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CAD/CAM and Digital Impressions

Written by Paul Feuerstein, DMD and Sameer Puri, DDS

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An Overview of CAD/CAM and Digital Impressions

by Paul Feuerstein, DMD

Educational Objectives

The overall goal of this section of this two-part course is to provide the clinician with information on CAD/CAM systems and the potential benefits of the various systems.

Upon completion of this section, the clinician will be able to do the following:

1. Describe the types of CAD/CAM systems available.
2. Describe the clinical applications and benefits of current CAD/CAM technology.

Abstract

Currently, two genres of CAD/CAM systems exist. One is used only in-office, while the other genre is a combination of in-office scanning and image transmission and milling of restorations or pouring of models in the laboratory. All systems start with scanning of the preparation, the method depending on the specific system.

CAD/CAM systems have developed considerably, offering accuracy and more options than previously. It can be envisioned that CAD/CAM technology developments will continue to offer dentistry more options for its use, including further CAD/CAM integration of procedures and imaging enhancements.

Introduction

There are two current genres of in-office CAD systems. One genre is a complete system where the practitioner can scan preparations, design restorations and manufacture a finished product in the office, in one visit. The other system concentrates on the scanning/digital impression and the practitioner then exports that information to a traditional dental lab or to a designated CAD/CAM laboratory for restoration or substructure fabrication. Both genres offer benefits compared to traditional methods and a number of systems are available for the practitioner to choose from, each using different technology to achieve the end results.[1,2]

Image Acquisition

Each system uses a different method to acquire the images. The first system introduced was the CEREC 1 in 1986. The CEREC 1, 2 (1994) and 3 (2000) systems (Sirona Dental) have all used a still camera to take multiple pictures that are stitched together with software. The E4D (D4D TECH) takes several images, using a red light laser to reflect off of the tooth structure and only requires the use of powder in some limited circumstances. The application of powder to the tooth is quick and simple, taking only seconds, and the powder is easily removed afterwards with air and water.

The iTero system uses a camera that takes several views (stills), and uses a strobe effect as well as a small probe that touches the tooth to give an optimal focal length; this system does not require the use of powder. The LAVA Chairside Oral Scanner (LAVA COS, 3M ESPE) takes a completely different approach using a continuous video stream of the teeth.

CEREC and LAVA currently require the use of powder for the cameras to register the topography. Other scanner systems are also available.

Figure 1. CAD/CAM systems

Each system uses a system-specific handheld device to scan the site (Figure 2).

Figure 2. CEREC (upper image) and LAVA COS (lower image)

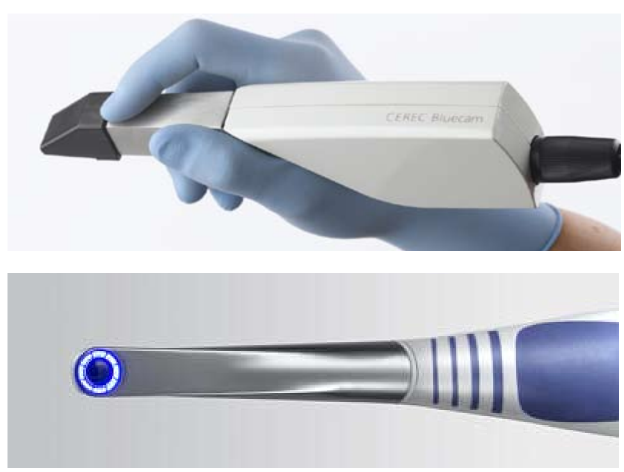


Image Retention/Transmission

Following image acquisition, the final image is either stored in the system and used for chairside fabrication or digitally transmitted to a laboratory for use. CEREC is a complete system that allows the restoration to be made chairside and until the introduction of the E4D system was the only CAD/CAM system achieving this. All other systems discussed are used with an indirect method and are digital impression systems rather than full CAD/CAM systems.

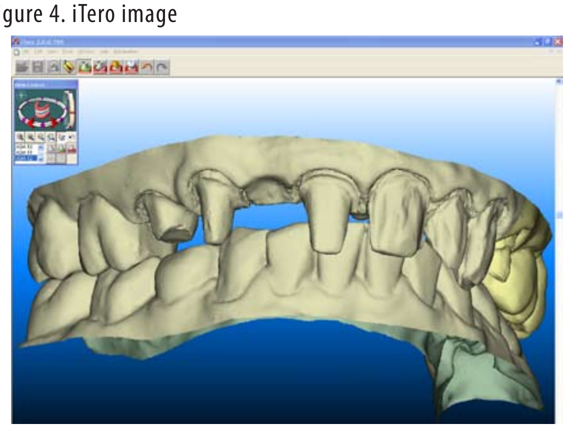
The form that digital transmission takes for the indirect CAD/CAM methods depends on the system used. CEREC Connect is used to export the final digital image directly to a laboratory, where the lab can mill, polish, stain and glaze these restorations to a level that is sometimes not practical in the dental office, using a CEREC inLab milling unit (Figure 3).

Figure 3. CEREC Connect

Depending on the system, the lab can create a physical model and fabricate restorations traditionally from any material, or design and fabricate restorations using CAD/CAM.

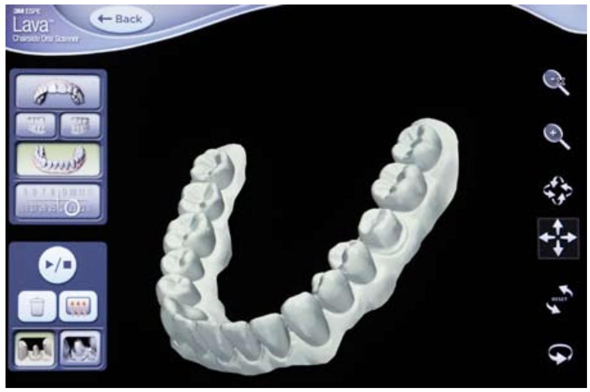
The iTero system offers two options – transmission of the digital image to an iTero laboratory where a model is milled using the image and can then be used in a traditional manner to create the restoration in CAD/CAM and non-CAD/CAM laboratories alike, thereby transforming the software image into a physical model; alternatively, the digital image can be used to create the restoration using CAD/CAM (Figure 4).

Figure 4. iTero image



The LAVA system enables transmission of the data directly to the LAVA lab machine (Figure 5) for a coping that can then be placed on the acrylic model for the porcelain or other material to be added; LAVA can be used to print via stereolithography (SLT) physical models. Alternatively, the digital impression can be sent to a laboratory for any CAD/CAM or traditional restoration fabrication. A chairside system is being developed that will scan a traditional impression in the office and create a digital impression file (3Shape).

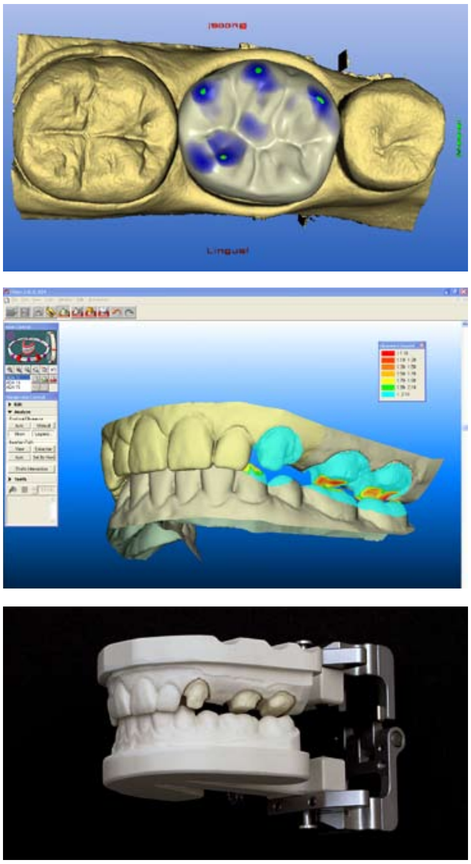
Figure 5. LAVA COS image



Each unit has its own method of determining centric. The LAVA COS and iTero have the ability to capture a bite from the buccal with the patient closed in total contact and occlusion. There is no wax or impression material between the teeth and the practitioner can guide and easily see if the patient is closed correctly. The software simply matches up the upper and lower scans and places them in centric. The clinician can then see this bite from all angles on the screen, including from the lingual, and can also look through the upper to the lower occlusal planes to examine points of contact (Figure 6). iTero has a feature that tells the clinician (on the screen as well as actually "talking") if there is enough occlusal clearance for the planned restoration. The CEREC 3D (2003) software currently available allows you to see the preparation and restoration from all angles and also has a built-in occlusal feature. After the virtual restoration has been seated on the digital impression, the occlusal contacts are visualized using virtual articulation paper. This process ensures that minimal chairside adjustments are necessary once the restoration has been seated.

An adjunct technology recently added to the available systems is Haptic technology (Sensable Technologies). This is a virtual waxup system whereby the technician can sit in front of a computer screen looking at a 3D model, and holding a computerized wax spatula (actually an elaborate computer mouse) place wax on dies, and even create partial frameworks, retention bars and other devices with a tactile feedback that feels like the operator is touching a model. These waxups can then be created by a CAD/CAM system. Haptic technology is also being applied for virtual cavity preparation for endodontic procedures.[3]

Figure 6. Imaging of occlusion



Benefits of Digital Impression and CAD/CAM Systems

Digital impression and CAD/CAM systems offer a number of benefits over traditional methods. In the case of a complete CAD/CAM system used to scan preparations and create restorations in-office, this eliminates a second visit for the patient (CEREC, Sirona Dental Systems; E4D, D4D Tech). With both complete systems and chairside scanning systems, accuracy benefits exist. CAD/CAM restorations have been found to have good longevity and a fit meeting accepted clinical parameters. [4,5,6,7,8,9]

Scanning an image and viewing it on a computer screen allows the clinician to review the preparation and impression, and make immediate adjustments to the preparation and/or retake the impression if necessary, prior to its being sent to the milling unit or a laboratory. This ensures no calls from a laboratory that a (physical) impression is defective - no missing margins, pulls or voids in the impression or steps between two viscosities used that are errors seen in physical impressions. This review, as well as seeing a preparation multiple times its normal size on a screen, can result in improved preparations. It is easier to visualize the details on a screen in a positive view, as opposed to reading the negative in the impression tray. A digital impression also means that patients do not have to have impression material and trays used, saving them discomfort. CAD/CAM restorations will have margins and proper contacts matching the accuracy of the impression. Using the in-office CAD/CAM systems, the restoration is precisely milled to the information given by the software and the images on the screen. There is of course room for operator error if the practitioner modifies either of these two parameters outside of the recommendations; however the newest software versions give a very clear alert. Less time is also required for occlusal adjustments of the final restoration, even although while centric occlusion is accurately recorded using scanners lateral excursions may not be digitally perfect.

Table 1. Digital impression and CAD/CAM systems

	CEREC	E4D	iTero	LAVA COS
Full-arch digital impressions indicated	Yes	No	Yes	Yes
Powdering required	Yes	Sometimes	No	Some
Acquisition Technology	Blue light LED	Red light laser	Confocal	Blue light LED Video
In-Office Milling	Yes	Yes	No	No
Connectivity to Labs	Yes	No	Yes	Yes
Restoration Design (CAD) Software	Yes	Yes	No	No
Indication for bridges	Yes	No	Yes	Yes

The digital impression systems that export the impression data to the laboratories and directly mill restorations offer the same accuracy as in-office milling. Similarly, Haptic technology ensures accuracy for frameworks and metal substructures as there is no possibility of casting or soldering errors. Other systems offering similar milling benefits for substructures, copings and abutments include Procera (Nobel Biocare) and Atlantis (Astra Tech). The Atlantis system scans the implant fixture level (traditional) impressions and creates implant abutments via CAD/CAM that are accurate and time-saving. At the same time, 'hardware' companies have incorporated features that will make CAD/CAM scanning easier, such as embossed patterns on healing caps (3i) to make it possible to accurately scan these for CAD/CAM systems. Scanning at this level removes the need for transfer abutments and traditional impressions.

For CAD/CAM systems creating a laboratory model, the model that the technician will work with is different to a traditional model. Using CAD/CAM technology, the model is milled or created with stereolithography by a computer-controlled system. The tolerances are in the microns making these models extremely accurate. The models are also manufactured in a very hard acrylic material, very different to stone – the hard acrylic margins do not chip away, and contacts are not worn away as the wax or ceramic are taken on and off of the model many times while the restoration is created. Dies are cut and trimmed by the laboratory computer and set up almost like a jig-saw puzzle with interlocking pieces, and cannot shift during manipulation. This is a great advantage over saw-cut plaster dies, even if they are held in a special matrix. CAD/CAM dies do not "wiggle".

Table 2. Potential benefits of CAD/CAM systems

Accuracy of impressions
Opportunity to view, adjust and rescan impressions
No physical impression for patient
Saves time and one visit for in-office systems
Opportunity to view occlusion
Accurate restorations created on digital models
Potential for cost-sharing of machines
Accurate, wear- and chip-resistant physical CAD/CAM derived models
No layering/baking errors
No casting/soldering errors
Cost-effective
Cross-infection control

CAD/CAM systems can save time, and after consideration of the financial investment, they are cost-effective. The advent of accurate scanning, transmission and fabrication of laboratory CAD/CAM restorations offers an opportunity to, in effect, cost share on the required equipment. Last but not least, CAD/CAM also aids cross-infection control.[10]

The Future

CAD/CAM systems have not completely replaced traditional impression taking. Undercuts would preclude the digital acquisition, and there are instances where it is difficult for scanners to read the image (e.g., preparations with long subgingival margins or bevels). It is possible in the future that abutment and implant scans will be combined, as well as other 'combination impressions scans' where frameworks and other appliances are currently pulled in the impression material. Orthodontic impressions are on the horizon, and there have been reports that full arch impressions are being created for fixed appliances with great success. A combined 3D CBCT radiography and CAD/CAM system can also be envisioned (such as CEREC and Galileos). Finally, it can be anticipated that software developments and refinements will continue in the areas of scanning and imaging of preparations and laboratory in-process images during the creation of restorations.

Summary

CAD/CAM technology currently includes a number of systems that fall into two basic genres – in-office and laboratory fabrication of restorations after digital scanning of images. CAD/CAM has been found to be accurate and offer a number of benefits over traditional in-office and laboratory techniques. It can be anticipated that CAD/CAM technology in dentistry will continue to develop.

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Author Profile

Dr. Paul Feuerstein received his undergraduate degree at SUNY Stony Brook where he majored in chemistry, engineering and music and learned how to program computers. He received his dental degree at UNJMD in 1972 and has a general practice in North Billerica, MA. He installed one of dentistry's first "in-office computers" in 1978 and has been teaching dental professionals how to use computers since the late 70s. He is currently the technology editor of Dental Economics and the high tech writer for the Journal of the Massachusetts Dental Society as well as a contributing author to several national dental journals. He is an ADA technology lecturer, speaking at the annual sessions, several state and local dental association meetings.

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Maximizing and Simplifying CAD/CAM Dentistry

by Sameer Puri, DDS

Educational Objectives

The overall goal of this section of this two-part course is to provide the clinician with information on CAD/CAM in dentistry and the clinical application of the technology.

Upon completion of this course, the clinician will be able to do the following:

1. Describe the development of CAD/CAM.
2. Know the clinical applications and results achievable using current CAD/CAM technology.

Abstract

CAD/CAM has been integrated into dentistry since the 1980s. It offers the clinician the ability to offer patients fixed restorations of all types. CAD/CAM technology has become easier to use for the clinician as well as more precise, and offers technological advances over earlier versions.

Introduction

CAD/CAM has been an integral part of our world in many aspects since its early beginnings in the 1950s.[1] From automotive and other industrial uses to the manufacture of products in all shapes and sizes, CAD/CAM allows us to fabricate items in an accurate and efficient manner. It is no surprise, then, that CAD/CAM has become an integral part of an increasing number of dental offices. From their rudimentary beginnings, the CAD/CAM systems of today can fabricate a multitude of restorations including inlays, onlays, veneers, full crowns and bridges. The restorations are fabricated from a number of materials including resin, porcelain and acrylic using prefabricated milling blocks of the chosen material. For many years, the only dental CAD/CAM system available was the CEREC system, and until the recent introduction of E4D it was also the only fully integrated chairside CAD/CAM system. Given these facts, much of the clinical data supporting the accuracy of dental CAD/CAM and the longevity of CAD/CAM restorations has been based on this system.

Dental CAD/CAM Development

The first CAD/CAM system for the dental office was CEREC 1. The system was developed by Prof. Dr. Werner Moermann in Switzerland and was eventually licensed to what today is Sirona Dental Systems. For early users, learning to use this machine was difficult and the results were frustrating. Early adopters who utilized the CEREC 1 had to have perseverance to get through the learning curve as well as patience to master the system.

The CEREC 1 was an integrated acquisition and milling unit that was moved from operatory to operatory. The teeth were powdered with an opaquing medium and images were taken with the camera. The DOS-based system allowed the user to fabricate simple restorations by utilizing a two-dimensional representation of a three-dimensional object. As a result of the early technology, these restorations had a relatively wide marginal gap compared to the current systems. Nonetheless, despite this gap, the restorations enjoyed a good success rate due to the strength of the porcelain used and the hybrid composite that was used to cement the restorations, thereby bridging the marginal gaps. Under in vitro conditions, composite-luting adaptation to porcelain, glass-ceramic and composite (assessed using scanning electron microscopy) has been found to be 100% with CAD/CAM restorations.[2] Under in vivo conditions in 1991, Bronwasser et al. found marginal adaptation of occlusal margins of CEREC inlays to be 93.6% when used with a dentin adhesive and liner.[3] This was both an earlier version of the CEREC than is currently in use as well as an earlier generation of adhesive bonding agent; one early study comparing indirect (CEREC) inlays with direct inlays using three different ceramic materials found all to be clinically acceptable after one year.[4]

The CEREC 2 and subsequent CEREC 3 as well as the eventual 3-D system replaced the original technology. Each evolution in the imaging technology led to more indications that the unit could fabricate, as well as a decreased learning curve as the software evolved. Initial versions could only fabricate rudimentary inlays. Subsequent versions could fabricate cusp replacement onlays, full coverage crowns and veneers. Laboratory versions developed the ability to fabricate all types of restorations including frameworks for bridges. Accuracy and fit also improved from the earliest versions.[5] One study found that CEREC 2 offered a 30% improvement in the luting interface fit of ceramic inlays compared to CEREC 1 inlays, and more than two times the grinding accuracy.[6] Schug and colleagues compared CEREC 1 and CEREC 2 inlays and found significant decreases in the luting interface gap using the more advanced technology (56 +/– 27 microns compared to 84 +/– 38 microns), as well as significant reductions in cervical line angles.[7] Simultaneously, luting cements developed offering more reliable cements and more choice for the clinician. While camera angulation using a CEREC 2 could be a concern, one study found that the average camera angulation error by clinicians was just under two degrees, insufficient to introduce error as the camera was tolerant of errors up to five degrees in buccolingual and mesiodistal planes.[8]

Clinical Accuracy

Numerous studies have found CAD/CAM restorations to offer clinical accuracy and precision. Reiss et al. studied 1,010 full-ceramic CEREC crowns between nine and twelve years after placement, finding a 92% success rate (81 failures) over this time span.[9] A second long-term study of CEREC inlays and onlays found a 95% likelihood of survival at nine years. [10] A long-term study on CAD/CAM veneers found that 92% of 617 veneers placed between 1989 and 1997 were clinically acceptable.[11] CEREC 3 software was considerably more advanced than its predecessor, making the in-office procedure simpler. Both CEREC 2 and 3 restorations were found to meet American Dental Association acceptable parameters.[12] In a one-year study of 20 crowns milled chairside using CEREC 3, Otto found all clinically acceptable at one-year follow-up with no fractures or loss of retention.[13] Following its original introduction, CEREC 3 offered several technology advances, including streamlining of the graphics interface, an occlusal-surface design based on biogenerics (the patient's existing dental structures) and the ability to preset the desired luting gap dimensions.[14,15]

Latest Developments

The most current version of the CEREC system is the new CEREC AC, a modular unit that contains an acquisition unit (Figure 1) and was introduced in January 2009. A separate milling unit (Figure 2) has evolved to allow it to fabricate virtually any type of individual restoration with ease and precision unmatched by its predecessors.

Figure 1. Bluecam scanner

Figure 2. CEREC AC unit

The main feature of the new system is the camera, which is referred to as the "Bluecam" and uses the blue spectrum of visible light and is the most accurate version fabricated. Bluecam uses blue-light light emitting diodes (LEDs) to create highly detailed digital impressions using shorter wavelengths of light than earlier systems. This results in increased precision. Unlike previous generations of scanners, which took one image at a time, the Bluecam is a "continuously on" camera that once you turn it on with a click of the mouse, it stays on, snapping images automatically as soon as the camera is held still over a patient's tooth. This allows the clinician to take a quadrant of images in as little as a few seconds. All the user has to do is simply place the camera over the tooth, move the camera to the desired area to be captured and hold the camera still. Once the image is captured, the camera is moved to the next tooth and the subsequent images are captured to create a virtual model of the restoration.

The clinical case below shows the use of CEREC AC.

Clinical Case:

The patient presented to the office for an examination. Initial examination revealed the patient had dental reconstruction done approximately seven years ago. The radiographic examination revealed recurrent decay on teeth #18 and #19 (Figure 3).

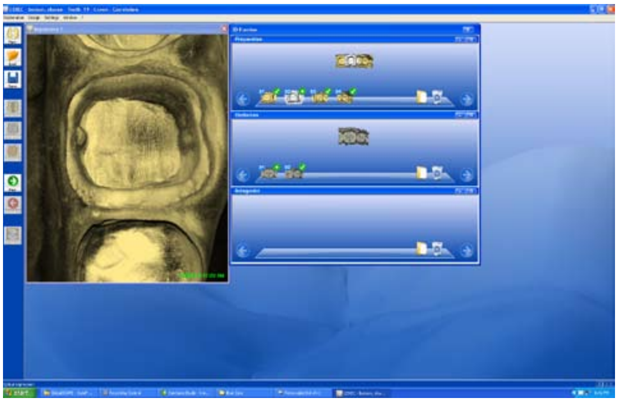
Figure 3. Recurrent decay

The patient was anesthetized with one carpule of septocaine and the existing crowns were removed. The preparations were refined and cord was placed to allow for retraction of the gingival tissues (Figure 4).

Figure 4. Preparation completed, gingival tissue retracted

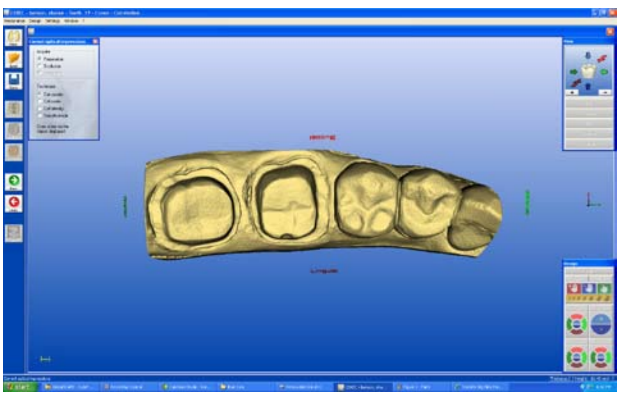
Digital impressions were taken with the CEREC AC and used to fabricate a digital mode. As the preoperative contours of the teeth to be replaced were close to ideal, the contours of the teeth were copied by taking images of the teeth prior to removing the existing crowns.

Figure 5. Scanned preparation



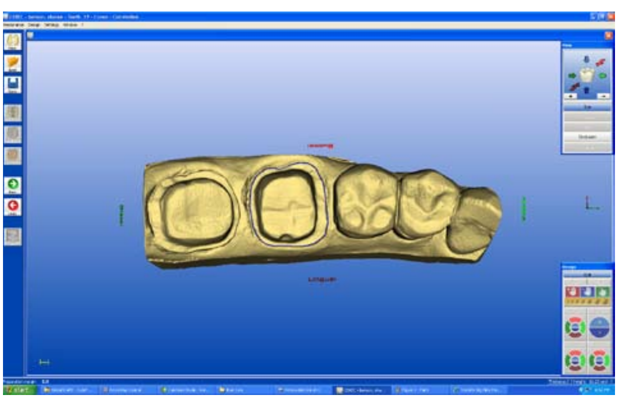
Once all the information had been captured, the software created a digital impression (Figure 6). The optical quality results in a detailed and complete model of the patient's arch. The margins of the prepared teeth are completely visible and ready for margination.

Figure 6. Digital impression



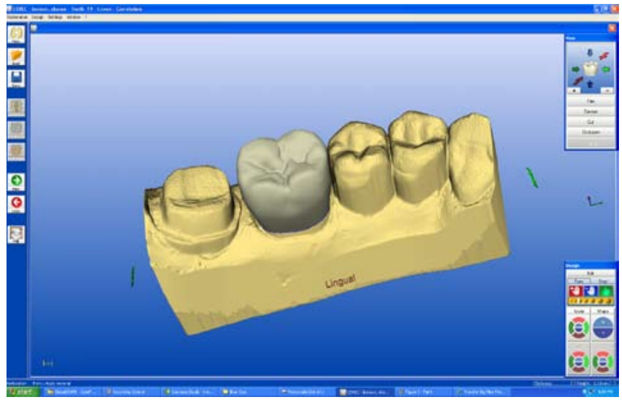
Utilizing the automatic margin finder, the margins of the preparation were marked and the model was ready to fabricate the initial restoration (Figure 7).

Figure 7. Margins of preparation marked



The initial proposal was created by the computer, which resulted in an exact copy of the preoperative situation (Figure 8). The model can be rotated in all angles and the restoration contours can be evaluated from different angles. Contours, occlusion and contacts can all be modified on the initial proposal.

Figure 8. Proposed restoration



Once the first restoration is designed, it can be sent to the milling chamber for fabrication from a variety of materials. Utilizing the software, the designed restoration can be "virtually seated" on the model and the process can be repeated for the second restoration (Figures 9, 10). By leveraging your milling time with your design time, the second restoration can be designed while the initial is milling. Milling time for each restoration ranges from 5 to 15 minutes for a molar restoration. Either a Compact or MC XL milling unit can be used.

Figure 9. First restoration virtually seated on the model

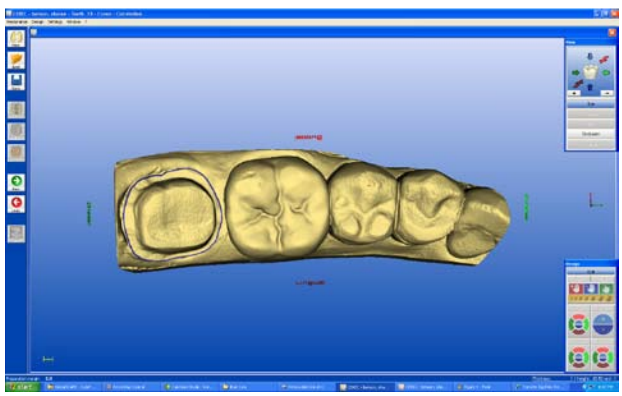
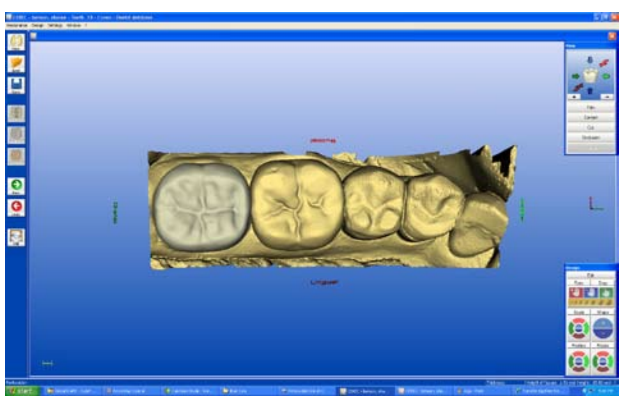
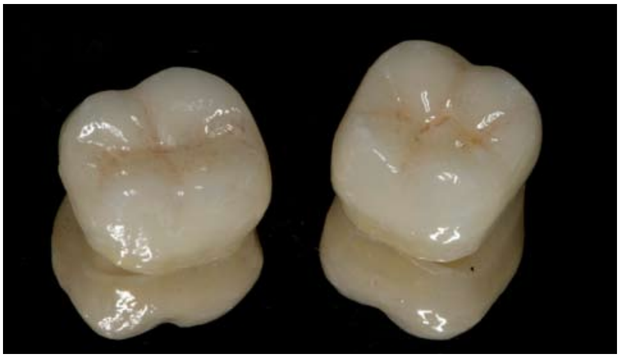


Figure 10. Second restoration virually seated on the model



After milling, the restorations are esthetically enhanced and prepared for bonding. A stain and glaze process is completed and appropriate colored stains are utilized to give the restoration depth and final esthetics (Figure 11).

Figure 11. Final esthetic restorations



The restorations are definitively bonded to the teeth, the occlusion is verified and adjusted as needed, and the patient is dismissed (Figure 12).

Figure 12. Final bonded restorations

Summary

Having been a CAD/CAM user for several years, our office and patients have enjoyed the benefits of one-visit dentistry. Patients appreciate the convenience of no provisional restorations and not having a second visit for the definitive restoration. The latest technology results in highly accurate restorations that will allow users to have a minimal learning curve and fabricate restorations with ease.

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Author Profile

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Questions

1. Each system uses a different method to _________.
   a. prepare the tooth
   b. acquire the model
   c. acquire the images
   d. all of the above
2. There are two current genres of in-office CAD systems.
   a. True
   b. False
3. All digital impression systems require the use of powder.
   a. True
   b. False
4. The _________ system uses a camera that takes several views (stills), and uses a strobe effect as well as a small probe.
   a. CEREC 1
   b. LAVA COS
   c. iTero
   d. all of the above
5. The _________ system uses a continuous video stream of the teeth.
   a. iTero
   b. CEREC
   c. LAVA Chairside Oral Scanner
   d. none of the above
6. Each system uses a system-specific handheld device to scan the site.
   a. True
   b. False
7. Laboratories can only create restorations from digital impressions if they have CAD/CAM units.
   a. True
   b. False
8. It is possible to fabricate _________ using CAD/CAM systems.
   a. only crowns
   b. crowns, bridges, inlay, veneers and onlays
   c. substructures and copings
   d. b and c
9. Some CAD/CAM systems are able to capture a bite from the buccal with the patient closed in total contact and occlusion.
   a. True
   b. False
10. An option to visualize the occlusion includes _________
    a. using virtual articulation paper
    b. viewing the bite from all angles on the screen and looking through the upper to the lower occlusal planes to examine points of contact
    c. milling the wax bite
    d. a and b
11. A virtual waxup system can be used for the _________.
    a. creation of dies
    b. creation of partial frameworks
    c. creation of porcelain
    d. a and b
12. A complete CAD/CAM system eliminates a second visit for the patient.
    a. True
    b. False
13. Scanning an image and viewing it on a computer screen allows the clinician to_________.
    a. review the preparation and impression
    b. make immediate adjustments to the preparation
    c. retake the impression if necessary
    d. all of the above
14. Less time is required for occlusal adjustments of the final restoration using the newest software versions.
    a. True
    b. False
15. It is easier to visualize the details on a screen in a _________, as opposed to reading the _________.
    a. positive view; negative in the impression tray
    b. negative view; positive in the impression tray
    c. negative view; neutral in the impression tray
    d. none of the above
16. There is no room for operator error using CAD/CAM systems.
    a. True
    b. False
17. All CAD/CAM systems are indicated for bridges.
    a. True
    b. False
18. Digital impression systems that export the impression data to the laboratories and directly milling restorations offer the same accuracy as in-office milling.
    a. True
    b. False
19. The use of CAD/CAM systems _________.
    a. saves time
    b. aids in cross-infection control
    c. removes the possibility of layering and baking errors
    d. all of the above
20. It is possible in the future that abutment and implant scans will be combined.
    a. True
    b. False
21. CAD/CAM restorations can be fabricated from _________.
    a. acrylic
    b. resin
    c. porcelain
    d. all of the above
22. Reiss et al. found a _________success rate for CAD/CAM crowns.
    a. 82%
    b. 87%
    c. 92%
    d. 97%
23. CAD/CAM restorations have been found to meet American Dental Association acceptable parameters.
    a. True
    b. False
24. A new scanner uses blue-light light emitting diodes (LEDs) to create highly detailed digital impressions using shorter wavelengths of light than previously.
    a. True
    b. False
25. A "continuously on" camera scanner is available that once you turn it on stays on and snaps images automatically.
    a. True
    b. False
26. The milling time for full coverage CAD/CAM porcelain crowns can range from _________minutes for a molar restoration.
    a. 5 to 10
    b. 5 to 15
    c. 10 to 20
    d. none of the above
27. Patients appreciate the convenience of no provisional restorations.
    a. True
    b. False
28. The first CAD/CAM system for the dental office was developed by _________.
    a. Prof. Dr. Werner Schmidt
    b. Prof. Dr. Werner Moermann
    c. Prof. Dr. Ernst Baumgartel
    d. none of the above
29. The margins of prepared teeth can be completely visualized and marginated using CAD/CAM.
    a. True
    b. False
30. CAD/CAM technology has become easier to use as well as more precise, and offers technological advances over earlier versions.
    a. True
    b. False

ANSWER SHEET

CAD/CAM and Digital Impressions

Name: ______________________ Title: __________ Specialty: ______________________

Address: ______________________ E-mail: ______________________

City: ______________________ State: __________ ZIP: __________ Country: __________

Telephone: Home (   ) ______________________ Office (   ) ______________________

Requirements for successful completion of the course and to obtain dental continuing education credits: 1) Read the entire course. 2) Complete all information above. 3) Complete answer sheets in either pen or pencil. 4) Mark only one answer for each question. 5) A score of 70% on this test will earn you 4 CE credits. 6) Complete the Course Evaluation below. 7) Make check payable to PennWell Corp.

Educational Objectives

1. Describe the types of CAD/CAM systems available.
2. Describe the clinical applications and benefits of current CAD/CAM technology.
1. Describe the development of CAD/CAM.
2. Know the clinical applications and results achievable using current CAD/CAM technology.

Course Evaluation

Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 0.

1. Were the individual course objectives met? Objective #1: Yes No Objective #3: Yes No
Objective #2: Yes No Objective #4: Yes No

2. To what extent were the course objectives accomplished overall?	5	4	3	2	1	0
3. Please rate your personal mastery of the course objectives.	5	4	3	2	1	0
4. How would you rate the objectives and educational methods?	5	4	3	2	1	0
5. How do you rate the author's grasp of the topic?	5	4	3	2	1	0
6. Please rate the instructor's effectiveness.	5	4	3	2	1	0
7. Was the overall administration of the course effective?	5	4	3	2	1	0

8. Do you feel that the references were adequate? Yes No

9. Would you participate in a similar program on a different topic? Yes No

10. If any of the continuing education questions were unclear or ambiguous, please list them.

____

11. Was there any subject matter you found confusing? Please describe.

____

____

12. What additional continuing dental education topics would you like to see?

____

____

Mail completed answer sheet to

Academy of Dental Therapeutics and Stomatology,
A Division of PennWell Corp.
P.O. Box 116, Chesterland, OH 44026
or fax to: (440) 845-3447

For IMMEDIATE results,
go to www.ineedce.com to take tests online.
Answer sheets can be faxed with credit card payment to (440) 845-3447, (216) 398-7922, or (216) 255-6619.

☐ Payment of $59.00 is enclosed.
(Checks and credit cards are accepted.)

If paying by credit card, please complete the following: ☐ MC ☐ Visa ☐ AmEx ☐ Discover

Acct. Number: ______________________

Exp. Date: ______________________

Charges on your statement will show up as PennWell

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2.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	17.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
3.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	18.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
4.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	19.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
5.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	20.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
6.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	21.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
7.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	22.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
8.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	23.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
9.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	24.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
10.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	25.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
11.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	26.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
12.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	27.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
13.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	28.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
14.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	29.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
15.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	30.	Ⓐ	Ⓑ	Ⓒ	Ⓓ

AGD Code 017, 250

PLEASE PHOTOCOPY ANSWER SHEET FOR ADDITIONAL PARTICIPANTS.

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COURSE EVALUATION and PARTICIPANT FEEDBACK

We encourage participant feedback pertaining to all courses. Please be sure to complete the survey included with the course. Please e-mail all questions to: macheleg@pennwell.com.

INSTRUCTIONS

All questions should have only one answer. Grading of this examination is done manually. Participants will receive confirmation of passing by receipt of a verification form. Verification forms will be mailed within two weeks after taking an examination.

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Completing a single continuing education course does not provide enough information to give the participant the feeling that s/he is an expert in the field related to the course topic. It is a combination of many educational courses and clinical experience that allows the participant to develop skills and expertise.

COURSE CREDITS/COST

All participants scoring at least 70% (answering 21 or more questions correctly) on the examination will receive a verification form verifying 4 CE credits. The formal continuing education program of this sponsor is accepted by the AGD for Fellowship/Mastership credit. Please contact PennWell for current term of acceptance. Participants are urged to contact their state dental boards for continuing education requirements. PennWell is a California Provider. The California Provider number is 3274. The cost for courses ranges from $49.00 to $110.00.

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RECORD KEEPING

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