LuxaPrint Ortho Flex

Validated workflow with DMG DentaMile

DMG

Application Note: LuxaPrint Ortho Flex

LuxaPrint Ortho Flex is a light-curing, biocompatible 3D printing resin specially developed for manufacturing bleaching trays and indirect bonding trays.

As a class I medical device, LuxaPrint Ortho Flex is ideally suited for manufacturing flexible splints. The excellent resilience of the material also makes the difference with bleaching trays. This ensures that the bleaching agent reliably remains where it is supposed to work. And not on the gums. The extreme tear-resistance and fracture resistance ensures maximum stability and longevity. LuxaPrint Ortho Flex is only slightly susceptible to discolouration, easy to clean, and also tasteless and odourless.

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 biocompatibility, stability and precision. The DentaMile workflow was developed at DMG according to strict criteria, and carefully tested in our digital application centre. Please follow the below procedure exactly. You can be sure that you will always deliver work of the highest quality.

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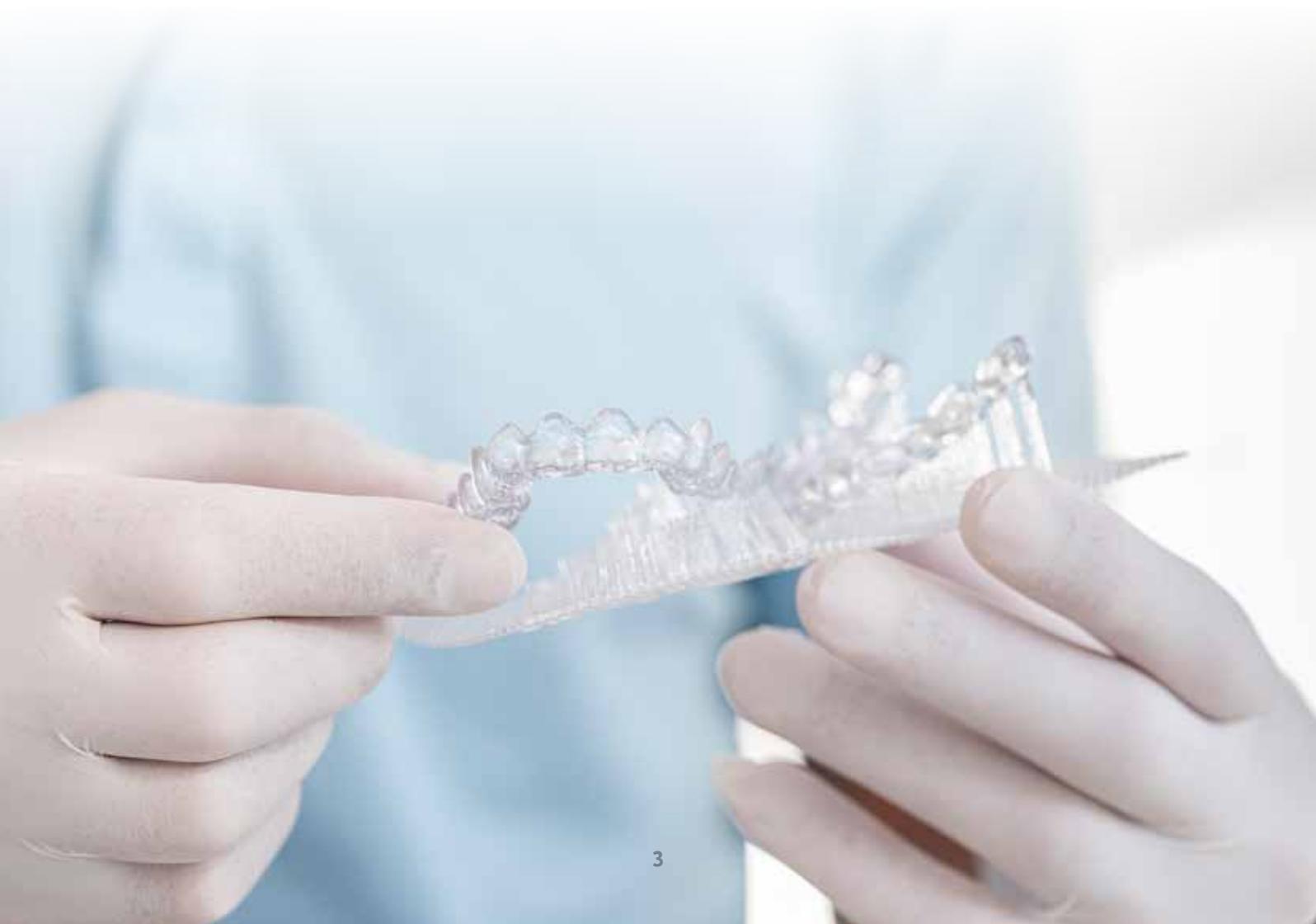
Required equipment and resources

SCAN
Intraoral scanner or optical desktop scanner

DESIGN
Bleaching trays:
Option a) **DMG DentaMile connect** Software
Option b) Dental design software (CAD) for creating bleaching trays

Indirect bonding trays:
Dental design software (CAD) fabricating indirect bonding trays

PRINT
Software: Option a) **DMG DentaMile connect** Software
(not for indirect bonding trays) Option b) Autodesk Netfabb

Resin: **DMG LuxaPrint Ortho Flex**

3D printers: **DMG 3Demax**, **DMG 3Delite**, **DMG DentaMile Lab5/Lab5 Pro**

Cleaning: Option a) **DMG 3Dewash** (cleaning fluid isopropyl alcohol, ≥ 99%)
Option b) Ultrasonic bath (cleaning fluid ethanol, ≥ 96%)

Curing: Option a) **DMG 3Decure** (LED light unit)
Option b) Xenon flash lamp device (Otoflash G171 or Heraflash/HiLite Power 3D)

1. Scanning

For the digital creation of splints, digital patient data must first be generated. This can be done at the dental practice with an intraoral scanner or in the dental laboratory with a laboratory scanner. Depending on the version, impressions of the patient's teeth or plaster models can be scanned directly with the laboratory scanner. The digital patient data can then be further exported to the design program.

**Indirect bonding trays (IBT):
Since brackets come in many different forms, it may be necessary to vary certain parameters in the design software to ensure an optimal fit of the brackets in the indirect bonding tray. Please check the fit of the brackets and their usability before clinical use!**

2. Designing

Based on the digital data of the patient's teeth, a splint can now be constructed using appropriate software. Regardless of the program you use, the following material-specific specifications should be followed:

Minimum material thickness for structures	Maximum material thickness
Bleaching trays: 1 mm Indirect bonding trays: 0.8 mm	7 mm

2.1. DentaMile connect (for bleaching trays)
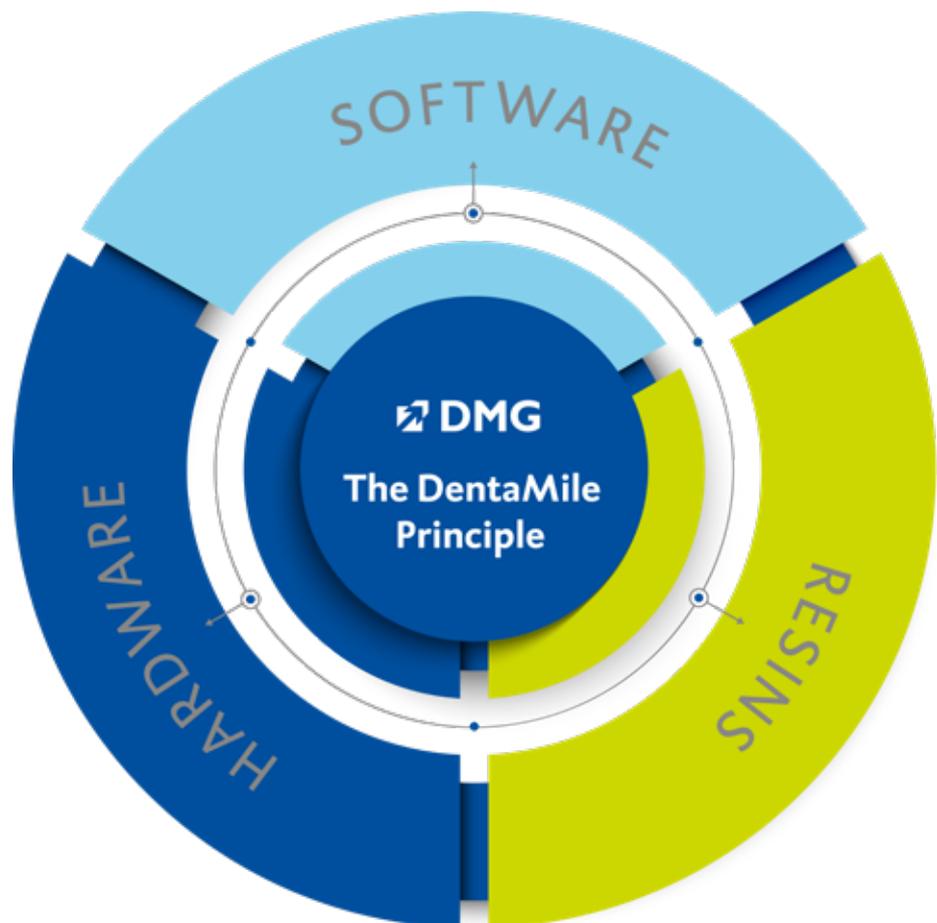
Our award-winning, cloud-based DMG DentaMile connect software not only allows you to enter our validated process flow at the design stage, but also provides you with additional options for digitally storing your patient data, which greatly simplifies your quality management.

The program intelligently guides you through the workflow so that you can fully concentrate on your work. Thanks to the intuitive interface, no entries are forgotten - and the result is impressive.

Visit **www.DentaMile.com** for more information

2.2. Dental CAD software from third parties (e.g. exocad or 3Shape)

Next, import the patient's scanned data in the design program. The program will guide you through the design process of the digital splint in several process steps. Make sure you follow the specifications of the software developer.

Good splint design is critical to comfort, patient fit, and clinical effectiveness of the end product. Our 3D printers and materials are set up so that the digital data can be reproduced with great precision. The splint should therefore be designed carefully and accurately.

For detailed instructions on how to design dental splints, please contact your software developer.

2.2.1. Indirect bonding trays

There are several different ways of constructing indirect bonding trays, depending on the software used and its settings. Three frequently used construction forms are:

- The sleeve type (offset-type)
- The bar type
- The positioning template

Depending on the construction form used, different settings in the design software can produce an ideal result. For indirect bonding, we recommend the sleeve type with a material thickness of 0.8-1.0 mm. Given the lower wall thickness, cutting out the splint is easier when the brackets have a sufficiently stable fit.

2.2.1.1. The sleeve type (offset type) construction form

The offset type is similar to a bite splint or bleaching tray in terms of its design. It encloses the relevant area of the dentition with a predetermined wall thickness. It is characterised by greater flexibility compared to the bar type, so it may be advantageous for certain bracket types to be fully encased by the splint (does not apply to brackets with hooks). For simple bracket shapes, we recommend encasing the lower 75% of the brackets with a wall thickness of 0.8 mm. This makes it easier to cut out the splint and ensures that when inserted into the patient's mouth, the fit of the brackets is sufficiently stable.

After completion of the splint construction, the final design is checked again and exported as an STL file (or another supported file format) for the printing software.

2.2.1.2. Bar type construction form

Due to its solid construction, the bar type offers a better grip and less flexibility.
The splint can also be printed directly on the building plate without any further support structures. When designing, ensure that the wall thickness in areas of the brackets is sufficiently low so that the splint material is flexible when removed and the brackets do not remain in the splint. It may also be helpful if the bracket pockets are not completely encased in the splint material.

The finished tray constructions do not have a flat underside in some design programs. Excess material on the antagonist side of the splint must be subsequently removed by a plane cut in order to allow pressure on the building plate (without additional support structures). This step can also be carried out in the slicing programs during print preparation

2.2.1.3. Positioning template for direct bonding

The positioning template for direct bonding may be regarded as a combination of classic direct bonding and indirect bonding using an indirect bonding tray. Typically, it corresponds in large part to an indirect bonding tray, although areas of the brackets are omitted. After inserting the splint into the patient's mouth, the brackets are bonded directly to the teeth in the recesses provided in the splint. This ensures highly accurate positioning and less effort compared to indirect bonding.

3. Preparing the print

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

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

3.1.   DMG DentaMile connect

DentaMile connect from DMG takes over all the necessary work in the printer software for you. The arrangement and orientation of the splint to be printed, the addition of support structures and the selection of materials and parameters are fully automated on your DMG 3Demax or DMG 3Delite 3D printer, without having to start the program manually. As the owner of a DentaMile Lab5 or DentaMile Lab5 Pro, you can download your STL files from DentaMile connect, position them in Autodesk Netfabb and then control the printer from Netfabb.

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3.2. Autodesk Netfabb for DMG DentaMile Lab5 (Pro), 3Demax and 3Delite (and Rapid Shape D series)

3.2.1. Selecting 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 of the software from start to finish.
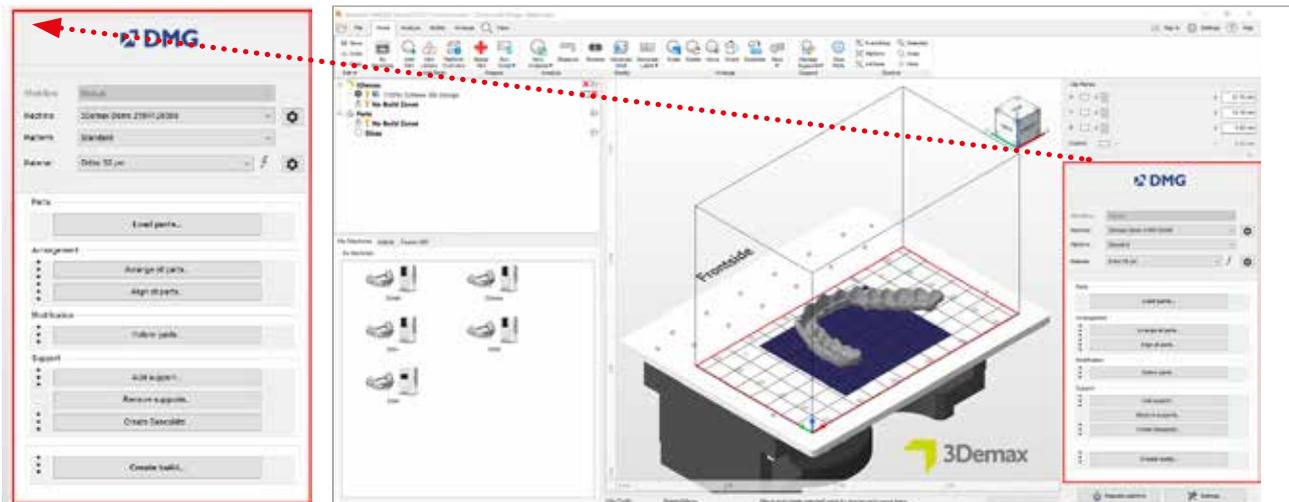

User interface
Autodesk Netfabb

First select your printer and the material »DMG LuxaPrint Ortho Flex« 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 at the time available and the desired surface quality.

3.2.2. Importing the splints

Import the previously created splint design in Netfabb. To do this, simply drag your file into the program's 3D view or select the item »Load Pieces...« in the DMG workflow area and navigate to your design.

Imported splint designs
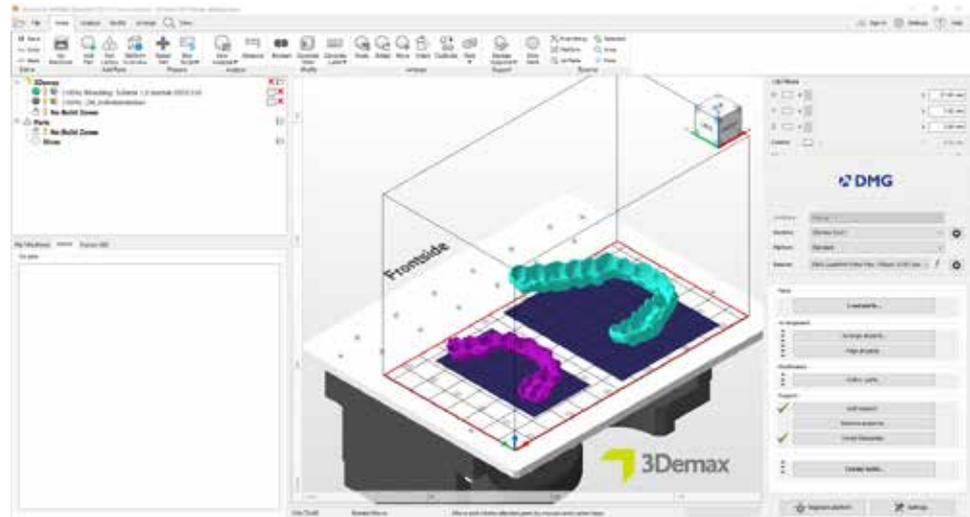
3.2.3. Aligning splints

Align the splints so that the inside of the splint, relevant to the fit, faces away from the building plate. This achieves the highest level of accuracy and ensures that no support structures are generated 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 precision of the pieces.

Background / Further information

One reason for the poorer fit with greater installation angles is overcuring in the Z direction, which is necessary to connect the individual layers to one another. Overcuring only occurs in the case of undercuts and holes or cavities in the object; namely whenever no object structure prevents hardening in the resin in the Z direction (beam path of the light rays from bottom to top or from the tub towards the building plate). With an alignment of 0° to 20°, the fitting surface of the splint (inside) is typically in the direction of the material tray (in contrast to a 90° oriented splint) so that overcuring does not take place there but only on the antagonist side, which will have to be treated in any case due to the existing support structures.

Exact reproduction of the digital data is therefore no longer guaranteed at angles greater than 20° (e.g. 60°, 90°).

Positioning and aligning the splints in Netfabb

3.2.4. Adding support structures

Support structures are required for the correct construction of the flexible objects for most construction forms of indirect bonding trays as well as for all bleaching trays. In the DMG Workflow area, select »Add support...« and in the next dialogue box, select »Use integrated support«. We recommend the 'Splint (Soft)' setting, which is optimised for use with flexible materials. The menu item »Lift components before support (in mm)« should also be selected to automatically lift your component a few millimetres from the building plate. A value of 2-4 mm is ideal.

»Support« window
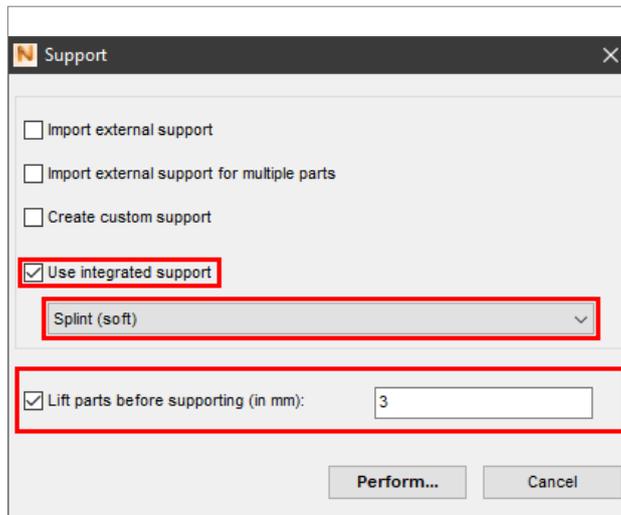
The program automatically calculates the optimal position of the supports and inserts it between the building plate and the splint.

Please examine the object for incorrectly placed support structures. No support structures should be found on the inner surfaces relevant for the fit. If necessary, remove individual supports.

PRACTICAL TIP

You can also use these external supports if you are using a different program to generate support structures. To do this, select the item »Import external support« or »Import external support for several components«.
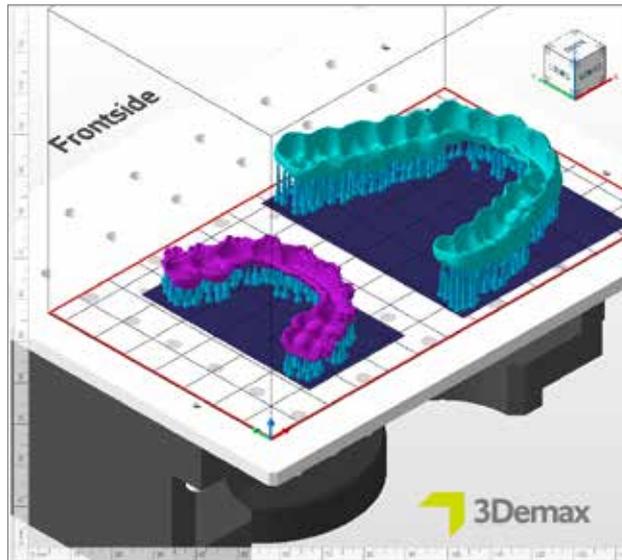
Supported splints on building plate in Netfabb

PRACTICAL TIP

If properly oriented, the automatic and integrated support script works perfectly in many cases. Because all printed objects are unique, it is possible that structures are placed incorrectly and have to be removed manually. It is also necessary to add individual supports manually in some cases.
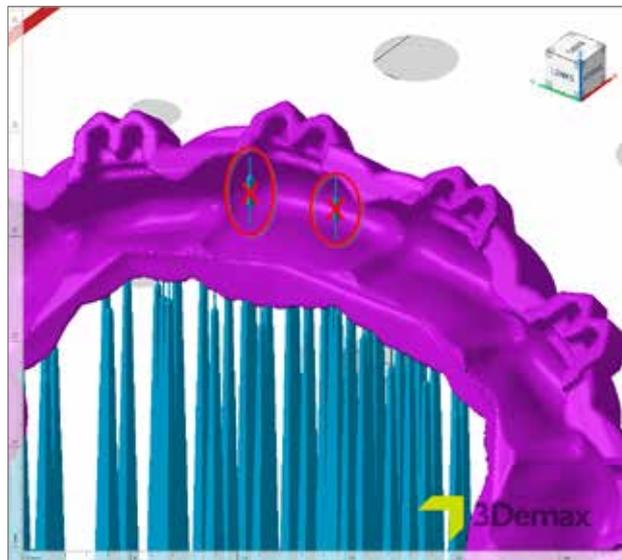

Incorrectly placed supports on the inside of the splint

3.2.4.1. Removing and adding individual support bars

To remove or add individual support bars, first select the object in question and then »Add support...«. In the subsequent dialogue, activate the box »Create individual support«. Also ensure that the box »Lift components before support (in mm)« is not activated. You will then be taken to a reduced view of your object and the associated support bars, where you can remove or add individual support bars as you wish. With the function »Select support« you can mark and remove individual bars (right click: »Remove selection«).

»Support« window
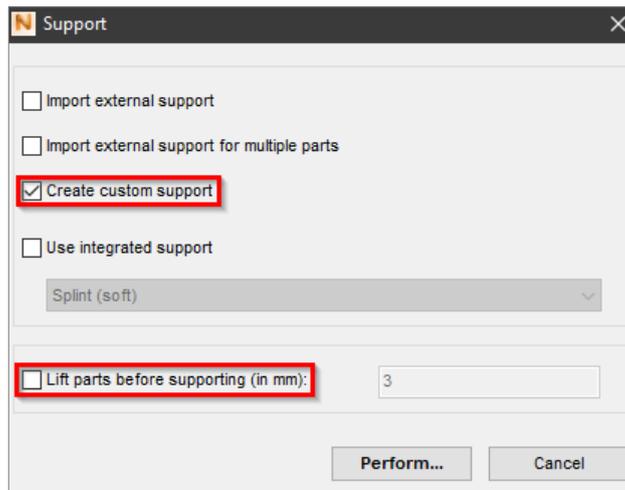
Incorrectly placed supports on the inside of the splint
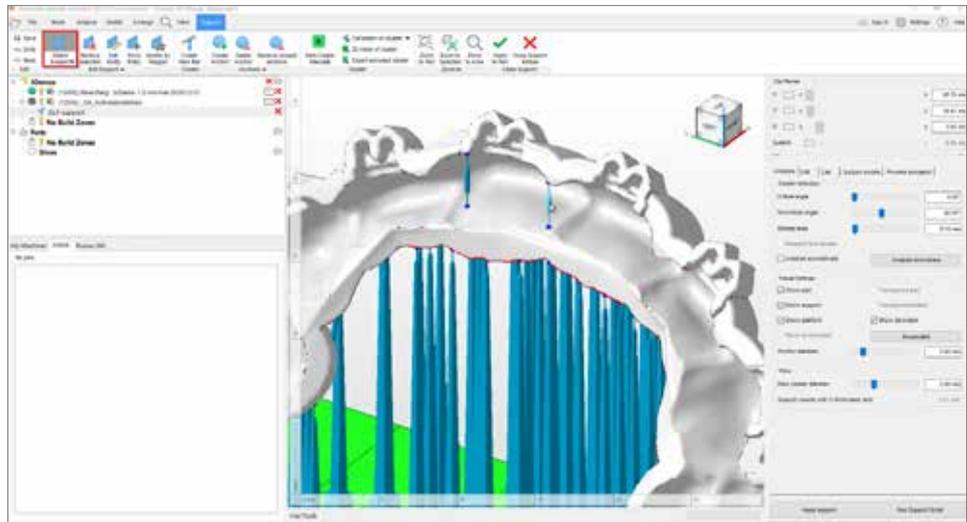
### 3.2.4.2.   Supports for indirect bonding trays

In some types of construction (sleeve/offset type), the bracket pockets are attached to the splints at right angles and must therefore be provided with supports. As the pockets can be quite small, they are not always recognised by the automatic support function and must be supported individually.

Missing supports (red circle) in the area of the bracket pockets on a bracket transfer splint
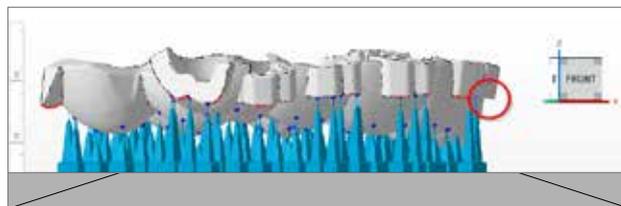
To do this, switch to the view for removing and adding individual support bars (see 3.2.4.1) and rotate the 3D view so that you are looking at the splint from below. This allows you to quickly identify areas that need further support bars.

Missing supports (red crosses) and correct supports (green ticks) in the area of the bracket pockets on a bracket transfer splint


To set new bars, select the function »Create new bar« in the upper menu toolbar. Double-click on the point on the splint to be supported to create a new support bar (alternatively: left-click to set an anchor point, right-click on the anchor point and click on »Create bar«).

Adding new support bars in Autodesk Netfabb using »create new bar« (red marking)
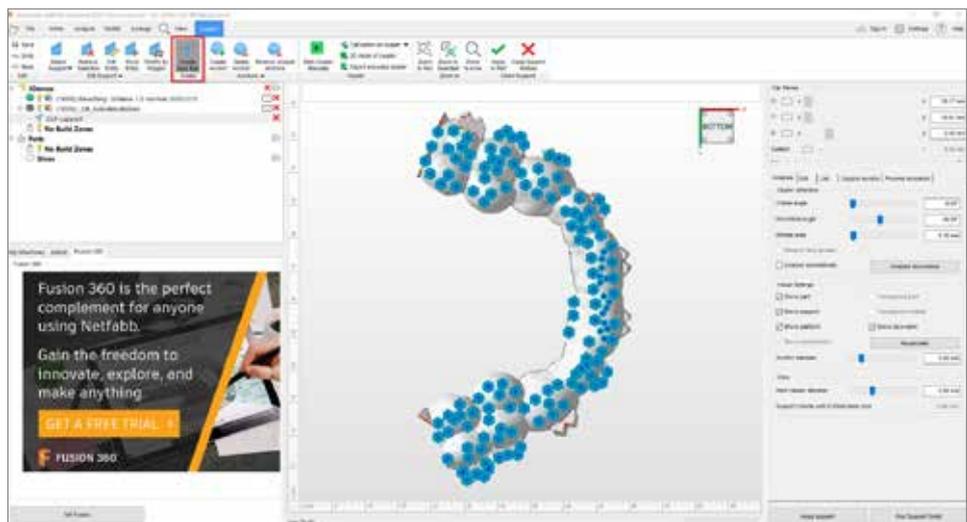
After completing the manual support set-up, check the splint again for correct positioning of the bars and make sure that all bracket pockets are supported. Click on »Apply« to apply the current supports and return to the building plate view.

Correct supports (green ticks) in the area of the bracket pockets on a bracket transfer splint
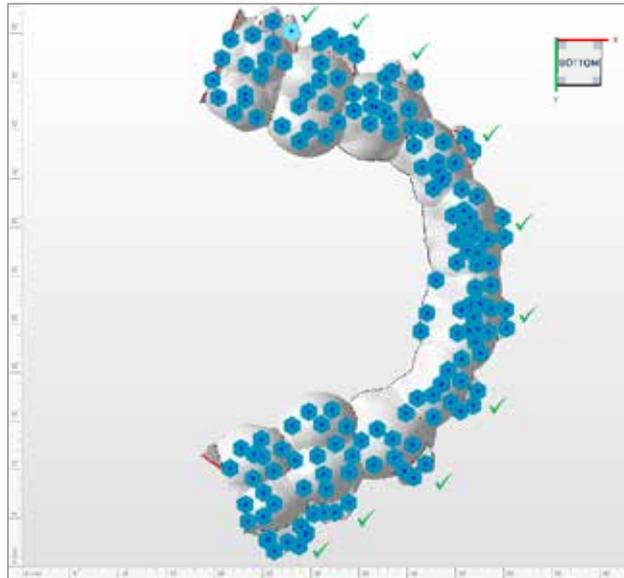
3.2.5. Baseplate

A baseplate ensures better adhesion to the building plate and thus minimises misprints. You should always use a baseplate when printing with LuxaPrint Ortho Flex. The basic settings suggested by Netfabb lead to good results in most cases (grid with hexagonal cells, height: 0.8 mm, cell size: 1.5 mm, offset at edge: 1.5 mm, wall thickness: 0.8 mm).

»Create baseplate« window
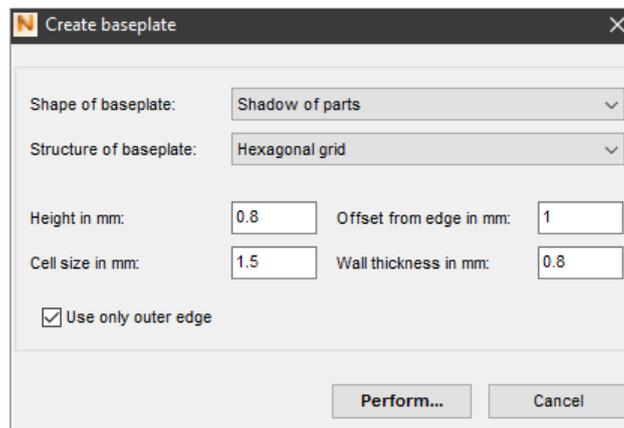
3.2.6. Creating a build job (»slicing«) and transferring it to the printer

As soon as you are satisfied with the arrangement of the pieces on the building plate, the support structures and the baseplates, check the material and machine settings again and create a printer-readable file via »Create build job«.

After the calculation of the individual print layers (the so-called »slicing«), a preview window appears. Here, you can scroll through the layers of the print job and review your object.

Now, transfer the finished print job to your 3D printer via a network connection or USB stick.

The entire build area is shown in black; the areas to be exposed are shown in white.
As an example, at layer 90 in the illustration, support structures are still partially being created, but the splint contour is already largely recognisable.
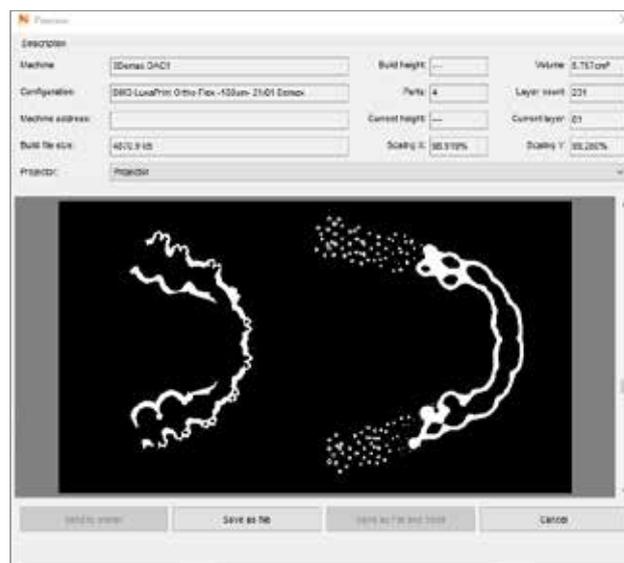
4. Printing

4.1.   Shake the material

≥ 1 min.

DMG LuxaPrint Ortho Flex must be shaken for at least one minute before use. This ensures that you always achieve a homogeneous product and thus consistently high-quality results.

4.2.   Scanning RFID tags

Scan the material's RFID code for greater process reliability. The 3D printer can detect possible incorrect material information in the software and will warn you if necessary (supported by DMG DentaMile Lab5/Lab5 ProDMG 3Demax/ DMG 3Delite (DMG), D30/D20+/D20+ cartridge/D10+ (Rapidshape), P20+/P10+ capsule (Straumann)).

4.3.   Adding printing material

Put LuxaPrint Ortho Flex in the resin reservoir of your 3D printer. Make sure that the reservoir is filled far enough, so that the resin can continue to flow even if the build plate is fully occupied. Please never fill the resin reservoir to the brim, or the resin may overflow and contaminate your printer. Use separate material trays for every biocompatible printing material to avoid cross-contamination.

4.4.   Starting a 3D printing job

Start the print job on your 3D printer.

5. Post-processing

Intelligent connectivity

As a user of a DMG 3D printing system consisting of 3Demax, 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 devices, where you only have to select the appropriate print job to start the individual post-processing.

5.1. Draining

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

5.2. Detaching pieces from the build plate

Carefully detach printed objects from the build plate. Use a spatula or the cutter that came with the printer (or similar cutting tool).

Removing the splints from the building plate

In the case of highly adhesive objects, carefully hit the handle of the spatula with a hammer to detach the baseplate of the printed object from the building plate. Always be careful not to damage the splints.

If you are using a DMG 3Delite (DMG), D10 + (RapidShape) or P10 + (Straumann), leave the objects on the build plate and hang the entire plate in the provided cleaning device (DMG 3Dewash, RS wash or P wash).

5.3. Cleaning

After printing, the splints must be carefully cleaned of any non-hardened material. Use separate cleaning solutions for every biocompatible printing material to avoid cross-contamination.

PRACTICAL TIP

Prolonged contact with the cleaning liquids can affect the accuracy of the objects as well as their mechanical properties. Please keep to the times stated here.

5.3.1. 3Dewash (or RS wash/P wash)

Simply place your printed objects in the cleaning chamber of the 3Dewash and select the program for DMG LuxaPrint Ortho Flex or the appropriate print job (requires Smart Connectivity). For best cleaning results, place the splint in the cleaning chamber with the mating surface facing downwards. The cleaning should be done with isopropyl alcohol (approx. 99%).

Splints in the DMG 3Dewash cleaning unit

5.3.2. Ultrasonic cleaning

If you do not have any of the cleaning devices mentioned above, pre-clean your splint with ethanol (approx. 96%) or isopropyl alcohol (approx. 99%) in an ultrasonic bath, for a maximum of 3 minutes. You can also use a brush, if necessary. Next, clean your pieces again in a separate container with clean ethanol (approx. 96%) or isopropyl alcohol (approx. 99%) for a maximum of 2 minutes in the ultrasonic bath.

5.3.3. Dry

Ensure the splints have completely dried before you proceed with post-curing. Use compressed air for this, or let the pieces air dry for about 30 minutes. Also make sure that no residue of uncured resin is left on your splints.

Drying the splints with oil-free air
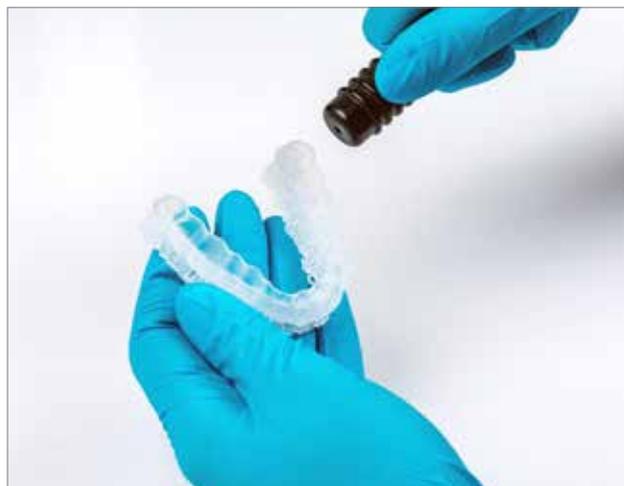
5.3.4 Final test

Inspect the splints thoroughly after drying and ensure that

◀ The splints are clean and completely dry

◀ No cleaning fluid or resin residues remain on the surface,
(indicated by a shiny object surface)

◀ No imperfections or solid resin particles can be found on the mating surface.

If there are still liquid resin residues on the surface, they can be removed e.g. with a spray bottle containing isopropyl alcohol or a cloth soaked in isopropyl alcohol. Then dry your splints completely as described above.

Removing liquid resin residues using isopropyl alcohol

5.4. Post-curing

Correct post-curing of the pieces is important to obtain a biocompatible result with optimal mechanical properties and a perfect fit. Therefore, always pay attention to the correct post-curing and adhere exactly to the given specifications. Never place splints on top of each other in the exposure chamber and make sure that the pieces receive light from all sides.

PRACTICAL TIP

Post-curing that is too short, too long, or too intensive can lead to a loss of accuracy due to distortions in the part and discolouration of the pieces.

Splints in the DMG 3Decure post-curing unit

5.4.1. DMG 3Decure

Simply place your printed object in the cleaning chamber and select the program for DMG LuxaPrint Ortho Flex or the appropriate print job (requires Smart Connectivity).

5.4.2. Otoflash / Heraflash / HiLitePower3D

Place your printed objects in the chamber of the exposure device and cure using the settings given below.

Light-curing unit	Light-curing time	Tips
Otoflash G171 (N36w0 bath)	2 x 2,000 flashes	After the first 2000 flashes, let the printed object cool down and turn it over
Heraeus Heraflash/Kulzer HiLite power 3D	2 x 180 seconds	After the first 180 seconds, let the printed object cool down and turn it over

5.5. Detaching support structures

Carefully detach the support structures. It is best to use a hand tool with a cutting disc, a plaster knife or a small pair of forceps or scissors. The remains of the support structures can then be carefully removed with a milling machine or a polisher.

PRACTICAL TIP

Although cutting off the supports 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.

Detaching support structures

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Rotating instruments for
manual post-processing

5.6. Finish and polish

LuxaPrint Ortho Flex offers fast and easy grinding and polishing for a smooth and slightly matt 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.

- A **tungsten carbide bur** can be used to remove supports and their residues.

- The splint can be pre-polished with a **(fine) buffing wheel** (sufficient for indirect bonding trays).

- Where a smooth surface is required, it can be polished manually with a **goat hair brush and (light) polishing paste** followed by a **high-lustre buffing wheel**.

- To remove polishing residues, splints are carefully steamed off using an **evaporator** or cleaned for 5-10 minutes at 30°C in an **ultrasonic bath** with a standard mixture of water and detergent. To avoid deformation of the splint, final cleaning of the splint using an evaporator should be directed over a wide area rather than selectively.

To prevent adhesion between brackets and splints, indirect bonding trays must be insulated in the patient's mouth before use.

PRACTICAL TIP

Please inspect your finished objects after completion for any damage or cracks. Damaged splints should never be used in patients.

Completed splints

6. Validated fitting accuracy

All of our materials and printing processes are examined and evaluated in terms of achieved accuracy.

The mating surfaces of the bracket transfer tray produced in the validated workflow using LuxaPrint Ortho Flex Resins, DMG 3Demax printer, DMG 3Dewash cleaning unit and DMG 3Decure post-curing unit show mean deviations of 43 μm. This means that 99.5 % of the mating surface is within 150 micrometres of the digital source data. 93.5% of the object surface deviates less than 100 micrometres from the digital output data.

Surface comparison of the mating surface of a bracket transfer splint produced with validated DMG DentaMile Workflow as compared to the digital output data.
99.5 % of data points lie within a tolerance of 150 μm. The median deviation is 43 μm.