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Amann Girrbach develops CAD/CAM full-denture prosthetics for Ceramill Mind

Dentures ex machina

An article by Dipl.-Ing. Ineke Lindemann and Dipl.-Ing. Falko Noack, both Koblach/Austria

Full-denture prosthetics, the stepchild of dental technology? Is this really the case? At least it appears as if no one wants them but everyone needs them. Amann Girrbach is now developing a software module that allows Ceramill CAD/CAM users to plan virtual full dentures and fabricate the try-in with the support of CAD/CAM. This means that at present the denture base is milled from setting-up wax and the denture teeth fitted to the base. This virtually eliminates errors during transfer – except with manual bite registration. Dental technology therefore comes a decisive step closer to the age-old dream of greater process reliability in this discipline.

Further development in the area of CAD/CAM is one of the key areas of modern dental technology. Though the focus of this development was more on the crown and bridge area in the past, in recent times other fields of work in dental technology are becoming accessible for this technology. Fabrication of primary units, splints or models for example has already been implemented and is therefore now available for the modern dental laboratory. The aim must continue to be to open up additional fields of work and maximise the range of functions of modern CAD/CAM systems because each additional indication or every additional material, which can be processed using this type of system, increases the benefits for the dental laboratory. It is even more important to master efficiently and reliably the daily orders in the routine work of the laboratory, particularly in times when qualified workers are in short supply. For the majority of dental laboratories this also includes the fabrication of full dentures.

For the first time the entire manufacturing process for full dentures up to wax try-in can be put into practice digitally using the Ceramill Mind full denture module. This opens up a completely new field for digital dental technology.

The main focus of the module is placed on interrelated and coherent workflow in which data collection, design and fabrication are perfectly coordinated. During development a conscious effort was and continues to be made to ensure implementation of the entire workflow. Because only if all process stages are sensibly integrated can this type of module be used profitably. Because not only the individual CAD module or milling machine, which can process pink-coloured PMMA, solve the tasks during production of full dentures. With a solution which was only focussed on the milling process, CAD/CAM would surely never have functioned in the area of crown and bridge. In fact the development approach must involve taking a holistic view of the task and envisaging a complete workflow. The following description is intended to give an insight into the approach chosen by Amann Girrbach for CAD/CAM fabrication of full dentures and show how full dentures can be fabricated in the dental laboratory in future.

Step 1: Recording the initial situation and digitisation

The patient situation is transferred to the dental laboratory in the conventional way via a functional impression with the accompanying bite registration, bite block, aesthetic template etc. The laboratory then fabricates the stone models and mounts them in the articulator in the usual way (Fig. 1). The digital workflow begins from this point onwards. The situation is then optically scanned using the Ceramill Map300 or 400 optical 3D scanner. The upper and lower models are first digitised individually and then in the transfer stand to transfer the position of the models to the design software.

Use of the virtual articulator is essential for digitally supported fabrication of functional full dentures, so that the static and dynamic functionality of the subsequent dentures can be taken into consideration during digital setting up. As a further option, aesthetic requirements may be taken into account using a digitised aesthetic template (Fig. 2). This information is incorporated later, particularly when setting up the anterior teeth and facilitates orientation in the virtual space.

Step 2: Model analysis

The Ceramill Mind software is used for the design of the full denture. Here the main focus is on model analysis. The

Fig. 1 The stone models of the edentulous jaws articulated in the Artex CR using the aesthetic template. This begins both the conventional and digital workflow

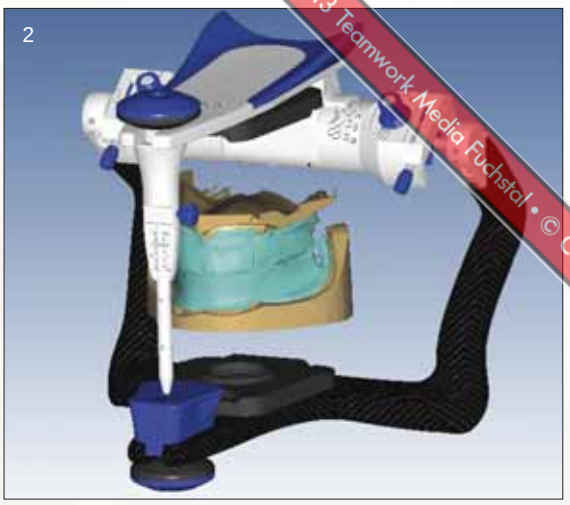

Fig. 2 The transfer key is used to commonalise the digitised models and aesthetic template in the Ceramill Mind software

software guides the user step-by-step through the analysis with the aid of illustrations and explanations. This makes it easier to learn the process and ensures a specific, reproducible technique. Using the instructions the user marks anatomical characteristics on the surface of the model, from which the software individually calculates the common set-up lines including the tolerance ranges (inner and outer correction) for each patient situation at the finish (Fig. 3). The position of the largest opposing teeth (tooth 6 position), the stop line and all set-up and margin lines for the anterior region are also determined. These steps are familiar to the dental technician, as they follow the known working procedures of manual model analysis. The advantages in comparison with the manual process are in the different detection and visualisation possibilities. For example sectional views can help identify and analyse anatomical characteristics. In addition, calculation algorithms help detect the midline of the alveolar ridge, a process that is comparable to determining the preparation margin with crown and bridge modules.

Step 3: Setting up

Digital, automatic setting up of the denture teeth is then completed. Using the results of the model analysis appropriate sets of denture teeth are suggested for the individual situation according to the respective space available. The user can then choose from the sets of denture teeth. These sets of denture teeth are conventional, denture teeth from different manufacturers stored as library data. The denture teeth selected are automatically positioned in the correct occlusal relationship and according to the determined set-up lines (Fig. 4). It is ensured that the static and dynamic occlusion is taken into consideration during positioning. In order to also take into account the aesthetic requirements of a full denture, the user can then customise the set-up of the anterior teeth for example. A suitable type of tooth can also be selected beforehand at this stage and the recommended set-up individually adapted for each

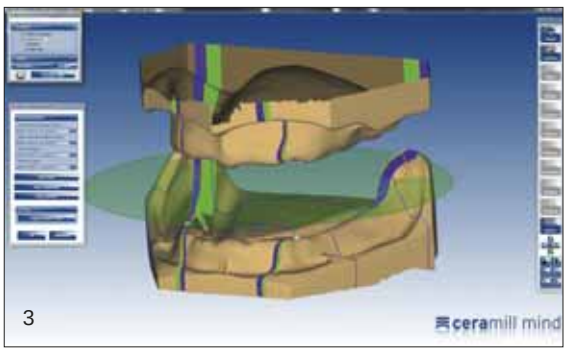

Fig. 3 This is how digital model analysis is displayed. All relevant parameters are taken into account during analysis

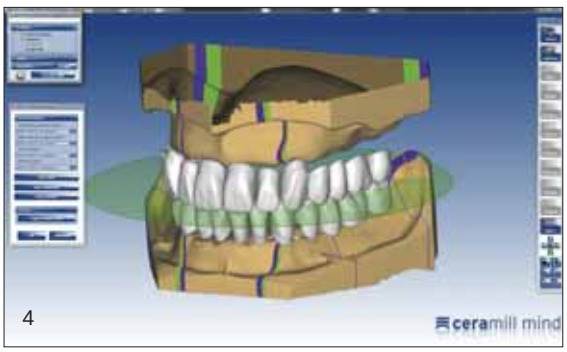

Fig. 4 Virtual set-up using the Ceramill Mind full-denture prosthetics module

Fig. 5 The software automatically creates a suggestion for the gingiva design based on the set-up

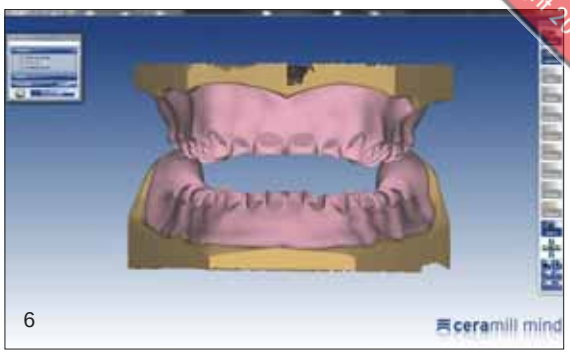

Fig. 6 On completion of the design, the software produces three data sets. One contains the milling data for the upper and lower bases

tooth. As already mentioned, the user also has the option of superimposing the digitised aesthetic template to provide orientation.

The position of the posterior teeth can also be adapted in the region of the tolerance lines. Hereby only one movement of the entire posterior tooth block is permitted to maintain the contact relationship given by the set-up system and the denture teeth used. This guarantees that the set-up functions ideally at all times. This type of computer-based set-up has the advantage that it can always be reproduced – results are therefore predictable. The dental technician also always has the possibility of retrieving a posterior tooth set-up, according to the manufacturer's factory-set interdigitation concept of the denture teeth with ideal contact assignment, at the press of a button. Another positive aspect is the saving in time compared with the manual set-up.

Once the set-up is complete, the gingival section is designed. An initial suggestion is generated automatically by the software (Fig. 5). The dental technician can influence the contouring of the papilla and the design of the gingiva using different setting options. The operator can also customise the design using a virtual wax knife. Uniform thickness of the denture base is guaranteed using preset, material-specific minimum values. This ensures that the denture is neither over nor under contoured. Taking both aspects into account is very important with respect to the function and durability of the restoration. In the final CAD stage the basal surfaces of the denture teeth are automatically reduced virtually and provided with retention taking into account the alveolar ridge contouring and minimum thickness of the subsequent denture. The corresponding sections of the denture base are punched out virtually and form the basis of the tooth sockets in which the teeth are exactly positioned after fabrication of the base. Three data sets in total are then generated. One data set each for the upper and lower base (Fig. 6) and one data set for basal adaptation of the acrylic denture teeth.

Step 4: Fabrication of the try-in

The upper and lower bases are milled water-cooled using the Ceramill Motion 2 using a gingiva-coloured wax blank (Fig. 7). Additional water cooling while milling the wax blank has the advantage that relatively soft wax, as is required for full-denture prosthetics, can be milled without smearing.

The denture teeth are then adapted by milling in the Ceramill Motion 2. Special denture tooth blanks are used for this in which the denture teeth are held in a defined position. The reductions completed during digital setting up can thus be transferred to the actual acrylic teeth (Fig. 8). When the basal adaptation is complete, the teeth can be removed from the blank and inserted into the cavities in the wax bases (Fig. 9). This eliminates any change in the contact relationships of the denture teeth, for example due to wax contraction during cooling.

This processing stage, in particular, facilitates the workflow for the dental technician, as it eliminates the need for manual adaptation of the base wax, the entire

Fig. 7 The upper base milled from setting-up wax under water cooling

Fig. 8 The respective denture teeth are retained in a special denture tooth blank and their fitting surfaces adapted to the designed denture base in the Ceramill Motion 2

manual setting-up process and waxing-up of the denture base. The denture teeth are waxed in position on the wax base. The denture is finally checked in the articulator (Fig. 10).

The procedure then follows the usual pattern: Try-in at the dentist and adjustment of the denture teeth, if required. The teeth can be adjusted in the conventional way, as the denture base has been fabricated using a wax that allows manual processing using a wax knife. The denture can also be finished in the conventional way, i.e. flasking etc.

Though direct CAD/CAM fabrication of the finished denture in acrylic can be completed digitally, at the moment there is still a risk of remake. This risk does not result from the new fabrication process described here but to a greater extent from manual bite registration.

Fig. 9 The basally modified denture teeth are inserted easily into the wax base

Correct registration of the intermaxillary relationship is always difficult and error-prone with edentulous jaws. Once this problem is solved, almost nothing can prevent direct CAD/CAM fabrication of acrylic denture bases. In future, development will focus on this area.

Conclusion

Digital full-denture prosthetics will be another milestone in dental CAD/CAM technology and optimise processes and continuity of the quality in this sector. It is important that users are provided with complete, coordinated processes, which can also be utilised. Only with a holistic approach and implementation of practical working methods will such a module be of benefit for the dental laboratory. The advantages for the dental technician are that it can ensure reproducible, efficient restorations and therefore value creation for the laboratory. The changes associated with digitisation in this sector will ensure dental technology remains in the laboratory and help avoid outsourcing and chairside tendencies.

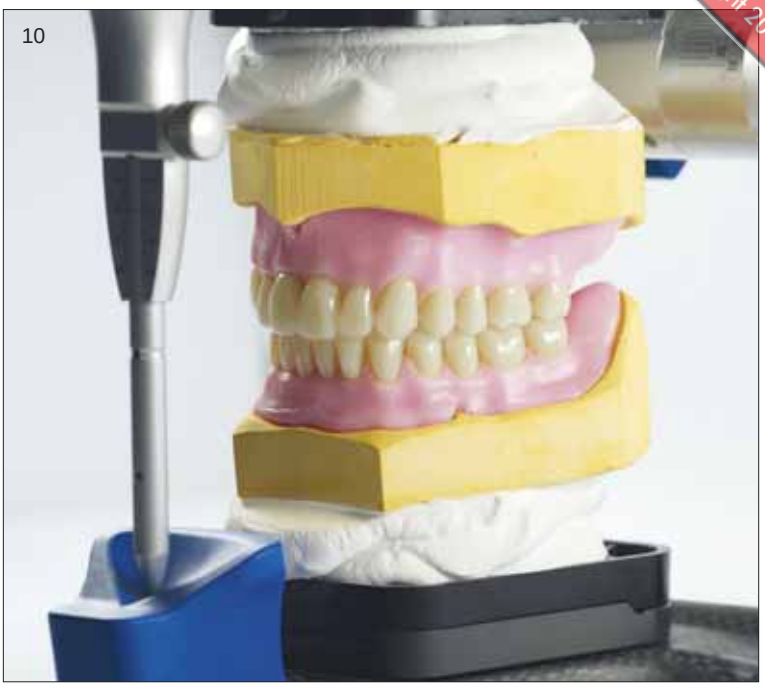

Fig. 10
After fitting the denture teeth in position with wax, the function is checked in the physical articulator before being sent for wax try-in

Product list

Produkt	Name	Manufacturer/ Distribution
CAD/CAM system	Ceramill CAD/CAM	Amann Girrbach
Milling machine	Ceramill Motion 2	Amann Girrbach
Model transfer	Ceramill Transferkit	Amann Girrbach
Scanner	Ceramill Map400 (oder 300)	Amann Girrbach
Software modul	Ceramill Mind Totalprothetikmodul	Amann Girrbach
Setting up wax, millable	Ceramill D-Wax	Amann Girrbach

About the authors

After about eight years working in the dental technology sector (Dental Laboratory Glaser; Boblitz/Brandenburg, Germany), during which he mainly specialised in the fixed/removable and implant prosthetics, Falko Noack decided to study at the University of Applied Sciences Osnabrück. After four years at the university he gained the title Dipl.-Ing in Dental Technology. During his study time he worked at the university on various projects in the field of metallography and material testing of dental materials. The topic of his diploma thesis was the development of a process chain for a zirconia pre-sintered blank manufacture. He then applied his practical and technological knowledge in research and development at Amann Girrbach, especially in the field of zirconia production and application technology. Falko Noack is now head of the Research and Development Department at Amann Girrbach.

After training as a dental technician (Dental-Labor Isenberg, Bönebüttel, Germany) Ineke Lindemann, like Falko Noack, also gained the title Diplom-Ingenieur in Dental Technology at the University of Applied Sciences (FH) Osnabrück. The topic of her diploma thesis was the investigation and evaluation of test methods and precision of dental, optical digitisation systems. For more than four years Ineke Lindemann has applied her practical and technological knowledge at Amann Girrbach in research and development, particularly in the CAD/CAM sector. She was involved in the development of the Ceramill system and is project manager in the development of the Ceramill Mind full-denture module.

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