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CAD/CAM Dentistry and Chairside Digital Impression Making
A Peer-Reviewed Publication
Written by Robert A. Lowe, DDS, FAGD, FICD, FADI, FACD, FIADFE
Educational Objectives
The overall goal of this course is to provide the reader with information on computer-aided design/computer-aided manufacturing (CAD/CAM) dentistry and digital impressions in the dental office. Upon completion of this course, the clinician will be able to do the following:
1. Know the requirements for ideal impression and model materials
2. Understand the differences between complete in-office and chairside digital impression CAD/CAM techniques
3. Understand the potential impact of CAD/CAM dentistry on productivity and accuracy
4. Know the potential impact on clinic-laboratory communication of chairside digital impression making and digital photography.

Abstract
Precision and accuracy of master impressions are critical to the overall excellence and marginal fit of definitive fixed restorations. CAD/CAM offers clinicians, patients and laboratory technicians methods that are reproducible and accurate, and allows for user- and patient-friendly clinical procedures. CAD/CAM systems are available that either digitally scan and create fixed restorations chairside or that capture chairside digital impressions that are then sent to a laboratory. In-office CAD/CAM allows clinicians to provide same-visit indirect fixed restorations that are accurate and esthetically pleasing. Chairside digital impression making allows for the creation of accurate models that can then be used for either traditional or CAD/CAM fabrication of restorations, and involves less chairside time. In the case of image verification and model milling in the manufacturer’s facility, standardized quality control procedures also benefit the final product. Compared to a traditional technique, in-office CAD/CAM does not require any communication with a laboratory, and chairside digital impressions enable seamless communication between the clinician and the laboratory technician. CAD/CAM dentistry is changing the way in which clinicians provide indirect restorations to patients, making the process more patient- and user-friendly, reliable and accurate.

Introduction
Demographics, combined with the increased demand for esthetic dentistry, have resulted in an increase in the number of fixed restorations being provided to patients. Aging baby boomers and older adults received less preventive care and more basic restorative work as children and teenagers than subsequent generations have. In addition, earlier traditional restorations were more invasive and led to more loss of tooth substance. Patients continue to receive fixed restorations, in part as previous restorations break down and weakened tooth structure fails. More patients are also retaining their teeth for longer. Furthermore, patients in all age groups now demand improved esthetics from dental materials and seek dental care that will improve their smile and overall appearance. Annually, an estimated 43 million crowns, bridges, and veneers combined are provided; this number excludes inlays and onlays. All require impression making to create a final restoration.

Ideal Impression and Model Properties
A master impression for fixed restorations must be accurate at the time of impression making and stable such that the impression is not distorted prior to development of a master model and die(s). In addition to accuracy and dimensional stability, other required and desirable properties for an ideal impression include short chairside time, biocompatibility, a material that is safe for the purpose intended, and a user- and patient-friendly material/technique. Currently, the most popular impression materials for fixed restorations typically utilize polyvinylsiloxane or polyether materials. In addition to the above requirements, an appropriate working and setting time for the given procedure; strong tear strength; adequate flowability, hydrophilicity and wettability; ease of removal and elastic recovery, so that any deformation during removal of the impression is rapidly reversed; a smell, taste and texture acceptable to patients; and ease of storage are needed.

Precision and Accuracy
Precision and accuracy of the master impression are critical and cannot be compromised. In terms of overall excellence and marginal fit, definitive fixed restorations are only as good as the master dies from which they are created. The master dies and models, in turn, can only be as good as the impressions from which they were derived. To be acceptable, a final impression must capture the marginal detail and the tooth structure apical to the restorative margin. Without these elements, the definitive restoration will be a clinical failure.

Only impressions with all details accurately portrayed can be used for clinically successful fixed restorations. The latest traditional impression materials are vastly superior to earlier generations and are capable of delivering accurate master impressions. Nonetheless, they remain technique sensitive, and the process can be unpleasant for patients. Traditional impressions also require accuracy during the model-pouring process. The model must be cast in stone that is hard, durable and dimensionally stable during setting; that reflects the accuracy of the master impression; and that does not chip, crack, break or lose substance during removal from the impression or during laboratory manipulation. Variability in accuracy has been found in impressions and resulting casts depending on the technique and material used. The advent of CAD/CAM
offers clinicians, patients and laboratory technicians methods that are reproducible and accurate, and allows for user- and patient-friendly clinical procedures. 3

CAD/CAM Dentistry
The era of CAD/CAM dentistry began in the 1980s with the arrival of the CEREC 1 (Sirona) machines, followed later by Procera (Nobel Biocare). The Procera was specifically designed to scan models that had been poured from traditional master impressions and to then fabricate metal copings for laboratories. The CEREC was designed for a complete in-office procedure, originally for the fabrication of inlays and onlays. 4, 5 The objective was to produce a clinically accurate digital impression that captured the marginal detail and tooth structure apical to the proposed restoration’s margin for the master model and die(s). Since then, numerous studies have demonstrated the potential for accurate and precise restorations using CAD/CAM technology. 6, 7, 8, 9 Conceptually, the development of chairside digital impression making is akin to the development of digital intraoral photography; both offer accuracy and speed, as well as the ability to indefinitely store the information captured without any material constraints and to quickly and easily transfer the digital images from dental office to laboratory and vice versa.

In-Office CAD/CAM and Chairside Digital Impression Techniques
Sophisticated CAD/CAM systems are now available that either digitally scan and create fixed restorations in-office or that capture chairside digital impressions that are sent digitally to a laboratory technician or manufacturing center (depending on the system). The current in-office systems with chairside milling are the CEREC (Sirona) and E4D (D4D Technologies) machines. Chairside digital impression systems with transfer of images to a laboratory or manufacturing facility include the iTero, CEREC and Lava C.O.S. systems.

The starting point for all systems is the capture of an accurate digital impression. The ability to capture impressions digitally can be an advantage in the case of a patient who is a gagger or cannot tolerate impression material in his or her mouth for several minutes, or if mandibular or maxillary tori or other undercuts are present that would make removal of a traditional impression difficult or impossible without causing the patient discomfort and/or tearing the margins on the impression (which results in a useless impression that must be retaken). 10 As there is no physical impression, no disinfection protocol is required for an impression before it is sent to a laboratory, nor is there any question of incompatibility of specific materials with specific disinfectants.

There are a number of considerations in choosing between an in-office technique (CEREC and E4D) or CAD/CAM technology that combines chairside digital impression making and laboratory fabrication of restorations on an individual patient basis; these include chairside time required, use of a laboratory, laboratory communication, standardized quality control, complexity of the case, desirability of a one-visit treatment and esthetic demands.

Since a considerable level of investment is required to purchase a CAD/CAM system, it is important to fully address these considerations before selecting a specific system. A further factor with chairside digital impression systems is whether the scan is used to generate models at a manufacturing center or sent de novo to individual laboratories. Recently, a third option has been in development: Instead of sending a physical impression, a scan is taken of the traditional impression and sent to the laboratory. In the opinion of this author, this third methodology may be useful for exporting images to remote locations without as great an investment or learning curve; however, this system retains many of the potential flaws and disadvantages inherent with a traditional impression since it is the traditional impression that is scanned.

System considerations include chairside time, standardized quality control, number of visits (one or two) and esthetic demands.

E4D (D4D Technologies)
The E4D (Figure 1) can be used for all fixed restorations except bridges and implants, and will scan up to 16 restorations.

Figure 1. E4D machine

The ability to capture impressions digitally can be an advantage for patients who are gaggers or have severe undercuts such as mandibular or maxillary tori.
The E4D has separate scanning and milling units within a cart, with automated interunit communication. The scanner reflects light from directly above the tooth, using a red light laser oscillating at 20,000 cycles per second to capture the series of images and create a 3-D model. This technology requires that the scanner be held a specific distance above the tooth, aided by rubber stops on the scanner head, and that the area be centered for imaging (aided by a bull’s-eye on-screen guide). There is no requirement to scan the opposing arch, as the occlusion and occlusal height of milled restorations are assessed from the preparation’s arch and an image of a physical registration bite. The dentist has the opportunity to examine the preparation from different aspects for accuracy and to view the proposed restoration prior to milling. The milling component includes a touch-screen panel that provides guidance during the process. The digital scan is transferred to the milling machine (with wireless or wired transmission), and the restoration milled from both sides simultaneously. The E4D does not offer the opportunity to scan and digitally transfer the images to a laboratory. The E4D scanner can also be used to scan a traditional impression for chairside milling of the restoration.

CEREC
The new CEREC AC gives dentists the choice of implementing in-office fabrication or sending the digital images with CEREC CONNECT directly to the laboratory, where the restoration can either be milled directly or a model can be created for traditional fabrication of the restoration.

CEREC AC Machine

After the clinician has verified that the digital preparation and interocclusal clearance are satisfactory, the system will digitally mark the margins and provide a digital version of the proposed restoration prior to its fabrication. The CEREC MC XL milling center can be used to create full contour crowns in six minutes. Alternatively, the MC L Compact Milling Unit can be used. All types of indirect restorations can be created.

Lava C.O.S.
The Lava C.O.S. system is used for chairside digital impression making (Figure 4).

Lava C.O.S. Scanner

The Lava C.O.S. scanner contains 192 LEDs and 22 lens systems with a pulsating blue light and uses continuous video to capture the data that appears on the computer touch screen during scanning. Almost 2,400 data sets are captured per arch. After scanning the tooth preparation, the dentist is able to
rotate and magnify the view on the screen and can also switch from the 3-D image to a 2-D view. The full arch is scanned after the preparation imaging is complete, followed by the opposing quadrant, and the occlusion is assessed by scanning from the buccal aspect with the teeth in occlusion and viewing the arches digitally. The laboratory information is completed after scanning. The images can be transmitted directly to an authorized laboratory where the laboratory technician digitally marks the margins and sections the virtual model prior to sending this digitally to the manufacturer. The model is then virtually ditched, articulated and sent to the model fabrication center for stereolithography (SLA) to create acrylic models. These models can then be used for conventional laboratory techniques or for CAD/CAM restorations. The Lava C.O.S. lab machine is also available to create CAD/CAM copings (substructures).

iTero
The iTero chairside digital impression scanner utilizes parallel confocal imaging to capture a 3D digital impression of the tooth surface, contours and gingival structure (Figure 5). It captures 100,000 points of laser light and has perfect focus images of more than 300 focal depths. The system captures 3.5 million data points for each arch. The scanner has the ability to capture preparations for crowns, bridges, inlays, and onlays. Parallel light emission from the scanner, which does not need to be held a set distance from the tooth and will also scan when touching the teeth, enables the detection of angled contours. During scanning, a series of visual and verbal prompts are given that are customized for the patient being treated and guide the clinician through the scanning process. For each preparation, a facial, lingual, mesio-proximal and disto-proximal view is recorded in around 15 to 20 seconds, after which the adjacent teeth are scanned from the facial and lingual aspect. The occlusion is captured by taking two interocclusal views with the patient in centric, after which the dentist can view the image within 30 seconds and ascertain that the interocclusal clearance is sufficient for the planned restoration prior to the patient leaving. No bite registration material is required.

The iTero system only allows scanning to begin after the prescription charting for the restoration (the “lab slip”) has been completed in the program, ensuring that the prescription is fully entered, with the option to scan either arch first, letting the clinician choose depending on the procedure. A process flow can be viewed on-screen (Figure 6). After the images have been captured, the digital impression is transmitted to the manufacturer’s facility and to the selected dental laboratory. There are no restrictions on the dentist’s choice of dental laboratory.

Figure 6. Process flow

The manufacturer mills the models on a 5-axis milling machine, using a proprietary resin material. Simultaneously, the dental laboratory technician can export the digital impression file to his or her CAD/CAM system and begin fabrication of copings and/or full coverage restorations. With the iTero CAD workstation, the dental laboratory technician may also digitally trim the virtual dies where there is evidence of soft-tissue impinging on the margin. The resin model can also be used for a traditional laboratory technique.

Commonalities and Differences
All traditional impressions require a dry, visible field for accurate impression making. CAD/CAM scanners also require a dry, visible field for scanning. Traditional impressions do have the ability to displace small amounts of crevicular fluid during impression making and can push against gingival tissue, but this is also a source of voids and defects in the final impression. Digital scanners cannot see through any fluid or gingival tissue and obviously have no ability to displace tissue close to the margin. To create an accurate master die, the optical scanner must be able to see and capture the complete restorative margin and the tooth.
or root surface just apical to the margin. Digital scanning must include proper tissue management to ensure accuracy. Soft tissue retraction and moisture control are essential in this process (these are also essential for clinically excellent traditional master impressions). A digital scan should capture the entire restorative margin as well as approximately 0.5 mm of the tooth/root surface apical to the margin. This information is required by the ceramist or milling machine in order to reproduce the correct emergence profile, or “gression silhouette” for the final restoration.

Depending on whether the restorative margin is supracrevicular (above the gingival tissues), equicrevicular (at the free gingival margin) or intracrevicular (in the gingival sulcus), either a traditional single- or double-cord technique, laser technique, chemical retraction technique, or a combination of these can be used to achieve a dry and visible field. For intracrevicular and equicrevicular margins, a double-cord tissue retraction technique can be used, with the more superficial cord removed gently just prior to scanning. If using a laser to trough the area, thereby creating a space between the preparation margin and the tissue (which will also aid hemostasis), it is important to consider the patient’s tissue type and the principles of biologic width first; there must be sufficient horizontal tissue thickness to avoid loss of vertical tissue height.

A digital scan should capture the entire restorative margin as well as approximately 0.5 mm of the tooth/root surface apical to the margin.

One difference between the various systems is the requirement for powdering. The CEREC system requires a coating of reflective powder on the dry preparation prior to scanning. Light powdering is required when using the Lava C.O.S. system. The E4D system typically does not require powdering, but will occasionally under limited circumstances. The iTero system does not require powdering.

Restoration-type limitations for CAD/CAM systems vary depending on the system used. Universal systems for all types of fixed restorations include the CEREC AC, the iTero and the Lava C.O.S. (the Lava C.O.S. system can be used for bridges up to a maximum of 4-units in length). Each system utilizes unique scanning technology and operates with different features and display capabilities.

**Productivity and Accuracy**

Digital scans take less time than conventional impressions, including the bite “registration.” This increases the efficiency and productivity of the office. If the clinician carefully follows the scanning procedure and checks the on-screen images for margin visibility, preparation form and interocclusal clearance, it is possible to make adjustments and take isolated scans to ensure a precise result. The results are instantly visible and enlarged on-screen as they are captured, enabling this process. In addition to the speed of image acquisition compared to traditional techniques, once the imaging technique has been learned, the digital images will be accurate for the laboratory and repeat impressions at the request of the lab will not occur. Verbal and visual prompts on scanner positioning and sequencing may also shorten the learning curve. It has

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**Table 1. Chairside digital impression systems with laboratory transfer capability**

<table>
<thead>
<tr>
<th>Features</th>
<th>Cadent iTero</th>
<th>3M Lava C.O.S.</th>
<th>Sirona CEREC AC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optical Technology</td>
<td>Parallel Confocal/Telecentric</td>
<td>Wavefront Sampling Technology (3D in Motion)</td>
<td>LED/Laser Sampling</td>
</tr>
<tr>
<td>Powder Required</td>
<td>No</td>
<td>Yes</td>
<td>Yes / Optispray</td>
</tr>
<tr>
<td>Focal Depth</td>
<td>13.5 mm 1:1 exact focus</td>
<td>Range from 5 to 15mm</td>
<td>Range from 5 to 15mm</td>
</tr>
<tr>
<td>Indications</td>
<td>All</td>
<td>Up to 4UB, and singles</td>
<td>All</td>
</tr>
<tr>
<td>Models</td>
<td>Milled / Polyurethane. Removable dies, soft tissue profile</td>
<td>Additive / SLA in blue resin. One solid model and one working model.</td>
<td>Additive / SLA; no tissue</td>
</tr>
<tr>
<td>Data Import / Export for Digital Interface</td>
<td>Major CAD front end systems – Dental Wings, 3 Shape, CEREC In-Lab, Standard STL Binary File.</td>
<td>LAVA</td>
<td>CEREC In-Lab</td>
</tr>
<tr>
<td>Articulator</td>
<td>All directions, attachment system to Whip Mix full articulator for complex cases</td>
<td>Articulated; centric and lateral excursions</td>
<td>Hinge-only</td>
</tr>
</tbody>
</table>

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been estimated that scanning takes three to four minutes, compared to almost double this for a traditional impression and bite registration technique. There are no material restrictions either, resulting in less risk of either clinic or laboratory errors, with no risk of errors due to distortion of impression or bite registration materials. The accuracy of scanning the occlusion and occlusal surfaces helps to reduce the time required for minor occlusal adjustments at the seating appointment.

Milled iTERO CAD/CAM resin (polyurethane) models are not subject to voids, shrinkage or expansion of materials, or other defects. These models are strong and durable, resulting in excellent marginal adaptation and fit of the restoration, and are resistant to abrasion or chipping; there is no risk of the restoration being too large due to abrasion of adjacent teeth interproximally on the model or the occlusal surfaces of the opposing arch. The Lava C.O.S. system also creates models, in its case using stereolithography (SLA). This system provides a solid model and a working model. The CEREC AC system also utilizes SLA. Virtual articulation and CAD/CAM mounting of models also improves accuracy, and minor displacement of the resin dies does not occur (as it does with stone dies that are abraded and segmented from stone models). Creating CAD/CAM models at a manufacturer’s facility allows for standardized quality control procedures that ensure reliable accuracy.

Clinic-Laboratory Communication
Chairside digital impression making offers an opportunity for improved communication between the laboratory technician and the clinician. The dentist accurately transmits all imaging data, and if desired the laboratory can feed back proposed designs and restoration contours and margins digitally for the clinician to check. Combining digital imaging with digital photography further improves communication and delivers optimal visual information. Digital photography provides the laboratory with shade and contour nuances beyond the realms of shading notations and shade guides. Shade guide stumps can be photographed overlaid on the tooth, which helps to highlight similarities and differences in areas of the tooth for custom shading and provides information on the initial preparation shade so that appropriate opaquing can occur. Well-documented digital photos supply the laboratory with information on form, shades, contouring and soft-tissue positions, whether a traditional or a CAD/CAM technique will be used for the restoration. Digital scanning and digital photography both offer the ability to convey accurate digital information between the clinician and the laboratory technician and vice versa.

Case Study
The case study below demonstrates the iTERO method of creating digital impressions, CAD/CAM resin models and restorations. Following completion of the preparation, soft-tissue management was performed using a double-cord technique (Figure 7). Note that the margins are completely exposed, the tooth is visible 0.5 mm apical to the margins of the preparation and the field is completely dry (Figure 8).

Figure 7. Preparation and soft-tissue management

Figure 8. Exposure of margins and teeth apical to the margin

Figure 9. iTero scanner over the occlusal surface of the preparation
After scanning of the tooth from the required angles and scanning of the remainder of the arch, scanning of the occlusion can begin. The clinician can view the interocclusal distance easily on-screen (Figure 10), and the occlusal clearance on the prepared and adjacent teeth can be viewed on-screen in contrasting colors (Figure 11).

Figure 10. Imaging of interocclusal clearance

Figure 11. Highlighting of occlusion on preps and adjacent teeth

The margin delineation tool visualizes the margin on-screen, enabling assessment of the margin, and the prep die can also be viewed (Figure 12, 13).

Figure 12. Margin delineation

Figure 13. Virtual preparation die

The resin models are then milled, articulated and utilized for either a traditional or CAD/CAM restoration (Figures 14-17). The scanning, resin models and CAD/CAM restoration result in ease of seating and minimal chairside adjustments.

Figure 14. Milling of model

Figure 15. Resin model output from the milling machine

Figure 16. Milled models mounted and articulated
Summary
In-office CAD/CAM allows clinicians to provide same-visit indirect fixed restorations that are accurate and esthetically pleasing. Chairside digital impression systems allow for the creation of accurate and precise laboratory models and restorations, involve less chairside time, and achieve fine-tuned esthetics that are difficult or time-consuming chairside.

CAD/CAM dentistry is changing the way in which clinicians provide indirect restorations to patients, with fabrication of highly precise, accurate models and restorations; increased chairside productivity; and improved clinic-laboratory communication.

References
11. Ibid.
16. Lowe RA. Using Digital Photography In Laboratory Communication.

Author Profile
Dr. Robert A. Lowe received his Doctor of Dental Surgery degree, magna cum laude, from Loyola University School of Dentistry in 1982. Following graduation, he completed a one year Dental Residency. Dr. Lowe taught Restorative and Rehabilitative Dentistry for 10 years at Loyola University School of Dentistry in Chicago, IL. Dr. Lowe has maintained a full-time private dental practice for 26 years. He is a member of the American Dental Association, a sustaining member of the American Academy of Cosmetic Dentistry, and a member of the American Society of Dental Aesthetics. Dr. Lowe has received Fellowships in the Academy of General Dentistry, International College of Dentists, Academy of Dentistry International, Pierre Fauchard Academy, American College of Dentists, and the International Academy of Dento-Facial Aesthetics. In 2004, Dr. Lowe received the Gordon Christensen Outstanding Lecturer Award for his contributions in the area of Dental Education. In 2005, he received Diplomate status on the American Board of Aesthetic Dentistry. Dr. Lowe has authored several hundred articles in many phases of cosmetic and rehabilitative dentistry, sits on the editorial board of several dental publications, and has contributed to dental textbooks. He is a consultant for a number of dental manufacturers world wide and is active as a key opinion leader in the development of new materials and techniques.

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1. An increase in the number of fixed restorations being provided to patients resulted from _______.
   a. the increased demand for esthetic dentistry
   b. a lack of restorative materials
c. demographics
d. a and c

2. A master impression for fixed restorations must be _______.
   a. accurate
   b. dimensionally stable
c. biocompatible
d. all of the above

3. Definitive fixed restorations are only as good as the master dies from which they are created.
   a. True
   b. False

4. A final impression must capture the _______.
   a. tooth structure apical to the restorative margin
   b. full arch
c. marginal detail
d. a and c

5. Variability in accuracy has been found in impressions and resulting casts depending on the technique and material used.
   a. True
   b. False

6. The era of CAD/CAM dentistry began in the _______.
   a. 1970s
   b. 1980s
c. 1990s
d. none of the above

7. Numerous studies have demonstrated the potential for accurate and precise restorations using CAD/CAM technology.
   a. True
   b. False

8. Chairside digital impression making and digital intraoral photography both offer _______.
   a. accuracy and speed
   b. the ability to digitally transfer images
c. the ability to indefinitely store the information captured
d. all of the above

9. The ability to capture impressions digitally can be an advantage in the case of a patient who cannot tolerate impression material in his or her mouth for several minutes, or if mandibular or maxillary tori or other undercuts are present.
   a. True
   b. False

10. Considerations in choosing between an in-office technique or CAD/CAM technology that combines chairside digital impression making and laboratory fabrication of restorations on an individual patient basis include _______.
    a. complexity of the case
    b. standardized quality control
c. chairside time required
d. all of the above

11. A system that scans traditional impressions, in the opinion of the author, retains many of the potential flaws and disadvantages inherent with a traditional impression since it is the traditional impression that is scanned.
    a. True
    b. False

12. All systems require scanning of the opposing arch.
    a. True
    b. False

13. The in-office CAD/CAM systems are the _______.
    a. E4D and CEREC
    b. CEREC and Lava C.O.S.
c. Lava C.O.S. and E4D
d. all of the above

14. Chairside digital impression systems include the _______.
    a. E4D and Lava C.O.S.
    b. iTero and Lava C.O.S.
c. iTero and DTD
d. none of the above

15. Depending on the system, model making following chairside digital impression making can be achieved using _______.
    a. stereolithography
    b. milling of resin
c. pouring of plaster of Paris
    d. a and b

16. Both stereolithography acrylic models and milled resin models can be used for a traditional technique to fabricate restorations.
    a. True
    b. False

17. All CAD/CAM systems are indicated for bridges.
    a. True
    b. False

18. During scanning, one system provides a series of visual and verbal prompts customized for the patient being treated.
    a. True
    b. False

19. For all chairside digital impression systems, the lab slip must be completed before scanning can begin.
    a. True
    b. False

20. The ability by the dental laboratory technician to digitally trim virtual dies helps where there is evidence of _______.
    a. hard-tissue impinging on the margin
    b. soft-tissue impinging on the margin
c. an overexposed scan of the image
d. all of the above

21. Both traditional impressions and CAD/CAM scanners require a dry, visible field for accurate impression making.
    a. True
    b. False

22. Digital scanners can see through any fluid or gingival tissue and obviously have the ability to displace tissue close to the margin.
    a. True
    b. False

23. A digital scan should capture the entire restorative margin as well as approximately _______ of the tooth/root surface apical to the margin.
    a. 0.25 mm
    b. 0.5 mm
c. 0.75 mm
d. none of the above

24. One difference between the various in-office CAD/CAM and chairside digital impression systems is the requirement for powdering.
    a. True
    b. False

25. Digital scans increase the efficiency and productivity of the office.
    a. True
    b. False

26. It has been estimated that scanning takes three to four minutes, compared to almost double this for a traditional impression and bite registration technique.
    a. True
    b. False

27. Virtual articulation and CAD/CAM mounting of models improves accuracy.
    a. True
    b. False

28. Milled CAD/CAM resin models are _______.
    a. not subject to voids, shrinkage or expansion of materials
    b. are resistant to abrasion
c. are resistant to chipping
d. all of the above

29. Combining digital imaging with digital photography further improves communication and delivers optimal visual information, compared to one of these techniques alone.
    a. True
    b. False

30. CAD/CAM dentistry is changing the way in which clinicians provide indirect restorations to patients.
    a. True
    b. False
### Educational Objectives

1. Know the requirements for ideal impression and model materials
2. Understand the differences between complete arch and indirect CAD/CAM techniques
3. Understand the potential impact of CAD/CAM dentistry on productivity and accuracy
4. Know the potential impact of clinical-communication of digital impression making and digital photography

### Course Evaluation

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

<table>
<thead>
<tr>
<th>Statement</th>
<th>Rating</th>
</tr>
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<tbody>
<tr>
<td>1. Were the individual course objectives met?</td>
<td></td>
</tr>
<tr>
<td>Objective #1: Yes No</td>
<td></td>
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<tr>
<td>Objective #2: Yes No</td>
<td></td>
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<tr>
<td>2. To what extent were the course objectives accomplished overall?</td>
<td>5 4 3 2 1 0</td>
</tr>
<tr>
<td>3. Please rate your personal mastery of the course objectives.</td>
<td>5 4 3 2 1 0</td>
</tr>
<tr>
<td>4. How would you rate the objectives and educational methods?</td>
<td>5 4 3 2 1 0</td>
</tr>
<tr>
<td>5. How do you rate the author's grasp of the topic?</td>
<td>5 4 3 2 1 0</td>
</tr>
<tr>
<td>6. Please rate the instructor's effectiveness.</td>
<td>5 4 3 2 1 0</td>
</tr>
<tr>
<td>7. Was the overall administration of the course effective?</td>
<td>5 4 3 2 1 0</td>
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<td>8. Do you feel that the references were adequate?</td>
<td>Yes No</td>
</tr>
<tr>
<td>9. Would you participate in a similar program on a different topic?</td>
<td>Yes No</td>
</tr>
<tr>
<td>10. If any of the continuing education questions were unclear or ambiguous, please list them.</td>
<td></td>
</tr>
<tr>
<td>11. Was there any subject matter you found confusing? Please describe.</td>
<td></td>
</tr>
<tr>
<td>12. What additional continuing dental education topics would you like to see?</td>
<td></td>
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</tbody>
</table>

### 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.

Mail completed answer sheet to: Academy of Dental Therapeutics and Stomatolgy, A Division of PennWell Corp.
PO. 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
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Acct. Number: _______________________________
Exp. Date: _____________________

Charges on your statement will show up as PennWell

### PLEASE PHOTOCOPY ANSWER SHEET FOR ADDITIONAL PARTICIPANTS.

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AGD Code 017, 250