# Digital complete dentures

Piero Venezia[1] and Pasquale Lacasella[1]

First clinical and technical experiences with the Digital Denture System (Wieland Dental) CAD/CAM technologies for dentistry were first introduced in the 1980s. At the time, they were mainly geared towards fixed prosthetics. This has now changed as some manufacturers have been developing software and hardware solutions for the digital manufacture of complete dentures in recent years.

Until a few years ago, the idea of using CAD/CAM processes to manufacture removable dentures appeared to be hardly realistic even though CAD/CAM technologies had already become an indispensable component of the workflow for fixed superstructures on natural teeth and implants. Recently, digital tools enabling the rapid and predictable treatment of edentulous patients have become available. This report describes a digital system (Digital Denture System, Wieland Dental) that allows complete dentures to be created in only three appointments. Digital denture design and denture base milling considerably streamline the workflow compared to conventional methods. At the same time, digital dentures ensure a high standard of quality in terms of esthetics and function.

## Case study

A 70-year-old female was wearing a complete maxillary denture and had suffered an avulsion of the anterior mandibular teeth four weeks before her first visit. Lack of support in the posterior mandibular region and continued pressure in the anterior maxillary region had led to severe atrophy. The clinical situation was therefore akin to the dental condition described as "combination syndrome" (Figs 1 and 2). Since the patient wanted a rapid and cost-effective rehabilitation with removable dentures, we opted for the "Digital Denture System" protocol.

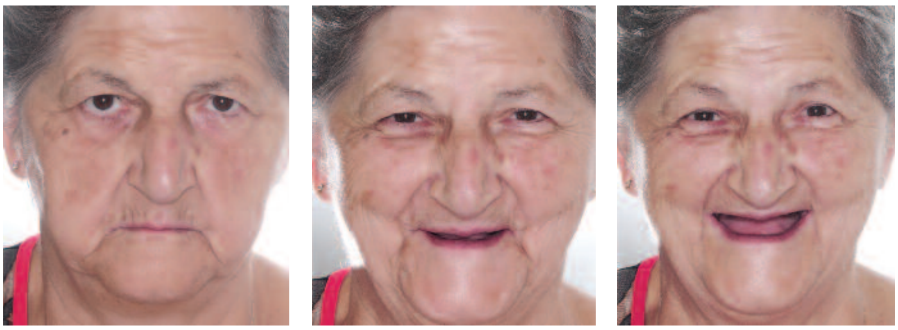
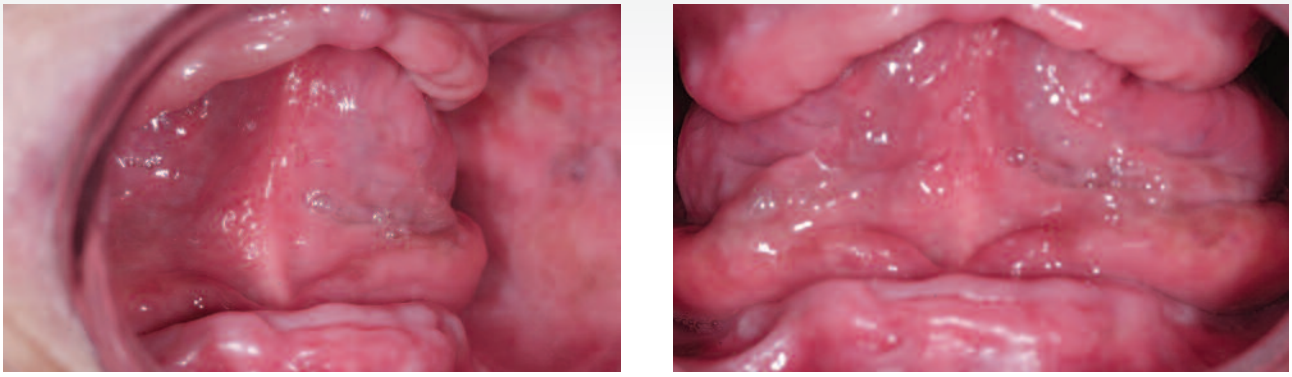


*Fig. 1: An edentulous patient requiring a prompt and cost-effective rehabilitation 16 of her upper and lower jaw*

[1] Dr Piero Venezia and Pasquale Lacasella
Bari/Italy

**Contact details:**
Dr Piero Venezia
Studio Cavalcanti & Venezia
Via G. Posca 15
70124 Bari
Italy
info@studiocavalcantivenezia.it

Pasquale Lacasella
Apulia Digital Lab SNC
Via Pappacena Enrico 10
70124 Bari
Italy
lacasella@apuliadigitalab.it



*Figs 2a and b: Intraoral view: resorbed alveolar ridges and a clinical situation similar to a combination syndrome*

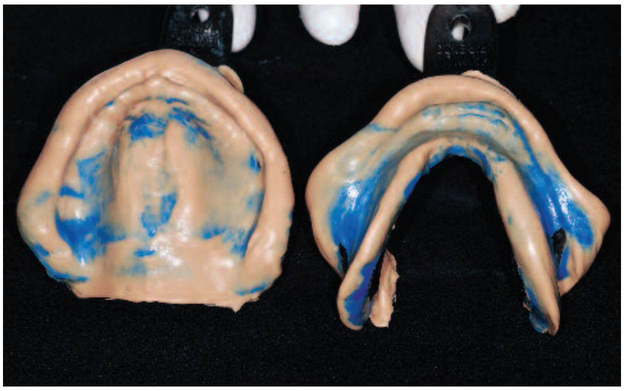


*Fig. 3: Double-mix impression of the upper and lower jaw*

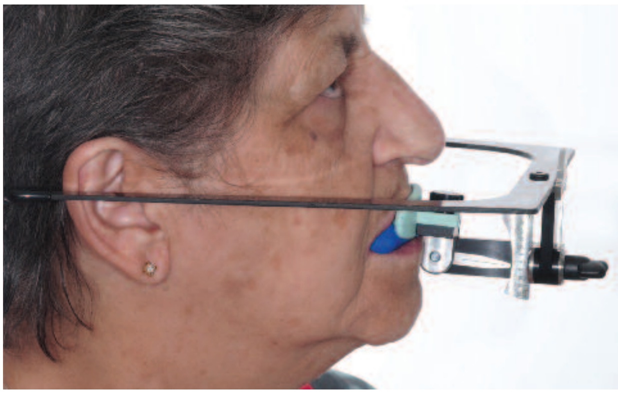
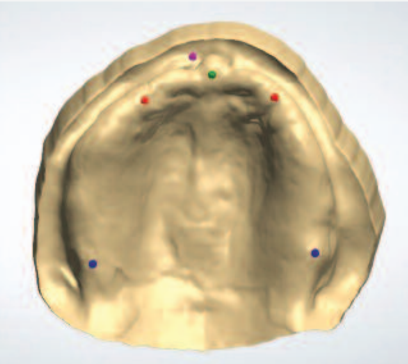
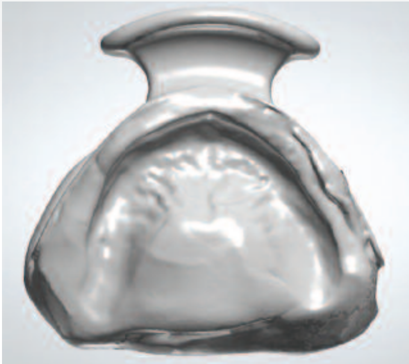


*Fig. 4: UTS CAD device to determine the occlusal plane*

## First appointment

For the preliminary impression, a prefabricated impression tray was coated with a tray adhesive (Virtual® Tray Adhesive) and the impression material was mixed with the catalyst ( Virtual Putty Regular Set). After the primary impression has been taken, the areas where excessive compression is present may be slightly reduced with the help of a micromotor handpiece. Next, the secondary impression was taken with a low- viscosity silicone (Virtual Light Body Regular Set) (Fig. 3). To determine the preliminary maxillomandibular relation and occlusal plane, two reference points, one on the chin and one on the nose, were marked and the distance between the two points was measured. The vertical dimension of occlusion was determined by subtracting approx. 2 to 3 mm from thesoftinterocclusal rest position, which corresponds to the freeway space. A Centric Tray was used to record the maxillomandibular relationships. This device consists of an acrylic arch with a retention rail. The Centric Tray was loaded with impression material (Virtual Putty Regular Set).We asked the patient to slowly close the jaws to the preliminary vertical height. After the impression material had set completely, an UTS CAD device Wieland Dental) was attached to the handle to establish the occlusal plane. The UTS CAD is a registration device to measure the angle of the occlusal plane in relation to Camper's plane (CP) and the bipupillary line (BP). Once measured, the angles were transferred to the CAD software to reproduce the virtual position of the occlusal plane for the design of the 3D Bite Plate (Digital Denture Professional Add-on,Wieland Dental) and the denture. The Centric Tray was attached to the adaptor of the UTS CAD and then the lateral braces of the bow were aligned to Camper's plane (Fig. 4). Next, the front part of the basic bow was aligned to the bipupillary line and the BP screw was fastened to secure the registration joint. The angle values of the patient were filled into the order form and then the form, impression and Centric Tray record were all forwarded to the lab.





*Figs 5a and b: Base for the next design steps: anatomical impression of the jaws and digitized preliminary registration*

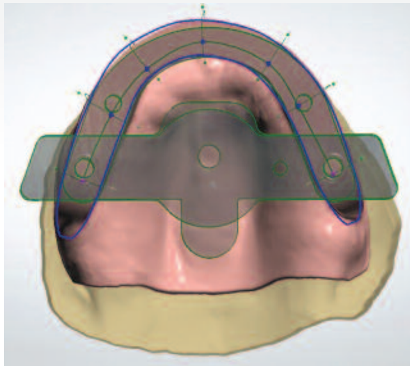


*Fig. 6: Design of the 3D Bite Plate taking the needle point tracing device (Gnathometer CAD) into account*

## In the lab

The impressions and the Centric Tray record (preliminary bite registration) were scanned using the Digital Denture Professional software add-on – based on the Denture Digital Design software (3Shape) – and the ScanIt Impression (3Shape) soft ware add-on. CP and BP angle modifications can be implemented with the above mentioned add-on. The program brings the two scans together and produces two virtual models of the edentulous jaws, which are aligned according to the clinical situation (Figs 5a and b).

The dental technician created a 3D Bite Plate for the functional impression and the needle point tracing record. The models were aligned to each other on the basis of the preliminary impression. Next, the dimension of the bite rims had to be established (Fig. 6). The 3D Bite Plate design allows for insertion of both the bite rim supports for functional impression-taking and the registration plates of the Gnathometer CAD device (Wieland Dental) for needle point tracing. The CAD data sets of the 3D Bite Plates were sent to a Zenotec select ion milling unit (Wieland Dental) for machining (Fig. 7).

*Fig. 7: CAD/CAM-milled 3D Bite Plates ready to be connected to the needle point tracing appliance*

## Second appointment

Prior to taking the functional impression, the bite rim supports were inserted into the 3D Bite Plates. For the registration, the bite rim supports were simply replaced by the registration plates. A vinyl polysiloxane material (Virtual Monophase) was used for functional border moulding. For this purpose, the material was applied to the margins of the maxillary plate. Once the plate was seated in the oral cavity, the muscles were activated. Next, an adhesive varnish (Virtual Tray Adhesive) was dispensed onto the inner surface of the tray. Once dried, Virtual Light Body impression material was applied and the 3D Bite Plate was seated in the mouth (Fig. 8).

The patient was asked to carefully close against the opposing jaw. After that, the UTS CAD appliance was used to check the parallelism of the occlusal plane to the bipupillary line and Camper's plane.

To determine the maxillomandibular relations, a Gnathometer CAD was used. This appliance is designed for taking needle point tracing records in edentulous patients. The bite rim supports were removed and the Gnathometer CAD mounted. Colouring material (crayon, felt tip pen) was applied to the lower registration plate and the patient was asked to perform retrusive, protrusive and lateral movements. The coloured registration plate showed the typical gothic

*Fig. 8: Functional impression with Virtual Light Body*

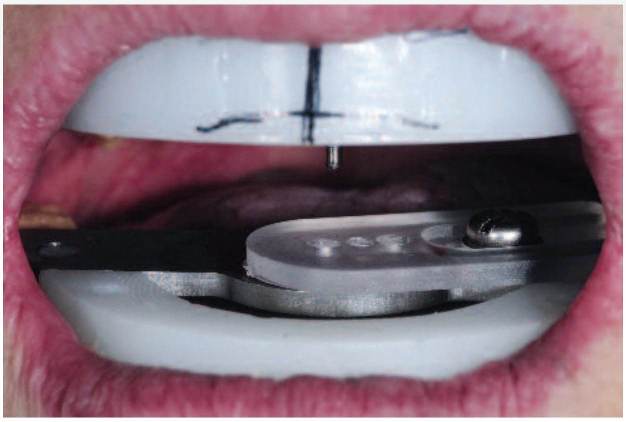


*Fig. 9: Needle point tracing: centric position verified by the patient*

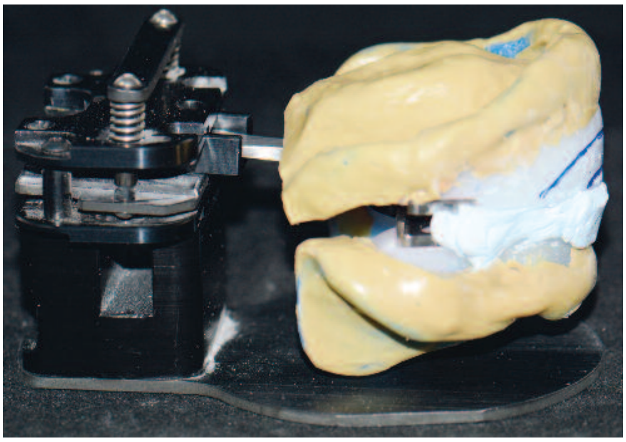


*Fig. 10: The exactly aligned impressions ( immobilized records) are digitized using a lab scanner.*

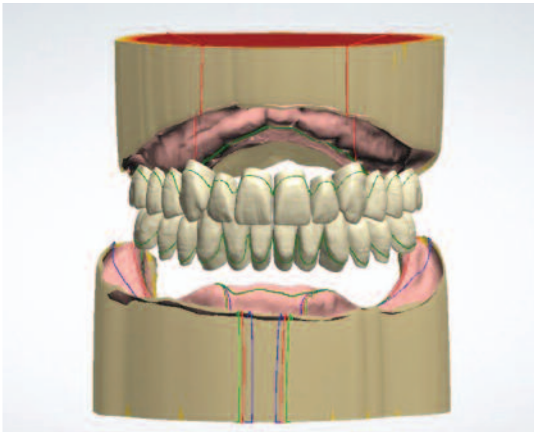


*Fig. 11: CAD tooth setup: an extensive software library of denture teeth assists in the process.*

arch tracing record produced by the tracing stylus. The perforation of the fixing plate was aligned with the arrow head of the arch (centric relation) and secured in position.

The patient was asked to occlude. This allowed us to check if the centric relation was established correctly (Fig. 9). The three-dimensional maxillomandibular record can be immobilized with a suitable material (e.g. CADBite). Lastly, the patient's esthetic lines (midline, canine-to-canine line, smile line, lip closure line) were marked on the record. The immobilized record was then forwarded to the lab, together with information about the tooth selection and CP and BP values.

## In the lab

Both sides of the record can be digitized in their exact position thanks to the denture scan holder (3Shape) (Fig. 10). The digitized jaw models were aligned with each other on the basis of the registered relations and the occlusal plane was established using the data captured with the UTS CAD.

The dental technician defined the extension of the denture and selected an appropriate tooth mould from a software library of denture teeth (Fig. 11). The Digital Denture Professional software add-on contains several examples of functional setups for select Ivoclar Vivadent and Candulor denture teeth. This saves considerable time. The functional parameters and mandibular dynamics can be verified in a virtual articulator similar to the Stratos 300 and possible interferences can be identified.

## Third and fourth appointment

The third appointment is optional. Here, a prototype was

*Fig. 12: Try-in of the prototype to check the functional parameters*

*Fig. 13: Complete dentures created with CAD/CAM*

*Fig. 14: The patient is clearly happy with her digitally produced set of dentures.*

tried in on the patient to check the esthetics, phonetics and function of the prospective final dentures (Fig. 12). Fine adjustments, such as corrections to the midline or reduction of the vertical dimension were communicated to the lab.

The needle point tracing record with the verified centric position and correct alignment of the occlusal plane delivers essential information for the denture tooth setup.

## In the lab

The denture design was approved for CNC production. A transfer template was computed automatically to facilitate the correct placement of the denture teeth. The CNC milling machine then finished the denture bases. The dentures were removed from the disc and polished (Fig. 13).

## Fourth appointment

Intraoral evaluation of the complete dentures and subsequent modifications are carried out in the same way as the procedures for conventional dentures. Hardly any alterations were necessary in this case. The dentures provided a firm and reliable fit and harmoniously integrated into the patient's overall facial appearance (Fig. 14).

## Conclusion

Scanning technologies, combined with CAD/CAM processes, substantially reduce the workload associated with the fabrication of complete dentures. Virtual setup and design facilities (CAD) and denture milling procedures (CAM) eliminate the engthy processes involved in model articulation and flasking. As polymerization shrinkage does not occur, the dentures exhibit a high accuracy of fit. The system described in this report meets the demographic and economic requirements for the production of straightforward, fast, cost-effective and high quality dentures for edentulous jaws.

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