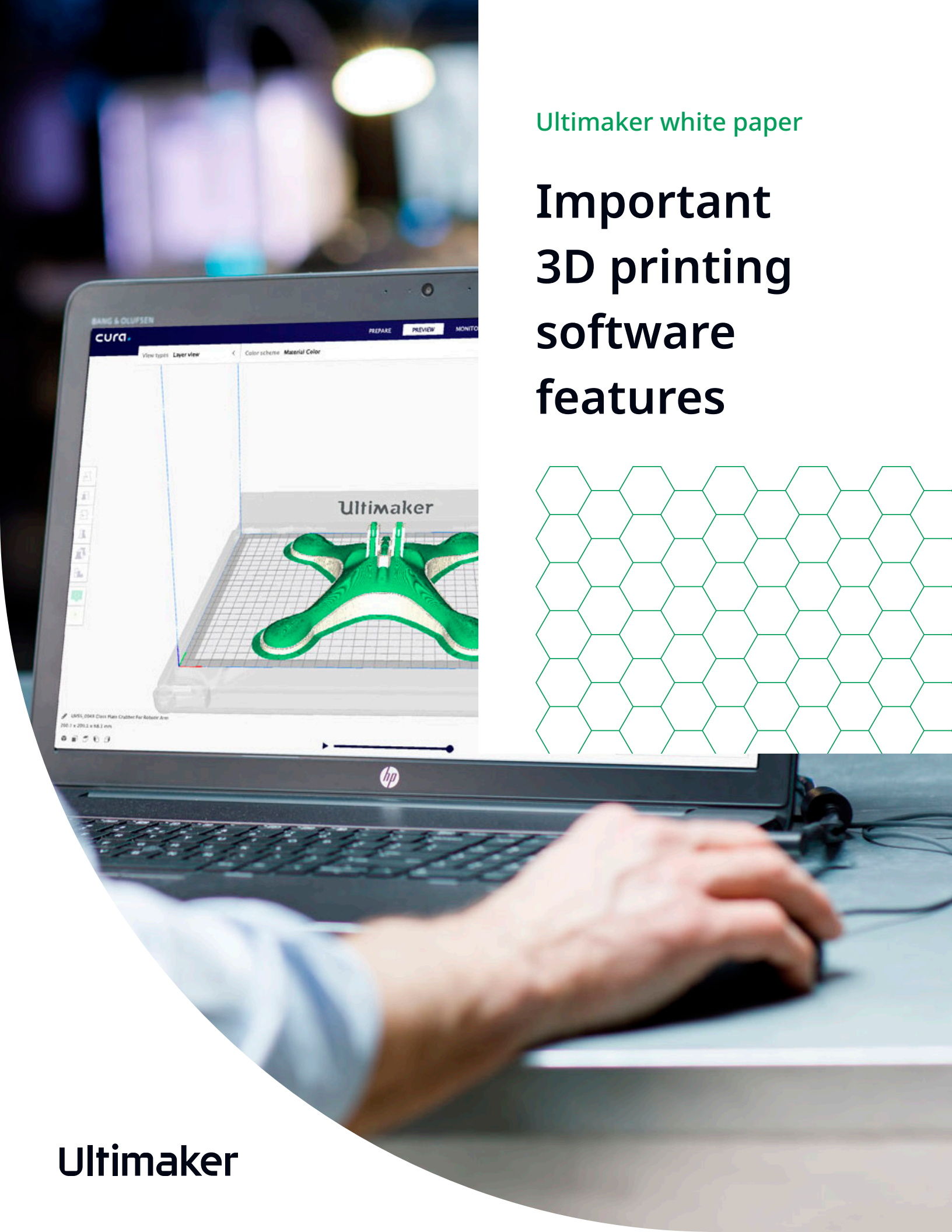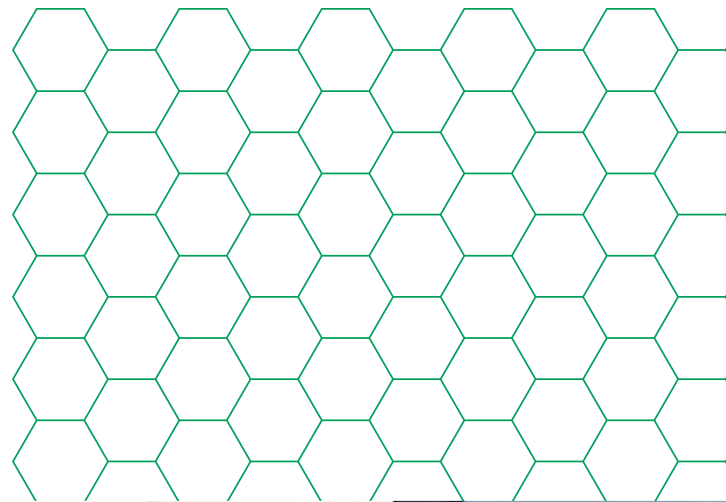# Important 3D printing software features

Ultimaker

Important 3D printing software features

Contents

Why software matters

Successful fused filament fabrication (FFF) 3D printing depends on a seamless integration between hardware, materials, and software. Because even the best hardware and materials have limited value without advanced software to control the printing process.

Fortunately, in the last decade 3D printing software has evolved to provide greater flexibility and accessibility to users, while enhancing hardware and material performance.

Using Ultimaker Cura as an example, this white paper highlights the capabilities of 3D printing software and the main features that it should include, to streamline processes and increase output quality.

To begin, 3D printing software in a professional environment should provide:
- Flexibility for a wide range of workflows
- A reliable process that delivers accurate results with minimal configuration
- An efficient process that optimizes print duration, material use, and part strength
- Support for multi-extrusion printers
- Functional scalability

Hardware   Software

3D printing

Materials
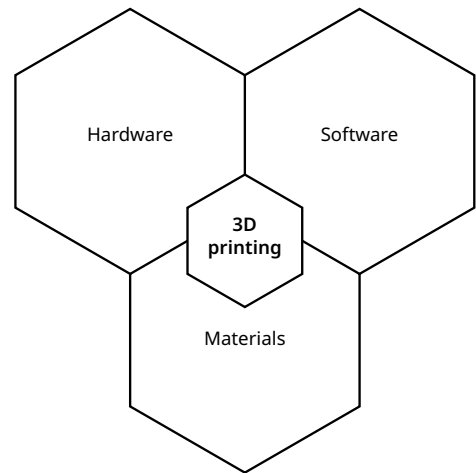
With the rapid adoption of FFF 3D printing, and with 3D printed parts becoming increasingly complex, it is vital to choose software that offers sufficient control over the 3D printing process.

Preparing a print in Ultimaker Cura

Examining the 3D printing workflow

The journey from idea to 3D printed object includes several steps, featuring two key phases: CAD and CAM.
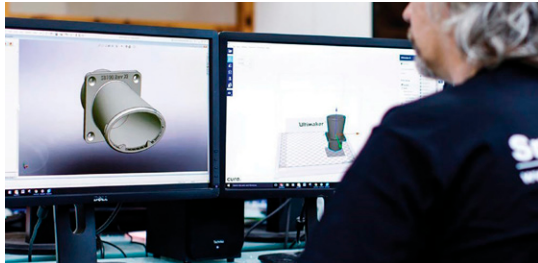
CAD

Computer-Aided Design refers to the phase in which a 3D model is designed. CAD software, such as SolidWorks, Autodesk Inventor, or Siemens NX is used.

CAM

Computer-Aided Manufacturing includes the preparation and manufacturing process. This phase results in a physical object, faithful to the digital 3D model. FFF 3D printing focuses on this phase.
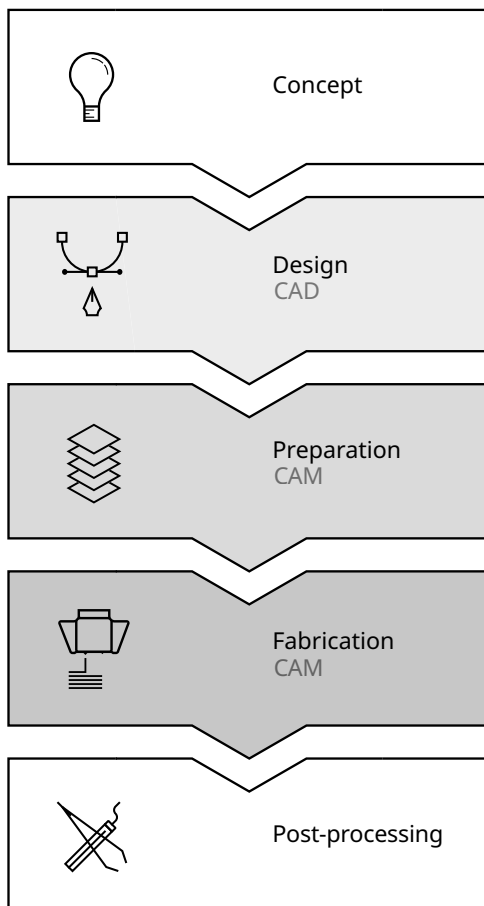
Concept	A sketch is created, refining the initial idea into a workable concept.
Design CAD	CAD software is used to create a 3D model of the concept, complete with accurate dimensions.
Preparation CAM	The 3D model is exported and prepared for 3D printing using slicing software.
Fabrication CAM	Slicing software sends a compatible file to the 3D printer, which fabricates the part.
Post-processing	Adhesion or support structures are removed. Where necessary, surfaces are finished.

The role of software

Every CAD model must be prepared for 3D printing using slicing software, which 'slices' the model into thin horizontal layers, suitable for FFF printing. Slicing software also performs a complex range of functions to prepare a 3D model for fabrication. The preparation process includes several phases:

| Input file | Configure slice settings | Slice | Output file |
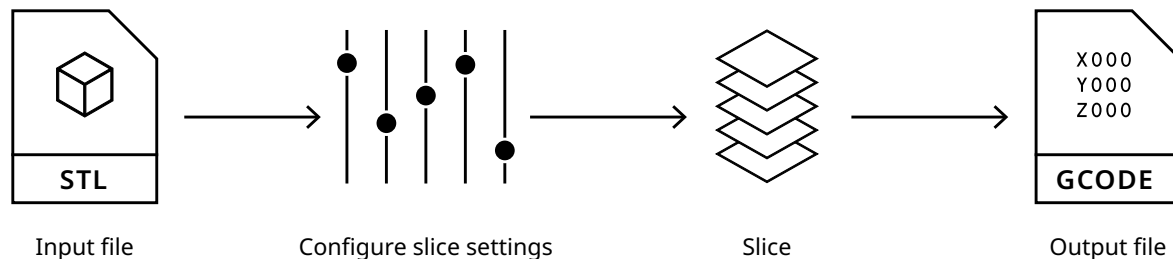
Input file
Slicing begins with an STL, OBJ, X3D, or 3MF file – easily exported from CAD 3D modelling software.

Ultimaker Cura works with these formats natively. It also supports plugins that enable users to directly open industry- standard CAD file formats.

Configure slicing settings
The user sets the parameters controlling how a 3D model will be sliced. These choices affect characteristics such as surface quality, part strength, and print speed.

Ultimaker Cura contains profiles that make printing easier by providing preconfigured parameters for factors such as print speed, infill density, and layer height.

Slice
Based on the settings selected, Ultimaker Cura 'slices' the model into thin layers suitable for 3D printing. It also calculates an efficient toolpath, the extruder and print head motion speed, and build temperature.

Output file
The sliced data is output as a GCODE file - a numerical control language compatible with 3D printers. This enables the accurate fabrication of the digital model, based on the slicing settings specified by the user.

Considerations for preparing a print

Preparing a part for 3D printing requires a balance between material properties and slicing settings. Designers need to work within these constraints to create a part that is true to the design intentions. Considerations should include:
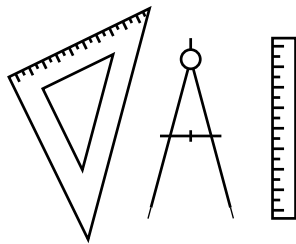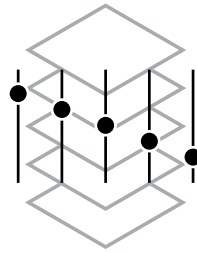
Geometry   Slicing settings   Final part

Geometry
Part geometry is a critical consideration when designing for FFF printing, as geometrically complex parts may need support material or adhesion structures. These additional elements can be generated by the slicing software, to ensure that prints are successfully completed.
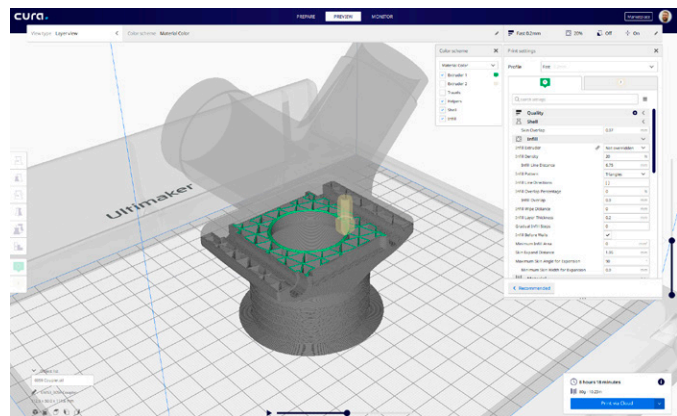
Slicing settings
Decisions made during the print preparation process have a significant impact on the outcome of a 3D print. This is explained in further detail in the next section.

Material properties
There is a wide range of FFF 3D printing materials, with a variety of mechanical properties. Nozzle temperature, fan speed, and print speed are all variables that can affect print results. This makes it vital for slicing software to include customizable settings that optimize material performance.

Print profiles in Ultimaker Cura include the ideal print settings for each material, reducing common 3D printing challenges such as warping and shrinkage.

And as part of the Ultimaker Material Alliance, Ultimaker partners with the world's leading FFF material suppliers. So you have access to the ideal print settings, even if you're using a third-party material.

*Simulating a print in Ultimaker Cura*

The impact of slicing settings

Overhangs and support
FFF printing is a bottom-up process. This means that each layer is supported by the material underneath it. Support material is needed when a part extends outwards from the base or includes an overhang.

Ultimaker Cura can detect areas which require support material and automatically add it to the print settings. This support material can be removed during post-processing.

Water-soluble support material, such as Ultimaker PVA, does not mark the printed surface and makes it possible to create nested or moving parts in a single print. Ultimaker Cura optimizes the orientation of a part to efficiently use support structures, reducing print time and material costs.
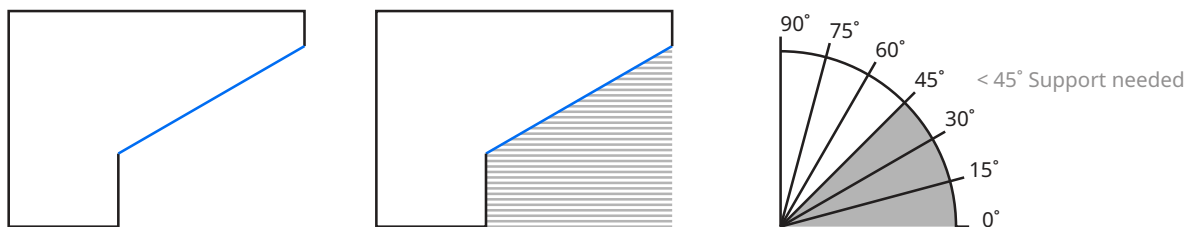

Overhangs and support material

Adhesion
A successful 3D print relies on good adhesion to the build plate.

A common adhesion method is a brim. This is an additional border printed around the first layer of a print, and anchors the part edges to the build plate, preventing warping.

Using a brim also primes the nozzle so the material flows consistently. A brim can be removed by hand or with a knife.

Material profiles in Ultimaker Cura specify the ideal adhesion method for a given material.
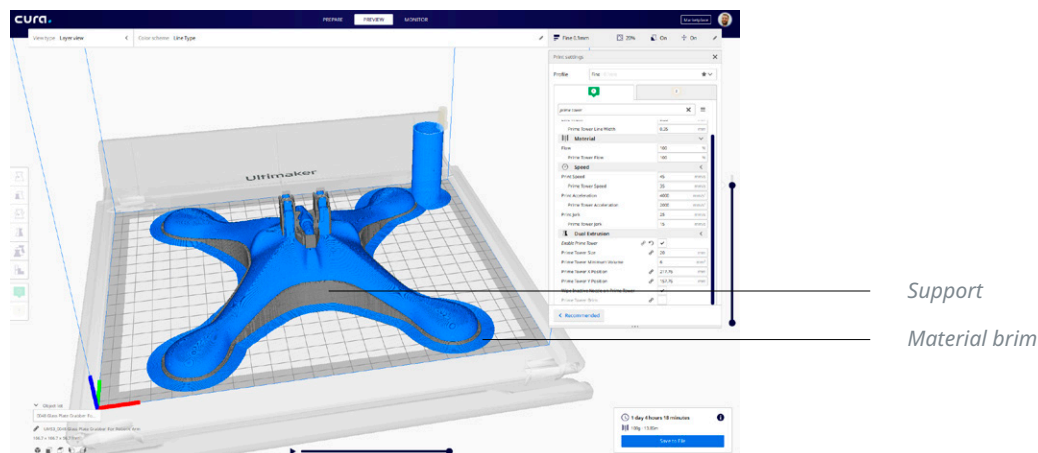
Support and adhesion elements ensure print success

Common preparation options

Object orientation
A part's orientation on the build plate influences which parts of the model overhang. Optimal orientation can therefore reduce the need for support material. Orientation also influences the properties of the final part, as well as print duration.

Plugins in the Ultimaker Marketplace can calculate the optimal orientation of a part to efficiently use support material and optimize print speed. The software includes functions to duplicate, scale, or rotate parts, and can automatically arrange multiple parts on the build plate, for efficient batch printing.

Wall thickness
A thicker outer wall makes for a stronger 3D printed part but extends print duration, as more material must be deposited. Your part's wall thickness should be equal to or larger than the size of the nozzle being used.

Layer height
Layer height is the thickness at which each horizontal layer is sliced, usually a fraction of a millimeter. A thicker layer height decreases print time, but also reduces resolution. Similarly, thinner layer heights produce a higher resolution, but extend print duration.

Ultimaker Cura includes an adaptive layers feature, which analyzes the part shape and optimizes the layer height, improving efficiency.

Infill density
Infill density refers to the printing of internal structures to add strength or support to parts with a flat top surface.

0% infill prints a completely hollow model, resulting in a faster print speed, but with reduced strength and impact resistance. A 100% infill prints a completely solid model with increased strength and toughness, but a longer print duration.

*Infill density configuration*

20% infill density
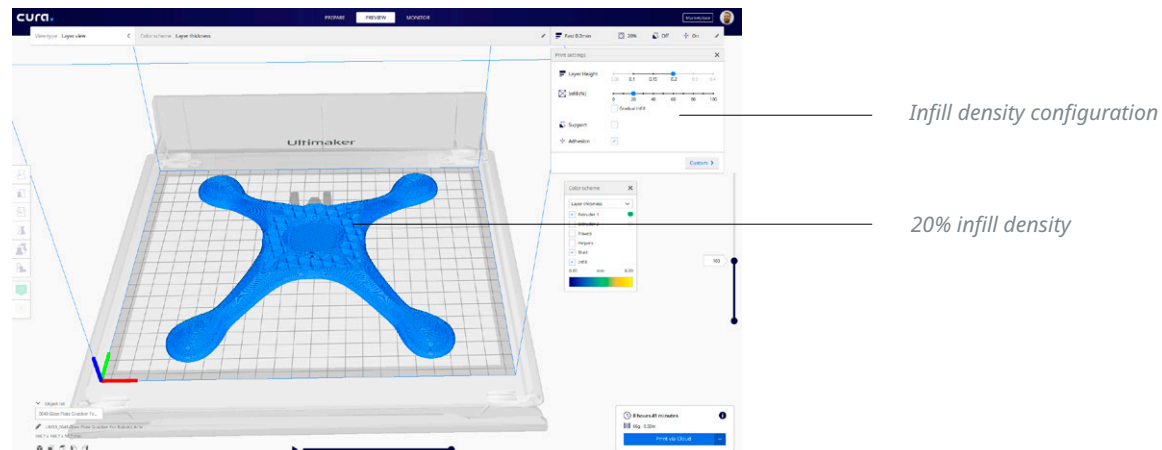
The advantages of dual extrusion

Dual extrusion means that a 3D printer can process two materials in a single print.

This enables support material to be printed alongside the primary build material. Alternatively, two different colors of the same material – or two different materials – can be used.

To prevent material cross-contamination, Ultimaker Cura includes a 'prime tower' feature for dual extrusion prints. This prints a prime tower next to the part, priming each nozzle before a nozzle switch occurs. The user is able to control the position and size of the prime tower.

Ultimaker PLA

Ultimaker PVA
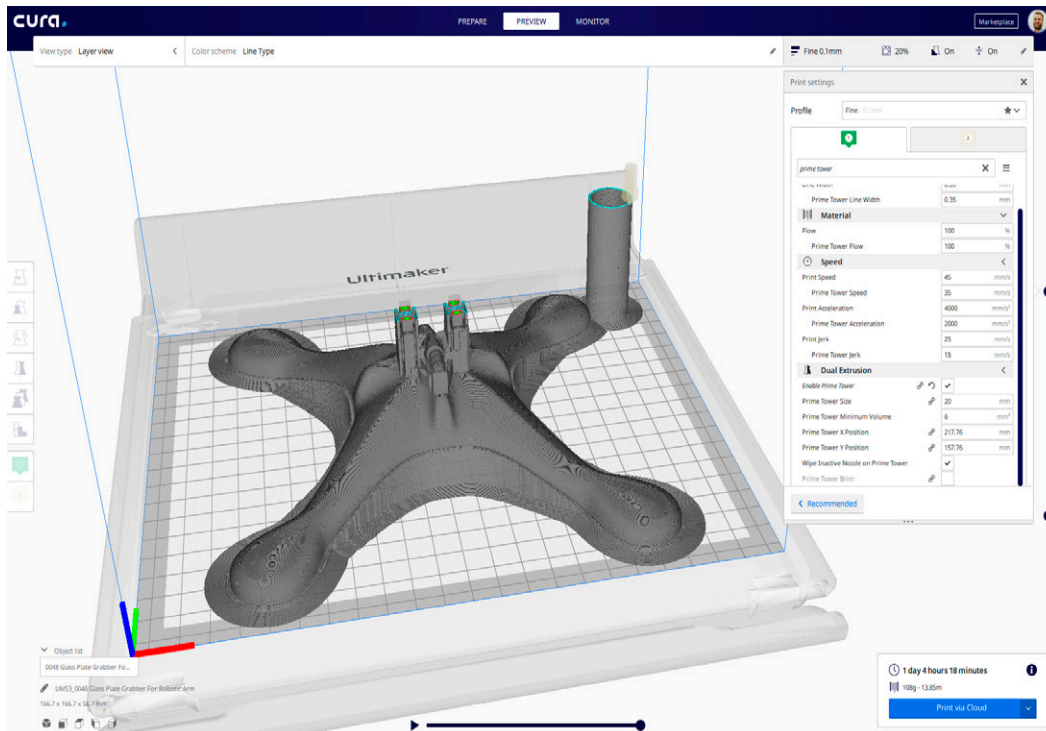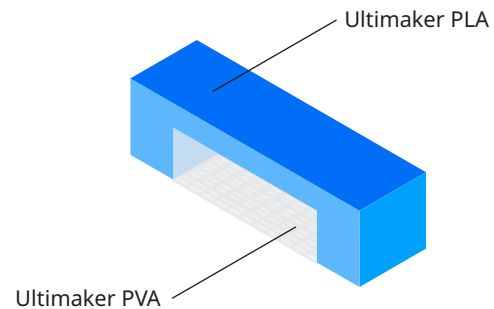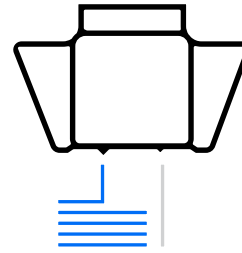
User experience

Slicing software requires a few fundamental elements: the right slicing features, a simple and intuitive interface, and customizable settings. But the more complex the software, the steeper the learning curve for users.

An unnecessarily complex interface is likely to intimidate new users. Conversely, a lack of customizable settings can frustrate advanced users. But slicing software designed with a focus on user experience improves software usability and accessibility, enhancing productivity.

A thoughtful and user-focused interface doesn't just look appealing – it has a consistent and logical workflow, and provides a balance between automation and control.

This makes complex settings accessible to both first-time and advanced users. Additional elements to look for in your 3D printing software, include:
- User modes
- Intuitive user interface
- Preconfigured print profiles
- Network connectivity
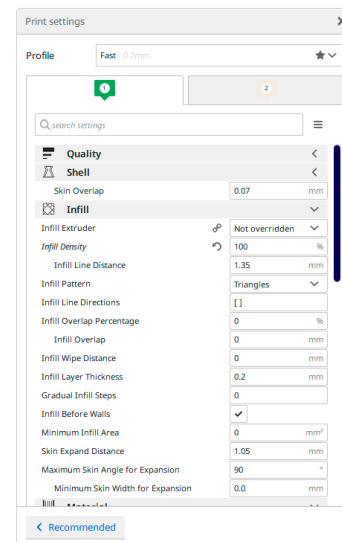- Multiple printer management

User modes

Different user modes provide different levels of accessibility, based on the user's needs.

Ultimaker Cura includes a 'Recommended' mode in which commonly used settings can be modified, and a 'Custom' mode containing over 400 configurable settings.
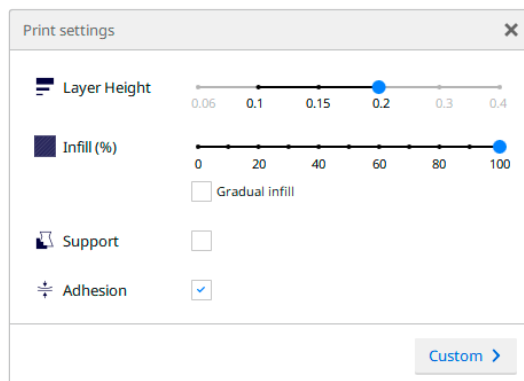

Ultimaker Cura Recommended mode

Ultimaker Cura Custom mode

Graphical user interface

A simple, clear, and intuitive graphical user interface (GUI) simplifies print preparation. Ultimaker Cura's interface reflects that of familiar CAD software: the part is prepared in a 3D environment, can be rotated 360 degrees, and hotkeys are used to quickly change manipulation tools.
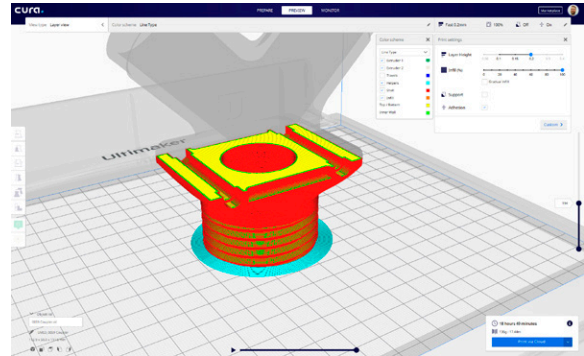

In Ultimaker Cura's 'Layer' view the user is able to inspect each layer, providing assurance that the printing strategy will achieve the best print results in an efficient timeframe.
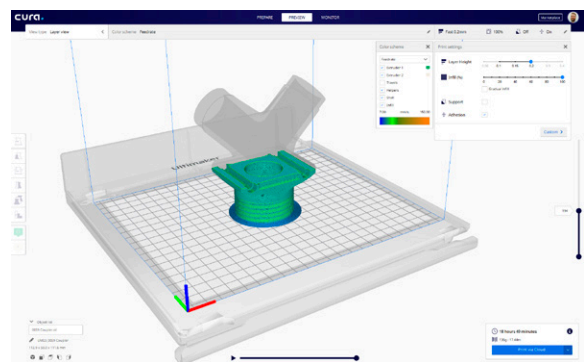
Preconfigured profiles

Ultimaker Cura includes preconfigured print profiles, configured and tested by Ultimaker's team of 3D printing experts. Selecting a print profile automatically configures the optimal print settings for the chosen material. This provides users with control, while avoiding time-consuming experimentation and labor-intensive configuration. Profiles can also be customized to meet individual needs.
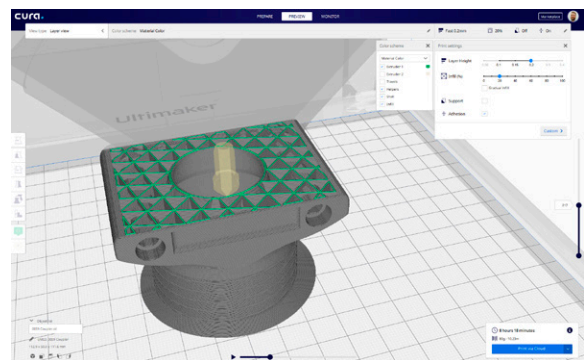
Network connectivity

Ultimaker's FFF 3D printers feature wireless network connectivity. With the addition of Ultimaker Connect, users are able to queue print jobs across one or multiple 3D printers, or reprint from a recent print job. Users can stay informed of print progress with built in camera support, receive maintenance schedule alerts, or update printer firmware over a network connection.

Ultimaker Cloud takes network connectivity a step further, by enabling you to send a print job to a 3D printer from anywhere in the world. Even if you are on a different network.

And for fast and simple setup, use Ultimaker Cloud to safely store your preferred print settings and profiles in the cloud, so they are accessible at any time and from any location.

Multiple printer management

Whether you are on the same network as the rest of your team, or in another country entirely, Ultimaker Connect and Ultimaker Cloud make it possible for you to manage multiple print jobs and printers across a number of locations.

Monitoring is made easy, with Ultimaker Connect's detailed print analytics enabling you to track and forecast material usage, identify your most-used material configurations, and determine completion rates at a glance

Plugins

Open plugin development in Ultimaker Cura empowers users to customize the software for their own business needs.

Plugins give flexibility to the core software, allowing extra functions and tools to be added for enhanced custom features.

Software integration

Plugins for software integration link Ultimaker Cura with other software, such as CAD, 3D scanning, and product lifecycle management (PLM) software. This streamlines the 3D printing workflow.

For example, there is a plugin that enables a CAD software package to automatically push 3D model data to Ultimaker Cura, eliminating the need to save intermediate file formats (such as STL files).

Custom file formats

File format reader plugins can open specific file formats natively in Ultimaker Cura, eliminating the need for multiple intermediate file formats.

For example, the SolidWorks integration plugin makes it possible to natively open SolidWorks part files (.sldprt) and SolidWorks assemblies (.sldasm) in Ultimaker Cura. There are also similar integration plugins for Siemens NX and Autodesk Inventor.

The development cycle

Ultimaker Cura's regular software updates ensure continuous improvement, introducing new features to meet rapidly evolving user requirements. A stable version of Ultimaker Cura is released every few months for Windows, MacOS, and Linux platforms. As open source software, the application and source code are available for free and development is completely transparent. This means that the core development team can curate new features contributed by the community and integrate them into the next public release.

Integrated development

There are distinct advantages to using hardware, software, and materials that are developed alongside each other. Consider a combination of hardware, software, and materials from different vendors: each would require manual configuration and a degree of experimentation to achieve reliable results.

On the other hand, integrated development offers the end-user a well-tested and cohesive ecosystem, so reliable results can be produced immediately, with minimal configuration. Ultimaker products are designed and tested for seamless interoperability, and maximum reliability and uptime.

Security and code signing

Code signing and certificates allow developers to assure users that their software can be trusted and does not come from a malicious source or pose a security risk.

Ultimaker Cura is certified for Windows and MacOS platforms, and digitally signed for Windows and Linux platforms. This verifies that each release comes from Ultimaker and does not contain any malicious code.

Technical support

Ultimaker Cura includes built-in tool tips to assist users when using features that require in-depth technical knowledge.

In addition, Ultimaker.com offers up-to-date resources explaining how to make the most of your 3D printer. Resources such as screencasts are readily available and specify how to use the software. Further, the Ultimaker online community of 3D printing experts share information and tips on an active online forum.

For developers, a dedicated resource base aimed at maintenance, troubleshooting, and plugin development is available on GitHub, where the source code for Ultimaker Cura is hosted.

Ultimaker product experts and Ultimaker's service partner network offer dedicated training on how to effectively use the hardware, software, and material products.

Download Ultimaker Cura

Ultimaker Cura is available for download, free of charge, at ultimaker.com/software. Download it today and take control of your 3D printing workflow.

Explore more 3D printing knowledge

Build your 3D printing knowledge with industry leaders and experts, or request a quote, on the Ultimaker website.

Read more 3D printing resources
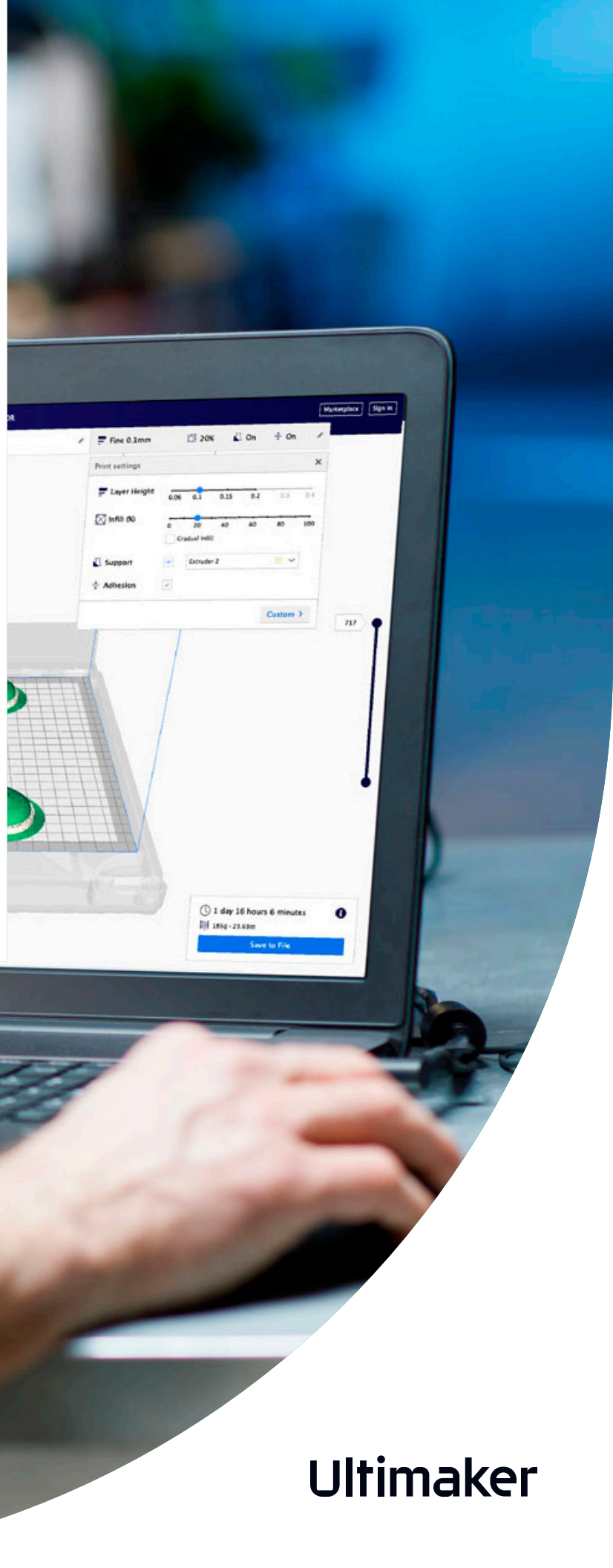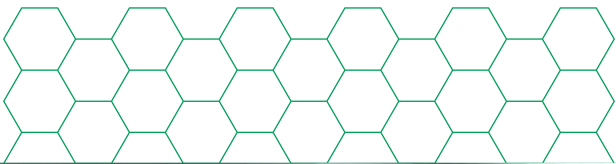
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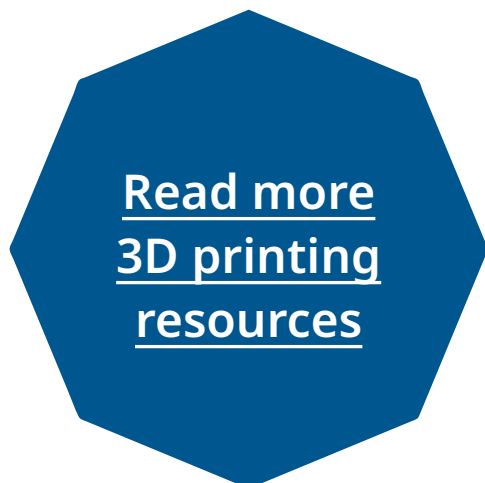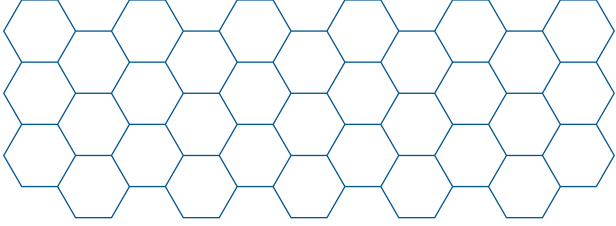
About Ultimaker

Since 2011, Ultimaker has built an open and easy-to-use solution of 3D printers, software, and materials that enables professional designers and engineers to innovate every day. Today, Ultimaker is the market leader in desktop 3D printing. From offices in the Netherlands, New York, Boston, and Singapore – plus production facilities in Europe and the US – its global team of over 400 employees work together to accelerate the world's transition to local, digital manufacturing.

ultimaker.com

General inquiries: info@ultimaker.com
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