KaVo CAD/CAM workflow with the new products ARCTICA AutoScan, KaVo multiCAD Virtual Articulator and VITA ENAMIC

**By KaVo**

With the production of two monolithic posterior crowns, the KaVo CAD/CAM application technology demonstrates a practical case in which the new CAD/CAM products ARCTICA AutoScan, KaVo multiCAD Virtual Articulator and VITA ENAMIC for KaVo ARCTICA play a major role.

Described below are the following individual steps, which consist of:

1. **Order preparation**
2. **Scanning**
3. **CAD construction**
4. **Preparation for manufacture**
5. **Manufacturing**
6. **Completion**

**Order preparation: 50 seconds**

First, the practitioner, the patient and the respective technician are defined in the order entry form. The second step consists of the definition of the indication including all parameters. In the present case, this concerns the creation of two full crowns to be made of VITA ENAMIC Regio 46 and 47. The parameters for the respective practitioner can be referenced in the KaVo multiCAD software. This function guarantees consistent quality regardless of the originator of the order (Figure 1, 2).

**Scanning: 180 seconds**

This case is scanned with the new fully-automatic ARCTICA AutoScan. The scan process is very simple as the software guides the user step by step through the scan process. The individual scans are performed completely automatically. First, the upper jaw is scanned, followed by the lower jaw. If necessary, single stumps may then be scanned separately. This is followed by a vestibular scan allowing the correct positioning of the jaws by the software (Figure 3).

The next step consists of matching the individual jaw scans and the vestibular scan by marking three identical points on the respective jaw and vestibular scan. Afterwards, the software calculates the exact position of the upper and lower jaw scans (Figure 4, 5, 6).

**Construction of the restoration in the KaVo multiCAD software: 180 seconds**

In the KaVo multiCAD software, the contact relief of the corresponding jaw is displayed in the scan software. For analytical purposes, it may be displayed in color. The respective color and intensity indicate the distance to the antagonist.

Afterwards, the articulator KaVo PROTAR evo 5B is started in the KaVo multiCAD software. The respective patient-specific settings of the physical PROTAR articulator such as, for example, the condyle track inclination and the Bennett angle, are entered into an entry mask. The correct positioning of the models in the virtual articulator (KaVo PROTAR 5B) is done automatically. Based on the scan of the articulated models in the ARCTICA AutoScan and the positioning of the models by the KaVo Splitcast system, the correct positioning is automatically transferred to the CAD software. This positioning also applies to models that were inserted into the articulator by means of a facebow.

After the adjustment of the patient-specific parameters, the motion tracks are simulated and any interferences are corrected by the software (Figure 7, 8, 9).

The illustration shows a laterotrusion to the left (Figure 10).

In the subsequent construction process, the movements of the jaws may be visualized at any time (Figure 11).

The manufacture of the two VITA ENAMIC crowns on 46 and 47 is performed quickly and easily by means of library teeth that are automatically positioned onto the preparations and may be loaded into the situation via a simple mouse click. Furthermore, the library teeth may subsequently be matched to the individual occlusal relief of the chewing surface. The user is able to adjust the suggestions of the software via a wizard (step-by-step assistant) at any time during the construction process. Various tools
Giomers are a remarkable class of bioesthetic restorative materials that exhibit the aesthetics, strength and durability of nano-hybrid resin composites, further enhanced with the benefit of fluoride and anti-plaque effect pertaining to S-PRG fillers. These unique fillers are manufactured through Shofu’s patented PRG filler technology that imparts Beautifil II, Beautifil Flow, Beautifil Injectable and FL-Bond II with protective fluoride benefits and greater tissue tolerance.
Now is the time to consider investing in your own CBCT System

By Ernesto Jaconelli

This Century has seen the introduction of 3D imaging as a readily available dental diagnostic tool. This trend has been inspired by the development of both Cone Beam Computed Technology (CBCT) and PC storage capability making 3D imaging more convenient, easier to use, and affordable.

To be able to view the area of interest in all three dimensions significantly improves the accuracy of diagnosis and this in turn makes for better patient treatment. Each year new systems are becoming available such as the new CS 8100 3D System from Carestream Dental. These new systems are now significantly smaller, more versatile and user friendly than their predecessors. The CS 8100 3D has a “resting” width of 55cm (110cm when in use) and weighs only 92Kgm so will fit easily into most compact dental clinics.

A very important feature of all modern CBCT systems is that they provide the Dentist with a choice of volumes that will be right for the area of interest. These volumes are known as the Field of View (FOV). The CS 8100 3D for example gives choices from taking a 2D Panoramic to capturing a selection of 3D FOVs of 4 x 4 / 5 x 5 / 8 x 5 / 8 x 8 and 8 x 9 mm. As with all x-rays it is essential to minimise the dose to the patient - the larger the FOV the more dose to the patient. Each area of dental surgery will require a different FOV depending on the treatment being considered so it is essential to have a choice of FOVs to select from.

For a single implant a FOV of 5 x 5 mm will be sufficient and the dose to the patient in this case will be similar to that from a 2D panoramic scan. However for the preparation of multiple implants or surgical guides then a single arch FOV of 8 x 8 / 8 x 9 mm FOV would be selected. Dentist who specialising in Implants were the first to fully appreciate the benefits of 3D imaging such that it is now unusual to find one who does a not have their own CBCT system.

For Endodontists, the key diagnostic tool is always their surgical loupes. But they are also adopting 3D image to reveal more clearly any additional canals that are present and possibly missed from a 2D image as well as their exact position and apical areas. A sectorial FOV of 5 x 5 mm will provide a very high definition image for an Endodontist to be able to examine the area in precise detail. Until now Orthodontists have mainly been satisfied with a 2D panoramic view. However having a CBCT system that switches easily from a 2D panoramic to 3D image allows the Orthodontist to select a 3D view when required. Retention and angulation for example are more precisely diagnosed from an 8 x 5 / 8 x 9 mm FOV.

3D imaging will soon be the norm for dental diagnostics requiring all dentists to be familiar with the technology and capable of analysing 3D images. There has never been a more appropriate time to consider having your own CBCT System. Manufacturers are supplying more in depth training such as at the Carestream Dental Training Centre at Ajman University of Science and Technology, and now that CBCT systems are available from 40,000€, a return on the investment can be achieved within two years.
Simple, planned aesthetic orthodontics for the General Practitioner

By Dr. Til Qureshi

Dr. Til Qureshi shows how digital technology has moved progressive smile design on and the enormous benefits this will have to the way we plan and consent. Digital Smile Design is making a come back in a very smart and intelligent form through the use of live video, cameras, and keynote presentations.

I commend the users of this technique as it is clearly a far better form of smile design planning than just using plain static before and after pictures with someone else’s smile stitched into place.

However in cases where there are alignment issues, I would still argue that any patient who does not at least go down the pathway of alignment and bleaching, cannot really see their teeth change in a dynamic way.

I have found that patient’s feelings about their smile change in ways you never think they want one thing but after they see their smile change a little they start to appreciate it in a different way. How can someone really be consented unless they are given the opportunity to bleach their teeth, perhaps with slight alignment and bonding.

This case is the perfect example and will show how progressive smile design also using digital technology can produce beautiful predictable results that often require far less invasive treatment.

We use digital technology in a different way of course and this is all to do with planning and consent. Previously with Inman Aligners, we had to use Resil models. These are effectively fairly crude stone models which take a cut and once repositioned in wax the aligner is then built on that model. As soon as the aligner is fitted into an uncorrected mouth the forces are there to push the teeth to the final position. The real downside of all this wax creates quite large inaccuracies and it is very difficult to see how much adjustments have been made to the teeth to get them to fit within the curve. This is even more so of a problem for flared teeth which have been out of the arch for many many years. These teeth tend to be highly triangular and often need more targeted adjustment to get them to fit within the arch form. You can visualize the wits of these teeth, it is almost impossible to accurately know how much production is required to each.

Of course with digital 5-D printing this has all changed. The difference if you like is night and day. We can also use print models to show the patients the proposed outcome. This is excellent for the consenting process. Untreated patients will now see any compromises areas and the final outcome. If they are not happy they could reject the treatment before it starts.

A case
A 22 year old gentleman did not like the appearance of his teeth especially because the two centrals was so prominent. He had considered having porcelain veneers done just to improve his smile in one treatment. He did not like the appearance of his enamel and also the discrepancy in the shape of his front teeth. We showed him the occlusal view of his teeth and he could see that the upper anterior is one mildly misaligned. Indirect veneers would have been fairly aggressive towards the preparation of the upper central incisors. By showing examples of other cases where simple alignment had dramatically improved the aesthetic value the patient agreed to try to align his teeth first before having veneers done.

Consent part one
A full orthodontic examination was carried out. All orthodontic options were discussed and the patient understood the benefits of fully comprehensive orthodontics, and was also given a range of short-term techniques that he could have chosen. He declined comprehensive orthodontics on the basis that he only wanted to deal with his anterior teeth.

He chose to have an Inman Aligner because of the shorter wear time and the minimal cost impact on his overall treatment desires. Our first goal was to evaluate the aesthetics and function to decide on landmark or reference teeth. As part of the digital planning process these teeth are not moved and ensure the setup accommodates these teeth to ensure the proposed curve is not flared out or over constructed.

In this case the patient also had a retained upper left deciduous tooth (no canine had developed). Fortunately this tooth was in the right position so it became the reference tooth and hence no orthodontic force would need to be applied to it. Both upper centrals needed to be retracted and both laterals slightly advanced. It was important to visualize a chin up view to ensure this is viable for the patient from an occlusal and guidance point of view. All the movements were possible.

Setting up

(Figure 1) Occlusal showing landmark and desired movements.
(Figure 2) Showing Spacewize trace- meaning the deciduous tooth and other canine were not moved at all. Centrals were retracted by about 5mm and the laterals advanced by about 1.75mm exactly. These setups can be viewed as digital files in 3D if needed beforehand by the dentist and adjustments can be made if needed. Once we are happy, the 3D model was printed.

Consent part two
The 3D model was returned and we could view the proposed setup made according to the spacewize instructions.
(Figure 5: Overjet before)
(Figure 4: Overjet reduced and proposed on 3D print)
(Figure 5: 3D Print Occlusal)

An appointment was made with the patient to sit down and examine the models. At this point the patient clearly sees any compromises in the posterior region of his mouth. These were again highlighted but the patient insisted he did not want these treated. The over jet was also discussed with the patient he could see a reduction but not a complete closure, he was happy with this.

You can see the width differences in the anterior teeth that would require adjustment and...
tooth shaping with PPR (predictive proximal reduction). This made it far easier for him to understand the processes required to create the space. Finally he could also see the differential wear in his tooth outline that would be evident after alignment. He clearly understood that edge bonding and tooth contouring might be required after alignment and bleaching were complete. That is assuming he did not want to continue with porcelain veneers.

It was noted that the patient had reviewed and understood the 3-D model and what it was proposing. The Inman Aligner was then built and fitted.

**Treatment**

Inter-proximal and Predictive proximal reduction were carried out in a progressive and measured manner over 5 visits. This was done to ensure good anatomy and to reduce the risk of gouging, over stripping and poor contacts. With Inman Aligner treatment stripping is never carried out in one go.

Composite anchors were also placed in a timed and sequenced manner to ensure the forces could be directed at the right time. This allows for rapidly increased treatment times.

After only nine weeks the patient’s anterior teeth had nearly creased treatment times. This allows for rapidly increased treatment times.

The patient bleaches 35 to 45 min a day while the aligner is out of the mouth. After a week the patient returned his teeth had improved in alignment already but with the improvement in color as well made him view his teeth in a different way.

At this point he decided not to have porcelain veneers and instead to ask for composite bonding and buildings. He had seen examples of this already. We used some mockup flammable material to show the patient what was possible and he was thrilled with the results. So an appointment was booked for 2 weeks to have this done.

**Figure 6:** Before Close front view
**Figure 7:** After alignment and bleaching at 10 weeks
**Figure 8:** Immediately after bonding

Composite bonding was carried out on the 7,9 and 10. A composite veneer was placed on the 11. All these were carried out with only roughening and no prep or bevel. Venus Diamond composite from Heraeus Kulzer was used. I find that the Opaque shade allows superb blocking out of light meaning that if layered as dentine, it means a long bevel is not required to block out the joint. Enamel shade can then be placed thicker towards the incisal edge.

A wire retainer was fitted and the guidance adjusted to ensure there were still balanced excursive contacts on the left side so the load was not focused on the deciduous tooth. Roughening, total etch Opti-bond solo and Venus flow were used to bond the wire in place.

A clear essix retainer was also given to the patient to wear at night initially then to use occasionally and to have as a back up if the wire de-bonded.

**Figure 9:** Before front smile view
**Figure 10:** After Alignment and bleaching at 10 weeks
**Figure 11:** After Edge bonding and retainer
**Figure 12:** Side profile before
**Figure 13:** Side Profile after
**Figure 14:** Side Smile before
**Figure 15:** Side Smile after alignment and bleaching

**Discussion**

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On viewing the sequenced shots it is clear to see the changes. The patient was delighted that he had emerged from the treatment with his own teeth looking more attractive rather than having ceramic porcelain veneers. As good as ceramic restorations are, they will always require further treatment/maintenance and replacement. On a 22 year old if alignment, bleaching and bonding can satisfy the patient that it has to be better than placing ceramic veneers. The problem with digital smile design is that the patient is not really given the opportunity to see the teeth change slowly and in situ.

It is fine if whitening, bonding and alignment are part of the protocols but arguably patients should not be shown images of multiple veneers until they can visualize their own teeth looking better. You can see how very subtle changes can dramatically improve the appearance. Even though the colour is not truly homogenous and the teeth have a mottled appearance the most important thing here is that the patient was completely delighted with the treatment.

Figure 16: Side Smile at 6 months
**Figure 17:** Before occlusal
**Figure 18:** After occlusal at 10 weeks
**Figure 19:** After 6 months with retainer

**Figure 20:** Before Full face
**Figure 21:** After full face (at 6 month review)

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Ultimately a patient being happy with their own smile has to far outweigh the parameters that are set up traditional smile design.

**Figure 22:** After edge bonding
**Figure 23:** After occlusal

Final images at the 6 month review are also shown.

Contact Information

Dr Tiff Qureshi teaches Inman Aligner Training For course info visit: www.inmanalignertraining.com or email: inman@mdentlab.com
may be used for this purpose, for example free forming, virtual wax knife, scaling, turning and shifting of teeth.

Interferences remaining after the construction will be displayed by the software and automatically removed in consideration of both static as well as dynamic factors (by means of the virtual KaVo PROTAR Evo 5B) including the previously identified motion tracks. This allows for a drastic reduction or even the complete omission of subsequent follow-up work in the mouth of the patient for the practitioner. Not only does this facilitate time and cost savings, the danger of chipping may be reduced as well (Figure 12, 15).

The following colour illustration shows the occlusal pattern after dynamic adjustment (Figure 14).

In the image, one can clearly recognize the deviations (color markings) between the static and dynamic structure and the adjustment of interferences in the chewing relief. The dynamic adjustment may be displayed over the static one as wire netting. Any interferences to be expected are clearly recognizable (Figure 15).

After the dynamic adjustment, the finalized VITA ENAMIC crowns may be displayed in the KaVo multICAD module TruS-mile in a photo-realistic manner (Figure 16, 17).

Preparation for manufacture in the KaVo CSS: 60 seconds

The next steps for the completion of the dentures are performed in the KaVo CSS software, which is a job, material, tool and machinery management software by KaVo.

First, the manufacturing method is defined. This means that the user has the opportunity to send the produced,
open STL data of the restoration to his ARCTICA engine, his Everest engine or to other KaVo milling partners via the free KaVo Everest portal. The work to be manufactured and the predefined material to be used may be reviewed in a 3D view. If necessary, additional modifications such as, for example, a change of the material may be made.

After the selection of the KaVo ARCTICA engine as the production machine and a VITA ENAMIC for KaVo ARCTICA block, which was previously booked into the KaVo CSS via RFID technology, the nesting, i.e. the positioning of the restoration in the virtual material block, may be performed (Figure 18).

Figure 18

Now, the blanks are inserted in the block bracket of the ARCTICA engine and affixed with a torque wrench with a defined tightening torque (Figure 19, 20, 21). Afterwards, the tool stack with the tools required for the VITA ENAMIC – in this case, 4 different grinding tools with diameters between 0.6 – 3.6 mm - is inserted.

These tools were also previously booked in the KaVo CSS software via RFID chip and assigned to the glass ceramic tool stack. The advantage is that the tool service times are precisely logged and that the ARCTICA engine uses a traffic light pattern (green, yellow, red) to show the user when a tool should be exchanged. This also helps to minimize application errors.

In case of an automatic tool change in the KaVo ARCTICA engine, the tools are once again inspected with a laser for breakage or faulty positioning once they have been removed from the stack.

The processing is started at the touch of a button on the touch-screen of the ARCTICA engine or, alternatively, directly at the PC (Figure 22).

Completion of the VITA ENAMIC crowns: 180 seconds each

After the successful production of the two restorations on the KaVo ARCTICA engine, the VITA ENAMIC crowns may be separated from the material block. The ARCTICA engine may be connected to a KaVo lab handpiece (ERGoGrip and POWErgrip) and used to further process the works. Prior to the start of the grinding procedure, there is also an opportunity to reduce the diameter of the connectors to a minimum at the end of the production process, so that the time expended for the separation of the restoration becomes negligible.

After the grinding procedure, the VITA ENAMIC crowns are polished in a time-saving manner with the tools from the VITA ENAMIC polishing set. An additional subsequent individualization of the work is possible with the colours of the VITA ENAMIC stains kits. In this case, an additional individualization was omitted upon the request of the patient (Figure 23, 24, 25).

Thanks to the use of the virtual articulator during the construction in the KaVo multiCAD software and the precise 5-axis technology of the ARCTICA engine, the work could be inserted directly into the mouth of the patient and corrections of the occlusal relief could be waived. As can be seen, precisely integrated process chains pay off.