Revolutionizing the impression process

Dr. Marc Lemchen and Scott Huge explore the impact of CAD/CAM technology on dentists and patients

Newer digital technologies have a positive effect on an orthodontic practice. Specifically, 3D intraoral imaging as a replacement for taking traditional impressions and pouring models offers tremendous advantages for the practice and patients. A closer look at the overall work flow and associated economics also illustrates the potential impact that this technology brings to the practice. The three components of the CAD/CAM process are: data in (3D intraoral scanning), data manipulation (software), and data out (printing plastic models or actual appliances).

The promise of imaging the patient's teeth and supporting structures with a 3D intraoral camera (such as the iOC™ powered by iTero™ as shown here) appeals to both dentists and patients (Figure 1). Older and younger patients alike dread the impression process. Parents often mention warning their child about the possible "molds" as impressions are often called (Figure 2). With 3D intraoral scanning, they are so relieved to hear that there will be no "molds." This technology truly differentiates the practice and gives the parent and patient a talking point for friends–"This practice does not take molds, they take 3D pictures (Figure 3)." Patients and parents are also very impressed that this "scan" is not radiographic, and they see this technology as "revolutionary."

Once the digital image is obtained, it can be quickly verified on the screen and saved as part of the patient's permanent record. Depending on the software, the digital images become part of the diagnostic work-up in the same way that a set of stone models would be used, but with all the advantages of 3D manipulations. Sophisticated model analysis and comparative tools can be part of a new "digital 3D patient presentation" when combined with other records such as cone beam images and 3D facial photographic images.

For staff members, substituting a digital imaging session for an alginate (or PVS) impression appointment is a welcome trade. As with any new technology, digital impressions take time to master. The cameras typically take from 5 to 8 minutes per arch with the operator checking at each "quadrant" the data build at each "pass" on the screen (Figure 4). The software has certain built-in corrective features, but the staff member must follow the imaging guidelines to produce an acceptable final image. Every staff member should be trained on this equipment and consistently use it as a daily part of the records process.

The potential for error-free digital records is positive for the practice and laboratory in terms of reducing remakes due to faulty impressions and models. In the laboratory, the most common cause of remakes is inaccurate models. Even the most experienced technicians cannot always tell if an impression or model is 100% accurate. Digital impressions facilitate an improvement in restorative fits and remakes that are reportedly reduced to less than one half of one percent (Figure 5).

Figure 1: iOC™ powered by iTero™ from Cadent

Figure 2: Traditional impressions can be difficult for young patients

Figure 3: 3D intraoral scanning is a "win-win" for the patients and the practice

3D digital images from the intraoral scanner are used in the laboratory for appliance fabrication. The first step is to convert the digital data into a physical model suitable for manufacturing. Resin work models are created from the digital scans using a 3D printer such as the Objet Eden260V™ (Figure 6). This equipment uses an additive process where ultra-thin layers of photo-curable polymer are built up using the digital data from the model geometry. Extremely accurate models are built and then used in the laboratory to fabricate appliances.

Presently, the cost of producing a single plastic arch using this technology is approximately $15. An upper and lower set is $27. This is in addition to any "scan charge" the scanner company imposes each time the unit is used which averages around $24 per patient with price reductions for certain volumes. Practices using an outside digital study model service save about $25 to $38 per patient immediately on this fee with the implementation of a 3D intraoral scanner. The software bundled with the scanner
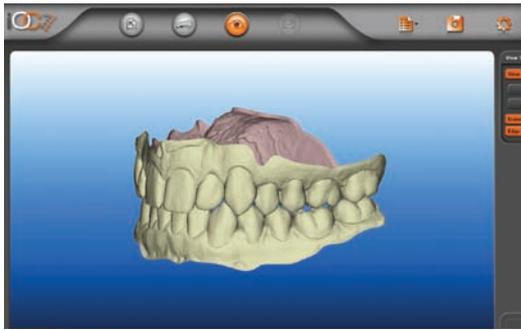
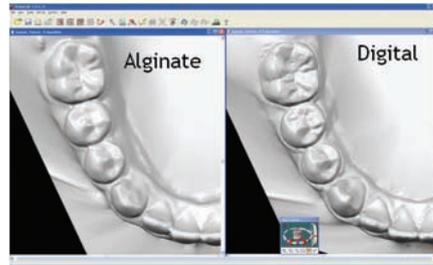Figure 4: The digital image is available immediately for verification

Figure 5: Detail and accuracy comparisons with impressions and 3D intraoral scanning

Figure 6: The Eden260V™ 3D printer from Objet

has many features comparable or exceeding those in the 3D model programs. For larger practices, the considerable savings helps to offset the "scan fees" associated with the 3D intraoral scanner.

Yet another consideration is the in-office laboratory for 3D intraoral scanning and plastic models. Model printing from digital files requires expensive equipment such as the Objet Eden260V, although smaller and less expensive models are available. Unless a practice considered purchasing and operating a 3D printer, the models used for the in-office laboratory will have to be processed at an outside digital printing laboratory with at least a 3 to 5 day delivery cycle. Another option is to take a traditional alginate impression and pour a model for the in-office laboratory fabrication of appliances such as final Hawley retainers. Reverting to traditional alginate impressions for part of the patient records may seem like a step backwards from a 3D intraoral scanner, but for practicality, time and money must be weighed against the technology.

Digital capture of the teeth and supporting structures is useful any time during treatment where an appliance may be used. The images can be used in the beginning of treatment, for example, when a Herbst appliance is indicated or for the initial indirect bonding set-up from a commercial or in-office laboratory (Figure 7). 3D records at the end of treatment can be used to fabricate Fixed Lingual Retainers (FLR) (Figure 8). With this appliance, the digital record can be modified in the software prior to printing to display only the teeth necessary to build the appliance. This saves material when printing and lowers the costs to the practice. This digital technology also offers the ability to adjust a tooth slightly prior to printing the model. For example, if there is a minor corrective tooth movement planned with the final wire, but the digital record reflects the tooth in the rotated position, the tooth can be rotated virtually in the software prior to printing. Then, the Fixed Retainer is processed and delivered, anticipating the teeth in the ideal position (Figure 9).

Another potential time savings is the delivery of the final invisible retainers when braces are removed. Using a digital scan prior to removal of the fixed appliances, the plastic models are printed for fabrication of the invisible retainers. Key point–the images are taken with the braces on, which prevents undesirable movement while the retainers are being made. Depending on the software used in the lab, the fixed appliances can be "trimmed" off the teeth prior to printing the models, adding to the accuracy of the clinical fit of the retainers. The invisible retainers can also be made to fit over a FLR which can be made at the same time as the invisible retainers. In this work flow, the clinical fit of the FLR is

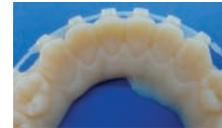Figure 7: The digital model as it appears from the iTero™ scan

Figure 8: The resulting resin model using in the laboratory to fabricate a Fixed Lingual Retainer

Figure 9: The Fixed Lingual Retainer is constructed directly on the printed resin model

assured as the teeth are stable while the final wire is in place.

We can speculate on future opportunities. With the 3D data exportable in a common STL format, the orthodontist or laboratory has options to design appliances as required to fit specific clinical needs. This may consist of custom bracket placement guides, tooth-moving removable appliances, splints, or a variety of finishing and retention appliances. Looking ahead, we can expect development of new materials designed to take advantage of digital manufacturing. These newer materials might include extruded resin or fiber wire frameworks, more elastic materials with perfect memory and custom biocompatible sintered parts made from powered metals which have highly desirable clinical properties. In the immediate future, it may be possible to directly "print" appliances using biocompatible materials such as the newly released clear "resin type" material from the Objet Corporation. Once these newer materials are proven clinically, and the software is made available to facilitate appliance design, orthodontists could potentially purchase a 3D printer for use in their in-house laboratory and "print" appliances. This is already happening in other industries, and orthodontics should also reap these benefits.

Dr. Marc Lemchen is a board-certified orthodontist, practicing in New York City. The founder of Dolphin Imaging and Management Solutions, he is part of a very elite group of cutting-edge creative thinkers and the author of several US and world patents. Dr. Lemchen received his training in orthodontics at Columbia University after he graduated from Tufts University Dental School. He is a member of the American Dental Association, American Association of Orthodontists, Diplomate American Board of Orthodontics, president of the New York Academy of Orthodontics, past president of the American Society of Laser in Dentistry and Advanced Technologies, a member of the Super Schulman Group, and has a Fellowship with the American College of Dentists. Dr. Lemchen was Clinical Assistant Professor of Surgery (Dental and Oral Surgery) at Cornell University Medical College and is the Senior Attending Orthodontist at New York Presbyterian Hospital. Dr. Lemchen developed the Virtual Intercom and Beyond Paperless computer software applications.

Scott Huge is the president and CEO of Specialty Appliances. Scott began his career in the orthodontic laboratory business in 1975. He started Specialty Appliances in 1981 and has grown the company to a leader in quality in the orthodontic field. He is known worldwide for his extensive experience in lingual braces and indirect bonding. He has lectured nationally and internationally on various topics.