APPLICATION NOTE

LuxaPrint Ortho Comfort

Validated workflow with DMG DentaMile

DMG

LuxaPrint Ortho Comfort

As stable as necessary. As soft as possible.

The unique material properties of LuxaPrint Ortho Comfort allow you to print bite splints that are doubly impressive. They are hard enough to withstand functional therapy yet also soft enough for your patients to feel comfortable wearing them.

Validated workflow with DMG DentaMile

In this application guide, we present our validated DentaMile workflow, which you can use to easily and reliably achieve a result that meets the high requirements of dental users in terms of stability, fit and biocompatibility.

The DentaMile bite splint workflow was developed at DMG according to strict criteria, and carefully tested in our digital application centre. Please follow the below process exactly. That way, you can rest assured that you always deliver work of the highest quality with maximum safety for your patients.

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Required equipment and software

- **Scan**
  Digital scanner or optical desktop scanner
- **Design**
  Dental design software for creating splints
  (e.g. DMG DentaMile connect)
- **Print**
  Validated printing systems:

Printer	Cleaning unit	Post-curing
DMG 3Demax DMG 3Delite DMG DentaMile Lab 5 (Pro)	DMG 3Dewash Ultrasonic bath	DMG 3Decure Otoflash G171
DMG DentaMile Desk MC-5	DMG DentaMile Wash MC DMG 3Dewash	DMG DentaMile Cure MC
RapidShape D10+ RapidShape D20+ RapidShape D50+ Straumann P10+ Straumann P20+ Straumann P50+	RS Wash Straumann P Wash Ultrasonic bath	RS cure Straumann P Cure Otoflash G171
Asiga MAX UV Asiga Max 2 Asiga PRO UV Asiga PRO 4k Asiga Ultra	Ultrasonic bath	Otoflash G171

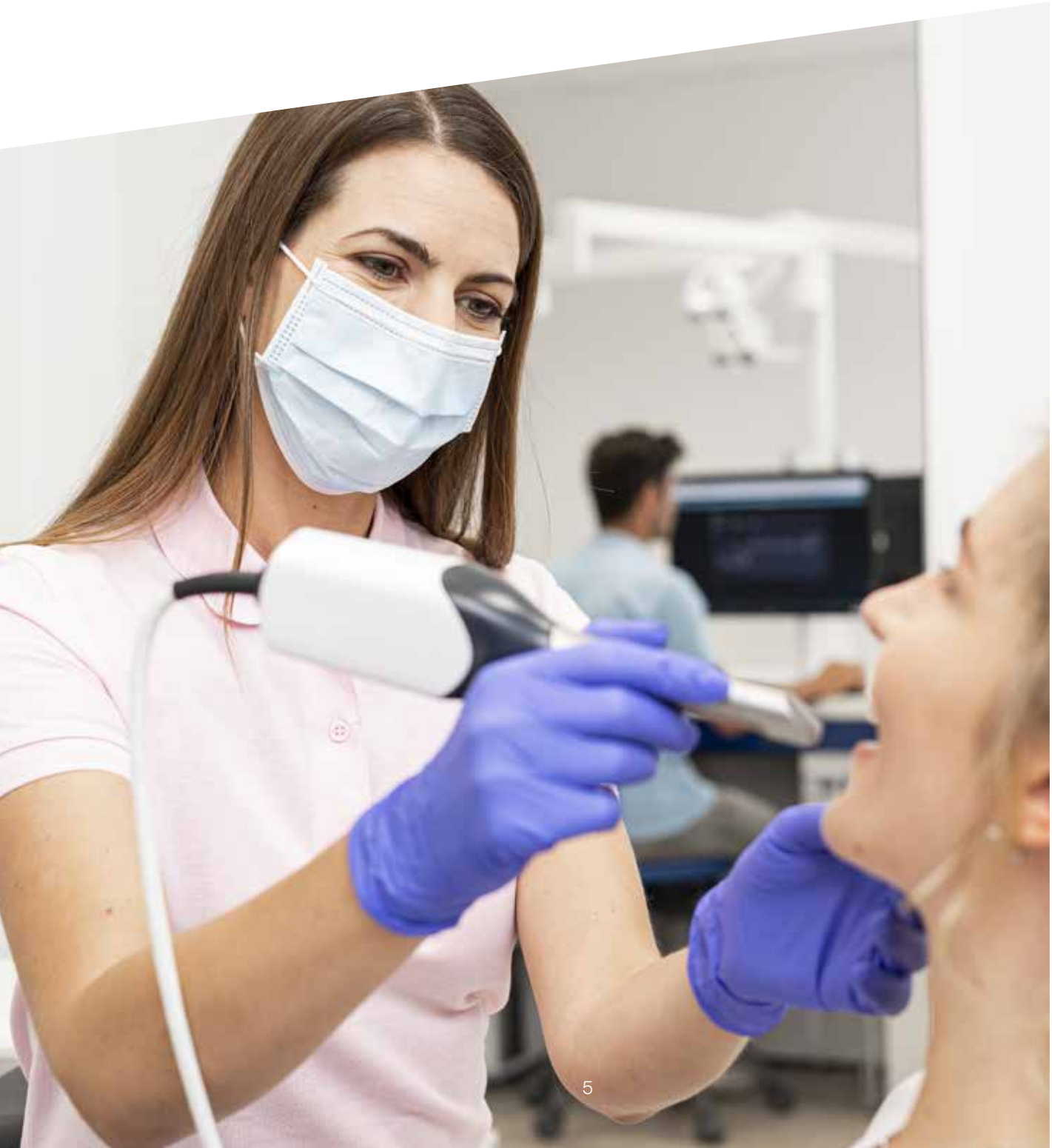
Practical tip:

Please always use the appropriate slicing software for your printing system with validated printing parameters (e.g. Autodesk Netfabb for DMG DentaMile Lab5 (Pro), 3Demax and 3Delite or DMG DentaMile CAM MC for DMG DentaMile Desk MC-5).

1. Scan

In order to design a bite splint, you need a digital impression of the patient's dentition. To create one, scan the patient with a digital scanner in the dental clinic or scan a model or a physical impression with a lab scanner.

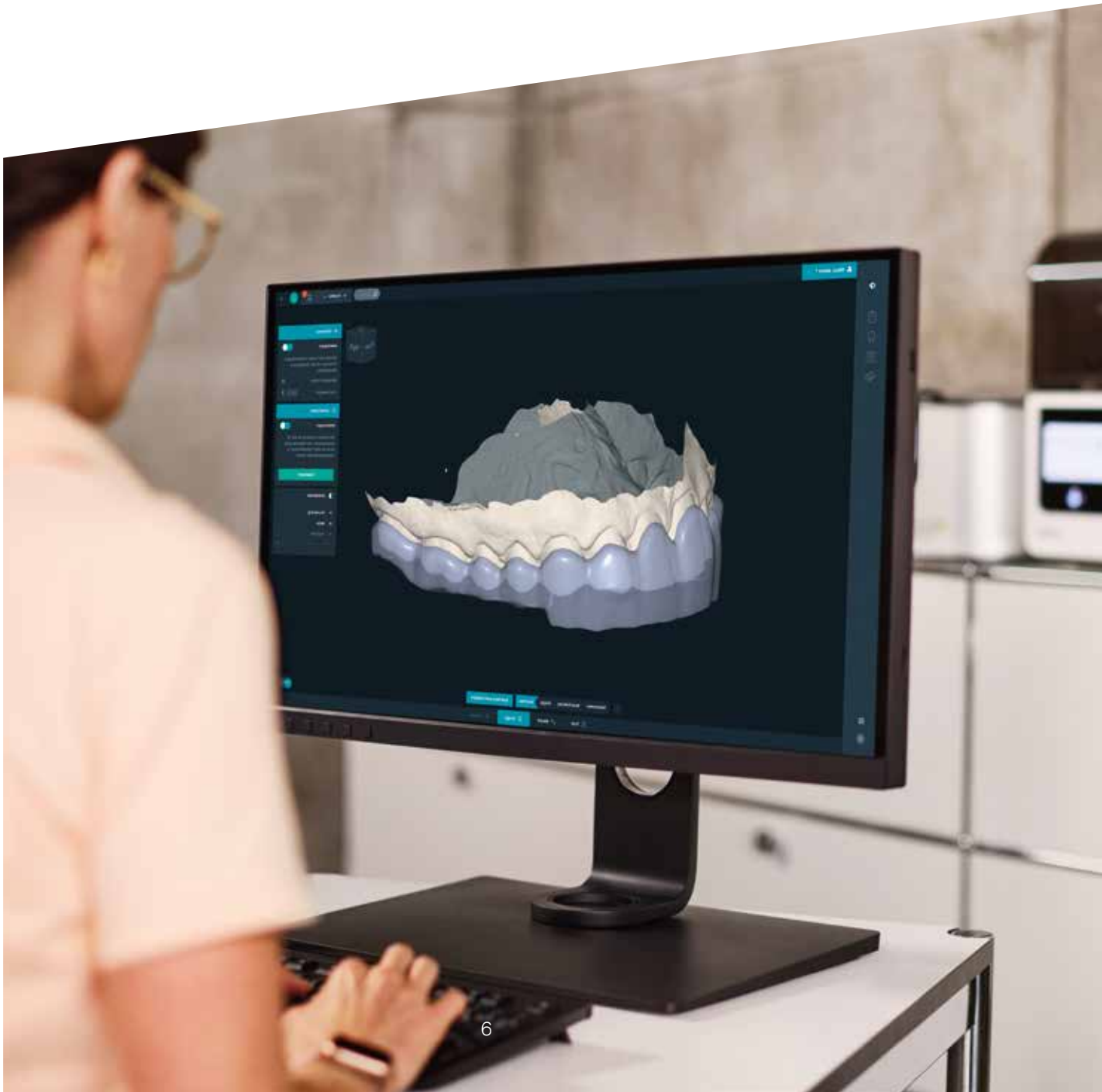
On the basis of this digital dentition, a bite splint is then designed with suitable dental design software.



2. Design

When it comes to designing the splints, the only limit is the dentist's or dental technician's imagination. LuxaPrint Ortho Comfort is suitable for occlusal splints in the case of bruxism and temporomandibular disorder, where a hard and slightly flexible splint material is needed. The splint can be designed with any appropriate software.

LuxaPrint Ortho Comfort can be designed, printed and used in any material thickness. For low thicknesses (e.g. 1.0 mm), the result is a flexible and comfortable splint. Adjusted bite splints or other splints with higher wall thicknesses have all the advantages of conventional hard splints and are both break-resistant and easy to insert.



2.1 DentaMile connect

The DentaMile connect software's validated digital bite splint workflow enables the creation of precision-fit dental splints for a variety of purposes. Adjusted bite splints for the upper or lower jaw, grinding splints to treat bruxism or TMD bite splints? All of these are easily possible with just one patient session.

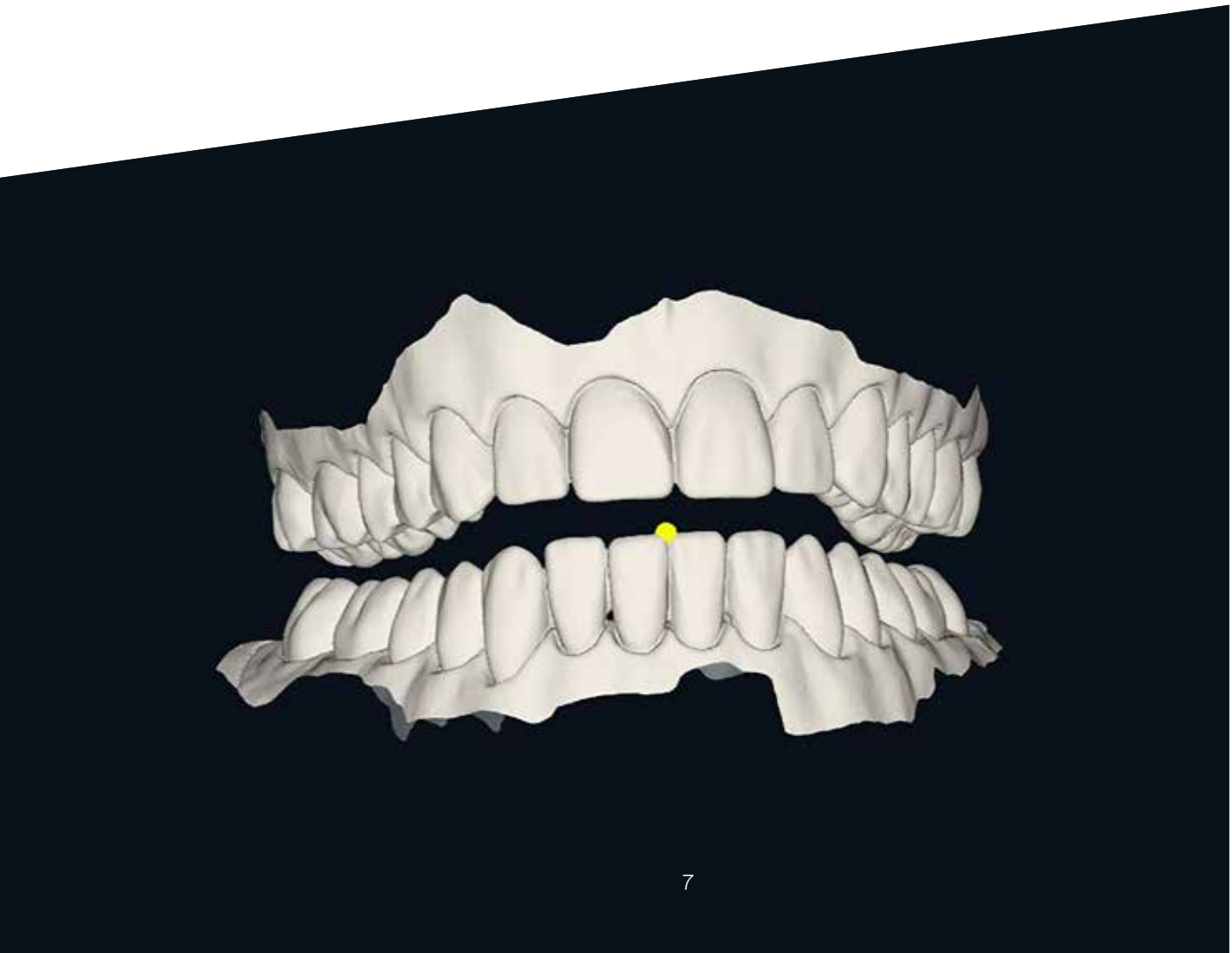
For extensive and up-to-date step-by-step instructions you can select the menu item 'Manual' in DentaMile connect directly or access the following link in your browser: **dentamile-connect-manual.com**

2.2 Third-party software

There are various dental software solutions available for the digital design of bite splints, including 3Shape Dental System and exocad. Choose the software that best suits your personal preferences and requirements. Once you have designed the splint, export it as an STL file in order to prepare it in the printer software for 3D printing.

2.3 DentaMile Design & Print Service

Don't have time to design yourself? No problem! Our DentaMile Design & Print Service can create the splint design in accordance with your specifications and you can then print it on your own system.



3. Print preparation

The digitally designed splint must now be imported in the printer software in order to prepare it for printing.

In this step, the splint is oriented, arranged and then provided with support structures in the build area of the 3D printer.

3.1 DentaMile connect

With DentaMile connect from DMG, the splint is prepared for printing automatically in the cloud. The orientation, arrangement, adding of supports and transfer to your DMG 3D printer are all performed in a validated process in the background. Simply start the print job on your 3D printer.

Practical tip:

Please always ensure that the correct machine and material parameters are used. Incorrect settings can lead to misprints and splints with a bad fit, as well as inadequate mechanical properties and a lack of biocompatibility.

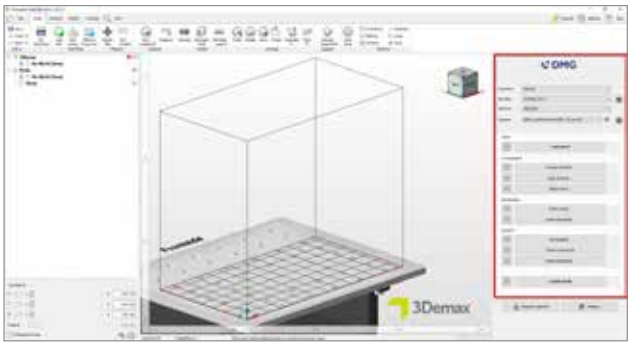
3.2 Autodesk Netfabb for DMG 3Demax and 3Delite, DentaMile Lab5 (Pro), RapidShape D-series

3.2.1 Selecting the material and machine

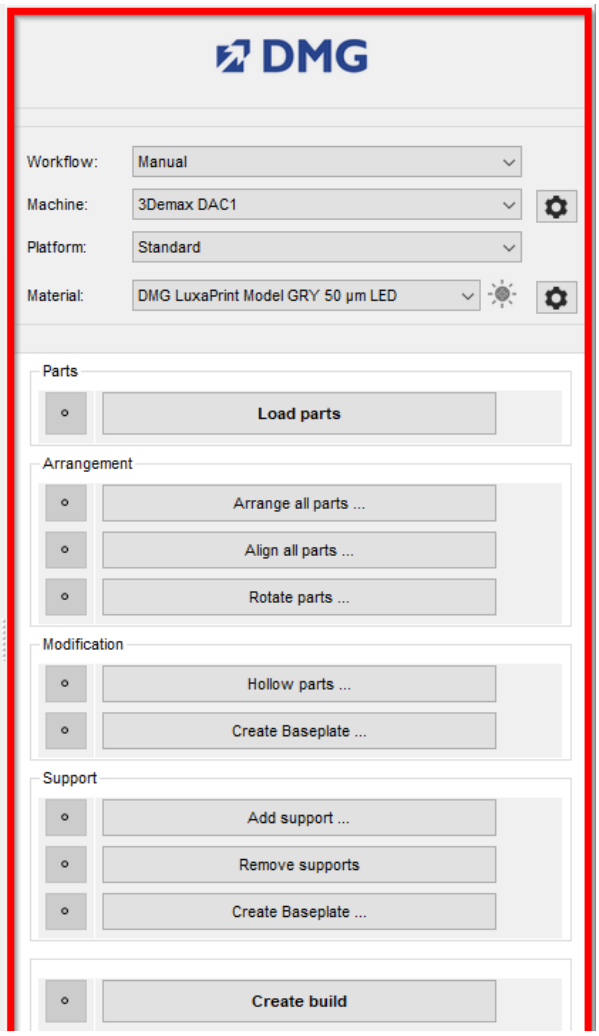
Open Netfabb and select your machine environment (e.g. DMG 3Demax). The DMG workflow area appears on the right-hand side of the screen (marked by the blue DMG logo). Here, you will be guided through all the relevant steps from top to bottom.

First select your printer and the material 'DMG LuxaPrint Ortho Comfort' as well as the desired layer thickness. If you have never worked with the material, you may have to use the setting wheel next to the material line to create it (see 3Demax/3Delite operating instructions, point 6.7).

All available layer thicknesses have been checked in our digital application centre and deliver an exact and reliable printed object. A lower layer thickness leads to a finer surface structure, higher accuracy and longer printing time. Please note that a finer surface can lead to time savings when finalising. Choose the correct layer thickness depending on your specifications regarding available time and desired surface quality.



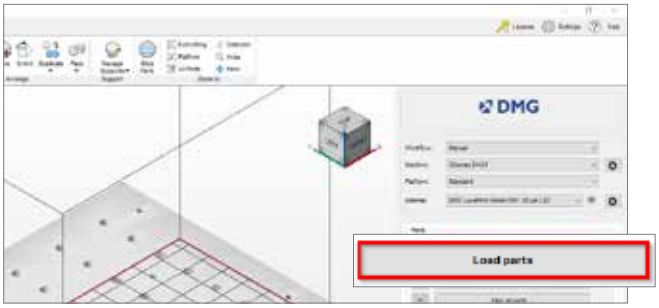
User interface Autodesk Netfabb



Selection of machine and material parameters in Netfabb

3.2.2 Importing STL files

Import the previously designed splints into the Netfabb software by simply dragging the files into the software's 3D view or by selecting 'Load parts' in the DMG workflow area and finding your files. The imported objects will then immediately appear in the 3D view:

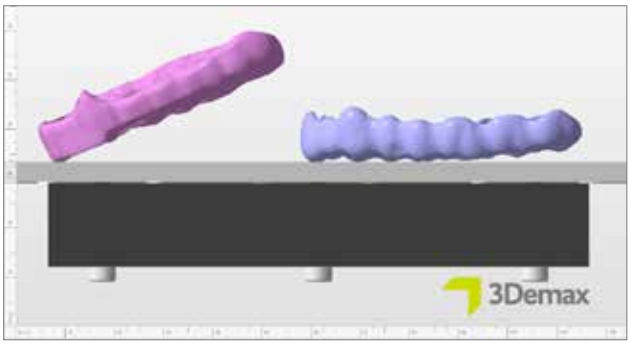


Importing STL files

3.2.3 Alignment

Align the splints so that the inside faces away from the build platform. This achieves the highest level of accuracy and ensures that no support structures are created on these surfaces. The best results are achieved with a horizontal alignment of the splints (between 0° and 20°). Steeper angles can affect the fit and accuracy of the pieces.

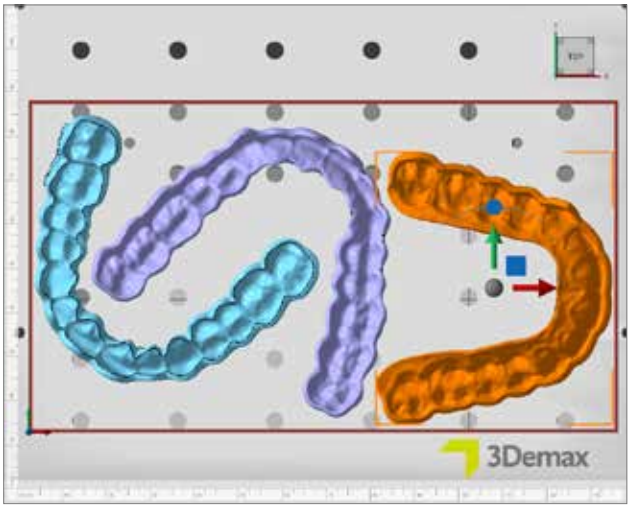
To rotate parts, click on an object and drag the circles that now appear.



Optimum alignment of the splints in Netfabb. For the best results, the splints should be oriented between 0° (right) and 20° (left).

3.2.4 Arrangement on the build platform

The splints can be placed anywhere on the build platform. On 3Demax (or Rapidshape D20+) it is normally possible to position three splints on the build platform at a time. To enable exact positioning, it is helpful to work in the view from **above**.

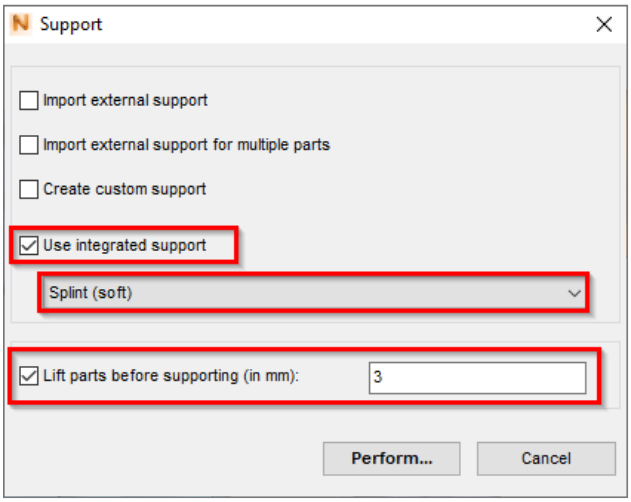


Arrangement of three splints on the build platform

3.2.5 Creating support structures

The splints require support structures to keep the build process running smoothly and without errors. In the DMG workflow area, select ‘Add support...’, and then select ‘Use integrated support’ in the next dialogue window. The default support style ‘Splint (soft)’ provides the best results and makes it possible to the remove the supports easily and cleanly. Activate the item ‘Lift parts before supporting (in mm)’ to lift your splints 2–4 mm from the build platform.

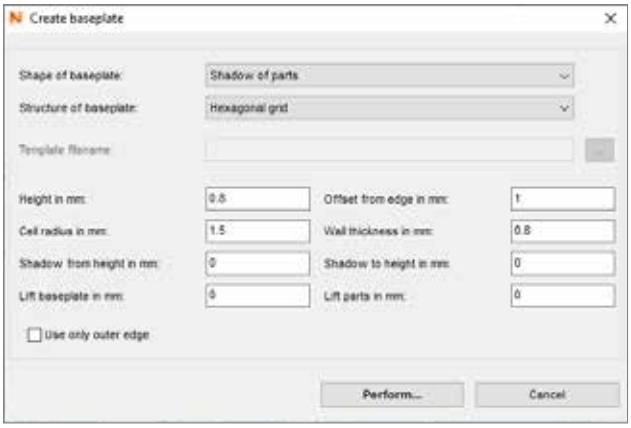
The software automatically calculates the optimal position of the support structures and positions them between the build platform and the splint. The support structures do not need to be edited manually.



Automatic support creation

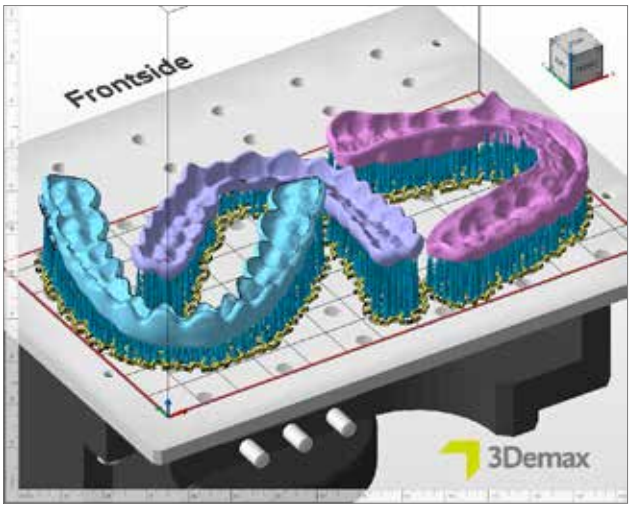
3.2.6 Creating the baseplate

A hexagonal grid baseplate should always be used when 3D-printing splints. The baseplate ensures better adhesion to the build platform and therefore prevents misprints from occurring. We recommend the following settings for LuxaPrint Ortho Comfort: shadow of each part, grid with hexagonal cells, height: 0.8 mm; cell radius: 1.5 mm; offset from edge: 1 mm; wall thickness: 0.8 mm.



Creating the baseplate

Your project including support structures and baseplate should now be ready for printing and should look something like this:

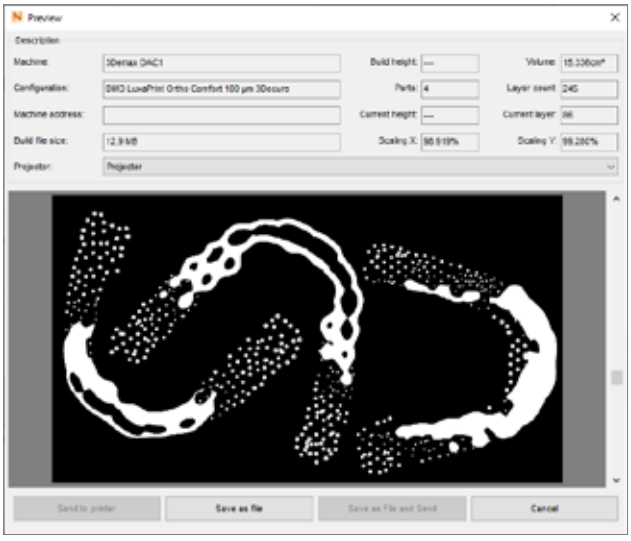


Complete build job in Netfabb with three splints. Two splints (left) with horizontal orientation, one splint (right) with an incline of roughly 20°.

3.2.7 Sending the build job to the 3D printer

Click on ‘Create build’ in the DMG workflow section to create the print job that includes the printing layers (‘slices’). Once calculation is complete, a preview window will be displayed where you can scroll through the slices and perform a final check to ensure that the parts and support structures are positioned correctly.

Next, transfer the build job to your 3D printer via a network connection or USB stick.

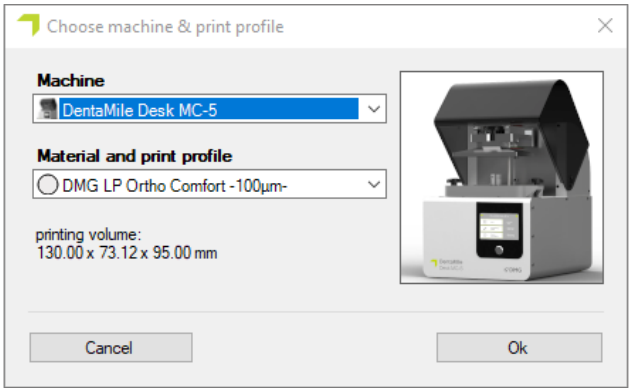


Preview of the print job with machine and material settings and a black-and-white depiction of the slices. This image shows slice 86. The white areas correspond to the exposed areas of the current layer.

3.3 DentaMile CAM MC for DentaMile Desk MC-5

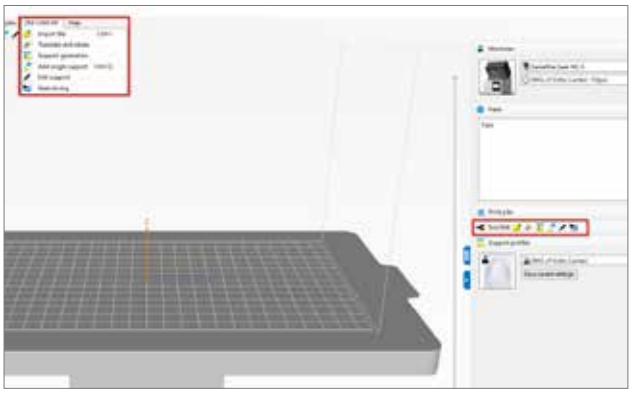
3.3.1 Selecting your printer and material

Open DentaMile CAM MC and select your printer (DentaMile Desk MC-5) along with the material and print profile for LuxaPrint Ortho Comfort.



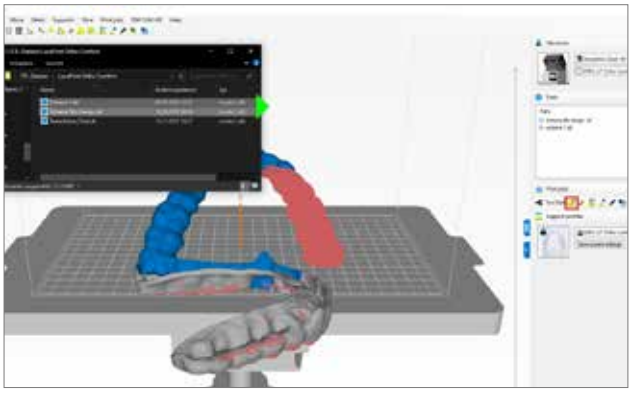
Selection of printer and material profile

The DentaMile CAM workflow area can be accessed via the 'DM CAM WF' tab at the top and from the menu on the right side of the screen. Here, you will be guided through the most important steps of the software.



3.3.2 Importing the print objects

Simply import the splints from the corresponding folder using drag-and-drop, or select the 'Import file' function and find your splint designs. Both options allow you to select multiple objects at the same time.



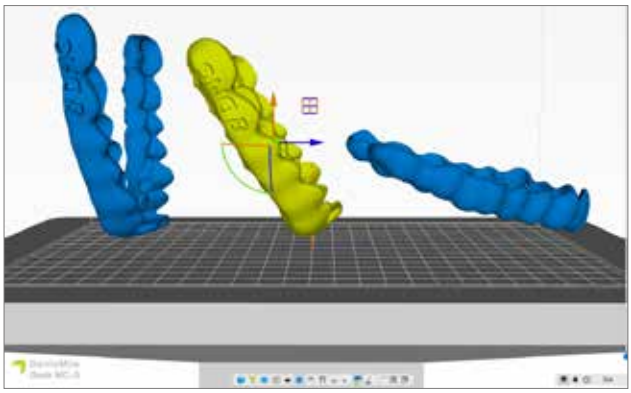
Importing splints into DentaMile CAM MC

3.3.3 Alignment

On the DentaMile Desk MC-5 system, splints can generally be printed with perfect fit in **any orientation**. For horizontal or angled orientations, the inside of the splint, which is relevant for the fit, should be turned away from the build platform (see figure 'Aligning splints') to prevent support structures from being generated on these surfaces.

For maximum precision and the fastest printing times for individual splints, we recommend using a flat orientation (0–20°). For printing multiple splints and for ease of removing support remnants, an upright orientation is the best choice.

For upright orientations, ensure that no overhangs ('islands') are created, as this would require support structures to be added for a perfect print. In many cases, this can be prevented by applying a slight incline.



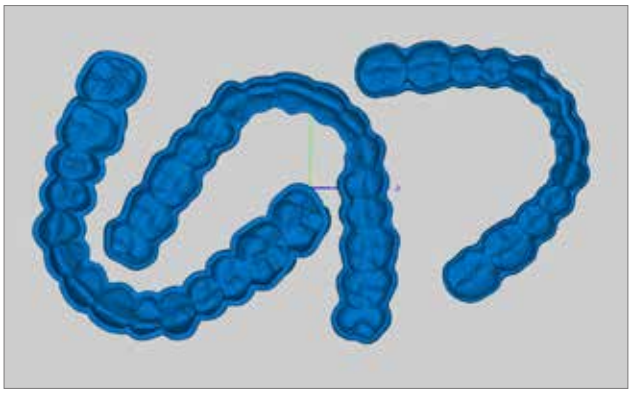
Aligning splints (left to right: 90°, 60°, 15°)

Practical tip:

With LuxaPrint Ortho Comfort you can achieve high levels of accuracy in the printed splints on DentaMile Desk MC-5 in all orientations. Depending on the desired fit, it may be necessary to adjust the spacer (the distance between splint and tooth) in the CAD software (e.g. by ±0.1 mm).

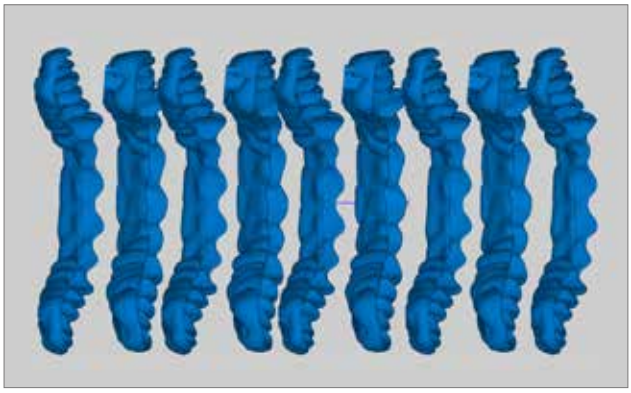
3.3.4 Arrangement on the build platform

The splints can be placed anywhere on the build platform. On the Desk MC-5, if a flat orientation is used, it is generally possible to position three splints on the build platform at a time. To enable exact positioning, it is helpful to work in the view from **above**.

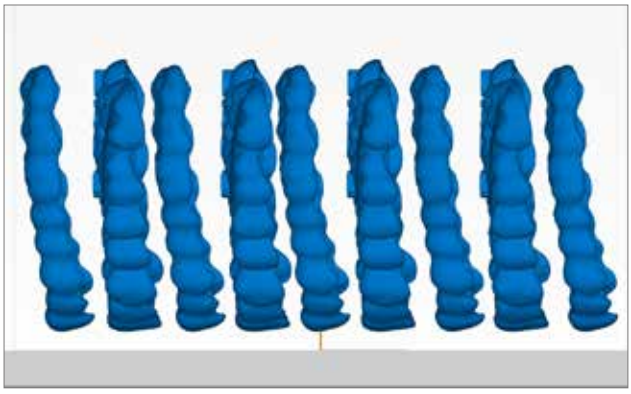


Three splints arranged with flat orientation on Desk MC-5

In the upright orientation, eight to ten splints can fit on the build platform of Desk MC-5, depending on the splint size. Once the splints have been oriented, they can then be positioned in the build area in the view from above. The splints can then be moved in the frontal view to achieve optimal spacing (see figure). The splints must not touch at any point. If the support structures or baseplates overlap in the next process step, this will not present any problems.



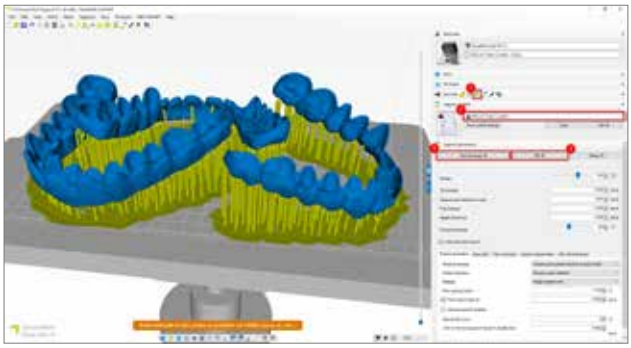
Nine splints arranged with upright orientation.
View from above



Nine splints arranged with upright orientation.
Side view

3.3.5 Support structures

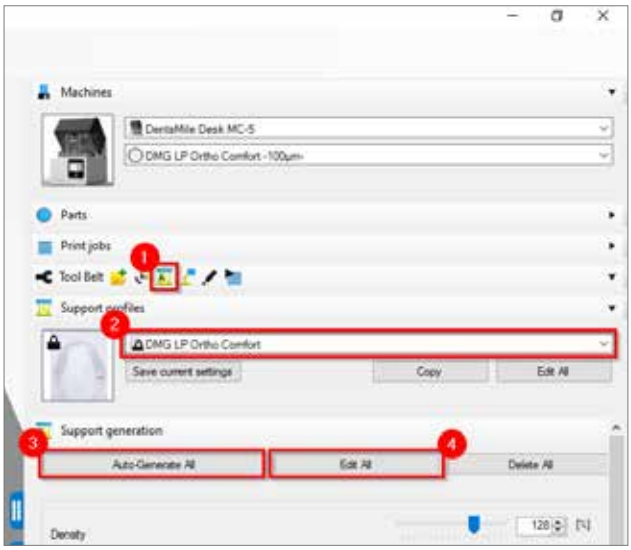
The splints require support structures to keep the build process running smoothly and without errors. Select ‘Support generation’ (1) in the tool bar. The support profile ‘DMG LP Ortho Comfort’ (2) has been specifically developed for the material and delivers optimal results. Click ‘Auto-Generate All’ (3) to generate the supports for all objects on the build platform. All parts will then be positioned a few millimetres above the build platform and given a base plate.



Generating supports in DentaMile CAM MC. For printing with flat orientation (0–20°), manual editing of the support structures is not normally needed.

Please check your splints for any supports that have not been put in place optimally. Supports that collide with the component are shown in red and should be removed. You can do this simply by selecting them with the mouse and clicking ‘remove’. Ensure that both the tip and the base of the support are removed.

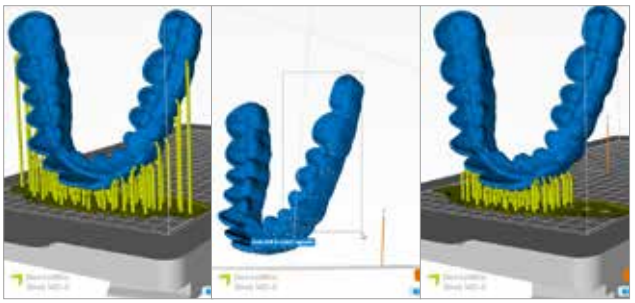
You can use the ‘Edit All’ function (4) to add individual supports with the same support profile as needed.



Printing with upright orientation

For printing with upright orientation, the automatic support profile function creates more supports than are needed. The ‘Edit All’ function (4) can be used to remove any excess structures. To do this, press and hold the mouse button and draw a rectangle around the area that you wish to remove supports from.

If the splint is printed **labially** in the direction of the build platform, it is generally sufficient if the splints are fully supported in the anterior region (see figure). This reduces the amount of work involved in sanding down the support remnants to a minimum.



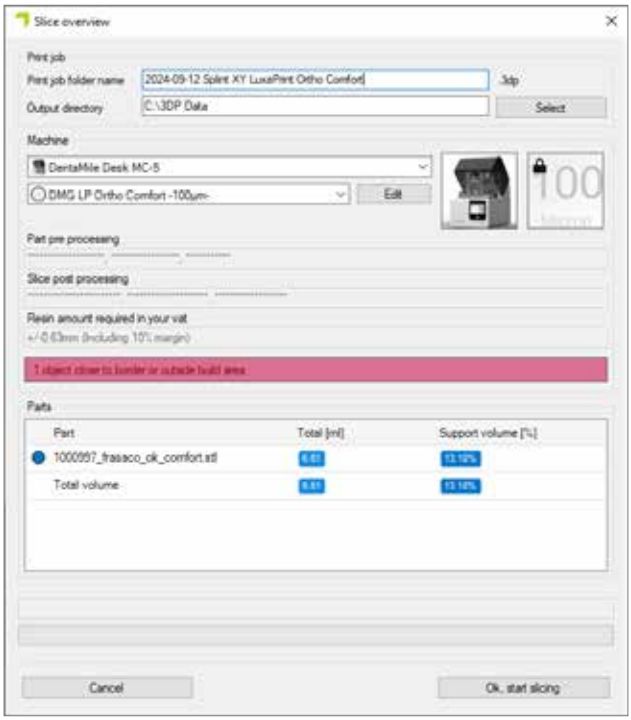
Generating supports for printing with upright orientation. Before (left) and after (right) manual editing of the supports. The editing function (centre) allows you to add and remove individual or multiple supports.

3.3.6 Creating a build job and transferring it to the printer

Once the parts have been arranged, oriented and supported, you can start the slicing process by clicking ‘start slicing’. In the next dialogue window, you can give your print job a new name or accept the suggested one. Next, select an outgoing directory, which has to be a folder on your computer’s local hard drive. This is where the print job will be saved. You can now also check all of the printer and material parameters again and change them.

If you receive a warning message that objects are close to the edge or outside the build area, check whether this relates to the objects or the baseplates. If it concerns the baseplates (as in this case), you can ignore the warning. If splints are located outside the build area, their orientation and arrangement will need to be changed and their supports may need to be adjusted.

Click on ‘OK, start slicing’ to create the build job. Now transfer the finished print job to your DentaMile Desk MC-5 via the web interface or USB stick.



Slice overview in DentaMile CAM MC

4. Printing

Start printing immediately
LuxaPrint Ortho Comfort was developed to enable a fast and straightforward workflow and does not need any preparation. No shaking, no heating up. Simply get started with the 3D printing process immediately.

4.1 Scanning RFID tags

Scan the printing resin's RFID tag by holding it in front of the integrated reader on the 3D printer. The printer will recognise the LuxaPrint material being used and compare it with the information stored in the print job. This means that accidental incorrect entries in the software can be identified early on and any manufacturing errors avoided. The system thereby supports you in complying with the validated DentaMile workflow **(supported by DMG DentaMile Lab 5 (Pro), 3Demax, 3Delite and Rapidshape 3D printers).**

4.2 Adding material

Add LuxaPrint Ortho Comfort to the resin tray of your 3D printer. Make sure that the tray is filled far enough, so that the resin can continue to flow even if the build platform is fully occupied. Never fill the tray to the brim, as the resin may overflow and contaminate your printer.

4.3 Starting a 3D printing job

Start the print job on your 3D printer.

5. Post-processing

Intelligent connectivity
As a user of a DMG 3Demax, 3Delite or Lab5 (Pro) and the post-processing units 3Dewash and 3Decure, you can benefit from the intelligent linking of the devices. As soon as the print job is finished on the printer, all relevant information is transferred to the post-processing units, where you only have to select the appropriate print job to start the individual post-processing.

5.1 Dripping off

After completing the printing process, let the splints hang in the 3D printer for about 10 minutes, so that any liquid resin can drip off. This saves material and cleaning.

5.2 Detaching parts from the build platform

Carefully detach the printed splints from the build platform with the corresponding detachment tool (spatula, blade scraper or similar). Push the tool under the baseplate and loosen the parts using gentle lever movements.

Practical tip:

Avoid direct skin contact with the liquid printing resin and parts prior to post-curing. Always wear suitable protective gloves when working.

Practical tip:

Use the drip aid (dripping rabbit) to enable the liquid resin to drip even faster and more effectively off your print objects. This saves print material and will reduce the number of times the isopropyl alcohol of your cleaning unit will need changing (does not work for DentaMile Desk MC-5).

The print data for printing the drip aid can be downloaded directly from the DentaMile website at: **dentamile.com**

5.3 Cleaning

Once printed, the splints have to be thoroughly cleaned to remove the residues of liquid resin from the component surface. Please use the cleaning devices (see Required equipment and software) that have been designed and validated for your printing system.

5.3.1 3Dewash (or RS wash / P wash)
Place the printed splints in the cleaning chamber with their inner side facing down and select the programme for LuxaPrint Ortho Comfort or the appropriate print job. The splints should be cleaned with 99% isopropyl alcohol (IPA).

5.3.2 DMG DentaMile Wash MC
Place the printed splints into the cleaning tray of the DentaMile Wash MC with their inner side facing down. Ensure that the isopropyl alcohol (99%) is sufficiently clean and change it as needed.

Select the cleaning programme 'Low' and set the timer to **5 minutes** for thorough cleaning of the printed objects.

5.3.3 Ultrasonic bath
If you do not have any of the above cleaning devices, you can also clean your model in an ultrasonic bath with isopropyl alcohol (99%). To do so, we recommend using two separate cleaning containers. The first for a prewash (max. 3 minutes) for removing most of the resin from the parts. This container will quickly become contaminated with resin, but can continue to be used for prewashing other parts.
The second container should contain fresh isopropyl alcohol and be used for fully removing all of the remaining resin residues (max. 2 minutes).

Practical tip:

The cleaning solution in the ultrasonic bath will start getting dirty once it has been used a number of times. Once this happens, you can use it to replace the now more heavily contaminated container used for the prewash, which requires proper disposal. You can then use a new isopropyl alcohol container as the main cleaning container.

Step 1 (prewash)	Step 2 (main wash)	Drying
Ultrasound	Ultrasound	Compressed air/ air
Isopropyl alcohol	Isopropyl alcohol (fresh)	
3 min	2 min	10–60 s / 30 min

5.4 Drying and visual inspection

Ensure the splints have completely dried before you proceed with post-curing. Use compressed air for this, or let the parts air dry for about 15 minutes.

Inspect the printed splints thoroughly after drying and ensure that:

- the splints are clean and completely dry and no cleaning fluid or resin residues remain on the surface (indicated by a shiny object surface),
- no imperfections, cracks or solid resin particles are evident on the surface.

If there are still liquid resin residues on the objects, they can be removed, e.g. with a spray bottle containing IPA or a cloth soaked in IPA. The remaining resin residues can also be rinsed away by briefly immersing the objects in a clean IPA container. Then dry your splints completely as described above.

5.5 Post-curing

Correct post-curing is essential for achieving biocompatible objects with optimal mechanical properties and a perfect fit. Therefore, make sure that the specified process conditions are always observed and only use the post-curing units (see Required equipment and software) that have been designed and validated for your printing system. Do not place the printed splints on top of each other in the light-curing chamber and make sure that the pieces receive light from all sides.

5.6 Removing the support structures

Remove the support structures with dental scissors, diagonal pliers or a hand tool with a cutting disc. The remnants can then be cut off with a plaster knife. The smaller remnants are sanded off when the splints are finished.

Check the splints for cracks as well as any other damage. Damaged parts should be discarded and reprinted.

Practical tip:

Although cutting off the support structures by hand is quicker than using a tool, it can tear out small areas from the splints and thus damage the splints or even make them unusable. We therefore recommend using a tool.

Light-curing unit	Settings
3Decure	LuxaPrint Ortho Comfort
DentaMile Cure MC*	OrthoCOM-DMG LP
Otoflash	2x2000 flashes (turn splints during the process)
RS wash / P wash	LuxaPrint Ortho Comfort

* If the post-curing programme for Ortho Comfort is not available in the device favourites, please contact our support.

5.7 Finish and polish

LuxaPrint Ortho Comfort offers fast and easy grinding and polishing. Using a polishing machine creates a smooth, high-shine surface. To avoid defects on the splint surface, ensure low rotational speeds when milling and polishing. The dental splints should be prepared under active suction due to the resulting dust exposure.

5.7.1 Chairside processing

- A tungsten carbide bur and/or a fine non-woven web wheel can be used to remove support remnants and smooth the splint surface.
- A goat hair brush and polishing paste are used to polish the splint (ensure that a low rotational speed is used).
- A high-lustre buffing wheel is used to give the splint a smooth surface.

5.7.2 Processing with a polishing machine

Polishing steps	Material	Implementation
Rough preliminary polish	Goat-hair brush and pumice stone/water mixture	• Rough preliminary polish at 3000 rpm. • The splint must be thoroughly wetted with the pumice stone/water mixture to enable cooling. • A roughened surface is created.
Fine preliminary polish	Nettle cloth buffer, fine, and pumice stone/ water mixture	• Fine preliminary polish at 3000 rpm. • The splint must be thoroughly wetted with the pumice stone/water mixture to enable cooling. • A fine rough surface is created.
Intermediate cleaning	Water	• Rinse the pumice stone/water mixture from the splint under cold running water.
High-gloss polish	Nettle cloth, fine, and polishing paste (e.g. Renfert universal polishing paste)	• High-gloss polish at 1500 rpm. • Ensure that excessive heat build-up is prevented! • A good high-gloss finish is created.
Final high-gloss polish	Cotton yarn and polishing paste (e.g. Renfert universal polishing paste)	• Final polish at 1500 rpm. • A good final high-gloss finish is created.

5.7.3 Cleaning polishing residue from the splints

The splints can be cleaned in the ultrasonic bath at 30 °C in a soap solution for 15 min. Clean the splints with a toothbrush and soapy water as needed. Stubborn polishing residue can be removed by brief and targeted steam-cleaning. Attention: Longer targeted steam-cleaning may cause deformations in the splint.

6. Validated fit accuracy

The fit accuracy of the fabricated splints is very important for us at DMG. The accuracy and the mechanical parameters and biocompatibility of all our materials and validated printing processes are therefore tested and assessed on the basis of a specified process.

In various studies[1, 2], the accuracy of 3D-printed splints and their influence on the fit was examined in comparison with conventionally manufactured and milled splints. The studies indicate that mean deviations of up to 174 micrometres in relation to the fitting surface (i.e. the inside of the splint facing the teeth) are within the scope of clinical applicability. The deviation for splints manufactured by injection-moulding and subtractive machining (milling) was 42 micrometres.

The fitting surface of a dental splint produced with the validated workflow using LuxaPrint Ortho Comfort, the DMG 3Demax 3D printer, DMG 3Dewash cleaning unit and DMG 3Decure post-curing unit shows mean deviations of 41 micrometres, and its accuracy is therefore comparable to that of splints that are conventionally manufactured or milled.

Accuracy of the fitting surface of a splint manufactured in the validated DentaMile workflow. The average deviation is 41 µm. Almost the entire fitting surface (99.2%) shows deviations below 150 µm.

[1] Wesemann, Christian, et al. 'Accuracy and its impact on fit of injection molded, milled and additively manufactured occlusal splints.' Journal of the mechanical behavior of biomedical materials 114 (2021): 104179.
[2] Marcel, Reymus, Hickel Reinhard, and Keßler Andreas. 'Accuracy of CAD/CAM-fabricated bite splints: milling vs 3D printing.' Clinical oral investigations 24 (2020): 4607-4615.

7. Productivity comparison: horizontal vs. vertical printing orientation

Printing splints in a vertical orientation seems very efficient at first sight, as more pieces can be produced at once with one printing process, compared to a horizontal orientation (up to 11 splints vertically, 3–4 splints horizontally in the 3Demax).

Because of the overcuring in the Z direction that is typical in the DLP method, the reproduction accuracy of the printed parts is often also reduced in the case of steeper orientation angles (see also point 3.2.3). In some cases this can result in inadequate fit. It is therefore recommended to 3D-print occlusal splints in a horizontal (flat) orientation, and this also has other advantages.

If you take a closer look at the overall process, it becomes clear that, in many cases, printing in a flat orientation also means a clear advantage in terms of productivity and speed.

A comparison of flat and upright printing orientations in the 3D printing of occlusal splints is given below. In our test scenario, we printed six splints in a vertical orientation and six vertically and post-processed them as described in this document. The time required for the individual processes was recorded. The following system was used: LuxaPrint Ortho Comfort, 3Demax, 3Dewash, 3Decure.

Print

Orientation	Maximum no. splints	Duration
0°	3–4	37 min
90°	11	97 min

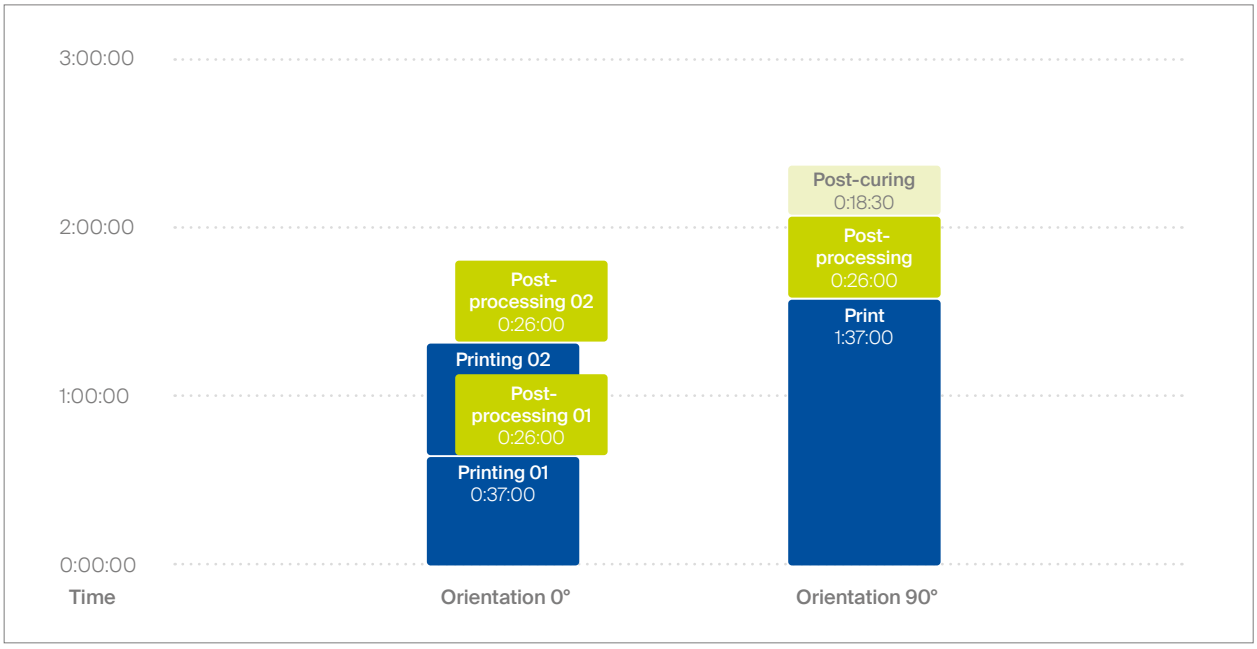
Post-processing

Process	Maximum no. splints	Duration
Cleaning (3Dewash)	5	7:30 min
Post-processing (3Decure)	5	18:30 min
Finishing (total)	5	26 min

Tab. 1: Required time for printing of splints and post-processing

The 3D printing of three splints with LuxaPrint Ortho Comfort took 37 minutes in the flat orientation, while printing six splints in the upright orientation took 97 minutes, because of the greater printing height. As 3Decure provides sufficient space for post-curing up to five splints, post-curing needs to be carried out twice in both cases. For printing with a flat orientation, however, this can be completed during the second printing process, while in the case of upright printing the second post-curing can only be carried out afterwards (the second cleaning can be performed during the first post-curing).

As a result, the total process of producing six splints takes one hour and 40 minutes for the flat orientation and two hours, 21 minutes and 30 seconds for the upright orientation. Using a flat orientation makes it possible to achieve time savings of over 40 minutes.



Time required for printing six splints in the validated DentaMile workflow in horizontal orientation (left) and vertical (right). Printing with a horizontal orientation makes it possible to achieve time savings of over 40 minutes.