EBOOK

How to Get Started with Digital Dentistry and 3D Printing

Learn how to move from analog to digital workflows and find a 3D printer for your dental practice.

formlabs

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Introduction

There's no way around it: the future of dentistry 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 dental practices worldwide. As CAD/CAM continues to replace traditional workflows and become the standard of care, digital solutions have become a necessary consideration for any dental business.

Throughout this white paper, you'll learn about:

- The benefits of going digital
- The digital dentistry workflow and how it's different from analog processes
- The best strategies for getting started with digital dentistry
- Differences between dental 3D printing technologies
- The comprehensive criteria and aspects to evaluate before investing in a 3D printing solution

If you are managing a dental practice, look no further—this is your ultimate guide to digital dentistry.

Why Go Digital?

High Quality and Precision

No two dental cases 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 is dependent on the skills of a given dentist, assistant, or technician, and achieving consistent, high-quality, affordable dental products with so many potential sources of error is incredibly difficult.

Digital dentistry reduces 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, giving technicians more accurate data to design from. 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 easily identify and fix mistakes.

Chairside 3D printers can deliver a range of high-quality custom products and appliances with repeatable results right your dental practice, increasing clinical acceptance by the patient and resulting in fewer errors and adjustments along the way.

Improved Efficiency: Time and Cost Savings

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

In a dental practice, saving time on menial tasks means shorter appointments, increased throughput, and increased patient satisfaction. Easy impression taking with 3D intraoral scanners reduces chair time and reduces labor, and cuts out the cost of materials and the need to ship impressions to the lab. There's instant feedback, and no manual errors like voids, bubbles, or tears, eliminating the need for retakes.

With chairside 3D printing, practices can bring production in-house for simple applications like diagnostic models, surgical guides, splints, or temporary restorations, saving both time and costs.

Chairside 3D printing empowers practices to manufacture applications like diagnostic models, surgical guides, splints, or temporary restorations in-house, saving both time and costs.

3D printed surgical guides enable quick and high-precision implant placement for just $2-6 per guide.

Better Patient Experience and Outcomes

One of the most significant benefits of digital technologies is improved patient experience and comfort. A satisfied patient is more likely to return and recommend a clinic to others, contributing to the long-term success of any dental practice.

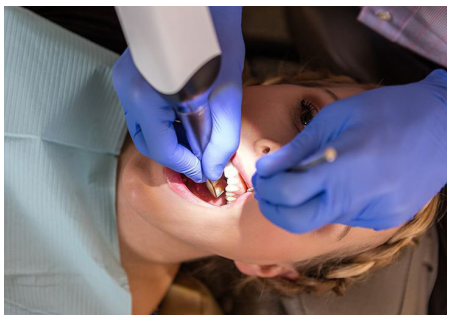
Digital technologies improve the workflow from diagnosis to planning to treatment. Intraoral scanning is faster and substantially more comfortable than regular impressions, while CBCT scanning adds a new dataset to assist planning. Virtual treatment planning and appliance design enable less invasive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

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

The Digital Dentistry Workflow

With a wide range of dental specialties from general dentistry to implantology and prosthodontics, the design of different treatments and prostheses varies somewhat by specialty and application, but they all follow the same basic workflow.

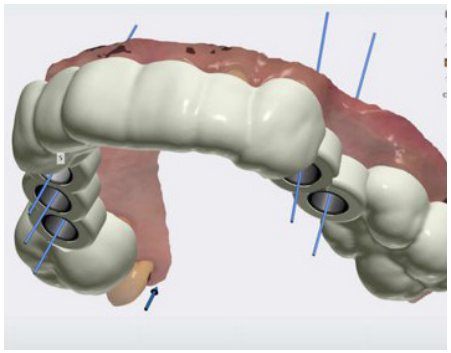
1. Scan



Like traditional dental product fabrication, digital production starts with the patient's individual anatomy. 3D intraoral scanners can be used in the dental practice to capture scans digitally from the patient, replacing manual impressions with fast and accurate impressions. Alternately, desktop optical scanners in dental labs can be used to scan traditional impressions or plaster models. For treatments and applications that require patient osteotomy, such as surgical guides for implants, an additional dataset needs to be collected using CBCT scanners.

Recommended tools for a dental practice: 3D intraoral scanner, CBCT scanner (optional)

2. Plan and Design



After scanning, patient anatomical data is imported into dental CAD software for planning treatments and designing prosthetics, mock-ups, and models. For simple diagnostic models, you can also convert intraoral 3D scan files directly into printable dental models in PreForm, Formlabs' print-preparation 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, PreForm (free)

3. Manufacture

To manufacture a dental product, 3D models are uploaded to the CAM or print-preparation software and then sent to a 3D printer or a milling machine. 3D printers are common in both labs and practices and can produce a variety of dental indications, including models, surgical guides, splints, retainers, wax-ups, castable patterns, dentures, temporary and permanent restorations, and more. 3D printers work by solidifying parts layer by layer to form the shape of the dental appliances and models with digital precision. Milling machines are more common in dental labs, but also have some limited applicability to the dental practice as well. These are typically used to create final restorations by subtracting from a solid block of material, such as zirconia.

Recommended tools for a dental practice: 3D printer

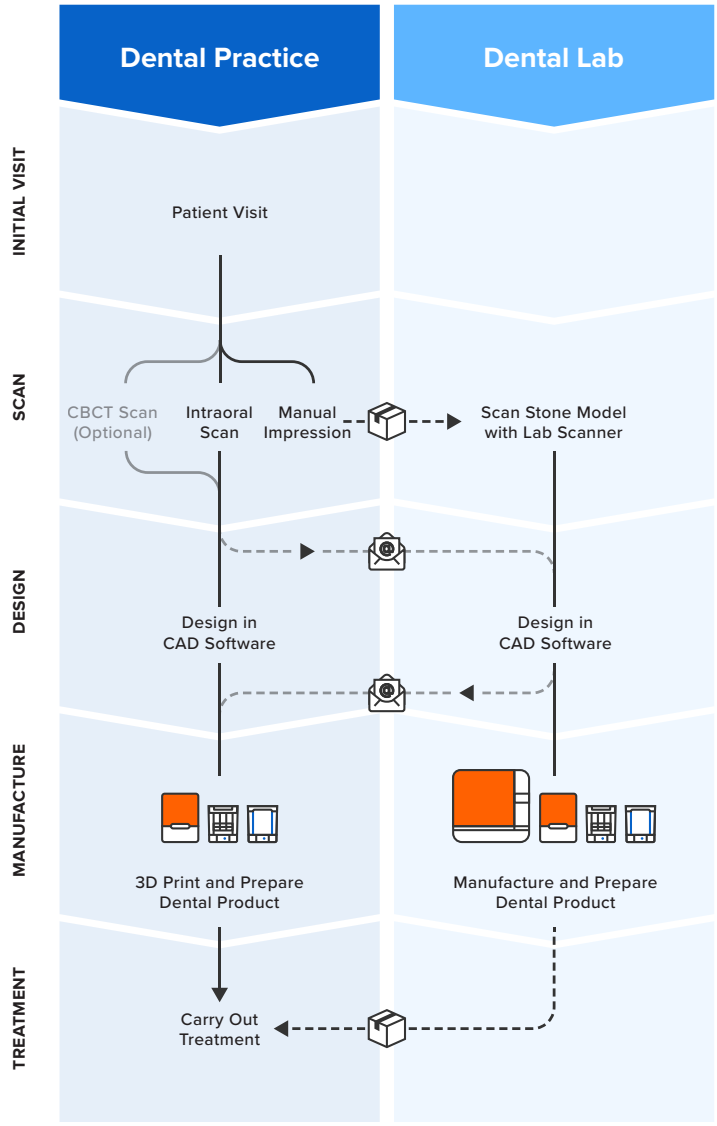
Workflow Between Lab and Practice

With the traditional workflow, the practice takes a physical impression of the patient, ships it to a dental lab that creates the required models, restorations, or other indication(s), 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, a dental 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, restorations, and other indications in-house in CAD software or outsource design to a lab. With chairside 3D printing, a practice can then manufacture simple indications like models, surgical guides or splints in-house and rely on a lab for complex parts such as all-ceramic restorations.

Overall, digital technologies simplify the workflow between practice and lab, offering unlimited freedom to optimize for speed, ease of use, or cost, depending on the case.



The digital dentistry workflow can move back and forth between dental practice and lab, increasing efficiency and collaboration.

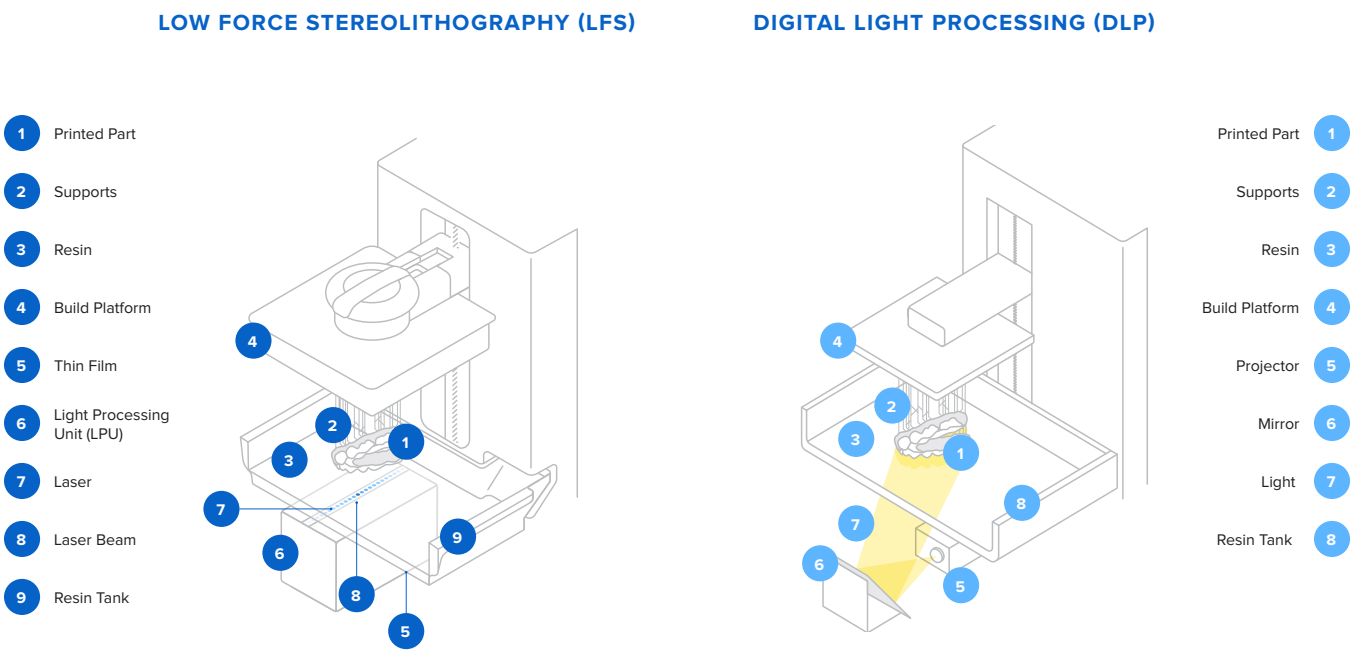
Dental 3D Printing Technologies

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

Today, two 3D printing technologies are common in dental practices: 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.

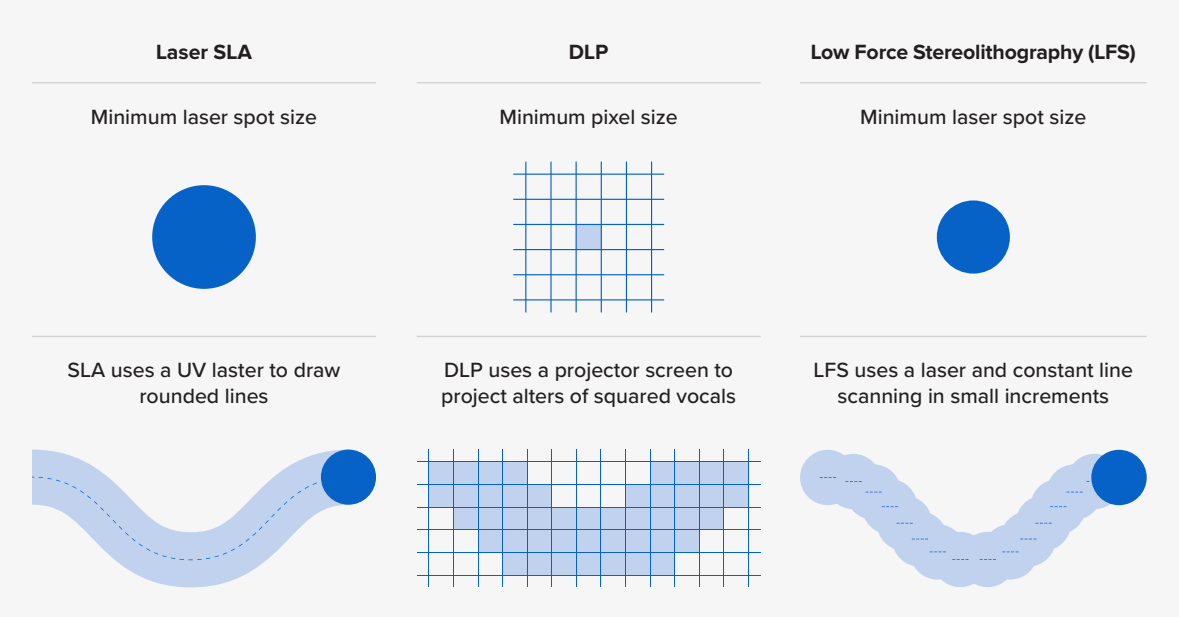
The way SLA, LFS, and DLP 3D printers work is similar—the differences in print quality, workflow, available materials, costs, and other factors are bigger from machine to machine more than technology to technology.

How to Evaluate Dental 3D Printing Solutions

Accuracy and Precision

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

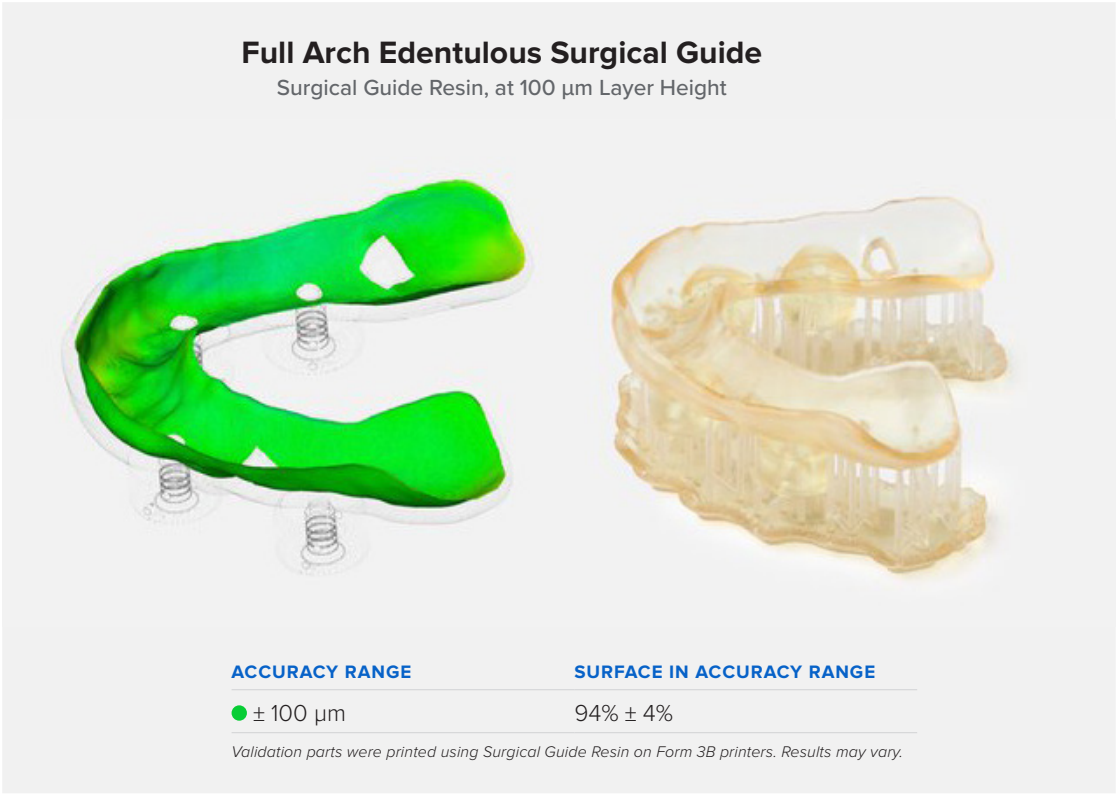
Some manufacturers may try to confuse prospective customers with misleading statements and technical specifications. Most commonly, they masquerade layer height, laser spot size, or pixel size as “accuracy”, even though these specifications do not have a direct impact on the accuracy of final parts.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



The basic units of the SLA, LFS, 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.



Accuracy study of a surgical guide 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.

Ease of Use

Another important consideration is how easy it is to use a 3D printer. After all, you and your team are going to have 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 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, or functions to save material and time.

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

Modern dental 3D printers, like the Form 3B, are designed intuitively so that practices used to outsourcing production to labs can get familiar with the process easily.

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 reduce the need for finishing and costly labor.

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% 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.

Form Wash and Form Cure automate post-processing, saving time and effort.

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 surgical guides in-house can often reduce costs by 80-95% for each part compared to outsourcing to labs or service providers—enough to pay for a 3D printer in a few weeks and save many times its price tag over the years.

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

Crown and Bridge Models
$2-4 USD per model

Orthodontic Models
$2-3 USD per model

Full Dentures
$8-10 USD per denture

Temporary and Permanent Restorations
$2-5 USD per unit

Occlusal Splints
$4-5 USD per splint

Surgical Guides
$2-6 USD per guide

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-unit material costs.
3. Servicing and maintenance costs. Beware of compulsory service contracts that can cost as much as 20% of the upfront cost of the printer annually.

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 dental practices, 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, surgical guides, castable/pressable restorations, and long-term and biocompatible dental products like 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 careful that you know what risks your practice takes by using not validated 3D printers and materials.

Surgical guides 3D printed on a Formlabs Form 3B dental 3D printer.

Manufacturers release new materials on a regular basis, so there's a good chance that the printer you buy today will become capable of creating an increasing variety of dental products in the near future.

Speed and Throughput

When thinking about speed in 3D printing, it's important to consider not just raw print speed, but also throughput.

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 depends only 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 restorative models or surgical guides 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.

How to Implement Digital Workflows in a Dental Practice

1. Pick an Application

Transitioning to digital dentistry doesn't need to happen all at once. Start with the easiest 3D printing workflows first, build your team's expertise, and gradually add new applications to avoid unnecessary risks.

The best place to start is with simple study models. These are the easiest products to 3D print because they don't require a third-party design software to prepare a digital impression for printing. Formlabs Dental 3D printer customers can use the Scan to Model feature in PreForm to turn their digital impressions into physical models for free.

If you want to start with something other than simple models, choose an application that is currently inefficient, unreliable, or expensive—or perhaps a product that you aren't currently able to offer your patients. Surgical guides and splints both have particularly simple workflows that an assistant can be trained to carry out. You can even outsource the appliance design step to a design service provider like Evident, Full Contour, or Digital Smile Design, and still do the appliance manufacturing in-house.

Whatever you choose, start with a single use case and extend to multiple applications, while continuing to rely on labs for complex cases and final restorations.

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 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.

An in-house 3D printer empowers you to create advanced applications like temporary crown and bridge restorations, inlays, onlays, and veneers with excellent marginal adaptation, strength, and aesthetics.

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 enabling 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 dentistry, practices can start small, see faster returns on investment, and scale up over time.

Get Started with Digital Dentistry and 3D Printing

With thousands of dental practices 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 a few years ago, 3D printers were only affordable to the largest dental labs and milling centers, now they are a common sight in dental practices.

Consider the factors discussed above and the needs of your practice—different 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 dental resources for free guides, step-by-step tutorials, white papers, webinars to learn how you can integrate 3D printing into your practice.

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 →

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