Digital Denture: Complete denture prosthetics for the 21st century

A new CAD/CAM-based procedure has the potential to revolutionise the way complete dentures are manufactured

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The term 'Digital Denture' describes an integrated manufacturing process for CAD/CAM-based complete denture prosthetics. The Digital Denture process was presented to the public for the first time at IDS 2015. Key elements of this process include innovative devices, software programmes and coordinated materials geared towards the needs of dental technicians and clinicians. Especially designed software programmes streamline complex working steps, i.e. the setup of denture teeth. Digital Denture results in accurately fitting CAD/CAM denture bases and reduces the active working time required for accomplishing complete dentures.

Digital Denture is a clearly structured process consisting of a well-defined number of working steps. The distinctive feature of this process is that users themselves can decide which parts of the process they want to accomplish digitally and which parts they want to perform conventionally. Below follows an illustrative description of the individual steps.

First step—Clinical

The process begins in the dental practice with an initial impression of the oral cavity. At the same appointment, a preliminary record of the patient’s centric and vertical relationship is taken using a Centric Tray. This information forms the basis for the fabrication of customised impression trays with integrated bite plates.

With the help of the preliminary bite registration, the patient-specific occlusal plane can be determined at the first patient visit. For this purpose, a UTS CAD device is attached to the handle of the Centric Tray. Once placed in the oral cavity, the basic bow is aligned to the Camper’s plane (CP) and the bipupillary line (BP) (Figs. 1 & 2).

The position of the occlusal plane can be read from the BP and CP scales respectively. The clinician forwards these data, together with the initial impression and preliminary bite registration, to the dental technician.
_First step—Technical_

The digital workflow can be entered as early as with the fabrication of the customised bite plates—no need for models or a physical articulator. The impressions and bite registrations are digitised one after the other using a scanning device. The two virtual models are set into relation with the data of the preliminary bite registration. For this purpose, the exclusive ‘Digital Denture Professional’ design software guides the user through the menu step by step. First, the position of the occlusal plane is defined. The CP and BP values defined by the clinician are entered into the virtual UTS CAD (Fig. 3). The patient-specific occlusal plane is determined. During the design process, a uniform offset space to allow for the later application of impression material can be defined for the entire basal surface of the bite plate. In addition, the design software includes the newly designed Gnathometer CAD needle-point tracing appliance utilised for the design of the bite rim (Fig. 4).

Milling is carried out using a Zenotec select ion milling unit—the latest member of the Zenotec select family. The acrylic particles produced during dry milling have a static charge and, as a result, they stick to the surfaces of the milling chamber. Zenotec select ion is equipped with nozzles directed towards the milling tools and acrylic blanks. These nozzles supply ionised compressed air during the milling procedure. The compressed air neutralises the static charge and the acrylic particles can be easily evacuated. As a result, clean uncontaminated milling chamber surfaces and milling materials are ensured at all times.

Upon completion of the milling procedure, the bite plates are conveniently removed from the disc and any sharp edges smoothed out. The connection to the Gnathometer CAD has been accurately transferred from the design to the bite plate so that the needle-point tracing appliance can be directly attached (Fig. 5).

_Second step—Clinical_

The dentist now creates the functional impressions. The basal surface of the bite plate is wetted with a commercially available tray adhesive. Subsequently, a closed-tray impression is taken while the patient is performing functional movements. The position of the occlusal plane may be checked another time using the UTS CAD and corrected as necessary.

The maxillomandibular relation is determined using the Gnathometer CAD needle point tracing device, which simply clicks into the milled biting plate. The vertical height of both jaws is set by adjusting the thread of the tracing stylus. Figure 6 shows a typical needle point tracing record.

After the centric relation between the upper and lower jaw has been determined, the bite

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Fig. 3 The provisional occlusal plane for the bite record is established using the patient-specific BP and CP values and included in the design.

Fig. 4 Individual tray and Gnathometer CAD aligned to the provisional occlusal plane.

Fig. 5 CAM-based custom tray for needle point registration.

Fig. 6 Patient-generated gothic arch to determine the centric relation.

Fig. 7 Patient-specific aesthetic landmarks: anatomical midline, smile line, lip closure line and canine position.
plates are immobilised using a registration sil-
cone. Lastly, the patient’s aesthetic lines—e.g.
midline, canine-to-canine line, lip closure line
and smile line—are marked on the record (Fig. 7).
This information assists the dental technician
in setting up the anterior teeth in line with the
patient’s specific aesthetic characteristics.

_Second step—Technical_

The immobilised record and the functional im-
pressions are scanned to generate the functional
models for the final dentures.

Using the digital UTS CAD function, the definite
final position of the occlusal plane is determined,
or corrected (Fig. 8). Following model analysis, the
teeth are chosen from a software library of select
denture teeth. The programme suggests a setup
that is already arranged in occlusion and takes ac-
count of the Spree and Wilson curve. The proposed
setup is based on the occlusal plane as defined by
the technician and can be fully individualised to
suit any individual requirements (Fig. 9). This step
allows the most significant time savings compared
with conventional setup methods. An additional
advantage can be achieved by overlaying the bite
plates to verify the position of the anterior teeth
using the aesthetic lines marked on the bite plates
as guidance. The result is one hundred per cent
reproducible.

At the next step, the software computes the
gingival portions. The technician is again given
every freedom to implement any desired changes
by adding or removing additional material with
the help of a ‘digital’ wax knife.

Upon completion of the denture design, the
technician is granted the option to mill a mono-
lithic PMMA try-in in the CAM unit. The shape of the
denture base corresponds 1:1 to the final denture.
If required, the gingival parts can be mimicked
with pink setup wax to achieve an aesthetic
contrast.

_Third step—Clinical_

Occlusion, phonetics, aesthetics and suction
effect are checked at the try-in, similar to
conventional wax try-ins (Fig. 10). If necessary,
desired corrections to the position of the teeth
can be marked on the try-in denture or on
a digital photograph, or, alternatively, directly
communicated to the technician. The technician
uses this information to modify the design
accordingly.

_Third step—Laboratory_

The technician calls up the saved denture
design and implements any modifications as
required. Before the output files of the final

Fig. 8. The final occlusal plane for
the denture design is defined on
the specified BP and CP values and
included in the denture design.

Fig. 9. The 28-tooth sample setup,
arranged in function, is already
aligned with the occlusal plane.

Fig. 10. The monoblock for the
esthetic try-in can be easily
modified using pink setup wax.

Fig. 11. A transfer template for the
insertion of the physical denture
teeth is automatically computed at
the same time as the output file for
the CAM procedure is created.
denture base are created for manufacturing in the CAM unit, the CAD software automatically computes an additional transfer template that depicts the occlusal surfaces and incisal edges of the maxillary and mandibular teeth (Fig. 11). This information is then fed into the CAM software to mill the dentures in the Zenotec selection milling unit.

If conventional methods are used, the denture teeth often have to be manually reduced at the basal surface using a handheld grinder, because the vertical dimension between the maxillary and mandibular teeth is in many cases too short.

The CAD/CAM manufacturing process addresses this situation by cutting two repositioning grooves into the IvoBase CAD for Zenotec disc. As a result, the disc can be secured only in one position using an especially designed disc holder. Then, in the first milling run, the denture base is milled from the top surface to its final shape including the holes for the placement of the physical teeth. After that, the disc is removed. The pre-fabricated denture teeth are polymerised to the denture base using IvoBase CAD Bond and the transfer template computed and prepared beforehand (Fig. 12). The transfer template is used to verify the correct placement of the teeth. To conduct the second milling run, this time on the basal surface, the disc is again secured to the disc holder in exactly the same position as before (Fig. 13). Now, if individual teeth turn out to be too long, the excess will be ground away during the second milling run. The result of the milling process is a CAD/CAM denture that can be polished to a high gloss using familiar methods.

_Fourth step—Clinical_

Incorporating the final dentures is carried out in the same way as the incorporation of conventional dentures (Fig. 14). Particularly noteworthy is the excellent basal fit of the dentures. As the manufacturing process is not affected by polymerisation shrinkage or any other thermal influences and results in the precision typical of CAD/CAM methods, the dentures exhibit an exceptional accuracy of fit and provide an outstanding suction effect.

_Outlook_

The trend towards digitisation is not a new or unknown phenomenon in dentistry. Digital technology has started to make inroads into fixed dental prosthetics several years ago and has advanced successfully. It was therefore only a question of time until it would also start to gain a foothold in removable prosthetics. The Digital Denture process may represent an essential milestone in the advance of dental technology in fixed prosthetics. And this trend is said to continue: additional indications will advance the modernisation of removable prosthetics and the efficiency of the manufacturing processes will be consistently optimised._

Fig. 12. The positioning jig allows the denture teeth to be easily placed in the holes milled for the physical teeth. An inspection window allows the user to check if the teeth are placed firmly in their position.

Fig. 13. The disc holder is especially designed to ensure precise repositioning of the disc for the final milling process.

Fig. 14. CAD/CAM-fabricated custom-made dentures: harmonious integration into the patient’s overall aesthetic appearance.