3D Printer Buyer’s Guide for Orthodontics

Learn how to move from analog to digital workflows and find a 3D printer for your orthodontic lab or practice.
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Introduction

There’s no way around it: the future of orthodontics is inevitably digital. With cutting-edge digital solutions for digital impressions, treatment planning, design, and 3D printing, what was once prohibitively expensive is rapidly becoming accessible, already transforming thousands of orthodontic practices worldwide. As dental CAD/CAM technology continues to replace traditional workflows and become the standard of care, digital solutions have become a necessary.

Throughout this white paper, you’ll learn about:

- Benefits of going digital
- Digital workflow and how it differs from analog processes
- Best strategies for getting started with digital orthodontics
- Differences between dental 3D printing technologies
- Comprehensive criteria and aspects to evaluate before investing in a 3D printing solution

If you are managing an orthodontic lab or practice, look no further—this is your ultimate guide to digital orthodontics.
Why Go Digital?

High Quality and Precision

No two orthodontic treatments are the same. Patient anatomy is unique, and each treatment is tailored, enabled by a long history of artisanal custom, human-centric craftsmanship. But, as with any trade, quality depends on the skills of a given orthodontist, assistant, or technician. Achieving consistent, high-quality, affordable dental products with so many potential sources of error is incredibly difficult.

Fully digital orthodontic treatments reduce the risks and uncertainties introduced by human factors, providing higher consistency, accuracy, and precision at every stage of the workflow. 3D intraoral scanning removes many of the variables associated with taking a traditional impression, providing more accurate data and information for planning treatments and designing appliances. Dental CAD software tools provide visual interfaces similar to traditional workflows, with the added benefit of being able to automate certain steps, as well as communicate instantly and efficiently.

3D printers can deliver a wide range of high-quality parts and appliances with repeatable results in your orthodontic practice or lab, improving clinical outcomes and resulting in shorter treatment times.

Improved Efficiency: Time and Cost Savings

Digital orthodontics can be a no-nonsense business choice, improving efficiency in dental procedures and streamlining workflows.

Saving time on menial tasks means shorter appointments, increased throughput, and higher patient satisfaction. Fast and efficient impression taking with 3D intraoral scanners reduces chair time. Instant feedback and no manual errors like voids, bubbles, or tears reduces the need for secondary or duplicate impressions.

Manufacturing thermoformed appliances like clear retainers and aligners over 3D printed orthodontic models is fast and affordable.
Digital design and manufacturing increase technician productivity, and reduce hands-on work, leading to streamlined production, fewer remakes, and less time per unit. Dental CAD software tools are incredibly powerful and application-specific, enabling technicians to design and plan a variety of restorations and appliances.

In many countries, orthodontists are required to store and keep patients’ physical models and records for years. The room required for this storage often leads to an orthodontic practice having to rent space or dedicate a significant part of their office just for storage. With digital impressions, patient anatomy can be saved in the cloud or on a local server which requires less room and makes it much easier to find specific cases quickly. Additionally, patient models can be rapidly produced from these digital impressions on-demand with desktop 3D printers.

With 3D printing, practices can bring digital model production in-house and remove one of the major barriers of adopting digital workflows, thus, gaining all of the benefits of adopting a completely digital workflow.

**Better Patient Experience and Outcomes**

One of the most significant benefits of digital technologies is improved patient experience: quicker appointments, more comfortable treatment, and better, faster results. A satisfied patient is more likely to return and recommend a clinic to others, contributing to the long-term success of any orthodontic business.

Digital technologies improve the workflow from case acceptance to treatment planning to completion. Intraoral scanning is faster and substantially more comfortable than regular impressions, while CBCT scanning adds a new dataset to assist planning. Virtual treatment planning and appliance design enable better treatments with less risk. Digital tools also simplify communications between the orthodontist and patient, and the practice and laboratory.

As a result, digital dentistry makes for faster treatments, fewer visits, and higher acceptance rates with measurably better clinical outcomes.

*Clear aligners provide patients a more aesthetic and comfortable treatment, and often faster results.*
The Digital Dentistry Workflow

While the design of different orthodontic treatments varies depending on the application, they all follow the same basic workflow.

1. Scan

Like traditional dental and orthodontic product fabrication, digital production starts with the patient's individual anatomy. 3D intraoral scanners can be used to capture scans digitally from the patient, replacing manual impressions with fast, accurate, digital impressions. Alternatively, desktop optical scanners, typically used by dental and orthodontic labs, can be used to scan traditional impressions or plaster models.

Recommended tools for a dental practice: 3D intraoral scanner

2. Plan and Design

After scanning, patients' digital impression is imported into dental CAD software. Most software packages use design processes very similar to traditional workflows, employing highly visual interfaces with features like virtual articulators that are familiar to technicians. Digital design results in easier, more precise treatments and simplified communication. After the treatments are designed, models can be exported for manufacturing. If a remake is needed, the same digital design can be reused without additional effort.

Recommended tools for a dental practice: Dental CAD software

3. Manufacture

To physically realize a digital model of a dental product, 3D models are uploaded to the CAM or nesting software and then sent to a 3D printer. 3D printers are common in both labs and practices and can produce a variety of products, including diagnostic and orthodontic models, retainers, surgical guides, splints, wax-ups, castable patterns, and dentures. They work by solidifying parts layer by layer to form the shape of the dental appliances and models. To create orthodontic appliances like clear aligners or retainers, manufacture them over the 3D printed models using existing workflows and tools such as thermoforming.

Recommended tools for an orthodontic practice: 3D printer, thermoforming machine
Workflow Between Lab and Practice

With the traditional workflow, the practice takes a physical impression of the patient, ships it to a lab that creates the required models or other indications, which the lab then ships back to the practice for the treatment.

In digital workflows, the individual steps can alternate easily between lab and practice, depending on the complexity of the case, the indication, the tools available at a practice, and other conditions.

For example, an orthodontic practice can take a digital impression or send a manual impression for scanning at the lab. With the digital impression, a practice can also design the models, aligners, and other indications in-house in CAD software or outsource design to a lab or design center. With 3D printing, a practice can then produce manufacture simple indications like models for thermoforming in-house and rely on a lab for more complex parts such as Hawley retainers.

Overall, digital technologies simplify the process, improve communication, and make interactions nearly instantaneous between the practice and lab.
Dental 3D Printing Technologies

Additive manufacturing is the latest piece of the workflow in digital orthodontics that has become a logical business choice for orthodontic practices and labs, combining high quality with low costs and streamlined processes. The market has been expanding rapidly, bringing this technology within reach for more businesses.

Today, two 3D printing technologies are common in dental: stereolithography (SLA) and digital light processing (DLP).

In stereolithography, a vat of liquid resin is selectively exposed to a laser beam across the print area, solidifying resin in specific areas. Low Force Stereolithography (LFS) technology, used by Formlabs’ Form 3B dental 3D printer, is the next phase in SLA 3D printing that reduces the strain created on a part when peeling it from the resin tank between layers, producing parts with unmatched surface finish, clarity, and accuracy.

Digital Light Processing operates with the same chemical process as SLA and LFS, but uses a digital projector as a light source to solidify the resin, rather than a laser.

The most common dental 3D printers work by selectively exposing liquid resin to a light source—SLA and LFS a laser, DLP a projector—to form very thin solid layers of plastic that stack up to create a solid object.

The way SLA, LFS, and DLP 3D printers work is similar—the differences in print quality, workflow, available materials, costs, and other factors are bigger from machine to machine more than technology to technology.
How to Evaluate Dental 3D Printing Solutions

Accuracy and Precision

Guaranteeing high-quality, accurate, final parts is the most important concern for any orthodontic practice. Unfortunately, not all 3D printers marketed for dentistry or orthodontics can deliver the quality, precision, and accuracy needed for dental applications. Additionally, comparing different 3D printing solutions goes beyond looking at technical spec sheets.

Some manufacturers may try to confuse prospective customers with misleading statements and technical specifications. Most commonly, they masquerade layer height, laser spot size, or pixel size as “accuracy”, even though these specifications do not have a direct impact on the accuracy of final parts. While most companies refer to a single number for accuracy (i.e. 50 microns or 75 microns), these are typically misleading, and most commonly represent the printer’s resolution limit.

![Diagram](image)

The basic units of the SLA and DLP processes are different shapes, making it difficult to compare the different machines by numerical specifications alone.

Fundamentally, accuracy and precision depend on many different factors: the quality of the 3D printer, the 3D printing process, materials, software settings, post-processing, and how well-calibrated all of these systems are, so a 3D printer can only be judged on its final printed parts.

Always evaluate accuracy studies with real scan data of printed parts. Even better, ask for a free sample part or a custom sample of your own design to check the fit or measure yourself against the original design.
Orthodontic Model
Grey Resin, at 160 μm Layer Height

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<tr>
<th>ACCURACY RANGE</th>
<th>SURFACE IN ACCURACY RANGE</th>
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<tr>
<td>± 100 μm</td>
<td>93% ± 6%</td>
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Validation parts were printed using Grey Resin on Form 3B printers. Results may vary.

Orthodontic Model
Draft Resin, at 300 μm Layer Height

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<tr>
<th>ACCURACY RANGE</th>
<th>SURFACE IN ACCURACY RANGE</th>
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<tbody>
<tr>
<td>± 200 μm</td>
<td>94% ± 4%</td>
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Validation parts were printed using Draft Resin on Form 3B printers. Results may vary.

Accuracy study of an orthodontic model printed on the Form 3B LFS 3D printer. Dental 3D printers can produce high-quality custom products and appliances with superior fit and repeatable results.

**Speed and Productivity**

When thinking about speed in 3D printing, it’s important to consider not just raw print speed, but also the overall productivity of a dental 3D printer.

Raw print speed for SLA, LFS and DLP 3D printers is comparable in general. As the projector exposes each entire layer all at once, print speed in DLP 3D printing is uniform and only depends on the height of the parts, whereas, SLA and LFS 3D printers draw out each part with a laser. As a rule of thumb, this results in SLA and LFS 3D printers being comparable or faster when printing a single part or smaller parts, while DLP 3D printers are faster to print multiple parts that fill up much of the platform.
However, there’s a trade-off between resolution and build volume for DLP printers. A small DLP 3D printer might be able to print fast, but you can only fit a few models on the build platform. A different machine with a larger build volume might be able to print more parts, but only at a lower resolution, which means that it might not be accurate enough for printing indications that require higher accuracy.

SLA and LFS 3D printers can produce all of these options in one machine and offer practices the freedom to decide whether they want to optimize for resolution, speed, or throughput, depending on the case.

For example, the Form 3B LFS 3D printer can produce a single orthodontic model a thermoformed aligner in about 20 minutes with the newly validated Draft Resin, while the large build volume of the printer also allows you to produce 12 models at once for overnight “lights out” production.

### Total possible daily production

The number of possible prints in an eight-hour workday + one print overnight

A small build platform DLP 3D printer can quickly produce at most a handful of models at once. As you need to prepare the printer, set up the print in software, and post-process the parts for each print, which results in much higher labor costs per part to fully utilize its production capabilities.

### Productivity and Cost of Dental Products with 3D Printing on a Form 3B Dental 3D Printer

**ORTHODONTIC MODELS FLAT TO BUILD PLATFORM**

- **Model Resin at 140 µm**
  - Up to 9 models per print in ~3.5 h or 1 model in ~45 min for $2-3 a model

- **Grey Resin at 160 µm**
  - Up to 9 models per print in ~3.5 h or 1 model in ~45 min for $2-3 a model

- **Draft Resin at 300 µm**
  - Up to 9 models per print in ~20 min for $2-3 a model

**ORTHODONTIC MODELS NEAR VERTICAL**

- **Model Resin at 140 µm**
  - Up to 9 models per print in ~3.5 hr or 1 model in ~45 min for $2-3 a model

- **Grey Resin at 160 µm**
  - Up to 16 models per print in ~8 hr for $2-3 a model
Ease of Use

Another important consideration is how easy it is to use a 3D printer. After all, you and your team will need to learn how to use the equipment and maintain it on a daily basis. Try to get a sense of the learning curve that will come with a new 3D printer by watching videos online, visiting a trade show, contacting sales teams, or asking colleagues about their experience.

Consider the types of everyday interactions and maintenance the printer will need once it is up and running. For example, automatic resin dispensing on Formlabs SLA and LFS 3D printers means that you never need to worry about running out of material.

Some 3D printers come with proprietary software to prepare 3D models for printing, such as PreForm for Formlabs 3D printers, while other manufacturers offer off-the-shelf solutions. Features differ by software tool, for example, PreForm offers a one-click print setup, powerful manual controls to optimize support density and size, adaptive layer thickness, and more functions to save material and time.

Curious to see how it works? Download PreForm for free to test features.

Parts printed with SLA, LFS, and DLP technologies require post-processing after printing.

First, the parts need to be washed in a solvent to remove excess resin. Biocompatible parts also require post-curing. For SLA and LFS 3D printers, Formlabs offers solutions to automate these steps, saving time and effort, and making a big difference in keeping a clean, low-maintenance production environment.

Lastly, depending on the design, some parts need to be cleared of support structures. To simplify this step, Formlabs’ Form 3B offers light touch supports that greatly reduces the need for finishing and costly labor.

Modern dental 3D printers, like the Form 3B, are designed intuitively so that any lab or practice can get familiar with the process easily.
Early 3D printers had an infamous reputation for spending half of their lives in service, with many failed prints even when they were online. Fortunately, the latest generation of printers delivers greatly improved reliability. For example, users of the Formlabs 3D printer reported a success rate of over 95 percent on millions of prints across tens of thousands of machines. Dig deep into published reliability information, and make sure that a manufacturer has appropriate warranties and service offerings to ensure you’ll be taken care of if service is needed.

**Costs and Return on Investment**

When you consider adopting a new technology, it needs to make sense for your business. The cost of dental 3D printers has dropped significantly since the early days and the systems on the market today offer the lowest costs for many applications.

For example, a practice printing models to produce thermoformed aligners in-house can often reduce costs by 80 percent for each treatment compared to outsourcing to labs or service providers—enough to pay for a 3D printer in a few months and save many times its price tag over the years.

When comparing different 3D printing solutions, remember to consider:

1. Upfront costs, including not just the machine cost, but also training, setup, and potentially software.
2. Running costs, best estimated with per-part material costs.
3. Service and maintenance costs.

Try our simple, interactive tool to calculate cost per part and lead time when 3D printing on a Formlabs 3D printer, and to compare time and cost savings to other production methods.

**Materials and Applications**

Professional 3D printers are some of the most versatile tools found today in orthodontic practices and labs, and the key to their versatility is dedicated materials.

The material selection varies by printer model. Some basic 3D printers can only produce diagnostic models, while more advanced systems can manufacture highly accurate crown and bridge models, castable/pressable restorations, and biocompatible applications like indirect bonding trays, surgical guides, splints, retainers, or dentures.

Some 3D printers work only with proprietary materials, which means your options are limited to the offerings of the printer manufacturer. Others have an open system, meaning that they can use materials made by third party manufacturers.

However, when using third party materials, it’s important to make sure that the results achieved clinically acceptable quality and accuracy. Furthermore, using biocompatible materials on non-validated 3D printers that claim to be “open” breaks the usage requirements and thus will produce non-biocompatible appliances. Be sure to know what risks your practice takes by using not validated 3D printers and materials.
Manufacturers release new materials on a regular basis, so there’s a good chance the printer you buy today will become capable of creating an increasing variety of orthodontic products in the near future.

**How to Implement Digital Workflows in an Orthodontic Practice or Lab**

1. **Pick an Application**

Transitioning to digital orthodontics is best done gradually, shifting application by application to avoid unnecessary risks. First, choose an application that can be transitioned from an external provider and where digital orthodontics makes the most sense for your business. Consider a workflow that’s currently inefficient, unreliable, or expensive—or perhaps a product that you aren’t currently able to offer to your patients.

In-house 3D printing can cut costs and lead times and enable the use of certain types of treatments such as indirect bonding trays. Splints, orthodontic, and diagnostic models have easy workflows that an assistant can be trained to carry out. Whatever you choose, start with a single use case and extend to multiple applications, while continuing to rely on labs for complex cases.

2. **Define and Test a Digital Workflow**

When you have a specific application in mind, piece together the complete step-by-step digital workflow for that application to make sure you understand all the pieces needed for scanning, design, and manufacturing.

First, consider whether it makes sense to invest in an intraoral scanner for your practice or if you will be sending stone models or physical impressions to your lab for scanning.
If you’re planning to design parts in-house, make sure to get a demonstration of the workflow of any design software to understand the step-by-step process before adopting it. Then, select a software package compatible with the scanning and manufacturing equipment of your choice. The easiest way to do this is to stick with software that allows open importing of scan files and open .STL file export, which ensures compatibility with all 3D printing solutions.

When considering different 3D printers, always source samples before buying equipment. Technical data and marketing specs can be misleading and hard to decipher. Instead of comparing sales brochures, compare actual parts—don’t hesitate to ask for a physical sample. There’s no better way to compare quality between two machines than holding the final product in your hand.

3. Start Small and Scale Up

Once you’re ready to start, trial the workflow for a few weeks before going to full production, leaving time to learn each step and iron out any wrinkles. As you get comfortable with the results, it’s time to switch the workflow fully to digital, and start scaling up.

In digital workflows, scaling up is a simple matter of adding scanning, design, or production capacity, depending on where bottlenecks appear. Desktop 3D printers offer more production flexibility than ever before and affordable machines enable you to add capacity as needed. Having multiple machines brings the added benefit of fault redundancy, a significant advantage over larger, more expensive systems.

Offering a new product or service doesn’t have to be a difficult decision with a long-term return on investment. With digital orthodontics, practices and labs can start small, see faster returns on investment, and scale up over time.

Get Started with Digital Orthodontics and 3D Printing

With thousands of orthodontic practices and labs already adopting digital workflows, there’s never been a better time to start exploring how to take advantage of new technology in your business. While 3D printers were only affordable to the largest dental labs and milling centers a few years ago, they are now a common sight in orthodontic practices and labs.

Consider the factors discussed above and the needs of your practice—some solutions might suit some businesses better than others. Make sure to do your research, evaluate actual parts, and avoid paying a hefty premium.
Explore How 3D Printing and Digital Technologies Transform Digital Dental Design

Explore Formlabs orthodontic resources for free guides, step-by-step tutorials, white papers, and webinars to learn how you can integrate 3D printing into your practice or lab.

Curious to see the quality firsthand? Pick a material and we'll ship you a free sample part 3D printed on the Form 3B to evaluate.

Request a Free Sample Part →