Digital Impressions and Stereolithographic Models

Use the full potential of technology to ensure optimal success for a dental prosthesis.

By Daniel Alter, CDT, MDT

Aims and Objectives:

This article will discuss the process by which a dental practitioner transmits information from within the intraoral cavity—including the preparations and adjacent dental landmarks prudent to the ultimate success of the prosthesis. This article will discuss the digitization and manipulation of digital outputs with the outcome of a stereolithographic model that ultimately leads to an accurate representation of the intraoral cavity and all of its characteristics.

Learning Outcomes:

After reading this article, the reader should be able to:

- list the disadvantages of conventional impression materials.
- discuss the importance of accurate representation of the intraoral environment in order to attain optimal prosthetic results.
- describe the process a digital impression takes from an intraoral scan to a stereolithographic model.

Abstract

For years, restorative dentistry and its professional team members—the dental technician and practicing clinician—relied on impression material to accurately capture the intraoral tooth preparation and surrounding tissue. Conventional impression materials have significant limitations and inaccuracies in respect to shrinkage, pulling, and other negative characteristics. The conventional restorative fabrication process introduces many opportunities for errors during the restorative process, from preparation and impressioning to model and die creation, the lost-wax technique, and insertion of the final restoration. Many discrepancies can be introduced within the fabrication chain that could, and many times do, present challenges and failures in the delivery of a properly fitting dental prosthetic.

Some discrepancies might be the result of human error, such as improper use of the materials or as a result of the inherent composition of the impression materials. If the materials are not mixed in the correct ratios, the accuracy of the impression will be greatly skewed. Temperature and moisture also greatly influence the shrinkage rate of the material, and when shipping the impression to the dental laboratory, the impression may be subject to extreme shifts in temperature. The stated accuracy of most polyether impression materials relies on dry storage at 73°F. It is also not recommended to store polyether impressions in a sealed, moist environment such as the commonly used infection control bags. Most impression materials are also affected directly and negatively by excessive direct sunlight. These inconsistencies are a great cause of anxiety for both the dental practitioner and dental laboratory. The process of taking and delivering a proper impression to the dental laboratory is subject to a multitude of potential problems. Some common problems include, but are not limited to, cross-contamination with other impressions or models, voids (Figure 1), tears (Figure 2), delamination (Figure 3), excessive heat or light, moisture, pulls (Figure 4), tooth-to-tray contact, poor bond at tray interface (Figure 5), and model-pouring discrepancies. The processes required to pour a model from these impressions are similarly affected by material manipulation and technique. Just as with impression techniques, an improper ratio of gypsum material to liquid will produce an inconsistent model with respect to expansion and shrinkage. Excessive expansion will make the prosthetic too loose, and excessive shrinkage will make the prosthetic too tight.

In the past decade, a new revolution has emerged in restorative dentistry as the analog industrial age gives way to the digital realm. Practicing dentists are now equipped with digital acquisition units or intraoral
impression scanners that allow them to capture multiple
digital images within the oral cavity and its dentition. The acquisition unit takes multiple simultaneous
images that are folded on one another to form a raw
data file. For some acquisition units, the raw data must
be unpacked and translated in order for CAD design
software to read the data. Translating that data has
fallen to software engineers who accept these raw data images and transform them with specialized software
into 3-dimensional displays that a dental professional
can work with and manipulate. From these 3D displays,
companies such as 3D Systems (www.3dsystems.com),
EnvisionTEC (www.envisiontec.de), Solidscape (www.
solid-scape.com), Sirona (www.InLab.com), and Objet
(www.objet.com) have innovated ways to 3D print a
physical model for the dental technician to work on and
for the dentist to evaluate the final dental prosthesis
prior to appointing the patient. Currently there are
limited numbers of facilities that can provide this
service to the dental profession; however, as the digital landscape opens up, opportunities for more robust
resources will emerge.

The limited numbers of facilities that can 3D print
analog models from digital data files stem from two
basic factors. First is the enormous cost of owning these
cutting-edge technological innovations, and the second
is proprietary ownership of and the ability to unpack
raw data files. The cost of large-frame stereolithography
(SLA) equipment hovers in the $500,000 range.
Fundamentally, this has been the system of choice
to produce solid dental models resulting in extreme
accuracy and material, but only large operations could
afford it. The second limiting factor is the proprietary-
scan data produced by the digital impression scanner.
The digital acquisition manufacturer either owns the
model production facility or gives exclusive rights to an
entity who can provide the translation and 3D printing
service to the general dental market. They do this by
means of closed data unpacking software, so that only
their production centers can read scanned data. In
today’s current digital age, the proprietary company
(the manufacturer of the digital acquisition unit) is then
able to take the raw data images originally sent by the
practicing dentist and manipulate them into another
software program that will then command the printing
machine to layer print a 3D model. Today, newer digital
impression acquisition units and 3D printing machines
offer options that allow more accessible data transitions
into the open market. Dental laboratories will be able
to manufacture models from digital data in house, thus
allowing the laboratory to simultaneously manufacture
the restoration and model by batching STL files from
multiple client sources. As a result, the digital process
alleviates the many issues that arise from conventional
physical impressions.

The current sequence for production of 3D models using
computer-aided design/ computer-aided manufacturing
(CAD/CAM) is as follows. The initial stage occurs in the
operatory, where the dentist uses the digital impression
acquisition unit to take a set of digital images of the
preparations and adjacent teeth. A scan of the mouth
in a closed-bite position allows the dentist to create a
virtual bite registration as well. The dentist is then able
to immediately evaluate the quality of the images, as
Stereolithography, also known as 3D layering or 3D printing, allows the user to create solid, plastic, 3D objects from CAD drawings in a matter of hours. Whether you are a mechanical engineer wanting to verify the fit of a part or an inventor looking to create a plastic prototype of an invention, stereolithography offers a fast, easy way to turn CAD designs into real objects. 3D printing is a very good example of the age we live in. In the past, it could conceivably take months to prototype a part. Today, it can be completed in hours. If you can imagine a product, within 2 days you can have a working model in your hands. The net result of the 3D printing process is an extremely accurate hard model (Figure 6) without any of the anxieties and worries of dental-stone expansion or shrinkage. It is controlled and consistent, bringing down any remake factor for the dental laboratory and practicing clinician to a factor of zero. Other methodologies used are the EnvisionTEC Perfactory® DDP (EnvisionTEC), CEREC® AC Connect (Sirona), Eden260V™ (Objet), and the ProJet™ 3000 multi-jet modeler (3D Systems). With this technology, a series of jets deposits a 32-μm layer of material and cures each layer with an overhead xenon light source. The result is a highly detailed model made in very high resolution and accuracy. The cost of this technology is a fraction of the cost materials and machines to produce the data in the open market.

**Conclusion**

What remains is the ability for opening the proprietary data transmitted from the intraoral scanner manufacturers. This is also currently a work in progress, as several manufacturers have realized that the best way to sell scanners is by allowing the open and unobstructed use of the acquired data.

There are obvious benefits for digitizing the process. These technologies will change the way dental practitioners and laboratories communicate. In the traditional method of pouring gypsum models, the laboratory involvement starts when the technicians open the box containing the impression. With digital data instantaneously flowing back and forth between the laboratory and dentist, it will be possible for the laboratory technician to view the case while the patient is still in the chair and provide critical feedback to ensure optimal success for the dental prosthesis. Being involved in the digital process can open up new avenues of communication, reduce infection control issues, and limit material inconsistencies as well as help to create a more unswerving workflow for all parties involved.

**Acknowledgment**

The author would like to thank Ron Snyder, CDT and dental applications manager for 3D Systems Corp. in Rock Hill, South Carolina, for his contributions.

**Originally published in**


**References**

“To claim your verifiable CPD you will need to answer these questions and submit them either by email to secretary@bidst.org or by post to the BIDST Membership Office 44-46 Wollaton Road, Beeston, Nottingham NG9 2NR. You will also need to keep a copy of the article together with your feedback sheet and certificate for revalidation.”

**Q1.)** At which temperature do polyether impressions store optimally?
A.) 63°F  
B.) 73°F  
C.) 78°F  
D.) 93°F

**Q2.)** How do temperatures and moistures influence the impression materials?
A.) They negatively affect the shrinkage.  
B.) They do not affect the shrinkage.  
C.) Temperature affects the shrinkage but moisture does not.  
D.) Moisture affects the shrinkage but temperature does not.

**Q3.)** Some common problems of creating and delivering a physical impression include:
A.) Tears.  
B.) Delamination.  
C.) Excessive heat or light.  
D.) All of the above

**Q4.)** Excessive expansion in the impression material will make the prosthetic too:
A.) Tight.  
B.) Accurate.  
C.) Loose.  
D.) Correct.

**Q5.)** Excessive shrinkage in the impression material will make the prosthetic too:
A.) Tight.  
B.) Accurate.  
C.) Loose.  
D.) Correct.

**Q6.)** Another word for a digital acquisition unit used by a dental practitioner is an:
A.) Intraoral scanner.  
B.) Extraoral scanner.  
C.) Intraoral digitizer.  
D.) Extraoral buffer.

**Q7.)** Who unpacks and translates the raw STL file?
A.) The dentist  
B.) The dental technician  
C.) The software  
D.) The patient

**Q8.)** What can be done with the unpacked and translated STL file?
A.) Manipulation in 3D  
B.) Manipulation in 2D  
C.) Packing  
D.) B & C

**Q9.)** What is the approximate cost of large-frame stereolithography (SLA) equipment?
A.) $50,000  
B.) $100,000  
C.) $500,000  
D.) $1 million

**Q10.)** How do production centers read scanned data?
A.) Closed data unpacking software  
B.) Open data unpacking software  
C.) Closed data packing software  
D.) Open data packing software