SKILLED UP
Co-funded by the Erasmus+ Programme of the European Union

DESCRIPTION OF MODULE

Sustainable Industrial Technology

Aim	The student is able to independently manage and constantly improve the technology of wood processing in order to ensure high quality of products and efficient production process by using most recent technological development advantages of digitalization, automatization and robotization in wood processing industry. The student understands the role of wood processing companies in the whole value chain of the forest industry and is able to apply his knowledge to improve every step of managing raw materials, wood processing processes, wood products and waste materials in accordance with the green principles of bioeconomy and circular economy.
Tasks **(Learning outcomes)**	***Within the scope of their duties and competences in the company, the student is able to:*** *choose sustainable raw materials;* *manage and monitor production processes, and implement technological improvements in order to achieve less consumption of any kind of resources;* *ensure the quality of the product to prolong its lifecycle and re-use or recycle possibilities.* **The student is able to:** choose sustainable raw materials that meet production specifics and quality requirements. **Knows:** types, specifics, quality requirements and sustainability indicators of raw materials (grades, dimensions, humidity, types of wood, problem areas, causes and solutions, certification systems). **Understands:** impact of raw material properties and quality on production technological processes and products (cause and effect). Understands the ways to apply acquired knowledge in production conditions by using digital tools. **The student is able to:** manage and monitor production processes; provide efficient and high quality production technological cycle for various products and implement technological improvements in order to achieve less consumption of any kind of resources. **Knows:** energy and resource efficient production technology for various wood products; technological equipment and its operation (maintenance, proper use), main components, including possibilities of digitalization, automatization and robotization in every step of production processes. **Understands:** relation between different technological processes and their impact on production efficiency. **The student is able to:** ensure the quality and sustainability of the product to prolong its lifecycle and re-use or recycle possibilities; ensure compliance with the quality of the production process and recognize, as well as eliminate the risks of quality mismatch. **Knows:** product quality and sustainability requirements at different stages of the production process; causes of manufacturing defects and ways to prevent them. **Understands:** the causal relationship between production technology, equipment and instruments (technical condition, specifications, maintenance) and its impact on production quality.
Assessment form	1. Within a module, during the learning process, the trainee prepares a description of the quality of the raw materials and at the end of the module describes how raw materials quality influences the production process and end result. 2. Within the module, prepares the scheme of technological process and functional parameters *(equipment settings, processing parameters, cutting tool parameters, productivity, and raw material characteristics)* of the equipment. At the end of the module, the student presents an analysis of the production technological processes and proposals for improving efficiency.

	3. During the module, the student monitors the adequacy of technological processes to ensure product quality. At the end of the module the student identifies the major quality mismatches and makes proposals for their timely elimination. 4. During the module trainee analyses the possibilities to improve management and production processes and presents the possibilities to implement recent technological development advantages of digitalization, automatization and robotization in his company.

CONTENT OF MODULE

Learning outcomes	Topics	Content (suggested)	Units	Assessment of acquired learning outcomes (optimal level)	Methods and ideas for learning process	
1. The trainee is able: - choose sustainable raw materials that meet production specifics and quality requirements. **Knows:** - types, specifics, quality requirements and sustainability indicators of raw materials (grades, dimensions, humidity, types of wood, problem areas, causes and solutions, certification systems). **Understands:** - impact of raw material properties and quality on production technological processes and products (cause and effect). Understands the ways to apply acquired knowledge in production conditions by using digital tools.	**1.1. Types and quality of round timber (Forestry)**	**1.1.1. Round timber as raw material for woodworking**	**1**	**Name round timber assortment suitable for wood product manufacturing.**	**Students learn about the types of round timber and its use in the woodworking industry. They also discuss assortment acquisition and use in their companies.**	
		1.1.2. Round timber: quality requirements, defects, measurement, and certification of sustainability		**Identify the main quality requirements and wood faults, estimate them, and define the quality of the round timber. Explain the principles of forest certification systems and available possibilities to ensure sustainability of wood raw materials.**	**Students measure the samples of the round timber and determine their compliance with the quality requirements. Students analyses examples of documents and procedures to ensure usage of sustainable wood materials in the production processes.**	
		1.1.3. How logging processes impact the quality of round timber		**Analyses and describes the impact of mechanical damage on the quality of round timber and the useful yield of wood to be produced.**	**Students learn about the results of the research on the impact of logging processes on the quality of round timber.**	
	1.2. Types and quality of wood materials	**1.2.1. Macroscopic features and properties of wood**		**Describe macroscopic properties of various sorts of wood, its use and impact on the processing.**	**Students study theoretical materials about the timber macroscopic properties and analyses their impact on woodworking processes and the types of products where this wood is used.**	
		1.2.2. Sawn timber classification, quality requirements, defects, measurement		**Visually estimate, measure and describe the quality of lumber.**	**Students sort lumber samples according to the requirements of theoretical contract between the customer and supplier.**	
		1.2.3. Types of plywood, quality requirements, defects and its measurement		**Visually estimate, measure and describe the sort of quality of a given sheet of plywood.**	**Students sort the plywood samples according to the set quality requirements.**	
		1.2.4. Wood panel materials: quality requirements and application		**Describes the types of wood panels, their physical-mechanical properties and possible use.**	**Students get acquainted with different wood panels and study theoretical materials about its properties and applications.**	
		1.2.5. Energy wood: types and quality requirements		**Describe types of energy wood, its most important characteristics and**	**Students get acquainted with samples of different types of energy wood and test**	

		1.2.6. Wood for pulp production: types and quality requirements		**production processes. Describe the types of wood intended for pulp production and applicable quality requirements.**	**of its characteristics in the laboratory. Students study theoretical materials about the types of wood used in pulp production and the quality requirements set for it.**	
2. Is able to: - manage and monitor production processes; - provide efficient and high quality production technological cycle for various products and implement technological improvements in order to achieve less consumption of any kind of resources. **Knows:** - energy and resource efficient production technology for various wood products; - technological equipment and its operation (maintenance, proper use), main components, including possibilities of digitalization, automatization and robotization in every step of production processes. **Understands:** - relation between different technological processes and their impact on production efficiency.	**2.1. Production of sawn timber**	**2.1.1. Production of sawn timber: technologies, machinery, cutting tools**		**Compare and explain the advantages and disadvantages of different technological lines and machine tools. Make proposals for the replacement of equipment and cutting tools at the sawmill production with the aim to increase production efficiency.**	**Students learn about real or theoretical sawn lumber production, production lines and/or machinery there. Make proposals for the replacement of equipment and cutting tools in real or theoretical sawn lumber production with the aim of increasing production efficiency.**	
		2.1.2. Lumber sawing techniques, basic principles of creating a sawing plan; software for creating a computerized sawing plan		**Create an optimal sawing plan, compare and analyze the advantages and disadvantages of various lumber sawing methods.**	**Students create a sawing plan using sawing or scouring, and then compare the resulting yield.**	
		2.1.3. Lumber drying equipment and technology of drying process		**Describe the types of sawn lumber drying equipment available on the market, its main parameters, operating principles, advantages and disadvantages.**	**Students get acquainted with theory and actual drying equipment at the sawmill factory. Evaluate its efficiency and compliance with the specific lumber factory conditions. Students also develop proposals for improving drying.**	
		2.1.4. Methods of sorting the lumber		**Describe the mechanized lumber sorting lines on the market, their main parameters, advantages and disadvantages.**	**Students learn about the mechanized sorting line for sawn timber at the real or theoretical factory Assess its effectiveness and compliance with the needs of a particular production. Offer proposals for improvement of sorting processes and technologies.**	
		2.1.5. Packaging and marking of lumber		**Give examples of requirements for the packaging of lumber, depending on the type of transportation, country of destination and specific customer requirements.**	**Students examine the types of sawn timber packaging depending on the type of transportation, country of destination, and customer requirements.**	
	2.2. Plywood production	**2.2.1. Plywood description and basic methods of its production**		**Describes the technology and aspects of plywood production in the future depending on the type of production and the type of raw material.**	**Students learn about the available literature independently and prepare an overview of peeled and shelled raw materials for plywood or any further use.**	
		2.2.2. Timber preparation for peeling and plywood shelling		**Describes quality requirements for raw material preparation, compares types of hydrothermal treatment of veneer logs, their advantages and**	**Students study theoretical materials on plywood production requirements, technologies, equipment and operating principles, as well the basic scheme of**	

Project number: 601123-EPP-1-2018-1-DE-EPPKA2-SSA

				disadvantages. Describes the most important parameters of the technological process of peeling, the effect of their changes on peeling process efficiency and plywood quality.	**peeling process – indicating the most essential requirements for hydrothermal treatment of timber.**	
		2.2.3. Transportation and crushing of shelled plywood		**Describe the crumbling principles and options of peeled plywood.**	**Students get acquainted with the process of peeled plywood crumbling and transportation, the basic schemes of plywood conveyor and cutting, its main elements and the importance of plywood crumbling.**	
		2.2.4. Importance, principles and process of plywood drying		**Compare the plywood drying methods, their advantages and disadvantages. Describe the most important parameters of the plywood drying process and how parameters' changes impact the process efficiency and quality.**	**Students learn about methods, equipment and operation of plywood drying at real or theoretical production facility.**	
		2.2.5. Dry plywood: defects and sorting		**Describe the most common plywood defects, the importance of plywood sorting and technological requirements. Use samples and visuals to determine the defect of the plywood and explain the cause.**	**Students get acquainted with information and visual samples regarding plywood defects and sorting methods, equipment and operation, as well as analyse the causes of the defects.**	
		2.2.6. Normalization of plywood quality and size		**Explain the importance of plywood normalization; describe its types and processes.**	**Students learn about the technology and importance of plywood size and quality normalization.**	
		2.2.7. Plywood bonding: types of adhesives, application of adhesives, stacking the plywood, cold pressing		**Describes the glues used in plywood production and their impact on the strength of the joints under various environmental conditions. Name the types of glue applications and technological parameters of the process.**	**Students receive information and study different types of glue and their application in different weather conditions and for different processing. Students learn about glue application technology, parameters and equipment for process implementation.**	
		2.2.8. Plywood: applying the glue and pressing		**Describe the types of plywood gluing and pressing, the importance of plywood pre-pressing and plywood pressing technology.**	**Students learn about plywood pressing technology, equipment and its operating principles, as well as key plywood pressing parameters.**	
		2.2.9. Plywood cutting, lubrication, finishing		**Describe the importance of plywood cutting, lubrication and sanding; describe applied technologies and the importance of further processing of plywood.**	**Students get acquainted with the types and significance of plywood cutting, lubrication and grinding, equipment and operation principles and causes of the most common plywood defects and**	

Project number: 601123-EPP-1-2018-1-DE-EPPKA2-SSA

					their prevention.	
		2.2.10. Plywood finishing options		**Describes the types of plywood finishing and its application depending on the use of the final product. Using visual aids, explain the applied finishing and how the product can be used.**	**Students learn about plywood finishing technologies and equipment.**	
		2.2.11. Plywood packaging and marking		**Describe examples of plywood packaging requirements, depending on the type of transportation, destination point, state or specific customer requirements.**	**Students receive information and study examples of plywood packaging depending on the transportation type, destination country and specific customer requirements.**	
	2.3. Fibreboard manufacturing	**2.3.1. Fibreboards: characteristics, principles of production and types of raw materials**		**Describes the production technologies of wood fiber boards (FB) depending on the type of their production and knows the differences in the further use of these boards.**	**Students independently get acquainted with the available literature, prepare an overview of the raw materials used for the production of FB.**	
		2.3.2. "Wet" fibreboard production: • Woodchip production • Wood fibre production and pulp preparation • Preparing the glue • Mixing the wood pulp with adhesives and shaping of fibreboard • Hot-pressing the fibreboard • Processing after pressing – hot treatment, wetting, shaping, storage		**Describes the full technological process of FB production (according to the wet method), starting from the preparation of raw materials - chips, ending with the post - processing of boards after their pressing.**	**Students independently get acquainted with the available literature of the full technological cycle of FB production (wet method) processes - preparation of raw materials (chips), processing modes, obtained materials, further use of boards.**	
		2.3.3. "Dry" fibreboard production: • • Preparation of pulp mass • • Adding paraffin and binders • • Drying of wood fibres • • Forging and pre-pressing the fibreboard		**Describes the full technological process of FB production (dry method), starting from the preparation of wood fiber mass, to the post-processing of boards after their pressing.**	**Students get acquainted with the full technological cycle of the FB production (dry method) processes - preparation of raw materials, processing modes, obtained materials, further use of boards.**	

		• Pressing the fibreboard in a hot press • Technological process after pressing – fibreboard conditioning, cutting, storage				
		2.3.4. Special fibreboard and its production: • Very firm boards • Soft boards • Refractory boards • Bio-resistant boards • Soundproofing boards		**Characterizes FB with special properties and specifics of their production in technological processes in comparison with traditionally produced FB.**	**Students independently get acquainted with the available literature for the production of FB with special properties and technological stages of production, differences in the use of raw materials and their benefits in improving the material properties of boards, as well as further possibilities of using these boards.**	
		2.3.5. Fibreboard finish		**Describes the types of FB finishing and their application depending on the use of the final product. Explain the benefits of the specific finishing materials and the technology used.**	**Students independently get acquainted with the available literature on the finishing possibilities of the FB, the finishing materials and the technologies used.**	
		2.3.6. Fibreboard: quality requirements		**Describe what indicators and at which technological stages of FB production are determined to produce quality boards. Describes plate testing methods. Explains the interaction of qualitative and quantitative indicators.**	**Students get acquainted with the methods of laboratory testing, determining the properties of FB, describing the interrelationships of qualitative and quantitative indicators.**	
	2.4. Chipboard production	**2.4.1. Chipboard: description, basic production principles, raw materials**		**Describes the full technological process of the production of chip board (CB), starting from the preparation of raw materials, ending with the post-processing of boards after their pressing.**	**Students get acquainted with the full technological cycle of CB production processes - preparation of raw materials, processing modes, obtained materials, further use of boards.**	
		2.4.2. Storage of raw materials		**Describes the diversity of raw materials, differences in preparation and their impact on the properties of CB. Describes the effect of the duration of storage of used tree species and raw materials on the properties of CB.**	**Students independently get acquainted with the available literature on the raw materials used in the production of CB and the technologies, equipment and principles of operation.**	
		2.4.3. Wood lengthening and peeling		**Describes the technologies, equipment and the quality to be**	**Students independently get acquainted with the available literature on round**	

Project number: 601123-EPP-1-2018-1-DE-EPPKA2-SSA

				obtained after processing of round timber used for the production of particulate matter.	wood lengthening and peeling technologies, the equipment used and the quality obtained after processing.	
		2.4.4. Wood processing in chips and sawdust		Describes the fractional composition of wood chips obtained for the production of CB and their further processing, requirements for the creation of boards and the equipment used.	Students independently get acquainted with the available literature on chipping and splitting machines used for the production of CB, technological solutions, obtainable bulk materials and quality requirements.	
		2.4.5. Storing chips and sawdust between the operations		Describes the importance of intermediate storage of chips and shavings for the production of CB, examines the equipment used and technological solutions.	Students independently get acquainted with the available literature on the equipment and technological solutions for intermediate operations of chips and shavings intended for the production of CB.	
		2.4.6. Transportation, drying and sorting of chips and sawdust		Describes the chip and chip conveyors used for the production of CB, chip drying operations, the importance of chip fractionation, equipment and technological solutions used to perform the above operations.	Students independently get acquainted with the available literature for chip and chip conveyors used for the production of CB, chip drying technological solutions, chip fractionation, equipment used for wood chip drying and fractionation.	
		2.4.7. Dispensing chips, sawdust and glue and mixing them together		Describes the adhesives used in the production of CB and their impact on the adhesive quality of adhesive boards, knows the stages of the technological process of adhesive application and dosing parameters.	Students get acquainted with information about different types of adhesives and their use according to the operating conditions. Gets acquainted theoretically with glue application technology, glue dosing parameters and equipment for process execution.	
		2.4.8. Shaping and pressing		Describes the basic principles of chipboard carpet formation in the production, knows the stages of the technological process, equipment, analyzing their operation. Can justify the importance of pressing and auxiliary equipment for their performance.	Students independently get acquainted with the available literature on the basic principles of chipboard carpet formation, stages of the technological process, equipment to be used, as well as technological solutions for board pressing.	
		2.4.9. Making the cyclogramm and pressing		Describes the types of gluing and pressing of CB and the observance of board pressing technologies and parameters during hot pressing of boards.	Students independently get acquainted with the available literature on CB pressing technologies, equipment and their operating principles, as well as the main technological parameters of slab pressing.	
		2.4.10. Chipboard size normalisation and finishing		Describes particle size	Students independently get acquainted	

Project number: 601123-EPP-1-2018-1-DE-EPPKA2-SSA

		options **2.4.11. Chipboard quality requirements**		**normalization processes, board lamination technology. Explains the benefits of the specific lamination materials used for further operation of the boards.** **Describes what indicators and in which technological stages of CB production are determined for obtaining quality boards. Describes board testing methods. Explains the interaction of qualitative and quantitative indicators.**	**with the available literature on particle size normalization and lamination technologies, as well as learn the advantages / disadvantages of each lamination material and further directions of use.** **Students get acquainted with the methods of laboratory testing, determining the properties of CB and describing the interrelationships of qualitative and quantitative indicators.**	
	2.5. Wood in construction	**2.5.1. Classification of wooden buildings by design**		**Describe and recognize the most common wooden building constructions, their features, advantages and disadvantages.**	**Students get acquainted with the most common types of wooden building constructions and discuss their peculiarities, advantages and disadvantages.**	
		2.5.2. Classification of wood materials in construction		**Name and recognize the materials used in the most common wooden constructions. Describe their usability, advantages and disadvantages. Recognize and name their quality requirements and specifics.**	**Students get acquainted with the most common materials used in wooden building constructions and study their usage, advantages and disadvantages.**	
		2.5.3. Production of wood composite materials for construction		**Name and recognize the most common wood composite materials. Describe their production process and structure; identify the most characteristic defects and their causes.**	**Students learn the most common wood composite materials, their construction and the general manufacturing process and defects that may occur during the production.**	
		2.5.4. Classification of most common joints in wooden constructions		**Name and recognize the most common joints. Understand their properties, markings and strength classes.**	**Students become familiar with the most common joints, their properties, marking and strength classes.**	
		2.5.5. Most common joints in wooden construction		**Name, recognize and theoretically select the most appropriate joints for different examples of constructions under different operating conditions.**	**Students get acquainted with the manufacturers' and regulatory enactments and recommendations for the proper use of various joints.**	

Project number: 601123-EPP-1-2018-1-DE-EPPKA2-SSA

		2.5.6. Requirements for most common joints in wooden constructions		**Correctly identify specific types and conditions for coupling devices. Be able to design the most common wooden building joints.**	**Students get acquainted with the conditions and recommendations from manufacturers and regulatory enactments regarding the proper installation and placement of various wooden joints. Discuss the examples of various joints.**	
		2.5.7. Constructive protection of wooden constructions against weather		**Understand the meaning, basics, action, advantages and disadvantages of wood constructive protection. Be able to choose and properly address the most appropriate constructive solutions for passive protection of wooden structures.**	**Students learn more about the basic principles of wooden constructions passive protection. Discuss various constructive solutions for protecting structures against weather.**	
		2.5.8. Chemical protection of wooden constructions against weather		**Understands the principles and action of wood chemical protection, and its advantages and disadvantages. Is able to choose and apply the most appropriate wooden chemical protection solutions for wooden constructions.**	**Students learn about the basic principles of wooden constructions chemical protection. Discuss various constructive solutions for protecting structures against weather. Also discuss the regulations regarding the topic.**	
		2.5.9. Compatibility and connection of wooden constructions with other materials		**Understands the compatibility and connectivity of wood and other materials. Understand their positive and negative qualities, risks involved and potential benefits. Be able to make well-founded decisions on possible solutions in different constructions.**	**Students study the most common materials used in the construction together with the wood; discuss different examples of good and bad practices; get to know the potential chemical and physical processes that can occur when combining treated or untreated wood with other materials.**	
	2.6. Wood by-products	**2.6.1. Types, uses and further processing of wood by products (energy wood):** • firewood, logwood; • wood chips; • briquettes; • wood pellets; • torrefacted wood and charcoal.		**Name and recognize the most common types of wood by-products. Describes their further processing technology and fit to purpose uses.**	**Students learn the most common types of wood by-products and can identify the most fit to the purposes uses. Students discuss the pros and cons of using wood in energy production.**	

	2.7. Green skills in wood processing	**2.7.1. The role of the forest sector in achieving Europe 's climate neutrality and biodiversity goals**		**Understands the Europe's climate neutrality and biodiversity goals, the role of the forest sector in achieving them, and recognizes tasks for each player within the value chain of the sector.**	**Students learn the goals set by EU and are able to discuss possible scenarios within the forest sector on how to move towards these goals.**	
		2.7.2. Energy efficiency in wood processing		**Describes main possible ways to reduce any type of energy consumption within wood processing company and selects the appropriate ones for their company situation.**	**Students learn about latest technologies, that allows to reduce consumption of fossil fuels, electro and heat energy, including efficient heating and ventilation systems, lightning technologies, digital tools of accounting and control of these systems. Students analyses their workplace, calculate and select most efficient solutions.**	
		2.7.3. Further options of digitalization, automatization and robitization of processes and technologies within wood processing company.		**Understands and are able to select most fit to purpose digitally and technologically advanced solutions in order to increase the efficiency of wood processing process.**	**Through the visits of most modern wood processing companies and lectures from companies that offer such digital and technological solutions, students learn about the available options. Students analyses situation in their company and identifies those solutions of digitalisation, automatization and robitization, that fits to their situation and helps to reduce consumption of multiple types of resources (energy, raw material, work time etc.)**	
Is able to: - ensure the quality and sustainability of the product to prolong its lifecycle and re-use or recycle possibilities; - ensure compliance with the quality of the production process and recognize, as well as eliminate the risks of quality mismatch. **Knows:** - product quality and sustainability requirements at different stages of the production process; causes of manufacturing defects and ways to prevent them. **Understands:** - the causal relationship between production technology, equipment and instruments (technical condition, specifications, maintenance) and its impact on production quality.	**3.1. Quality control system**	**3.1.1. Quality control systems:** **essence and importance**		**Describe the quality control system essence and meaning, define quality**	**Students meet the description of the quality management system and its benefits for companies.**	
		3.1.2. Quality control systems		**Describes the principle of quality management system and its continuous improvement**	**Students learn about the basic principles of quality management systems and examples of its continuous improvement.**	
		• **LVS EN ISO 9001:2017**		**Describe ISO 9001:2017 basic principles and major requirements**	**Students study the basic principles and requirements of ISO 9001:2017, and analyse its advantages and disadvantages.**	
		• **LEAN (5-S)**		**Describe the basic principles and requirements of LEAN (5 S) system**	**Students learn about the basic principles of LEAN (5 S) system and analyse its advantages and disadvantages**	
		• **Comprehensive quality management**		**Describe the general principles and requirements of quality management**	**Students study the basic requirements of comprehensive quality management, analyse its advantages and disadvantages and determine the main**	

Project number: 601123-EPP-1-2018-1-DE-EPPKA2-SSA

					differences between ISO 9001:2017	
		3.1.2. The essence of the approach to the process		**Describe the essence of the process approach and its implementation in the company. Tell about the activities for effective process approach.**	**Students study the essence of the process approach and the conditions for an effective process approach.**	
		3.1.3. Typical basic processes at various woodworking companies		**Describe the processes in the company.**	**Students learn about the basic processes and their identification in a woodworking compan Identify such processes and its flow in their company.**	
		3.1.4. Measuring the process		**Describes the process measurement parameters, criteria, frequency and type.**	**Students learn about the methods of measuring the processes. By taking examples from their company, they compile process measurement parameters, criteria and frequency.**	
		3.1.5. Implementation of the quality management system: the main stages		**Describe the major stages of quality system implementation.**	**Students get acquainted with the main stages of the implementation of the quality system and determine the implementation stages in their company.**	
		3.1.6. Implementation of quality control system: typical problems		**Describe the challenges in quality system implementation.**	**Students get acquainted with practical difficulties encountered during the implementation of the quality system; determine the difficulties of implementation of the quality system and the possibilities of its reduction in the company.**	
		3.1.7. How the partners' requirements impact the quality management system		**Describe how the partners' requirements are identified and how they impact on the quality management system**	**Students learn the methods of identifying partners' requirements and the impact of these requirements on the quality management system.**	

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