A New Dimension in Printing

A comprehensive look at 3-D printers

Orthodontics is going completely digital, which means an “impressionless” practice is a real possibility. Intraoral scanner technology and orthodontic planning software have reached the mainstream for both price and performance, so orthodontic offices are ready for the next era of technology: in-office 3-D printing.

The 3-D printer is the final “missing piece” of an in-office digital clinical workflow. For years, orthodontists have scanned, planned, and treated patients using in-house methods and outsourced models, aligners or appliances. With in-office 3-D printing, they gain control of the entire process, eliminating outsourcing and delivering more streamlined, cost-effective patient care.

In this three-part package, a few orthodontists who’ve implemented in-office 3-D printing share their insights about this technology, while Bob Davis, director of marketing of the SureSmile treatment program, also discusses how to combine 3-D printing and cloud-based planning software for a new approach to aligner therapy.

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Step 1: Scanning

*Capture digital files with an intraoral scanner*

The first intraoral scanners were not well accepted in orthodontics because of poor usability, inaccuracies and long patient-scan times. Since then, improvements in intraoral scanner technology have exponentially increased the adoption rate among orthodontic practices. Today’s intraoral scanners are easier to use, more accurate and faster than ever; in fact, consultants have estimated that more than 40 percent of orthodontic offices now incorporate intraoral scanners when creating digital impressions.

Step 2: Planning

*Use design software to plan treatment*

Digital design software for clear aligners, indirect bonding and other applications has been around for years. Recent technology improvements have made planning software more intuitive and easier to use, providing practitioners with more options and greater control over cases.

Some software companies, such as SureSmile, further assist in streamlining the process. Once a digital scan is captured and sent via the cloud, the software prepares the case so the orthodontic practice can 3-D print the models to create aligners.

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**MID-1980s**

*CAD/CAM is introduced in dentistry but is cumbersome to use, requiring a long time to capture a scan.*

**1984**

Stereolithography lets designers create 3-D models using digital data.

**1990**

3D printing is used for molds and tooling.

**1999**

Dental design software is introduced, allowing digital setups.

**2005**

Design software delivering true dental design platforms is introduced.

**2009**

First intraoral scanner is introduced for full-arch capture for the ortho market.

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Step 3: Printing
Create models and appliances in-office using a 3-D printer

3-D printing was introduced in the 1980s, and some dental and orthodontic labs have been 3-D-printing models for more than a decade. In those early days, cost was an insurmountable barrier for single practices. Also, the printers were large, slow to print, difficult to set up and use, and required ventilation. Available printing materials didn’t provide the detail or durability required for dental or orthodontic applications, and postprinting cleanup was cumbersome and time-consuming (Fig. 1).

Over the past few years, significant improvements in 3-D printer technology have made owning an in-office 3-D printer a real possibility. Today’s dental 3-D printers deliver consistently accurate results, often in less than an hour, with minimal postprocessing steps (Fig. 2).

Some models, such as the EnvisionTEC Vida, are compact, require no special ventilation, and can be integrated into any office network. Orthodontic-specific materials have been introduced and approved by the FDA, further expanding the range of 3-D printed options. In addition, advancements in printer components have made 3-D dental printers even more affordable.

This printing technology “should be in every orthodontist’s armamentarium,” said Dr. Edward Lin of Orthodontic Specialists in Green Bay, Wisconsin.

Step 4: Treatment
Control the entire patient experience

With a 3-D printer and the impressionless practice, orthodontic practices have more control over patient treatment, patient starts and treatment retention because the entire clinical workflow is managed in-house.

Digital scans are more precise than traditional impressions, so 3-D printed models are often more accurate than alginate impressions, resulting in better-fitting retainers, indirect bonding trays and appliances.

“Our goal was to provide comfort and convenience for our patients, without sacrificing accuracy,” said Dr. Michael Lyons of Lyons Orthodontics in Placentia, California.

In addition, 3-D printing brings a new level of technology to the office, which can enhance the practice image. “The most exciting part has been the reactions from our patients,” Lyons said. “Most of the moms remember the impression process as a horrible, gag-inducing experience. When I tell their kids that they not only don’t have to have impressions, but that we also 3-D print their teeth right in the office, they’re amazed by the technology. We frequently give the models to our patients at the retainer delivery, and they all seem to think that’s pretty cool.”

“Parents cannot get over seeing the printer involved in treatment,” said Dr. Todd Bovenizer of Bovenizer Orthodontics in Cary, North Carolina.

2011
Intraoral scanner technology can capture anatomy for the creation of clear aligners.

2013
The introduction of dental 3-D printing materials, along with more advancements in printer technology, makes in-office 3-D printing a reality in the dental market.

2011
Advancements in 3-D printer technology produce smaller, faster and more accurate desktop 3-D printers—at a lower price—for personal and professional use.

2015
Next-generation dental 3-D printers are introduced with additional dental-specific materials, delivering even greater accuracy and speed.
In-office 3-D printing can provide several direct benefits to key orthodontic applications, including clear-alignment therapy, indirect bonding, retainers and appliances.

**Clear-alignment therapy**

One of the most significant advantages of in-house 3-D printing is the creation of clear aligners. With 3-D printing, orthodontists can maintain complete control over patient treatment, enjoy faster start times, and realize significant cost savings.

When third parties print clear aligners, orthodontists often lose control of the patient treatment experience. The vendor provides a full set of trays at the onset of treatment and if a patient’s treatment needs change, orthodontists must then take another digital scan and submit the new files to the vendor to create a whole new set of aligners, resulting in a significant waste of time and resources.

With in-office 3-D printing, the orthodontist simply scans and imports the case into the design software. The software stages the models based on the doctor-approved setup, then the practice prints out just enough models to start the case (Fig. 3). The orthodontist now has complete control to make treatment adjustments as needed.

Most routine aligner cases could be completed entirely in-house, but practitioners still can send more complex cases off to third parties for planning or aligner creation, if desired. Or, orthodontists could send their digital files to those third parties for planning, then print the resultant models “in-house” to create aligners.

“We use SureSmile to set up the digital model,” said Dr. Edward Lin of Orthodontic Specialists in Green Bay, Wisconsin. “From there, we take over and do everything ourselves.”

“We’re offering orthodontists more options for clear-aligner-based therapy with additional control and flexibility, and at a significant savings,” said Bob Davis, director of marketing for SureSmile.

Having a 3-D printer in-house often means faster start times for aligner cases—treatment can begin as soon as the next day. Patients also enjoy faster treatment times when practitioners implement a fixed-appliance-and-aligner hybrid approach, in which the patient starts treatment in braces and finishes in aligners.

**Fig. 3: A clear aligner using the 3-D printed model**
“I think the greatest ROI has been increased case conversions,” said Dr. Michael Lyons of Lyons Orthodontics in Placentia, California. “I’m in an area of high-density competition, so sometimes the fact that we offer this new technology is the deciding factor when my new patients are choosing their orthodontist.”

In addition to affording the orthodontist greater control and efficiency during treatment, in-office 3-D printing significantly reduces aligner costs. With a 3-D printer, practices can create a set of 20 clear aligners in-office for $300–$500 per case, compared with outsourcing costs of $1,000–$1,700 or more.

“Just one aligner case per month pays for my entire monthly 3-D printer investment,” said Dr. Ken Dillehay of Dillehay Orthodontics in Wichita, Kansas, who uses an in-office 3-D printer largely for clear-aligner therapy.

Indirect bonding

Indirect bonding techniques can often reduce doctor chair time and the length of patient treatment. Now, the greater precision of digital scans and the resultant 3-D printed models (Fig. 4) have provided even more advantages, such as reduced turnaround time, fewer repositions and greater patient comfort.

“3-D printing has allowed me to provide the most consistently accurate IDB treatment of any process I have used before,” said Dr. Benjamin Foster of Foster Orthodontics in Shreveport, Louisiana.

Retainers and appliances

In-office 3-D printing has helped simplify the creation of retainers and appliances — appliances are created directly on the printed model. Because of the high degree of precision and accuracy using 3-D printed models, devices fit better with fewer adjustments, and because impressions are stored electronically, models can be printed at any time.

Today’s printing materials have been FDA-approved specifically for orthodontic appliances and lab work. The materials are strong, durable and heat-resistant.

“Printed 3-D models allow us to solder directly on the model when creating Hawley appliances, rather than creating stone models,” Lyons said. “The printed models provide the greatest efficiency, accuracy and fit.”

Digital impressions also simplify appliance delivery. “We give our patients a 3-D model so if they lose or break a retainer and aren’t near my practice, they can take it to another office,” Lin said. “They’re impressed by the technology and the fact that we don’t have to take another impression.”
What do I want to print? What am I spending now on outsourcing? What’s an acceptable ROI?

The first step in deciding whether in-house printing is right for you is to determine what you want to print, how much you're currently spending, and how much you think you can save.

“Carefully assess how you plan to implement the new technology,” said Dr. Michael Lyons of Lyons Orthodontics in Placentia, California. “It’s easy to be penny-wise but pound-foolish when looking at the cost of new technology. If you really weigh the ROI, I think most orthodontists will agree that the investment is worthwhile.”

Lyons said the only real downside he experienced with the 3-D scanner was the lab fees associated with printing the models. “It seemed that no matter who you talked to, there were setup, processing and printing fees that totaled about $15 per arch,” he said. “I knew that I could print the models myself for less than half that. We market ourselves as the ‘impressionless’ orthodontists, so we try to stand by that. That means close to 100 percent of our impressions are captured with the scanner.”

Do I already have an intraoral scanner? If not, what’s my plan to get one?

Digital models are becoming the standard of treatment in orthodontics. “At this point, practices without an intraoral scanner are falling behind the technology curve,” said Dr. Todd Bovenizer of Bovenizer Orthodontics in Cary, North Carolina. “We scan as many patients as possible—up to 80 percent of our impressions are now digital. In fact, now we have a cone beam, an intraoral scanner and a 3-D printer. If I had to give up one of them, I’d give up the cone beam.”

What’s the right printer for my practice? Which vendors am I going to consider to help implement this technology?

Selecting the right 3-D printer and distributor are critical decisions. The most important considerations should be selecting a quality product backed by industry knowledge and unparalleled service and support. This doesn’t always come at the lowest price.

“Research the different options available and get to know the company/distributor that you’ll be working with, to be sure they’re able to properly support your investment,” said Dr. Edward Lin of Orthodontic Specialists in Green Bay, Wisconsin. “You need to be sure that the group you choose to work with can quickly solve any challenges that may come up.”

Lin opted for a Vida printer from EnvisionTEC, while Bovenizer said he went with 365 Printing “because we know they would help make sure we were successful with it.”

MONTHLY RETURN ON INVESTMENT: CLEAR ALIGNERS

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Is Your Practice Ready for 3-D Printing?

Questions to ask before you spring for an in-office setup