WHITE PAPER

3D Printer Buyer's Guide for Dental Labs

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

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 manufacturing, what was once prohibitively expensive is rapidly becoming accessible, already transforming thousands of dental labs 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 laboratory.

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 laboratory, 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 and inputs similar to traditional workflows, with the added benefit of being able to automate certain steps, as well as easily identify and fix mistakes.

Digital manufacturing equipment such as 3D printers or milling machines deliver a range of high-quality custom products, prosthetics, and appliances with superior fit and repeatable results, increasing clinical acceptance by dental practices and resulting in fewer errors and adjustments while lowering costs.

3D printed removable die models are similar to traditional made models used for fit checking final restorations.

Improved Efficiency: Time and Cost Savings

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

In a dental lab, 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 softwares are incredibly powerful application-specific that enable technicians to design and plan a variety of restorations and appliances.

Milling machines and 3D printers can batch jobs together, operate unattended and even overnight, adding an extra shift to a lab's workforce at no extra cost. The latest professional systems are now so cost effective that dental labs of any size can take advantage.

New Business Opportunity

The dental industry is going through rapid change. Labs who delay adopting new technologies risk falling behind their competition or an over reliance of milling centers and outsource providers.

A survey of 300 dental labs in the US by The Key Group in 2018 found that 36% of dental laboratories in the United States have 3D printing technology and 49% are planning or considering purchasing a 3D printer in the next 12 months. The technology adoption is partly driven by the need to cater to dentists: On average, 15% of their client dentists are sending digital files, but in some regions their share has already reached more than 35% and is increasing every year.

But those labs that embrace change and react fast can turn it into a competitive advantage. Accepting digital impressions cuts out the lengthy shipping time for physical impressions. As a result, digital labs can service clients in a wider geographical area or specialize in certain products.

3D printed surgical guides enable quick and high-precision implant placement for just $2-5 per guide, up to 90-95% cheaper than outsourced guides.

The Digital Dentistry Workflow

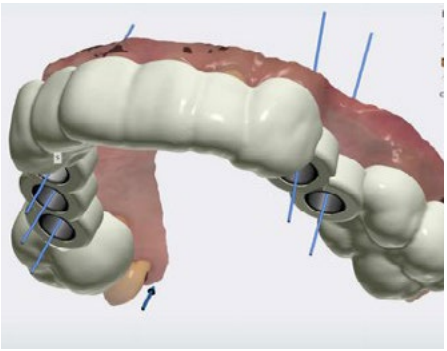
With a wide range of dental specialties from general dentistry to implantology and prosthodontics, the design of different treatments and prostheses varies somewhat by specialty and application, but they all follow the same basic workflow.

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 lab: desktop optical scanner

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. 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 lab: 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 or a milling machine. 3D printers are common in both labs and practices and can produce a variety of products, including dental models, surgical guides, splints, retainers, wax-ups, castable patterns, and dentures. 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 lab: 3D printer, milling machine

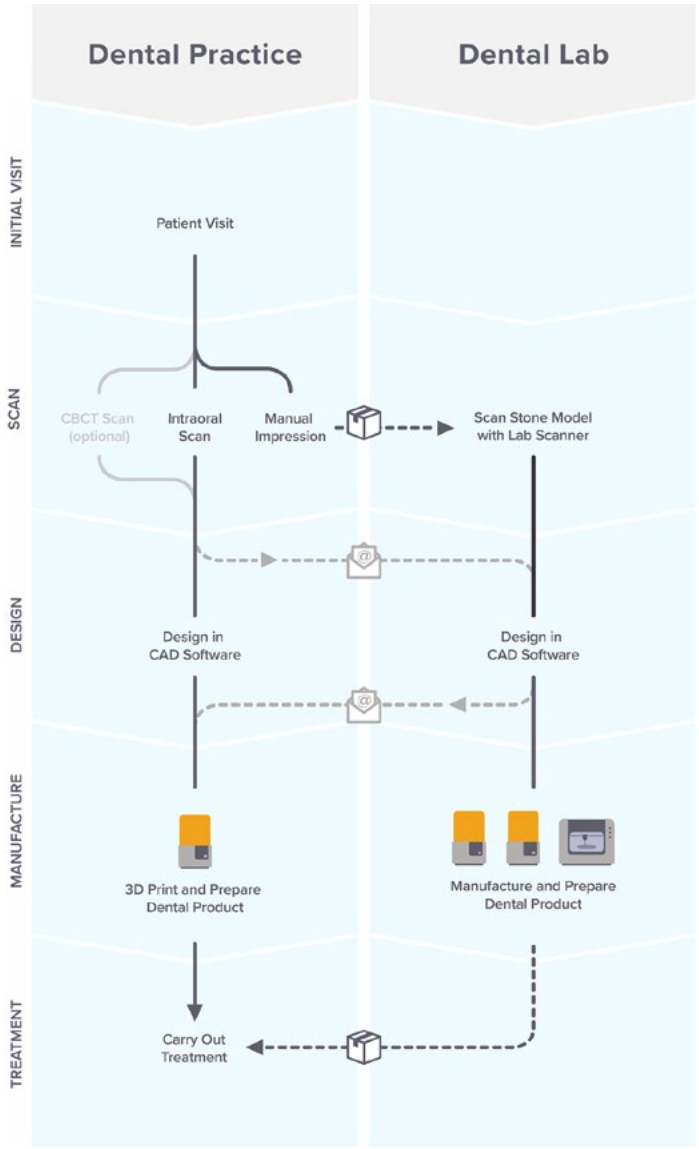
Workflow Between Lab and Practice

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, and other conditions.

For example, a dental practice can take a digital impression or send a manual impression for scanning with a desktop optical scanner at the lab. Either the lab or the practice can then use the digital impression to design the models, restorations, and other indications. At last, labs can manufacture parts in-house with 3D printing or milling or offer design as a service and send the design files to their customer for chairside 3D printing in the dental practice.

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.

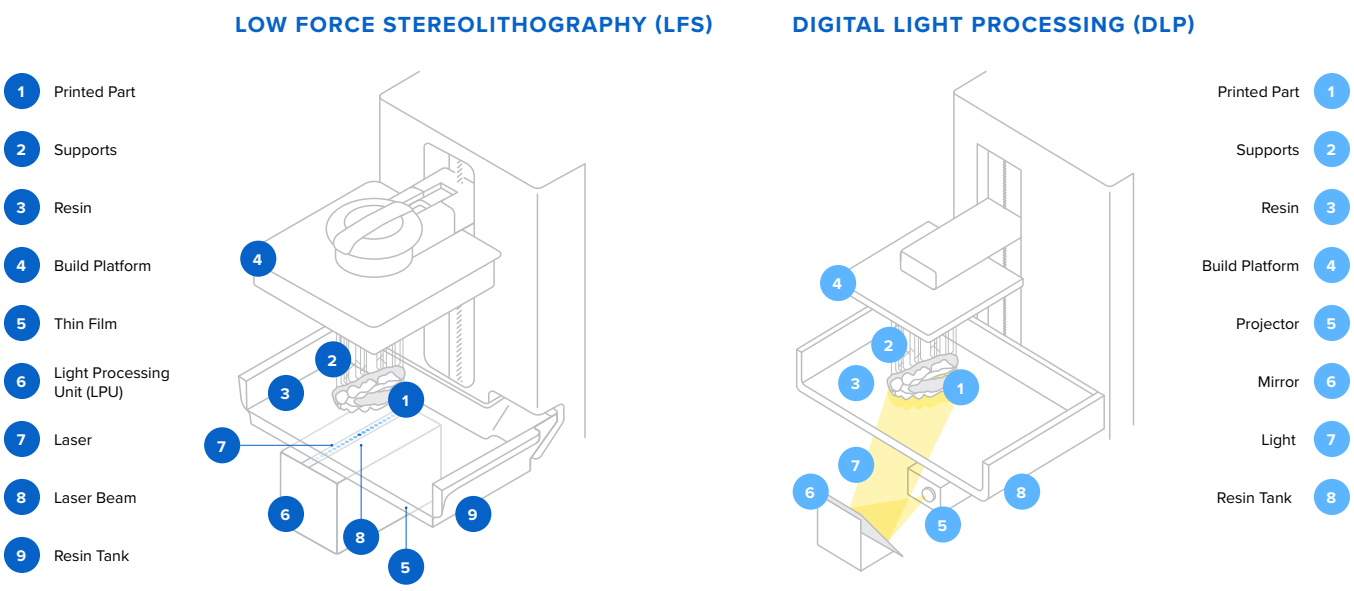
Dental 3D Printing Technologies

Additive manufacturing is the latest piece of the workflow in digital dentistry that has become a logical business choice for dental labs, 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 labs: 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.

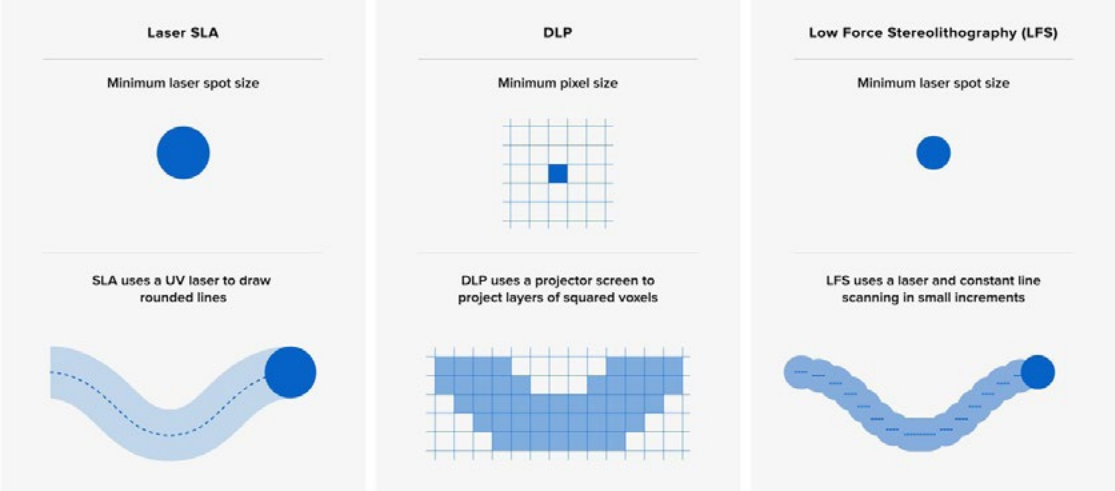
The way SLA, LFS, and DLP 3D printers work is similar—the differences in print quality, workflow, available materials, costs, and other factors are bigger from machine to machine more than technology to technology.

How to Evaluate Dental 3D Printing Solutions

Accuracy and Precision

Guaranteeing high-quality, accurate, final parts is the most important concern for any dental lab. 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.

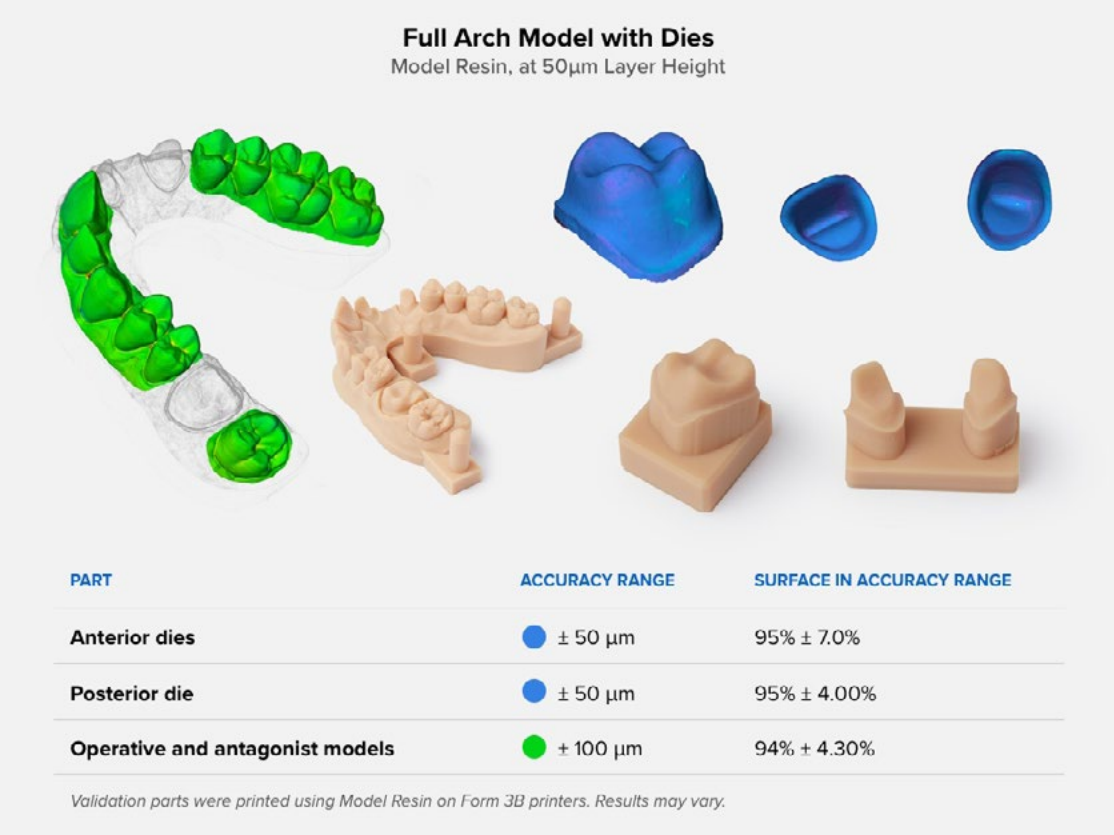
Some manufacturers may try to confuse prospective customers with misleading statements and technical specifications. Most commonly, they masquerade layer height, laser spot size, or pixel size as “accuracy”, even though these specifications do not have a direct impact on accuracy of final parts. While 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 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 full arch model with dies 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 and Reliability

How easy a 3D printer is to use is another important consideration. 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.

Fortunately, most modern SLA and DLP printers are designed intuitively, so that also practices that are used to outsourcing production to labs can get familiar with the process easily.

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.

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.

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.

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 dental lab printing surgical guides in-house can often reduce costs by 75% 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.

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 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, 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.

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 dental lab 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.

Throughput and Scalability

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 labs the freedom to decide whether they want to optimize for resolution, speed, or throughput, depending on the case.

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

QUADRANT MODELS FOR FIXED PROSTHETICS

Model Resin at 50 µm

Up to 8 quad model kits (upper, lower, and die) per print in ~9.5 h for $2-4 a kit

FULL ARCH MODELS FOR FIXED PROSTHETICS

Model Resin at 50 µm

Up to 2 full arch model kits (upper, lower, and die) per print in ~9.5 h for $6-8 a kit

PATTERNS FOR FIXED AND REMOVABLE PROSTHETICS

Castable Wax Resin at 50 µm

Up to 100 crowns andaor copings per print in ~9.5 h for $0.25-0.50 a unit

Up to 7 RPD frames per print in ~7.5 h for $3-5 a part

LARGE DIAGNOSTIC MODELS

White resin at 100µm

Up to 2 model sets (upper and lower) per print in ~5 h for $6-9 a set

DIAGNOSTIC MODELS

Model Resin at 100 µm

Up to 2 model sets (upper and lower) per print in ~5 h for $6-9 a set

SURGICAL GUIDES

Dental SG Resin at 100 µm

Up to 29 quadrant surgical guides per print in ~5 h for $2-$4 a part

Up to 8 full arch surgical guides per print in ~4 h for $3-$6 a part

OCCLUSAL SPLINTS

Dental LT Clear Resin at 100 µm

Up to 8 splints per print in ~2.5 h for $4-$6 a part

DENTURE TEETH

Denture Teeth Resin at 50 µm

Up to 8 denture teeth sets per print in ~5.5 h for $3-$5 a part

DENTURE BASES

Denture Base Resin at 50 µm

Up to 8 denture bases per print in ~9 h for $5-$7 a part

Multi-machine print cells allow 3D printing for multiple different applications in parallel, balancing production needs and lowering risk through redundancy.

Another important consideration for labs is whether to fulfill capacity with a single machine or multiple units. Production with multi-machine print cells often reduces upfront costs compared to larger-format machines. By buying one low-cost machine at first, labs can test out production methods before ultimately scaling up production with demand. This provides the opportunity to pay for production only when it is needed, rather than making large long-term investments in a rapidly-evolving market.

Print cells also reduce risk through redundancy. If one machine needs servicing, production can be balanced across the rest of the print cell.

How to Implement Digital Workflows in a Dental Practice

1. Pick an Application

Transitioning to digital workflows is best done gradually, shifting application by application to avoid unnecessary risks. First, choose an application where digital dentistry 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 customers.

For dental labs, 3D printers and milling machines offer a variety of digital workflows. Professional 3D printers are incredibly versatile: it's possible to manufacture a wide range of products, including restorative models, surgical guides, splints, ortho models, aligners, digital wax-ups, castable prosthetics, and dentures, on the same machine, just by switching materials. Milling machines offer solutions for crowns and bridges, splints, full or partial dentures, and more. Each fabrication method should be considered based on quality and cost-efficiency. For example, a dental milling machine is best used for milling all ceramic restorations not low yield products like diagnostic wax-ups or custom impression trays.

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.

For scanning equipment, consider whether you'll only receive digital impressions from dentists or you'll need a desktop optical scanner to scan stone models or physical impressions.

To get familiar with digital design, 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 manufacturing equipment such as milling machines or 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 of a milled crown, a 3D printed splint, or whatever you're considering. 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 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 workflows, dental labs 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 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 a few years ago, 3D printers were only affordable to the largest dental labs and milling centers, now they are a common sight in labs of any size.

Consider the factors discussed above and the needs of your lab—different solutions might suit some businesses better than others. Digital dentistry is developing rapidly, and new desktop solutions can produce dental products with similar or even better quality and accuracy traditional large-format 3D printers. Make sure to do your research, evaluate actual parts, and avoid paying a hefty premium.