

Continuing Esthetics

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The Essence of Innovation: Integration and Versatility of a Chairside CAD/CAM Restoration System

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The first unaided takeoff by a heavier-than-air aircraft was the accomplishment of Brazilian-born inventor Alberto Santos-Dumont. He wasn't so much concerned about lift, airflow or engines; rather, he was more focused on the "big picture" and considered flying an invention that would "unite the world."¹ Although the Wright brothers were the first to build an airplane that actually flew, Santos-Dumont is often credited with inventing the first *practical* airplane, meaning one that could fly higher, faster, longer, and with better control²; one that could take off from a flat runway without the need for a launching apparatus such as a pulley or catapult, as did the Wright brothers' aircraft.²

What does this have to do with dentistry? For starters, new technology-based equipment and instruments are constantly being introduced to the dental market. The ultimate success or failure of these tools depends on many factors. First of all, the product has to fill a need in the practice, and hopefully it does so in a manner that is better, faster, simpler, and easier to use than its predecessors. It needs to integrate readily into the procedure, the process, and the practice workflow as a whole. The technology needs to be both 100% clinically viable and 100% safe. And it must also be practical. Technology can promise the world, but if it is not practical, it just will not "fly" with the profession, and will end up stuffed in a drawer or collecting dust.

Among the array of innovations to consider in dentistry today are digital x-rays, digital charting, cosmetic imaging systems, intraoral cameras, digital shade systems, silent interoffice communication, computerized occlusion analysis, and chairside computer-aided design/computer-aided manufacturing (CAD/CAM) systems. As we continue through this time of technological evolution in dentistry, a critical eye needs to be developed to evaluate and judge these technologies. The technologies we decide to implement will directly affect how we manage our practices for effectiveness, efficiency, and productivity.

Integrity, Integration, and Versatility

At the heart of all technologies are integrity, integration, and versatility. Webster's dictionary defines integrity as a "state of being complete or whole; honesty." Integration is defined as a "coordination of mental processes with the individual's environment. The process of making whole." Versatility is defined as "the quality of embracing a variety of subjects, fields, or skills" or "turning with ease from one thing to another." In other words, integration is process-dependent and versatility is the application of these processes.

Jim Collins, author of the book *Good to Great*, summarizes the purpose of any technology as: "when used right, technology becomes an accelerator of momentum, not a creator of it."³ Technology is meant to speed up a process. He also states that, "good-to-great organizations avoid technology fads and bandwagons, yet they become pioneers in the application of carefully selected technologies."³ The success of our practices is not based on technologies themselves, but on how carefully selected technologies can accelerate our practice vision. Central to this decision-making process are the following questions:

1. How does this technology I am interested in bring integrity to our practice vision? How does it make the patient whole or how does it restore the patient?
2. How is the integration of this technology scored? How easy is it to use?
3. What is the versatility of the technology in question? What practice systems will benefit?

CAD/CAM Integration

Among all the technologies I have incorporated into my practice, the CEREC 3D System (Sirona Dental Systems) has provided the most immediate and long-term positive impact. It allows us to restore a patient in a single visit (integrity), both clinically and administratively; and its ease of assimilation (integration) into daily practice was aided by a reasonable learning curve.

For true success, a learning curve should be viewed without a finish line; it is not a goal, but rather a continually evolving process.

The benchmark of success with this technology is its versatility. It is the application of knowledge and technology to drive successful results in variable clinical circumstances. Simply put, versatility is the practitioner's ability to resolve their patients' needs and to expand and improve on the model that delivers the solutions.

The Evolution of Chairside CAD/CAM: Restoration Design

When CEREC was first introduced, the operating software was clinically successful, but required mastery of a steep learning curve. The user interface was a stumbling block mainly because the on-screen representation of the tooth or restoration to be designed looked nothing like a real tooth. It was the equivalent of viewing a computed tomography (CT) scan of individual tooth "slices" rather than the whole tooth at once, which proved challenging to comprehend in a visual-spatial sense. The recently released CEREC 3D software version 3.00 has reduced the learning curve so that the visuals are "what you see is what you get."

The new software starts with an improved graphical user interface with updated icons and a more intuitive tooth selection dialog box. The addition of an on-screen "crosshair" icon aids in the alignment of the infrared camera during the optical impression. This leads to better-centered scans and an increase in the accuracy of the proposed restorations. Defining the margins is also streamlined, as the clinician draws a single-segment margin regardless of the type of restoration being designed. A single blue line will define the margins of all inlays, onlays, crowns, and veneers in the design process.

The design window features the enabled position, rotate, and scale-all tools for inlays and onlays. This feature allows the clinician to reposition, rotate, and resize the proposed restoration as a whole on the preparation. The cut tool is integrated into the design window, so the clinician can slice through any portion of the proposal and preparation, similar to a CT scan.

The new software features "biogeneric tooth reconstruction," which is a method for automatically generating inlay and onlay proposals. This mode allows the on-screen visualization of the biogeneric process as the software analyzes the tooth preparation structure and searches internal information for the best occlusal fit from the database library. The proposal is then modified via a morphing process to create a distortion-free proposal of the new tooth. It is the equivalent of having a talented and experienced laboratory technician perform a wax-up to the most ideal occlusion with consideration to overall size and tooth position within the scan provided.

Three changes have been made to the fabrication (milling) process:

1. **Automatic milling mode selection:** the system will automatically mill the restorations based on the bur installed and according to the dentist's preference.
2. **Parallel touch process:** time is saved in the pre-mill as both burs move in parallel during the touch process. The touch process tests for appropriate block size and position as well as diamond integrity before each milling cycle.
3. **Step-bur continued milling optimization:** A worn or nonfunctional step-bur that needs replacing during milling meant a restart of the milling from the beginning. The software has been optimized to reduce the "air-mill" time.

Integration of this chairside CAD/CAM system into our practice has allowed us to accelerate our model of patient-centered dentistry that generates health, vitality, and longevity in a single visit. We are able to meet or exceed the patient's expectations. As a team, we practice versatility by providing restorations on natural teeth with inlays, onlays, crowns, and veneers, repairing fractured porcelain on bridges and porcelain-fused-to-metal (PFM) crowns, restoring implant crowns, rehabilitating occlusions, and creating esthetic results in a single visit with predictable longevity.⁴⁻⁷

In the June 2006 issue of the *Journal of the American Dental Association*, Carl J. Drago, DDS, stated that the long-term success of crowns and fixed partial dentures on natural teeth and implants depends on several variables:

1. Accuracy of fit between castings and abutments and teeth
2. Impression materials and techniques
3. Dental stone manipulation
4. Casting and finishing processes.⁷

In his findings via the electrical discharge test, CAD/CAM was the one technique that met the passive-fit criteria of less than 10.0 μm .⁸ The benefits of the CAD/CAM technique are founded on homogeneous milled restorations without defects associated with castings, polymerization (shrinkage), and/or porcelain firings. Drago confirms, "ultimately, the success of implant-retained restorations depends on several complex factors: bone response to the implants, soft tissue response to the implant-abutment/crown interfaces, and stability and accuracy of the implant abutment connection."⁸



Figure 1 - Preoperative intraoral photograph of tooth No. 19.



Figure 2 - Radiograph of implant after complete integration.



Figure 3 - Abutment placed on implant and tightened to manufacturer's specifications.

Clinical Examples

Integration of the CAD/CAM process and Drago's findings leads us to the following example of a single-visit implant restoration case. A 57-year-old woman lost tooth No. 19 as a result of an unreparable vertical fracture (Figure 1). She selected an implant tooth replacement option. A NobelReplace Tapered Groovy 5.0 mm x 10.0 mm implant body (Nobel Biocare) was placed and allowed to integrate to the bone (Figure 2). Using the new software, a single-visit implant restoration without anesthetic, impressions, or temporary crowns was treatment-planned in the dental database articulation mode. Tissue health was evaluated at the healing cap junction at the beginning of the appointment. The healing cap was removed and the abutment was placed and tightened to 35.0 Ncm (Figure 3). Interocclusal clearance of 2.0 mm or greater is required for functional and stable porcelain restorations.⁹ A 2.0+ mm clearance was confirmed with a periodontal probe. Herculite XRV composite (Kerr Corporation) was placed to cover the abutment screw and provide an occlusal table on the implant abutment. The bite registration and implant abutment were scanned into the CEREC 3D System (Figures 4 and 5). An implant crown was designed using the dental database function using virtual articulation (Figures 6 and 7). A Vita 2M2C TriLuxe size 14 block (Vident) was selected to mill the restoration. The milled implant crown was homogeneous, defect-free and accurate, and allowed a passive fit on the abutment. The crown was not stained but glazed after verification of occlusion (Figure 8). The crown was cemented with dual-cure Variolink (Ivoclar Vivadent) to provide mechanical retention only. Note the integrity of the implant crown, occlusion, and tissue health at cementation (Figure 9).



Figure 4 - Bite registration for tooth No. 19 and opposing (occlusal) dentition.

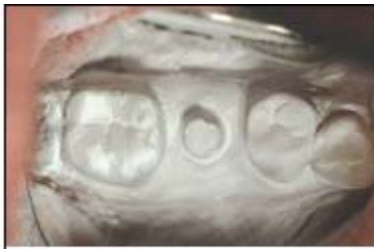


Figure 5 - Implant abutment is powdered and ready to be scanned.

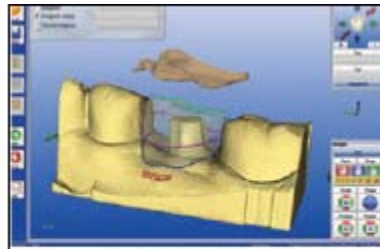


Figure 6 - CEREC 3D image showing interaction of opposing dentition via bite registration.

The versatility of the new software can be further demonstrated by some before and after treatment examples using the dental database with and without function, correlation, and replication modes:

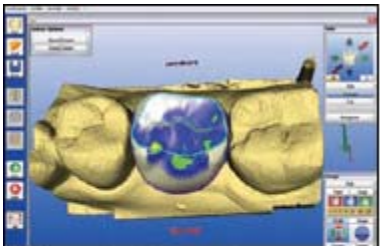


Figure 7 - Proposed crown design color-coded to indicate strength of contact with opposing dentition.



Figure 8 - Occlusion is verified with articulating paper.



Figure 9 - CEREC all-ceramic crown after cementation on implant abutment.

Dental database mode – In this clinical example using the database mode, a 62-year-old woman received a single-visit CAD/CAM onlay that treated recurrent decay under a previously placed gold onlay (Figures 10 and 11).

Dental database with function mode – A 53-year-old woman received a single-visit three-quarter crown restoration to treat recurrent decay with open margins under an existing amalgam. We were easily able to maintain her occlusal stops without generating interferences in excursive movements (Figures 12 and 13).



Figures 10 and 11 - Gold onlay replaced with all-ceramic CAD/CAM onlay.



Figures 12 and 13 - Failing amalgam replaced with 3/4 all-ceramic CAD/CAM crown.



Figures 14 and 15 - PFM crown replaced with all-ceramic CAD/CAM crown.

Replication and correlation mode – A 48-year-old woman presented with a tooth No. 7 that had existing composite restorations with recurrent decay on the mesial, lingual, distal, and facial aspects. The patient was also unhappy with the PFM crown contours and color on tooth No. 10. She desired the shape of both of the lateral incisors to match tooth No. 7. Tooth No. 10 was restored first in replication mode, allowing us to duplicate and mirror the exact contours of tooth No. 7. Tooth No. 7 was then restored in correlation mode to recapture the existing contours. Note the symmetry of contours on tooth No. 7 and tooth No. 10 (Figures 14 and 15).

Conclusion

The CEREC 3D system with software version 3.00 has had the most rewarding personal and professional impact on my practice based on the principles of integrity, integration, versatility, and practical application. Dr. Werner H. Mörmann proved we could "fly" with chairside CAD/ CAM dentistry when he invented the first CEREC system more than 20 years ago. He wasn't concerned about preparations, powdering, and picturing-he knew the "big picture" of single-visit CAD/CAM restorations meant amazing things to the future of dentistry, and that the evolution of CAD/CAM was inevitable when he provided the means to help get it off the ground. CEREC 3D, with its "innovation integration" philosophy, has made CAD/CAM dentistry part of our daily protocol and I cannot envision my practice without it by my side in clinical application every day. References

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