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A new era in dentistry

The age of CAD/CAM is here, and it’s more exciting than anything I could have dreamed of even a few years ago. I can attest to the reality of this excitement from several different perspectives — first, the perspective that comes from seeing the design and production process of the CAD/CAM hardware and software firsthand during my visit to Dallas to meet with engineers on occlusal principles and seeing a magnificent organization that has been developed from just a dream several years ago.

Chairside CAD/CAM is a boon to progress in our profession and a representation of the innovation we need to help move dentistry into the digital age. Not only did the engineers quickly master the concepts, they wrote software code to make the CAD/CAM machines create occlusal surfaces based on time-tested, functional, occlusal principles.

My other perspective comes from the fact that I am enjoying perfectly fitted chairside CAD/CAM (E4D Dentist) crowns on two of my premolars, which were made and produced by the very talented hands of Dr. Jeff Scott. I was tremendously impressed with how smoothly all of the procedures went from start to finish.

I can also attest to the perfection of the margins because the crowns that were replaced looked good, even on the radiographs, but I had some bleeding I couldn’t seem to stop. The day the new CAD/CAM restorations went in, the tissue began to tighten, and now it is as firm as it can be. The floss contacts are perfect, the bite is perfect and I was amazed at how little adjusting had to be done.

I have to admit that early CAD/CAM restorations left a lot to be desired, and I have seen a number of CAD/CAM cases that I didn’t think were very good. Like so many technological advances, getting the technology perfected took time and experimentation. From my experience, I can conclude that the technology has truly arrived because the marginal fit, the contours and the occlusion are so good.

A caution is in order, however. In the hands of a clinician who doesn’t understand the principles of good occlusion, CAD/CAM will enable him or her to “mess people up” faster. When a patient has a perfectly equilibrated mouth before insertion of new restorations, the outcome is always more predictable. Dentists desiring to adopt CAD/CAM in their practices need to understand and practice the principles of occlusion and complete dentistry more than ever. I am convinced, though, that no compromise of these principles is necessary.

It is indeed a wonderful new era of restorative dentistry, and I am pleased to welcome you with this inaugural edition of CAD/CAM magazine.

Sincerely,

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Cover image provided by D4D Technologies.
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Direct ceramic restoration using digital technologies

Author: Lyndon Cooper, DDS

The use of computer-aided design/computer-assisted manufacturing (CAD/CAM) represents one approach to providing single-tooth crowns for select indications. The prosthetic principles for tooth preparation and restoration are well defined. Patient, tooth and material factors converge to guide the selection of one or another restorative material. When these factors lead to selection of a crown, the therapeutic principles involved are balanced by tooth, peri-coronal or peri-implant tissue, and functional and esthetic parameters. The selection of an all-ceramic material for tooth restoration opens a floodgate of information about emerging materials and techniques. Central among these techniques is CAD/CAM. In its proper place, CAD/CAM offers a therapeutic pathway to clinical dental excellence using all-ceramic materials for single tooth restorations.

The stated advantages of CAD/CAM technology for crown fabrication include: a) the application of new materials, b) reduced labor, c) cost effectiveness and d) quality control (Miyazaki et al. 2009). However, an added principle value of CAD/CAM is the computer control of data and its embodiment of clinical information. The correct acquisition of data regarding tooth- and tissue-specific information and the management of information related to the designated restorative form, as well as the engineering details related to the proscribed material, can be organized around three-dimensional representations of the tooth or teeth in question. This empowers thought and discussion and permits careful interrogation of the tooth preparation, the restoration contour and interproximal or occlusal contacts of the restoration, as well as a detailed analysis of the dimensional requirements based on material selection (Fig. 1). CAD/CAM offers a platform for collaboration that has not existed between clinical and laboratory processes.

Data acquisition for fabrication of a crown has historically been an iterative process blending clinical skills and laboratory arts. A classical impression is made using one of many impression materials that is subject to procedural and material issues of fidelity. Contemporary materials, including vinyl polysiloxane impression materials, offer high fidelity and dimensional accuracy, thus leaving the responsibility of good impression making to the clinician. Creating working dies and articulating master casts to produce an analog of the clinical situation is also supported by excellent material choices, but again requires the diligence of the dental laboratory technician.

The fidelity of the laboratory die and casts must be maintained throughout the process of sculpting and creating a metal, metal-ceramic or all-ceramic crown by a lost wax or build-up technique. This is another example where materials are optimized, but skill and care are demanded. Ultimately, a crown can be well made using classical techniques involving a multistep process demanding careful attention to detail. This attention to detail represents the classical approach to data acquisition and management. An iterative review of the data requires physical steps.
to create physical proposals — typically in wax — for discussion. The computer aspects of CAD/CAM bring this data management to a focus in a proposed preparation and restoration in three dimensions on a computer screen. Its value is that it is an efficient and effective point for critical inspection and discussions of the proposed restoration prior to its fabrication.

Data acquisition in the digital arena is clinically based on optical methods. Laser displacement line beam or interference stripe technologies predominate in the marketplace. Both video and still CCD cameras or laser-specific sensors capture images for intraoral imaging using handheld devices capable of scanning single tooth regions or entire dental arches. The general concept of collecting a digital representation of the tissue and teeth involved in a restoration is to provide a direct patient-to-computer conduit of accurate data that permits the construction of a three-dimensional model of the clinical site in question. An advantage of increasing computing power is that the process can be viewed in real time and the proposed models can be generated (calculated) nearly as fast.

Unfortunately, digital impressions require the same clinical features of tooth and tissue management excellence as conventional impressions. The optical methods utilized in intraoral imaging imply a simple rule of physics that light travels in a straight line, and thus, if you can’t see it, you can’t image it (Fig. 2). Clearly, careful margin management and control of axial undercuts are essential to any tooth preparation and impression process. The main advantage of the digital process is its direct link to the computer and its software. Other relative advantages include the magnified, real-time viewing of the preparation (for acceptance or refinement), the speed and patient comfort of the procedure and the absence of incremental costs of additional impressions as required.

Digital technology captures images of prepared teeth with fidelity. It is necessary that preparations meet clinical-, technological- and material-specific guidelines. For single-tooth crowns, ideal preparation form involves consideration of margin location, depth of preparation, height of axial wall, axial wall parallelism and occlusal/functional reduction. A crown manufactured by milling via CAD/CAM technology will be made of one or another ceramic material requiring adequate reduction (depth of preparation, occlusal/functional reduction) and carefully rounded line angles.

Typically, reduction for the various materials utilized is greater than 0.75 mm. The margin configuration should be a deep chamfer or a shoulder and these should be carefully refined without undulation, chattering or lips present at the cavo-surface. Chamfers may offer some advantage. When preparation total convergence was examined, Beuer et al. (2008) demonstrated that a preparation with total convergence of 12 degrees provided less marginal opening than more parallel designs. All marginal openings were less than 50 micrometers.

A recent evaluation by Castilillo Oyaque et al. (2010) demonstrated that significantly larger vertical marginal discrepancies were noted for shoulder versus chamfer margins when zirconia-milled crowns were evaluated for preparations with 15 or 20 degrees total convergence. The angle formed between the gingival floor (chamfer or shoulder) and the tooth surface (the margin angle) may be important to the integrity of the milled ceramic crown margin. The chipping factor of CEREC and EVEREST copings milled from e.max CAD blocks was found to be 2.8 percent, 3.5 percent and 10 percent (CEREC) and 0.6 percent, 3.25 percent and 2 percent (Everest) for 0-, 30- and 60-degree margins. While marginal chipping is related to the milling path and the system employed, there may be greater chipping for high margin angles (Giannetopoulos et al. 2010).

Despite the limited clinical data available, general guidelines for tooth preparation in anticipation of producing a milled ceramic restoration include: a) consistent preparation depth meeting the needs of the material (less than 0.75 mm), b) total convergence of approximately 12 degrees and c) a deep chamfer margin configuration with a minimal margin angle.

Data management highlights the strength of CAD/CAM for single-tooth restorations. Under-scored by proper software, data management can facilitate the procedure of crown manufacture, both from a reproducible quality standpoint as well as from an efficiency standpoint.

From a clinician’s or a patient’s perspective, it is the quality issue that warrants further discussion. A crown has a number of features: a) the margin or cavosurface, b) the chamfer and its depth, c) the axial walls and their relative parallelism, d) the occlusal surface and the reduction depth, e) the contour of the crown, f) the occlusal contact(s) and g) the in-
The adage for computer programming is “garbage in/garbage out,” and nothing is truer in the realm of CAD/CAM dentistry. When good information is provided by a quality preparation, excellent tissue management and a good intraoral scan, the management of these seven features of a single crown is facilitated using CAD/CAM. In the virtual environment, crown margins grow to centimeters, occlusal clearance can be visualized from the lingual surface and interproximal contacts can be directly measured by the computer itself. The generation of high-quality digital models of the crown itself is a critical step in the CAD/CAM workflow, leading to exemplary and robust crowns.

A CAD/CAM restoration can be highly esthetic. There exist different materials for different optical properties of teeth. Translucency can be controlled by material selection (e.g., HT [high translucency] or LT [low translucency] in IPS Empress CAD or IPS e.max CAD, Ivoclar Vivadent, Amherst, N.Y.). Coloration may be controlled by material selection and utilization (e.g., IPS Empress CAD Multiblocks). Additionally, simple modifications can be made using staining and glazing of appropriate substrates. Finally, more sophisticated changes can be made by the milling of cut-back library tooth forms and the esthetic veneering of compatible ceramics to impart the detailed esthetics desired or required.

As an example, a single central incisor can be adequately matched using the proper material selection. The contour and form of the restoration should be carefully managed, and all primary and secondary anatomy is imparted in design. After milling, tertiary anatomy (surface ridges, grooves, pits) can be imparted. Thereafter, surface staining and glazing can provide lifelike color and achieve an acceptable esthetic integration of the tooth.

CAD/CAM offers many approaches to clinical success and provides innovative solutions to clinical problems. The capacity of direct CAD/CAM systems (exemplified here by the E4D Dentist system, D4D Technologies, Richardson, Texas) to solve clinical problems immediately in the clinical setting is based on the ability to acquire, compute, evaluate and utilize the scanned data representing the clinical scenario. A frequently encountered challenge is immediate restoration of a fractured tooth or crown. The patient may present without an existing crown, therefore without information regarding its shape or form. Using computer-based libraries of proposed crown anatomy, it is possible to quickly propose, modify and create a suitable replacement for the patient on an immediate or nearly immediate basis. This process is illustrated in Figure 4.

While there remain to be further advances in the development of CAD/CAM fabrication of crowns by a direct clinical approach, current positive experiences with emerging new ceramic materials demonstrate the possibility to fabricate esthetic restorations with acceptable clinical fit and function. Scanning of well-prepared teeth after ideal tissue management can lead to high-fidelity scans that permit iterative deliberation of crown design.

The availability of computer algorithms and tooth form libraries make the generation of crown forms expeditious and effective. The milling of newer ceramic materials using the information created by the design software can provide high-strength, good-fitting crowns with detailed anatomic form. This is the basis for an outstanding all-ceramic crown. When the appropriate clinical scenario is presented, the intraoral scanning and direct fabrication of a milled all-ceramic restoration may be rewarding for the patient and clinician.

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**About the Author**

Lyndon Cooper, DDS, PhD, is the Stallings Distinguished Professor of Dentistry of the Department of Prosthodontics at the University of North Carolina at Chapel Hill. He is chairperson and acting director of graduate prosthodontics and the director of the bone biology and implant therapy laboratory. Cooper is a diplomate of the American Board of Prosthodontics and served as the 2010 president of the American College of Prosthodontists (ACP). He received the ACP’s 2004 Clinician/Researcher Award and the IADR’s 2009 Distinguished Scientist Award for prosthodontics and implantology. Cooper’s laboratory focuses on bone biology, adult stem cell bone regeneration and clinical evaluation of dental implant therapies. Its research findings have been presented in more than 90 publications and as a part of more than 250 national and international presentations. Contact him at Lyndon Cooper DDS, PhD, Chair, Department of Prosthodontics, 330 Brauer Hall, CB#7450, University of North Carolina, Chapel Hill, NC 27599.
Maximizing material selection with CAD/CAM dentistry

Author: John C. Schwartz, DDS

Depending on the clinical situation and the location of teeth, materials with different mechanical properties need to be employed when restoring teeth with fixed porcelain veneer crowns. This is pivotal in full-mouth rehabilitation. However, the use of many different materials may entail difficulties in achieving harmonious shading or even render a uniform outcome impossible.

The exceptional properties of lithium-disilicate glass-ceramic enables dental professionals to create natural-looking restorations, which fulfill the different requirements — without having to make concessions with regard to shading.

Typically, strength values of dental porcelains are relied on to indicate porcelain crown performance. However, strength is a conditional rather than an inherent property of dental porcelains. In vitro strength data alone cannot be used to assume a material’s long-term performance in vivo. In two-phase porcelain systems consisting of a framework and veneering material, the design of the substructure has a decisive influence on the overall strength. It is therefore logical to consider fabrication design as a factor in the overall strength performance of an all-ceramic crown in vivo.

Apart from the physical properties of the materials, the correct dimensional relation between the veneer and the substructure is a prerequisite for the success of two-phase porcelain systems. While the substructure functions primarily as the system’s strength, the veneering porcelain provides its esthetics. Examples of two-phase porcelain systems include porcelain-fused-to-metal crowns, zirconia crowns and veneered lithium-disilicate crowns. Increasing the strength function of the system would imply thickening the substructure. Thickening the substructure creates less room for the outer phase to perform its esthetic function.

Traditionally, creating a structural design to maximize esthetics has reduced the strength value of biphase systems because of small dimensions of the substructure. An example is limiting a substructure to a coping form. While esthetic, the coping design leaves the veneering porcelain unsupported in cusp-to-fossa function and vulnerable to long-term stress fracture. Possessing a high-strength substructure that has considerable esthetic advantages over other substrates can improve the strength of a system without compromising esthetic values.

A hybrid substructure design, which supports a cusp-to-fossa relationship, increases the strength of the system. Refractive index values increase when the substructure thickens; increasing the thickness of the substructure results in a crown of higher value. By acknowledging the individual strengths and weaknesses of the components of the biphase porcelain systems, it is possible to engineer structural stabilization factors in esthetic crown design. The material that most closely fits these ideal synergistic criteria is lithium disilicate.

Applications of lithium-disilicate glass-ceramic

Monophasic lithium-disilicate crowns can be used on molars, for which strength is a desirable trait. For anterior reconstructions, however, veneered lithium-disilicate should be used to emphasize est-
A synergy between the strength of the lithium-disilicate substructure and the esthetics of the veneering material can be attained with IPS e.max® System. This product allows all-ceramic restorations to compete with traditional restorations in terms of in vitro strength. At the same time, the esthetic value expected from all-ceramic crowns is not compromised.

Monophasic lithium-disilicate restorations can be used in posterior areas where strength is most important. When used in the bicuspid region, the facial aspect (visible portion) should be layered using IPS e.max Ceram. As a result, esthetics is improved without compromising the core integrity strength. In the fabrication of anterior crowns, the artistic skills of dental technicians are utilized to achieve high esthetics. When creating full-contour, monophasic IPS e.max LS2 crowns, the cusp-to-fossa relationship should be studied first. Proper “waxing” in cusp-to-fossa physiology limits compression and shearing forces. Monophasic construction also allows higher resistance to fracture. The ideology behind the monophasic lithium-disilicate crown is similar to that of full-cast gold crowns (Fig. 1).

**Case presentation**

In this particular case, a 59-year-old male complained about his unattractive smile and wanted one that was more esthetically pleasing. At the time of presentation, the patient had a long dental history of missing posterior teeth, root canal therapy, tooth mobility issues, sensitive teeth, full-metal crowns, PFM crowns, amalgam fillings, discolored teeth and difficulty in chewing (Figs. 2, 3).

Additionally, the clinical and radiographic examination revealed clicking and popping upon opening of the mouth in both temporomandibular joints (TMs). Upon palpation, there was also a slight discomfort of the posterior capsule of the right TMJ, but the left posterior and lateral capsules were within normal limits.

**Diagnosis: occlusion**

The patient’s maxillary and mandibular midlines were aligned but demonstrated tracking to the right upon opening. There was a Class III occlusal relationship with a deep overbite that approached an edge-to-edge overjet anterior position, with a lack of anterior guiding patterns.

**Diagnosis: gingiva**

A periodontal examination revealed generalized pocketing of 1 to 3 mm, with isolated pocketing of 4 mm. Additionally, anterior and posterior isolated gingival recession was noted, with associated isolated thinning of keratinized gingiva. Other issues, such as wide keratinized gingival banding, blunted papillae and uneven periodontal outline form, were observed during the examination. The gingiva was irritated and demonstrated isolated bleeding upon probing.

**Diagnosis: dental hard tissue**

During the dental evaluation, missing teeth, crowns, amalgam fillings, composite fillings, heavy wear facets, exposed dentin surfaces, enamel splintering and clinical crown loss estimated between 20 and 70 percent were revealed.

**Treatment plan**

The diagnosis from this evaluation encompassed worn dentition, collapsed occlusion, generalized chronic mild gingivitis, generalized chronic mild periodontitis and mild MPDS/TMD. Based on this diagnosis, it was necessary to develop an extensive treatment plan that would not only increase the esthetic value of the patient’s teeth, but also their functionality. The treatment plan included opening the bite and establishing a vertical dimension of occlusion, establishing anterior guidance patterns and restoring the dentition.
It was also decided that a diagnostic wax-up, based on photographic analysis, would be used in this treatment plan (Fig. 4), which allowed the planned restoration to be built up in a precise and detailed manner. The wax-up was used to establish the length-to-width parameters of the natural teeth, the incisal plane, occlusal plane and the fixed arch parameters. These steps were all necessary to provide an outcome that was both esthetically pleasing to the patient and, more importantly, functional.

**Fabrication considerations**

The benefits of hybrid restorations (veneered frameworks) are that the design of the framework can be adjusted to the requirements of the clinical situation and optimum support of the veneering ceramic can be ensured regardless of whether the press or CAD/CAM technique is used. In the case presented, the CAD/CAM technique was employed (E4D Dentist CAD/CAM System, D4D Technologies, Richardson, Texas). The copings were designed on the computer as described below. A coping form of 1.25 mm to 1.5 mm minimum thickness was designed. The central developmental lobes were designed to within 1 mm of the final desired cusp allocation. Next, the proximal developmental lobes were waxed to within 1 mm of the desired marginal ridge location.

Located on the buccal and lingual aspects of a natural tooth, there is an area of demarcation between enamel and dentin. Ceramists term this area the “enamel break,” which is where the enamel appears to become thicker and less supported by the thickness of the dentin. The location of the enamel break should be determined from preoperative photographs. On the working cusps of the crown, a ledge should be waxed at the enamel break to within 0.5 mm of the final survey outline form of the crown. This strengthens the working cusp and creates a stress breaker in the middle of the crown. This stress breaker relieves tension at the margin of the crown where the bond can be subjected to long-term effects of occlusal stresses.

The working ledge can be concealed due to the chameleon effect of the lithium-disilicate material. The balancing (i.e., nonworking) cusps do not require a working ledge of support. However, nonworking cusps should be prepared for the development of parafunctional interferences by waxing shearing stress breakers into the coping design. Once this had been accomplished, the lithium-disilicate high-strength copings were milled using IPS e.max CAD lithium-disilicate blocks (Figs. 5, 6).

Creating the esthetics began with the application of deep stains to the lithium-disilicate coping. Next, to lower the value of the coping and create a luminary zone for light refraction, the crown was built up entirely using IPS e.max Ceram Transpa neutral. Enamel stains and characterizations were applied (Fig. 7). This
enhances the esthetics particularly in the anterior region. Finally, the outer enamel layer was finished in the appropriate shade S2 enamel, and the crowns were baked again (Fig. 8). The crowns were then texture finished with stones and surface polished with the Astropol® polishing system. A light layer of glaze was then applied for the final bake.

Once the final bake had been completed, the monophasic lithium-disilicate crowns were ready for seating in the mouth (Figs. 9, 10). The lithium-disilicate crowns were tried in to ensure proper seating and to prevent any issues during the final cementation and polishing processes. Once any issues had been addressed, final placement of the lithium disilicate restorations could be accomplished.

**Conclusion**

Creating high-strength lithium-disilicate crowns without compromising the esthetic function of the all-ceramic restorations can be achieved by utilizing monophasic molar crowns, biphasic bicuspid crowns with facial layering and anterior biphasic crowns with lingual support (cf. Fig. 1). In vitro strength values of dental porcelains may indicate the performance of these restorations, but these data alone cannot be used to assume the structural performance of the restoration in vivo. Therefore, it is not only important but necessary to consider fabrication design as a factor in the overall strength and performance of an all-ceramic crown. The use of a lithium-disilicate material, as described herein, can enable dentists and laboratory ceramists to provide patients with structurally durable and esthetically pleasing restorative results even in difficult cases when slight functional problems are present._
It has become well known that all-ceramic crowns offer clinically similar, if not better, results than conventional crown materials such as alloys. However, despite advances in techniques and material sciences, dentists still face many challenges when undertaking restorative cases requiring the placement of crowns in the posterior region. Although entirely possible to overcome, these challenges require the utmost attention to detail in the treatment planning and diagnostic stages to ensure that a patient receives not only the best in esthetics but also the greatest overall benefit to his or her oral health.

For example, cases requiring the restoration of the posterior dentition and areas of the oral cavity that are not easily accessible can still present challenges to even the most experienced and well-trained dental professional. In these areas of the oral cavity, isolation is often not possible and curing may be extremely awkward and difficult.

Additionally, the posterior dentition is subject to the greatest forces of mastication during function. Therefore, conventional ceramic layered over zirconia crowns have demonstrated the tendency to chip or fracture when placed in the posterior. Although esthetics should always be a focus of treatment, the forces that will be placed on restorations in the posterior must be accounted for.

When restoring dentition in these areas, the restorative material chosen should demonstrate excellent esthetics, the strength and durability to withstand function, and offer multiple and durable bonding options. Recently, restorative materials fabricated using computer-aided design and manufacturing technologies have worked to resolve many of the issues often experienced with conventional crown materials.

Further, the bonding or cementation material chosen in the posterior should offer ease of use, quick and easy clean-up and provide a reliable and durable bond to the restorative material to prevent issues such as marginal leakage, secondary caries and restorative failure. Newer generations of universal resin cements feature many of these benefits, along with excellent reliability and the ability to withstand the forces of mastication.

IPS e.max CAD

Resolving the issues typically experienced in posterior restorations, an innovative lithium disilicate material with high monolithic strength, IPS e.max CAD (Ivoclar Vivadent, Amherst, N.Y.), demonstrates many advantageous features over conventional glass-ceramic materials. Most notably, IPS e.max CAD demonstrates two-and-a-half to three times the strength (360 MPa) of conventional materials, making IPS e.max CAD suitable for use in a variety of indications, including inlays, onlays, veneers, partial and full crowns, copings and implant super-

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Fig. 1 After try-in, the restorations are cleaned with phosphoric acid, rinsed and dried.

Fig. 2 Monobond Plus universal restorative primer is applied to the internal surfaces of the lithium disilicate crowns.
The exceptional strength of the material is directly related to its ability to crystallize in 20 to 30 minutes at 840 degrees Celsius. Additionally, IPS e.max CAD allows dentists or technicians to impart excellent shading, translucency and brightness to deliver the best in esthetics.

Giving the dentist the option to mill restorations utilizing chairside CAD/CAM technology, IPS e.max CAD restorations may also be laboratory fabricated. To ensure the best in fit and function, the material may be manually cut-back or adjusted, as necessary, in just a few quick and easy steps.

Distributed in block form, IPS e.max CAD is available in three distinct levels of translucency, as well as two different sizes. The high translucency (HT) blocks are ideal in cases requiring minimally invasive, full-contour restorations, including inlays, onlays and veneers. The HT blocks may be characterized with staining materials to further characterize the restoration and to achieve the highest esthetics.

Low translucency (LT) blocks provide the perfect solution for restorations in the anterior region, such as partial and full crowns, and may be completed utilizing a cut-back technique and layered with IPS e.max Ceram (Ivoclar Vivadent, Amherst, N.Y.) stains to further enhance the aesthetics of anterior restorations. For vital and slightly discolored teeth, high opacity (MO) blocks may be used to develop frameworks that can then be veneered with IPS e.max Ceram.

Available in 16 A–D shades and four bleach (BL) shades, the HT and LT blocks offer the ideal solution when fabricating full-contour restorations. In cases requiring the recreation of a tooth's opacity, the MO blocks are available in group shades and work exceptionally well when combined with a layering technique.

Multilink Automix

Demonstrating excellent reliability in the posterior, Multilink Automix (Ivoclar Vivadent, Amherst, N.Y.) is an innovative, multi-purpose, adhesive cement indicated for use in the adhesive cementation of indirect restorations, including inlays, onlays, crowns, bridges and posts for a variety of restorative material selections, including metal and metal ceramics, oxide ceramics, fiber-reinforced composites, all-ceramics and precious alloys. Featuring patented hydrolytically stable acidic monomers that ensure high immediate bond strength and durable adhesion, Multilink Automix allows for a reliable and
A long-lasting bond, regardless of restorative material choice.\textsuperscript{11}

Designed for fast and easy application, the Multilink Automix system includes a one-step primer that self-etches, self-cures and seals the dentin in merely 15 seconds, which provides excellent marginal adaptation and high immediate bond strength.\textsuperscript{11} Now available in an easy clean-up formulation, excess material may be light cured in 1–2 seconds per quarter surface (mesio-oral, disto-oral, mesio-buccal, disto-buccal), which transforms the material into an easy-to-remove gel-like substance.\textsuperscript{11}

Clinically validated by various independent studies, Multilink Automix offers a simplified procedure with a proven chemistry and is available in three shades.

\textbf{Case presentation}

A 65-year-old female patient presented with previously placed large restorations on teeth \#20 and \#21, as well as facial erosion caused by acid reflux disease.

Additionally, the patient displayed porcelain-fused-to-metal crowns on other teeth, which she disliked due to the opaque appearance, and feared the possibility of the formation of dark margins as the restorations aged.

After discussing restorative options with the patient, it was ultimately decided that Ivoclar Vivadent’s IPS e.max CAD, cemented with Multilink Automix, would replace her previous restorations and restore the esthetics of her dentition.

\textbf{Fig. 8} The restorations are seated on the preparations.
\textbf{Fig. 9} The restorations are stabilized to ensure proper margins and contacts are obtained.
\textbf{Fig. 10} Each quadrant is spot-cured for 1–2 seconds.
\textbf{Fig. 11} Excess cement is peeled away using a dental scaler.
\textbf{Fig. 12} Dental floss is used to remove excess cement from the interproximal areas.
\textbf{Fig. 13} After all excess cement is removed, the restorations undergo a final light cure.
To facilitate the development and fabrication of a provisional restoration, an alginate pre-impression (Identic Fast Set, DUX Dental, Oxnard, Calif.) was taken first. The patient was then anesthetized with 3 percent mepivacaine. To prepare the teeth for full-coverage CAD-fabricated ceramic (IPS e.max CAD) restorations and to allow for ideal ceramic thickness, 1.5 mm of axial wall reduction was completed, followed by 2 mm of occlusal reduction.

After preparation was complete, a final impression, opposing impression, bite registration and shade photographs were taken to provide the laboratory with the proper diagnostic information. A bisacryl provisional (Luxatemp, DMG America, Englewood, N.J.) was then fabricated and cemented with provisional cement (TempBond NE, Kerr Corporation, Orange, Calif.) to allow the patient to function while definitive restorations were fabricated.

Upon their completion, the patient returned to the office for delivery of the IPS e.max CAD lithium disilicate restorations. The patient was anesthetized with 3 percent mepivacaine, and the provisional restorations were removed. The preparations were then cleaned and rinsed to remove any remaining cement or contaminants. The final restorations were then tried-in to confirm margins, contacts and shade. Upon patient and dentist approval, the restorations were prepared for final seating.

The internal surfaces of the porcelain were cleaned with 37 percent phosphoric acid, rinsed and dried (Fig. 1). It is important to note that the laboratory had etched the restorations with a 5 percent hydrofluoric acid for 20 seconds prior to delivery to achieve the proper etch pattern. The crowns were then rinsed with water and air dried.

A universal, single-component, restorative primer (Monobond Plus, Ivoclar Vivadent, Amherst, N.Y.) was then applied to the internal surface of the restorations. After 60 seconds, the primer was air dried [Fig. 2]. To facilitate adhesive cementation, the surfaces of the preparations were cleaned, rinsed and lightly dried (leaving the dentin moist) prior to cement placement (Fig. 3).

A self-etching primer (Multilink A/B, Ivoclar Vivadent, Amherst, N.Y.) was dispensed, mixed and scrubbed onto the preparations for 15 seconds on the dentin and 30 seconds on the enamel, then air dried (Figs. 4–6). Immediately following, the universal adhesive resin cement (Multilink Automix) was applied to the internal surfaces of the lithium-disilicate CAD-fabricated restorations (IPS e.max CAD) [Fig. 7]. The restorations were then seated on the preparations and stabilized to ensure proper margins and contacts (Figs. 8, 9).

After placement, the restorations were spot-cured per quadrant for 1 to 2 seconds to partially polymerize the excess cement (Fig. 10). Remaining excess cement was then peeled away using a dental scaler (Fig. 11). Utilizing dental floss, excess cement was removed from the interproximal spaces (Fig. 12). It is recommended that no more than two restorations be placed at one time to facilitate faster and simpler clean up. The restorations then underwent a final clean up to ensure all excess cement was removed, and then a final cure (Fig. 13).

Upon completion of the case, the patient was very pleased with the function, strength and esthetics of her new lithium-disilicate crowns (Fig. 14).

Through the use of innovative materials and techniques, the dentist in this case was able to replace the patient’s aging restorations with new highly esthetic crowns and fulfill the patient’s desire for a more naturally appearing smile. Although challenging, all-ceramic crowns may be placed in the posterior region when a comprehensive treatment plan is followed and the proper materials are selected. An innovative material (IPS e.max CAD), placed with universal adhesive resin cement (Multilink Automix), will ultimately provide the necessary strength and longevity required of restorations placed in the posterior.

Editorial note: A complete list of references is available from the publisher.
Digital dentistry is exploding. From digital radiography to digital impressing, we have seen a dramatic shift in the way we capture images. We are using digital technology to capture and visualize data on a much larger scale. Suddenly we have the opportunity to identify and critique the small details that were often lost using traditional final impressions.

What has not changed, however, is the essential necessity of maintaining the fundamentals of crown and bridge dentistry: comprehensive treatment planning, proper preparation design and soft-tissue management, along with proper margin placement and identification. As technology evolves, we see that it has become even more critical that we have visual access and identification of the margins prior to scanning. With the traditional impression technique, the injection of a low viscosity material into the sulcus may physically force some of the soft tissue out of the way.

Digital scanners can only capture what they see

For years, retraction of soft tissue has meant packing a cord into the sulcus before taking the final impression. This is often a daunting task as we battle inflamed and bleeding gingival tissue. In areas where access is difficult, proper isolation becomes more of a challenge. This report will offer alternative methods for effective ways to optimize clarity and manage soft tissue when using digital impressing.

The most effective way to achieve clear visualization of the margin is to prepare the tooth using supragingival margins. The reality is that teeth that are being prepared for a crown often have old restorations with subgingival margins. The health of tissue in these areas is often compromised. In most cases, there is at least a portion of the prepared tooth that falls below the free gingival margin. When subgingival margins are present, the tissue must be separated from the edge of the preparation to allow clear visualization for the digital scan. Unclear margins may be undetected in traditional impressions; however, with digital scanning the quality of retractions and margin clarity can be identified immediately in a single scan. The clarity of a scan is determined by the quality of retraction and its ability to reveal a clear margin.

In areas of inflammation or subgingival margins, the use of a soft-tissue laser may be extremely effective. A soft-tissue diode laser such as Odyssey Navigator (Ivoclar Vivadent) provides a simple method to trough the marginal areas. It is an invaluable tool to assist in the removal of unhealthy, inflamed gingival tissue that is covering the margin or creating exces-
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sive bleeding. It then stimulates the cells to regrow in a healthier environment. A peroxide solution can be used to remove tissue debris left after using the laser.

In areas of moderate to minor inflammation, a retraction paste such as the Traxodent Hemodent Paste Retraction System (Premier Dental) is very effective in providing hemostasis and physical separation of the tissue from the margin of the preparation. Traxodent Hemodent Paste Retraction System is a viscous paste that is injected into the sulcus, and a specially designed, firm cotton roll is placed over the paste. The patient applies firm biting pressure to the cotton for two to five minutes, and the paste is easily rinsed from the tissue and tooth structure. A clear view of the margin is readily achieved.

Procedure

A patient presented with an old crown with a poor distal margin on tooth #14. A treatment plan was developed to replace the crown with an IPS e.max CAD (Ivoclar Vivadent) restoration using E4D Dentist (D4D Technologies). The tooth was prepared using Premier Two Striper Burs (Premier Dental).

Figure 1 shows the prepared tooth and surrounding inflamed gingival tissue. One of the most effective ways to achieve retraction, isolation and hemostasis is to use the Odyssey Navigator with Traxodent Hemodent Paste Retraction System. The diode laser effectively and efficiently removed the unhealthy tissue (Fig. 2).

The retraction paste maintained hemostasis, provided retraction of the healthy tissue and was easily rinsed from the sulcular area (Fig. 4). Clear visualization of the margin by a digital impressing system was readily achieved (Fig. 5).

Clinical observations

The proper marginal fit of a final restoration is determined by the ability of the operator to identify the margins of a preparation. The quality of the retraction dictates how well the margin can be identified in a digital scan. Removing unhealthy tissue by using a diode laser and minimizing the trauma to the healthy tissue through the use of retraction paste provides the optimal environment to capture a scanned image.

Conclusion

The entire process of fabricating a quality final restoration begins with proper and complete tissue management. Whether the restoration is being fabricated using the technology of E4D Dentist to capture a digital image or using traditional methods, exposing the margin is the key to accuracy.

Using the Odyssey Navigator diode laser in combination with Traxodent Hemodent Paste Retraction System, E4D Dentist can readily capture the image and create a model with clear margins. When used together, the healthy and unhealthy tissue are managed in the ideal way to minimize patient discomfort and allow the tissue to heal under the optimal conditions.

about the author

Santine Anderson, DDS, is a general dentist in Ann Arbor, Mich. She is a graduate of the University of Michigan School of Dentistry and Albion College, where she earned a BS in chemistry. She began her career during undergraduate school while working for The Dental Advisor. Anderson brings clinical knowledge and experience to the dental profession through lectures, editorials and clinical case reports. You may contact her at dranderson@enspiredental.com.
Technology in the dental curriculum

The goal of all dental educational institutions is to prepare their students with the fundamentals and skills necessary to ensure future competency and proper patient care. This includes all aspects of diagnosis and treatment as well as awareness of the current (or future) standard of care in technology, materials and techniques. Today's dental students, more than ever before, have lived and been educated in an interactive world, using technology to enhance the learning process and expecting an immediate response, feedback and results. Current and future technological advances in dentistry, e.g., CAD/CAM, digital radiography and digital record keeping, must be incorporated in existing dental curricula in order to prepare tomorrow's dentists properly.

At the same time, many dental schools across North America are experiencing a shortage of funds and faculty, along with an ever-increasing curriculum crunch. There is a nationwide emphasis to address a purported “access to care” issue through increased class size in existing dental schools and the building of numerous new ones. Under these circumstances, in order for any new technology to have a viable chance of being incorporated into an existing dental curriculum, it must save time and money and be a better solution than the current modality.

This article will detail the possibilities of maximizing the learning experience for students using chairside CAD/CAM systems (E4D Dentist, D4D Technologies, Richardson, Texas) and evaluation software (E4D Compare, D4D Technologies) at the Medical University of South Carolina and Georgia Health Sciences University.

In private practice, chairside CAD/CAM systems offer the advantage of in-office scanning, designing, milling and delivery, providing clinicians with complete control of their schedule, their quality and consistency. They provide a tremendous convenience factor for patients and practices as well as maximizing profitability. While these same advantages provide benefits to the university/teaching environment, there are many more advantages of chairside CAD/CAM systems that can enhance the learning experience and provide unparalleled opportunities for faculty and students.

In the simplest terms, current chairside CAD/CAM systems can be used as learning tools and methodologies to enhance educational objectives in the following categories:

- tooth anatomy and morphology (Fig. 1)
- preparation design (Fig. 2)
- restoration design
- material understanding and selection
- occlusion/articulation (Fig. 3)
The E4D Dentist chairside CAD CAM system offers improved profitability, complete restorative control, and enhanced patient convenience using powder-free laser based scanning, intuitive design and precision milling – all in your office.

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One major advantage of CAD/CAM from an educational standpoint is the students’ ability to magnify preparations on the computer screen and mark their own finish lines. It is remarkable how they grow as student clinicians when they can see at 50x magnification the errors in their finish line designs. The most common errors are lipped margins, bevels, rough spots and feathered areas. Before CAD/CAM, a student would not have the opportunity to evaluate his or her preparations at this level of detail and magnification. As a result, the quality of preparations starting in the pre-clinics and carried over to the clinics has been remarkable and considerably better since the introduction of CAD/CAM.

The addition of CAD/CAM in the pre-clinical curriculum mandates increased knowledge and more curriculum time devoted to the study of ceramic materials. Students are very familiar with all types of ceramics, from leucite reinforced (IPS Empress, Ivoclar Vivadent) to lithium disilicate (IPS e.max CAD, Ivoclar Vivadent), and have hands-on time manipulating, custom characterizing and bonding a variety of materials before they reach the clinics. Students have a profound understanding of advanced ceramics and adhesives that are essential to successful treatment in a modern dental office.

There are some who feared having students utilize digital dentistry would compromise or cause them to lose the fundamentals and conventional techniques that are essential to successful comprehensive care. Ironically, in many ways, CAD/CAM technology has resurrected some principles that were no longer taught. For example, gold inlays and onlays were removed from the curriculum as gold prices increased, patient demand decreased and curriculum load increased. Now, however, using the E4D System, students learn about conservative all-ceramic onlay and inlay preparation principles and design elements.

Before the end of the pre-clinic semester, students will prepare, scan, mill and bond an onlay on the dental simulator in addition to various other anterior and posterior crowns. Furthermore, this treatment option is carried over when they get to the clinics, and more conservative partial coverage restorations, such as onlays, are being treatment planned over more aggressive full-coverage options.

**E4D Compare**

Software is being developed by D4D Technologies in order to improve the evaluation of students’ pre-clinical work. E4D Compare™ objectively compares two similar environments: prep to prep, prep to pre-op, pre-op to restoration — essentially any combination of comparisons. E4D Compare will automatically and objectively evaluate a student’s preparation based on an ideal preparation of the same tooth that a faculty member scanned into the system (Fig. 4), effectively removing all subjectivity from grading. Performance evaluations can be more objective and less likely to be called into question.

This software will scan a student’s work, create a 3-D model and superimpose this model onto the ideal, allowing instant feedback and visualization of errors (Fig. 5). The digital model can be rotated and magnified on the screen and viewed from all angles.

Students can instantly get truly objective feedback. Not only will this assist the objective evaluation, but it will also improve the learning process as students progress along their “confidence curves.” They can self-evaluate their preparations or restorations and gain reinforcement toward continual improvement on their own, not just when faculty members are present.

Each institution must decide the degree to which this technology will become part of its curriculum. Timing of the various aspects to be incorporated is equally critical. Any change to the curriculum will undoubtedly create a certain degree of angst among the majority of the faculty. It is therefore imperative to present to the entire faculty the advantages of CAD/CAM technology and how it can enhance our students’ dental education throughout the curriculum.

It is clear that CAD/CAM technology is the future of dentistry, and the earlier we can teach students the indications and contraindications the better. With quality CAD/CAM systems available from various manufacturers, it is only a matter of time before more institutions adopt this technology as a way to teach students and provide more conservative and economical care to patients.
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A new alternative to PFM

Author: George Tysowsky, DDS, MPH

For nearly 50 years, porcelain-fused-to-metal (PFM) restorations have been successfully used in dentistry to restore function to patients with failing natural dentition. During that period, dental technologies have changed dramatically and are changing at a faster pace than ever before. Dentistry is advancing every day; digital records, digital impressions, digital radiography, caries risk detection, laser dentistry and computer-aided restorative fabrication are just some of the elements in a dental office that have undergone a technological revolution. Even with these advancements, PFM remains the most prevalent restoration in clinical practice. However, these types of restorations can have some challenges from an esthetic and functional perspective. Marginal discoloration, opacity and a lifeless appearance are some of the more commonly seen limitations with PFM crowns.

As technology has progressed, so has material manufacturing with regard to glass ceramics. With the introduction of IPS e.max lithium disilicate, strength and beauty are combined into a single all-ceramic material, offering the versatility of conventional cementation. In addition, clinical and laboratory testing is continuing to demonstrate that IPS e.max lithium disilicate is an extremely durable material capable of long-term success. The question remains, though: is there something that can replace PFM restorations as the current standard of care? Recent test data indicates there is an alternative.

Mouth-motion fatigue testing lithium disilicate and porcelain fused to metal

Researchers at New York University (NYU) utilized unique mouth-motion simulators to evaluate the effects on restorations of chewing in a wet oral environment. The researchers placed crowns of various materials on these machines and subjected them to increasing chewing loads and cycles to determine a survival rate for each material. The NYU testing concluded that results seen with IPS e.max lithium disilicate restorations are comparable to the “gold standard” of PFM.

Clinical evaluation

A clinical evaluation of chairside lithium-disilicate CAD/CAM crowns at the University of Michigan evaluated the survival of patient crowns delivered with different cements. For restorations that had been in service for more than three years demonstrating 100 percent survival: “There were no clinically identified cases of crown fracture or chipping.”

Four-year clinical performance

The rate of fracture is “lower than other ceramics documented by THE DENTAL ADVISOR over the past 26 years.” In regards to IPS e.max Press: “Performance has exceeded that of traditional PFM restorations as well as many all-ceramic restorations.”

Clinical success

In addition, Ivoclar Vivadent has performed multiple clinical trials with renowned international centers with restorations of up to eight years, demonstrating the long-term clinical success of IPS e.max lithium disilicate. Ivoclar Vivadent continues to build clinical confidence through its global technical validation with ongoing laboratory and clinical studies of IPS e.max lithium disilicate.

Editorial note: A complete list of references is available from the publisher.
The efficacy of in-office CAD/CAM

Author: Christopher Pescatore, DMD

Today's dental professional has more technology available at his or her disposal than ever before. It is truly an exciting time to be in dentistry. Advances in every facet of patient care enable the practitioner to provide not only a superior level of care, but usually in a more expedited fashion. This is especially important because of today's current economic situation where it is not easy for most people to take time off work for multiple dental appointments.

Though I love to embrace new technologies brought into dentistry, I was very hesitant to explore CAD/CAM technology, or more specifically, in-office CAD/CAM. The thought that a machine could fabricate a dental restoration as well as a human being was inconceivable to me. Add to this the fact that these in-office CAD/CAM companies were touting that you could deliver a restoration in one visit and it made me even more skeptical.

The truth is, these things are indeed possible. They are not only possible but also predictable and very rewarding for the dental practitioner. Though many misconceptions about in-office CAD/CAM systems are floating around the dental profession, if clinicians were to actually take a very detailed look into the technology, as I did, they would not only be pleasantly surprised but motivated to adopt it.

My first realization that CAD/CAM was going to be a serious contender in the dental profession was the fact that many dental laboratories were embracing the technology. As I visited numerous laboratories, I started to see more and more CAD/CAM machines and the restructuring of the laboratories to incorporate this technology. It was then I thought I should take a more serious look at CAD/CAM restorations. I started to become more educated about the process, the software and the various porcelain blocks available.

After watching many dental restorations being fabricated in the laboratory with CAD/CAM, I grew to appreciate the technology and the beautiful restorations that these labs were producing. I then thought that if the laboratories can incorporate this technology and make these restorations, why couldn’t a dentist? My next step was to explore the various in-office CAD/CAM systems and the financial considerations.

‘After watching many dental restorations being fabricated in the laboratory with CAD/CAM, I grew to appreciate the technology and the beautiful restorations that these labs were producing. I then thought that if the laboratories can incorporate this technology and make these restorations, why couldn’t a dentist?’

Fig. 1. Maxillary posterior quadrant exhibiting multiple failing restorations.
Laboratory CAD/CAM can increase productivity because these machines are estimated to have the capabilities equivalent of up to seven lab technicians.\(^1\)

Another reason that dental laboratories are embracing CAD/CAM systems is the exceptional fit and contours created by these machines. The fit of CAD/CAM restorations is well documented to be as good or better than restorations fabricated by hand. Research has shown that in-office CAD/CAM systems can produce restorations that are equal to or superior to laboratory-made restorations.\(^2\) According to the Millennium Research Group (MRG), the global authority on medical technology market intelligence, CAD/CAM restorations/technology will grow from 40 percent to almost 70 percent in 2015, with the introduction of newer ceramic materials, such as lithium disilicate (IPS Emax), with increased strength and durability.\(^1\) CAD/CAM machines automate the process of fabricating dental restorations and are sure to dominate the dental laboratory environment in the future.

_Taking the plunge_

My first in-office CAD/CAM system was a good system, an adequate system, but left me wanting more. When fabricating a restoration, I wanted to create the most ideal restoration possible. I needed more options, more tools and a system with greater expandability. I wanted a system that was built for the future, a system that was being developed by people who truly want to make their system better and, therefore, listened to their clients. These desires led me to discontinue the use of my initial in-office CAD/CAM system and purchase the E4D Dentist by D4D Technologies.

The E4D Dentist system allows me to fabricate single tooth, multiple tooth or full-mouth rehabilitations. Combine this with the superior toolset to change, manipulate and verify my restorations and my dreams for the ideal in-office CAD/CAM system had come to fruition.

The toolset of the E4D Dentist system is truly unique. Besides being able to scan intra-orally without the need to powder or apply some other type of anti-reflection medium (the vast majority of the time), the E4D Dentist system can scan impressions. This saves the dentist the time and expense of pouring up the impression in order to scan the model. For quadrant dentistry (Fig. 1), there are many ways to view and evaluate your proposals before milling. The ability to view and manipulate all the teeth at once is not only timesaving but provides a smooth workflow in using the software (Fig. 2). Being able to “slice” all the restorations in the quadrant enables the clinician to evaluate all the thicknesses at once (Fig. 3).

Additionally, to evaluate the material thickness...
of restorations, the E4D Dentist system has a unique color-coding system that gives visual confirmation immediately (Fig. 4). After milling the restorations, they can quickly be stained and glazed with a one-step process (Fig 5), thus producing naturally beautiful restorations (Fig. 6). These kinds of quick visual verifying tools make fabricating larger anterior restorations much more straightforward and predictable (Figs. 7–9).

In all my years of using an in-office CAD/CAM system, I have realized that there are certain keys to using it successfully. The first is to understand how and when to use the system. The operator must get comprehensive and thorough training on the E4D system; luckily, this as well as many other things, is included with your purchase. With the proper time dedicated to learning the software, the practitioner will feel empowered and confident.

The second key is to understand all the ways the system can be used: the single-visit scenario, the traditional two-visit scenario or as a modality to send data to a laboratory.

The third key to success is tissue management. One quickly learns that in using an intraoral digitizer to take virtual impressions, you cannot cut corners managing the tissue around the prepared teeth. There are many modalities to control tissue, including conventional cord, electro-surgery units, lasers and putty retraction systems, though the most overlooked tissue management protocol is to keep your margins supragingival.

A fourth key is to understand that this is only computer software. If you input bad data, you will get bad data (restorations) out. A common misconception is that these in-office CAD/CAM systems produce inferior restorations. Saying that is akin to saying your dental handpiece only cuts poor preparations. The quality of the restorations produced by in-office CAD/CAM systems, and subsequently inserted into the patient’s mouth, is directly related to the standards of the dental practitioner.

So what are the advantages of having an in-office CAD/CAM system? The obvious advantages are the lowering of your (monthly) laboratory invoice, not having to use impression material, not having to fabricate a provisional restoration and being able to eliminate the second (insertion) appointment. Another advantage, which is equally important yet often overlooked, is the ability to customize every single restoration and provide superior customer service.

Yet, it is this author’s opinion that the most overlooked advantage of an in-office CAD/CAM system, such as the E4D Dentist, is the personal satisfaction that the dental professional will get from having one of these systems.

In-office CAD/CAM is in the heart of every dental practitioner who truly loves and enjoys what he or she does. Dentists are creative people. We love to prepare, design and fabricate. In-office CAD/CAM can do so much for a practitioner’s own enjoyment of his or her craft, as well as his or her practice.
I would have never thought years ago that I would not only embrace but also highly recommend that dental practitioners investigate and evaluate their needs regarding in-office CAD/CAM systems. For me, it is my in-office CAD/CAM system, E4D Dentist, which has not only rejuvenated my excitement for the profession but has provided me with greater empowerment in performing my work.

To know that I prepared the tooth, managed the tissue properly, scanned, designed, stained and glazed and then adhesively inserted the restoration brings me great satisfaction and pride. It is a satisfaction that I wish all of my fellow practitioners would experience.

References
1. Dental CAD/CAM Ceramic Technology to Skyrocket to Nearly 70% of All-Ceramic Unit Share in 2015, Millennium Research Group, Toronto, CAN, Jan 12, 2011.
ENVISION THE DIFFERENCE

BEGIN
The E4D Design Center powered by DentalLogic™ software guides the operator through the entire process – from scanning to milling – with rich graphics and screens that are easy to understand and navigate.

DESIGN
Autogenesis™ automatically positions and shapes the initial tooth proposal to match neighboring central grooves, cuspal heights, contours and marginal ridges. User-defined settings for contacts, both proximal and opposing, as well as internal spacers streamline the design process. Only on E4D can you design up to 16 units simultaneously with just a point, click, and drag of a mouse to your clinical preferences.

SEND
The E4D Dental Logic software analyzes the proposals and generates a custom milling path for each restoration. E4D Sky® allows patient data to be transferred between systems whether it's to another office or laboratory.

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*available in version 1.9.5 of the DentalLogic™ software
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What good are technological advances if they just sit in your office unused? How many advances can you think of during the past 25 years that did just that? Oh, I can think of plenty, and I’ll bet you can, too. The great news is that CAD/CAM restorative dentistry is not one of those technologies. Fortunately, you’ll be making money with it quickly, providing a great service for your clients, reducing your overhead and differentiating your office from others for years to come.

Here’s the skinny on what chairside CAD/CAM dentistry can help you achieve.

Watch your overhead drop

Got your attention? I hope so. Every single unit of restorative dentistry (crowns, veneers, inlays and onlays) can be done in your office with no lab bills, no impressions and decreased chair time. My lab bill was easily cut in half, if not more. (Actually, it was more than cut in half). And I have complete control, something we dentists kind of like in our practices, don’t we? Come on, I know you hold your breath when you seat a crown.

Name a better service for your patients

OK, I know, getting them out of excruciating pain or securing their dentures with implants ranks up there pretty high, but I can tell you from lots of experience that my patients are thrilled to know they have no temporary restorations to wear, no impressions to gag them and they’ll have their final restorations in one appointment. That is exciting for them.

Rev up your team with something super high-tech

You’ll want to get everyone involved, but this time you won’t need to be the horse pulling the cart. Give your team the green light to run with this great technology and they will. Open the gates. You can even get your team members certified as CAD/CAM dental designers (CDD) — the ultimate in motivation, career development and teamwork.

Ready for that missing competitive edge?

Chairside CAD/CAM dentistry will have your office join an elite group of professionals offering the best dentistry has to offer. If you were a patient, would you prefer “old school” or “new school”? Hint: people trust new tech/high tech, and there’s no reason not to, especially with something this advanced.

Penny wise, pound foolish

When you are presenting dentistry to your patients, what’s their No. 1 reason to not proceed? Money. Of course, if you could only help them understand the benefits a little bit better, including the emotional ones, you know they’d do it in a heartbeat. The same goes for you and chairside CAD/CAM dentistry. Now if only I could get you to clearly see the benefits and get over the hurdle of money. It makes sense and cents.

Don Deems, DDS, FAGD, known as The Dentist’s Coach, is a trained professional business coach and a practicing dentist. He has been a top leader in continuing education for the past six years and is the author of “The Dentist’s Coach: Building a Vibrant Practice and the Life You Want.” He can be reached at drondeems@drdondondeems.com.
It was 1983 when LensCrafters® first opened, bringing a clinician (optometrist) and a laboratory (lens grinding) together under one roof to offer control of the entire procedure and offering patient convenience like never before. Those of you who need glasses and are old enough to remember the days before LensCrafters and "glasses in an hour" likely remember visiting your optometrist, getting diagnosed, selecting choice "A" or "B" as the optometrist flipped through lenses, then picking out your perfect "lens-free" frames only to be told: "Come back in two weeks and we'll have them ready for you."

Today, unless we have designer frames, special coatings or a unique case, we get a little impatient waiting more than an hour to get our new glasses, and we don't think twice about the quality of the end result. Instead, we watch in awe as machines create our customized lenses behind big glass display windows, and we immediately (or within the hour) gain all the benefits of 20/20 vision. In the same decade ('80s), three dental pioneers (Duret, Moermann and Andersson) began work on a somewhat similar concept in dental care utilizing digital data for computer-assisted design with computer-assisted manufacturing (CAD/CAM).

In spite of the fact that it's been more than 25 years since the successful introduction of a chairside restorative system (CEREC), only around 10 percent of dental practices in North America have embraced the technology. Why so few? Most of us have heard directly or indirectly the stories of the first couple decades of development where occlusion had to be created by hand. Or we've had cases show up in our offices and have attributed any less-than-ideal restoration to the evils of CAD/CAM dentistry, somehow forgetting that those restorations weren't placed by the CAD/CAM systems but merely fabricated by them.

It seems those experiences and stories are forever imprinted in our dental minds and even today create prejudices against any possible improvement in the technology and possibilities. So it is nice to see the clinical successes of CAD/CAM documented and discussed in a wide variety of online forums, as well as read clinical documentation of the quality and efficiency of the entire system. But more than anything else, it is important that we as a profession take a clear 20/20 look at all that is possible with chairside CAD/CAM dentistry today and really see the difference it can make in our quality of care, patient satisfaction and entire practice motivation. Chairside CAD/CAM dentistry will open your eyes to all the possibilities that modern dentistry has to offer, and best of all, the return on investment with these systems provides you an even greater financial opportunity to see and take advantage of more technological opportunities (e.g., lasers, diagnostics, digital communication and record keeping) to enable a higher level of diagnosis and care.

I just celebrated the 10th anniversary of having my own private practice specializing in comprehensive care utilizing the latest in technology to provide
my patients state-of-the-art dentistry in a friendly, safe and cost-effective environment in Grandville, Mich., a suburb of Grand Rapids. I have always invested heavily in technology that would improve my diagnosis and care, incorporating intraoral cameras in 2002, hard- and soft-tissue lasers in 2004, digital radiographs and charting in 2008 and the E4D Dentist System in 2009. I made the decision for chairside CAD/CAM dentistry after seeing the quality of restoration possible combined with the ease of use of the software, powder-free scanning and unlimited on-line support via S.O.S (Support On Site). My patients might not be "main street" patients, but they immediately appreciate the fact that I offer them the latest technology, and they know if I’ve incorporated it, it will provide them a better solution. I made the investment because of the quality and control it would provide me, but it is amazing that once you incorporate chairside CAD/CAM dentistry into your routine care, patients also appreciate and see the difference. Few dental patients have actually experienced or witnessed the benefits of the technology at work during their dental appointments, whether for impression taking, planning their treatments or fabricating their restorations.

In my experience, when they do have that opportunity, they are engaged in the process. What’s more, the presence of CAD/CAM technology in the dental office gives patients a different perspective about the practice, one that says, “Wow, they’re on top of it and they’re willing to bring in new technology to better my care.” And chairside CAD/CAM does enable better
‘Few dental patients have actually experienced or witnessed the benefits of the technology at work during their dental appointments, whether for impression taking, planning their treatments or fabricating their restorations. In my experience, when they do have that opportunity, they are engaged in the process.’

But the CAD/CAM "wow" factor encompasses more than just patients. It extends to, but also radiates from, the dental team. Dental team members absolutely love in-office CAD/CAM because it reinforces their place on the leading edge of patient care and as part of the restorative solution. They take ownership of the fact that they work for someone who invests in technology and can provide services and treatments that other practices don't.

For the dentist, it provides a complete sense of professional satisfaction in doing one's job — and performing an aspect of it that's fun. For me, the tooth repair aspect of dentistry sometimes isn't fun, but custom designing a restoration, feeling it in your hand once it's milled and characterizing it with stain and glaze to make it look its most natural — that's fun, that's rewarding and that's a professional "wow" factor.

Take a new look with 20/20 vision (not hindsight) at what options are available with chairside CAD/CAM dentistry — and see the difference it can make in your own practice._

References
1. www.luxottica.com, Lenscrafters history

_about the author_

After completing his undergraduate studies at Michigan State University, Douglas Klein attended The Ohio State University College of Dentistry, earning his doctorate of dental surgery degree in 1997. Following dental school, Klein completed a one-year residency in advanced general dentistry in Columbus, Ohio, before coming home to West Michigan where he has been providing dental care since 1998. Klein is an active member of numerous dental societies, including the American Dental Association, Michigan Dental Association, Academy of General Dentistry and Academy of Laser Dentistry. He is a past-president of the West Michigan District Dental Society and Kent County Dental Society.

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Can you afford not to have a chairside CAD/CAM system?

Author_Rick Willeford, CPA
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representative. It’s called a Digital Practice Analysis Tool, and it can show you the many ways you can run your practice more effectively and efficiently while still delivering a higher standard of care and excellence in dentistry without compromise.

Have you considered the marketing advantage of being able to offer quality, same-visit service? Think of the time off work, gas and travel time a patient saves if you can eliminate a second appointment. Not to mention having to hassle with temporaries. I have clients who have lost patients to nearby offices that offer same-day crowns. I want other practices losing patients to you!

From a purely financial standpoint, there are some exciting tax depreciation changes that almost cut the effective cost in half!

**Depreciation and Section 179: What’s the big deal?**

Unless you have been living under a rock, you probably heard a lot of excitement at the end of 2010 about raising the Section 179 limits. Yet, you may have wondered what the excitement is all about and whether it might help you.

First, here is some background information. When you write a check for day-to-day operating expense items such as wages, supplies, lab fees, etc., those expenses reduce your taxable profit and are tax deductible. The assumption is that such items are consumed in the current tax year. However, not all purchases are immediately deductible. For instance, if you buy items that are expected to last at least a few years (dental equipment, vehicles, computers, etc.), the IRS requires that you spread the tax deduction over five to seven years (or up to 39 years in the case of a building). This is done in the form of an annual depreciation expense deduction.

Well, would you rather have an expense deduction all in the current year rather than spreading the tax benefits over five to seven years? Enter Section 179, named after the IRS code section, as well as another benefit called “bonus depreciation.” These two options give you the right to treat a large purchase as deductible. The assumption is that such items are consumed in the current year rather than spreading the tax deduction over five to seven years (or up to 39 years in the case of a building). This is done in the form of an annual depreciation expense deduction.

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Congress gave us a (rare) pleasant surprise in late 2010 when it suddenly raised the limit on the amount of equipment purchases that you could elect to deduct immediately under Section 179. For 2010 and 2011, that limit was raised to $500,000. For 2012, the limit will drop to $250,000. Even more startling is the fact that the bonus depreciation rules allow you to immediately deduct an unlimited amount in 2011 for new items only and 50 percent of an unlimited amount in 2012. Thus, congress is clearly encouraging businesses to invest in new equipment as a means to stimulate the economy.

So how does this all affect you? Well, if you are in the 40 percent marginal tax bracket (federal, plus state, plus Social Security taxes) and you purchase and expense a $120,000 chairside CAD/CAM system, then you would get a 40 percent tax refund of $48,000. This means your after-tax cost is essentially only $72,000.

A word of caution: Incorporating a chairside CAD/CAM system represents a very large potential deduction, and its actual impact will affect each clinician differently. This is because of your actual tax situation as well as whether you are a sole proprietor or incorporated, so it is imperative that you have a good CPA to analyze your circumstances. I would suggest you use a good dental CPA who can help analyze the clinical impact on the operations of your practice as well as the tax impact. The Academy of Dental CPAs (www.ADCPA.org) is a great place to start. It’s an association of 26 dental CPA firms that represent about 7,000 dentists throughout the country.

While dentistry is a great profession, it is also a business, and to make your livelihood more productive and profitable, you can either work harder or work smarter. Investing in technology that will improve your bottom line and your financial and clinical margins is a good idea. Check out the latest technology and offer yourself, your team, your patients and your family all of the benefits._

_CAD/CAM_
Coding with Confidence is a unique coding guide that offers much more than the typical list of dental codes found in other coding manuals.

This coding manual provides expert assistance to staff who find it difficult to keep up with the frequent changes to dentistry’s CDT codes. Reader-friendly tips and graphics help dental practices prevent common coding errors and understand common reimbursement policies.

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Insuring success with CAD/CAM restorations

Author: Charles Blair, DDS

_In restorative cases, insurance reporting_ for chairside or lab-fabricated CAD/CAM restorations is equivalent to reporting conventionally fabricated metal-free restorations (ceramic and composite) using other methods. Utilizing the correct codes (CDT = current dental terminology) is now mandatory on all insurance processing and helps ensure proper claim adjudication. In order to file insurance efficiently, the clinician and business assistant must develop appropriate insurance documentation/justification scenarios. In general, ceramic onlays and full crowns are reimbursed with appropriate documentation.

The clinician and staff should educate patients as to the uniqueness and benefits of chairside CAD/CAM. The digital camera, intraoral camera, GURU (patient education) and CAD/CAM all go hand-in-hand. With the intraoral and/or digital camera, the clinician should take photographs and X-rays to accompany the insurance claim, along with an in-depth narrative to build a strong case for reimbursement.

_Insurance reimbursement for CAD/CAM restorations_

Unfortunately, insurance companies may not always reimburse conservative (tooth saving) techniques at the same level as more aggressive C&B procedures (full coverage) despite the fact that the materials and techniques require the same or greater effort on the part of the clinician/office team and actually provide the patient greater benefits. Most dental insurance policies will reimburse indirect intra-coronal restorations at a comparable direct (composite or amalgam) rate.

On the other hand, most dental insurance policies do reimburse ceramic onlays and ceramic full crowns. Ceramic and resin-type veneers are considered "cosmetic," so generally expect no insurance reimbursement. However, replacing failed veneers may have a chance for reimbursement under some insurance contracts. For the private-pay patient, insurance reimbursement policies are immaterial.

_Documentation for CAD/CAM restorations_

For CAD/CAM or other indirect restorations, excellent documentation may enhance dental insurance reimbursement and reduce delays. A pre-op X-ray and photo of the tooth may be provided along with a photo of the prep. This documentation, along with the narrative, should be filed initially with each CAD/CAM restoration for payment, greatly reducing hassles, delay, requests for additional information, etc.

Expect headaches without an intraoral camera or digital camera for documentation! Photos often reveal problems that X-rays do not, so be sure to submit photos routinely.

One of the unique aspects of the E4D™ Dentist system is the fact that each scan, whether preoperative or of the preparation, is saved to the hard drive as a small thumbnail, which can be used to further document the procedure for patient records or insurance justification.

Provide a narrative that discusses fracture and decay, plus any missing, undermined or fractured cusps. If a photo is included, describe what is seen as supplemental to that in the X-ray. For onlays, always mention "capping the cusp(s)" in the narrative. According to the description in the CDT 2010 ADA Glossary (page 212), an onlay requires "restoring one or more cusps and adjoining occlusal surfaces or the entire occlusal surface." Thus, an MOD is not an onlay; it must include a facial and/or lingual cusp in its description. For example, an MODFL or MOL would be a validly reported onlay. A general rule of thumb is "if
the tooth needs a crown, then an onlay will probably be reimbursed.*

_Dental codes for chairside materials_

Milling prefabricated blocks has the advantage over other methods of metal-free restoration fabrication as they ensure the homogeneity of the material through and through and are not subject to many of the variables of hand stacking, pressing or fabricating restorations by hand. Each type of manufactured block has its own distinct properties, clinical advantages and application.

It should be noted that a small percentage of insurance contracts specifically exclude the resin-based, composite restoration as a material for reimbursement. In addition, some contracts reimburse a lower fee for the resin-based restoration compared to the ceramic restoration’s fee.

_How to profit from inlays_

As previously mentioned, the reimbursement level of inlays may be lower compared to onlays or full coverage restorations. Often, the equivalent of an amalgam or composite fee is reimbursed for an inlay. Thus, many patients are reluctant to pay a large amount “out of pocket” for inlays, and dentists rarely mention them for this reason.

However, there is a profitable strategy for CAD/CAM inlays. Typically, the CAD/CAM crown and onlay are priced at the level of a conventional lab-fabricated restoration ($895 to $1,095). If the volume of these higher-fee restorations “cover” the monthly payment, then the only additional cost to fabricate and deliver chairside inlays is the direct (fixed) cost of about $30/unit (bur, block, materials).

Thus, the concept of the “lower-fee” CAD/CAM inlay strategy may be utilized: The long-lasting inlay is offered as an alternative to the amalgam/composite at a lower fee, say $450. If the materials are $30, the net gross profit is $420. If the dentist will delegate and work with two assistants, the dentist’s chair time for CAD/CAM will be equal to or less than an amalgam/composite restoration. One of the assistants can work on the imaging, designing, milling and making small occlusal and interproximal adjustments outside the mouth. The dentist only preps the tooth and bonds the inlay in place. Meanwhile, the dentist produces with the other assistant elsewhere.

“Lower-fee” inlays will be quite profitable if the dentist is willing to train/utilize/delegate the dental assistant properly. Many patients will accept inlay treatment if they only pay the fee difference of $450 and the regular amalgam/composite reimbursement fee. The patient’s out-of-pocket could be less than $200 for an inlay with some plans.

In the end, the patient is grateful for a single appointment and long-lasting inlay at an affordable price, while the dentist makes a substantial profit offering the best conservative dentistry available. It’s even more profitable if the inlay is fabricated in conjunction with other CAD/CAM restorations in the same quadrant.

_Shouldn’t you consider chairside CAD/CAM technology?_

Chairside CAD/CAM is economically viable for most restorative practices. The economics of a one-visit restoration plus the capacity of same-day dentistry is compelling. The capital cost of owning a CAD/CAM system is often more than offset by a reduction in the fabrication fees, an increase in upgrading direct restorations and the increase in new patients wanting this type of technology. With the addition of inlays and onlays to the clinical service mix, even more additional profits are available while providing the best in patient care._

_about the author_

Dr. Charles Blair consults about insurance, fee and procedure mix. He is a highly sought after speaker for dental meetings and conventions nationwide. Blair is available to work with E4D users regarding specific strategies, coding and fees. Proper insurance coding and proper alignment of fees in the practice is very important. Dentists are unaware of the mistakes they make that could often leave $100 to $500 a day “on the table.” Most dentists can “get an E4D for free” with Blair’s Revenue Enhancement Program, plus a $115,000 tax deduction. For additional information, call (866) 858-7596 or e-mail info@drcharlesblair.com.
Restorative control, scheduling freedom, staff empowerment: Today’s in-office CAD/CAM!

Author: Heather Hennen, DAII, CDD, CIS

Whether it’s the same day, next day or next week, in-office chairside CAD/CAM provides dental teams with the flexibility to meet patient and professional demands for excellent dentistry on their terms. That’s because today’s in-office chairside CAD/CAM is an empowering tool that enables dentists and their staffs to take complete control of several aspects involved with creating and delivering durable and esthetic all-ceramic restorations.

In-office chairside CAD/CAM systems allow every member of the dental team and their patients to benefit from powerful capabilities. Systems designed with intuitive software (such as the E4D Dentist System, manufactured by D4D Technologies), enable trained dental assistants and other team members to effectively design a beautiful, accurate restoration.

When utilizing the chairside CAD/CAM system that we have in our office, we benefit from features such as “rubber tooth,” which enables the user to manipulate any part of the restoration by clicking and pulling as if the restoration were made of pliable rubber. The IMAGEVERY™ View allows the user to see 360 degrees of actual hard and soft tissue — both the preparation features and the structure of the tooth or teeth. This feature is incredibly useful because there is no need to cover the preparation with a contrast agent or reflective coating. The final resulting crowns, inlays, onlays or veneers are accurate, esthetic and predictable.

Steps in the treatment process — such as scanning impressions, digitally designing the restorations and selecting the appropriately colored ceramic block for milling — can be delegated to trained staff members who can expertly complete these tasks. When dental auxiliaries are trained as CAD/CAM Dental Designers (CDDs), their professional abilities soar and the pride and ownership they take in the practice, and their patients’ care, increases dramatically.

That, coupled with the inherent benefits associated with CAD/CAM restorations — such as increased accuracy from digital impressions, durable all-ceramic restorations, cost savings from reduced material use and efficient operatory room turnover — and in-office CAD/CAM becomes even more empowering. Patients enjoy appointments without messy and uncomfortable traditional impressions, treatments usually don’t require a temporary, restorations fit and feel more accurate and treatment is more conveniently scheduled.

Having visited many offices across the country, I know it can take time to transition chairside CAD/CAM systems to provide maximum benefit. That’s why careful planning and communication are crucial. By clearly defining expectations and ensuring staff members are well-trained, the transition can be smooth and successful. The ultimate goal is to provide patients with the best possible care while maintaining a high level of efficiency and productivity within the dental practice.
CAD/CAM into the practice in a way that works best for a specific team. Fortunately, having the technology in the office makes it easy to schedule its use and accommodate patients who are ideal candidates for CAD/CAM restorations. Whether it's the same day, next day or next week, the best way to determine how your CAD/CAM system will work for your practice is to try it. Create a plan for what you visualize for your practice and follow the steps necessary to execute it.

_Same-day dentistry_

For example, schedule same-day patients at 8 a.m., 11 a.m., and 2 p.m. Block your schedule for about two hours, which will allow ample time to complete the patient's work. These times may be shortened to accommodate more same-day patients, but this is a good starting point. Patients can wait in a waiting area or choose to leave for an errand and return later. This would allow you to use your operatory for another patient, if needed.

Alternatively, plan to prepare same-day patients in the morning and have them return in the afternoon for delivery. This scenario requires more time for setup and breakdown, but may be best for a busy practice. Establish realistic expectations for the patient from the beginning; explain that every effort will be made to provide this wonderful service, but surgeries or other schedules that run behind could cause a delay that would require him or her to have a temporary.

Also, be sure to plan enough time to complete what is needed in a reasonable time frame. Allow more than a one-hour appointment for everything if it normally takes you 45 minutes to numb and prepare.

The benefits of same-day dentistry include accuracy and time and money savings. Having one appointment and keeping the restoration in-house optimizes profitability. With complete control over how information is collected and the result produced, there are no longer issues with contacts, embrasures or shade.

_Next-week or next-day dentistry_

CAD/CAM need not mean same day, every day for everything. Even if same-day dentistry isn’t the best option for your practice, CAD/CAM may still provide many advantages over conventional dentistry, including increased profitability.

A feasible option could be taking a digital impression rather than a conventional impression and keeping your patient on the same two-week delivery schedule you always had. The lab fabrication fees that you eliminate can make using your chairside CAD/CAM system as your “in-office lab” not only work well but also consistently increase your profitability. Additionally, you have full control over the outcome of your patients’ restorations, as well as the convenience of doing same-day dentistry if, and when, you choose.

Perhaps “next day” is best for your office. Patients can be scheduled for preparation on Mondays and Wednesdays, with delivery on Tuesdays and Thursdays. This is a very efficient way of utilizing the system, one that leaves the option, if needed, for performing same-day restorations for emergencies or special situations.

Some large group offices purchase the scanners and mills needed for their practices, but may have one office performing same-day dentistry while allowing their other offices to use it as their “lab.” In this scenario, delegate one or two people to operate the system. The software has features to simplify these situations.

Each office has its own dynamic and, therefore, will utilize its CAD/CAM system differently. The option of choosing one scenario and evolving will always be there. Many offices will combine all three of the options mentioned above and utilize the system for all it can offer. One thing is certain: No matter which path you choose, you will certainly realize a huge benefit in implementing chairside CAD/CAM into your practice!
The history of D4D Technologies

_D4D Technologies is dedicated to providing dental professionals with the most innovative, patented technologies for proven health-care performance. It all started with a dream when Mark and Henley Quadling were in graduate school. The dream evolved over the years as they started to design commercial software applications and took on the challenge posed by dental scanning. With Basil Haymann, they brought together a team of gifted engineers to develop the hardware and software that was to become the E4D system, which is now being delivered to dental professionals around the world._

_Dream_

In the early 1990s, Mark and Henley Quadling graduated in South Africa and moved to the United States to join the graduate school at the University of Minnesota (UMN). Mark worked in artificial intelligence in the computer science department, and Henley entered the high-energy theoretical physics program. In 1993, Mark came across an intriguing job posting for 3-D digital dentistry at the bio-materials lab in the UMN Dental School, and that was the beginning. In 1997, while finishing his dissertation in quantum chromodynamics, Henley joined Mark in the 3-D dentistry project. In 1998, Mark and Henley started a business to produce software to operate 3-D scanners and motion systems and manipulate 3-D data for many diverse applications. The most difficult of all the applications was dental scanning. In particular, intra-oral scanning was deemed by most observers to be practically impossible, and existing solutions at the time were not being embraced by the industry or considered successful.

Intra-oral 3-D scanning requires that a medically safe device operate in a very small confined space, working in a high-stress environment with severe time constraints and scanning partially translucent materials. In addition, the accuracy requirements were extreme, with 25-micron marginal accuracy being the ultimate goal.

_Design_

In 2000, the Quadlings started a new business called Q3D, which worked on 3-D and automation projects in multiple fields, including dentistry and orthodontics. One project involved the development of a laser-based 3-D bench-top scanner and a full suite of 3-D CAD/CAM software for digital dentistry for which Q3D produced a successful prototype by 2002. A longtime friend and professor at UMN suggested that they visit his childhood friend, a successful businessman and entrepreneur, during a business trip to Texas.

They met Basil Haymann to pitch their ideas and to gather some feedback and guidance. A couple hours later, after a demonstration of the prototype software and the digitized data, Basil shocked Mark and Henley by suddenly exclaiming (much to his wife’s horror) that he would fund the entire project from this point on and would be moving them down to Dallas. Mark and Henley agreed to this chance of a lifetime, and two months later, D3D was formed.

_Develop_

For the next year, D3D remained very small, with three employees, and produced a more refined high-speed multi-line laser scanner prototype, along with the dental design software and tool path generation for a CNC milling machine. Once the high-speed laser-scanning concept was proven and demonstrated to industry experts on behalf of Henry Schein, D3D entered into an exclusive distribution agreement with Schein, and the momentum snowballed. At this time, for trademark reasons, the name of the company was changed to D4D Technologies.

By the end of 2003, the first intra-oral prototype with a touch-screen monitor and no keyboard had been designed along with a small portable in-office CNC milling machine. This prototype system was first shown in private demonstrations at the Chicago Midwinter Meeting in February 2004 to collect feedback from dental professionals.

In response to the feedback in Chicago, the engineering team redesigned and enlarged the milling machine. They were able to produce optimum parameters for the milling process for each material type in close cooperation with the material compa-
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HENRY SCHEIN DENTAL
In the summer of 2007, Henry Schein started inviting its customers to “previews” of the E4D system at D4D’s state-of-the-art, 9,200-square-foot training facility. By late 2007, the system software and hardware refinements and specially trained Henry Schein technicians were in place, the first sales were made and the first customers arrived at E4D University for training.

Early in 2008, the E4D Dentist system was fully launched. All customers come for training (which is included in the package for two people) at D4D. D4D also became a global company that year, shipping to customers in Canada, South Africa and Australia.

D4D was honored to be a gold recipient in the Medical Design Excellence Awards for 2008, the only dental product manufacturer to receive the award that year. D4D participated in all of the major U.S. dental meetings in Henry Schein booths and created marketing programs to educate the dental profession about the system as well as to support clients’ patient marketing activities.

The Schein previews became weekly events for dental professionals to try out the system and produce a restoration. Basic training classes were held twice a week, and intermediate classes were soon in demand to help E4D operators take their skills to the next level. A new CAD/CAM Dental Designer (CDD) self-paced certification program was developed for auxiliaries. D4D’s education program received continuing education authorization from ADA CERP, the Dental Assisting National Board and the National Association of Dental Laboratories, where all classes provide C.E. hours from at least one of these bodies.

Throughout the year, the support and technician teams expanded as new customer installations came on stream. New versions of the software were released, and systems were updated at no additional charge. The owners of D4D made the decision early on that restorative software updates would be included with the product warranty.

In 2009, D4D introduced the system at the International Dental Show in Cologne, Germany, and made the first shipments to New Zealand. Later, a distributor was appointed for the Nordic countries. A new software update was released and installed at no charge under warranty. Advanced courses were introduced for multiple posters and smile design.

Leading dental professionals and organizations, such as Clinicians Report and Dental Advisors, continued to be involved with E4D system evaluations throughout the year, and many presented their findings at CADapalooza 2009 in Miami Beach. D4D extended the training program so that the standard system package included one day of in-office clinical integration with an experienced dental assistant who was also a CDD.

D4D also expanded its presence in dental schools in the United States and other countries, and large E4D installations at several schools ramped up for pre-clinical instruction as well as clinical.

The Metroplex Technology Business Council, the largest technology trade organization in Texas, named D4D the 2010 winner of the Tech Titan Award. The company also received ISO 13485 certification, indicating that the company had established and maintained a quality management system that meets worldwide standards for medical devices.

D4D formed its own district sales force to work with Schein’s digital technology specialists and field sales consultants in promoting D4D products. Another major change in the organization occurred at the end of the year when Haymann, one of D4D’s founders, resigned as CEO to pursue other business interests. He remains an investor and board member.

CADapalooza ‘10 was held at the new Cowboys Stadium in Dallas to focus on how chairside CAD/CAM is rapidly changing the dental office in many ways—from the financials to empowerment of the dental team. D4D also expanded into new markets with military and government installations in the United States and globally in Mexico and the Middle East. Regional “previews” were scheduled around the United States in dozens of locations. New software capabilities and enhancements were introduced with another software update, and the 100th CDD to achieve certification.

2011 promises to be another banner year with the introduction of new products and capabilities that build on the current system as well as take the company into new areas of dentistry._
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Digital dentistry events

_Experience CAD/CAM dentistry at a hands-on preview event

Regional preview events scheduled:
- May 6: Charlotte, N.C.
- May 11–14: CDA Spring, Anaheim, Calif.
- June 3: San Francisco, Calif.
- June 10: Louisville, Ky.
- June 17: Baltimore, Md.
- June 24: Cleveland, Ohio
- July 15: Toronto, Ontario, Canada
- July 22: Cincinnati, Ohio
- August 12: Indianapolis, Ind.
- August 26: Tampa, Fla.
- September 9: Boston, Mass (Tufts University)
- September 16: San Antonio, Texas
- September 21-24: CDA Fall, San Francisco
- September 23: Calgary, Alberta, Canada
- September 30: Kansas City, Kan.
- October 7: Houston, Texas
- October 14: New York, N.Y.
- October 21: Detroit, Mich.

_Course description_
Dental professionals interested in learning about the latest that digital dentistry has to offer have the opportunity to attend a one-day program and experience a hands-on session with the E4D Dentist system. Participants will gain an overview of the science, clinical indications, materials and techniques of current and emerging technologies.

The program includes a technology demonstration and interaction with full professional systems and enables participants to scan, design, mill and characterize a restoration during the session.

For more information or to register, contact your local Henry Schein Dental representative or D4D Technologies at preview@d4dtech.com and (877)-293-4945). For complete course description, visit www.e4d.com/preview.

*The demonstration portion of this program is of a commercial/promotional nature.*
submissions: formatting requirements

Please note that all the textual elements of your submission:
- the complete article,
- all the figure captions,
- the complete literature list and
- contact info (bio, mailing address, e-mail address, etc.)

must be combined into one text document. Please do not submit multiple files for each of these items.

In addition, images (tables, charts, photographs, etc.) must not be embedded in the text document. All images must be submitted separately, and details about how to do this appear below.

If you are interested in submitting a C.E. article, contact us for additional instructions before you make your submission.

Text length

Article lengths can vary greatly—from a mere 1,500 to 5,500 words—depending on the subject matter. Our approach is that if you need more or less words to do the topic justice then please make the article as long or as short as necessary.

We can run an extra long article in multiple parts, but this is usually discussing a subject matter where each part can stand alone because it contains so much information. In addition, we do run multi-part series on various topics.

In short, we do not want to limit you in terms of article length, so please use the word count above as a general guideline and if you have specific questions, please do not hesitate to contact us.

Text formatting

Please use single spacing and un-indented paragraphs for your text. Please do not put a blank line between paragraphs.

We also ask that you forego any special formatting beyond the use of italics and boldface, and make sure that all text is left justified.

If you would like to emphasize certain words within the text, please only use italics (do not use underlining or a larger font size). Boldface is reserved for article headers.

Please do not “center” text on the page, add special tab stops, or use underlining as all of this must be removed before layout. If you require a special layout, please let the word processing program you are using help you to do this formatting rather than doing it by hand on your own.

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The fact is that no matter how careful one might be, errors have a way of creeping in when you try to hand number footnotes and literature lists.

Image requirements

Please number images consecutively throughout the article by using a new number for each image. If it is imperative that certain images are grouped together, then use lowercase letters to designate the images in a group (i.e., Fig. 2a, Fig. 2b, Fig. 2c).

Please put figure references in your article wherever they are appropriate, whether that is in the middle or end of a sentence but before the period. If you are not directly mentioning the figure in the body of your article, when it appears at the end of the sentence the figure reference should be enclosed within parenthesis and appear before the final period.

In addition, please note:
- We require images in TIFF or JPEG format.
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- Images cannot be any smaller than 80 KB in size (or they will print the size of a postage stamp).

Larger images are always better, and something on the order of 1 MB is best. Thus, if you have an image that is greater than 1 MB, please do not bother “sizing it down” to meet our requirements, but send us the largest file size available.

The larger the starting image is in terms of bytes, the more leeway the designer has in terms of resizing the image to fill up more space should there be room available.

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An abstract of your article is not required. However, if you choose to provide us with one, we will print it in a separate box.

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Questions? Comments?

Please do not hesitate to contact us for our International C.E. Magazine Author Kit or if you have other questions/comments about the article submission process:

Group Editor Robin Goodman
r.goodman@dental-tribute.com

Managing Editor Fred Michmershuizen
f.michmershuizen@dental-tribute.com
CAD/CAM
the international magazine of digital dentistry

U.S. Headquarters
Dental Tribune America
116 West 23rd Street, Ste. 500
New York, NY 10011
Tel.: (212) 244-7181
Fax: (212) 244-7185
feedback@dental-tribune.com
www.dental-tribune.com

Publisher
Torsten R. Oemus
t.oemus@dental-tribune.com

Chief Operating Officer
Eric Seid
e.seid@dental-tribune.com

Group Editor
Robin Goodman
r.goodman@dental-tribune.com

Managing Editor
Fred Michmershuizen
f.michmershuizen@dental-tribune.com

Designer
Kristine Colker
k.colker@dental-tribune.com

Designer
Sierra Rendon
s.rendon@dental-tribune.com

C.E. Director
Julia Wehkamp
j.wehkamp@dtstudyclub.com

C.E. International Sales Manager
Christiane Ferret
c.ferret@dtstudyclub.com

Marketing Manager
Anna Wlodarczyk-Kataoka
a.wlodarczyk@dental-tribune.com

Marketing Assistant
Lorrie Young
l.young@dental-tribune.com

Accounting
Melissa Chan
m.chan@dental-tribune.com

List Manager
Edwin Figueroa
e.figueroa@dental-tribune.com

Product/Account Manager
Mark Eisen
m.eisen@dental-tribune.com

Product/Account Manager
Humberto Estrada
e.estrada@dental-tribune.com

Product/Account Manager & Interactive
Gina Davison
g.davison@dental-tribune.com

International Product/Account Manager
Jan Agostaro
j.agostaro@dental-tribune.com

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