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Digital Machines for Joiners

CNC

Laser cutter

Shaper machine

3D printer

3D scanner

Robot

Handbook 1

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Erasmus+ Project: **Digital Joiner 4.0**

2023-1-DE02-KA220-VET-000154860 Key competences for VET Joiners

Website: digitaljoiner.com

Chapter 1

CNC: *Computer Numerical Control*

History

The first experiments with the (Numerical Control) machine started in 1949.The first CNC machine was developed in 1952 by a team of scientists working at MIT (Massachusetts Institute of Technology) and was patented patented in 1958.

CNC machining has revolutionized the manufacturing industry since it was first introduced in 1952 in the form of the Cincinnati Milacron Hydrotel. Since then, advanced robotic systems have been incorporated into production to improve productivity.[1]

What are digital tools?

If we are looking around us nowadays, we are using a lot of digital tools without even being aware of it. Not only in form of computer programs like Excel, Word, and many more, just think about how the use of a calculator was integrated in many different professions, and why.

In the woodworking and joinery professions, digital tools have become a very common feature the modern woodworker's toolbox.

The most used tools for example are digital caliper's, angle measurer's, distance measurers, moisture meters, etc.

Manufacturers of handheld, small, as well as big industrial machinery have replaced analog clocks, and handwheels for adjustment etc. for digitalized readers/screens. The first digitalized readers were introduced as NC readers. NC stands for **Numerical Control** readers which are digital input systems integrated into machines to control positioning or measurement with numerical precision, which were installed on radial saws for cutting at length.

Now we can find digital steering and readers which are connected to handwheels and touchscreens for adjusting several aggregates within one machine, like edge banders, wide belt sanders, essentially for all modern woodworking machinery.

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[1] [1]https://laszeray.com/the-history-of-cnc-machinery/

https://en.wikipedia.org/wiki/History_of_numerical_control

What is the benefit of using digital tools?

The main interest and reason for digital tools is speeding up processes. Time is money.

In the workshop, digitalized machines are operated, calibrated and maintained by qualified personal. These machines have a crucial role and impact on the financial result, within the business.

A professional will be able to setup and adjust the machinery with help of digitalized screens/readers much more quickly, compared to traditional analog machinery adjustments.

Digital tooling is not only helping us with speeding up processes but is also a powerful tool for precise and consistent work.

Are digital tools actual tools?

Yes, digital tools are tools, but they aren't necessary physical tools.

Nowadays we are using a lot of computer programs which offer us the possibility to make a drawing (CAD), customer presentation (3D), calculation of used materials, workshop drawings, cutlists, and CNC-programs all at once or independent of each task.

Most of these programs are based on Excel. Within these programs you can add data and values by choice, which refer to a certain formula or action; for example, to manufacture a cut-list or create a program for a specific CNC task.

Examples of use of digital tools.

As mentioned earlier, there are many examples of digital tooling, such as Microsoft Word, Excel, Alphacam, Inventor, Wooddesigner, Stairdesigner, Cut-list app, and many more examples of computer programs used in the industry. We also should remember that most all machinery in the workshop, such as or mobile telephones, are in fact digital tools.

A great example of implementing digital tooling could be baggage handling at airports, or package delivery at warehouses. Both use scanners and barcodes to receive and deliver items to the right places at the right time.

Many manufacturers in our industry are using the same kind off systems in their production to optimize processes and reduce human failure.

Drawings and orders are being prepared at the office, sent to the manufacturing area where machines take over and start processing and coding each individual part with labels or by laser scanning. Each part will follow its own processing route, and at each station the parts will be read by scans, and the machine will adjust and activate itself to execute the processes needed to produce the part according to the data the part is carrying.

What is the output of the use of digital tooling?

Digital tooling is economically much more effective and is a time saver; at the same time it provides the possibility to speed up all processes, while offering a precise and consistent result, as well. By using and implementing digital tooling from the initial idea to the final design and product delivery, you can minimize costs and foresee possible issues. It even reduces human mistakes at stroke of the computers keyboard.

Some people might say regarding digital tooling, “work smart, not hard”. In blunt terms, digital tools aid us in keeping our work *idiot proof*.

Should we be afraid of digital tooling?

Digitalizing is happening widely in different areas of production and has a direct effect on jobs and sectors of society. Yes, it effects the workplace and job availability but can also help to resolve hard or stressful jobs, or at least make them easier, which will be cheaper in length, because of a healthier life, which could aid in the consequential governmental costs for the health sector. Besides that, there still will be the need for educated professionals to program, draw, operate, or just translate mankind’s thinking to develop the tooling itself.

Can digital tooling give us other possibilities?

There are still a lot of possibilities to implement digital tooling, but we are just getting started. If we look at social media today, such as Facebook and Instagram for example, we see how far and quick they reach users; it’s surprising that we don’t exploit those possibilities in a more favorable way in the woodworking industry.

Despite global connectivity, live meetings, data sharing, and even remote control of computers and machines, we still manufacture locally and ship worldwide. In an era of growing environmental concern, digital tools could play a key role in reducing our ecological footprint. "Quality" can mean different things to different people, which remains a key reason for producing locally or in-house.

Digital tools make it worthwhile to engage with local manufacturers and establish direct communication to ensure quality. While still emerging, this approach is gaining traction across industries through both global operations and entrepreneurial initiatives. It is likely that more profession-specific platforms and web-based tools will appear, allowing users to place orders that local manufacturers can accept and fulfill upon agreement.

For example, consider a manufacturer with a Homag CNC using WoodWop. The goal might be to serve as many customers as possible—both locally and internationally—and to make use of slower periods by producing for others. The question then becomes: how can this potential be realized?

One approach could be to develop an app or web-based platform specifically for Homag and WoodWop users, where local professionals can submit offers on pre-programmed manufacturing and installation jobs. Members of this network could both post and respond to job listings, creating a mutually beneficial ecosystem that also helps fill production gaps during slower periods.

Conclusion: Digital tooling and computational thinking offer significant opportunities in woodworking, thus, enabling smarter collaboration, optimized workflows, and greater flexibility in meeting demand.

Let's value and see it as it is.

Digital tooling and computational thinking have gradually entered woodworking, accelerating alongside broader IT advancement, and they're here to stay. For Generation X and beyond, automation is the norm, driving continuous progress. These developments should be embraced as opportunities, not feared, with enthusiasm for what lies ahead and a mindset open to further exploration.

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Chapter 2

Types of CNC machines used in the wood industry

Handheld CNC machines "Small workshops"

Small CNC machines have an advantage in terms of light weight, portability, advantageous price making them more suitable for smaller productions.

Handheld/movable small CNC machines have been developed for workshop use. They are relatively cheap compared to large industrial machines, small and easy to implement for small-scale production.

Shaper

One of the machines entering commercial use in 2024 is the *Shaper*. It is a CNC machine that resembles a handheld router in form but offers far greater precision. A built-in camera detects reference markers placed on the workpiece, allowing the machine to coordinate its movements with the user's hand in real time. This enables highly accurate milling of pre-planned designs. The Shaper is also equipped with a touchscreen interface for intuitive operation and control.

These compact machines are ideal for small workshops, prototyping, and hobby use. Tools are manually changed and require a vacuum cleaner. Programming is done via the manufacturer’s website, with display functions on the machine and access to downloadable programs from other users.

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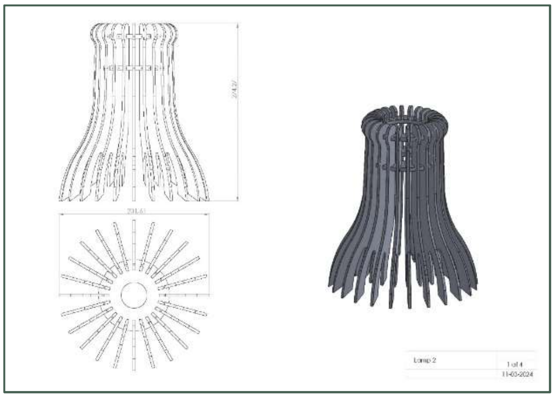
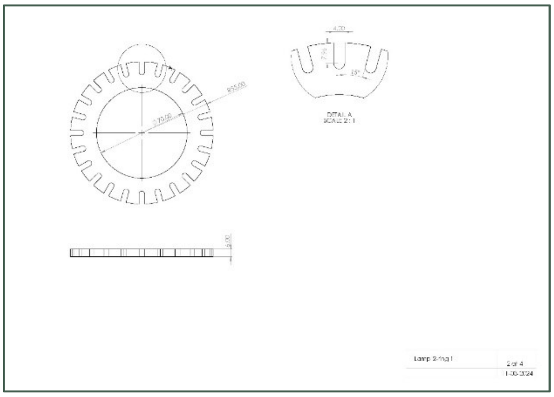
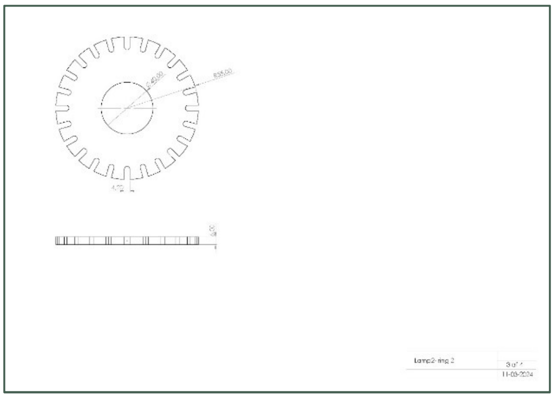
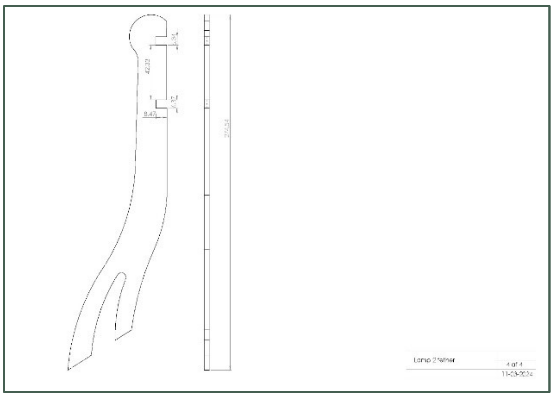
Examples of using Shaper

Here is an example of small parts that can be produced with a Shaper; a lampshade made from plywood.





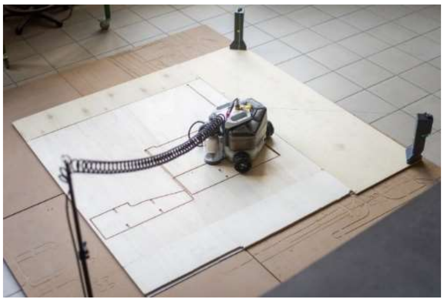




Drawings must be vector graphics that can be saved as SVG files.

Goliath CNC

Another machine entering commercial use in 2024 is the *Goliath*, a portable CNC unit capable of operating autonomously on surfaces up to 3.5 meters. It uses corner-mounted sensors for orientation, and programs are run from an external computer.



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Examples Using Goliath CNC

Goliath is well-suited for working on large surfaces such as floors or oversized panels, making it ideal for laying out multiple components simultaneously. It is not intended for small-scale production but excels in prototyping and handling specialized, one-off tasks that require flexibility and space.

Horizontal CNC Machines for Small Workshops

Small CNC table machines are designed for limited-scale production and are essentially compact versions of larger industrial models. They feature a fixed work area and operate along three axes: X, Y, and Z. Available in various sizes and quality levels, they typically use an external milling spindle of the user's choice, with tools changed manually.

Before use, the machine requires a program, typically created in software that generates G-code. It primarily handles flat items like boards, though more complex parts like chair legs are also possible. However, securing workpieces can be a challenge, as these machines usually lack built-in clamping or suction systems.

Examples of small CNC use

Small CNC machines are suitable for both small-scale series and one-off productions. They work well in compact workshops and can handle moderate output. Their size also allows them to process standard sheet materials efficiently.

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Vertical CNC machines for industry

Vertical CNC machines are industrial systems designed for producing standardized sheet material furniture and components. Machining occurs with the sheet positioned vertically. These machines feature a tool bank with milling, drilling, and sawing tools, allowing for automatic tool changes during operation.

The program is created with integrated software WOODWOP (Homag) or NC-hops (Holzher), which is located on the machine's local computer via dedicated programs that can create G codes for operating the CNC machine.

The workpieces are fixed with suction cups, and the machine is also equipped with suitable dust extraction.

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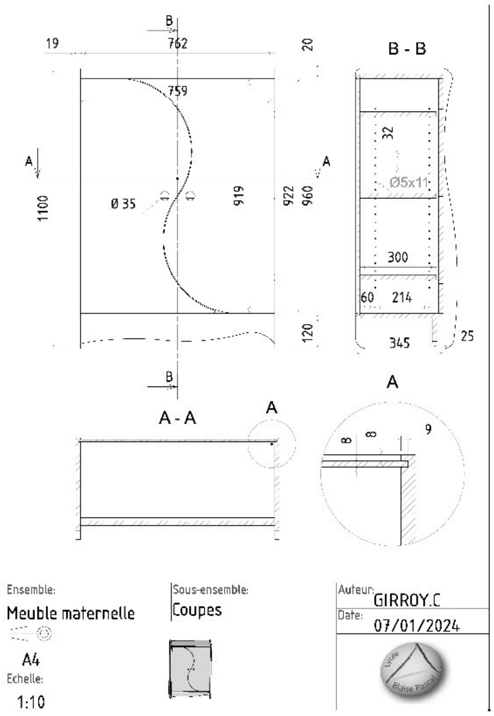
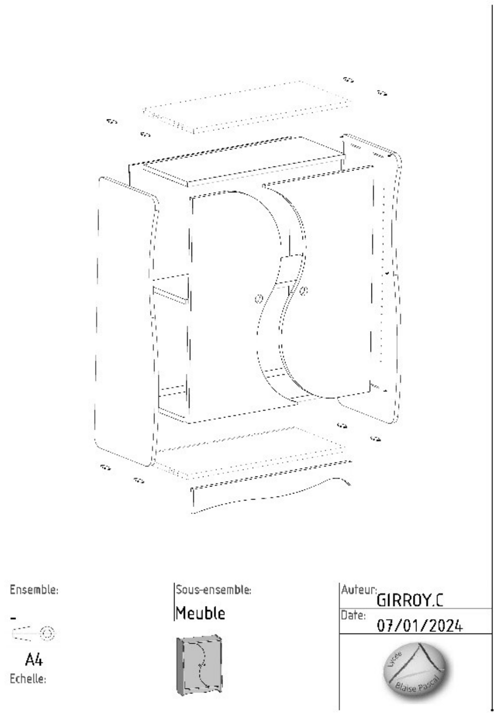
Examples of Vertical CNC Machine Usage

Vertical CNC machines are compact industrial systems designed specifically for cabinet production, such as kitchen units. Their small footprint allows installation in limited spaces, but boards must be pre-cut to fit—typically side dimensions plus 6 mm.

Below is an example of a cabinet that can be produced.





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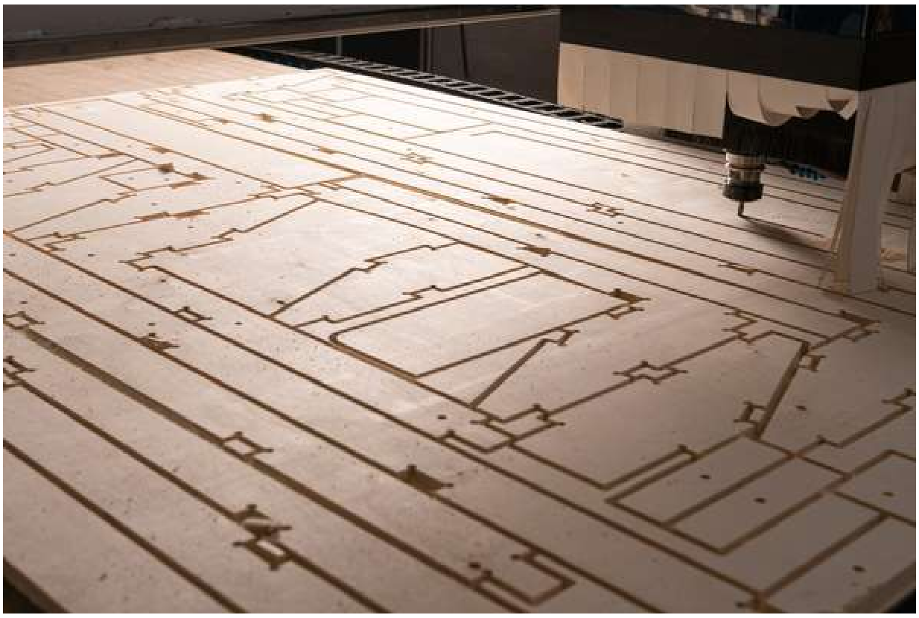
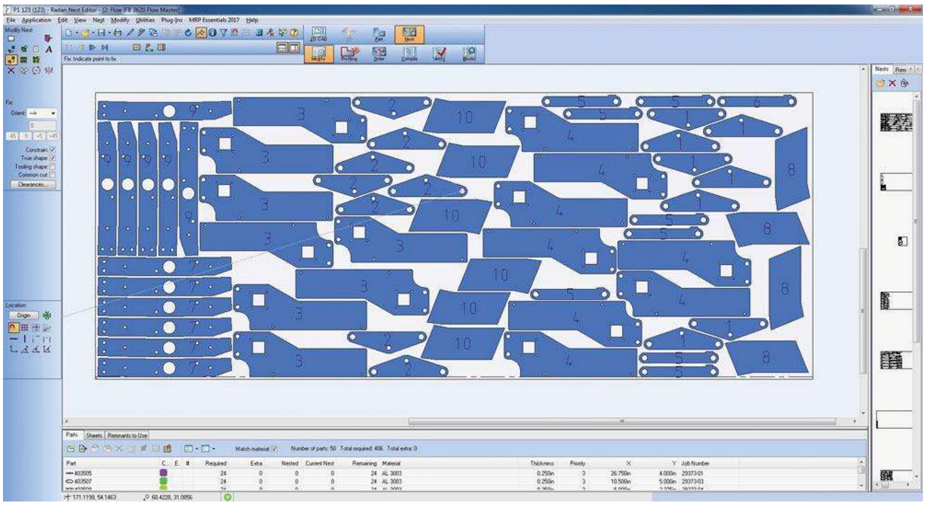
Nesting CNC machines for industrial use

Nesting machines are large industrial CNCs designed to process full sheets with high speed and precision. They operate on X, Y, and Z axes, typically machining from the top to create cabinet sides, holes, and grooves. Workpieces are held in place by vacuum suction to a sacrificial plate. These machines include tool banks and dust extractors.



Examples of using Nesting Machines

Nesting machines can process multiple parts arranged across a full sheet of material. Here's an example of item placement on a single panel.



5-axis CNC Machines for Industrial Use

Multi-axis machines enable complex 3D machining, such as contoured surfaces, angled cuts, and precise drilling. They feature tool banks for automatic changes, though work area and height are limited. Parts are secured using suction cups or custom fixtures.

Example of the use of 5-axis CNC

5-axis machines are full industrial machines capable of making complicated machining. For example, a handrail molding with curvature for stair production.

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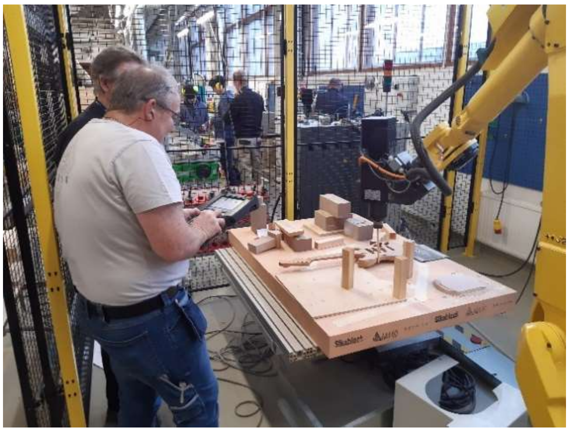
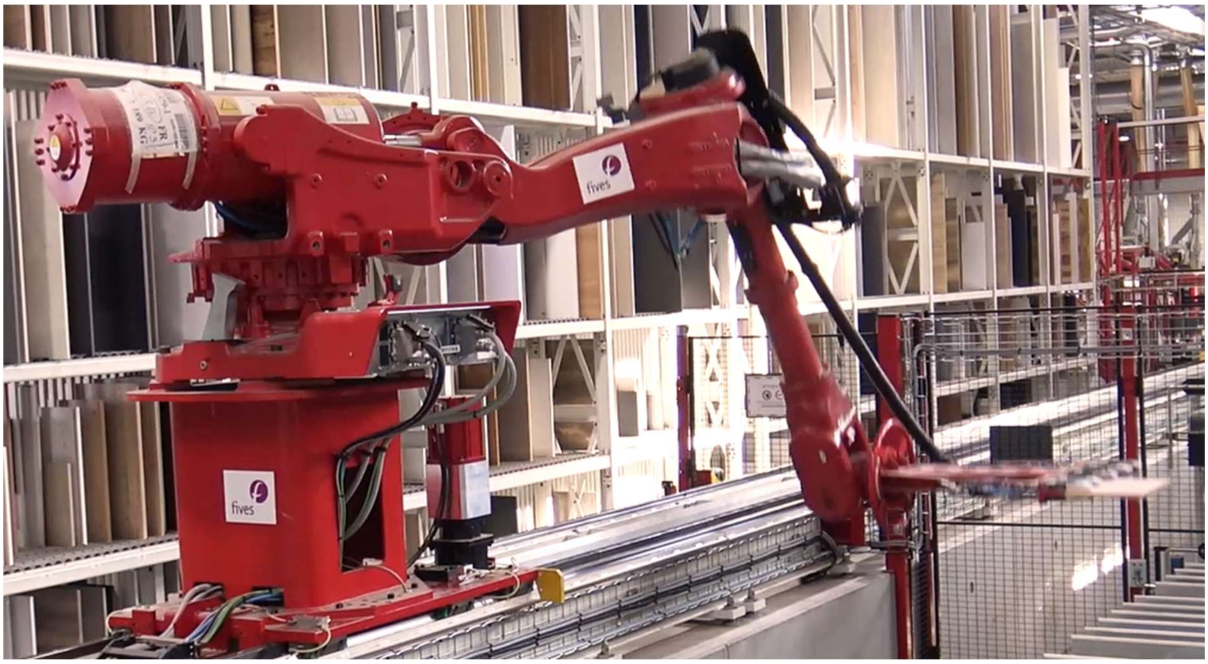
Robotic Arms

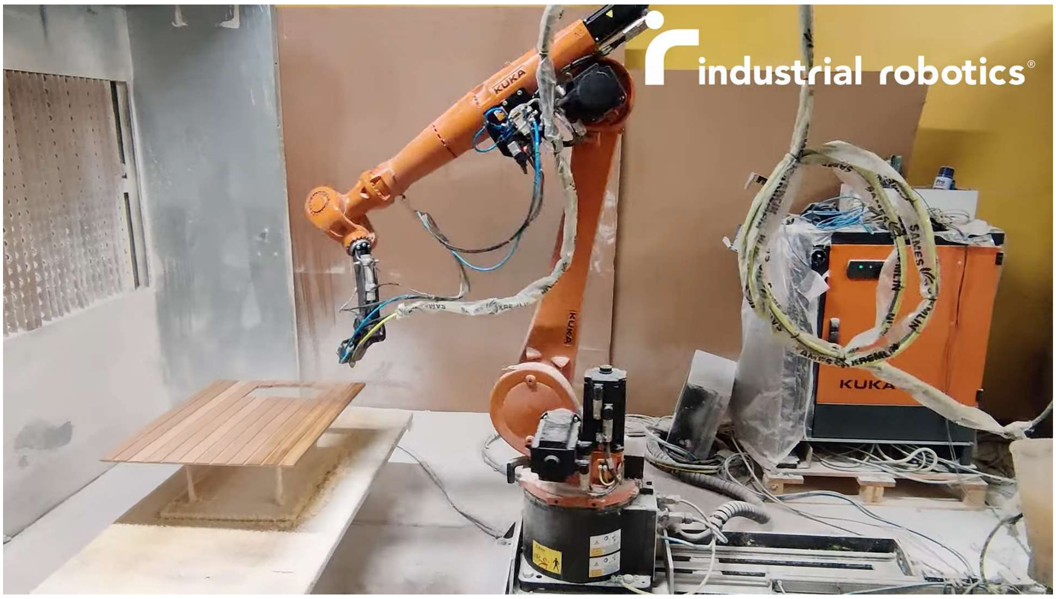
Robotic arms are versatile CNC machines that perform tasks like milling, sanding, sawing, or lacquering, depending on the tool attached. Their key advantage is enhance to complex geometries.





Examples Robotic Arms

Robot Arms can perform very complicated tasks such as milling chairs, scaling, or sanding workpieces.



Chapter 3

Additive and Subtractive Technologies

Additive and subtractive technologies represent two fundamental approaches to fabrication. Additive manufacturing, such as 3D printing, builds objects by depositing material layer by layer based on a digital model. This method is ideal for creating complex geometries with minimal waste, often using materials like plastic filament or resin.

In contrast, subtractive manufacturing, like laser cutting, creates objects by removing material from a solid block or sheet. A high-powered laser precisely cuts or engraves the material, making it well-suited for flat parts or designs that require clean, accurate edges. While additive processes construct from the ground up, subtractive methods shape by cutting away.

3D Printer

3D printers work by melting and depositing material—typically plastics like PLA, ABS, or PETG, and in some cases metals—layer by layer to build up a three-dimensional object based on a digital model. This process, known as additive manufacturing, allows for complex geometries that would be difficult or impossible to achieve with traditional subtractive methods like milling or cutting.

Most consumer-grade and desktop 3D printers are compact and relatively slow, with a typical build volume around 200 × 200 × 250 mm, making them well-suited for small objects. However, industrial and large-format printers can produce significantly larger items, such as furniture components, architectural models, or full-size prototypes.

Advanced printers may also support multi-material or multi-color printing, flexible filaments, or high-temperature materials, expanding their range of applications. Whether in product design, education, healthcare, or hobbyist workshops, 3D printers offer a versatile and increasingly accessible tool for modern fabrication.

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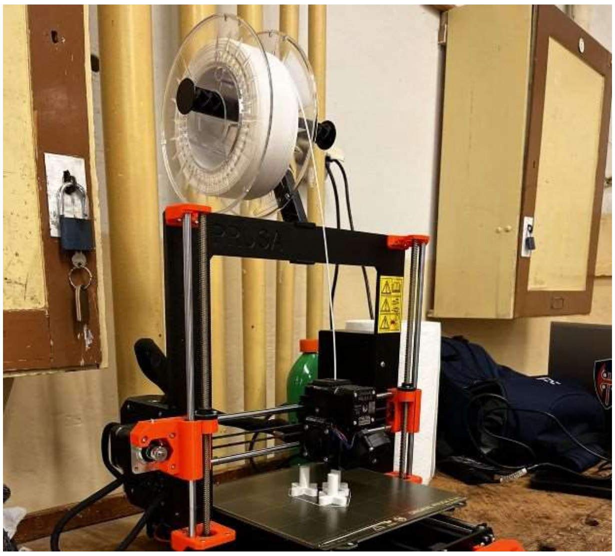
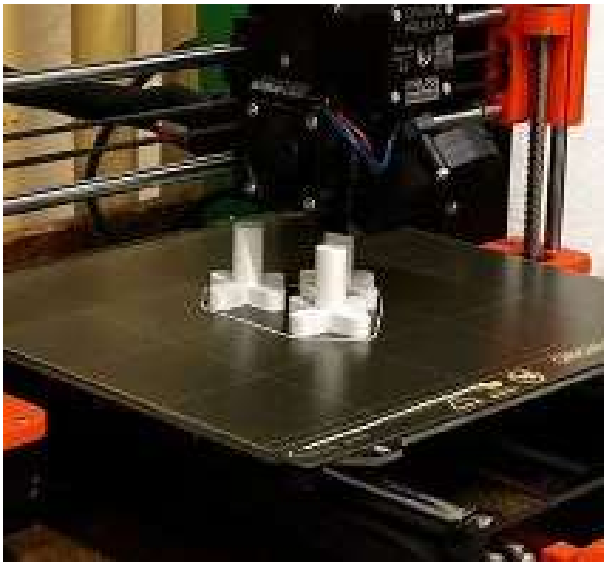
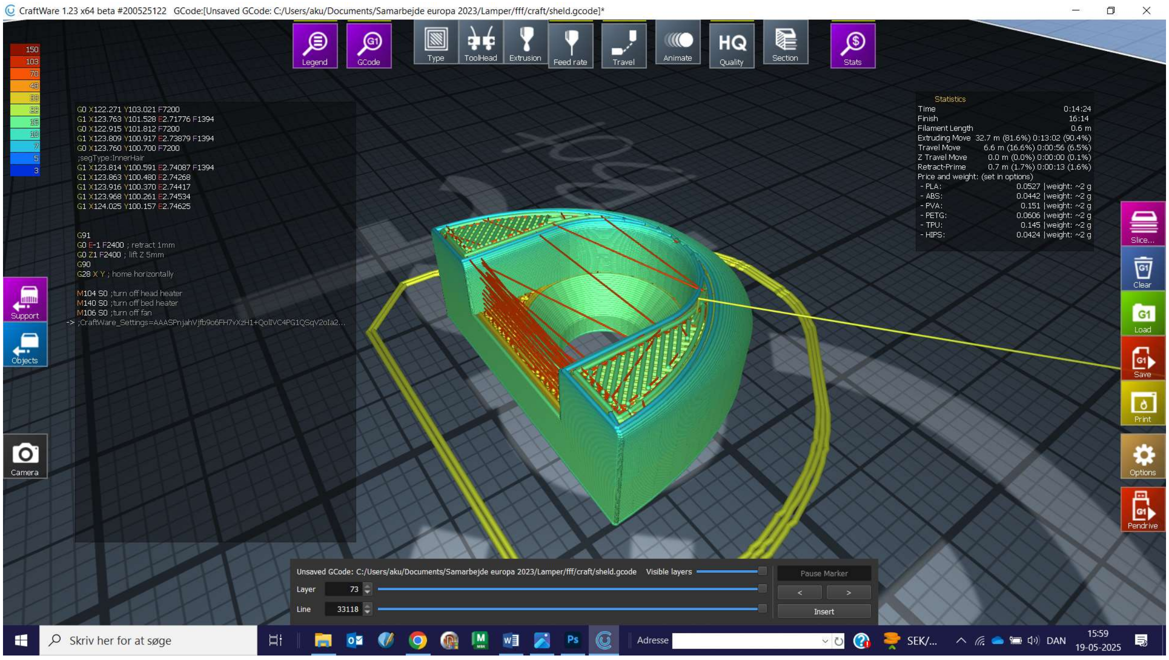




Examples of 3D Printers

3D printers are only useful in development work, where it is necessary to build models for testing. They can be used for manufacturing smaller items or items in scale ratios; typically not effective for larger productions. They are widely used for rapid prototyping, allowing designers and engineers to test fit, form, and function early in the development process. Beyond prototyping, 3D printers are also employed to produce spare parts for machines, tools, or products that are no longer manufactured or require customization. This includes replacement gears, casings, brackets, or even ergonomic tools tailored to specific tasks.

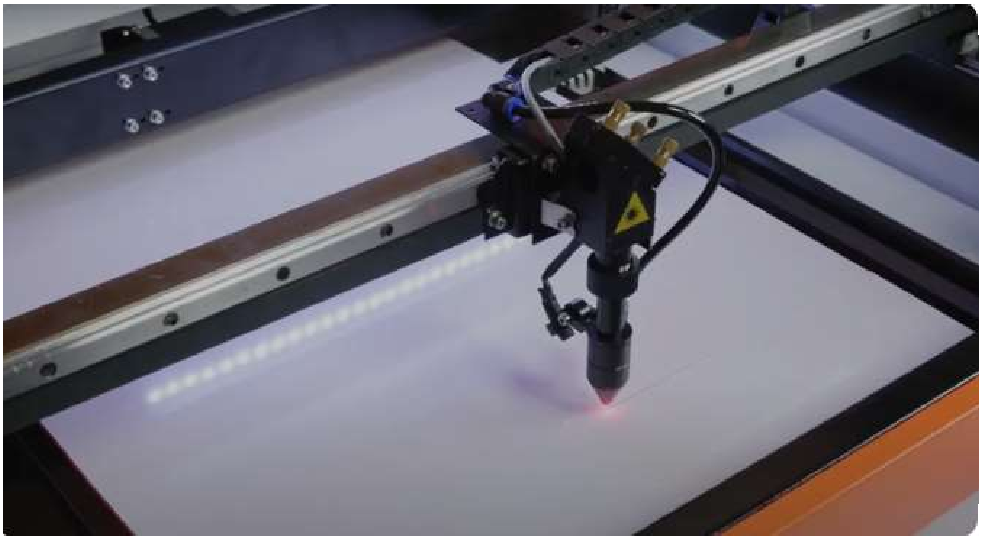


Laser Cutters

A laser cutter uses a highly focused beam of light to burn, melt, or vaporize material with exceptional precision. The power of the laser determines the thickness and type of material it can process. In woodworking, lower-power CO_2 lasers are ideal for cutting and engraving wood, including plywood, MDF, veneer, and solid wood types like birch, walnut, and oak.

Laser cutters are especially valued in woodworking for producing clean edges, detailed cuts, and intricate designs without the need for extensive finishing. Common woodworking applications include cutting decorative panels, making custom inlays, engraving signage, crafting detailed ornaments, building scale models, producing wooden puzzles, creating jigs and templates for routing, and personalizing products such as boxes or furniture components.

Some laser cutters also support raster engraving, allowing text, logos, and patterns to be burned onto wooden surfaces for branding or artistic purposes. Their speed, accuracy, and ability to handle repetitive tasks make them indispensable in both small woodworking studios and larger production workshops.



Example of Laser Cutters in Use

Laser cutters are highly precise tools capable of handling a wide variety of intricate tasks. They can cut templates for routing, perform detailed intarsia work, and etch or engrave text, patterns, or images onto surfaces such as wood, acrylic, leather, glass, or anodized metal. This makes them ideal for producing signage, decorative panels, customized gifts, architectural models, jewelry, and even detailed inlays. While typically used for

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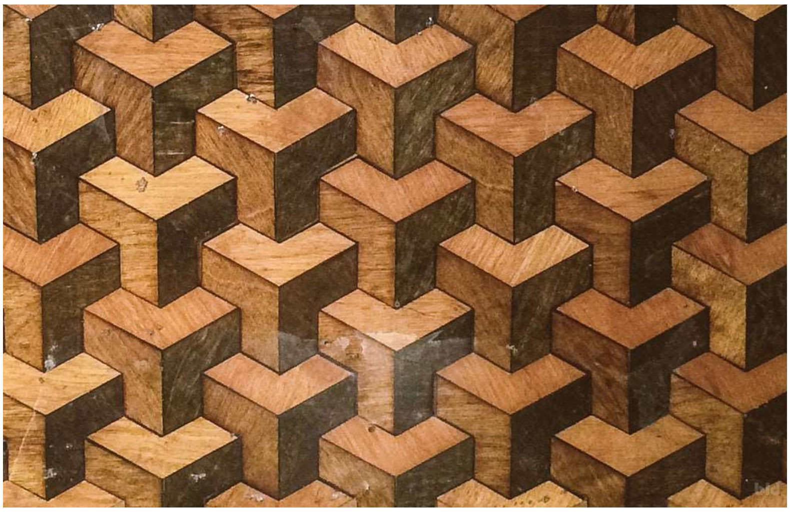
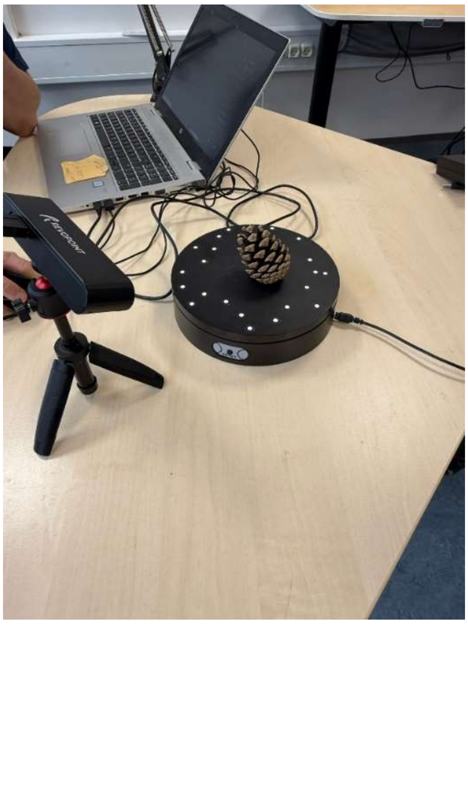
smaller-scale projects due to size and material thickness limitations, their accuracy and versatility make them invaluable in both hobbyist and professional workshops.



3D scanner

A 3D laser scanner is a non-contact tool that captures precise digital measurements of physical objects using laser light. In woodworking, it's used to scan complex shapes like carved details, curved surfaces, or existing furniture components. The scanner projects a coded light pattern that maps the object's surface, creating a digital 3D model.

The resulting mesh file can be imported into CAD software for design modifications, replication, CNC machining, or 3D printing. This makes it ideal for restoration, custom fittings, or reverse-engineering unique wooden parts.



Chapter 4

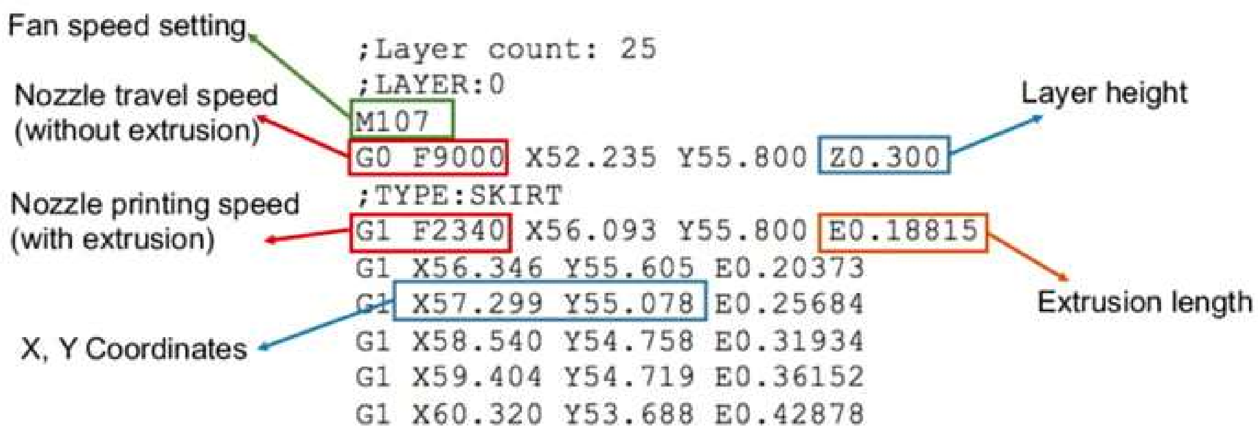
Programs

All CNC machines—whether milling machines, 3D printers, or laser cutters—require a programmed set of instructions before operation. This digital code guides the machine's movements and actions, ensuring accurate and repeatable results.

CNC Programming

A CNC milling program defines key parameters such as material size, tool selection, cutting direction, spindle speed, and start/stop points. These instructions are written in G-code—the standard language for CNC machines—where, for example, "G1" commands linear movement to a set coordinate.

Traditionally, operating CNC machines required manual G-code programming. Today, user-friendly CAD/CAM software can automatically generate G-code from digital designs, making it easier to produce items like cabinet parts, joinery, or decorative carvings in woodworking.



CNC programs can be either standalone software or integrated into 3D design platforms. For example, **Alphacam** is an external CAM program that imports 3D models from other software, defines material size, selects tools, and sets machining operations. It also includes built-in tools for creating operations without importing external models.

The conversion of these operations into machine-readable G-code is handled by a **post-processor**—often referred to as a *"mail process"*—which translates the planned actions into precise machine movements.

Integrated platforms like **SolidWorks** and **Fusion 360** include built-in CAM modules that allow users to both design and plan machining steps in the same environment. These also rely on a post-processor to generate the final G-code for CNC execution.

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3D printer program

When 3D printing, a program called a *slicer* is used to generate the G-code needed for the printer to operate. The slicer breaks the 3D model into thin horizontal layers and calculates the exact path the printer will follow to deposit material

Laser program

Laser cutting is programmed using dedicated software like **LightBurn** or **RDWorks**. These programs typically import **DXF** files created in design tools such as **Illustrator** or **AutoCAD**. Most laser software also includes built-in tools for drawing shapes and adding text directly within the program, allowing for both imported and in-program design work.

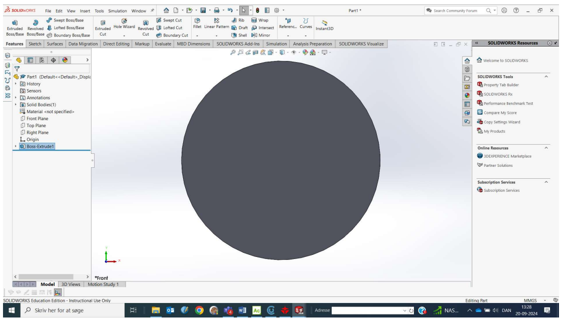
3d scan

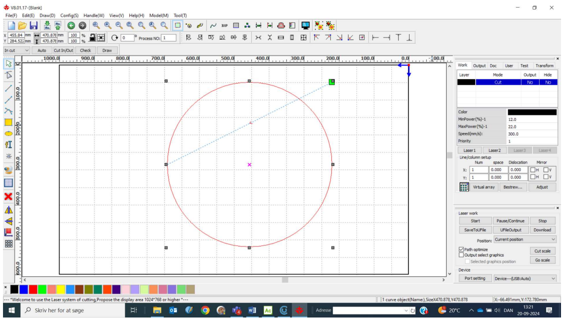
A **point cloud** is the raw result of a **3D scan**, consisting of thousands or millions of points that capture the exact geometry of an object or environment in 3D space, each defined by X, Y, and Z coordinates. Collected using scanners like laser or structured light systems, point clouds do not form surfaces on their own but serve as the basis for creating 3D models by converting them into meshes or solid geometry using CAD software. In woodworking, point clouds are especially useful for digitizing complex or hand-carved shapes—such as curved moldings or furniture legs—for precise measurement, modification, or reproduction.

Example of Laser Cutting Programming

To begin laser cutting, an object or model must first be created or imported—either as a 2D or 3D design using software such as **Adobe Illustrator** or **AutoCAD**. These designs are typically exported as **DXF files**, which are compatible with most laser cutting software.

Once the design is imported, the cutting settings must be adjusted to match the material and its thickness. There are usually three key parameters to configure: **laser power (maximum and minimum)** and **cutting speed**. Fine-tuning these ensures clean cuts and prevents burning or incomplete passes, depending on whether you're cutting wood, acrylic, paper, or other materials.





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Flexijet digital measuring system

With Flexijet 3D, every carpenter can quickly, efficiently and cost-effectively create measurements and allowances directly in CAD. Carpenters no longer need to note down measurements, because they can see immediately what they are measuring. The option of including photos and audio notes in the measurement drawing enables the carpenter to create comprehensive documentation on site. The building dimensions for a staircase, for example, can be recorded without any scaffolding, ladders or other helpers.

There is no need to move the furniture to measure staircase holes or other parts of the building. Curves, arches and angular components can be measured quickly and precisely.

In contrast to other measurement systems, Flexijet 3D does not provide a confusing cloud of points, but the measuring points are directly connected by CAD drawing commands to form meaningful arrangements. The finished CAD drawing is created on site during measurement, without the need for post-processing as is necessary with point clouds.

Elements such as walls, doors, arches or entire room situations are created as precise three-dimensional CAD drawings on site. Before leaving the construction site, you can compare the finished CAD model with reality and ensure that all dimensions relevant to planning have been recorded.

The data can be transferred directly to your CAD software via a variety of export interfaces. At the same time, some planning programs support direct integration of the Flexijet hardware.