Only a few years ago, the idea of using CAD/CAM to fabricate removable dentures seemed scarcely realistic even though such technologies had already become an indispensable component of the workflow for fixed superstructures on natural teeth and implants. Recently, digital tools that help to provide 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 produced in only three appointments.

A 70-year-old female patient wearing a complete maxillary denture had suffered an avulsion of the anterior mandibular teeth four weeks prior to 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. 1a–c, 2a&b). Since the patient wanted a rapid and cost-effective rehabilitation with removable dentures, we opted for the Digital Denture System protocol.

**First appointment**

For the preliminary impression, a prefabricated impression tray was coated with a tray adhesive (Virtual Tray Adhesive, Ivoclar Vivadent) and the impression material was mixed with the catalyst (Virtual Putty Regular Set, Ivoclar Vivadent). After
the primary impression had been taken, the areas where excessive compression was present were 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, Ivoclar Vivadent; Fig. 3).

In order 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 approximately 2 to 3 mm from the soft interocclusal rest position, which corresponds to the freeway space.

A Centric Tray (Ivoclar Vivadent) was used to record the maxillomandibular relation. Consisting of an acrylic arch with a retention rail, this device 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, a UTS CAD device (Wieland Dental) was attached to the handle to establish the occlusal plane. This registration device measures the angle of the occlusal plane in relation to Camper’s plane (CP) and the bipupillary plane (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 3-D bite plate (Digital Denture Professional add-on software module, Wieland Dental) and the denture. The Centric Tray was attached to the adapter of the UTS CAD and then the lateral braces of the bow were aligned to CP (Fig. 4). Next, the front part of the basic bow was aligned to the BP and the BP screw was fastened to secure the registration joint. The angle values of the patient were recorded on the order form, and then the form, impression and Centric Tray record were forwarded to the laboratory.

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

The dental technician created a 3-D bite plate for the functional impression and the needlepoint tracing appliance (Gnathometer CAD) into account. 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 3-D 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 needlepoint tracing. The CAD datasets of the 3-D bite plates were sent to a Zenotec select ion milling unit (Wieland Dental) for machining (Fig. 7).
Second appointment

Before taking of the functional impression, the bite rim supports were inserted into the 3-D bite plates. For the registration, they were simply replaced with the registration plates. A polyvinyl siloxane material (Virtual Monophase, Ivoclar Vivadent) was used for functional border moulding. For this purpose, the material was applied to the margins of the maxillary plate. Once the plate had been seated in the oral cavity, the muscles were activated.

In order to determine the maxillomandibular relation, a Gnathometer CAD was used. This appliance is designed for taking needlepoint 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 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 that the centric relation had been established correctly (Fig. 9). The 3-D maxilla–mandibular record can be immobilised with a suitable material (e.g. CADbite, Ivoclar Vivadent). Finally, the patient’s aesthetic lines (midline, canine–canine line, smile line, lip closure line) were marked on the record. The immobilised record was then forwarded to the laboratory, together with information about the tooth selection and CP and BP values.

Next, an adhesive varnish (Virtual Tray Adhesive) was dispensed on to the inner surface of the tray. Once dried, Virtual Light Body impression material was applied and the 3-D 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 BP and CP.

In the laboratory, both sides of the record were digitised in their exact position using the denture scan holder (3Shape; Fig. 10). The digitised 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.

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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 add-on contains several examples of functional set-ups for select Ivoclar Vivadent and CANDULOR denture teeth, saving considerable time. The functional parameters and mandibular dynamics can be verified in a virtual articulator similar to the Stratos 300 (Ivoclar Vivadent) and possible interferences can be identified.

### Third appointment

A third appointment is purely optional. In this case, a prototype was tried in on the patient to check the aesthetics, phonetics and function of the prospective final dentures (Fig. 12). Fine adjustments, such as corrections to the midline and reduction of the vertical dimension, were communicated to the laboratory. There, 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

Intra-oral evaluation of the complete dentures and subsequent modifications were carried out in the same way as the procedures for conventional dentures. Hardly any alterations were necessary in this case. The dentures provided a secure 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 set-up and design facilities (CAD) and denture milling procedures (CAM) eliminate the lengthy processes involved in model articulation and flasking. As polymerisation 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 patients.

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