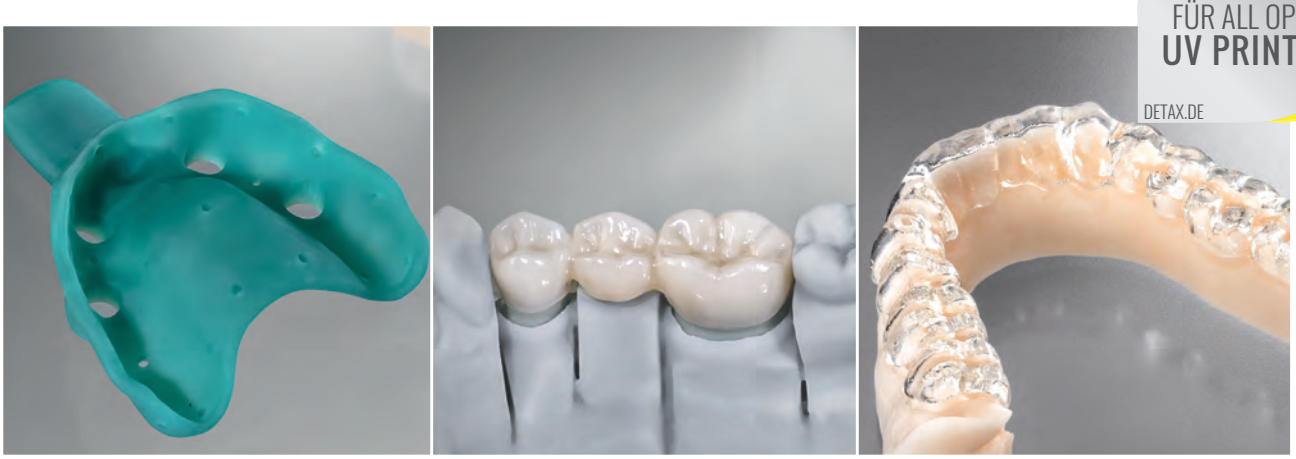

Practice-oriented use of 3D printing in the dental lab

Application report from Uwe Aupperlen, Aupperlen Dental Technik GmbH

Digitalisations in dental technology has advanced at an enormous pace over recent years, such that it is hard for the lab owner to keep up with developments.

That is why it is important to assess which options make sense in the lab. Wrong paths and bad investments can have devastating implications.
Since establishing our lab in 1989, we have been producing dental prosthetics for around 28 years now. The first scanner arrived in our lab in 2007 and ushered in a new era. Over the years our CAD/CAM domain has been expanded with various scanners and milling systems. As a means of relieving the burden on our milling systems and to take care of further workflows in digital fabrication, we decided to take advantage of the possibilities offered by a 3D printer. We opted for the open "FREEFORM PRO 2" 3D printer from Asiga, which uses UV LED light for curing materials. The materials from the company DETAX, as approved and accepted by Asiga, meet the requirements of the German Medical Devices Act (MPG) and round off the production line.

The materials used:

- Freeprint® ortho UV, for fabrication of splints and various templates and much more besides.
- Freeprint® tray UV, for fabrication of individual trays and bases for bite registration.
- Freeprint® cast UV, for fabrication of a wide range of cast objects.
- Freeprint® temp UV, for fabrication of temporary crowns & bridges.
- Freeprint® model UV, for fabrication of dental models.

The "Otoflash G171" xenon photoflash unit from NK-Optik with a protective gas atmosphere is used for final curing of objects cleaned with pure isopropanol in an ultrasonic bath.
As previously, the different STL files for the respective 3D printing jobs are generated with our open "3shape" and "Zirkozahn" systems with the associated software.
In order to obtain the "Class IIa" medical device liability classification for drilling, X-ray and bite splints, it is absolutely necessary for all those involved to adhere to the prescribed procedure. The following pictures and explanations present a selection of the areas in which 3D printing is used in our lab.

Bite splints
The occlusally adjusted splints made in the "Zirkonzahn Bite Splint Module" can be generated in 20 - 40 minutes (Fig. 1). The object placed with the "Asiga Composer Software" is transmitted via

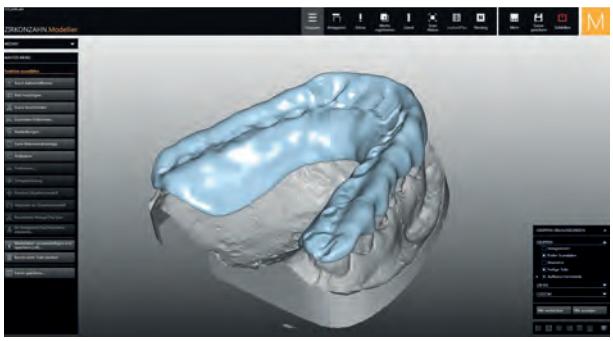

Fig. 1

the network to the 3D printer and printed. The "Asiga Composer Software" allows placement of individual or multiple objects or splints. The size of the printer's platform in our case allows setting of up to 6 parallel aligned bite splints. The number


Fig. 2


Fig. 3


Fig. 4


Fig. 5

of objects depends on the height of the splints and their placement angles relative to the printer platform (Fig. 2). The more acute the angle to the platform is chosen, the thicker the polymerised layers through the object and the shorter the printing time. The finished printed Freeprint® ortho UV (DETAX) splints are removed from the printer together with the printing plate to detach the objects (Fig. 3). These are easy to separate from the printing plate with a spatula. The objects are also cleaned with isopropanol for 2x 3 minutes in the ultrasonic bath. Cleaning detaches the sticky, shiny layer and the splints become matt (Fig. 4). After the final curing in "Otoflash G171" (Fig. 5) the support structures can be removed. The splints are placed onto the model, finely ground and polished to a high gloss – 25 - 40 mins. should be included for this. Further adjustments can be made with the modelling resin Freeform® (DETAX). Common rotary instruments, such as mills, round burs, rubber polishers etc., can be used to finish off the splints. What matters here too is that the more precisely the preparatory work is carried out, the easier it is to obtain a high gloss using rotary brushes with pumice powder and then to polish on high gloss buffing wheels.

X-ray / drilling templates and navigated drilling templates

X-ray and drilling templates are created in the "3shape Implant Studio Software" using digital volume tomography (DVT) (Fig. 6, 7). They enable precise location and therefore also precise placement of the planned implants. The templates are placed in the same way as the splints, printed with Freeprint® ortho UV (DETAX) (Fig. 8), removed


Fig. 6


Fig. 7

from the printing plate and cleaned. Finishing off to a high gloss level is not absolutely necessary here. After final curing and removal of the support, the splints can precisely fitted to the models without difficulties. The selected X-ray sleeves can now be inserted in the mandibular X-ray template (Fig. 9) and so a DVT can be created. This then serves as the basis for producing a drilling template.


Fig. 8


Fig. 9


Fig. 10

The appropriate guide drilling sleeves can now be inserted in the maxillary drilling template (Fig. 10). Navigated placement of the implants can be planned.

Trays and bases for bite registration

The individual tray was produced in 3shape with the Dental Designer (Fig. 11) in approx. 10 mins. and placed with the "Asiga Composer Software" (Fig. 12) and sent to the 3D printer via the network.

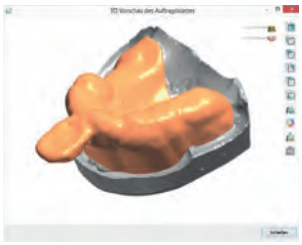
Fig. 11

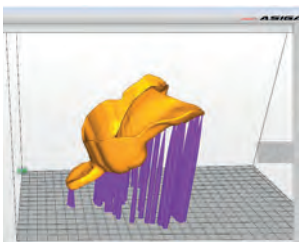
Fig. 12

Once the print has been finished with Freeprint® tray UV (DETAX), the platform moves up and the printing plate plus trays can be removed (Fig. 13). After releasing the objects, they are cleaned with isopropanol in the ultrasonic bath 2x every 2 minutes, the support structures are separated and

the objects are cured in the flash curing device with 2000 light flashes. The trays can now be finished with a few polishing steps.

Fig. 13

Duplicate prosthesis

A maxillary prosthesis is scanned using the Zirkonzahn System (Fig. 14) and reproduced with the 3D printer (Fig. 15). This enables an implant impression to be taken while simultaneously

Fig. 14

adopting the existing bite position (Fig. 16). At the same time, all information from the prosthesis worn for years is acquired for the new job. Figure 17 shows the way from the edentulous jaw, a duplicated printed prosthesis for the DVT, through

Fig. 15

Fig. 16

Fig. 17

to the navigated drilling template with guide sleeves inserted for implantation.

Prototypes

The originally produced denture is fabricated in the 3D printer prior to milling the final appliance (Fig. 18, 19) and is tried-in. This way, modifications can be undertaken, patient wishes observed and any errors spotted and rectified, such that the final denture fulfils all wishes and meets all needs (Fig. 20).

Fig. 18

Fig. 19

Fig. 20

Crowns, bridges, single-piece cast frameworks

The STL data for the subsequent cast are generated in the "3shape System" and "Zirkonzahn System". A 12-unit bridge is constructed using the modelling software (Fig. 21). The resulting STL data record is printed in the residue-free, castable resin Freeprint® cast (DETAX) in the way previously described (Fig. 22). Once the bridge has been cleaned in the usual, previously described way (Fig. 23), it can be invested and cast in the conventional manner. After finishing the perfectly fitting bridge, it is then oxide

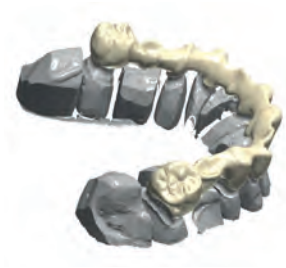

Fig. 21

Fig. 22

Fig. 23

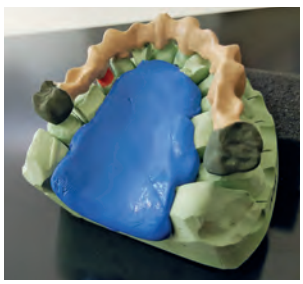

Fig. 24

fired and subsequently acid cleaned, primed with opaquer and prepared for ceramic veneering (Fig. 24). Model casts can also be created this way. A model casting plate is designed in the 3shape model


Fig. 25


Fig. 26


Fig. 27


Fig. 28

casting module (Fig. 25, 26). Once the data record has been printed with the residue-free, castable resin Freeprint® cast UV (DETAX), this object too is ready for investing and casting (Fig. 27, 28).

Temporary crowns, bridges
A 13-unit bridge was created using the "Bridge Modelling Program" (Fig. 29) and printed on the Asiga Freeform printer with Freeprint® temp UV (DETAX) (Fig. 30). Freeprint® temp UV is a class IIa medical device.

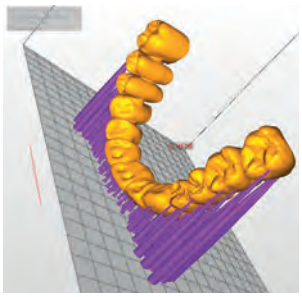
Fig. 29


Fig. 30

After the ever-recurring, same cleaning process, the bridge, freed of residual resin, is matt. The supports can be removed and the bridge placed on the model (Fig. 31). The bridge is processed in line with the usual, known methods and as a result of the final polishing takes on a gloss finish. Now the bridge is ready for use as a temporary denture (Fig. 32). Individualisation prior to final polishing to confer the final gloss can be achieved with the aid of the smartrepair® system (DETAX).

Models and working/master models
A model with removable stumps can be produced


Fig. 31

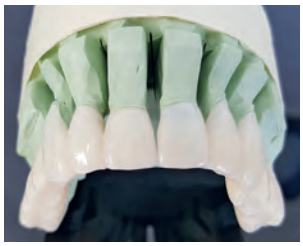
Fig. 32

digitally from a digital impression using the "Modellbuilder" from Zirkonzahn. The data record is sent to the printer for processing and is printed with Freeprint® model UV (DETAX). The fully printed dental arch with the associated stumps can now be detached from the plate, cleaned and placed in the light polymerisation unit for final curing (Fig. 33). From this data record, a model with removable stumps can be created and printed from a data record using the "Modellbuilder" from Zirkonzahn at the same time as the zirconia bridge is created and milled. The finished model with bridges (Fig. 34), model and bridge separated (Fig. 35).


Fig. 33


Fig. 34


Fig. 35

Equipment
3D printer: ASIGA Freeform PRO 2
Xenon photoflash unit: NK Optik Otoflash G 171
Scanners: 3Shape, Zirkonzahn

Materials (DETAX)
Freeprint® ortho UV
Freeprint® tray UV
Freeprint® cast UV
Freeprint® temp UV
Freeprint® model UV
Freeform®
smartrepair® System

Author:
Uwe Aupperlen
Aupperlen Dentaltechnik GmbH
Teckstr.17 · 73230 Kirchheim
info@dentaltechnik-aupperlen.de
www.dentaltechnik-aupperlen.de