# Chairside CAD/CAM is the new age dental phenomenon

By James Klim, DDS, FAGD, AAACD

*"Chairside CAD/CAM is the new age dental phenomenon. Designing dental restorations digitally is going to be the standard in dentistry..."*

Welcome to the new age of digitally designed restorative dentistry. With the in-house millings and out-sourcing option with CEREC Connect, the CEREC AC Bluecam technology can now be the central management system for all indirect restorative needs.

Chairside CAD/CAM success relies primarily on the effective management of the restorative clinical theater: periodontal support, biomechanical application, preparation design, sound optical impressions and bite records, placement protocols and finishing.

The principles in preparing for a CAD/CAM optimal impression is dictated by meeting the engineering criteria for the replacement material to be used. With the past generations of intraoral digital optics, much of preparation design was directed by the limitation of the digital capturing technology. With the CEREC AC Bluecam's generous optical 14mm depth of field, automatic capture mode and precise resolution, the restorative preparation(s) and adjacent quadrant teeth are easily captured with multiple images and then stitched together for a very accurate virtual die.[1] The CAD/CAM clinician now has the flexibility of preparing for optimal tooth/restoration performance and the aesthetic requirements of the particular clinical situation at hand without constraints from the digital system.

When using a state-of-art adhesive protocol and applying specific dimensional design principles, the tooth/restorative assembly will recapture functional tooth strengths equal to or surpassing natural teeth.[2-4] All-ceramic conservative restorations perform best when the internal design surfaces are smooth with the simplest possible basic geometry. Avoiding sharp internal preparation angles will facilitate smooth internal restoration surfaces, maximizing fracture resistance of the ceramic.[5] Because of adhesive bonding, a retentive shape of the preparation is not necessary.[6,7] In those clinical cases requiring a full crown or onlay, the CAD/CAM user has the lithium disilicate (IPS e.max CAD) option for increased functional strength needs, making the second molar region a very practical zone to treat.[8]

With the introduction of lithium disilicate to the CAD/CAM world, there is now a robust and aesthetic material that surpasses and will functionally out-perform zirconium veneered and PFM crowns and has compatible wear characteristics to enamel.[9] IPS e.max CAD is milled in the intermediate lithium metasilicate crystal "blue" stage and can then be efficiently glazed and crystalized with the same firing cycle. Delegating the finishing process to the clinical team facilitates a very reasonable delivery model for a one-appointment highly functional crown system.

*Figure 1. Caries was diagnosed on buccal of tooth 15 and tooth 17. Patient desired amalgam removal while aligning her buccal corridors.*

*Figure 2. Conservative preps were utilized, removing the caries and amalgam on the cervical buccal of 14, 15 and 17. Tissue retraction was created with a diode laser.*

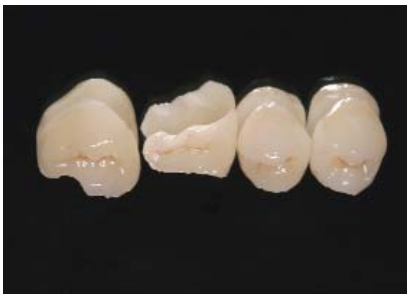

*Figure 3. Milled, stained and glazed TriLuxe ceramics before bonding.*


*Figure 4. It is customary to try-in ceramics prior to bonding. Note the accuracy of the dry-fit restorations. This rivals the fit accomplished by the best labs in the country.*

*Figure 5. The occlusal view of these metal-free CEREC restorations occurred at one week, demonstrating the precision and blend of CAD/CAM technologies.*

The specific dimensional design protocol for CAD/CAM restorations are the same as for all-ceramic laboratory pressed restorations. The posterior IPS Empress CAD conservative restoration dimensions are 2mm for the working cusp contact area with the isthmus 3mm wide and 1.5mm thickness at the depth of the fissures.10 For the more functionally challenged occlusal profiles being restored, IPS e.max CAD recommended dimensions are 1.5mm in the occlusal contact zone and 1.0-1.5 mm depth at the isthmus.[11]

Another significant restorative principle for creating a smooth chairside CAD/CAM experience is preparing optimal draw between the preparation and adjacent tooth's interproximal surfaces. This principle becomes even more important when applied to CAD/CAM quadrant applications of two or more teeth being restored at the same time. The author will often recontour and polish the remaining interproximal surfaces in order to create the optimum proximal contact diameter dimensions which will later simplify the virtual design process and the seating of the milled restoration.

The final element for a smooth digital impression is the creation of well-defined margins. With the precise milling of the MC XL (optical resolution of 7.5µm), margin design may vary between a shoulder to a very light chamfer depending on the preconditions of the tooth, functional requirements, aesthetic demand and choice of restorative material.[12] Subgingival optical margin crispness can effectively be exposed with soft tissue laser troughing, significantly simplifying the optical impression process. [13,14]

One advantage of a digital impression is the instantaneous preparation and margin assessment. If needed, alterations can be accomplished in the mouth and re-imaged in a timely fashion, to assure precise margin outline and preparations that will fulfill the engineering requirements for a successful functional and aesthetic outcome.

With the CEREC AC Bluecam optical read, the minimal use of imaging enhancement medium will facilitate a simple and efficient image capturing process. The aperture (mesial-distal dimensions) of the Bluecam camera provides enough optical overlap so with one capture of each tooth and preparation(s) in the quadrant, enough digital data will be formulated to precisely stitch and create a user friendly virtual die. The CEREC AC software algorithms compute optically artifact-free virtual dies generated from the multiple images. In most cases, the optical impression for a full quadrant can be accomplished in approximately 15 seconds and a full arch impression in less than a minute with the Bluecam auto-capture trigger feature.

The operator is able to visually verify the virtual die development on the screen and is notified if additional exposures are needed for virtual die completion. Even for a single tooth preparation, it is advantageous for the intuitive software design features to capture the full quadrant being treated. The addition of a digital bite registration will complete the records the computer needs to propose an anatomically correct and functional restoration design.[15,16]

The CEREC designed software has evolved through the years to the current user friendly version. The design process can often be delegated to a team member because of the simplified and intuitive design steps. With proper geometrically prepared teeth and the corresponding optical impression, the CEREC restorative design process will take minimal time and is very predictable.

Once the operator approves the virtual die, the next step in the design process is outlining the preparation margins with the automatic margin finder. The biogeneric software takes over the design process for inlay and onlay restorations by drawing on examples of hundreds of natural teeth in the software's databank.[17] It takes about 15 seconds for the computer to automatically finalize the proposed biogeneric virtual restoration.

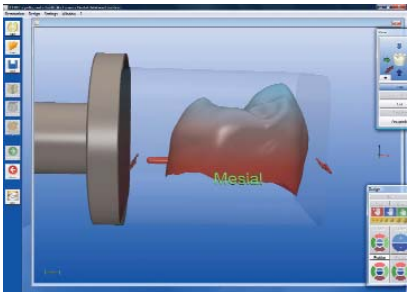


*Figure 6. Positioning principle of the Multi block, aligning the cusp or incisal portion of the virtual restoration in the desired transparent zone simplifies the matching process.*

*Figure 7. Pre-existing large amalgam on first molar and caries on mesial of second molar.*

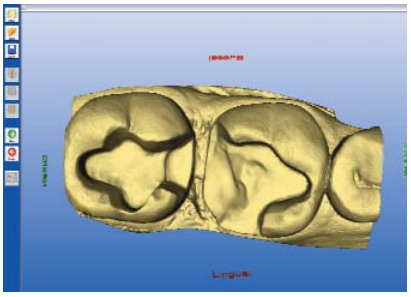

*Figure 8. Conservative preparations, maximizing dentin and enamel preservation.*

*Figure 9. Once bonded, the fiber-optic blend of the gradient restorations to the natural tooth will take over resulting in a natural recreation.*

*Figure 10. Pre-treatment view of worn crowns.*

*Figure 11. Milled intermediate phase IPS e.max CAD lithium disilicate crowns prepared for crystallization.*

*Figure 12. Crystalized IPS e.max CAD HT A1 restorations, completed chairside.*

*Figure 13. The e.max high translucency (HT) ceramic restoration will handle functional areas in the mouth and is very aesthetic.*

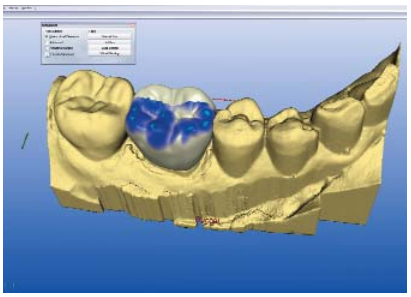

*Figure 14. The virtual crown is proposed from the database template, aligned into arch using the virtual study model and bite registration used to apply desired occlusal contact placement.*

*Figure 15. Precondition of incisal wear on right central and exposed root/margins on adjacent central.*

*Figure 16. Restored centrals restorations milled from gradated blocks with subtle stain characterizing.*

*Figure 17. The solution for highly aesthetic implants: the Sirona TiBase; a mesostructure milled out of a prefabricated zirconium oxide block inCoris ZI meso; and a feldspar or glass-ceramic crown.*

*Figure 18. Restored centrals restorations milled from Tooth #8 presented with internal resorption and resulting.*

*Figure 19. Customized zirconium abutment in place ready for final CEREC crown.*

*Figure 20. CEREC digital design and mill is assessed on poured model prior to cementation.*

*Figure 21.*

*Figure 22. Patient was ecstatic about the final outcome of her enhanced smile. CEREC veneers on adjacent central and laterals completed the aesthetic harmony.*

Full crowns are effectively proposed from a library of templates or biogeneric crown options to be introduced later this year. The operator chooses the one that best fits the morphology of the adjacent teeth and the software will seat the virtual crown to fit the preparation space. The operator only needs to verify the proposed occlusal and proximal contacts, then the restoration is ready to be milled.

Alternative design features are included with the CEREC software. The operator has the option of using correlation design mode. This is a design method that takes a digital scan of a proposed wax-up or the pre-preparation condition of the quadrant and translates the optical information into the proposed virtual design.

Another design option is call replication which is effective for anterior aesthetic restorations. For example, when restoring one central incisor, the computer will setup the steps to image the adjacent central and propose the mirror image, thereby maintaining the aesthetic subtleties that "fingerprint" the proposed restoration and harmonize with the adjacent teeth.

The CEREC software has support design tools to modify virtual surfaces for the operator's design preferences. In most cases, with proper preparation geometry and optical impression technique, minimal tweaking is needed for the proposed restoration.

The aesthetic challenges of historical CAD/CAM monochromatic restorations has now been enhanced with a wider selection of block colour and transparency options. With the introduction of Vita Triluxe/Forte and IPS Empress CAD Multi (gradient blocks), the aesthetic blend for inlay/onlay cavo-surface margins has been enhanced. The virtual restoration, prior to milling, can be positioned and rotated in the virtual block to reproduce the desired gradient zones (cervical to incisal) to best aesthetically blend the restoration. In many ways, we are recreating similar colour/transparency transition and optic influences as seen in a natural tooth.

For anterior CAD/CAM applications, pre-mill block shade selection is primarily determined by desired brilliance for the incisal half of the restoration. The cervical half can then be controlled by depth of preparation and stump's optical colour influence (thickness of ceramic), margin design (chamfer, shoulder or feather), virtual block opacity (controlled by positioning the virtual restoration in the gradient block) and stain characterizing.

Post-mill finishing techniques can be as straightforward as polishing or adding stain and glaze where the aesthetics require more customization. With the gradient ceramics, it can sometimes be difficult to discern a polished restoration from a glazed one when proper finishing techniques have been learnt and applied.

Having the ability to control contours, occlusion and finishing is one of the significant restorative advantages to chairside CAD/CAM dentistry. For those that desire this control, obtaining a customized laboratory result is within reach with the proper training and application and can usually be accomplished in one appointment.

In clinical cases such as bridges, gold or aesthetics where demands that go beyond chairside reality, the CEREC user can optically scan the clinical case and cyber send the digital information to one of the CEREC Connect laboratories. The dental technician designs the restoration on the basis of the virtual model and lab prescription, without the need for a physical model. The restoration is then fabricated on the inLab milling unit. If the laboratory prefers a conventional production method or for larger aesthetic cases, a digitally fabricated CEREC Connect model can be ordered through infiniDent, using the same virtual die information.

As from the end of 2009, the Sirona inLab system will be capable of producing customized zirconium oxide abutments for a wide range of popular implant systems. Following the successful launch with CAMLOG Implants in the fall of 2009, Sirona has now introduced its own titanium bases for implant systems from Nobel Bio-

care, Straumann, Astra Tech, Friadent, Biomet 3i and Zimmer. The matching TiBase connector, supplied in a set together with the scan body and abutment screw, is adhesively bonded to the milled and sintered zirconium oxide mesostructure.

With the aid of the new inLab 3D for Abutments V3.65, it is now possible to design a zirconium oxide abutment and a matching crown in a single step. This top-down method delivers convincing benefits in terms of speed and convenience. After the user has digitally acquired the implant position, the operator can design a fully anatomical crown in a single step. The mesostructure is created automatically by reducing the crown. Optimum flexibility is ensured by various adjustable parameter settings e.g. telescope angle, shoulder width and gingival pressure.[18]

Such custom abutments are the ideal basis for aesthetically sophisticated and clinically reliable all-ceramic restorations. Compared with outsourced abutments and standard abutments requiring adaptation, in-house production delivers considerable time savings.

The concluding chapter to CEREC restorative success is managing the adhesive placement. Apply adhesive steps with a microscopic mindset relative to the manufacturer's recommendations and a moisture-free environment.

The CEREC AC Bluecam digital technology with the Sirona MC XL milling unit is a significant upgrade for efficiency, virtual design, and precision. With the availability of "tooth-like" gradient block options, the industry now has both the premium materials for performance and the most advanced aesthetics applications in dentistry.[19-20] Once learnt, the CEREC system has been designed to be effectively applied to most dental practice operating models. With the intuitively designed software, the primary clinical demand is in the preparation and digital acquisition phase.

With good digital information, the software will propose most of the virtual design for the operator. The MC XL precision milling quality will streamline post-mill finishing and seating procedures, therefore contributing to a very time efficient process.

Chairside CAD/CAM is the new age dental phenomenon. Designing dental restorations digitally is going to be the standard in dentistry. CEREC AC Bluecam with CEREC Connect is pushing the limits on the options for indirect, virtual restorations, establishing the standard for dentistry.

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*Figure 23. Pretreatment arch to be restored using CEREC technology.*

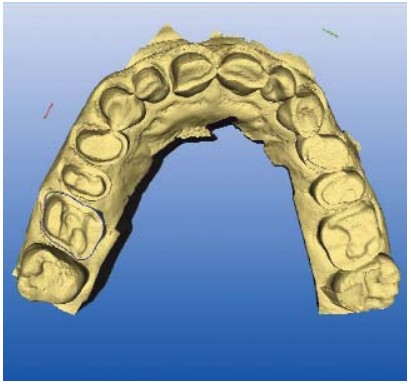

*Figure 24. Full arch CEREC AC Bluecam scanned virtual model.*

*Figure 25. The completed upper arch demonstrates preferable cusp angles and occlusal plane alignment designed from CEREC templates to best fit patient s functional envelope.*

## About the author


*Dr James Klim is an international speaker, author and instructor on dental technology, practice development and aesthetic dentistry and has taught at several advanced post graduate institutes around the US. He has been awarded fellowships from the Academy of General Dentistry and Academy of Dental-Facial Esthetics and currently has a full time restorative practice in Santa Rosa, California. He is the founder and director of CADStar™, a learning centre for advanced CEREC education.*