of building a safe space, where every question is welcomed as legitimate and every contribution, even the simplest, is valued. Encouragement, respectful feedback, and recognition of individual progress are powerful levers for increasing student confidence. In this way, no one feels judged or excluded, and the group itself becomes a supportive learning community, capable of growing together and transforming diversity into wealth.

3.7. Tutor's Operational Checklist

At the end of each lesson, we will propose an Operational Checklist: this is a practical tool that accompanies the tutor throughout the training course, a sort of compass that helps them not to lose sight of the fundamental steps. We intend it as a dynamic support to be consulted before, during, and after each module. At the beginning, the checklist reminds the tutor to thoroughly familiarize themselves with the content and to plan moments of assessment and discussion, so as to organize a coherent and well-structured course. During the course, it helps to keep the dialogue alive, propose practical activities, and provide clear and motivating feedback: actions that seem simple but require consistency and attention. Finally, in the concluding phase, the checklist invites you to monitor progress, report any critical issues and, above all, promote a positive and inclusive atmosphere. Used in this way, it becomes a discreet but effective work companion: it ensures that nothing is overlooked, helps to better manage energy and gives the tutor the confidence to proceed methodically. In other words, it is the common thread that links the organizational and relational dimensions, allowing the online experience to be transformed into a true path of shared growth.

4. Operating Guidelines

4.1. Module 1: Introduction to 3D Printing

Chapter Objectives

The tutor should help students to:

1. Understand what 3D printing is and how it differs from traditional manufacturing.
2. Learn about the main historical milestones and developments in the technology.
3. Identify the main 3D printing technologies (FDM, SLA, SLS, etc.).
4. Recognize the advantages and limitations of 3D printing.
5. Discover its applications in different sectors (healthcare, industry, crafts, fashion, architecture, etc.).

Introduction and Motivation

- Start the discussion by asking:
- "What is your first image or idea when you think of 3D printing?"
- Connect the topic to the students' everyday experience (customized prostheses, decorative objects, 3D-printed houses).
- Present 3D printing as a transformative technology, not just a technical tool.
-

Explanation of Key Concepts

- Difference from traditional manufacturing: use concrete examples (e.g., a chair made by cutting wood vs. one printed in 3D).
- Historical milestones: propose a collaborative online timeline (Padlet, Miro, or Google Jamboard).
- Main technologies: show a simplified infographic summarizing principles and applications (FDM, SLA, SLS, etc.).

Practical tip: have students create a comparison chart with: technology / principle / application examples.

Active Learning Activities

- Guided discussion: ask students to identify an industry they are familiar with and speculate on how 3D printing could transform it.
- Mini research: invite each student to look for a real-life example (news item, startup, company) and share it in the forum.
- Critical analysis: encourage reflection on benefits vs. limitations. Example of a stimulating question:
- "In your opinion, will 3D printing be more useful for customization or mass production? Why?"

Support and Clarifications

- Some students may be confused by the technical terms. The tutor should:
    - Refer to the module glossary (CAD, G-code, FDM, SLA, etc.).
    - Provide short, simplified examples (e.g., "G-code is like a recipe that tells the printer what to do step by step").
- Help students distinguish between professional technologies (SLS, DMLS, EBM) and more accessible ones (FDM, SLA).

Tips for Stimulating Creativity

- Invite students to draw a simple object (either freehand or using basic CAD software such as Tinkercad) that they would like to print.
- Propose a group "challenge": imagine an object that would not be possible to make using traditional methods.
- Encourage peer exchange: comments and suggestions on each other's projects.

Tutor Checklist

- Did I introduce 3D printing with concrete and motivating examples?
- Did I facilitate understanding of the historical stages and technologies?
- Did I stimulate practical activities and discussions?
- Did I clarify doubts about terminology and technical concepts?
- Did I guide students in reflecting on advantages, limitations, and applications?

- Did I use the final quiz as a tool for comparison?

Final Quiz – Introduction to 3D Printing

1. What distinguishes 3D printing from traditional manufacturing?

a) It uses cheaper materials

b) It adds material layer by layer instead of removing it

c) It only allows you to create plastic objects

d) It is always faster than traditional techniques

Correct answer: b

2. In which decade did the first 3D printing technologies appear?

a) The 1960s

b) The 1970s

c) The 1980s

d) The 1990s

Correct answer: c

3. Which of the following technologies is most widely used in the consumer sector?

a) SLS (Selective Laser Sintering)

b) SLA (Stereolithography)

c) FDM (Fused Deposition Modeling)

d) DMLS (Direct Metal Laser Sintering)

Correct answer: c

4. What is a major advantage of 3D printing?

a) Rapid production of large quantities

b) Creation of complex and customized geometries

c) Zero material costs

d) Printing without electricity

Correct answer: b

5. What is one of the main limitations of current 3D printing?

a) It does not allow customization

b) Long production times compared to mass production

c) It cannot produce functional objects

d) It is always more expensive than traditional production

Correct answer: b

6. Which sector has benefited greatly from 3D printing in the creation of customized prostheses?

a) Fashion

b) Healthcare

c) Architecture

d) Automotive

Correct answer: b

7. Stereolithography (SLA) uses:

a) Extrusion of plastic filaments

b) Fusion of metal powders

c) Liquid resin hardened by a UV laser

d) Precision mechanical molds

Correct answer: c

8. Which of the following materials is commonly used in FDM printing?

a) Stainless steel

b) PLA and ABS

c) Liquid epoxy resin

d) Sintered sand

Correct answer: b

9. Which statement is correct regarding the impact of 3D printing?

a) It is only useful in specialized laboratories

b) It has cross-cutting applications in many industrial and creative sectors

c) It does not yet have concrete applications in the real world

d) It can only produce aesthetic, non-functional models

Correct answer: b

10. What is the function of the G-code file in 3D printing?

a) To design the object in 3D

b) To control the movements of the printer and the extrusion of the material

c) To store projects in the cloud

d) To check the quality of the material before printing

Correct answer: b

4.2. Module 2: 3D printing technologies

Chapter Objectives

The tutor should help students to:

1. Understand the main 3D printing technologies (FDM, SLA, SLS, DMLS, Binder Jetting, etc.).
2. Recognize the operating principles of each technology.
3. Distinguish the advantages and disadvantages of the different techniques.
4. Identify the typical fields of application for each technology.
5. Know how to match the most suitable technology to the type of material and production context.

Introduction and Motivation

- Start the chapter with a stimulating question:
- "In your opinion, what is the difference between printing a plastic prototype and a titanium prosthesis?"
- Emphasize that the diversity of technologies is the key to applying 3D printing in very different sectors.
- Show a short video or comparative image of the processes (FDM, SLA, SLS) to spark interest.

Explanation of Key Concepts

- FDM (Fused Deposition Modeling): extrusion of plastic filaments → educational applications, rapid prototyping.
- SLA (Stereolithography): photopolymer resin solidified by UV laser → detailed models, dentistry, jewelry.
- SLS (Selective Laser Sintering): sintering of powders → functional prototypes, mechanical components.
- DMLS/SLM (Direct Metal Laser Sintering / Selective Laser Melting): metal powders fused by laser → aerospace, biomedical.
- Binder Jetting: adhesive on powders → architectural models, complex non-structural pieces.
- Advantages and limitations of each technology (costs, materials, speed, precision, resistance).

Tip: prepare a comparison table to discuss with students.

Active Learning Activities

- Comparison exercise: divide students into groups, each of which will study a technology in depth and present its applications and limitations.
- Case study: propose a problem ("A startup wants to produce a customized titanium prosthesis. Which technology would you use and why?").
- Mid-term quiz in the virtual classroom to test understanding of basic principles.

Support and Clarification

- Pay attention to technical terms (sintering, photopolymerization, extrusion).
- Use simple metaphors:
    - FDM = "a computer-controlled hot glue gun."
    - SLA = "a printer that solidifies liquid with light."
- Explain the differences between amateur use (e.g., low-cost FDM) and industrial use (SLS, DMLS).

Tips for Stimulating Creativity

- Ask students to imagine an object that would be impossible to create using traditional techniques and to think about which 3D technology would be most suitable.
- Encourage the use of CAD software to design a basic model and discuss the ideal printing technology.
- Highlight the variety of applications (from fashion to biomedicine).

Tutor Checklist

- Have I introduced the main technologies in a clear manner?
- Have I guided students in comparing advantages and limitations?
- Have I proposed practical and group activities?
- Have I clarified technical terms with simple examples?
- Have I stimulated creative thinking about the uses of technologies?

- Have I checked understanding with questions and quizzes?

Final Quiz – 3D Printing Technologies

1. What is the most widely used 3D printing technology at the consumer level?

a) SLA

b) FDM

c) SLS

d) Binder Jetting

Answer: b

2. Stereolithography (SLA) uses:

a) Molten plastic filament

b) Metal powders

c) UV-cured photopolymer resin

d) Sintered sand

Answer: c

3. Selective laser sintering (SLS) works with:

a) PLA filaments

b) Plastic or nylon powders

c) Liquid resins

d) Plaster and adhesives

Answer: b

4. Which technology is used to print high-strength metal components?

a) SLA

b) FDM

c) DMLS/SLM

d) Binder Jetting

Answer: c

5. What is the main advantage of SLA technology?

a) Low costs

b) High precision and fine details

c) Production speed

d) Use of metals

Answer: b

6. An architect who wants to print a scale model will probably choose:

a) FDM

b) Binder Jetting

c) DMLS

d) SLA

Answer: b

7. What disadvantage is common to FDM technology?

a) Rough surfaces and the need for post-processing

b) High cost of machines

c) Printing times that are too fast

d) Exclusive use of metals

Answer: a

8. What is the distinctive feature of Binder Jetting technology?

a) It uses a binder to bind powders

b) It extrudes filaments

c) It solidifies resins with UV lasers

d) It melts metals at high temperatures

Answer: a

9. Which of the following technologies is best suited for low-cost rapid prototyping?

a) SLS

b) SLA

c) FDM

d) DMLS

Answer: c

10. What is the most important factor when choosing a 3D printing technology?

a) Preferred color

b) Material and end use

c) Availability of CAD software

d) Internet connection

Answer: b

4.3. Module 3 - 3D Printing Equipment

Chapter Objectives

- Guide students in understanding the criteria for choosing 3D printing equipment (types of printers, features, costs).
- Support familiarization with basic operating procedures (installation, loading materials, calibration, and starting a print job).
- Encourage responsible behavior in terms of safety, health, and environmental sustainability.
- Stimulate students' ability to evaluate costs, ROI, and environmental impact when using technology.

Introduction and Motivation

- Present the equipment as the operational heart of 3D printing, highlighting how the right choice affects quality, costs, and sustainability.
- Motivate students by emphasizing the importance of knowing how to assess their design needs (e.g., size, materials, precision) before purchasing a printer.
- Highlight how mastery of operating procedures and safety practices makes students more independent and professional.

Explanation of Key Concepts

- Printer selection: criteria (project objectives, material compatibility, technical specifications, costs, scalability).
- Printer operation: setup, material loading, calibration, print management, post-production.
- Safety and environment: use of PPE (gloves, masks, goggles), proper ventilation, waste and material management, waste reduction, choice of eco-sustainable materials.
- Regulations and compliance: knowledge of standards and regulations (e.g., CE, ISO, REACH).

Active Learning Activities

- Guided discussion: ask students to compare printer models for a real project (e.g., wooden prototype vs. mechanical component).
- Hands-on exercise: guide students through a setup and calibration simulation, highlighting critical steps.

- Cost analysis: propose a small business case to calculate the ROI and operating costs of a printer.
- Safety workshop: analyze real-life accident cases and discuss how to prevent them.

Support and Clarification

- Provide in-depth resources (manuals, video tutorials, articles suggested in the module).
- Clarify doubts about technological differences (FDM, SLA, SLS) with practical examples.
- Remind students to always check the manufacturer's manuals, as procedures vary from model to model.

Tips for Stimulating Creativity

Encourage students to think beyond technical functionality: how can different equipment open up new design possibilities?

Stimulate ideas for the use of alternative and sustainable materials.

- Propose creative challenges: e.g., design an object while optimizing material and energy consumption.

Tutor Checklist

- Did I introduce the topic by emphasizing the importance of equipment selection?
- Did I explain the main selection criteria (materials, precision, costs, ROI)?
- Did I guide students through a setup and calibration simulation?
- Did I highlight safety practices and environmental impact?
- Did I stimulate problem-solving and creativity?
- Did I verify that students can distinguish between the main types of printers and materials?

Final Quiz

What is the first fundamental step in choosing a 3D printer?

A) Filament color

B) Defining project objectives

C) Lowest price available

D) Best-known brand

Correct answer: b

Which parameter defines the maximum size of the printable object?

A) Printing speed

B) Build volume

C) Resolution accuracy

D) Energy consumption

Correct answer: b

Which material is considered biodegradable and more sustainable?

A) ABS

B) PLA

C) Nylon

D) Standard resin

Correct answer: b

Why is it important to level the print bed?

A) To reduce printing time

B) To ensure proper adhesion of the first layer

C) To make the printer quieter

D) To increase the color of the filaments

Correct answer: b

What PPE is recommended when handling liquid resins?

A) Latex gloves and goggles

B) Nitrile gloves and safety goggles

C) Mask only

D) None, if the environment is ventilated

Correct answer: b

What is the main function of G-code?

A) To define the density of the material

B) To give operating instructions to the printer

C) Choosing the print color

D) Establishing the post-processing time

Correct answer: b

What is the main risk of storing filament in a humid environment?

A) Loss of color

B) Breakage of the spool

C) Absorption of moisture that degrades print quality

D) Increase in extrusion speed

Correct answer: c

What does ROI mean when choosing a printer?

A) Return on investment

B) Reduction of operational impact

C) Optimal innovation ratio

D) Industrial operational performance

Correct answer: a

Which measure reduces the environmental impact of 3D printing?

A) Always print with 100% supports

B) Only turning off the printer at the end of the week

C) Using recycled filaments and material recovery systems

D) Using more expensive materials to reduce waste

Correct answer: c

Which European body regulates the safety and environmental impact of chemical materials?

A) UNESCO

B) REACH

C) OSHA

D) ISO

Correct answer: b

4.4. Module 4: Design for 3D Printing and CAD Modeling

Chapter Objectives

The tutor should help students to:

1. Understand the principles of design for 3D printing.
2. Become familiar with the basic concepts of CAD modeling.
3. Recognize the criteria for design for additive manufacturing (DfAM).
4. Develop skills in using basic CAD software (e.g., Tinkercad, Fusion 360, FreeCAD).
5. Evaluate how design affects the quality, cost, and sustainability of a printed object.

Introduction and Motivation

- Introduce the chapter by emphasizing that design is the starting point for 3D printing: without a good model, you won't get good results.
- Motivate students by emphasizing that CAD skills are now in demand in many sectors (engineering, fashion, art, architecture).
- Stimulus question: “Have you ever thought of an object that you would like to customize or modify? With CAD and 3D printing, this becomes possible.”

Explanation of Key Concepts

- Design principles for 3D printing: minimum thicknesses, critical angles, tolerances, need for supports or not.
- CAD files and formats: STL, OBJ, STEP and their characteristics.
- Basic CAD tools: creation of simple shapes, extrusions, Boolean operations.
- DfAM (Design for Additive Manufacturing): designing with the unique characteristics of 3D printing in mind (lightweighting, complex geometries, reduction of assembled parts).
- From CAD to printing: transition through slicing and G-code.

Suggestion: present a comparison chart of the most commonly used CAD software with pros and cons.

Active Learning Activities

- Practical exercise: guide students in creating a simple model (e.g., key ring, nut, small container) with free online CAD software.
- Group challenge: design an object by optimizing the supports (e.g., reduce material consumption without compromising functionality).
- Group review: ask students to upload their models and discuss their strengths/weaknesses.
- Case study: analyze a real object that could not have been produced using traditional methods.

Support and clarification

- Some students may find CAD software difficult: the tutor should simplify the technical language, showing step-by-step examples.
- Emphasize the differences between beginner software (Tinkercad) and professional software (Fusion 360, SolidWorks).
- Remember that CAD is a skill that is acquired gradually: encourage students even when they make mistakes.

Tips for Stimulating Creativity

- Invite students to start with an object from their everyday life and think about how to improve it with 3D printing.
- Suggest experimenting with generative designs and organic shapes.
- Encourage the creation of personalized objects (e.g., gadgets, accessories, small tools).

Tutor Checklist

- Did I introduce the topic by linking design and 3D printing?
- Did I explain the key concepts of CAD modeling and file formats?
- Did I lead practical exercises with basic CAD software?
- Did I clarify the principles of DfAM?
- Did I encourage collective review of models?
- Did I propose creative and personalized activities?

Final Quiz

What is the most common file format for 3D printing?

A) .PDF

B) .STL

C) .DOCX

D) .JPEG

Answer: B

What does DfAM stand for?

A) Design for Additive Manufacturing

B) Digital fabrication and modeling

C) Draft for advanced modeling

D) Design for Automated Machines

Answer: A

What is the main advantage of CAD modeling for 3D printing?

A) It allows printing without slicing

B) It allows you to create editable and accurate digital models

C) It automatically reduces printing time

D) It avoids the need for supports

Answer: B

What principle is fundamental in 3D design to avoid fragile objects?

A) Use appropriate minimum thicknesses

B) Always avoid curved shapes

C) Print in color

D) Use only metallic materials

Answer: A

Which software is considered suitable for beginners?

A) SolidWorks

B) Tinkercad

C) Fusion 360

D) Catia

Answer: B

What is the function of the STL file?

A) Save 2D images

B) Describe the 3D geometry of the object

C) Check the print parameters

D) Manage data security

Answer: B

Why is it important to consider overhang angles in 3D design?

A) To increase the color of the model

B) To reduce the need for supports

C) To speed up file loading

D) To improve printer ventilation

Answer: B

What is the intermediate step between CAD files and actual printing?

A) Conversion to G-code via slicing

B) Creation of a PDF file

C) Direct printing from CAD

D) Saving in DOCX format

Answer: A

Which criterion can reduce costs and time in 3D printing?

A) Increase geometric complexity

B) Reduce infill density

C) Always printing at a 1:1 scale

D) Using expensive materials

Answer: B

What is an example of a generative design application?

A) Creating identical models in series

B) Obtaining optimized, organic shapes that reduce weight and material consumption

C) Printing files without supports

D) Always producing in metal

Answer: B

4.5. Module 5: Obtaining the Physical Model Through 3D Printing Services

Chapter Objectives

The tutor must support students in:

- Understanding the criteria for choosing a 3D printing service provider.
- Preparing CAD files correctly and in accordance with the technical requirements of the providers.
- Understanding the stages of review, testing, and improvement of printed models.
- Evaluate the quality and functionality of the printed model, recognizing any critical issues.
- Explore opportunities for presenting and marketing printed models as an innovative tool.

Introduction and Motivation

- Explain to students that it is not always necessary to own a printer: using external services can be more efficient and professional.
- Emphasize how collaboration with providers requires good communication, clear specifications, and evaluation skills.
- Motivate by linking the topic to the possibility of transforming a digital idea into a real object, opening up both professional and creative scenarios.

Explanation of Key Concepts

- Choice of supplier: available technologies (FDM, SLA, SLS, DLP), materials offered, quality, times, costs, assistance, reputation.
- Model preparation: correct formats (STL, OBJ, AMF), file validation, complexity reduction, orientation, preview, testing.
- Review and improvement: quality analysis (dimensional, aesthetic, functional), design iterations, optimization of parameters and materials.
- Marketing and promotion: use of printed models as a promotional tool, real-world examples (Coca-Cola, Volkswagen).
- Challenges and limitations: costs, scalability, dependence on the provider, delivery times.

Active Learning Activities

- Practical exercise: simulate the selection of a supplier by comparing three different services based on cost, time, and quality.
- CAD lab: prepare a file ready for external printing and validate it according to guidelines.
- Real-world case studies: study marketing campaigns that have used 3D models (e.g., Dior, Adidas, Volkswagen).

- Assessment test: analyze a printed model (photo or prototype) and discuss its strengths/weaknesses.

Support and Clarification

- Guide students on how to communicate with providers, emphasizing the importance of specifying materials, dimensions, and timing.
- Provide examples of detailed quotes and help interpret them.
- Clarify how to distinguish between acceptable defects and serious printing problems.

Tips for Stimulating Creativity

- Invite students to think about the added value of printed models in different contexts: product design, rapid prototyping, merchandising.
- Encourage the creation of a promotional concept that uses customized 3D models.
- Encourage reflection on the link between traditional craftsmanship and digital technologies.

Tutor Checklist

- I introduced the topic by emphasizing the importance of 3D printing providers.
- I explained the criteria for choosing a supplier.
- I guided students in the correct preparation of CAD files.
- I illustrated the stages of reviewing, testing, and improving models.
- I proposed practical analysis and comparison activities.
- I stimulated reflection on the creative and promotional use of printed models.

Final Quiz

What is the first step in working with a 3D printing supplier?

A) Test the printed model

B) Choose the right 3D printing service

C) Market the product

D) Iterate the design

Correct answer: B

Which file format is commonly accepted by providers?

A) .PDF

B) .DOCX

C) .STL

D) .TXT

Correct answer: C

Why is it important to request samples from the supplier?

A) To check the printing speed

B) To evaluate the quality of the prints

C) To verify software compatibility

D) To reduce shipping costs

Correct answer: B

What is one of the main criteria when choosing a supplier?

A) Number of employees

B) Social media presence

C) Type of materials available

D) Company logo color

Correct answer: C

What does it mean to "validate" a CAD file?

A) Convert it to PDF

B) Check it for errors that could compromise printing

C) Add textures and colors

D) Insert watermarks

Correct answer: B

Which test verifies the strength of a printed model?

A) Aesthetic test

B) Tensile or compression test

C) Orientation test

D) Preview test

Correct answer: B

What advantage does the use of 3D models offer in marketing?

A) Immediate mass production

B) Customization and greater customer engagement

C) Automatic reduction of advertising costs

D) Elimination of the need for prototypes

Correct answer: B

Why is it useful to iterate the printing process?

A) To increase the number of saved files

B) To improve the quality and functionality of the model

C) To reduce the complexity of CAD software

D) To print in multiple colors

Correct answer: B

What is the risk of choosing a service that is too cheap?

A) Delivery that is too fast

B) Compromises on model quality

C) Surcharges for transport

D) Exclusively metallic materials

Correct answer: B

What is the final stage of the process with 3D printing providers?

A) Review of CAD files

B) Model iteration

C) Strength testing

D) Presentation and marketing of models

Correct answer: D

4.6. Module 6: Printing a 3D Object

Chapter Objectives

The tutor should help students to:

- Understand the complete workflow for printing a 3D object, from file to physical model.
- Become familiar with the main parameters of slicing and printer configuration.
- Know how to prevent and solve the most common problems during printing.
- Evaluate the quality of the result and interpret any defects.
- Develop autonomy in moving from idea to physical prototype.

Introduction and Motivation

- Explain that this chapter represents the practical and central moment of the entire course: transforming the digital design into a real object.
- Motivate students by reminding them that 3D printing allows them to touch their ideas with their own hands, making them concrete.
- Link the process to the concept of rapid prototyping and the possibility of testing and improving designs.

Explanation of Key Concepts

- From CAD to G-code: the role of slicing software (Cura, PrusaSlicer, Simplify3D).
- Main printing parameters: nozzle and bed temperature, printing speed, layer height, infill, supports, bed adhesion.
- Starting the print: loading filament, bed leveling, heating, first test lines.
- Common problems: warping, under-extrusion, layer shifting, poor adhesion, clogging.
- Quality control: checking dimensions, surfaces, strength, finish.
- Post-processing: support removal, sanding, painting, special treatments.

Active Learning Activities

- Slicing simulation: guide students to modify parameters (e.g., infill 20% vs. 80%) and observe differences.
- Practical exercise: print a small test object (e.g., calibration cube) and discuss the results.
- Problem solving: analyze defects in real prints and ask students to identify possible causes and solutions.
- Post-processing workshop: show how to finish a printed model.

Support and Clarifications

- Provide quick guides on slicing parameters, with numerical examples of common settings (PLA, ABS, PETG).
- Offer video troubleshooting resources for the most common problems.
- Clarify differences between materials (PLA is easier, ABS is more complex but more resistant).
- Remind students of the importance of basic maintenance (nozzle cleaning, filament replacement, bed care).

Tips for Stimulating Creativity

- Ask students to design and print an object that is useful in everyday life.
- Encourage them to experiment with different parameters to see how the result changes.
- Suggest creating small collections of personalized objects (gadgets, accessories, tools).
- Stimulate critical thinking: how can a printed object be improved in terms of aesthetics and functionality?

Tutor Checklist

- I introduced the importance of printing as a central phase of the process.
- I explained the key concepts of CAD → slicing → printing → post-processing.
- I have guided practical exercises in slicing and printing.
- I have discussed common problems and their solutions.
- I have proposed creative design and printing activities.
- I have verified that students know how to evaluate the quality of the printed model.

Final Quiz

Which software converts CAD files to G-code?

A) Photoshop

B) Cura

C) Excel

D) AutoCAD

Correct answer: B

Which parameter affects the internal strength of the object?

A) Filament color

B) Infill (fill percentage)

C) Layer height

D) Printing speed

Correct answer: B

Why is it important to level the printing bed?

A) To reduce printing time

B) To ensure proper adhesion of the first layer

C) To improve fan speed

D) To reduce filament consumption

Correct answer: B

What is the defect called “warping”?

A) The nozzle clogs

B) The layers separate at the edges, lifting off the bed

C) The print is tilted to one side

D) The filament changes color

Correct answer: B

Which material is considered easiest to print?

A) ABS

B) Nylon

C) PLA

D) PETG

Correct answer: C

Which parameter controls the visual quality of the details?

A) Layer height

B) Infill

C) Fan speed

D) Spool diameter

Correct answer: A

What does the term “under-extrusion” mean?

A) Printer motor overload

B) Insufficient amount of extruded material

C) Printing bed too hot

D) Lack of supports

Correct answer: B

What should be done at the end of a print with supports?

A) Leave them as decoration

B) Remove them carefully during post-processing

C) Dissolve them in water without supervision

D) Reuse them in another print

Correct answer: B

Which parameter has the greatest influence on printing times?

A) Printing speed

B) Nozzle temperature

C) Material color

D) Type of slicer

Correct answer: A

Which activity belongs to post-processing?

A) Slicing

B) Support removal and smoothing

C) Bed leveling

D) Filament loading

Correct answer: B

4.7. Module 7: 3D Printing and the Woodworking Craft Sector

Chapter Objectives

The tutor should guide students to:

1. Understand how 3D printing can innovate the woodworking craft sector.
2. Analyze cases and examples of integration between traditional and additive techniques.
3. Learn about wood-based materials for 3D printing and their characteristics.
4. Recognize opportunities and challenges in applying 3D printing to craftsmanship.
5. Stimulate reflection on the contamination between ancient knowledge and emerging technologies.

Introduction and Motivation

- Present 3D printing as a complementary tool to woodworking, not as a replacement.
- Motivate students by showing how technology can help preserve traditional know-how while enriching it with new possibilities.
- Stimulating question: "How would you imagine a craft workshop that uses both chisels and 3D printers?"

Explanation of Key Concepts

- Wood-based materials for 3D printing: PLA filaments enriched with wood fibers, aesthetic and mechanical characteristics.
- Concrete applications: furniture prototypes, decorative components, customized design objects, restoration and reproduction of missing parts.
- Tradition-innovation synergy: use of 3D printing to create models, templates, and tools to support craftsmen.
- Opportunities: extensive customization, rapid prototyping, cost reduction.
- Critical issues: limited strength compared to solid wood, need for post-printing treatments, cost of specific materials.

Active Learning Activities

- Case study: analyze examples of companies that integrate 3D printing and craftsmanship (e.g., lamp design, custom furniture).
- Practical exercise: design a small decorative object in CAD (e.g., inlay, handle) and hypothesize its production with wood-based filament.
- Guided discussion: pros and cons of using 3D printing in the workshop.
- Comparative workshop: show a traditional wooden object and one printed in 3D with wood-like material, discussing differences and potential.

Support and clarification

- Provide students with visual examples of filaments and objects printed in wood-based PLA.
- Clarify that wood-PLA composite materials are not a substitute for solid wood, but are valuable for prototypes, design, and creative production.
- Support students in the use of technical terminology (e.g., density, finish, post-processing with sanding and varnishing).

Tips for Stimulating Creativity

- Invite students to imagine new handcrafted products combining wood and 3D printing (e.g., a piece of furniture with printed inserts).
- Suggest the creation of custom design lines that take advantage of textures and grains that can be simulated with wood-based filaments.
- Encourage reflection on the theme of sustainability, considering the recovery of wood waste transformed into filaments.

Tutor Checklist

- Did I introduce the topic by linking craftsmanship and innovation?
- Did I explain wood-based materials and their real-world applications?
- Did I lead practical exercises and comparative discussions?
- Did I clarify the limitations and opportunities of 3D printing in the wood industry?
- Did I stimulate creativity and reflection on sustainability?

Final Quiz

Which material is commonly used to simulate wood in 3D printing?

A) ABS

B) PLA with wood fibers

C) Nylon

D) PETG

Correct answer: B

What is a typical application of 3D printing in the wood industry?

A) Production of solid boards

B) Creation of decorative components and prototypes

C) Automatic wood sawing

D) Artificial drying

Correct answer: B

What advantage does 3D printing offer woodworkers?

A) It reduces the use of traditional hand tools

B) It allows for rapid prototyping and customization

C) It eliminates the need for surface treatments

D) It always guarantees superior strength to solid wood

Correct answer: B

What is a critical issue with wood-based filaments?

A) They are always cheaper than standard PLA

B) They do not require any calibration

C) They have limited strength compared to solid wood

D) They are not compatible with FDM printers

Correct answer: C

In what context can 3D printing support wood restoration?

A) In industrial mass production

B) In the reproduction of missing parts of furniture or decorations

C) In the replacement of floorboards

D) In the sawing of logs

Correct answer: B

Which treatment can improve the aesthetics of an object printed in wood-based PLA?

A) Sanding and varnishing

B) Rapid heating

C) Immersion in water

D) Polishing with aggressive solvents

Correct answer: A

What is meant by tradition-innovation synergy in the wood sector?

A) Total replacement of manual techniques

B) Use of 3D-printed models and tools to complement craftsmanship

C) Elimination of the design phase

D) Exclusively digital production

Correct answer: B

What aesthetic feature can a filament with wood fibers offer?

A) Transparency

B) Wood-like texture and grain

C) Metallic effect

D) Glass-like shine

Correct answer: B

What opportunity does 3D printing offer a craft workshop?

A) Reducing the manual work of craftsmen

B) Expanding the range of customized and innovative products

C) Standardizing products on a large scale

D) Completely replacing traditional techniques

Correct answer: B

What aspect of sustainability can result from the use of wood-based filaments?

A) None, they are always synthetic

B) Recovery and reuse of wood waste transformed into printing material

C) Reduction in the lifespan of objects

D) Increased production of plastic waste

Correct answer: B

4.8. Module 8: Designing a Wooden Object with the Support of 3D Printing

Chapter Objectives

- Understand the potential of integrating traditional woodworking with 3D printing.
- Support students in the digital design of a wooden object with 3D-printed components.
- Guide students in the use of CAD software and slicers to transform the design into a printable model.
- Encourage the learning of post-processing techniques and the integration of wooden parts and printed components.
- Stimulate students' creativity and innovation in combining aesthetics, functionality, and tradition.

Introduction and Motivation

- Present the chapter as the point where theory meets creative practice: students have the opportunity to design an original object.
- Emphasize how 3D printing does not replace carpentry, but enriches it, allowing for rapid prototyping, customization, and new aesthetics.
- Encourage students to see this chapter as a "creativity gym" where they can experiment without fear of making mistakes.

Explanation of Key Concepts

- Wood + 3D printing integration: illustrate concrete examples of objects that combine printed elements with traditional components.
- Design factors: dimensions, printing limitations, joints between wood and printed parts, choice of materials (PLA wood-fill) .
- Use of CAD and slicing: show how a digital model becomes physical through G-code.
- Post-processing: importance of sanding, painting, coloring, and assembly.
- Sustainability: use of recycled or wood-based filaments and an eco-friendly approach to design.

Active Learning Activities

- Offer a practical workshop: each student chooses a small wooden object (e.g., key ring, stand, tool) to embellish with 3D-printed details.
- Have students practice the transition from sketches on paper → CAD model → STL file → slicing.
- Organize collaborative sessions where students discuss the joints between wood and plastic, comparing creative solutions.
- Provide opportunities for peer review: students present their concepts and receive feedback from their classmates.

Support and Clarifications

- Be prepared to explain the differences between various CAD software (Tinkercad, Fusion 360, Meshmixer).
- Help solve common printing problems: overhangs, bridging, first layer adhesion, inaccurate hole measurements.
- Offer practical examples of design adaptations to overcome the technical limitations of FDM printers.
- Provide links to free CAD libraries and open source slicers (e.g., Cura, Slic3r).

Tips for Stimulating Creativity

- Encourage students to "think hybrid": what can wood do better and what can 3D printing do better?
- Suggest exploring different finishes (painting, coloring, embedding elements).
- Promote the use of local makerspaces and FabLabs as spaces for inspiration and collaboration.
- Encourage personalization: an object designed for a friend, family member, or to solve a practical problem.

Tutor Checklist

- Present the importance of the synergy between wood and 3D printing.
- Verify that each student knows how to create a basic CAD model.
- Ensure that students have understood the design rules for printability.
- Encourage discussion and sharing of projects.
- Monitor the use of slicing software and the preparation of G-code files.
- Evaluate the originality and feasibility of the projects developed.

Final Quiz

What is the main advantage of integrating woodworking and 3D printing?

A) Reduced carpentry costs

B) Greater precision and creative possibilities (**correct**)

C) Elimination of traditional processes

D) Shorter product life

Which software is suitable for beginners in CAD modeling?

A) Fusion 360

B) Tinkercad (**correct**)

C) AutoCAD

D) SolidWorks

What does the STL file represent in a 3D project?

A) An image file

B) The digital model translated for printing (**correct**)

C) The painting file

D) The assembly guide

Why is the "first layer" so important in 3D printing?

A) It defines the strength of the piece

B) It ensures the adhesion and stability of the model (**correct**)

C) It reduces printing time

D) It improves the coloring of the piece

What characteristic distinguishes wood-filled PLA filaments?

A) They are made entirely of wood

B) They contain wood powder or fibers mixed with PLA (**correct**)

C) They are transparent

D) They are more flexible than nylon

What is "bridging" in 3D printing?

A) A painting technique

B) A suspended section without support (correct)

C) A type of filament

D) A software error

Which technique improves the appearance of wood-printed parts?

A) Rapid cooling

B) Sanding and painting (**correct**)

C) Increasing the printing speed

D) Avoiding the use of CAD

What is the main advantage of collaborating with a FabLab?

A) Access to advanced tools and community support (**correct**)

B) Reduced delivery times

C) Greater isolation from other makers

D) Elimination of CAD

Why do projects with mixed wood+3D printing parts require planning?

A) To reduce costs

B) To ensure compatibility between materials (**correct**)

C) To simplify the use of filaments

D) To limit the number of components

What does DfAM mean?

A) Design for Additive Manufacturing (**correct**)

B) Design for Automated Machining

C) Draft for Advanced Modeling

D) Digital fabrication and Milling

4.9. Module 9: Case Studies in Wood Manufacturing

Chapter Objectives

- Understand how 3D printing is transforming various wood-related sectors (furniture, construction, restoration, crafts).
- Analyze real case studies to discuss innovations, advantages, and limitations.
- Stimulate students' critical thinking skills in comparing traditional practices and 3D applications.
- Promote reflection on the impact of technology in terms of sustainability, costs, and creativity.

Introduction and Motivation

- Begin by explaining that case studies are practical tools: not just theory, but real examples that show how 3D printing is already changing manufacturing sectors.
- Emphasize that students will need to connect the information with the skills learned in previous chapters.

Explanation of Key Concepts

- Present the most significant cases, emphasizing:
  - Sustainability (use of wood powder, manufacturing waste).
  - Innovation (low-cost housing and smart bricks).
  - Restoration (wooden sculptures with missing parts).
  - Design and furniture (lamps, complex joinery).
- Guide students in a comparative analysis of the advantages and limitations of each case.

Active Learning Activities

- Guided discussion: divide students into groups, assign a case to each group, and ask them to prepare a short presentation of the pros and cons.
- Concept map: work together to build a map that links the different case studies with the themes of sustainability, creativity, and costs.
- Problem solving: ask students to imagine a new sector in which to apply 3D printing in wood.

Support and Clarification

- Help distinguish between what is already available on the market (e.g., PassivDom houses) and what is still in the experimental phase (e.g., lignin-cellulose ink).
- Answer practical questions: costs, scalability, materials used.

Tips for Stimulating Creativity

- Invite students to connect the past and the future: how certain craft practices can be revived with 3D printing.
- Encourage them to think in terms of sustainability: what alternative materials could be used besides wood?

Tutor Checklist

- Present case studies in a clear and comparative manner.
- Actively engage students with open-ended questions.
- Encourage group work and brainstorming.
- Emphasize the links between traditional craftsmanship and digital innovation.
- Conclude with a group discussion on the most inspiring cases.

Final Quiz

Which university developed a lignin and cellulose-based ink for printing wooden structures?

A) Harvard

B) Rice University

C) Boston University

D) MIT

Answer: B

How many hours does it take to print a house of approximately 40 m² using PassivDom technology?

A) 4

B) 36

C) 16

D) 8

Answer: D

In which parish was a wooden sculpture restored using 3D-printed parts?

A) Villar San Costanzo

B) Villar Perosa

C) Villar San Andrew

D) Villar San Pietro

Answer: A

3D printing in the construction industry allows for:

A) No cost reduction

B) Mass customization and reduced environmental impact

C) Only plastic constructions

D) Only prototypes, not homes

Answer: B

Which Italian company was the first to use a printer that uses wood powder?

A) Sviluppo Basilicata

B) Kite Bricks

C) Trentino Sviluppo SPA

D) Godesk

Answer: C

The Emerging Object project demonstrates that objects can be printed in:

A) Only metals

B) Only plastics

C) Innovative materials such as wood, salt, paper

D) None of the above

Answer: C

What is the main advantage of 3D printed joinery?

A) Eliminating natural wood

B) Simplifying complex geometries and reducing costs

C) Increasing production times

D) Need for nails and screws

Answer: B

Which startup offered 3D printed mobile and self-sufficient homes?

A) Apis Cor

B) PassivDom

C) Dus Architects

D) Kite Bricks

Answer: B

Why is the use of 3D printing important in restoration?

A) It completely replaces the craftsman

B) It allows for reversible additions and digital documentation

C) It is not compatible with artistic materials

D) It is too expensive for museums and superintendents

Answer: B

Which concept best describes the impact of case studies in the wood sector?

A) Reduction in artisan creativity

B) Fusion between tradition and innovation

C) Exclusion of small artisans

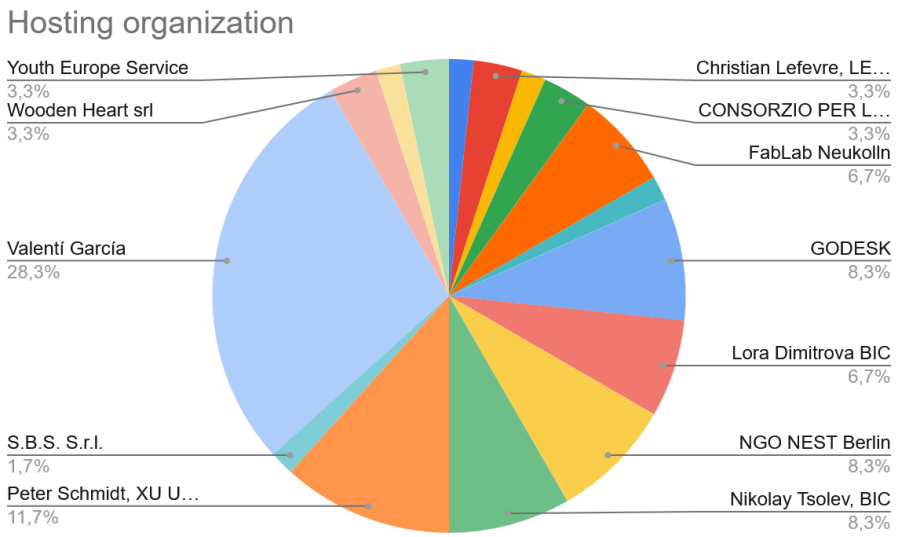
D) Only prototypes, no real applications

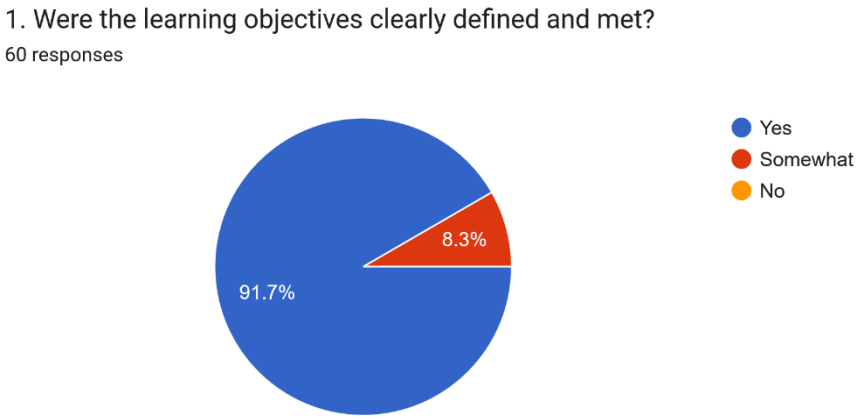
Answer: B

5. Mentorship Programme Trainee Survey

After participating in the Mentorship Program, participants were asked to complete a survey to evaluate the quality of the program.

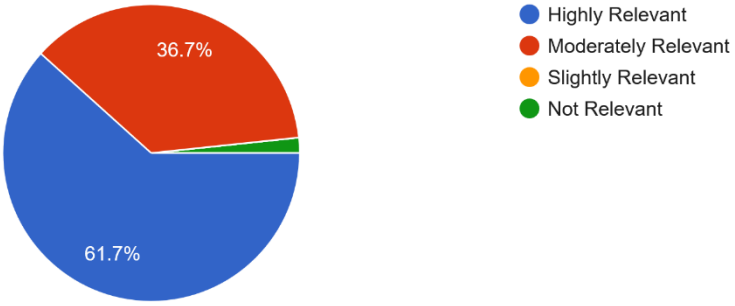
N. respondents: 60





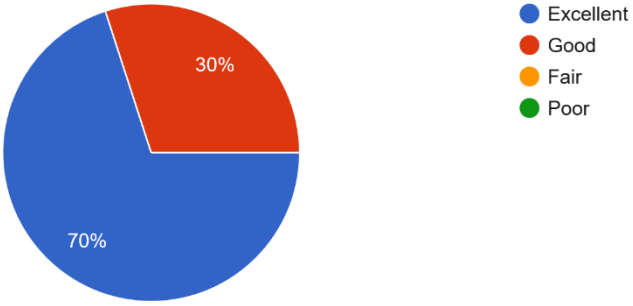
2. How relevant were the skills and knowledge gained to your professional development?

60 responses



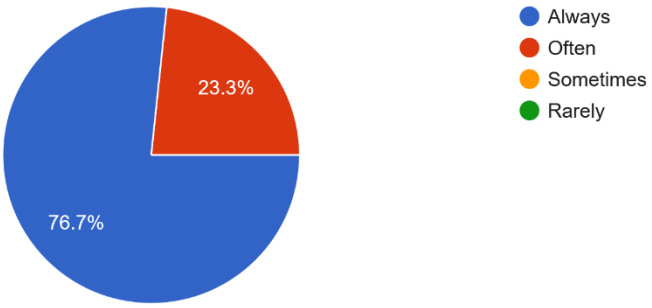
1. Rate the quality of interaction with your mentor

60 responses



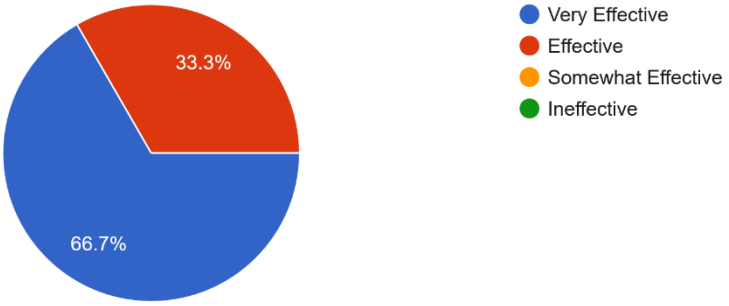
2. Did your mentor provide adequate support and guidance?

60 responses



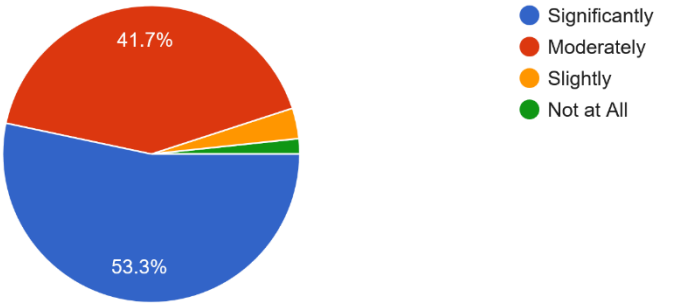
3. How effective was the communication between you and your mentor?

60 responses



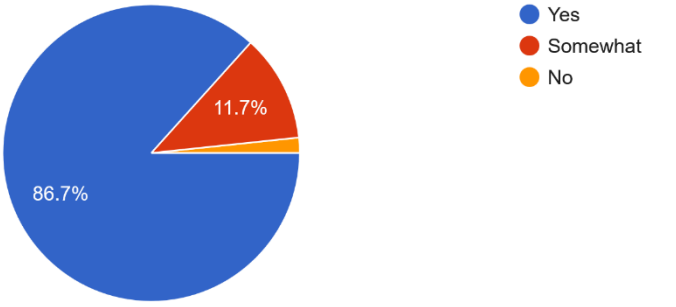
1. To what extent has the programme enhanced your skills in 3D printing and digital modeling?

60 responses



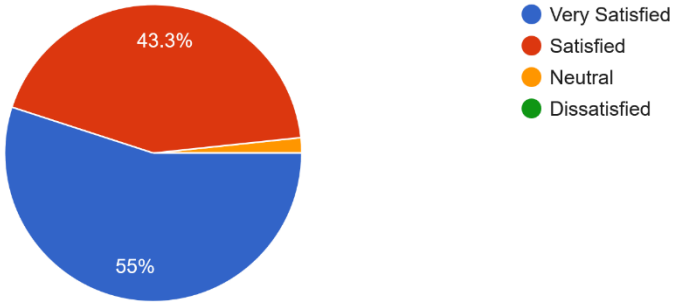
2. Do you feel more prepared to adapt to technological advancements in your field?

60 responses



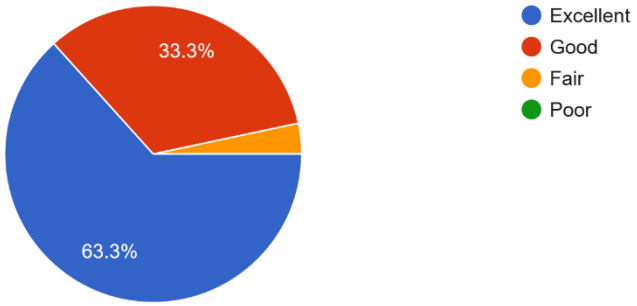
1. How satisfied were you with the duration and scheduling of the programme?

60 responses



2. How would you rate the support from the hosting organization?

60 responses



6. Recommendations from participants

The transition to an online format offers great opportunities, but also requires methodological adaptation to maintain high levels of learning and engagement. The feedback received provides numerous useful ideas for improving the distance learning experience. This chapter collects the main suggestions and translates them into operational guidelines for the development and management of the CRAFT3D online course.

6.1. Better structuring of time and duration

One of the most frequent pieces of feedback following the Mentorship Program concerns time management. Many students expressed a desire to have more days available or a better-structured schedule. Online, this translates into:

- Scheduling shorter synchronous sessions spread over several days, avoiding marathon hours in front of the screen.
- Creating a clear and accessible calendar, with fixed times for webinars, mentoring sessions, and assignment deadlines.
- Integrating structured breaks and opportunities for free discussion to maintain concentration.

6.2. Strengthen individual mentoring

Personalized mentoring was identified as the greatest value of the program. For an online course, it becomes even more central:

- We recommend that tutors make themselves available for one-to-one tutoring sessions that can be booked via a shared calendar.
- Provide at least two mandatory check-ins (midway and at the end of the course) to ensure that each participant receives targeted feedback.
- Use platforms with screen sharing and real-time 3D file review capabilities to simulate direct interaction.

6.3. Improve interaction and collaboration

One of the risks of online learning is isolation. The comments show how useful it was to collaborate and exchange feedback. Some practical solutions:

- Create small working groups assigned at the beginning of the course to encourage ongoing collaboration.
- Use virtual rooms (“breakout rooms”) for practical activities or short discussions in subgroups.

- Organize structured peer review sessions: each student uploads their project to a shared platform and receives feedback from at least two classmates, as well as from teachers.

6.4. Make objectives and progress clear

To maintain high motivation online, it is essential to make the results achieved visible.

- Define weekly learning objectives and communicate them clearly.
- Introduce milestone systems with badges or intermediate certificates that make progress visible.
- Offer personalized reports at the end of the course that summarize each participant's strengths and areas for improvement.

6.5. Support adaptation to digital tools

Some students have reported difficulties in learning new tools and workflows, while considering them opportunities for growth. For online learning, it is crucial to:

- Introduce an initial technical onboarding session dedicated to familiarizing students with the platform, software, and collaboration tools.
- Set up a quick helpdesk (including via chat) to resolve technical issues without interrupting learning.

6.6. Focus on communication and ongoing support

A recurring piece of feedback concerns the feeling that some requests have not been heard. This risk increases online:

- Establish an official channel for questions and requests (e.g., a dedicated forum or an email inbox managed weekly).
- Ensure clear response times (e.g., maximum 48 hours).
- Schedule a feedback session halfway through the course so that you can correct the course while it is in progress and not just at the end.

6.7. Quick implementation tips

To immediately translate feedback into concrete actions, we suggest some short-term interventions:

1. Create 5 extra video tutorials on key software (modeling, slicing, rendering).

2. Set up an online calendar to book individual mentoring sessions.
3. Introduce a discussion forum with thematic sections (software, design, technical questions).
4. Introduce digital badges for completing weekly milestones.
5. Create a digital welcome kit with technical instructions, useful links, and practical tips for organizing home study.

7. Monitoring, Evaluation & Certification

7.1. Tracking Progress

- *Manual Attendance Logs* - Supervisors at stakeholder firms can maintain attendance records to monitor trainee engagement.
- *Direct Observations* - Regular evaluations by mentors or supervisors can assess trainee performance and provide immediate feedback.
- *Remote and Hybrid Participation* - Schedule regular video conferences to discuss progress, address challenges, and set goals.

7.2. Mentor-Trainee Feedback Sessions

- Arrange consistent feedback sessions, either in-person or virtually, to facilitate open communication, address concerns promptly, questions or suggestions.

7.3. Final Evaluation

Mentors will fill a questionnaire summarizing the skills acquired, challenges faced, and overall effectiveness and the duration of the mentorship program. This feedback will be gathered and compiled into a single document, highlighting conclusions and recommendations across all organizations.

CRAFT3D Mentorship Programme Mentor Evaluation Form

Your feedback is invaluable in helping us enhance the mentorship experience. Please take a few moments to reflect on your 30-day duration of the experience as a mentor during the CRAFT3D mentorship programme and provide honest responses to the following questions.

Mentor Information:

- Mentor's Name: _____
- Trainee's Name: _____
- Hosting Organization: _____
- Programme Duration: _____
- Date of Evaluation: _____

Section 1: Programme Structure and Content

1. Were the learning objectives clearly defined and met?
    - Yes
    - Somewhat
    - No

2. Were the learning objectives clearly defined?
    - Yes
    - Somewhat
    - No
3. How relevant was the programme content to the trainee's learning experience?
    - Highly Relevant
    - Moderately Relevant
    - Slightly Relevant
    - Not Relevant

4. Were the resources and materials provided sufficient to support your role as a mentor?

    - Fully Adequate
    - Mostly Adequate
    - Insufficient

Section 2: Trainee Engagement

1. How actively was the trainee involved during the programme?
    - Very Actively
    - Moderately
    - Slightly
    - Not at All
2. Did the trainee show interest and initiative in learning?
    - Always
    - Often
    - Sometimes
    - Rarely
3. Was the trainee's initial preparation adequate for the programme?
    - Very Adequate
    - Adequate
    - Slightly Adequate
    - Inadequate

Section 3: Communication and Support

1. How effective was the communication with the trainee?
    - Very Effective
    - Effective
    - Somewhat Effective
2. Did you receive sufficient support from the CRAFT3D project team during the mentorship period?
    - Always
    - Often
    - Rarely
    - Never

Section 4: Results and Impact

1. Do you believe the trainee acquired practical skills in 3D printing and digital modeling?
    - Significantly
    - Moderately
    - Slightly
    - Not at All
2. Did the mentorship experience bring value to your organization?

- Significantly
- Moderately
- Slightly
- Not at All

Section 5: Additional Comments and Suggestions (Optional)

1. Do you have any suggestions or feedback to improve future editions of the mentorship programme?

_____
_____
_____
_____

_____
_____
_____
_____

Mutual Learning Agreement Confirmation (MLA) – Trainer / Hosting Organisation

☐ I confirm, on behalf of the hosting organization, that a **Mutual Learning Agreement (MLA)** has been established between our organization and the trainee(s) participating in the CRAFT3D Mentorship Programme.

☐ I acknowledge that this agreement defines the shared learning objectives, roles, and responsibilities, including the 30-day Work-Based Learning (WBL) phase, collaborative engagement, and continuous feedback.

Thank you for your time and insights. Your feedback is crucial in helping us enhance the CRAFT3D Mentorship Programme.

CRAFT3D Mentorship Programme Trainee Evaluation Form

Your feedback is invaluable in helping us enhance the mentorship experience. Please take a few moments to reflect on your 30-day duration of the experience and provide honest responses to the following questions.

Trainee Information:

- Name: _____
- Mentor's Name, Organization: _____
- Programme Duration: _____
- Date of Evaluation: _____

Section 1: Programme Structure and Content

1. Were the learning objectives clearly defined and met?
    - Yes
    - Somewhat
    - No
2. How relevant were the skills and knowledge gained to your professional development?
    - Highly Relevant
    - Moderately Relevant
    - Slightly Relevant
    - Not Relevant

Section 2: Mentor-trainee Relationship

1. Rate the quality of interaction with your mentor:
    - Excellent
    - Good
    - Fair
    - Poor
2. Did your mentor provide adequate support and guidance?
    - Always
    - Often
    - Sometimes
    - Rarely
3. How effective was the communication between you and your mentor?
    - Very Effective
    - Effective
    - Somewhat Effective
    - Ineffective

Section 3: Personal and Professional Development

1. To what extent has the programme enhanced your skills in 3D printing and digital modeling?
    - Significantly

- Moderately
- Slightly
- Not at All

2. Do you feel more prepared to adapt to technological advancements in your field?
   - Yes
   - Somewhat
   - No

Section 4: Programme Logistics

1. How satisfied were you with the duration and scheduling of the programme?
   - Very Satisfied
   - Satisfied
   - Neutral
   - Dissatisfied
2. How would you rate the support from the hosting organization?
   - Excellent
   - Good
   - Fair
   - Poor

Section 5: Overall Experience and Suggestions

1. Please reflect on your experience in the CRAFT3D mentorship programme by discussing the most valuable aspects, any challenges you encountered, suggestions for improvement, and any additional feedback or comments you wish to share.

7.4. Declaration of Completion – MOOC Courses (CRAFT3D Project)

☐ I confirm that I have successfully completed the MOOC courses offered under the CRAFT3D project.

☐ I acknowledge that I am now prepared to apply this knowledge practically through the Mentorship Programme and Work-Based Learning (WBL) experience.

Thank you for your time and insights. Your feedback is crucial in helping us enhance the CRAFT3D Mentorship Programme.

Certification

- *Participation* - Trainees must engage fully in all scheduled activities, whether on-site or remotely.
- *Completion of Evaluations* - All required assessments and feedback forms must be submitted.
- *Achievement of Learning Objectives* - Trainees should demonstrate proficiency in the program's core competencies.

THE TRAINEE	THE MENTOR
_____	_____
SIGNED	SIGNED

Co-funded by
the European Union

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