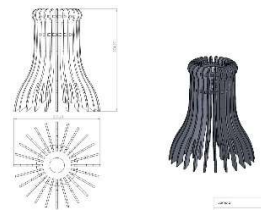
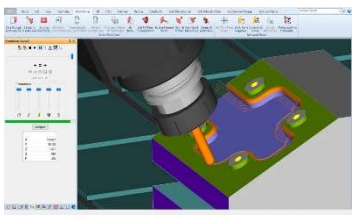
Concept proposal: Teaching modules for teaching digital content and tools in joiner classes

Modul No.	**Module name Students can...**	**Didactic methodological notes**	**Example projects**
1	draw and dimension the product in 3 views using 2D CAD. You will use MS Excel to create a template file for a material list and calculate the material price for 20 pieces. You will be familiar with the most important Windows commands and file formats. You will record the coordinate system with X, Y and Z axes for CNC dimensioning.	Teaching the basics of Autocad. Two simple shapes (rectangle, drill hole) with dimensioning, text and plotting of the drawing.	Cutting board solid wood 
2	explain the structure of the CNC machining centre. You will learn the basics of WOP programming and tool allocation. Geometry and tool use for milling cutters and vertical drilling. You will be able to create the suction cup positioning and manufacture cutting boards. You will check the quality and precision of the finished boards. You will learn the basics of a 3D CAD programme: Pytha, Solidworks, Topsolid.	Teams of two work on content with a WOP script. Programmes are saved and checked	
3	learn the most important functions of Sketchup and generate STL files. They prepare the 3D plotter for the production of 4 pluggable individual parts. The students search specifically for a fitting part in Häfele's online database, e.g. pot hinge, screw-on lock, flap holder.	Group work for the programming of individual parts Individual computer work with integration of DXF files in construction drawings	
4	Learn the basics of the Shaper Origin machine using a variety of methodical approaches. Alignment, download from the Shaper Hub. Setting up the machine. Milling of simple products e.g. TT bats, slats, lamp. Explain how the Shaper Origin works and name its possible applications in the carpentry trade, manage digital design data (SVG files) in the Shaper Hub and prepare it for processing.	Machine demonstration. Teamwork with several machines (min. 3) Introduction to the principle of hand-guided CNC technology with integrated camera and marker recognition. Demonstration of the mode of operation by the teacher. (Scanning process, milling, correction functions). Practice-orientated exercises in small groups on several shaper devices Teaching the basics of CAD data creation for SVG files (e.g. with Sketchup or Inkscape) Reflection on the advantages and disadvantages compared to stationary CNC systems	 
5	design, plan and manufacture a wardrobe with a revolving door. You create the 3D views and production drawings from 3D CAD and integrate fittings into the production drawing. Programming of the individual parts sides, shelves, hinged door by format, grooving, rebating, drilling, hole line drilling. The students search specifically for a fitting part in Häfele's online database, e.g. pot hinge.	Design work in a team, visualisation for customers. Excel material lists for 10 parts. WOP programming. Fittings list for batch size 10. Control of quality and accuracy of CNC machining.	
6	**Manufacture complex** individual parts using the A-axis. Generate 2D production drawings from 3D CAD. - Create a 3D model in Pytha or Solidworks - Use the A-axis (rotary axis) of the CNC machine - Derive 2D production drawings automatically from the 3D model - Develop manufacturing strategies for complex geometries - select tools and clamping devices for rotationally symmetrical parts	Introduction to 4-axis machining via demo videos and practical examples. Step-by-step development of the machining strategy (planning, clamping concept, tool selection) Work in small groups to create and check the CAD data. Reflection on the manufactured parts and optimisation of the programs.	

***** Handout on the integration of key digital skills in vocational education and training - Ministry of Schools and Education NRW: pages 31, 32 and 47. Application know-how: digital cooperation with companies and learning location partners, online catalogues, 3D CAD for design and visualisation, workshop-oriented programming (WOP), material list generation from 3D drawings.

[1] ibid: Digital process chain for the production of individual pieces of furniture. Page 47 : Pytha, AlphaCam, Flexijet, 3D printer

	Optional modules - tools and devices are available in the school equipment		
7	CAM programming with **AlphaCam**. 1 - Import a 3D geometry into AlphaCAM - Create machining strategies (e.g. roughing, finishing, drilling, pocket milling) - Simulate tool paths and check for collisions - Set post-processors correctly and transfer finished programmes to the CNC machine Identify sources of error and adapt programmes.	• Introduction to the AlphaCAM interface and workflow using an example part • - Simulations on the computer to avoid machine crashes • - Application of strategies for efficient machining times • - Supplemented by troubleshooting in predefined faulty programmes	
8	**Interior measurement with Flexijet** for partition wall, interior door, straight staircase. - Interior measurement with digital measuring technology. Transfer to construction drawing. Acceptance of measurements for production. - Explain how the Flexijet 3D measuring system works - Create a precise digital interior measurement (e.g. for partition walls, interior doors, stairs) - set measuring points correctly and record geometric features - create a dimensionally accurate 3D model from the measurement data - transfer the data obtained to CAD programmes and prepare it for production - derive a complete design drawing for production	Presentation by experienced technician. Students mark points, record the room dimensions and generate the 3D drawing. - Introduction to digital measuring systems and their advantages over conventional measuring methods - Demonstration by experienced technicians or master craftsmen (live measurement in the room) - Practical exercise: students work in small groups and carry out measurements independently - Data transfer to the CAD programme (e.g. Pytha or AutoCAD) and creation of a complete room drawing - Reflection on measurement accuracy, sources of error and optimisation options in the planning process	 

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