Share:

Compendium

May 2011, Volume 32, Issue 4
Published by AEGIS Communications

CAD/CAM Dental Technology: A Perspective on Its Evolution and Status

Edward McLaren, DDS, MDC

In the 1970s, Francois Duret conceptualized how digital technology used in other industries could be adapted to dentistry, such as for digital impression making either directly in the mouth or indirectly on a model. The latter represents the original process for capturing data used in what ultimately became the computer-assisted manufacturing (CAM) of dental restorations, with digital data of impressions transferred to a production-milling unit to fabricate restorations.

The concept hasn't changed much since then, but it has been improved and refined. What's interesting, however, is that 80% of high-volume, laboratory-based production CAD/CAM fabrication in dentistry is for copings, onto which porcelain is either hand-layered or pressed.

Dental CAD/CAM's evolution over the past 25 years has centered on the chairside market, beginning with CEREC® (Sirona, www.sirona.com) and most recently the E4D Dentist System (D4D Technologies, www.e4dsky.com). This is because the real appeal of the CAD/CAM concept is that it offers dental professionals and their patients the convenience of same-day dentistry. Other companies also are attempting to enter the marketplace. It is now possible for patients to present with a condition requiring treatment, have their tooth prepared and digitally scanned/imaged (as opposed to having a traditional impression taken), and have a final restoration seated in the same day.

Interestingly, after 25 years there is only roughly 10% market penetration of chairside CAD/CAM in the United States. By some accounts, an estimated 10,000 to 15,000 CEREC chairside systems are in use, which, considering there are an estimated 150,000 US general dentists, translates to only 10% market

penetration. Although significant, compared to non-dental business models that adopt revolutionary products at a penetration rate of 10% after only 10 years, and more than 50% at 25 years, dentistry is lagging behind the typical business model.

CAD/CAM and Dental Laboratories

The slower pace with which dentists are adopting chairside CAD/CAM units could provide interesting opportunities today for dental laboratories. At a time when the laboratory industry struggles with surviving in a drastically changing dental marketplace—one in which skilled technicians are being replaced with dental devices and outsourced overseas labor—CAD/CAM provides new potential working models for laboratories. For example, laboratory technicians apply porcelain to copings fabricated from zirconia, alumina, glass ceramic (of various forms), or titanium using CAD/CAM processes.

This provides an incredible opportunity for the laboratory industry in the United States to adapt to the need for a digital dental team, one in which dentists capitalize on the benefits of digital impressioning devices to transfer patient preparation information to the laboratory to expedite restoration fabrication and enhance patient comfort and convenience. Laboratory personnel then become digital designers who machine single-crown or multi-unit bridge restorations and, when necessary, layer or press the veneering porcelain to the CAD/CAM copings—enamelizers, as one could call them—as well as impart esthetic characterizations or final contouring to the restorations.

This is where real opportunities for growth are. All normal, basic, and repetitive procedures will disappear and be replaced by CAD/CAM. In the not-too-distant future, most model work for single- or two-tooth restorations will be completed by CAD/CAM, since dentists will most likely incorporate digital impression taking. When traditional models are used—which will also be generated by CAD/CAM—they likely will involve multiple teeth, or cases requiring occlusal adjustments.

Applications and Indications for CAD/CAM in Dentistry

Duret's initial attempt was to fabricate a full-contour restoration from some form of glass ceramic. Until recently, most dental CAD/CAM applications were limited to fabricating copings to replace the casting processes in the laboratory. Most chairside applications for dentists have been for inlays, onlays, and a single posterior crown.

With the advent of better and multilayered materials, the applications for dental CAD/CAM have evolved into anterior indications and almost any type of restoration. The materials available for dental CAD/CAM now offer such benefits as higher quality, user-friendliness, and enhanced esthetics. Originally, only zirconia or alumina were available for machining copings, but manufacturers have introduced machinable materials, including such glass ceramics as Vita Mark I, then Vita Mark II (Vident™, www.vident.com), and now IPS Empress® CAD (Ivoclar Vivadent, www.ivoclarvivadent.usi) and IPS e.max® CAD (lithium disilicate) (Ivoclar Vivadent). Multilayered blocks are also available to significantly improve esthetics.

Enhancements to the milling technology itself have given rise to more accurate and precise anatomy in CAD/CAM restorations, thus form and function have also improved significantly compared to the original rudimentary anatomy of original machined restorations. Today, a patient would feel comfortable with the esthetics and fit of a CAD/CAM-generated restoration for a molar and maybe a bicuspid, but at this point some augmentation from a laboratory ceramist—through the digital dental team concept—might be necessary so it is customized for the patient's mouth.

In the author's opinion, however, for CAD/CAM restorations for anterior teeth—though available from chairside systems—the quality of the final esthetics from machining alone is marginal at best. Ideally, anterior teeth that are initially machined, even with a chairside CAD/CAM, strongly benefit by skilled laboratory ceramists who can provide the finishing artistic and esthetic touches required for the esthetic zone. Additionally, restorations to satisfy the requirements for the resurging area of minimal- to zero-preparation veneers—or mini or sectional veneers—also are not appropriate for dental CAD/CAM processes. Because these restorations typically are paper-thin or replace only an incisal corner, the use of CAD/CAM technology for such applications would be too cumbersome and, therefore, would defeat the goals of this technology of ease of use and convenience.

Another convenient application for CAD/CAM processes is the fabrication of customized implant abutments, either titanium or zirconia. This is especially the case for the bicuspid forward, since esthetic zone implants typically require customized abutment shapes. CAD/CAM implant abutment systems include NobelProcera™ (Nobel Biocare, www.nobelbiocare.com), Lava™ (3M ESPE, www.3MESPE.com), and Atlantis™ (Astra Tech Inc, www.astratech.us).

In the author's opinion, eventually all frameworks and bars also will be made by some CAD/CAM process because enhanced materials are now available. When these components are machined instead of cast, less distortion occurs during porcelain placement.

Prerequisites for Dental CAD/CAM Success

Like other indirect restorations, the predictability and success of CAD/CAM restorations are predicated on a good preparation, a detailed impression (in this case, optical/digital scan), and understanding how to design (or traditionally wax-up) a restoration that will satisfy dentist and patient expectations. Marginal accuracy is always a concern, and CAD/CAM has advanced to the point where margins now fit within 50 μm if all processes are properly followed.

This assumes step-by-step procedures will be incorporated into the treatment and emphasizes the benefit of working with adept digital designers, whether in the practice or at a skilled CAD/CAM capable laboratory. However, it would be a misconception to think that dental CAD/CAM technology has advanced to the point that non-dentally trained individuals could run the technology and fabricate restorations. This is not the case.

Rather, clinical, functional, and esthetic success of CAD/CAM restorations necessitates operation by an intelligent dental professional who can visualize in the 3-dimensional (3-D) world what the proposed restorations should be. This includes anatomy and margin placement, as well as enamel (veneering porcelain) characterization. Such individuals also must understand the machining capabilities of the milling unit and how to optimize designs to work within those capabilities.

Conclusion

Today's dental CAD/CAM technologies increase efficiencies, help resolve labor issues, and enable dental professionals to interact with each other and their patients in more convenient and service-oriented ways than ever before. The materials and machining capabilities are improving drastically. As the cost of the technology continues to decrease while its ease of use and predictability increase, greater opportunities for job growth in the laboratory industry and dental practice through creation of dentally trained digital designers can be realized.

Whether a dentist's motivation is realizing a decreased turn-around time for treatments or providing a service

he or she was unable to offer previously, now is a good time to consider incorporating CAD/CAM technology in whatever manner best suits one's practice and/or laboratory.

About the Author

Edward McLaren, DDS, MDC
Professor, Founder, and Director
UCLA Post Graduate Esthetics

Director
UCLA Center for Esthetic Dentistry
Los Angeles, California

Share this:

Related Articles

- **Technology Integration: CAD/CAM Today - A 22-year Retrospective**
- **Focus On: CAD/CAM**
- **Lithium Disilicate - The Restorative Material of Multiple Options**
- **Overcoming Unforeseen Incidents**
- **CAD/CAM Technology in Restoring Implants**

Back to Top

Select an Issue

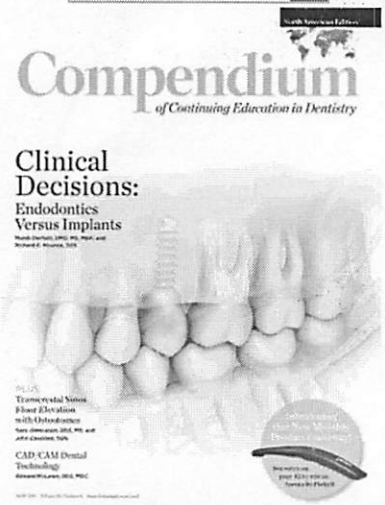

Table of Contents