

Communicating Digitally with the Laboratory: Design, Impressions, Shade, and the Digital Laboratory Slip

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Digital technology permeates every aspect of daily life, and dentistry has, somewhat cautiously, welcomed this influx of digital technology into daily practice. One area that has been slow to evolve is the digital information transfer from the dentist to the dental laboratory. The primary and conventional tools of communication between the dentist and the technician are photography, written documentation (including restoration type, teeth treated, and shade)—all in the form of a laboratory slip—and impressions of the patient's existing dentition, the clinical preparations, and the opposing dentition. This article will review and explore some of the digital opportuni-

ties and rationales for digital communication of all forms of clinical information from the dentist to the laboratory.

DIGITAL PHOTOGRAPHY

Like the rest of the world, dentistry has moved from analog photography to digital, but this modality is used only occasionally to transfer information to the laboratory. It is an unfortunate situation because visual documentation makes it significantly easier to demonstrate problems and thus motivate patients to accept needed treatment. An extremely important point in this information-transfer process is that the ceramist who fabricates the porcelain restoration needs as much shade information

of the adjacent natural teeth. Several articles showing the specific “how-to’s” of taking good, quality clinical images have been documented.¹⁻⁴ In the brief scope of this article, the objective is not to completely cover the technique of clinical dental photography, but to cover some of the techniques to simplify information transfer from the dentist to the laboratory.

One point that the author would like to make regarding camera selection is to choose a camera that allows interchangeable lenses: a digital single-lens reflex (DSLR). The Nikon D90 (Nikon Inc, Melville, NY) (Figure 1) and the Canon SX1 (Canon USA, Inc, Lake Success, NY) (Figure 2) are both excellent cameras and perform as well as more expensive professional versions for dental purposes. Next, take important images in “RAW” file format—the owner’s manual of either the Nikon or the Canon instructs you how to set the file format to RAW. The most important images to take RAW are the shade images as the full spectrum of exposure; white balance, tonality, and many other color and exposure data are captured with one image. What is seen in the viewfinder or on the screen are the current parameter settings. This function alone allows the correct color/exposure parameters to be reset in case the camera was set wrong. In the very common JPEG file format, the camera only captures data at the current camera settings. If there were incorrect exposure or color settings, it cannot be reset to the correct values because the information was not captured with the image (Figure 3). It is possible to fix a JPEG image but it requires an editing program such as Adobe® Photoshop® or Adobe® Photoshop® Elements (Adobe Systems Inc,

San Jose, CA). For beginner to intermediate users, it is best to work with a company that specializes in dental photography (eg, Photomed at www.photomed.net or Norman Camera at www.normancamera.com). These companies can save time and money in the long run because both are experts in the needs of dentists.

If you do choose a “dental point-and-shoot” camera (which is not what the author would recommend) make sure that you choose one that will capture images in a RAW file format (many will only capture in the less satisfactory JPEG file format). The Canon G10 (Canon USA) dental set up from Photomed will take good images in RAW file format. There is one fundamental benefit to these systems in that the “learning curve” is easy.

One of the biggest concerns with digital photography and taking RAW files (which are very large) is how to transfer this information quickly and easily to the laboratory. A CD or small removable drive could be added to the case pan but this would defeat the purpose of quick digital transfer. E-mail works fine for small files like JPEG but cannot accommodate the larger RAW file type. The best way to transfer larger files over the Internet is by a process called a file transfer protocol (FTP). It is a simple application that uses the Internet to transfer larger



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Figure 1 Nikon D90 camera with the Nikon R1C1 dual-point flash and Winphotec Bracket.



Figure 2 Canon SX1 camera with the Canon 24 EX dual-point flash and Winphotec Bracket.



Figure 3 An image opened in Adobe Photoshop Camera RAW. Notice the white balance and other color or exposure sliders that can be reset to show the different data that was collected with the RAW image.

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files relatively quickly. When you download something from the Internet, you are generally using a FTP. You will need to purchase and download a FTP program, but they are inexpensive and easy to use. For a PC, SmartFTP (SmartSoft Ltd) can be purchased at www.smartftp.com (Figure 4). For a Mac, Fetch (Fetch Softworks, Etna, NH) can be purchased at fetchsoftworks.com (Figure 5). Essentially, once an FTP program is installed, open the program, select the images to be uploaded to the FTP server, and specify a filename to which they will be uploaded. Then e-mail a link to that file to the laboratory. The laboratory

will just click on the link and click on the individual files to download them.

DIGITAL SHADE ANALYSIS

An important tool in the dental armamentarium today is a shade-taking computer. There are several computerized shade-taking devices available and there are several systems at UCLA that the author and his colleagues use on an ongoing basis both for daily work and for research. The author believes from experience that a device should be simple and give an accurate base shade. The VITA Easyshade® (Vident, Brea, CA) (Figure 6) has been shown in UCLA tests to

provide an equivalent or better base shade value than the average visual shade taken by a group of dentists. This system will give base tooth shade and three zones (ie, gingival, middle, and incisal) of shade if desired. Recently, the author has used the Olympus Crystaleye (Olympus America, Inc, Center Valley, PA), which also gives excellent shade information. The system will give a detailed shade map of the tooth, which is especially useful if additional digital photography is not taken, but the system is significantly more expensive because of these added features. Ideally, the computer is used to get the base shade only and then compared with the visually derived shade information that has been documented with digital photography. The author's experience at UCLA has shown that the use of digital photography for shade analysis, along with using a separate device for digital shade analysis, has given the best shade-match results.

DIGITAL LABORATORY SLIPS

Most laboratory prescriptions are handwritten, with a copy placed in the chart and one in the case pan. This can be problematic,

as everyone knows. Many laboratories updated this process by creating their own digital laboratory slip that can be used to upload information instantly. Check with your laboratory to see if they have one available but, if not, it is relatively easy to create a simple document in Microsoft® Word (Microsoft Corp, Redmond, WA) or a more sophisticated form can be created in a program like Adobe® Illustrator (Adobe Systems). These blank forms can be filled out electronically and e-mailed to the laboratory. An even easier solution is to use a product designed for this purpose; for example, Dentrrix/Henry Schein Practice Solution (American Fork, UT) has an option called DDX (available at www.ddx-dental.com) that is specifically written for this purpose (Figure 7 and Figure 8). To use the DDX system, complete the simple login process to your laboratory's DDX home page. Then start a new case, view cases scheduled to be completed and shipped, and view any charges related to any of your cases. A dentist or staff member enters the patient's name under "start a new case." All of the case information is entered via

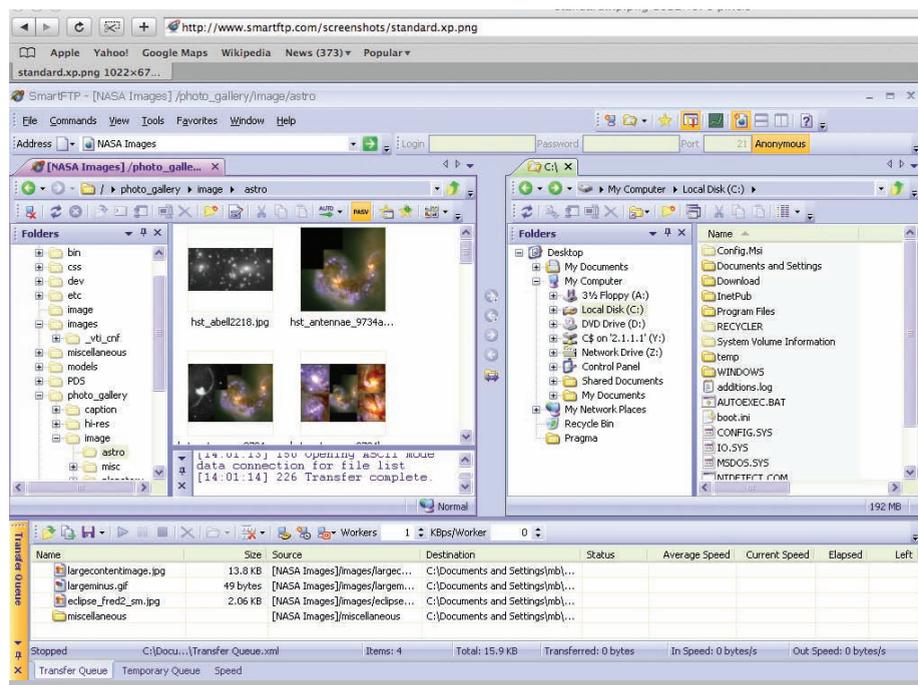


Figure 4 The interface and Web site of Smart FTP, an FTP application for a PC.



Figure 5 The interface and Web site of Fetch, an FTP application for a Mac.



Figure 6 The EasyShade digital shade-taking device.

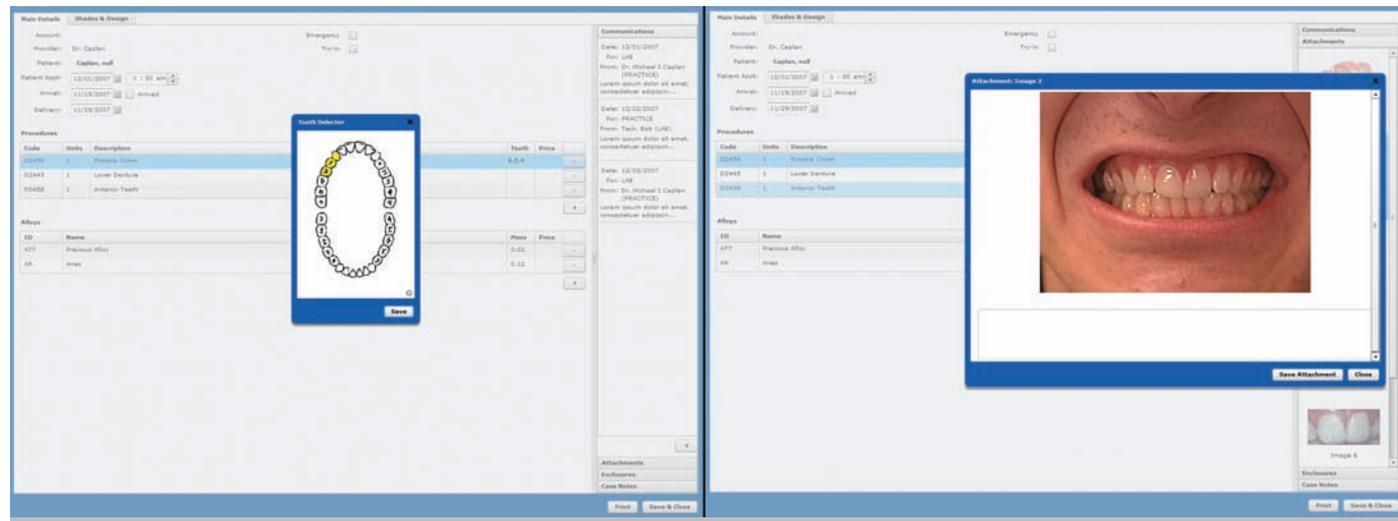


Figure 7 and Figure 8 Images of two of the types of interfaces with the DDX program. All typical types of laboratory slip information can be added along with images.



Figure 9 Image of a lower one third smiling exposure that has been digitally altered with Photoshop on the patient's left maxillary only.

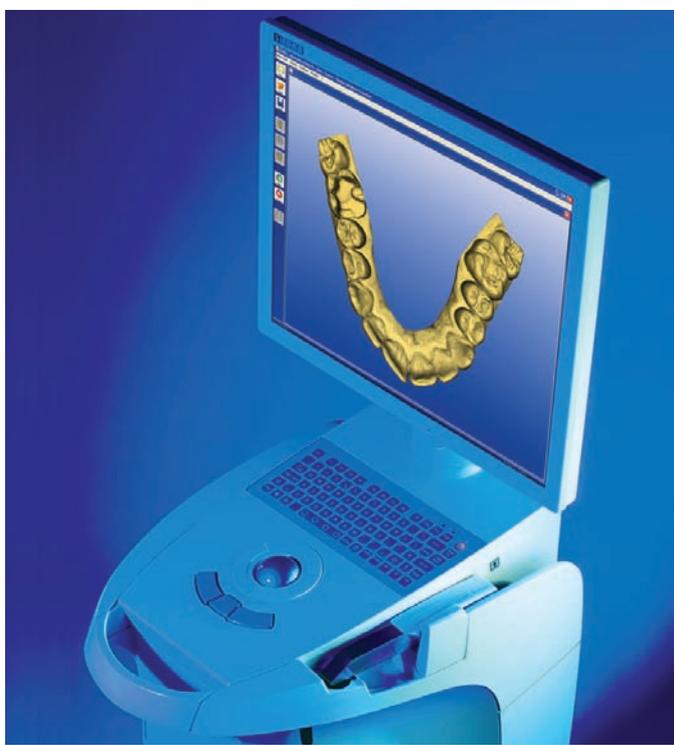


Figure 10 The CEREC 3 system.



Figure 11 The E4D system.

drop-down menus. Additional notes, shade data, and other pertinent information are entered into the form on the Web browser. If photographs are necessary, they are simply uploaded from the folder where they are stored on your network and sent with the case. Copy the information to the patient's electronic chart and print out a hard copy to send with the case if physical impressions are being used. If a paper chart is still being used, a second copy is filed with the chart.

DIGITAL SMILE DESIGN

One of the most powerful processes that can be used for communicating with and

motivating the patient to accept esthetic dentistry is digital image manipulation, or so-called "digital smile design." The process can be done on a close-up smiling view (Figure 9) or on a full-face view. It is relatively easy to lengthen teeth, close spaces, and whiten teeth with a program like Photoshop Elements 6. In the new version, Elements 7 (only available on a PC at this time), there is a "quick-brush tooth-whitening" tool. The tool selects the teeth to be demonstrated and, once applied, whitens the image to a pre-set level that most patients like. There are services such as Smile Vision on the Internet (available at www.smile-vision.net/home.php) and some laboratories are now offering this service, which is certainly beneficial to use. The author's strong recommendation is that someone on your team actually learns the skills necessary to do at least simple digital smile alterations, so that subtle changes can be demonstrated directly to the patient in the treatment consultation. This would be a great nonverbal skill that would demonstrate your level of "smile expertise" to a prospective patient. The author estimates that doing this directly with his own patients has more than doubled esthetic case acceptance.

DIGITAL IMPRESSIONS

Digital image capture has evolved to the point that, in the not-too-distant future, the author believes that most dental impressions of prepared teeth will be done with digital capture devices. CEREC® Connect (Sirona Dental Systems, Charlotte, NC) is a chairside CAD/CAM system that has been on the market for more than 20 years in the United States. It uses an optical scanner that connects to its component, in-office, milling machine to do same-day indirect restorations (Figure 10). This year, the E4D Dentist™ (D4D Technologies, Richardson, TX) released the first direct competitor to the CEREC system and benefits from not having to use an optical contrast power to take an optical impression (Figure 11). UCLA uses both systems and, when used by a well-trained operator, considers the results with E4D to be very good. Both systems are developing direct-to-laboratory imaging capabilities, with the CEREC Connect system being marketed now.

Two other chairside digital scanners that connect directly with the laboratory but do not have chairside milling units are also available. The first system is the Cadent iTero™ (The Cadent Company, Carlstadt, NJ) (Figure 12) and the second, released late in 2008, is the Lava™ COS (3M ESPE, St. Paul, MN) (Figure 13). In a study conducted at Tufts University by Dr. Gerard Kugel (personal communication), of 100 patient cases fabricated from both conventional and digital COS impressions, almost 70% of the crowns fabricated from the COS system were

cemented clinically. Further, in a simple bench study completed at UCLA (unpublished data), five crowns each were fabricated with conventional impressions, COS digital impressions, and iTero digital impressions, and all 15 restorations were rated as alpha or bravo by two evaluators. One of the best benefits of digital impression, other than not having to put goop in a patient's mouth, is that a large, 3-D image can be brought up on the screen that can be rotated and easily evaluated to see if it

was imaged (impressed) correctly. The future of this technology will also see digital assessment of reduction; a preparation—scanned and with computer processing applied—could be assessed to within microns as to how much tooth reduction actually had been done.

CONCLUSION

The digital dental superhighway is evolving at a breath-taking pace. Several digital technologies have been discussed here

that, when used to their fullest extent, the author believes will improve and strengthen the process of dentist–laboratory communication and solve many of the issues that have plagued both parties for years.

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Figure 12 Digital impression scanning with the iTero system.



Figure 13 Digital impression scanning with the COS system.