The way to functional and aesthetic anterior restorations, Part 1

All or nothing

Authors:

Dietmar Schaan,
Master Dental
Technician
Knut Miller, Dental
Technician
Koblach/Austria

Indexes:
Patient data based
on dynamic data
Model fabrication
Programming of the
articulators
Preparation for virtu-
al implementation

From the fabrication of a precision model over transfer of the patient data into the Ceramill CAD/CAM system to the design and fabrication of the final result – in a five-part article Dietmar Schaan and Knut Miller present an exemplary, step-by-step method of fabricating functional and aesthetic restorations based on an anterior restoration.

All or nothing – this could also describe the guiding principle of Amann Girrbach. The company sets new standards with its Artex articulators in terms of function and advances to become a global player with the Ceramill CAD/CAM system. From the outset the dental specialist focussed on the complete dental laboratory process chain in order to ensure maximum functionality and precision. The objective and purpose of the Ceramill system has therefore always been and remains a functional framework based on the latest technology, which meets the requirements of the user as far as possible. Software, products and process stages have been refined by permanent research and development and have now been perfected in "Digital Functional Prosthetics" (DFP); an integrated method that produces a functional, interference-free restoration – highly precise and with maximum value creation for the laboratory.

◀ **Fig. 1 Patient situation before preparation of the anterior teeth**

The first part of our series of articles deals with the acquisition of patient data based on dynamic data, model fabrication, programming of the articulator and preparation for virtual implementation.

Individual patient data

More and more restorations are being fabricated nowadays using a digital workflow with material suitable for use with CAM. In order to fabricate dynamically functional restorations it is still essential to transfer the individual data of patients into the CAD software.

▲ **Fig. 2 Artex facebow in situ; facebow with Leipzig glabella und 3D condyle support in conjunction with the bite fork for determining the cranium-axis relationship of the upper jaw**

Fig. 3 Protrusion registration for determining the inclination of the condyle guidance in the Artex CR from Amann Girrbach

▲ **Fig. 4 and 5 Laterotrusion registration left and right for determining the Bennett angle right and left in the Artex CR**

The dental technician still requires diverse impressions of the patient situation (Fig. 8), if it was an advantage for every restoration, the technician would

Fig. 6

Fig. 7

Fig. 8

Fig. 9

▲ **Fig. 6** The three dynamic Aluwax registrations for setting the dynamic values on the Artex CR

▲ **Fig. 7** Determining the centric relationship with the aid of the Amann Girrbach sliding guide designed by Dr. Woelfel. The occlusal locking in this case is 1.8 millimetres.

▲ **Fig. 8** Impression of the lower jaw as antagonist; the two impressions of the upper jaw – once before treatment for fabrication as a diagnostic model and once as a master model

▶ **Fig. 9** Giroform model fabrication from Amann Girrbach, based on the Giroform pin-drilling unit and plastic baseplates for the sectioned model

Fig. 10

Fig. 11

▶ **Fig. 10** Smartmix X2 from Amann Girrbach; an automatic mixer for accurate dispensing of water and plaster to ensure exact control of the plaster expansion

▶ **Fig. 11** Smartmix X2 from Amann Girrbach, a vacuum mixer for producing a homogeneous water plaster mixture

Fig. 12

Fig. 13

Fig. 14

▲ **Fig. 12 The master model with individual segments, dies and gingival masks**

▲ **Fig. 13 The assembled, segmented master model**

◄ **Fig. 14 The segmented opposing jaw model**

also have even more patient information available.

The dentist can communicate these individual, static and dynamic registrations to the dental technician with relatively little effort.

▼ **Fig. 15 Bite fork fixed in positioned with plaster in the Artex transfer stand for subsequent transfer of the facebow registration in the Artex CR**

▼ **Fig. 16 The upper jaw model is fixed in position in the Artex CR articulator with the aid of the Artex transfer stand**

Fig. 15

Fig. 16

Fig. 17

▲ **Fig. 17 The lower jaw is articulated against the upper jaw taking into account the centric relation registration**

Fig. 18

▲ **Fig. 18 Upper and lower jaw situation in the Artex CR with the customised incisal guidance unit**

▶ **Fig. 19 Setting the sagittal inclination of condylar guidance on the articulator using the protrusion registration**

▼ **Fig. 20 Setting the right Bennett angle using the left laterotrusion registration**

▼ **Fig. 21 Setting the left Bennett angle using the right laterotrusion registration**
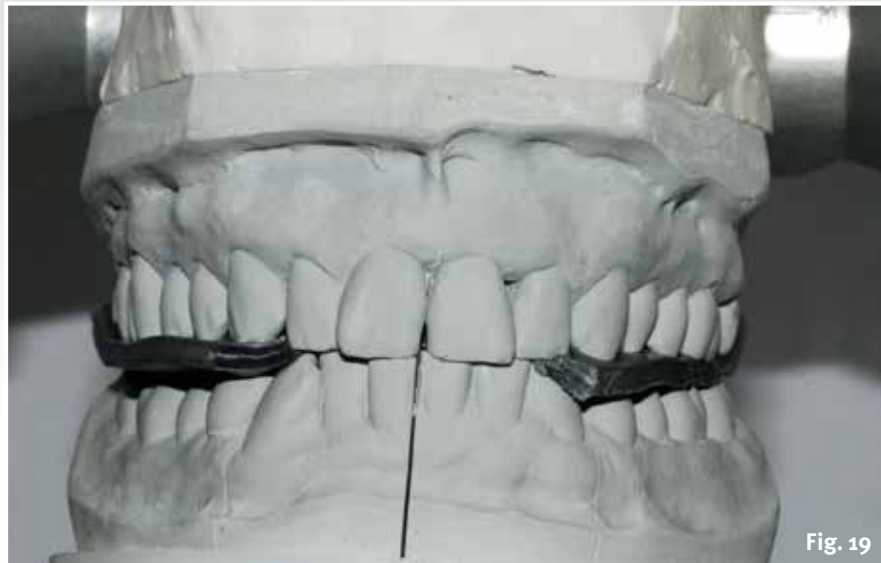
Fig. 19

Fig. 20

Fig. 21

Fig. 23

Fig. 22

Fig. 25

Fig. 24
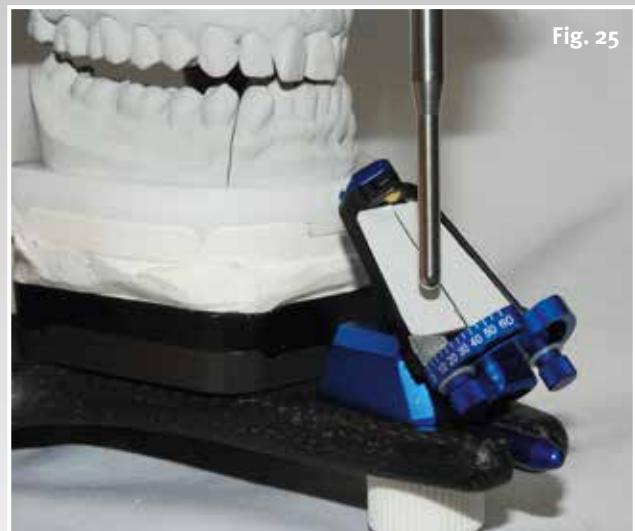
Facebow registration (Fig. 2) is an indispensable part of these patient data. The cranium-axis relationship of the upper jaw can be transferred to the articulator and articulated (Fig. 15 and 16) with the aid of the facebow registration. Once the dental technician finds the centric occlusion using the centric relationship (Fig. 7) and can thus eliminate interfering high spots, there is nothing in the way of fabricating a functional restoration.

With the aid of the dynamic bite registration (Fig. 3 to 6) the individual values of the inclination of condylar guidance (Fig. 19) and Bennett angle (Fig. 20 and 21) can also be individually programmed on the articulator.

A functioning articulator in the CAD software provides the user with the possibility of already incorporating all the functional procedures in the resto-

▲ **Fig. 22 Frontal view of the working model situation in the Artex CR**

▲ **Fig. 23 Determination of the angle of the incisal guidance using the incisal guidance unit**

▲ **Fig. 24 The readable value of the incisal guidance angle: 46 degrees**

▲ **Fig. 25 Determination of the canine guidance, left**

ration using these parameters during the design.

From analogue to digital

The dental technician already lays the foundations for a fitting, functioning restoration during model fabrication (Fig. 9 to 11). With the segmented models and the resulting expansion control (Fig.12 to 14), the technician can

► **Fig. 26 The incisal pin is in contact with the left wing of the incisal guidance unit: canine guidance 30 degrees**

Fig. 26

Fig. 27

Fig. 28

Fig. 29

▲ **Fig. 27 Determination of the canine guidance, right**

▲ **Fig. 28 The incisal pin is in contact with the right wing of the incisal guidance unit: canine guidance 34 degrees**

▲ **Fig. 29 Laterotrusion right with the upper master model guided by the customised incisal guidance unit**

The illustrations clearly illustrate which differences arise during the design of functional surfaces if the incisal guidance is lost due to preparation of the anterior teeth and the technician incorrectly engages posterior tooth guidance (Fig. 31 to 33).
Once the requirements for a functional restoration are created in the analogue world, the way is optimally prepared for a successful restoration in the digital world. ∎

accurately establish which functional parameters should be incorporated in the restoration.
In addition to the patient parameters supplied, the dental technician can mechanically determine the incisal and canine guidance with the aid of the customised incisal guidance unit (Fig. 23 to 30) and also reproduce this later using the virtual articulator.

The next issue deals with the different Artex articulators, their calibration, customised incisal guidance table as well as their customised programming and 1:1 transfer of the patient data in the Ceramill CAD/CAM system.

Fig. 30

Fig. 31

Fig. 32

Fig. 33

▲ **Fig. 30** Laterotrusion left with the upper master model under guidance of the customised incisal guidance unit

▲ **Fig. 31** Without customised incisal guidance unit: much too flat premolar guidance during protrusion with the master model because there is no longer any natural incisal guidance

▲ **Fig. 32** The same with laterotrusion right because there is no longer any natural incisal guidance

▲ **Fig. 33** The same with laterotrusion left because there is no longer any natural incisal guidance

Correspondence address:

Knut Miller, Dietmar Schaan
c/o Amann Girrbach AG
Herrschaftswiesen 1
6842 Koblach/Austria
Internet www.amanngirrbach.com

More detailed information about the authors at
www.dlonline.de/service.de/autoren.html

http://bit.ly/1iBUUFP   http://bit.ly/18aYPVI
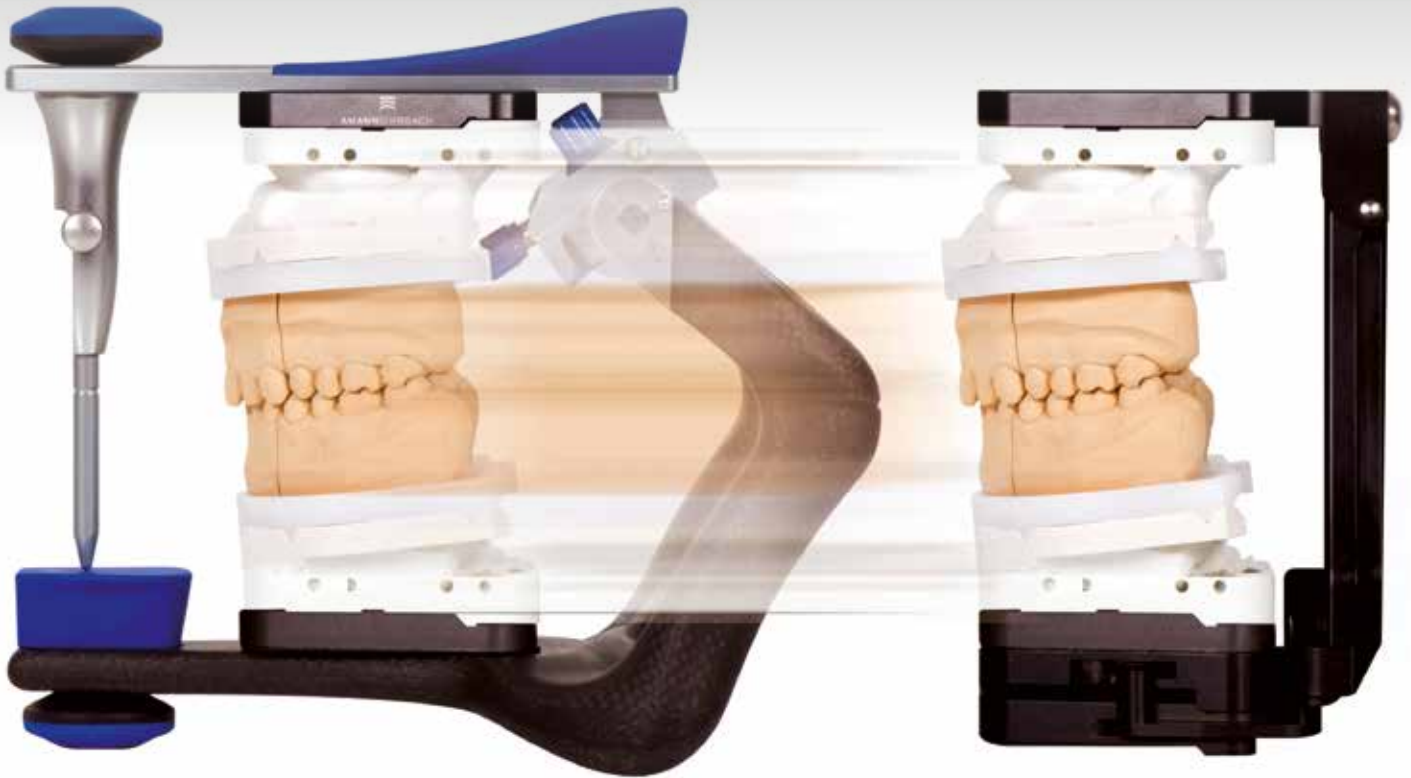
The way to functional and aesthetic anterior restorations, Part 2

All or nothing

Authors:

Dietmar Schaan,
Master Dental
Technician
Knut Miller, Dental
Technician
Koblach/Austria

Indexes:
Selection
of the articulator
Customised
calibration
Customised incisal
guidance table
Data transfer in the
Ceramill CAD/CAM
system

In this series of articles Dietmar Schaan and Knut Miller demonstrate the importance of a closed process chain for an anterior restoration. The first part focussed on the model fabrication as the basis for the digital workflow. In the second part the authors explain how to select the articulator and customised calibration. The objective is to transfer the patient data exactly in the Ceramill CAD/CAM system.

Which articulator is suitable for which type of restoration? Basically, the following applies: if it involves a simple restoration, a simple articulator is sufficient. If the dentist dispenses with the use of individual patient parameters, the dental technician can work with a se-

mi-adjustable non-arcon articulator (for example Artex CN or Artex CT; Fig. 1 and 2). The outcome, however, bears the risk that even a single restoration appears too high intraorally and has to be painstakingly ground in by the dentist. If the dentist provides individual values of the sagittal inclination

Fig. 1

Fig. 2

Fig. 3

Fig. 4

▲ **Fig. 1 Artex CN non-arcon articulator with fixed inclination of condylar guidance 35°and individually adjustable Bennett angle**

▲ **Fig. 2 Artex CT non-arcon articulator with individually adjustable inclination of condylar guidance and individually adjustable Bennett angle**

▲ **Fig. 3 Artex CP arcon semi-adjustable articulator (sagittal inclination of the condylar guidance and Bennett angle)**

▲ **Fig. 4 Artex CR arcon fully adjustable articulator (sagittal inclination of the condylar guidance, Bennett angle, ISS, protrusion and retrusion)**

Fig. 6

Fig. 5

Fig. 7

▲ **Fig. 5 Calibration key for interchange-ability of all Artex articulators**

▲ **Fig. 6 Splitex plate set for inter-changeability**

◄ **Fig. 7 Customised incisal guidance unit for all Artex articulators**

of the condylar guidance, Bennett angle and corresponding ISS values with impressions and facebow registration, the dental technician will use a semi-adjustable or fully adjustable arcon articulator (Fig. 3 und 4).

The individual parameters are necessary to convert a standard Artex CR into a customised mastication simulator, which is coordinated to the patient (Fig. 11 to 16). The dental technician can help to ensure that the dentist does not have to grind in the restoration intraorally. The technician must transfer the existing patient situation

to the articulator, so that the restoration functions physiologically in the mouth.

The Artex CR (Fig. 4) along with the customised incisal guidance unit (Fig. 7) is a prerequisite for the fabrication of a high-quality, functional restoration. The vertical alignment of the upper jaw to lower jaw is defined and controlled by opening of the centric lock and the free space on the articulator hinge. It is also possible to re-establish the lost guide surfaces using the mechanical measurement of the incisal and canine guidance, or reconstruct them with new values. Thanks to these simple procedures using a flexible incisal guidance table (Fig. 7 and 10) the patient situation can be more accurately

Fig. 8

Fig. 9

Fig. 10

▲ **Fig. 8 Calibration key in the Artex for fixing the lower Splitex plate in position**

▲ **Fig. 9 Calibration key in the Artex for calibration of the customised incisal guidance unit**

◄ **Fig. 10 Customised incisal guidance unit for determining the incisal and canine guidance on the models in the articulator**

produced, whereby the restoration is always more precise using the data determined clinically by the dentist.
A comparison of different articulators shows that not every model meets the requirements. The excursions of the Artex CN semi-adjustable articulator (Fig. 1) are limited for example, as the alignment of the condyles in the milled condyle path does not allow for freedom.
Excursions with the Artex CT are considerably better (Fig. 2), as the adjustable inclination of the condylar path and Bennett angle enables more accurate control of the dynamic functions. Complex excursions are possible with the Artex CP and CR arcon articulators (Fig. 3 and 4): the condyles glide over the

fine surfaces of the plastic inserts in the hinge. Every dental technician appreciates the advantages of an Artex CR, particularly during fabrication of a therapeutic splint, i.e. when it not only involves restorations. The Artex CR is indispensible in the laboratory. Its setting options range from the sagittal inclination of the condylar angle, Bennett angle (Fig. 17 to 26), immediate side shift to adjustment of the free space with a long centric. The option of calibrating all articulators using the calibration key (Fig. 5 and 8) is also an advantage of the Artex system.

Fig. 11
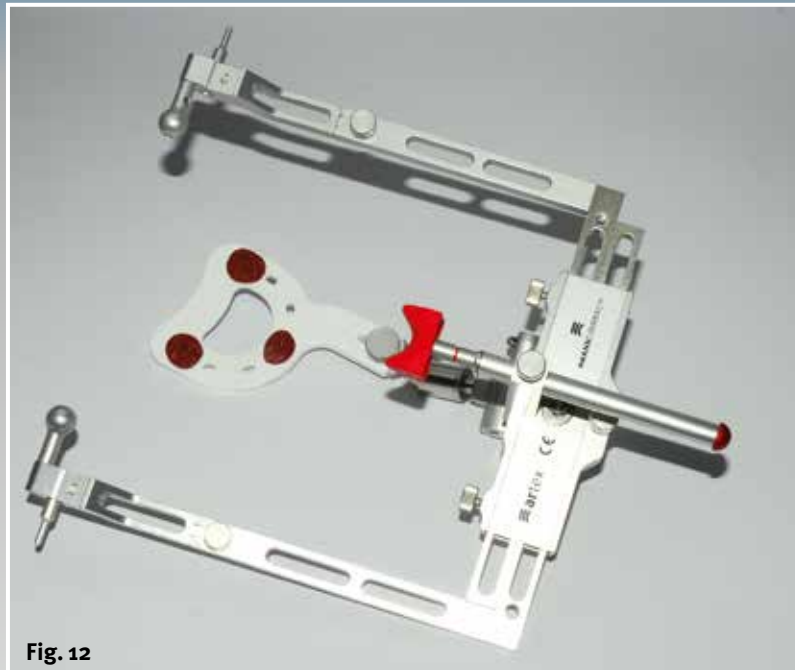
Fig. 12

Fig. 13

Fig. 14

▲ **Fig. 11 Artex facebow with Leipzig glabella and 3D support**

▲ **Fig. 12 Artex facebow prepared for facebow registration**

▲ **Fig. 13 Artex facebow with flexible nasal point and axis plane indicator**

▲ **Fig. 14 Artex facebow prepared for facebow registration, e.g. in relation to the Frankfurt horizontal**

Dental technicians and dentists can communicate about the patient situation in two different articulators by coordinating the Splitex plates (Fig. 6) using calibration keys. With a tolerance of 8µ no details are lost between the two articulators. This precision is the result if both the model and occlusion are simultaneously transferred into the "Ceramill Mind" CAD software of the Ceramill CAD/CAM system.

Fig. 15

▲ **Fig. 15 Alternative to the use of disposable bite forks or reusable metal bite forks**

▶ **Fig. 16 After facebow registration, the bite fork is plastered onto the transfer table**

Fig. 16

▼ **Fig. 17 to 20 The individual sagittal condylar guidance is set bilaterally using the protrusive bite registration**

Fig. 17

Fig. 18

Fig. 19

Fig. 20

Fig. 21

Fig. 22

Fig. 23

▲◄ **Fig. 21 to 23** The individual Bennett angle is set bilaterally using the laterotrusive bite registration (the right Bennett angle in the picture)

►▼ **Fig. 24 to 26** The same procedure on the right side for setting the left Bennett angle

Fig. 24

Fig. 25

Fig. 26

The transfer stand of the Ceramill Map400 scanner (Fig. 27) is calibrated using the same calibration key, so that the dental technician can be certain that the occlusion and excursions can be transferred 1:1 into the virtual system. This ensures that the new occlusion and functional surfaces are designed reliably. All patient values determined – including the incisal and canine guidance values, recorded with the customised incisal guidance unit (Fig. 10) – are attained by entering "Articulator excursions" in the Ceramill Mind software.

This digital processing of dynamic and static values ensures reproducible parameters and functional working with the models for the user. It is therefore worth using a method, which does not allow any compromises and which is constantly precision based. Well-devised process sequences and controlled stages in work preparation are prerequisites for a high-quality restoration. The next part focuses fully on scanning in the Ceramill Map400 as well as the correct choice of material and working with the "Ceramill Artex" virtual articulator. ∎

▲ **Fig. 27 Transfer of the patient situation from the actual Artex CR to the virtual world using the transfer stand of the Ceramill MAP400 scanner, which has also been calibrated**

Correspondence address:

Knut Miller, Dietmar Schaan
c/o Amann Girrbach AG
Herrschaftswiesen 1
6842 Koblach/Austria
Internet www.amanngirrbach.com

More detailed information about the authors at www.dlonline.de/service.de/autoren.html

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The way to functional and aesthetic anterior restorations, Part 3

All or nothing

Fig. 1

▶ **Fig. 1 Input for indication and design of the restoration to be fabricated**

▶ **Fig. 2 Transfer stand and adhesive-retained Splitex plate with the calibration key**
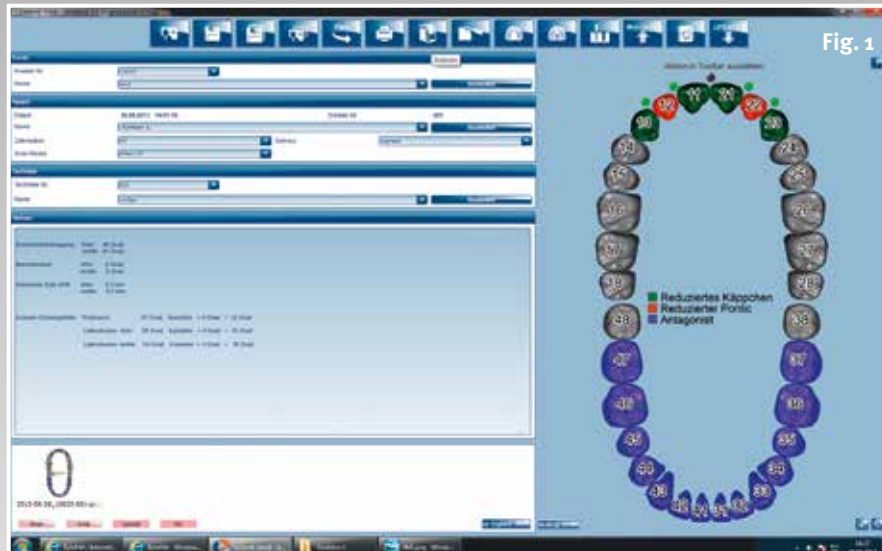
What is the procedure after acquiring the patient data, model fabrication and transfer of the data in the Ceramill CAD/CAM system? In the third part of their article Dietmar Schaan, Master Dental Technician, and Knut Miller, Dental Technician, demonstrate the fabrication of a functional anterior restoration: scanning of the model using the Ceramill Map400 and how to use the Ceramill Artex virtual articulator.

Fig. 2

Authors:

Dietmar Schaan,
Master Dental
Technician
Knut Miller, Dental
Technician
Koblach/Austria

Indexes:
Model scan
Virtual record card
Virtual articulator
Ceramill Artex

The database of the Ceramill CAD/CAM system (Fig. 1) ensures that the requirements are the same for functional restorations in the virtual world: dental technician, dentist and patient are entered in the opened record card, followed by the details of the restoration. With the aid of these data the programme guides the dental technician from the scan to design to positioning the blank and transfer of the milling path to the Ceramill Motion2. Calibration of the Ceramill transfer stand using the calibration key of the Artex articulator (Fig. 2) guarantees that all relevant patient parameters can be transferred to the Ceramill Mind CAD software.

The software shows the way

After the Ceramill Map scanner is started, the user follows the instructions of the software: gingiva, antagonist, working model, diagnostic model and buccal scan (Fig. 3 to 18). The virtual articulator is calibrated in the scan process using so-called "three-point alignment" (Fig. 14a, 14b and 15). This guarantees precise relationship and transfer of the model from the articulator and transfer stand into the virtual Artex CR articulator.

▼ **Fig. 3 Result of the gingival scan before matching**

Fig. 3

Fig. 4

Fig. 5

Fig. 6
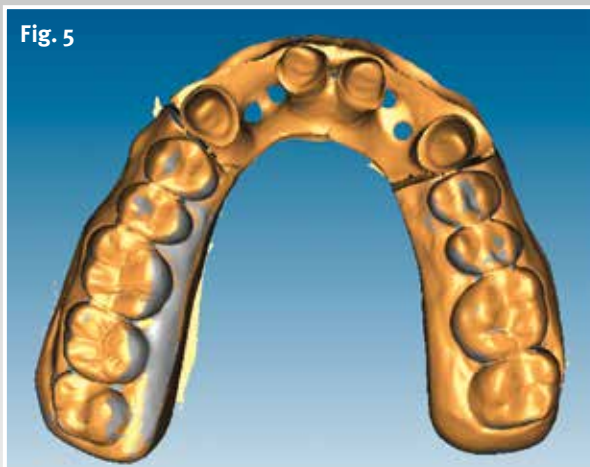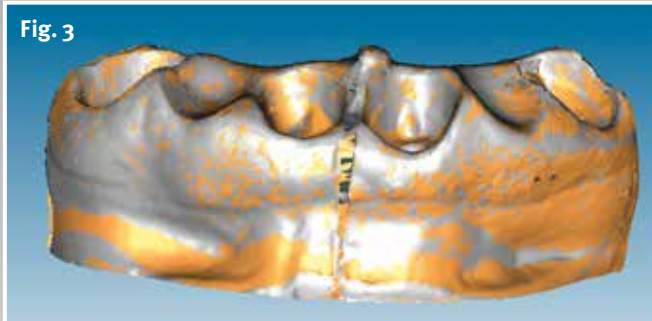
The software guides the dental technician clearly through the individual stages to the accurate CAD models. This creates models on the screen with a gingival mask (Fig. 3 and 16), antagonist models (Fig. 8 to 9a), working model including dies (Fig. 5), diagnostic models (Fig. 7 and 17) and last but not least a buccal scan (Fig. 13). Basically this is just one scan, which serves as a matrix to insert and align the upper and lower jaws in the correct position (Fig. 14) in the virtual articulator. Overall it is rather a scan process that directs the dental technician to the CAD software (Fig. 19) where the technician can begin with the design of the entered indication.

All the data of the scan are saved on drive D under Constructions.

▲ **Fig. 4 Alignment of the tooth position for the 3D scan of the upper working model**

▲ **Fig. 5 Occlusal view of the completed upper scan as working model before matching**

▲ **Fig. 6 Preparation for the 3D scan of the diagnostic model**
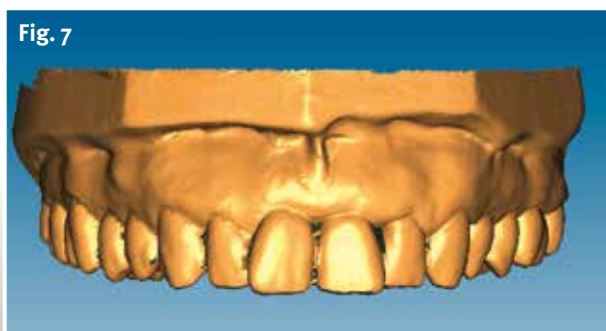
Fig. 7

Fig. 8

◄ **Fig. 8 First step for the lower 2D scan for overview of the model size**

◄ **Fig. 7 Completed situ scan from the labial before matching**

Fig. 9

Fig. 9a

Fig. 10

Fig. 11

Fig. 12
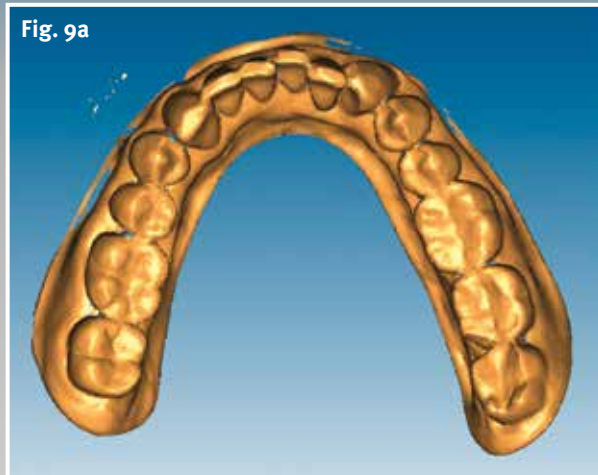
▲ Fig. 9 Definition of the 3D scan field for the antagonist model

▲ Fig. 9a Completed lower scan before matching

▲ Fig. 10 Upper and lower in the transfer stand, prepared for the buccal scan in the identical relationship as in the articulator

▲ Fig. 11 Mounted transfer stand in the Ceramill Map400 scan for the buccal scan

▲ Fig. 12 Buccal view of the transfer stand in the scanner
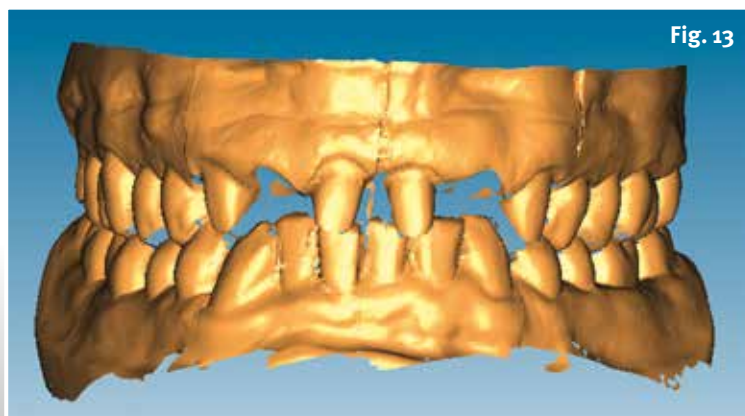

Fig. 13

◄ Fig. 13 Completed buccal scan before matching

Fig. 14
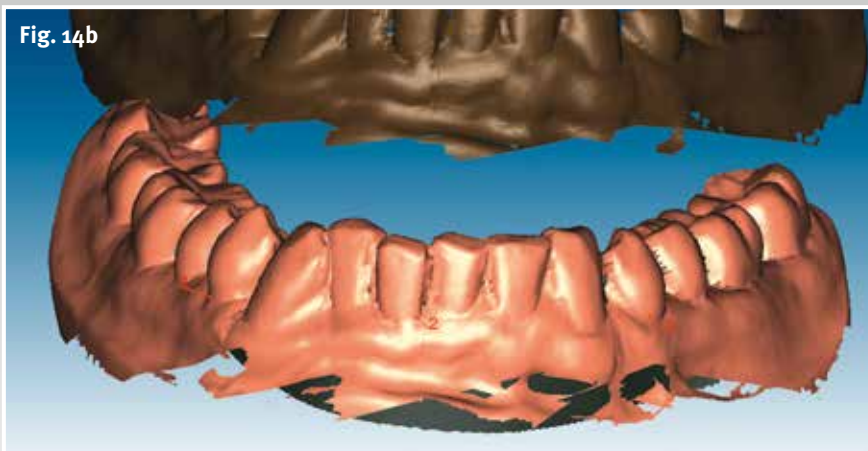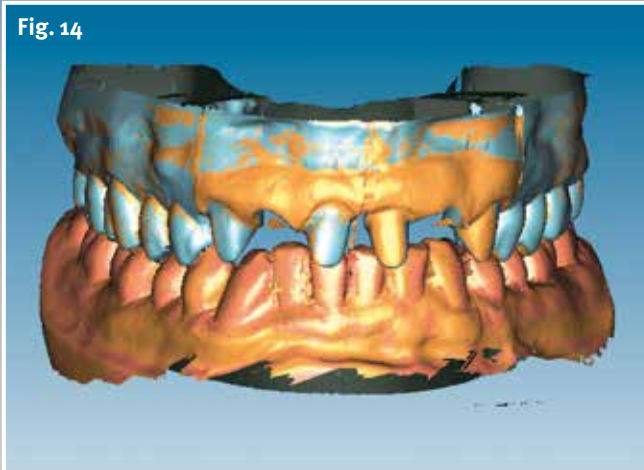
Fig. 14a

Fig. 14b

▲ **Fig. 14 Occlusal align-
ment of the upper and lower
model in the relationship
process for the buccal scan**

▲ **Fig. 14a Calibration of the
virtual articulator in the scan
process using three-point
alignment**

▲ **Fig. 14b In the first step
three points are defined in
the lower model that are
also found on the buccal
scan – the same procedure is
then performed with the
upper model**

The models can be accessed from here for the CAD software and made available for the design (Fig. 20). If the dental technician has selected the Artex CR in the database under the scan mode, the CAD software automatically starts with the virtual articulator. The design is accompanied by the virtual helper, Ceramill Mind Wizard, which guides the operator logically through the individual tools. Trained and experienced users, however, have the possibility of individually intervening in the design at any stage.
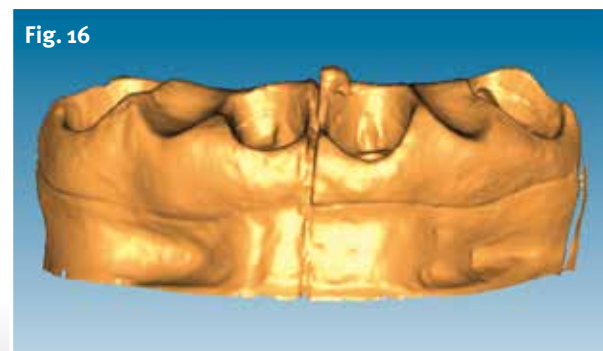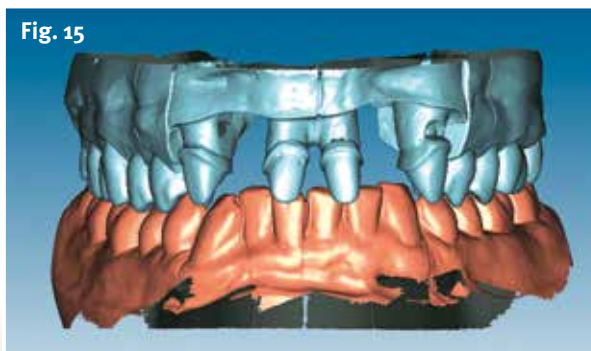
Fig. 15

Fig. 16

▲ **Fig. 15 Matched scan data of upper and
lower after three-point alignment**

▲ **Fig. 16 Completed matched
gingival mask**
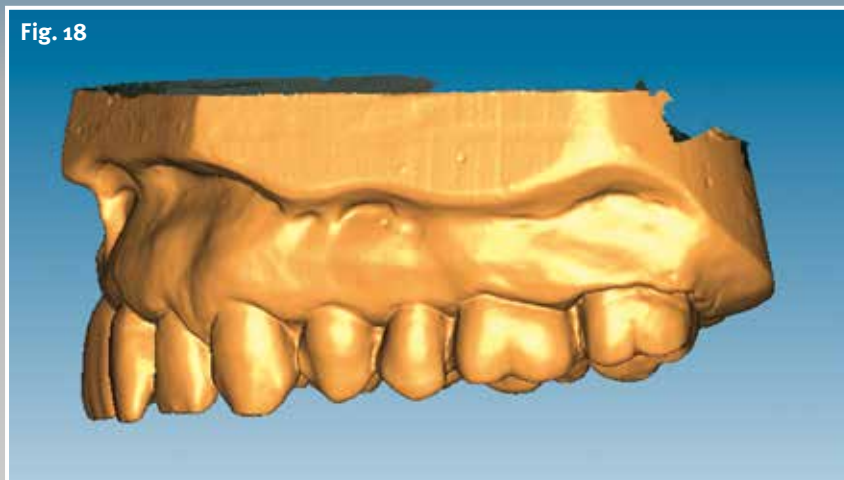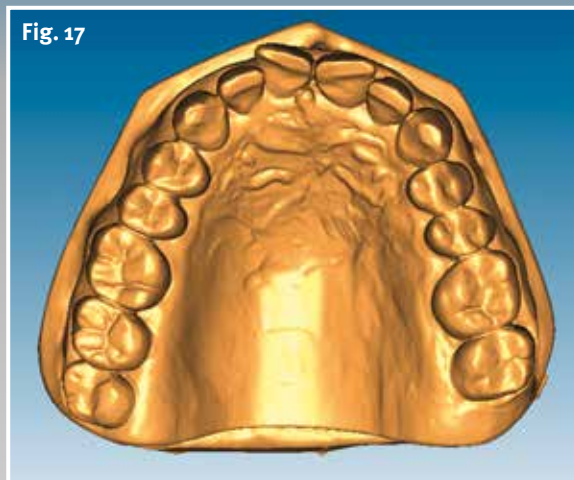
Fig. 17

Fig. 18

▲ **Fig. 17 Completed, matched diagnostic model**

▲ **Fig. 18 Optimisation and completion of the scan data for transfer to the design software**

▶ **Fig. 19 Start of the design in the database**
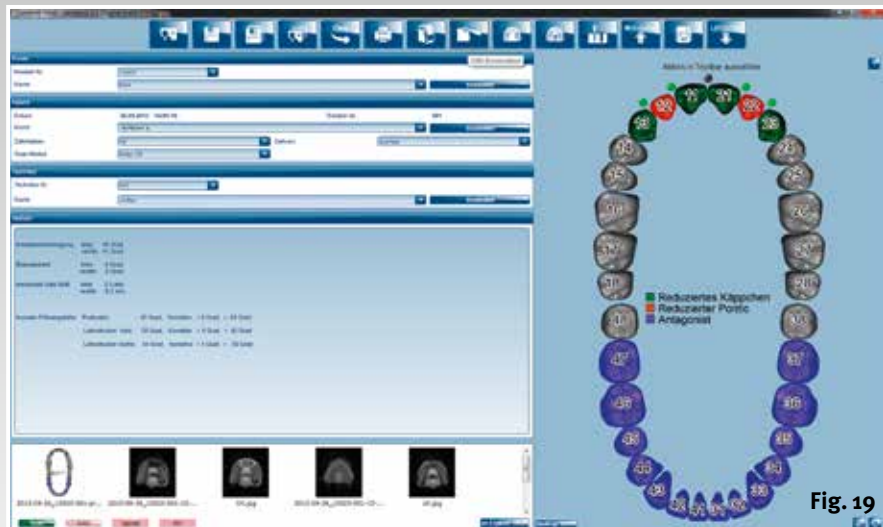
Fig. 19

Patient analogous

In this case the first step involves starting the virtual articulator (Fig. 22). The articulator is programmed analogous to the patient according to the patient parameters supplied.
The screen displays the Artex CR with the customised incisal guidance unit.

Fig. 20

▶ **Fig. 20 Scanned model in the Ceramill Mind software – beginning the design**
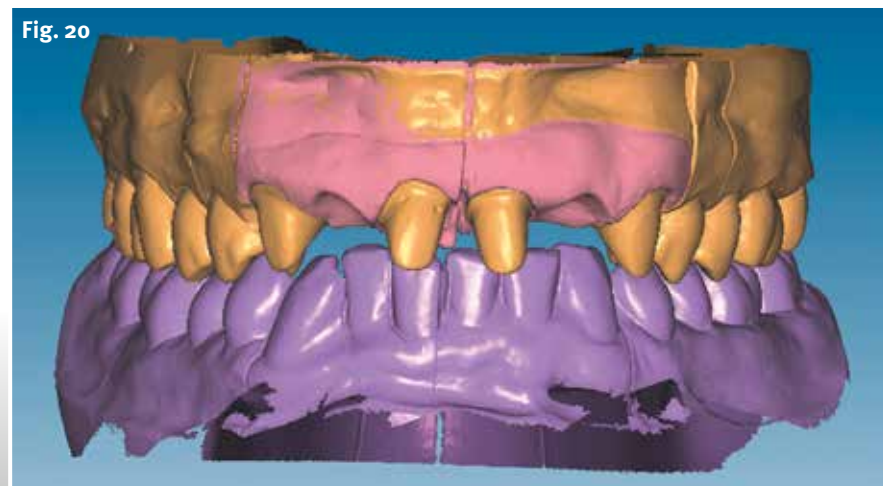
Fig. 21

◀ **Fig. 21 The virtual articulator is programmed with all patient parameters**

Fig. 22

◀ **Fig. 22 After the excursions, the functionally relevant parameters are stored in the software**

All patient parameters are transferred to the virtual articulator beginning with the extent of the excursions – protrusion, laterotrusion to the left and right as well as retrusion (Fig. 21).

The facebow registration and dynamic bite registration ensure that all excursions can be individually reproduced in the virtual world. The software records the patient data determined by the dentist. This includes centric occlusion, freespaces in centric occlusion, all processes of the incisal and canine guidance and abrasion surfaces as important reference points, which are part of a functional restoration. The user can rely on the fact that the individual patient parameters are available at any time in the CAD software. The next part demonstrates the step-by-step creation of the aesthetic and functional design. ∎

Correspondence address:

Knut Miller, Dietmar Schaan
c/o Amann Girrbach AG
Herrschaftswiesen 1
6842 Koblach/Austria
Internet www.amanngirrbach.com

More detailed information about the authors at
www.dlonline.de/service.de/autoren.html

http://bit.ly/1iBUUFP   http://bit.ly/18aYPVl

The way to functional and aesthetic anterior restorations, Part 4

All or nothing

▶ Fig. 1 Starting point of all design elements: the Artex CR virtual articulator

Fig. 1

Model fabrication, scanning, virtual articulation: this is the basis for a planned anterior restoration. After entering the patient data in the CAD software in the third part of the article series, Master Dental Technician, Dietmar Schaan and Dental Technician, Knut Miller will now focus on the step-by-step design of an aesthetically functional restoration.

Authors:

Dietmar Schaan,
Master Dental
Technician
Knut Miller, Dental
Technician
Koblach/Austria

The Ceramill Wizard guides the user through the design process precisely and efficiently. It is integrated in the CAD software and helps both new users as well as experienced users to move confidently in the programme during the design phases.

Model preparation

In the first tool the operator enters all patient-relevant dynamic data using the articulator and stores them in the background (Fig. 1). A left click on the option "Continue" takes the operator to the next processing stage.
The tool "Positioning the diagnostic model" gives the dental technician an idea of the shape and position of the anterior teeth, so that the technician knows how the design of the finished restoration could look at the end of the design. Using "three-point alignment" and "Best fit adaptation" the software calculates the definite alignment of the situ scan to the working model. The subsequent working stages can be checked and reliably implemented at any time thanks to this superimposed cover as diagnostic model over the working model (Fig. 2 to 3).
The Ceramill Wizard next shows how the preparation margins can be defined on the individual dies using a single mouse click. The Wizard then calculates the margins fully automatically. The dental technician can enter adjustments at any time (Fig. 4 to 5) before starting preparation of the virtual model.
A uniform cement gap can be determined via the "Gap" tab. The contact surfaces of the crown margins can also be defined by the operator, so that it is immediately visible what the size of the cement gap will be on the surface of the die (Fig. 6).
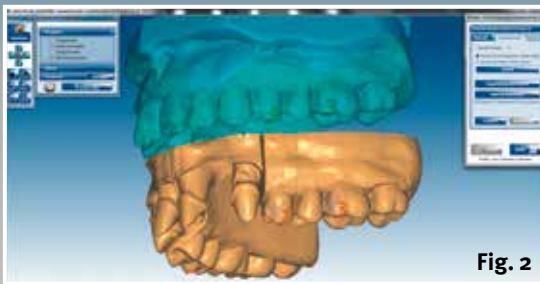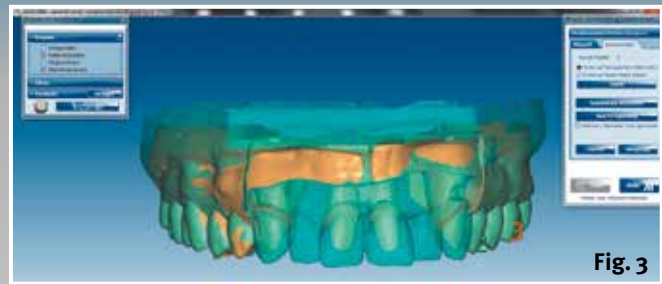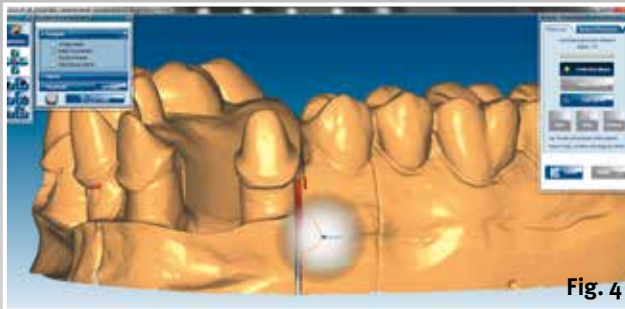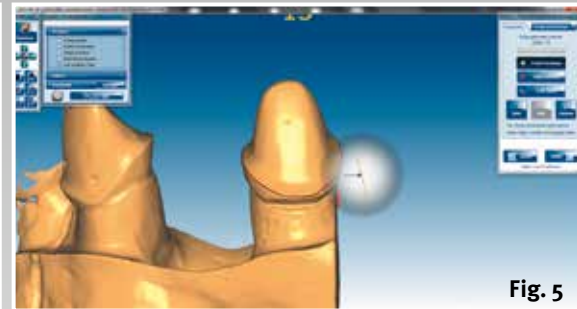
Fig. 2

Fig. 3

Fig. 4

Fig. 5

▲ **Fig. 2 Positioning the diagnostic model; a cornerstone of the design in producing a functional result**

▲ **Fig. 3 Anterior restoration true to the situation due to optimal positioning of the original situation via the working model**

▲ **Fig. 4 Definition of the crown margins, structured stages of the design based on clear guidelines of the Wizard**

▲ **Fig. 5 Fitting of each single reduced crown on the die using a mouse click**

simply orientates according to the situ scan to find the original position. The teeth can then be moved into the correct position and alignment according to the situation. The pontics can then be calculated to the gingiva using the "Pontic" tab – exactly on contact, with a defined distance or defined penetration, depending on requirements (Fig. 9 to 10). The library teeth are calculated in the shell of the diagnostic model to assume the initial situation using the "Adapt to the situ model" tool, so that the shape, size and alignment of

▼ **Fig. 6 Digital guidelines during model preparation; definition of the cement gap thickness**

▼ **Fig. 7 Determination of the crown margins using individually coordinated parameters**

The second tab takes the dental technician to the definition of the crown margin. The margin is minimally strengthened to suit the material to prevent breaking off at the margin or chipping (Fig. 7).

Design

When the next tool is opened the software positions the relevant library teeth on the individual dies. The dental technician moves the teeth to the required position by sliding, rotating and scaling them (Fig. 8). The technician
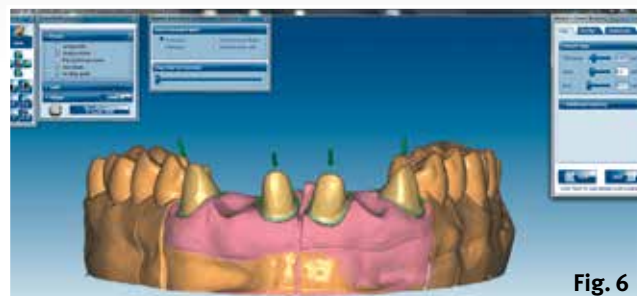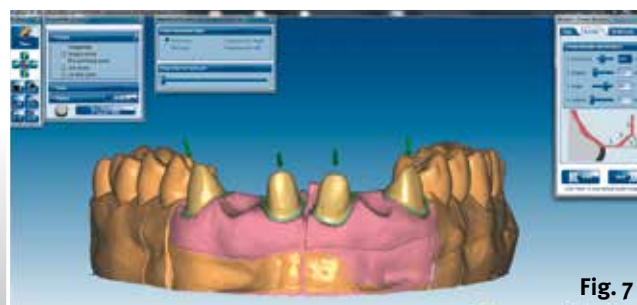

Fig. 6

Fig. 7

▶ **Fig. 8 Tooth shapes from the library enable an initial impression of the final restoration**

▼ **Fig. 9 The first details of the design are prepared using the "Freeform tool" (cervical of the tooth, length of the teeth)**
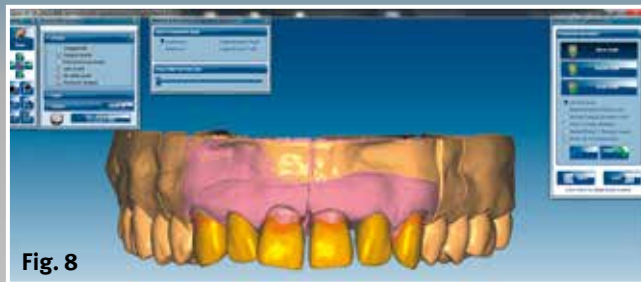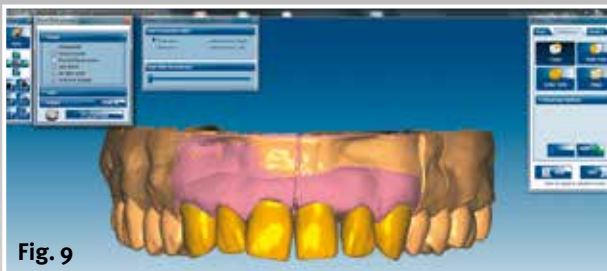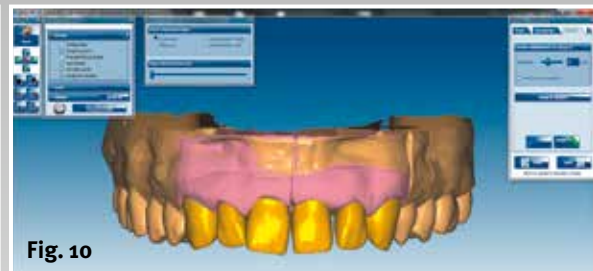

Fig. 8

Fig. 9

Fig. 10

▶ **Fig. 10 The pontic is adapted to the gingiva**

▼ **Fig. 11 The library teeth are adapted to the existing situation taking the "old situation" into account**

the teeth are clearly displayed. The guide surfaces on the two central incisors and canines are clearly visible from the palatal (Fig. 11 to 13).

Customised with a mouse click

In the next section the "Freeform tool" is activated. The "Add and remove tool" helps to adjust the functional surfaces. Using the additional tool "Distance to the antagonists" the functional surfaces can be clearly determined and shown as penetration in the oppo-

sing teeth. The gradual movement of the articulator into the protrusion and right and left laterotrusion helps the dental technician to identify the guide surfaces later (Fig. 14 to 16).
The operator accesses the most important tool of the entire design by clicking on "Continue" – to "Adapting the design teeth to the antagonists".

By activating the Artex CR in the database the software enables automatic grinding in of the contact and guide surfaces of all individual excursions. In
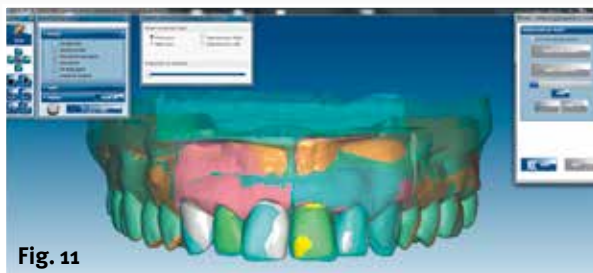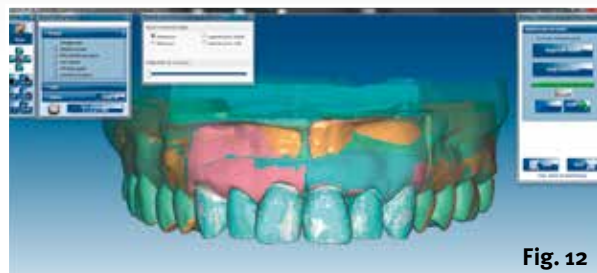

Fig. 11

Fig. 12

Fig. 13

▶ **Fig. 12 The software makes a one-to-one comparison of the "surface situation" with the surface of the new teeth**

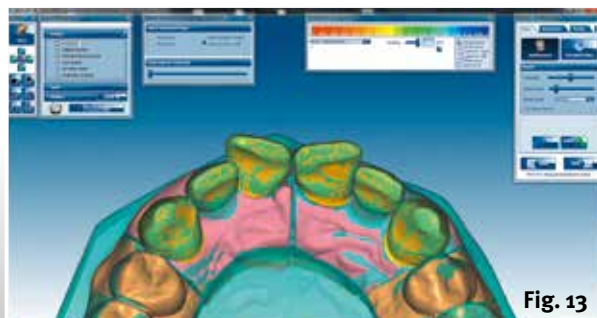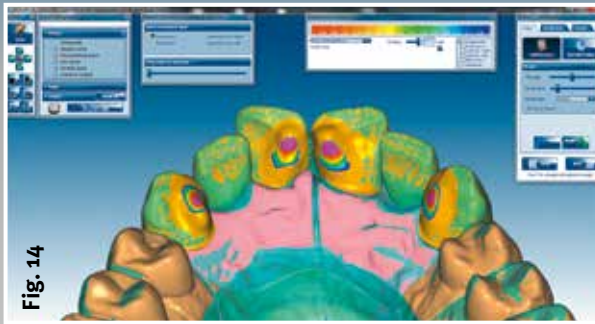▶ **Fig. 13 Clearly visible from the palatal: functional surfaces (abrasive anterior and canine guidance)**

▲ **Fig. 14 Restructured guide surfaces using the "Freeform tool"**

the case of dynamic grinding in – in contrast to static grinding in – the guide surfaces can be very finely prepared from the palatal (Fig. 17 to 20).

▲ **Fig. 15 The guide surfaces control the gradual protrusive movement**
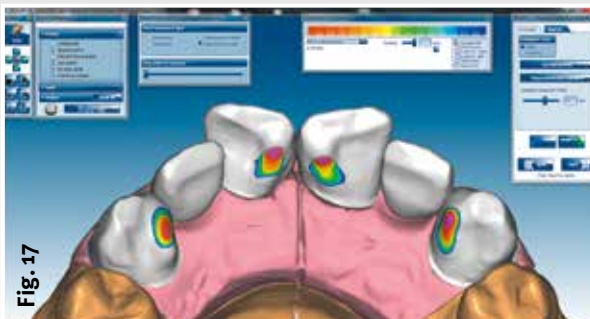
▲ **Fig. 16 Also laterotrusion**

▲ **Fig. 17 "Adapting to the antagonists" determines where there is penetration and "grinds" in this high spot**

▲ **Fig. 18 Functional surfaces would be inadequately prepared without a virtual articulator**
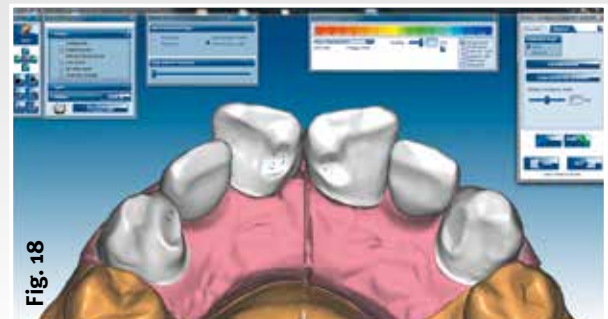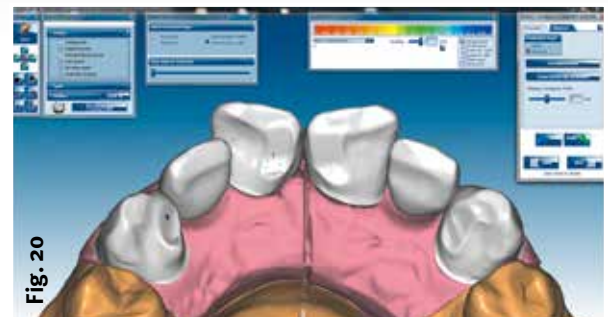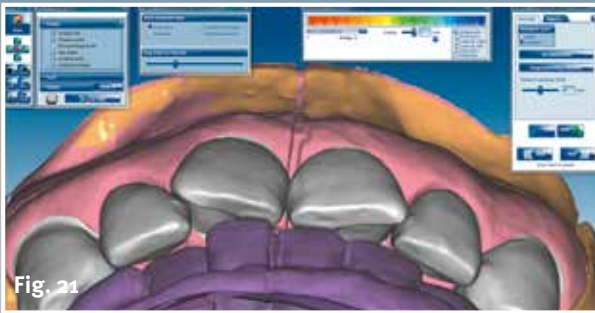
▲ **Fig. 19 Cleary visible high spots on the functional surfaces with only static adaptation to the opposing jaw**

▲ **Fig. 20 Adaptation using the virtual articulator shows all the guide surfaces in function without high spots in protrusion or laterotrusion**

Fig. 21

Fig. 22

Fig. 23

Fig. 24

▲ **Fig. 21 The virtual articulator enables step-by-step control of all excursions**

▲ **Fig. 22 Guide surfaces show the function of guidance and freespace, laterotrusion, left…**

▲ **Fig. 23 … and also laterotrusion, right**

▲ **Fig. 24 Final comparison of the adopted situation and current design**

▼ **Fig. 25 The functional surfaces to be produced in the framework material are highlighted in colour**

The surfaces, which are absolutely essential for a functional restoration, are precisely prepared on the incisors and canines taking into account all excursions and patient parameters. Even with analogue preparation the dental technician cannot achieve wider functional surfaces.

It can be clearly seen from the frontal view where and how the guide surfaces are placed.

Fig. 25
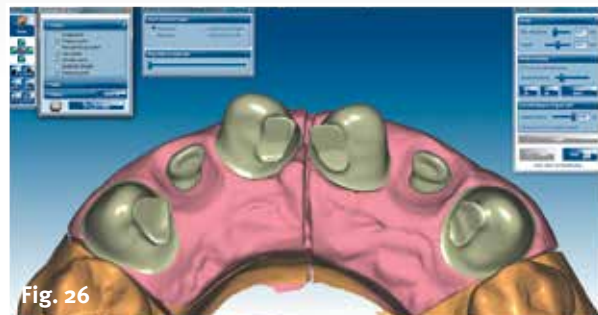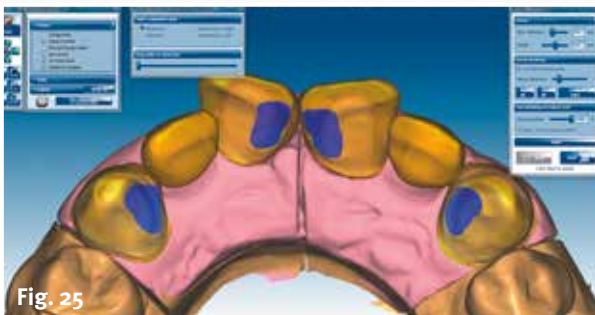
Fig. 26

Fig. 27

▶ **Fig. 26 The software reduces the anatomical framework to an anatomically reduced framework; prescribed minimum thicknesses and required reduction are maintained**

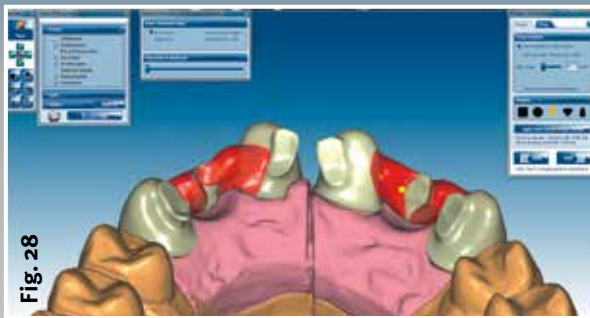▶ **Fig. 27 Edges and corners on the design are smoothed with the aid of the smoothing tool**
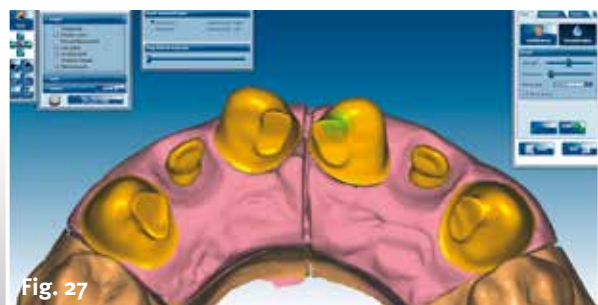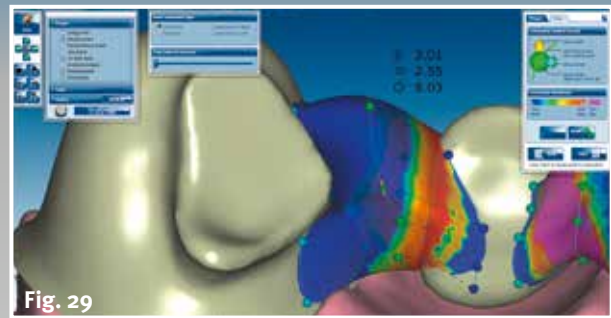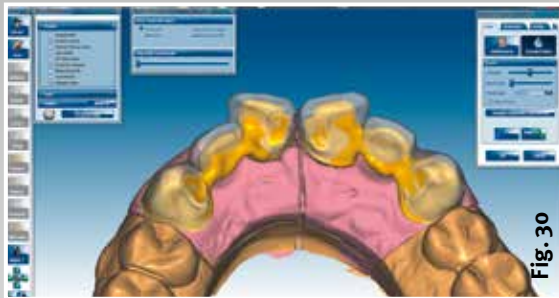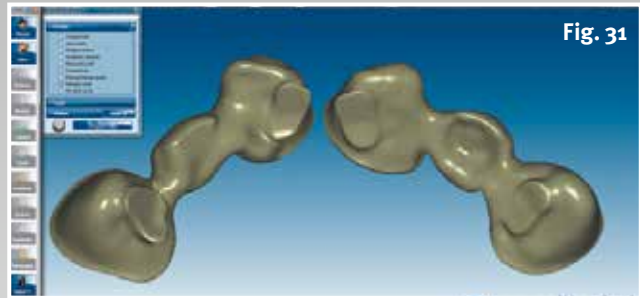
Fig. 28

Fig. 29

Fig. 30

Fig. 31

The operator can view the optimised guide surfaces with the superimposed diagnostic model (Fig. 21 to 24). The fully anatomical shape of the framework can be reduced to a defined dimension using the next tool. The guide surfaces should be highlighted in colour, so that they are maintained in the framework material. Viewed palatally they remain like islands on the framework. These surfaces guarantee that movements in the mouth are physiological (Fig. 25 to 26). The sharp edges or slight irregularities are again smoothed using the "Freeform tool". The finer the surface is the more precise the subsequent milling result (Fig. 27). The dental technician places the connectors between the reduced copings and pontics as the final component of the design. The focus is also on functionality and stability when placing the connectors. The diameter of the individual connectors depends on the material and design. In this case – two three-unit anterior bridges each with one translucent zirconium Ceramill Zolid pontic – a minimum of 7 to 10 mm2 cross-section surface should be allowed (Fig. 28 to 29).

▲ **Fig. 28 The connectors between the copings and pontics are contoured as the final component of the design**

▲ **Fig. 29 The focus here is also on customisation of the individual connectors**

▲ **Fig. 30 Final fine preparation of the designed occlusal surfaces using the "Freeform tool"**

▲ **Fig. 31 Connection of the components completes the design**

Fig. 32

Fig. 33

▲ **Fig. 32 Transfer of the design components to the Ceramill Match 2 nesting software**

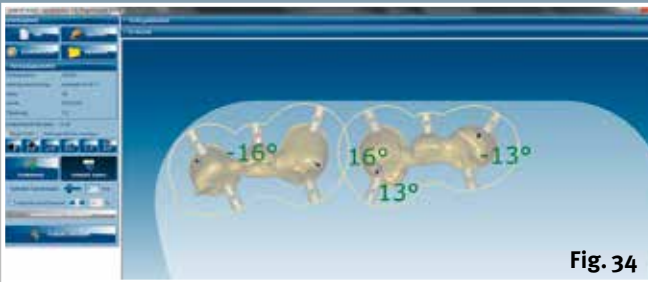◄ **Fig. 33 Registering a new blank**

Fig. 34

Fig. 35

Fig. 36
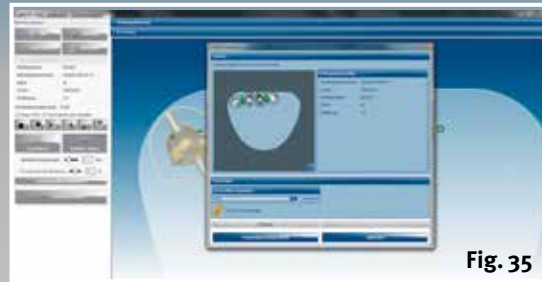
▲ **Fig. 34** Space-saving positioning of the design in the blank including adaptation of the connectors between the bridge and blank

▲ **Fig. 35** Activation of the software for milling path calculation for all the design elements positioned in the blank

▲ **Fig. 36** Activation and centering of the Motion 2 5-axis milling machine

▶ **Fig. 37** Transfer of the milling strategy and milling parameters to the Motion 2

▶ **Fig. 38** Milling by Motion 2 under control of the milling parameters (tool wear, extraction, cooling, milling duration)

Fig. 39

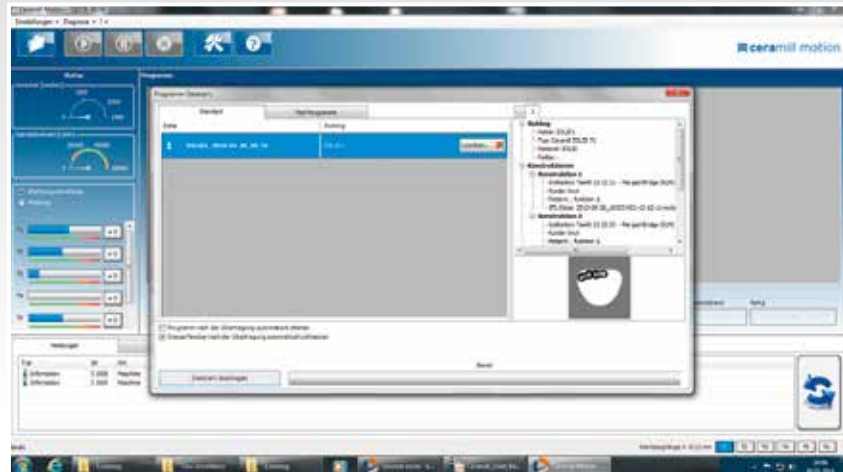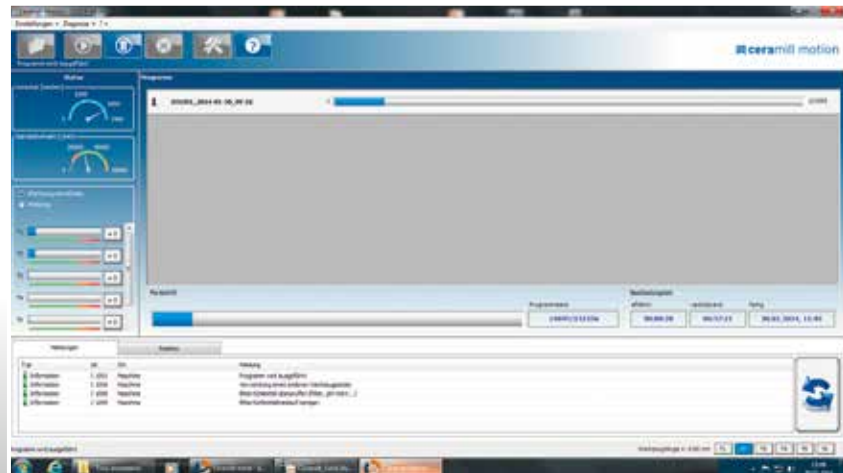◄ **Fig. 39 Milled frameworks from Ceramill Zolid**

After merging the designed components, the surface is finely finished. With the end of the "Upper jaw" design the dental technician now has the finished restoration on the screen (Fig. 30 to 31). This completes the design.

Data transfer and milling

The operator saves the finished scene in the Ceramill Mind software. The technician then opens the nesting software to place the framework in the blank by activating the Ceramill Match2 CAM software. The software automatically selects the material determined at the beginning of the database; in this case the translucent zirconium oxide Ceramill Zolid. If there is no user in the blank library or the correct height of blank is not available, the dental technician creates a new one, which can be used immediately (Fig. 32 to 33).

Using the "Positioning" tool the technician places the framework in the blank so that as much material as possible is saved. It is cost-effective to mill as large a number of units from one blank as possible. The milling path is calculated after the connectors have been checked and possibly repositioned, (Fig. 34). Once this has been completed, the operator activates the Motion2 to transfer the milling data to the machine (Fig. 35 to 37).

When the spindle and blank holder have been set to the zero position, the milling process is started with a final click on the "Start" button. The type and size of the framework determine the duration of the milling procedure. In this case the dental technician can assume approx. 45 minutes milling time (Fig. 38 to 39). Finally, the bridges are separated from the blank and prepared for the sinter process.

In the next part of this series the authors demonstrate the preparation of the framework for sintering and also the fit and function on the model. ∎

Correspondence address:

Knut Miller, Dietmar Schaan
c/o Amann Girrbach AG
Herrschaftswiesen 1
6842 Koblach/Austria
Internet www.amanngirrbach.com

More detailed information about the authors at www.dlonline.de/service.de/autoren.html

http://bit.ly/1iBUUFP

http://bit.ly/18aYPVl

The way to functional and aesthetic anterior restorations, Part 5

All or nothing
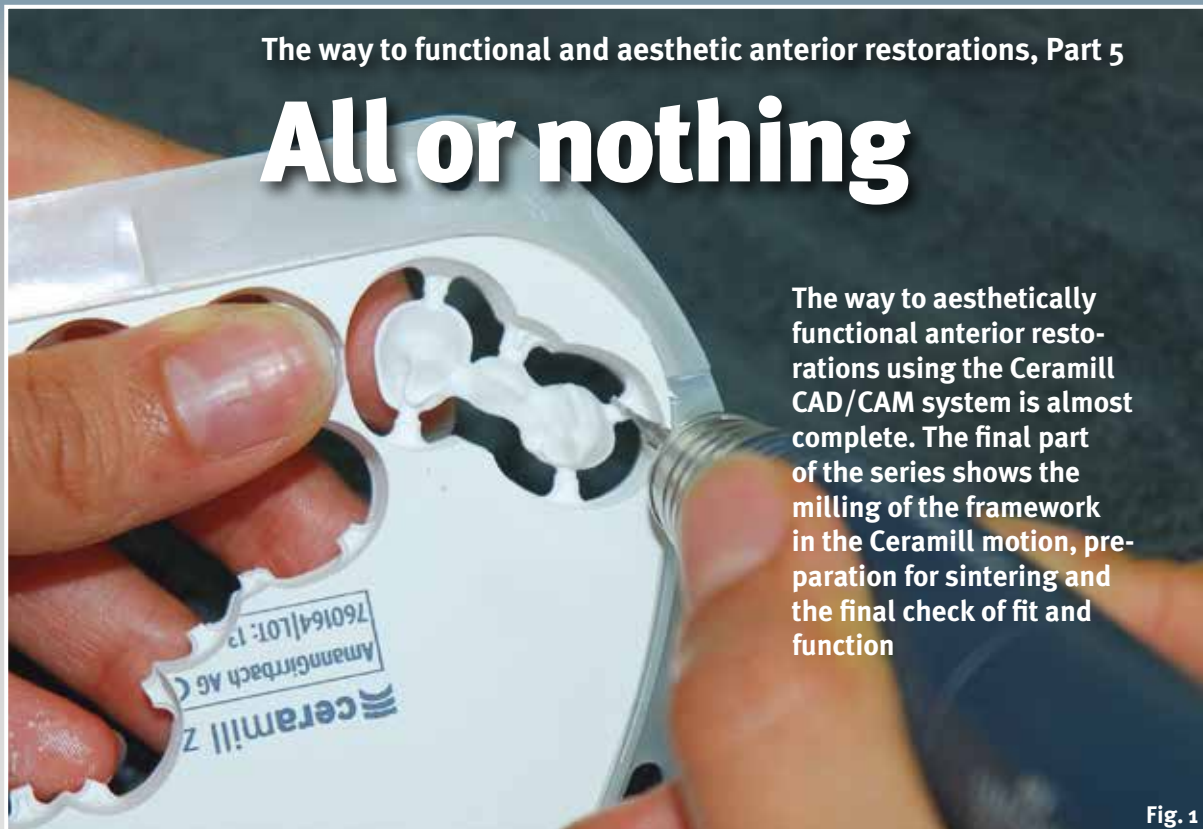
The way to aesthetically functional anterior restorations using the Ceramill CAD/CAM system is almost complete. The final part of the series shows the milling of the framework in the Ceramill motion, preparation for sintering and the final check of fit and function

Fig. 1

Authors:

Dietmar Schaan, Master Dental Technician Knut Miller, Dental Technician Koblach/Austria

Indexes:
Ceramill Motion
Cutters
Staining
Sintering
Fitting
Polishing

While the Ceramill Motion starts the calculated milling path and mills the frameworks from the blank, the dental technician can turn to another case. This allows the technician to utilise the working time effectively.

After the bridges have been milled from the blank, the connectors can be separated using a tungsten carbide cutter and the frameworks removed from the blank (Fig. 1). Before sintering, the connection points of the connectors should be trimmed and then these areas smoothed using a soft polisher with a medium grit size (Ceramill Polish-kit Lab) (Fig. 2 to 3). At this working stage the slightly over contoured crown margins are taken back and thinned.

The still "soft" presintered zirconium can be reworked very precisely using low speed and minimal pressure application. The next working stage is decisive: the grinding dust should be removed from the surface using a brush. The same procedure is carried out on the inside of the crown. This prevents

▲ **Fig. 1 Separating the finished milled bridges from the blank**

firmly fired zirconium dust impairing the fit after sintering (Fig. 4).

Staining

The frameworks are now air dried using compressed air and immersed in the colour solution. The frameworks must be completely immersed in the liquid for 10 seconds before they are removed again from the solution (Fig. 5 and 6). The surface of the frameworks must be thoroughly dried before the sinter beads can be positioned on them in the sinter tray (Fig. 7). The frameworks are best dried using a soft paper towel, which absorbs the last traces of moisture.

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6

Fig. 7

▲ **Fig. 2 Trimming of the connectors**

▲ **Fig. 3 Thinning of the margins, light polishing of the surface**

▲ **Fig. 4 Removal of the grinding dust from the surface and the inside**

temperature of 1450°C: This temperature is held for two hours and lowered using a controlled cooling phase to 900°C as well as the final cooling of the furnace.

▲ **Fig. 5 Prepared frameworks, immersed in the colour solution for basic staining**

▲ **Fig. 6 Removal of the bridges from the colour solution after 10 seconds**

▲ **Fig. 7 Preparation of the sinter tray with the stained and dried bridges**

Sintering

Finally, the zirconium frameworks are sintered in a sintering furnace. It should be noted that both systems are compatible for sintering (Fig. 8). The Ceramill Therm2 sintering furnace, which is suitable for the Ceramill system, is designed to operate the respective sinter parameters very precisely. This involves both the temperature rate up to the final temperature of the sintering procedure and the related times in the sintering cycle.
The sintering diagram clearly shows the sequence of the entire sintering process in the Therm2 (Fig. 9). It shows the temperature rate up to the final

Fig. 8

◄ **Fig. 8 Clear start Therm 2 sintering furnace**

Fig. 9

Fig. 9

Ceramill ZOLID Sinterprogramm mit integrierter Trocknungsstufe im Ceramill Therm II für neue Ceramill Liquids

Fitting

The frameworks are removed from the sinter tray after cooling (Fig. 10) and can be checked initially for fit. The margins can be finished and – if necessary – minor corrections on the framework undertaken using a water-cooled turbine and fine diamond rotary instruments (Fig. 11). The margins are then pre-polished using diamond-coated polishing discs with a medium grit size (Fig. 12).

▲ **Fig. 9 Diagram of the sintering programme in the Therm 2**

▶ **Fig. 10 The sinter result: two sintered three-unit bridges**

Fig. 10

Fig. 11

Fig. 12

Fig. 13

▲ **Fig. 11 Check of the fit and finishing of the crown margins**

▲ **Fig. 12 The margins are pre-polished using diamond polishers (medium grit size)**

▲ **Fig. 13 High-lustre polishing of the margins**

Fig. 14

Fig. 15

▲ **Fig. 14 Final check of the fit**

▲ **Fig. 15 Check of the frameworks with the gingival mask in place**

The fit of the crown margins is completed using high-lustre polishing (Fig. 13). The check shows a perfect fit, shoulderless margins and an initial overall view of the frameworks on the working model (Fig. 14). With the gingival mask in place the technician gets an initial impression of which stages must still be taken into account in further work with the framework (Fig. 15).

◄ **Fig. 16
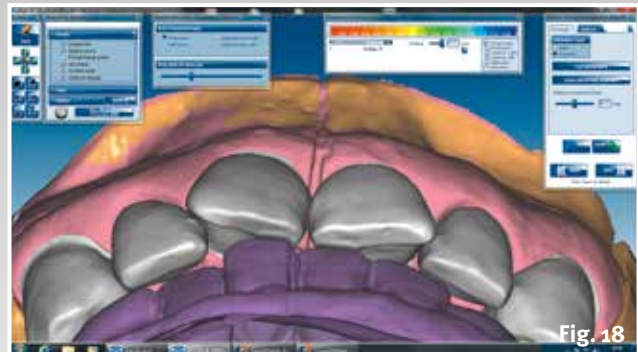Important: the polish on the zirconium guide surfaces**

Fig. 17

Fig. 18

Fig. 19

Fig. 20

Polishing

The functional surfaces, customised incisal and canine guidance surfaces have not yet been explicitly checked. The functional surfaces are polished to a high lustre before checking. These surfaces should also assume the function in situ later without any interference factors. Any roughness – no matter how minor – on such functional surfaces would result in abrasion on the opposing tooth and cause permanent damage to the antagonist. Careful polishing is therefore indispensible (Fig. 16). After placing the models with the finished frameworks in the articulator, the functional surfaces can be checked

▲ **Fig. 17 Check of the guide surfaces in the Artex CR, incisal guidance in protrusion**

▲ **Fig. 18 In comparison, the protrusion in the virtual articulator**

▲ **Fig. 19 Check of the right laterotrusion in the Artex CR**

▲ **Fig. 20 The right laterotrusion in the virtual articulator**

and very closely examined. The Artex CR should show the same function as its virtual counterpart and reflect exactly what was prepared during the design in the CAD software. Figures 17 to 22 show the comparison of the situation in the Artex CR and in the virtual articulator.
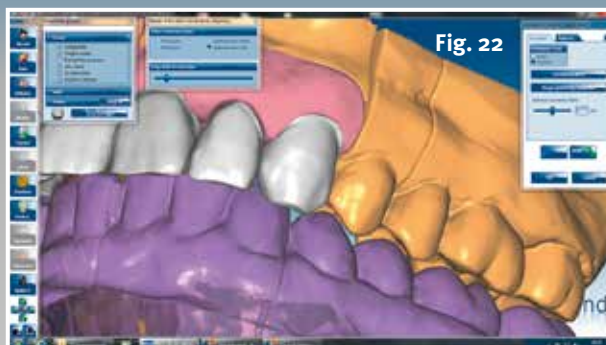
Fig. 21

Fig. 22

▲ **Fig. 21 Check of the left laterotrusion in the Artex CR**

▲ **Fig. 22 The left laterotrusion in the virtual articulator**

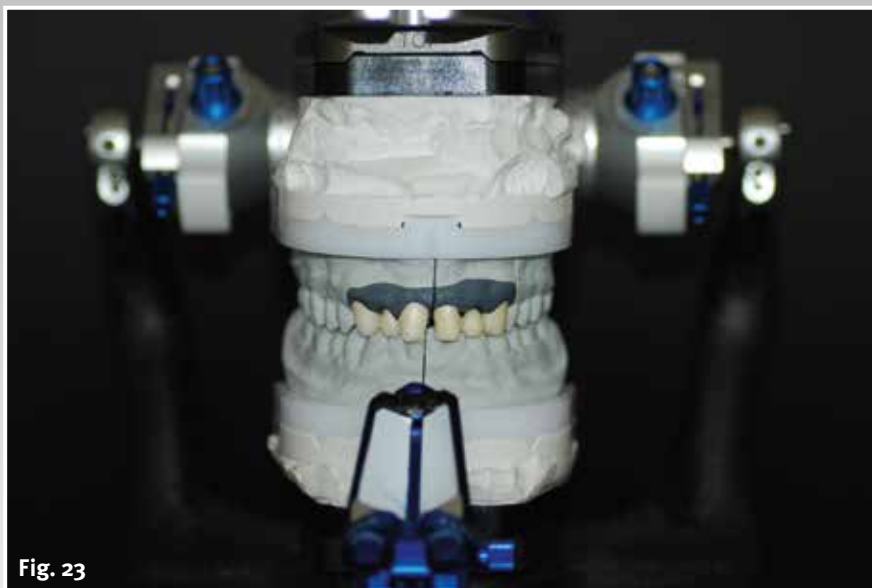▶ **Fig. 23 The frameworks ready for porcelain veneering**

Fig. 23

The checked, slightly adjusted and polished restoration is ready for finishing (Fig. 23).

The porcelain can now be applied. A framework that has been designed to function intraorally is available for the ceramist. The artistic dental technological skill of the ceramist finally ensures that the restoration is finished to an aesthetically high standard.

Conclusion

Linking the analogue working stages with the virtual world of the Ceramill CAD/CAM software solution provides a high degree of reliability and therefore also cost-effectiveness in the process chain of modern dental restoration fabrication. The controllable, consistently repeatable procedures enable the individual working stages to be easily reproduced and are therefore a guarantee for functional and aesthetic restorations. ∎

Correspondence address:

Knut Miller, Dietmar Schaan
c/o Amann Girrbach AG
Herrschaftswiesen 1
6842 Koblach/Austria
Internet www.amanngirrbach.com

More detailed information about the authors at www.dlonline.de/service.de/autoren.html