Digital Radiography and Paperless Dentistry

By Bruce Stephenson, DDS, FAGD

General Electric has a clever TV ad showing the advantages of new technology. It opens by showing the faces of a hot, sweaty, struggling boat crew straining at the oars to propel a primitive ship. The captain provides the necessary "motivation" with a lash. Suddenly, a similar ship powered by a sail instead of human muscle overtakes their ship. The oarsmen's faces reflect awe as they see that the crew on the sail-powered ship is relaxing at a party on the deck, and the captain is water-skiing behind this faster, "new technology-enhanced" ship!

The water skiing may be a slight overstatement, but the technological advantages of sail power versus muscle power are certainly clear! The captain on the muscle-powered ship must have had some questions about exactly how to add sail power to his ship. These same types of questions concern many dentists as they make the transition from "muscle-powered," paper-based records to computer-powered paperless dentistry. You can stick a piece of canvas up in the air and call it a sail, but that doesn't mean it will really provide power! It may just capsize the boat!

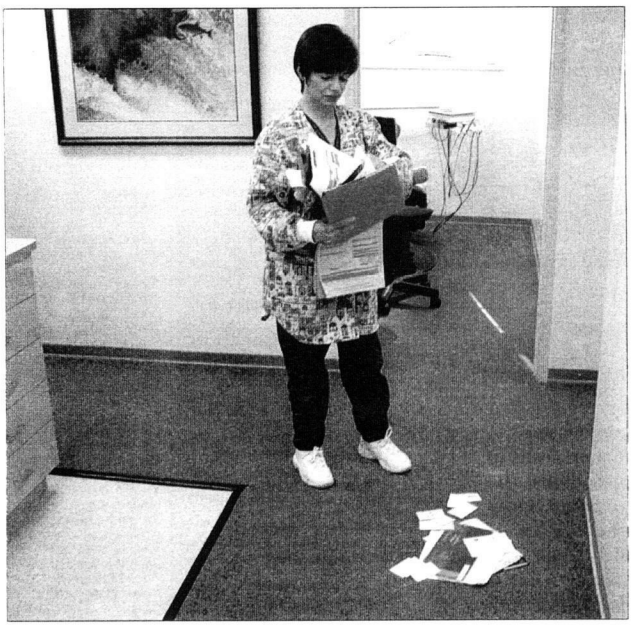

Figure 1. "That x-ray's in here somewhere!" If the processor didn't eat it and the insurance company didn't lose it, when you finally find the x-ray you want, it won't be nearly as good an image or contain as much diagnostic information as a digital x-ray.

The advantages of digital radiography and its contributions to paperless dentistry are profound. It is better, easier, and ultimately less expensive and more reliable than chemical, plastic, and paper-based systems.

Digital radiography is very much like a sail. An integral part of the paperless practice, it is probably the most expensive single component and requires some thought and planning to prevent it from "capsizing" a practice. The purpose of this article is to discuss some of these considerations.

FOUR TYPES OF DIGITAL X-RAY

Direct digital sensors are what most dentists think of when they hear "digital x-ray." Instead of conventional x-ray film, an electronic sensor is placed in the patient's mouth. The x-ray image is captured in a series of individual "cells" on the sensor and then transmitted by a wire (or now wirelessly) to a computer for processing. The number of cells on the sensor determines the number of pixels (the dots that make up a digital image) available at the computer. As with a digital camera, the more pixels, the higher the resolution of the image. But more pixels cost more money to manufacture and more computer speed and memory to process. However, additional pixels do not necessarily translate into additional diagnostic image quality or the ability to see more "line-pairs."

In digital radiography, the contrast of the image and the processing done by the software are also very important factors. Table 1 shows the advantages and disadvantages of the 4 types of digital radiographs. As you can see, acquisition speed (how fast the image gets onto the computer screen) is much better with direct digital sensors. The image is on the screen in 5 to 15 seconds. When taking a series of x-rays, such as 4 bitewings or an 18-image full mouth, good software can automatically save the image and move to the next expected image. All the operator has to do is reposition the sensor and tube head, then press the exposure button again so multiple images can be taken without returning to the computer. Because the operator can immediately see the image, cone-cuts or overlapping contacts can be immediately corrected. This potentially results in a better set of images. Table 1 also shows the primary disadvantage of direct digital sensors; they are inflexible and bulky. They also require more training and practice to master.

Phosphor plate technology is the second most common type of digital radiography modality. Instead of a bulky, rigid sensor, a flat, thin, flexible piece of plastic (which looks and feels just like a piece of conventional x-ray film) is used to capture the image. It is used exactly as conventional film is used but is placed into a laser image reader (analogous to a chemical x-ray processor), where the latent image on the phosphor sheet is transferred to the computer. The image is available on the computer screen in as little as 17 seconds but requires that the operator complete all the exposures in the series, then feed the individual plates into the laser reader. This adds extra time to image taking but provides excellent patient comfort and very little staff training. It also provides good image contrast and can be used with existing panoramic x-ray machines. (Note: the "retrofit" of a panoramic machine only involves placing a black piece of paper in the film cassette. It is probably the cheapest retrofit in the history of dentistry! Now if we could just do that with our water lines!)

The third type of digital x-ray modality is the *flatbed optical scanner* with a *transparency adapter*. This device can be used to acquire any type of printed or transparent image, including conventional chemical x-rays, 35-mm slides, or printed pieces of paper. This is an often-overlooked modality that I feel is a "must-have" item for a paperless office. Sails did not completely eliminate the use of oars. There were still some people who insisted on doing things the hard way. Likewise, there are many dentists still using conventional x-rays, and paperless offices have to share images with them. Even paperless dentistry offices have old images of their own they may wish to use. The absolute easiest, cheapest, and best way to "duplicate" a chemical x-ray is to scan it into the computer, then print it on an inexpensive photo-quality printer. (Laser

printers provide images that are more than adequate for insurance companies.) A good scanner is versatile and can be used to scan letters, forms, photographs, and any of the other miscellaneous paper documents that used to end up in the patient's paper folder. The flatbed optical scanner is useful for offices during the transition to paperlessness but also continues to see daily use in a full paperless dentistry practice.

The fourth digital radiography modality is the fully *digital panoramic x-ray*. As I mentioned before, existing panoramic machines can be retrofitted for phosphor plate technology and sometimes for an add-on direct digital sensor. But a machine designed with an integrated digital sensor provides, in my opinion, an image that is far superior to any retrofit, add-on, or chemical x-ray system. When combined with good enhancement software, the ability to see and diagnose with a direct digital panographic radiograph provides a big step forward in dental imaging. The units are expensive, ranging from $25,000 to over $50,000, but a group practice or a specialist such as an oral surgeon or orthodontist can return the investment quickly. Even in my 2-doctor restorative practice, we calculate a 1-year return on our investment.

WHICH DIGITAL X-RAY?

So, which of these wonderful modalities is right for you? Table 2 lists some of the "environmental" considerations, such as the type of procedures you do, your office computer infrastructure, and—probably most importantly—your staff. I think every office should purchase a flatbed scanner with transparency adapter. This is a great way to immediately start benefiting from digital technology. Duplicating chemical films and using the associated software is a great way to introduce "computer-allergic" staff to some of the labor-saving advantages offered by paperless dentistry. It also allows you to send patients home with a very graphic 8- x 10-inch image of their tooth. The patient and other family members can easily see the big, black cavity about to pounce on the poor little gray pulp. With apologies to my endodontic colleagues, no pa-

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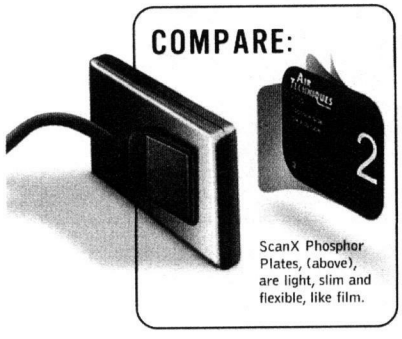

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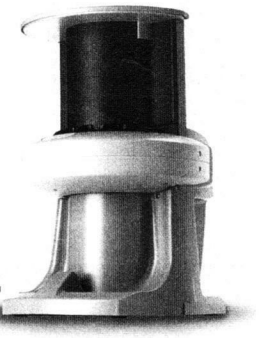

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Digital Radiography...
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Table 1. Advantages and disadvantages of digital radiography modalities

	Acquisition Speed	Image Quality	Immediate Error Correction (cone cuts, etc)	Patient Comfort	Learning and Training Required
Direct Digital Sensors	Very Good	Good	Yes	Poor	Extended
Phosphor Plate Systems	Good	Very Good	No	Very Good	Short
Flatbed Scanner with Transparency Adapter	Good	Good	No	NA	Moderate
Direct Digital Panoramic	Very Good	Very Good	Yes	Very Good	Moderate
Traditional Chemical X-Ray	Poor	Poor-to-Good	No	Very Good	NA

Table 2. "Environmental" considerations for digital radiography modalities

	Need for Quick Images (endo, implants)	Pediatric Patients (small mouths)	Desire to Share Images with Patients	Desire to use Existing Panoramic Machine	Frequent Staff Turn-Over Or Frequent Temporary Staff*
Direct Digital Sensors	Very Good	Poor	Very Good	Poor	Poor
Phosphor Plate Systems	Good	Very Good	Very Good	Very Good	Good
Flatbed Scanner With Transparency Adapter	Poor	NA	Very Good	Very Good	Good
Direct Digital Panoramic	Very Good	Very Good	Very Good	NA	Fair
Traditional Chemical X-Ray	Fair	Very Good	Very Poor	NA	Good

*The last column, staff considerations, is probably the most important. Digital radiography, like paperless dentistry, requires training and experience. You are unlikely to find replacement staff or "fill-in" who already knows how to operate in such an office environment.

tients want to have the "nerve pulled out of their tooth." A nice printout not only is worth a 1,000 words but helps prevent both root canals and failed appointments!

SOFTWARE

In addition to the sensor modalities you select for your office, you also need dental imaging software. The benefits provided by this software are at least as important as the sensors themselves. This software is usually sold with direct or phosphor plate x-ray systems. When you purchase sensors, you are pretty much "stuck" with them until you decide to buy new ones. There is usually no way to "upgrade" a sensor. With software, however, upgrades are common, expected, and usually fairly inexpensive, so features not offered by your specific software today may be added tomorrow.

Imaging software does 4 things: (1) it acquires the image from an x-ray sensor, flatbed scanner, digital camera, intraoral camera, etc; (2) it stores and catalogs the images automatically for easy retrieval; (3) it enhances the images to improve contrast, reduce "noise," and allow you to see things you cannot detect in the unprocessed image; and (4) it outputs the images to printers and other software.

All of these features are important, but the ability of the software to enhance the image is rapidly improving. These enhancement tools are extremely useful in daily practice. Is caries present? Is the PDL thicker or absent at the apex? Sometimes, with one image you cannot tell. But applying a software tool that optimizes the contrast for the gray area you are studying will give you more detail and may allow you to discern the answer. Other tools that provide what's called "edge enhancement" will often call your attention to details you

may have missed. These software tools can be easily mastered and quick to use. Once you start using them, like digital radiography itself, you wonder how you ever got along without them.

BACKUP

Any discussion of dental computers—and especially digital x-ray—needs to at least mention the importance of backup. I hope you don't go out in your boat without your life preserver, and I hope you don't attempt digital x-ray or paperless dentistry without valid, tested backup systems. The means and media to do the backup are less important than the end result. Think of it this way: if your office burned to the ground tomorrow, what would you need to do to restore all your patient records, including x-rays and all of the critical practice information required to resume the care of your patients? The only correct answer I can see is this: you would go home and retrieve the "backup computer" that was configured with all your office software and contained all of your current data. If you cannot do this, you should not, in my opinion, be doing either digital x-ray or paperless dentistry.

There are many methods you can use to back up your data and transport it to your home. Network Attached Storage (NAS) devices such as Snap Servers are my current favorite, but external hard drive modules such as Iomega's Peerless drives and many other drives also work well. "Rotating" notebook computers are also a slick solution. Even tape backup units may work. (Think about it. Where else do you still see magnetic tape used for anything?) The ability to have a complete duplicate of your critical office information is not just a *benefit* of paperless dentistry. I think it is a *requirement* for paperless dentistry!

RUN UP THE SAILS!

Water skiing behind a sail-powered boat may be an exaggeration, but the advantages of sail power over oar power are undeniable. Likewise, the advantages of digital radiography and its contributions to paperless dentistry are profound. It is better, easier, and ultimately less expensive and more reliable than chemical, plastic, and paper-based systems. You see things you simply could not see before, and you can make better decisions on behalf of your patients.

The next time you are struggling to find an x-ray or chart for a patient, look up. See that sailboat going by your practice? The members of its crew may not be having a party on the deck every day, but they have every piece of information they need right at their fingertips! Rowing may be good exercise, but it is no longer the best way to power a dental practice.

Bon Voyage!✦

Dr. Stephenson participates in a paperless and wireless restorative dental practice in San Leandro, Calif. You can obtain information about his seminars by visiting paperlessdentistry.com. He can be reached at bruce@painlesscom.com.

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