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3D printing

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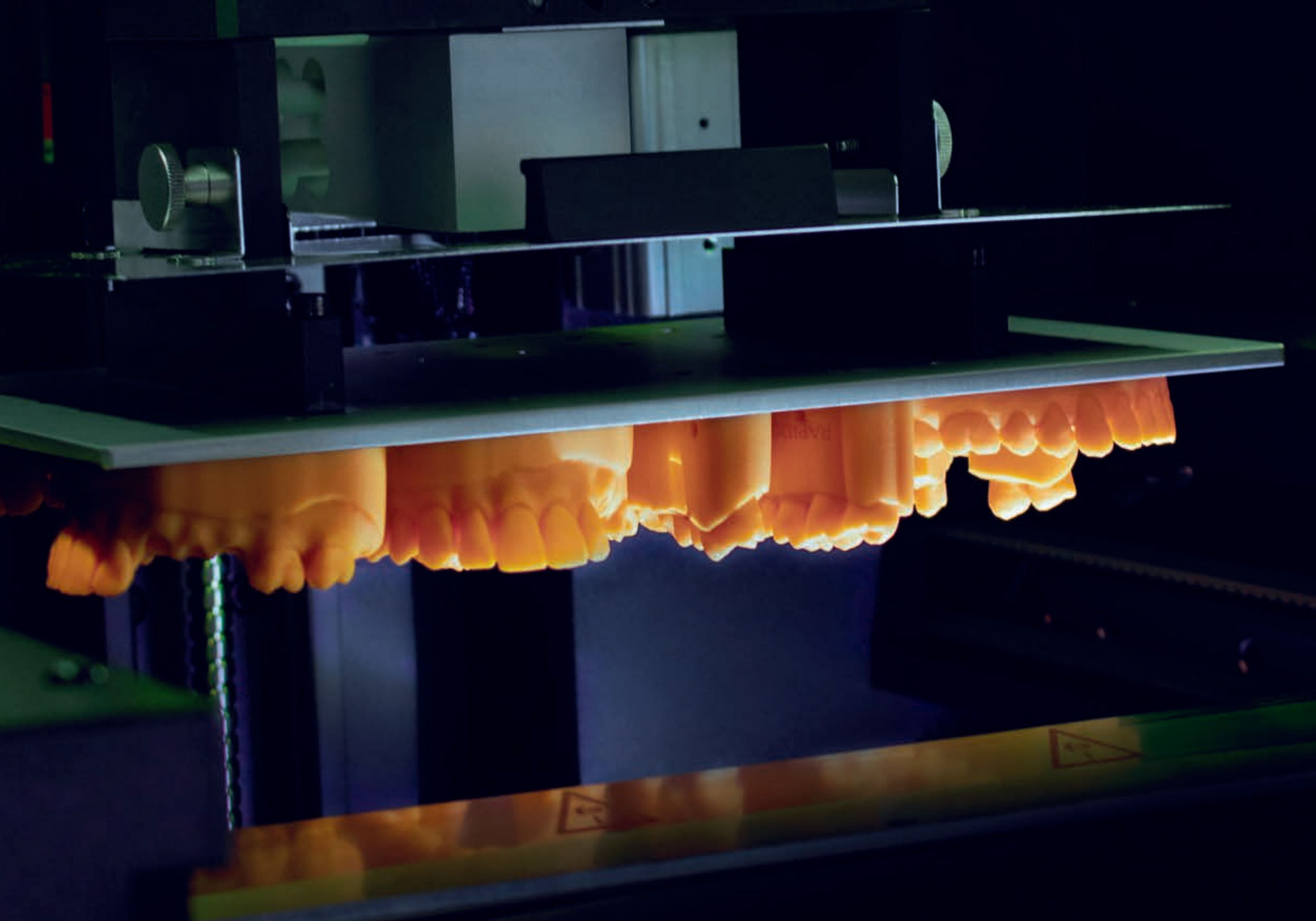


case report
Same-day conservative aesthetic rehabilitation with Permanent Crown Resin

opinion
3D printing drives innovation

buyer's guide
Resins in 3D printing in dentistry

dti] Dental Tribune International

Dr George Freedman

Editor-in-chief

3D printing in dentistry: The need for leadership

3D dental printing is harmonious with the continuing positive evolution of dentistry. As a field of study and practice, it is clearly distinct from prior dental technologies and techniques yet totally in sync with the arc of dental development. The rapid acceptance and uptake of 3D-printing technologies in a wide range of dental procedures points to the need for an organisational structure to set manufacturing, laboratory and clinical standards and to begin the formulation of a comprehensive educational platform that will serve to train dentists and technicians worldwide.

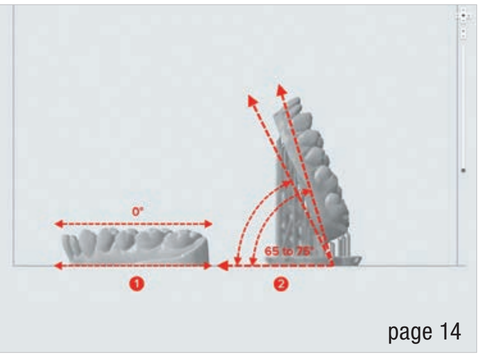
Because 3D dental printing is *so* innovative, *so* promising and *so* disruptive, it is unlikely to find a truly accommodating niche, one that would nurture its growth and progress, within existing, and necessarily competitive, dental organisations. For the very same reasons that cosmetic dentistry could not have flourished as it did within the confines of prosthodontics or traditional restorative dentistry 40 years ago, 3D printing must engage open minds and imaginative spirits and empower science-based risk-takers who will challenge conventional wisdom and established practice. Thus, it is essential that a new organisation dedicated solely and exclusively to 3D dental printing be convened, at the earliest opportunity. Ideally, this will be an organisation that will offer an open forum for free discussions and timely presentations of new ideas (even if they seem far-fetched), an open membership that is affordable and one that will not only attract and collect information and clinical feedback, but effectively disseminate this information around the globe.

What groups of experts are required to lay the foundation for the next major leap in dentistry? They must include:

- hardware experts (who develop the printing technologies and devices);
- software experts (who drive the hardware and link clinicians, laboratory technicians and patients);
- technicians (who use the technology to turn raw materials into restorations etc.); and
- dental professionals (who diagnose, plan treatment and deliver restorations to patients).

And would it not be interesting, and ultimately appropriate, to have this convening meeting at the International Dental Show, where so many of the world's experts in the fields mentioned gather? The show is celebrating its 100th anniversary, and it would be fitting to initiate its second century by inaugurating this most fundamental transformation of the dental profession.

Dr George Freedman
Editor-in-chief

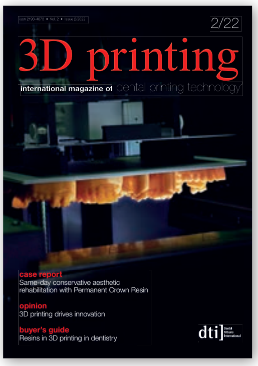


page 14

page 18

page 68

Cover image courtesy of Rapid Shape (www.rapidshape.de).



Study finds 3D printing more accurate than milling when it comes to dental crowns

By Anisha Hall Hoppe, Dental Tribune International

Using the exact same dataset and an industrial 3D digitiser to identify deviations, researchers at Tohoku University Graduate School of Dentistry in Japan found that producing a crown by digital light processing (DLP) 3D printing results in a better-quality product than can be achieved through milling.

CAD/CAM-produced milled crowns have proved a popular alternative to traditional metallic restorations in recent years, thanks to the better wear and aesthetic qualities of resin-composites. However, the new study indicates that advances in DLP printing can offer dentists a far better product in terms of less wastage and higher accuracy than has previously been available.

Compared with the milled crowns created during the study, the DLP-printed crowns were consistently more accurate and had fewer marginal discrepancies. The researchers noted that, particularly at the crown cusps, the milled crowns had a higher rate of dimensional deviations and that, when offset correction was attempted on the internal surfaces of the milled products that had negative deviations, grooves would result.

DLP-based 3D printing achieved a higher level of dimensional fitting accuracy and high trueness, regardless of the abutment shape. When it comes to milling, the trueness is very dependent upon the material properties, and those which are more brittle, such as ceramics and polymer-infiltrated ceramics, are prone to chipping during processing, meaning that too much milling can result in a lower-quality piece.

DLP also provides a broader possible range of fitting accuracy than can be provided by milling.

The researchers noted that future studies could evaluate the fracture resistance and biocompatibility of 3D-printed crowns as permanent prostheses and that additional research utilising different printing parameters and fabrication systems would be useful.

Editorial note: The study, titled "Comparison of the accuracy of resin-composite crowns fabricated by three-dimensional printing and milling methods", was published online on 6 July 2022 in Dental Materials Journal*, ahead of inclusion in an issue.*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Artificial intelligence may automate design of biomimetic single-tooth protheses

By Franziska Beier, Dental Tribune International

Even with the support of modern CAD/CAM technology, creating a dental prosthesis is still rather time-consuming, resulting in more chair time and high costs for patients. To facilitate the design of molar crowns, researchers from the Faculty of Dentistry at the University of Hong Kong (HKU) and the Department of Computer Science of Chu Hai College of Higher Education in Hong Kong collaborated to develop a novel approach using artificial intelligence (AI).

When asked what inspired the research, lead author Dr Walter Yu Hang Lam, clinical assistant professor in prosthodontics at the Division of Restorative Dental Sciences at HKU, told Dental Tribune International: "Some patients sense a very subtle hair-thin high spot on their dental prosthesis. Therefore, in the dental curriculum, a significant proportion of time is dedicated to occlusion theory and clinical training to provide a dental prosthesis that fits the patient's mouth. My colleagues and I hoped to figure out a solution for improved treatment efficiency and patient experience."

In order to restore the patient's original appearance, masticatory function and general oral health, dental protheses should have the same occlusal morphology and 3D position of the natural teeth. These can be deduced for a missing tooth from those of the surrounding dentition because the teeth of an individual are all controlled by the same set of genes and exposed to the same oral environment. The researchers hypothesised that AI could thus generate the design for a single-tooth prothesis based on the characteristics of the remaining dentition.

The research team used a machine learning approach called a generative adversarial network (GAN) to train and validate their AI system and have tested it on 175 participants. The system was able to reconstruct the shape of a natural tooth and automate the process of dental protheses design based only on the digital model of the patient's dentition.

"The 3D GAN algorithm was selected due to its superior performance on 3D object reconstruction compared with other AI algorithms. In the preliminary study, 3D GAN was able to rebuild similar shapes to the original teeth for 60% of the cases. It is expected to mature with more AI training data," commented co-author Dr Reinhard Chun Wang Chau, research assistant in the Division of Restorative Dental Sciences and of Applied Oral Sciences and Community Dental Care at HKU, in a press release. For future research, the team proposes to investigate whether the presence of opposing teeth will help the AI to generate a more natural tooth.

Asked about the advantages of this method for dental professionals and patients, Dr Lam said: "It's less time-consuming for both of them. Dentists will spend less time on registering jaw relationships and chairside adjustment, greatly facilitating the entire treatment process and enabling them to take on more cases."

He continued: "Patients will spend less time and money on the treatment. In addition, the dental prostheses they receive will fit better to their remaining dentition and are thus less likely to cause jaw problems."

According to Dr Lam, the research group hopes to make the AI technology available for dental professionals within the next five years, after having tested its accuracy further in simulated and clinical scenarios. Moreover, the researchers believe that the method may be applied to the fabrication of crowns for other teeth and of multi-unit restorations in the future.

Editorial note: The study, titled "Artificial intelligence-designed single molar dental prostheses: A protocol of prospective experimental study", was published online on 2 June 2022 in PLOS ONE.

In a recent experimental study, Hong Kong researchers demonstrated that their AI system could generate the design of a molar (red) based on the features of the remaining dentition (dark grey). *(Image: © HKU)*


ASIGA
ASIGA

Researchers develop customised 3D-printed toothbrush handle for patients with limited dexterity

By Jeremy Booth, Dental Tribune International

A team of researchers from universities in India has developed a method of fabricating a customised, interchangeable handle for tooth cleaning products for patients having limited manual dexterity. The 3D-printed handle brings cost-saving advantages and could improve the oral health and quality of life of patients having restricted hand and finger movement, such as stroke survivors, elderly patients and those with arthritis.

Oral self-care can empower patients who have limited manual dexterity; however, it is essential that oral care products can be used easily.

A technical report summarising the research explained that patients with diminished manual dexterity face greater challenges when it comes to maintaining their oral health and that these challenges can be compounded by impaired sensory and masticatory function. Oral self-care can empower these patients and prevent the onset of oral diseases; however, it is essential that oral care products can be used easily.

The researchers developed a simple technique whereby silicone putty impressions of the patient's grip are made manually and then used to 3D-print a customised handle using polylactic acid. The handle features the patient's name, is durable and costs approximately INR2,500 (€31) to produce. The technique used is simple and requires less time than other techniques do. The handle can be used interchangeably to hold a toothbrush or an interdental brush and reused with different toothbrush designs and is, therefore, cost-effective.

Modifications of toothbrush handles for patients having limited manual dexterity are mentioned in existing literature; however, the researchers emphasised the need for modified handles to be customised to the patient's hand.

Corresponding author Dr Shreya Colvenkar, professor in the department of prosthodontics at MNR Dental College and Hospital in Sangareddy, told Dental Tribune

"Although caregivers can help in such a situation, maintaining their own oral hygiene by self-brushing can increase patients' self-esteem."

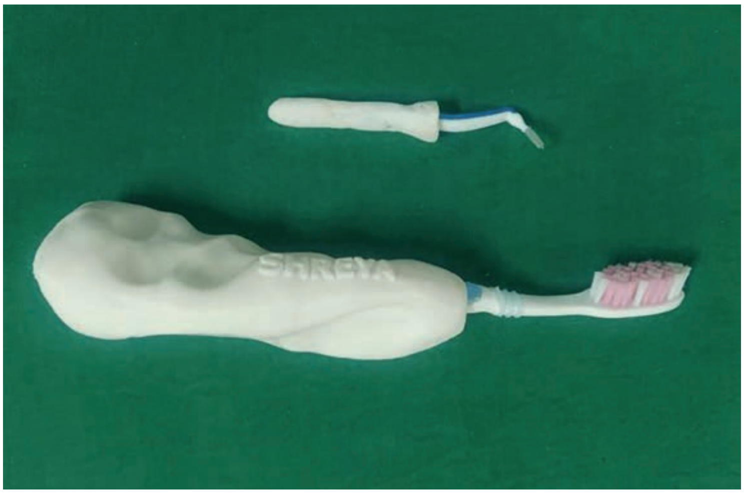
International (DTI) that the 3D-printed two-in-one customised handles will improve the oral health of patients having limited manual dexterity. She said that elderly people and other patients having limited finger and hand movement need extra help to maintain good oral health and that being able to do so reduced dependency on others and brought a sense of empowerment. "Although caregivers can help in such a situation, maintaining their own oral hygiene by self-brushing can increase patients' self-esteem," she explained, adding that it was very much necessary to have a design that

> "To maintain good oral care, the focus should be on preventing oral diseases and reducing the need for comprehensive dental treatment."

properly fits in the patient's hand in order to improve the quality of brushing.

Dr Colvenkar told DTI that the research team was waiting for expressions of interest from manufacturers and researchers so that the 3D-printed handle can be made available and benefit the population.

In their report, the authors emphasised: "To maintain good oral care, the focus should be on preventing oral diseases and reducing the need for comprehensive dental treatment. The final objective should focus on maintenance and self-care to improve quality of life."



Researchers in India have developed a customised and interchangeable 3D-printed handle for tooth cleaning products for patients with limited manual dexterity. *(Image: © Dr Shreya Colvenkar et al./Cureus)*

Editorial note: The report, titled "Individually modeled 3D printed toothbrush and interproximal brush handle with name for patients with limited manual dexterity", was published online on 21 July 2022 in the Cureus Journal of Medical Sciences*.*

"Our bodies aren't naturally perfect geometries": 3D printing advances customisation in treatment

An interview with Rebecca Hall

By Anisha Hall Hoppe, Dental Tribune International

For many of our readers, 3D printing has either become an essential part of their digital practice or might be a transition still in process. Regarding the possibilities of 3D printing, Dental Tribune International spoke with Rebecca Hall, a final-year mechanical engineering student at the University of Central Florida in Orlando in the US who in her internships at NASA and Tesla gained forefront experience of the relevance of 3D-printing advancements for a variety of industries, dentistry included.

> "In the past […] most people never had the experience of designing something and holding it in their hands."

Ms Hall, you've worked with 3D printing in some cutting-edge companies. Many of our readers are familiar with 3D-printing processes in dental clinics. How is 3D printing used by engineers?
3D printing has meant that people across many industries are all now basically engineers who can design parts, do CAD, all without having to study engineering. In the past, you would have to design a part and order it to be manufactured, so most people never had the experience of designing something and holding it in their hands. This massive and expensive barrier has been removed with 3D-printing advancements.

Across my internships, 3D printing was used for rapid prototyping of smaller-scale parts to save time and money. Of course, this still requires creating a design, but once it has been printed, this provides a good idea of whether the part is actually going to function before putting in an order for manufacturing at great cost. We wouldn't often use 3D printing for finalised parts unless there was a highly specialised need for that part, a special material or a very advanced printer.

Interns were expected to already know about 3D printing, but in reality most engineers just google what they need to know. A big part of working with 3D printing is troubleshooting, and that's not something taught in college. You have to learn troubleshooting on the fly, and a great resource is online 3D-printing hobbyist communities.

What should instruction in 3D printing involve?
I was first introduced to 3D printing in middle school by my older brother who had a 3D printer as a hobby. He helped me use open-source CT scans of a brain to print one for my high school psychology class. I did not encounter it in an educational curriculum until college, where we had a printing lab, and the basics were taught in my introduction to engineering course.

However, I think that principles of 3D printing should be taught starting at the high school level and that at university students should be taught more than fused deposition modelling printing. Students' access to stereolithography, selective laser sintering, metal printing, concrete printing and large-scale printing at the university level needs to be encouraged because that's where the industry is headed.

What recommendations do you have for our readers who have not received an education in 3D printing and engineering?
3D printing is making certain things, like prostheses, a lot more affordable and is overall a huge asset to the medical community because our bodies aren't naturally perfect geometries. 3D printing allows practitioners to come up with solutions to accommodate everybody.

For those who are just starting out learning about 3D printing in general, my tip would be to start out with CAD,

Rebecca Hall, a final-year mechanical engineering student at the University of Central Florida in Orlando in the US.

“A big part of working with 3D printing is troubleshooting, and that’s not something taught in college.”

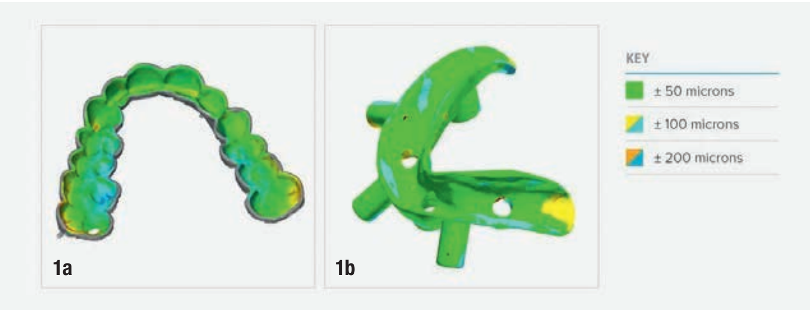
by taking a basic CAD course or one on an industry-specific program to learn how parts are designed.

But you don’t have to know CAD to be successful at 3D printing; you can always grab existing files available online to start out and just print. Buying a cheap, basic printer is a great way to practise and to learn how to troubleshoot before investing in anything specific for your business. You will waste less money later by practising before you graduate to a more expensive, task-specific printer. Google, YouTube and hobbyist groups are going to be the best resource as you learn.

A lot of off-the-shelf 3D printers are very beginner-friendly, as is the software itself. They’ve eliminated a lot of steps we needed to use in the past. Often, I find them easier to use than a regular, 2D, printer!

A guide to evidence-based clinical evaluation of dental 3D printing

Dr Elisa Praderi, Germany



Figs. 1a & b: Surface analysis of occlusal splint **(a)** and surgical guide **(b)**.

Solutions

Technologies are producing a paradigm shift in all areas of healthcare. Dentistry has seen significant changes in this context. Alongside new patient digitalisation tools, manufacturing processes and materials are evolving to such an extent that they are changing the way we understand new data and redefining how we approach our workflows. The fast-paced development of these new dental materials complicates the decision-making process for dental professionals, how research is being conducted and how fast evidence is being produced to back up these new solutions and protocols. This article provides some guidelines for dental professionals and educational institutions to understand, adopt and shape the future of digital dentistry using 3D printing.

Taking an evidence-based approach to digital dentistry

Forward-looking dental professionals who seek detailed results on newly available 3D-printing materials may find themselves disappointed if they ask the same questions they would for traditional materials. Instead, they should consider the following avenues of enquiry when evaluating a new 3D-printing solution.

Compare manufacturing options and categories

Understanding new materials starts with understanding the different manufacturing methods for which they are used. Here, three key areas of distinction are presented in increasing order of specificity.

Comparing conventional and digital manufacturing

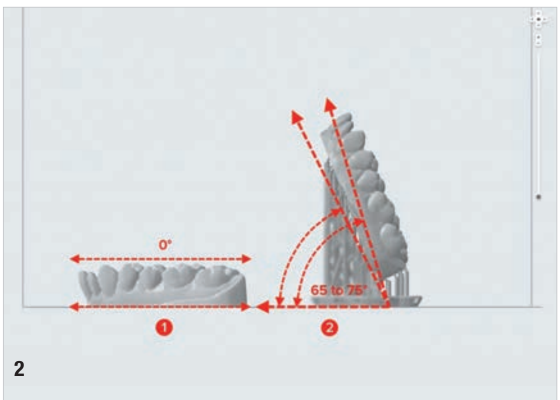
Today, the digital clinical process includes four major steps: patient digitalisation (via intra-oral scanning, CBCT, photography, and static and dynamic occlusion), design (via CAD software), manufacturing (milling or 3D printing) and final steps for delivery of the appliance (thermoforming or other). Just like we understand the traditional workflow, we need to understand how the intra-oral scanning techniques and CAD can affect the printed outcome.

Some aspects remain the same. For instance, the consequences of not following protocols and manufacturer's instructions are the same for both traditional and digital workflows: a poor intra-oral scan will lead to a defective virtual model, just like a poor impression will yield an inaccurate model.

Some aspects are different. With the digital workflow, precision and accuracy can be quantitatively measured, such as via surface scanning and comparison with the digital impression (Fig. 1). This is fundamental for predicting how parts will adapt intra-orally and has the added benefit of peace of mind for both clinician and patient that the prostheses and appliances are suitably accurate for the patient's condition.

Additionally, the timing of the delivery of digital products may have implications for the patient's appointment schedule. For example, for a complete denture, the digital workflow requires half the number of appointments compared with traditional workflows. Moreover, in case of loss or fracture,

Fig. 2: Design of a model for clear aligner and retainer production printed horizontally with the base directly on the build platform or vertically with supports.
Fig. 3: Design of an occlusal splint with supporting structures.



a new denture can be easily refabricated using the digital files and only a seating appointment is required.

Comparing milling and 3D printing

Milling has been used in the dental profession for longer than 3D printing. The most significant difference between the two technologies is how they are conducted. Milling, or subtractive manufacturing, begins with a solid block of material (such as PMMA or zirconia) and uses cutting tools to remove material until the final shape is achieved. In contrast, 3D printing, or additive manufacturing, uses various processes to build up the raw material into its final shape, one layer at a time. Dental 3D printers typically use a viscous liquid resin that reacts with light to become solid, using a laser or other light source to selectively expose the material to light and polymerise it in place.

Given the difference in the nature of the manufacturing processes, the design parameters to bear in mind are different. In milling, we acknowledge limitations such as milling radius compensation during the design and preparation of our restoration or splint for its specific output. In 3D printing, there are fewer design limitations, but file preparation for manufacturing requires more attention, such as the orientation of the part relative to the printer (Fig. 2) and the use of supporting structures to hold the part securely during the printing process (Fig. 3).

The costs of operation and maintenance of each manufacturing option are relevant when analysing investment. In milling, it is important to acknowledge the total waste generated in production, as well as the long-term maintenance costs. In printing, the waste is reduced owing to the nature of the manufacturing process, but some equipment requires nearly as much maintenance as milling machines, and consumables like resin tanks can be expensive.

Lastly, the materials available and developed for each manufacturing system and clinical indication are important to analyse and understand, as well as the clinical scenarios for which dental professionals will opt for one technology or the other.

Comparing 3D-printing technologies

As mentioned, most dental 3D printers use a liquid resin in a technology called vat photopolymerisation, but several other technologies exist, including powder bed fusion (such as selective laser sintering), material extrusion (such as fused deposition modelling) and material jetting. Within the category of vat photopolymerisation are the techniques of low-force stereolithography, stereolithography, digital light processing and liquid crystal display (Fig. 4). When choosing a 3D-printing technology, it is important to consider several aspects, the most important of which are accuracy, production time and material availability.

Accuracy can be measured in multiple ways. Trueness and precision refer to how closely the produced part matches the digital file. This can be achieved through a combination

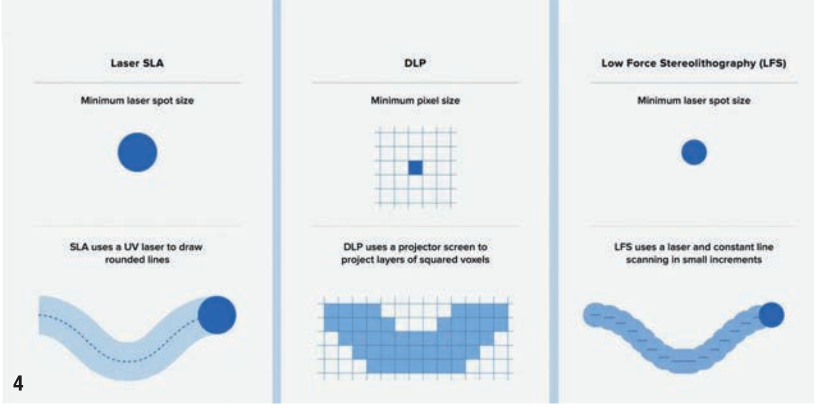


Fig. 4: Different 3D-printing categories. SLA = stereolithography; DLP = digital light processing; LFS = low-force stereolithography.

of equipment specifications, such as resolution in the *x*- and *y*-axes, layer height (resolution in the z-axis) and laser spot size. Post-processing methods, such as post-polymerising the printed part, can also impact accuracy.

With the fast pace of clinical dentistry, timing is critical. However, printing time is only one step of the process. File preparation, post-processing and final clean-up of parts may be more time-consuming, and crucially, these are the steps that take up valuable technician or assistant time. Be sure to evaluate the entire production time, not just the printing speed, when looking at production speed.

Lastly, material availability varies. Consider whether it is more important to you to have highly versatile equipment or to have equipment that is specialised for a certain use case. Research your intended use case and look for material availability, often categorised by whether it is biocompatible or not—if biocompatible, whether it is Class I or Class IIa—and the intended application. It is also important to look into certifications or product approvals (U.S. Food and Drug Administration, EU medical device regulations, and others) and the implied suitability for the intended application (Figs. 5 & 6).

Carefully read and follow protocols

In the absence of *in vivo* results, following the right protocols according to the manufacturer's instructions is key (Fig. 7). Manufacturers conduct testing according to International Organization for Standardization (ISO) standards to guarantee that the mechanical and biocompatible properties of parts made with their materials are suitable for their intended application, and they publish these protocols in their instructions for use documents. Following these protocols precisely is mandatory to ensure biocompatibility and optimal performance of the printed part.

Fig. 5: Complete denture printed in Denture Base Resin and Denture Teeth Resin (both Formlabs) in 50 µm. **Fig. 6:** Restorative model printed in Model Resin (V3, Formlabs) in 50 µm.

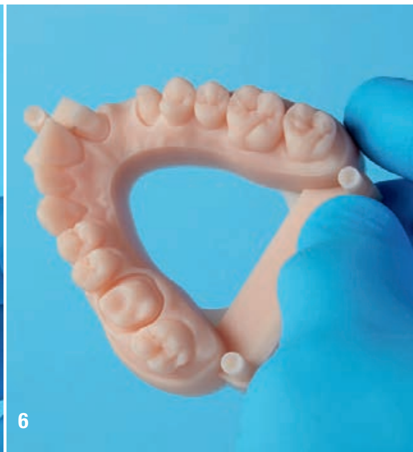


Fig. 7: Following the right protocols according to the manufacturer's instructions is key. IPA = isopropyl alcohol.

Many published research studies have explored how the mechanical properties of a printed part can vary when the post-processing steps are altered, but it is important to bear in mind that altering these parameters means that the protocol provided in the instructions is not being followed and safety and biocompatibility could thus be at stake.

Consider *in vitro* and technical data

Randomised controlled clinical trials and systematic reviews provide the strongest evidence, but to generate these, we need one fundamental thing: time. In light of the fast-paced development of new dental materials, simulated *in vitro* data is extremely helpful and a good starting point for understanding material performance. Manufacturers of dental materials need to understand that conducting *in vitro* studies will help build preliminary trust of materials. These need to be focused on answering key questions, such as how long this material will last, what the cementation protocol of these new materials is, and what clinical considerations need to be taken into account based on this material.

ISO standards are a valuable resource when analysing technical data sheets. The introduction of these specifications is beneficial to the dental community, as we have benchmarks and standardised tests available to measure the performance and quality of dental materials. As mentioned in *Phillips' Science of Dental Materials*: "Dentists are provided with criteria for selection that are impartial and reliable. Awareness by dental laboratory technicians and dentists of the requirements of these specifications is essential in recognising the limitations of the dental materials with which they are working."[1] Current and future generations need to be instructed on ISO standards as part of traditional dental education to guide their clinical decisions. Moreover, it is an opportunity to test and define if these standards are enough or need to be updated in order to cover any upcoming new categories of materials.

Manufacturers of 3D-printing materials publish safety data sheets and often marketing brochures that may contain additional technical data. Be sure to evaluate these documents carefully to glean important information about how the material has performed against ISO standards, to gain important insights into material performance in the absence of *in vivo* research.

Implications for research

Of course, evidence cannot end with *in vitro* data. On the contrary, these are the foundations and evidence for institutions to start conducting clinical studies. The industry and research institutions need to work closely to help build this data and start executing *in vivo* studies as soon as the material is available. New research strategies will need to be developed in order to produce relevant and significant clinical evidence in an appropriate time frame. Since new 3D-printing technologies and materials are introduced to the market so quickly—multiple new innovations are introduced commercially every year—clinicians and researchers need to be creative in their strategies to deliver useful clinical results before the products they are testing become obsolete. For instance, researchers can conduct multicentre studies to maximise the sample size of tests using the same protocol. Forward-looking educational institutions should also consider more collaborations with industry to rigorously test the next generation of materials while they are still in development.

3D printing is not the future—it is the present

3D printing is here, and clinicians, researchers and manufacturers are pushing forward the capabilities of this technology together. It is time for the dental community as a whole to start understanding and learning about this technology and adapting to this fast pace of innovation if we want to be able to benefit from the advantages that technologies bring while providing safe treatment options to patients. Expanding dental materials knowledge to include these new procedures and protocols while promoting more cross collaboration among research institutions worldwide is what will allow the dental profession to continue to innovate and thrive using up-and-coming technology.

about

Dr Elisa Praderi graduated from the Catholic University of Uruguay in Montevideo in 2017. She participated in the 2018 Unilever Hatton Competition, presenting a study she had conducted in the area of aesthetic dentistry at the 96th general session and exhibition of the International Association for Dental Research. She has worked at the Catholic University of Uruguay's emergency service and in private dental practice. Dr Praderi has particular interest in dental materials, clinical workflows and technology integration in the daily practice, encouraging her pursuit of a professional career in 3D printing. Consequently, in 2019, she joined Formlabs, where she holds the position of senior clinical protocols and key opinion leader manager.

Same-day conservative aesthetic rehabilitation of the maxillary anterior region with Permanent Crown Resin

Dr Alejandro Pineda, Uruguay

Fig. 1: Initial situation.

In this clinical case study, I give a step-by-step guide on how to produce anterior aesthetic restorations using Permanent Crown Resin via a full in-house CAD/CAM workflow for same-day delivery.

Introduction

Owing to the constant influx of new materials and digital workflows, digital dentistry is constantly advancing and changing. It is clear that the focus lies on further simplification of workflows that will not sacrifice the quality of results. Within the adhesive aesthetic rehabilitation field, there are two different options available for production: subtractive (milling) and additive (3D printing) manufacturing. These technologies are widely used in the dental field, and while being complementary, both have different advantages and disadvantages.

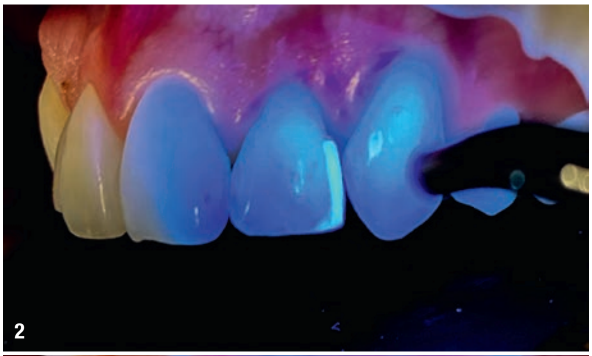
Regarding working and production time, for example, for small batches of four-unit elements, subtractive manufacturing is the fastest method of production. However, 3D printing is excellent for high-volume production, as the print time per part is optimised (the more parts you add, the less time it takes to print each individual element).

Regarding costs per part, in-house 3D printing costs only US$4–US$5 per unit, compared with between US$15 and US$18 per unit for milling. If parts need to be produced again, then costs rise for milling and are more favourable with 3D printing. Moreover, 3D printing is very cost-effective, as it requires less investment in equipment, takes a shorter time to learn to use and allows for chairside procedures.

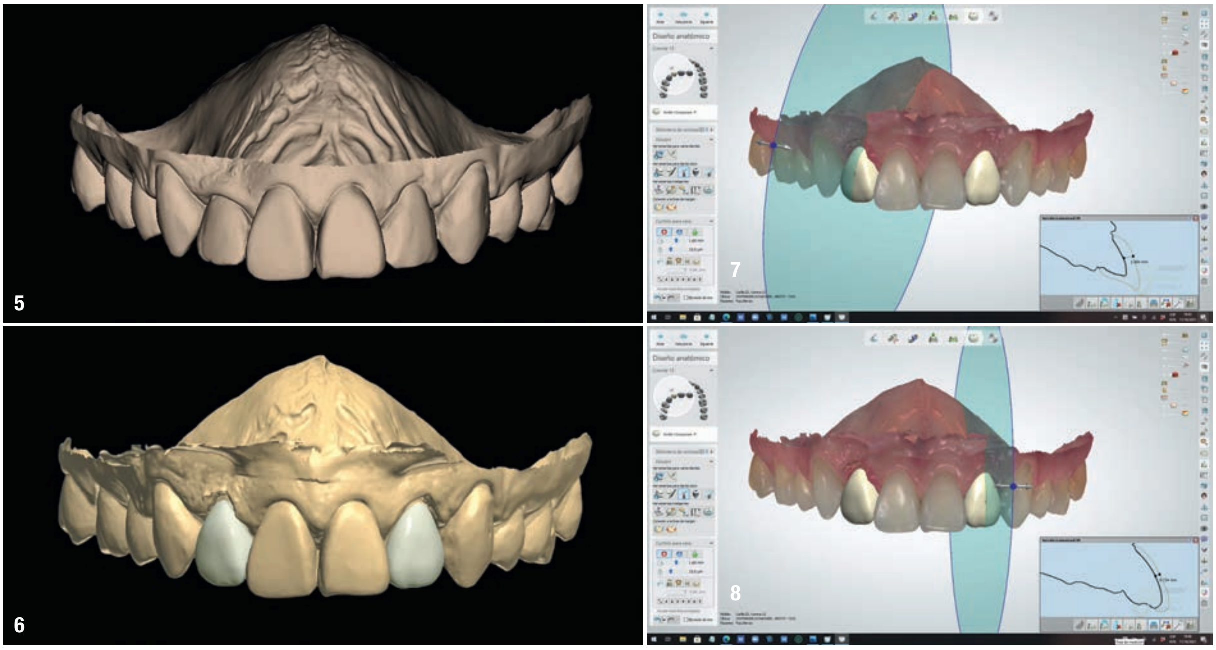
Answering critical concerns

Can 3D-printing materials be used to fabricate permanent restorations?

3D printing plays a major role in optimising permanent restoration workflows, where the key for innovation in



Figs. 2 & 3: Detection of previous restorations via K-Lite fluorescence. **Fig. 4:** Outcome of flapless crown lengthening of tooth #12 under K-Lite fluorescence.



Figs. 5–8: Digital scanning and design.

digital dentistry lies. This technology allows dental professionals to obtain optimal results with fewer digital tools, less investment in equipment and reduced costs per part, among other advantages.

The question now is what the best material is for the different dental applications, specifically for restorative dentistry. I have tested all dental materials available for use with 3D printing, but lately I have been focusing on the new restorative ones, such as Temporary CB Resin and Permanent Crown Resin (Formlabs). Today, my overall perception is that these materials are a viable solution and guarantee a promising future for upcoming restorative printable materials. These resins have been proved to be able to produce good clinical outcomes, having the right mechanical and aesthetic properties to last for a long time. We always look to use dental materials that simulate the natural tooth and possess properties that mimic those of the natural structures.

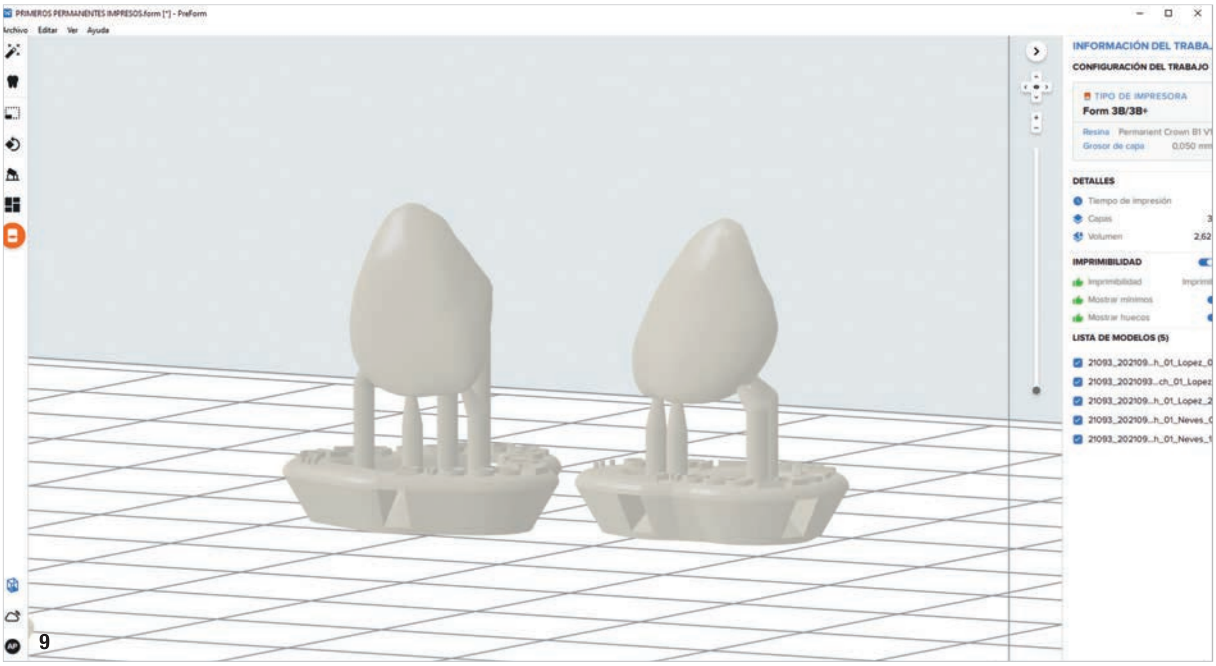


Fig. 9: Oriented and supported restorations in PreForm.

Fig. 10: Permanent Crown Resin Shade B1. **Fig. 11:** Sandblasting. **Fig. 12:** Support removal with an ultra-fine diamond disc. **Fig. 13:** Application of DiaShine Super Fine Soft with a soft brush at 8,000 rpm.

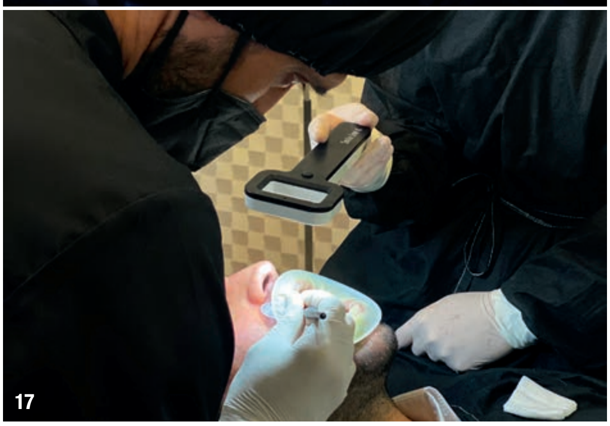


Fig. 14: Application of DiaShine Coarse with a medium brush at 8,000 rpm. **Figs. 15 & 16:** Characterisation and glazing using OPTIGLAZE Color. **Fig. 17:** Characterisation of restorations in the patient's mouth.


Fig. 18: Isolation of the operating field. **Fig. 19:** Try-in of restorations.

Can 3D-printed restorations be considered a good aesthetic solution?

It is important to understand that these printable materials are monolithic and therefore are aesthetically different to ceramics, for example lithium disilicate. This is important because colour modulation and aesthetic perception will differ from those of traditional layered restorative materials when placing these in the patient's mouth. Though for posterior restorations the aesthetic demands are lower, this have raised questions about how aesthetic these monolithic restorative materials appear in the anterior region. Should we limit their use to specific sections of the mouth? With this clinical case, I want to showcase that high-quality aesthetic outcomes can be achieved with this material, but that it does not depend on the printing phase alone. It is critical that an optimal design is done in the CAD phase, allowing the creation of natural textures that will be then replicated via 3D printing and will play a vital role in light modulation and overall perception.

Moreover, it is critical that dental professionals learn and follow the manufacturer's instructions and protocols regarding post-processing, including specific washing times, polymerisation cycles with times and temperatures, characterisation and glazing, and finally, adhesive cementation in order to guarantee the short- and long-term success of the printed restorations. Following the instructions guarantees biocompatibility of the parts and that their mechanical properties will be optimal.

Case presentation

Diagnosis

A 30-year-old male patient consulted us for a clinical evaluation, as he was unhappy with the current evolution and timing of the orthodontic treatment he was undergoing in another clinical practice (Fig. 1). A CBCT scan was indicated in order to perform an interdisciplinary evaluation of bone and periodontal structures with the orthodontist. After the clinical and paraclinical eval-



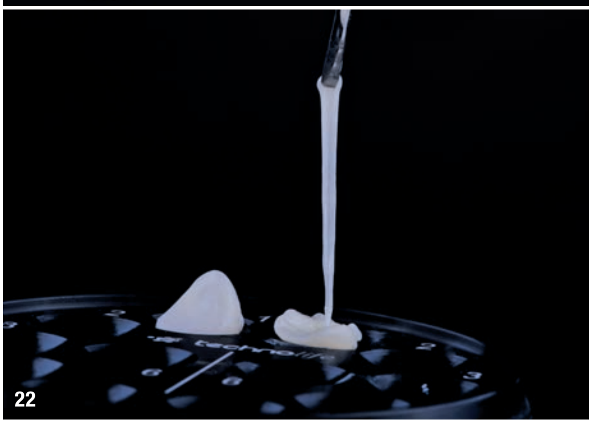


Fig. 20: Sandblasting. **Fig. 21:** Silanisation. **Fig. 22:** Cementation via the preheated resin adhesive technique.

Fig. 23: Cleaning surfaces with the AquaCare. **Fig. 24:** Protection of neighbouring teeth with PTFE. **Fig. 25:** Acid etching.

uation, the patient was discouraged from continuing his orthodontic treatment and recommended to allow stabilisation of the structures before moving to any restorative or further orthodontic procedures. Once the stabilisation of tissue had been achieved, the aesthetic and health demands of the patient would be treated.

At the clinical examination, we identified a colour change, pulpal involvement, absence of pulp vitality of and a voluminous composite restoration on tooth #12 and a defective distal closure of a diastema (towards tooth #23) with composite on tooth #22, which presented with pigmentation.

Treatment plan

The treatment plan was prepared with an interdisciplinary team and would consist of root canal therapy of tooth #12, placement of an aesthetic fibre post and restoration with a complete crown and placement of a veneer on tooth #22 to achieve distal diastema closure. The restorations for teeth #12 and 22 would be fabricated via 3D printing using Permanent Crown Resin.

Execution of treatment plan after endodontic treatment

Based on the treatment plan and depending on the expertise of the dental professional and team managing each one of the steps of the workflow, one or two appointments are needed for the aesthetic rehabilitation. In this case, the restorations were designed and produced fully in-house in one single appointment without temporisation.

Flapless crown lengthening of tooth #12 was performed, and the pre-existing composite restorations were removed under K-Lite fluorescence (Smile Line; Figs. 2–4). #7 Sil-Trax gingival retraction cord (Pascal International) was used to manage the soft tissue. Sufficient tooth preparations of different thicknesses guided by the tooth substrate were done of tooth #12 for a crown and tooth #22 for a veneer.

After completing the tooth preparation, the shade was taken by considering the final colour to be achieved by observing both the colour of the healthy neighbour teeth and the final colour of the prepared tooth substrate (darkened), which also determined the amount of tooth preparation needed.

Intra-oral scanning (TRIOS, 3Shape) was performed to capture the data to proceed with design. In the CAD phase, natural tooth libraries were utilised to design the restorations (Dental System, 3Shape; Figs. 5–8). Once the design had been completed, the file was exported in STL format.

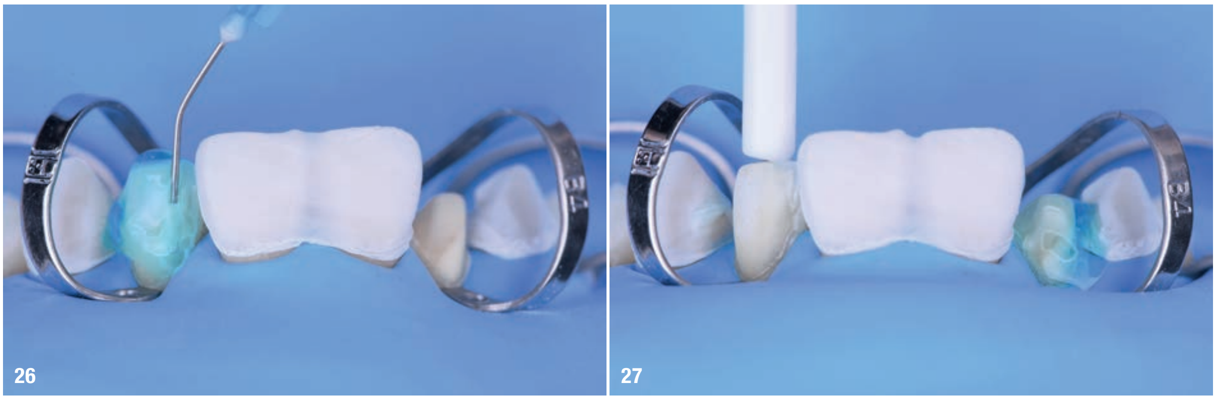


Fig. 26: Acid etching. **Fig. 27:** Washing and drying.

Fig. 28: Washing and drying. **Fig. 29:** Application of primer and bonding. **Fig. 30:** Placement of restorations.

Manufacturing stage
The STL file was imported into PreForm print preparation software (Formlabs), where the restorations were given the correct print orientation and supporting structures (Fig. 9). The restorations were sent to the Form 3B printer (Formlabs) to be fabricated with Permanent Crown Resin in Shade B1 within our clinic (Fig. 10).

After printing, the restorations were removed from the build platform and washed in 99% isopropyl alcohol for 3 minutes in the Form Wash (Formlabs). The parts were dried using compressed air.

The first polymerisation cycle was done in the Form Cure (Formlabs) for 20 minutes at 60 °C. The surfaces were sandblasted carefully to remove the powder surface coating (ceramic fillers contained in the resin) using the AquaCare (Velopex) at 150 kPa maximum pressure (Fig. 11). We then removed the supporting structures using a diamond disc (Fig. 13). The second polymerisation cycle was done in the Form Cure for 20 minutes at 60 °C.

The next steps were critical for guaranteeing success. All external surfaces of the restorations were polished in two stages, first using DiaShine Super Fine Soft with a soft brush at 8,000 rpm (Fig. 13) and then using DiaShine Coarse with a medium brush at 8,000 rpm (Fig. 14). The restorations were then characterised and glazed (OPTIGLAZE Color, GC) for further customisation (Figs. 15 & 16).

After completing this step, a final characterisation step with the restorations seated in the patient's mouth was done. This was a critical step to ensure the perfect aesthetic integration of the restorations. After placing the printed restorations in the patient's mouth, an evaluation on the impact of the tooth substrate colour on the restorations was done. In a moisture-controlled operating field, the restorations were finally characterised in different areas (cervical, incisal edges and borders). Glaze was applied to finalise the restorations (Fig. 17).

Delivery and cementation protocol
As this case was for same-day delivery, no temporary restorations were necessary. The operating field was set up using a dental dam. This allowed us to completely isolate the site from the moisture of the oral cavity and improve visibility. The restorations were tried in to validate their insertion and fit (Figs. 18 & 19).

As for cementation, the following steps were performed simultaneously on the tooth structures and the internal surface of the restorations with the help of the dental assistant.

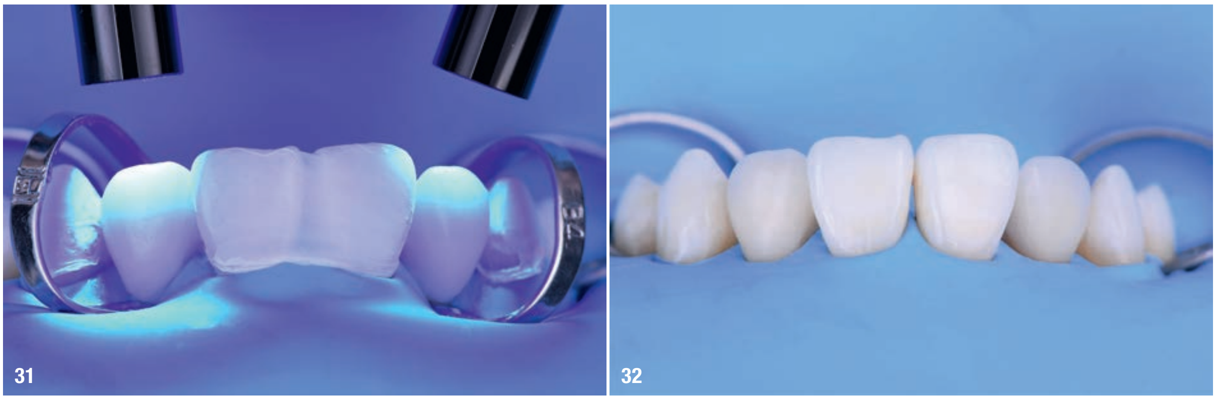


Fig. 31: Light polymerisation. **Fig. 32:** Cemented restorations.

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Fig. 33: Final photograph with restorations in place. **Fig. 34:** Tooth #12 with a complete crown. **Fig. 35:** Tooth #22 with a veneer.

Internal surface preparation of the printed restorations (Figs. 20–22):

1. Sandblasting with 53 µm aluminium oxide particles (Velopex) with the AquaCare to increase mechanical retention;
2. Cleaning to remove the aluminium oxide particles with water and compressed air;
3. Silanisation (Porcelain Primer, BISCO) for 2 minutes and drying; and
4. Cementation using the preheated resin adhesive technique (69 °C in Hot Set, Technolife) and placing the cementation agent on the internal surfaces of the restorations.

Tooth structure preparation for adhesive cementation (Figs. 23–32):

1. Cleaning of surfaces with aluminium oxide particles and Sylc with the AquaCare;
2. Protection of neighbouring teeth with PTFE;
3. Etching for 15 seconds on enamel;
4. Washing with water and drying; and
5. Application of self-conditioning adhesive system by active application to dentine for 20 seconds and then drying for 15 seconds to evaporate the solvent.

The restorations were placed on the prepared teeth, excess cement was removed with a brush, and the restorations were light-polymerised for 40 seconds. The dental dam was removed, the occlusion was checked and photographs were taken for documentation purposes (Figs. 33–35).

Follow-up

After six months, the printed restorations were stable and without any signs of clinical concern.

Conclusion

The 3D-printable ceramic-filled resin Permanent Crown Resin is an excellent option to offer to patients who are in need of adhesive anterior aesthetic and conservative restorations, and it allows the production of these via a full in-house CAD/CAM workflow. With this material, we achieved very good results with regard to adaptation, morphology, texture, surface finish and colour.

Regarding investment costs, 3D printing has considerably lower costs associated with hardware, resins and consumables compared with milling systems. Moreover, as for overall production costs, printed restorations are three times less expensive than milled restorations. This clinical case is evidence that printable materials are here to stay.

Acknowledgements

Thank you to Dr Verónica Champret for performing the endodontic therapy, to Evangelina Escobar for her clinical assistance, to Lorena Moncalvo and Paola Arzarello for their patient care, and to Formlabs, Formlabs Dental and Vacodir Uruguay, for developing high-quality solutions for digital dentistry and for providing your constant support.

about

Dr Alejandro Pineda graduated in dentistry from the Universidad de la República in Montevideo in Uruguay in 2002 and undertook further studies abroad, including postgraduate courses on implantology and aesthetic rehabilitation. During this journey, he collaborated with well-known clinicians and dental laboratory technicians around the world, developing digital workflows that he now uses to drive positive patient outcomes. He is a digital dentistry specialist and passionate about aesthetics, design and driving state-of-the-art clinical results.

At his practice in Montevideo, Clínica Lhasa, where he is director, he has implemented full in-house digital workflows. An early adopter of innovative dental technologies, he first invested in Formlabs 3D printers in 2016. Based on the practice's philosophy of having full control of all the digital steps, including diagnosis, scanning, design and production, each clinical case is produced digitally from start to finish within the practice to guarantee the best quality, full control over production and delivery times, and personalised care of patients.


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Extremely minimally invasive mock-up-guided veneer preparations in the aesthetic area

Dr Alessandro Pezzana, Italy


Fig. 1a: Initial situation. Teeth in intercuspal position, frontal view. **Fig. 1b:** Initial situation. Teeth in protrusion, frontal view.

This clinical case describes an aesthetic approach to the anterior dentition using veneers. The differential thickness of each veneer was obtained on the basis of extremely minimally invasive preparations. Such preparations are less invasive for enamel integrity than veneer preparations carried out directly on the tooth. The controlled preparations were carried out using a working mock-up created on a wax-up that closed the diastemas between the anterior teeth.

Case report

A 25-year-old male patient came to the practice to resolve an aesthetic problem regarding the anterior dentition, namely the gaps between his teeth. This had become such a problem for him that he avoided showing his teeth in photographs. He had high aesthetic expectations of treatment and desired complete closure of the anterior diastemas.

The patient was in good general health and did not report any medical problems. He was certain that his oral hygiene was good, which was supported by the fact that he did not have any caries.

Records and diagnosis

An intra-oral physical examination, vitality test and probing were conducted, periapical radiographs were taken and initial tooth colour was assessed. There were no signs or symptoms of periodontal disease. The patient had previously had orthodontic treatment requiring the extraction of the third molars. At the time of the appointment, the patient had excellent Class I canine and molar occlusion. The maxillary arch presented with a diastema and further gaps between the central and lateral incisors. The diagnosis was diastemas after orthodontic therapy.

Treatment plan

The treatment method adopted aimed to afford better conservation of the dental tissue than is possible with conventional veneer preparation performed directly on the tooth. This extremely minimally invasive approach


Fig. 2: Initial photograph showing a detail of the maxillary arch. **Fig. 3:** Occlusal photograph of the anterior sextant.

would be achieved with a mock-up for advanced aesthetic dentistry permitting controlled preparation, that is, preparation that is calibrated on the different thicknesses of the mock-up. This basis would be used to create semi-indirect veneers for space closure (Type IIB veneers according to Magne and Belser).[1]

Treatment

During the first appointment, photographs (Figs. 1–3) and alginate impressions of the dental arches were taken. After photographic study of the case, the necessary aesthetic and functional corrections were performed by means of an analogue diagnostic wax-up phase. The wax-up was transferred to the patient's mouth in the form of a mock-up that he tested in his mouth for a few days prior to the operative session. At the following appointment, this was used as a working mock-up for calibrated preparation, that is, a mock-up-guided approach for extremely minimally invasive, controlled tooth reduction.

To simulate the final result as already seen with the analogue wax-up as accurately as possible, the waxed-up model was scanned.[2] For moulding the mock-up from the wax-up (Figs. 4a & b), a silicone index was created on the wax-up (Fig. 4c). Composite (Structur 3, VOCO) was injected into this silicone key to create the mock-up. The diagnostic mock-up was temporarily cemented (Provicol QM Aesthetic, VOCO) in the patient's mouth for a few days until the operative session.

At the next appointment, the mock-up took on the role of a working guide for controlled preparation. Controlled-thickness reduction grooves were made in the mock-up for orientation, as they were used to determine the depth of the preparation and thus the desired material thickness of the veneers (Fig. 5). For providing clear orientation, the guiding grooves were marked with a pencil (Fig. 6). Where the residual mock-up remained, the tooth was intact (extremely minimally invasive preparation). Only in the areas where the mock-up had been completely ground down was there an effective preparation of the tooth structure (Fig. 7). Compared with conventional veneer preparation, for which the dentist grinds the tooth structure directly from the beginning, this procedure allowed for much more conservative tooth reduction. It was decided not to intervene in the lateral and protrusive movement.

The first step was to perform window or Walls, Steele and Wassell Type A preparations,[3] meaning that the preparations were only carried out on the vestibular aspect, without finishing margins and without any reduction of the incisal edge. However, an incisal butt joint margin was carried out to cover the incisal edge without any vertical reduction in the palatal area. It has been shown that such a covering of the incisal edge achieves a higher survival rate than preparations with a palatal chamfer.[4,5]

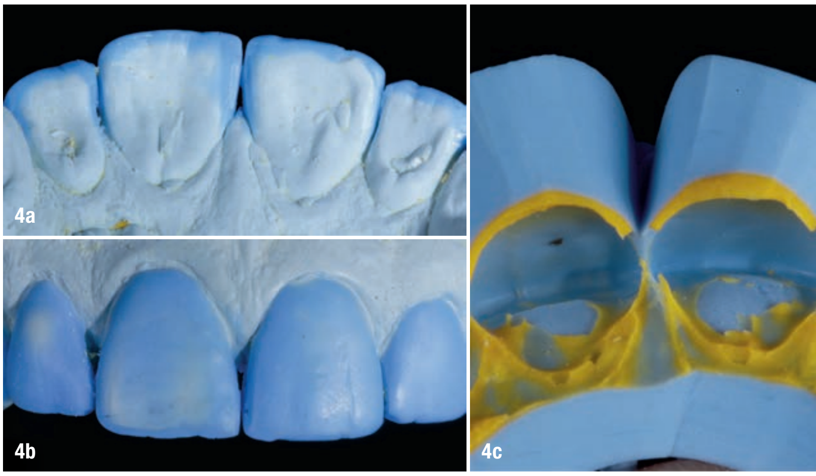

Fig. 4a: Analogue wax-up on the gypsum model, palatal view. **Fig. 4b:** Analogue wax-up on the gypsum model, vestibular view. **Fig. 4c:** Silicone index for moulding the mock-up in composite for the provisional restoration.

Fig. 5: Operative phase in which the mock-up acted as a guide for highly conservative, controlled preparations. **Fig. 6:** Guide grooves marked with pencil for calibrated preparation primarily on the composite. **Fig. 7:** Mock-up removed with pencil marks where the preparation would continue directly on the tooth (sacrificing the mock-up spared healthy hard tissue).

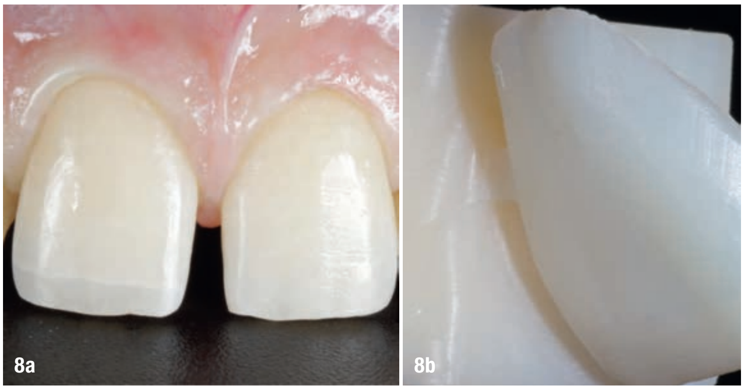

Fig. 8a: Completed extremely minimally invasive preparations without finishing lines ready for digital impression taking. **Fig. 8b:** First veneer fabricated by digital milling.

Once the final preparations had been obtained (Fig. 8a), they were scanned, initiating the digital phase of the workflow that ended with the fabrication of the veneers using a CAD/CAM milling unit (M2 Teleskoper, Zirkonzahn). The veneers were made of a highly filled nano-ceramic hybrid material (Grandio blocs, Shade A2, low translucency; VOCO; Fig. 8b).

Once they had been cleaned, the prepared teeth were rinsed thoroughly and dried with a gentle jet of compressed air. The veneers were inserted carefully by exerting slight pressure. The chromatic effect met the expectations of both the patient and the clinician (Figs. 9 & 10). Before being finished and polished, the veneers created using CAD/CAM technology underwent chromatic characterisation so that the pigmentation (FinalTouch, VOCO) was fixed under this thin layer of composite.

The dental dam used to obtain isolation was secured using special cervical clamps for incisors (clamp #212, Hu-Friedy; Figs. 11 & 12). This was followed by proper adhesive priming of the surfaces to be luted to one another (inner surfaces of the restorations and surfaces of the prepared teeth). As a protective measure in view of the subsequent clinical steps, the adjacent surfaces that were not to be covered were isolated using PTFE tape.

The tooth surfaces were then conditioned, first by pretreatment with glycine powder, which through micro-abrasion increases the retentive potential of the bonding (Fig. 13). Etching was then performed using 35% orthophosphoric acid (Vococid, VOCO) for 20 seconds (Fig. 14). The acid was then removed by suction and rinsing for 20 seconds, and the surface was dried with compressed air to obtain a matt chalky white appearance. The universal adhesive (Futurabond U, VOCO) was applied and gently rubbed for 20 seconds using a brush (Single Tim, VOCO; Fig. 15). The solvent was then evaporated thoroughly with compressed air for at least 5 seconds to obtain a thin, immobile and shiny layer of adhesive, which was polymerised from various directions using a high-power LED curing light (Celalux 3, VOCO) for 10 seconds each time, in accordance with the manufacturer's instructions. This created a matt–shiny preparation surface that was evenly coated with adhesive.

> "The working mock-up ensures greater thickness control of the veneers before proceeding with the precision impression for the digital design of the final veneers."

For the pretreatment of the inner surfaces of the veneers, abrasive sandblasting with 25–50 µm particles of aluminium oxide was performed at 1.5–2 bar pressure, and a silane adhesive coupling agent (Ceramic Bond, VOCO) was applied and left to act for 60 seconds and then dried for 5 seconds. The veneers were finally cemented using a dual-polymerising universal luting composite (Bifix QM, VOCO; Fig. 16). The veneers were inserted (Fig. 17) and fixed by means of polymerisation at marginal level using a Celalux 3 mesially and distally from the vestibular side, followed by mesial and distal polymerising from the palatal side. In order to avoid an oxygen inhibition layer and thus avoid poor polymerisation,

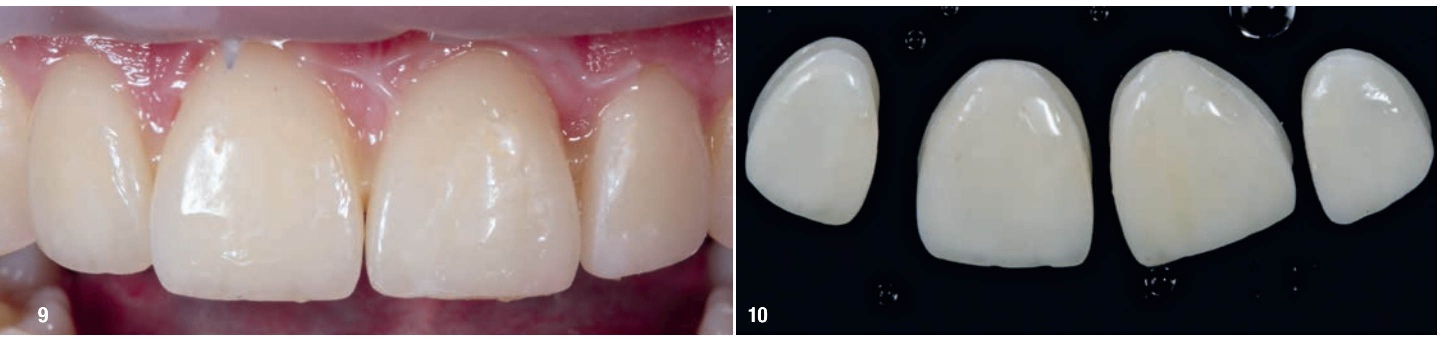

Fig. 9: Veneer fit test. **Fig. 10:** CAD/CAM veneers after characterisation, finishing and polishing.


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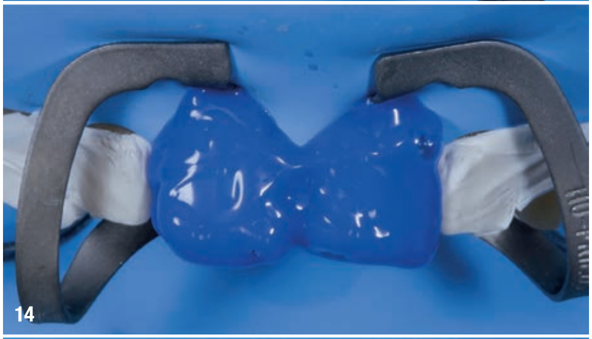

a glycerine gel was applied to all margins prior to polymerisation (Liquid Strip, Ivoclar). By means of this oxygen inhibition gel, a significant improvement of the adhesive margins could be achieved. The glycerine was rinsed off, and at the end of the setting time of approximately 3 minutes, it was then possible to proceed with elimination of the excess material using a metal instrument and dental floss, interproximally. The interproximal contact zones were finished using abrasive strips. After checking the occlusion and making corrections in accordance with conventional functional concepts, normal finishing and polishing was performed using diamond polishers (Dimanto, VOCO). The patient was completely satisfied with the significant improvement in his smile (Figs. 18–22).

Discussion

Based on an analysis of the scientific literature concerning the closure of anterior diastemas, a semi-indirect approach using nano-hybrid composite veneers was chosen.[6] The clinical indication of diastema closure classifies the veneers used for this case as Type IIB according to the Magne–Belser classification.[1] Since feldspathic ceramic veneers were outside the patient's budget, such an indirect technique was ruled out. The direct layering technique was ruled out because the patient had high aesthetic expectations. It was decided to use veneers

Fig. 11: Isolation of the operative field using a dental dam, frontal view. **Fig. 12:** Isolation of the operative field using a dental dam, occlusal view. **Fig. 13:** Isolation using PTFE and appearance of the sandblasted surfaces. **Fig. 14:** Orthophosphoric acid etching of a substrate that was still enamel thanks to the extremely minimally invasive approach adopted. **Fig. 15:** Application of the adhesive luting agent to the surfaces to be bonded. **Fig. 16:** Bifix QM luting system (VOCO) applied to the tooth #21 stump and PTFE tape covering the adjacent teeth. **Fig. 17:** Insertion of the veneers.


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Fig. 18: Final result, frontal view. **Fig. 19:** Final result, right lateral view. **Fig. 20:** Final result, left lateral view.

on both the central and the lateral incisors, as this would make it possible to obtain more harmonious relative dimensional proportions.

The wax-up must first be transferred to the mouth in the form of a provisional prototype with a dual clinical function as a diagnostic mock-up for aesthetic and functional aspects and as a working mock-up for


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Fig. 21: Teeth in intercuspal position one year after the treatment, frontal view. **Fig. 22:** Teeth in protrusion one year after the treatment, frontal view.

calibrated preparation, that is, a guide for controlled, extremely minimally invasive tooth reduction.[7] The diagnostic mock-up is the composite provisional restoration for the usual in-mouth fit test, and it allows immediate and effective communication with the patient and makes it possible to test in-mouth tolerability for a few days prior to the operative session. These prototypes fitted on the individual teeth have a wow effect on patients, as they provide an in-mouth preview of the aesthetic results to be achieved. In the initial stages of tooth preparation, the working mock-up for controlled preparation is calibrated based on the physical dimensions of the mock-up. With controlled preparation, the provisional restoration is gradually destroyed, resulting in a far more minimally invasive preparation than that performed directly on the tooth. Using special calibrated burs, this preparation ensures the most enamel-sparing thicknesses possible and the highest aesthetic and functional characteristics. The working mock-up ensures greater thickness control of the veneers before proceeding with the precision impression for the digital design of the final veneers. The adhesive protocols described were compared with authoritative sources (Magne)[8] and with recent literature (Blatz et al.).[9]

Conclusion

Full patient satisfaction was achieved. The success of the treatment was due to the combination of two factors: minimal tooth preparation and complete closure of the diastemas without adverse repercussions on shape, proportions or chromatic integration.

This case has demonstrated that less is better. Indeed, mock-up-guided veneer preparations reduce the biological sacrifice of the tooth to a minimum while guaranteeing function and maximising the long-term aesthetics. This approach also demonstrates how conventional and digital workflows can be combined effectively.

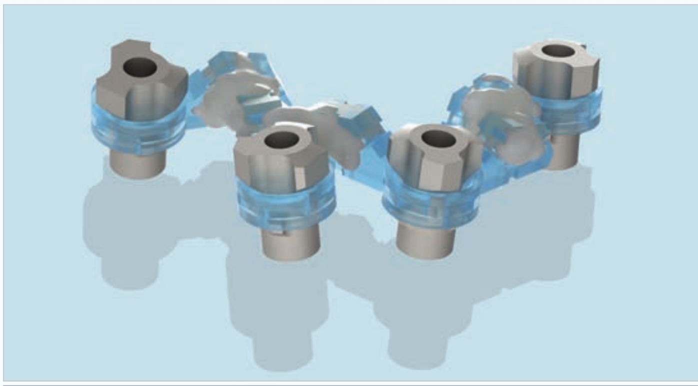
Editorial note: A list of references is available from the publisher.

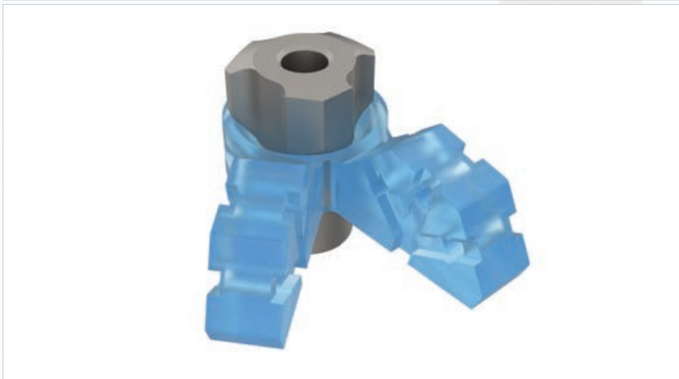
contact

Dr Alessandro Pezzana graduated in dentistry from the University of Turin in Italy in 2012. Since 2013, he has been practising in his own practice, Studio dentistico Pezzana e Togno, in Omegna in Italy. He also teaches and researches aesthetic and adhesive dentistry at the University of Turin. Dr Pezzana's areas of expertise are aesthetic restorative dentistry, endodontics and dental photography. He can be contacted at alessandro.pezzana@hotmail.it.

3D printing drives innovation

Leif Svensson, Australia





My digital dental journey started around five years ago when I received a call from the CEO of Australia's largest branded dental service organisation, asking me to assist in negotiating one of the largest intra-oral scanner deals in the southern hemisphere, as well as to develop a training programme to support the use of the scanner for the almost 600 dentists in the group. I am a dental practitioner by trade, but at that time, I was responsible for managing a brand within the group in over 40 locations. At the same time, I had oversight of one of the largest dental laboratories in Australia. As the Pacific Smiles Group's founder Dr Alex Abrahams put it, he wanted me to take the group from a horse and cart to a Tesla as fast as possible. Knowing that I did not have a century to achieve this, I looked to other innovative companies to assist me. There are a myriad of intra-oral scanners out there, creating digital files as an output from the intra-oral scan. It was in wondering who could help us with using the output of these files that my passion for 3D printing began. Little did I know that my passion would pay dividends in terms of rapid prototyping of dental solutions well into the future.

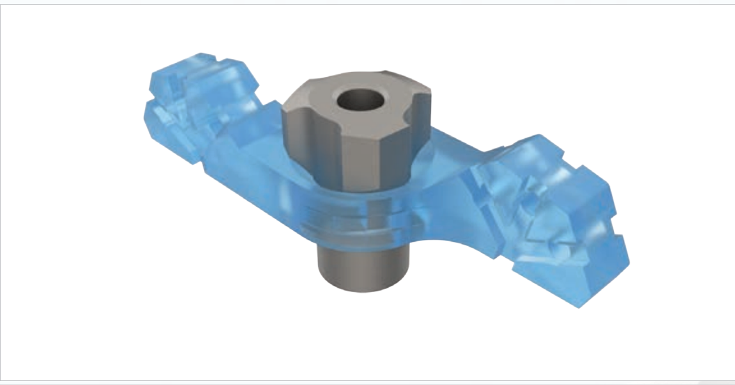
Closing the innovation loop

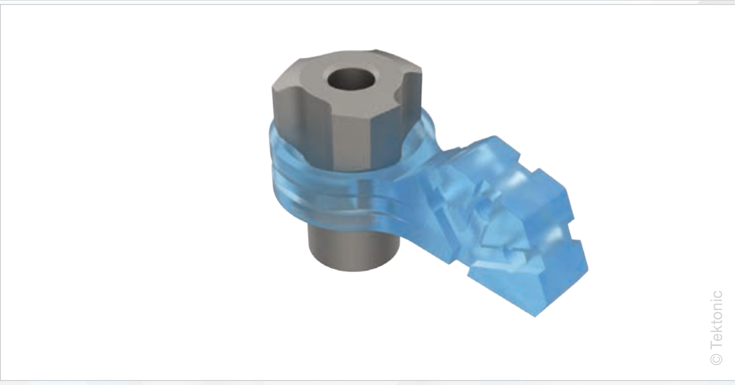
Tektonic is a patented long-span intra-oral scanning solution. It allows for accurate recording of implant positions to enable digitally fabricated implant prostheses quickly, simply and, more importantly, accurately. There were many iterations of the product, resulting in the development and testing of multiple prototypes before the product was ready for clinical use.

The cost of multiple testing phases and changes to a prototype using traditional approaches would have been prohibitive. This is where 3D printing has made such a difference. For Tektonic, 3D printing the device prototypes has enabled us to close the innovation loops quickly as we identify and refine our innovative ideas into practical solutions. What would have taken us weeks or months in the past, now quite literally takes us minutes or hours. Speed is one thing, but when working with single-digit micron tolerances, it is critical to have an output device that can fulfil the requirements of the product, including functioning in a patient's mouth. Asiga 3D printers delivered this to us in spades through their precision printing technology.

Changing the game for digital implant dentistry

I have taken almost 3,500 complex intra-oral scans in my daily practice, and one thing that I have learned when recording implant positions is that anatomy does not care about dental innovation. The anatomy presents in unique and often very complex patterns. When you add multiple implants to that environment (which are often at divergent angulations) and then





try to accurately record these positions digitally, it can be very difficult to scan, particularly in the edentulous mandible.

That is why Tektonic is not a horizontal scanning system. It is a vertical one with fixation points to allow a myriad of geometric wing piece options which overcome the incongruent nature of the oral anatomy. The 3D-printed wing pieces are selected according to the best shape for the implant position and anatomy. They are then locked on to the titanium core piece. This core piece is then screwed to the implant multi-unit abutment so that the practitioner can bond the wings together in the Tektonic guttering systems using dental composite. This results in a rigid scanning bridge upon which to follow and record implant position and soft tissue—a verification jig (both virtual and physical). The bonding together of the wings allows a truly unique scanning path that is very easy to traverse.

Tektonic workflow

To demonstrate the use of Tektonic, this example will cover the steps of a workflow for an immediate loading protocol in the case of a patient with a complete maxillary denture opposing failing mandibular natural dentition. The treatment goal was to extract the mandibular teeth, place the implants and then as quickly as possible produce a temporary restoration that would be immediately loaded.

Pre-extraction scans of the mandibular dentition and of the maxillary denture in occlusion were first taken. Selected teeth were then extracted from the mandible, and the anterior implants, multi-unit abutments and sutures were placed. Tektonics with wings were placed upon the anterior multi-unit abutments and bonded within the wing guttering systems. The bonded Tektonics and the remaining teeth were scanned (although we only kept two teeth for superimposition, it still worked very well). This allowed the laboratory team to align the anterior implant positions with the bite in the pre-extraction scan. After scanning, the Tektonics were removed and the rest of the teeth were extracted. The posterior implants, multi-unit abutments and sutures were placed and the anterior Tektonics re-affixed. As a result of the Tektonic wing-to-wing bonding system, the Tektonic scanning bridge will not be affected by vertical shrinkage and will thus not incur any meaningful dimensional change in the cross-arch scan. The posterior Tektonics were placed, the full complement of the cross-arch Tektonic scanning bridge was scanned and the Tektonics were removed. Depending on the type of scanner being used, the Tektonic scan file can be locked and copied so that a digital verification and full soft-tissue scan can be created. This is done by cropping the Tektonics from the scan and then rescanning over the multi-unit abutments and any soft tissue that may have been missed in the full-arch Tektonic scan. The files were then sent to the laboratory for the temporary fixed restoration.

The present and the future

For the dentist, Tektonic's innovation will mean significant time saved and less stress, along with more confidence in the accuracy of the restoration fitting, all while using a fully digital workflow. The patient will also be far less inconvenienced, thanks to shorter appointment times, and feel more comfortable with dental procedures, as traditional intra-oral impressions and record taking are no longer required. The emergence of intra-oral scanners and 3D-printing technology has revolutionised the practice of implant dentistry and enabled the development of the Tektonic system. I look forward to seeing how the Tektonic system continues to evolve with ongoing development of innovative digital workflows.

about

Leif Svensson is the co-founder and creative director of Tektonic Scankraft company in Australia which offers innovative solutions for full-arch implantology. More information can be found at www.tektonicscan.com.

3D printing in the dental office: A user report

Dr Ingo Baresel, Germany

The launch of new materials and technologies in recent years has put the focus squarely on digital manufacturing techniques in the daily workflow of dental laboratories. The rising prevalence of intra-oral scanners in dental offices has further advanced the possibility of a fully digital workflow. For a long time, only subtractive techniques were available for fabricating dental workpieces such as models, crowns and bridges. Then 3D-printing technology arrived on the scene a few years back. At the beginning, various factors greatly limited 3D-printing applications: the materials, accuracy and permanent stability of 3D-printed objects, and biocompatibility of resins were all found to be lacking. Additionally, the first devices on the market were very expensive.

1

Fig. 1: Dr Ingo Baresel is a dentist with a particular focus on digital dentistry and is president of the Deutsche Gesellschaft für digitale orale Abformung (German association for digital oral impressions).

Things have significantly improved in the meantime. Today it is possible to print precise models, night guards, surgical guides for implant insertion and temporary restorations. Materials are now available that are approved to remain permanently in the mouth. Printers capable of additive manufacturing of zirconia crowns are also now available.

3D printing is an extremely economical manufacturing process: only the material needed to produce the workpiece is actually consumed. The object to be printed is initially designed in CAD software and is then transferred to the printer software. The software breaks down the object into thin layers. Depending on the printer type, various techniques are used to print the layers consecutively until the object is completed. The layer thickness can be modified in the software. In principle, the thicker the layer is, the faster the printing phase will be. Thicker layering leads

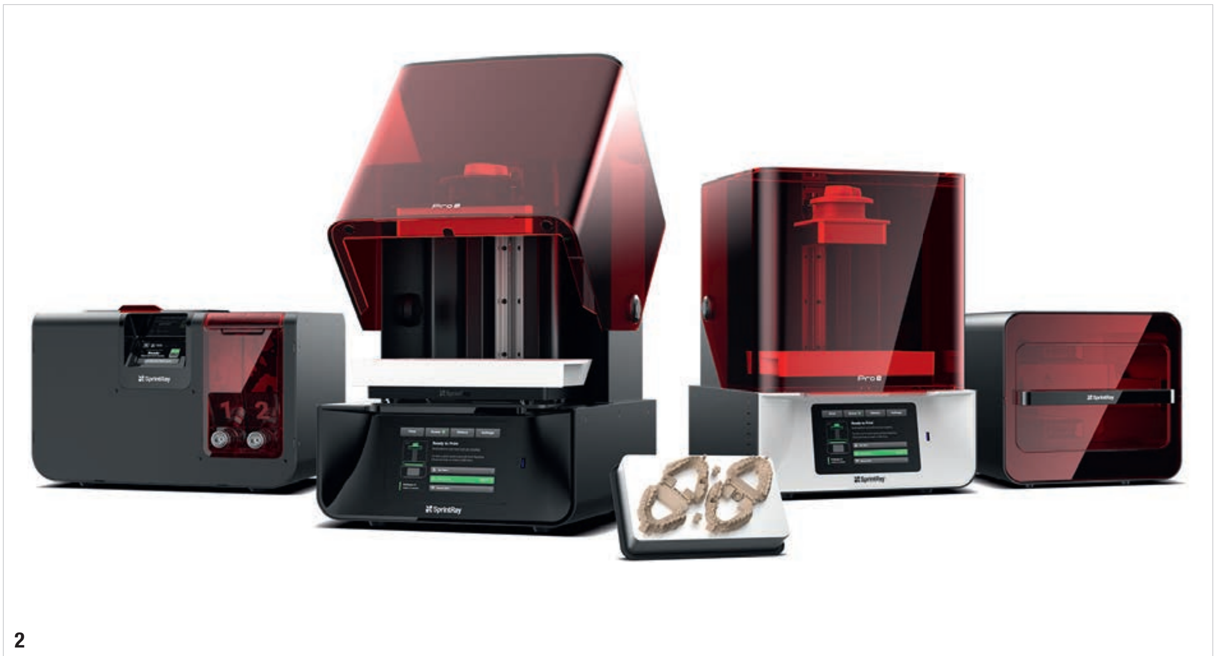


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Fig. 2: The complete 3D-printing solution from SprintRay includes the SprintRay Pro S printer, the automatic washing and drying system Pro Wash/Dry and the polymerising unit ProCure 2. The printing software RayWare supports the user in easy placement of the print objects.

3

Fig. 3: The SprintRay Cloud Design service supports users who are looking to print directly from the scan without performing CAD themselves. With fast turnaround times, specialised design teams individually prepare printable STL files according to users' requirements.

to greater inaccuracies, however. It is therefore important to know the correct layer thickness for each workpiece. There are also a few basics to keep in mind for achieving good printing results. For example, the printer should not be placed in direct light, the room temperature should be kept stable and the air should be as dust-free as possible.

We have been using various intra-oral scanners in our dental office since 2012. Our dentures and splints are also fabricated digitally. A milling machine is also available to us to enhance chairside workflow. The launch of 3D printing using the SprintRay Pro printer closed the yawning gap in our internal digital fabrication processes. It has always been important to us that all processes are quick and easy alongside the daily office routine and do not have to be transferred to dental technicians who have to be specially employed for the task.

This process also clearly defines the range of indications for workpieces produced in the office. Fabricating models for creating retainers, splints, thermoformed aligners, custom trays and even simple night guards is now easy to accomplish in the dental office. Temporary restorations, eggshell temporary restorations and digital mock-ups can also be produced in this way. The appropriate CAD software must be available for these applications. As the added value remains in the office, the acquisition costs can be paid off very quickly.

SprintRay has also introduced a cloud design service recently, which we have not tried yet, but which would take the CAD software completely out of the equation.

The printing software (RayWare) that is used with a SprintRay printer is very simple and can also be used by practice staff after induction training. RayWare supports the user in positioning the object, mounting any necessary supporting structures, and selecting the right resin and the required layer thickness. Plenty of materials are available for the SprintRay printer, from the manufacturer and from third parties. Special cartridges are not required. The appropriate resin tank is then placed in the printer, and the printing process is started. With the new RayWare Cloud solution, all these steps are automatic.

Post-processing of the printed workpiece is important in achieving a good printing result. Pro Wash/Dry is a very high-quality device from SprintRay for washing objects in isopropanol. This is an automated process. After washing the object, the object is then light-polymerised in ProCure 2, heating and light intensity varying depending on the material. The software sets the pressure and polymerisation parameters automatically according to the material specifications.

3D printers are now an indispensable tool in the digital dental office for fabricating a wide variety of workpieces.

Latest updates in dental 3D printing

By Rapid Shape

Numerous factors can make or break the process of achieving high-quality and precise 3D-printing results. The most important factors involved are the technology of the 3D printer and the post-processing equipment, a seamless end-to-end process and the selection of the right 3D-printing resins.

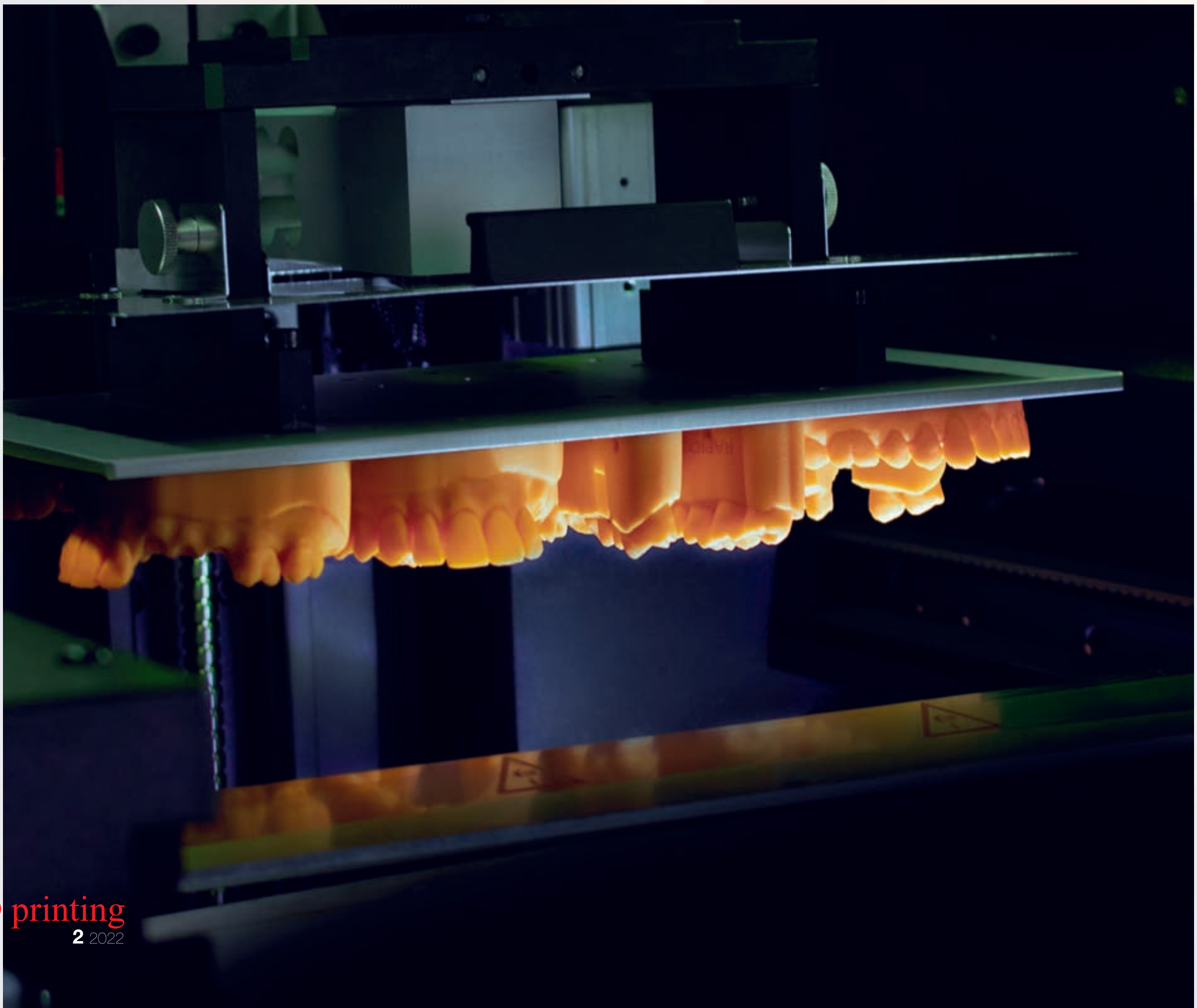
A workflow tailored to the specific indication, including scanning, design, 3D printing and post-processing, enables laboratories and dental technicians to consistently produce at the highest quality and efficiency level each day. Validated workflows support users thanks to the state-of-the-art software integration of all devices along the process chain. Laboratories, dental technicians and dentists work hand-in-hand while using modern 3D-printing technology. This is the contemporary reality, and patients appreciate the resulting fast and effective treatment.

Freedom for the user through an open-material system

Several 3D printers, for example, the D50+, engineered and produced by the German company Rapid Shape, offer an open-material system. In addition to the more than 200 validated resins, Rapid Shape 3D printers can process all technically available resins owing to this open material system. The device is also equipped with radio-frequency identification. This means that the material bottle selected by the user is immediately recognised, and any necessary settings on the device are made available automatically.

A broad material selection for various applications in the dental sector is available

Almost ten years have passed since the market breakthrough of dental 3D-printing materials. In this respect, laboratories and practices not only have access to a broad spectrum of material manufacturers but also to a wide range of applications. Certain dental applications within 3D printing, such as bruxism splints, crowns and inlays, used to be trickier to accomplish but have become standard today owing to long-term experience and clinical studies. Material manufacturers, including dentona, DETAX, DMG, Keystone and Straumann, offer a wide selection of very high-quality resins.



Research and development in the field of resins is ongoing. Regulatory requirements have become stringent owing to the new EU Medical Device Regulation and the latest U.S. Food and Drug Administration regulatory framework for the 3D printing of medical devices. Thus, validated manufacturing processes are indispensable prerequisites which include the—often underestimated—post-processing steps: washing and postcuring. Compliance to wavelength, intensity, time, and atmospheric conditions such as vacuum are essential. Seamless end-to-end processing equipment allows users to execute and protocol the validated process parameters at the touch of a button, all linked to the specific patient case.

Bioresorbable 3D-printing resins—helping people heal in the future

So where will the resins of the future take us? Consider as a future application the ideal polymer for use in regenerative medicine. Such resins must not only be biocompatible but also exhibit non-toxic biodegradation with mechanical properties matched to specific applications, whether they be soft tissue, connective tissue or bone.

The UK-based company 4D Biomaterials is intensively engaged in the development of 3D-printable, biocompatible and bioresorbable material and is supported in its work by the 3D printer manufacturer Rapid Shape. The 4D Biomaterials photocurable resin brand 4Degra is based on polycarbonate urethane chemistry and is available in several grades. Early tests show that 4Degra materials promote cell growth significantly better than incumbent bioresorbable polymers such as polylactic acid and polylactic-co-glycolic acid. The resin inks are already available for use in research and development projects.

Sustainability in 3D printing—material savings and material recovery

Sustainability and environmental compatibility are the words of the day in many industries and are hot topics for manufacturing companies. For this reason, every company must make sustainability its goal, acting in the interest of future generations. Material use, material savings and material recovery are all-important in 3D printing in order to make the printing process not just sustainable but also effective and economical.

Manufacturers of modern 3D printers have established the technical prerequisites for material savings. An automatic part separation module reduces idle time between two print jobs significantly and enables operations to produce multiple print jobs seamlessly one after the other in a self-determined sequence without having to remove the build platform from the printer and without requiring manual removal of the print job. The excess material remaining on parts and the platform can thus be recovered during the automatic separation process. This allows up to 25% resin recovery. As such, the 3D printer comes with a designated device for clean material recovery.

3D printing of the future is automated

3D-printing technology is in its prime. In terms of projection technology, meaning digital light processing, manufacturers are moving at the highest technical level. This is because this technology makes it possible to print high-resolution parts repeatedly over a long period of time. Handling is manageable, and the system ends up remaining cost-effective. In addition, the processes are becoming increasingly digitalised and automated, providing process reliability and saving time.

As for the materials in 3D printing, we foresee continual, strong development on the horizon as research continues. Close collaboration between material manufacturers and 3D printer manufacturers will continue to lead to innovative solutions. The everyday use of 3D-printing systems has already proved useful in many new areas and is sure to become standard across production.

UnionTech and JC Dental Technology revolutionise dental industry together

By UnionTech

Fig. 1: The possibilities of 3D printing by UnionTech for dental applications.

In the Industry 4.0 era, 3D-printing technology is developing rapidly to revolutionise production modes for all industries. With over 20 years of experience in the field of 3D printing, UnionTech has been committed to empowering the dental industry with advanced technology. Since 2016, it has been cooperating with JC Dental Technology, a leading denture manufacturer in China. Now, UnionTech and JC Dental Technology have announced they will work together to create more digital dental application scenarios. UnionTech and JC Dental Technology have analysed the current pain points of the dental industry and dentists for the development of a more convenient production solution.

Pain points dentists face

High communication cost and difficulty in saving important information

To perform dental procedures or restorations, dentists need to communicate with several manufacturers in advance. In addition, the dental design software is often too difficult for dentists to use, so they have to communicate with designers. Dentists need to find a reliable technician when preparing for a dental procedure, since the procedure may be risky without the technician's help. Clearly, much time is taken up by communication about a single project, and important information might be accidentally lost in the process.

High case management cost and difficulty in traceability

Currently, dentists spend much time on system management, and because most case management systems cannot be used to track products, it can be difficult to coordinate with the design software. In addition, cases from different clinics are kept in different systems that vary significantly in operation. As a result, dentists need to spend a great deal of effort on case management.

Based on 3D-printing technology, UnionTech and JC Dental Technology cooperate to develop a new mode of dental care

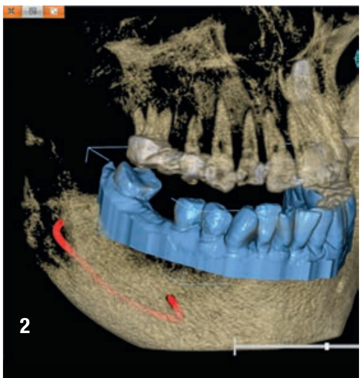
To solve the above-mentioned issues facing the dental industry and dentists, JC Dental Technology has developed a comprehensive digital solution that covers the whole process, covering the design system, service package, chairside service and case management for dental practices, based on customer-centred service and 3D-printing technology. This solution has transformed the traditional dental industry. It is completely digital and alleviates the substantial time and effort previously required from dentists for communication and management tasks. It removes the communication barrier between patients and dentists, improving treatment accuracy and efficiency.

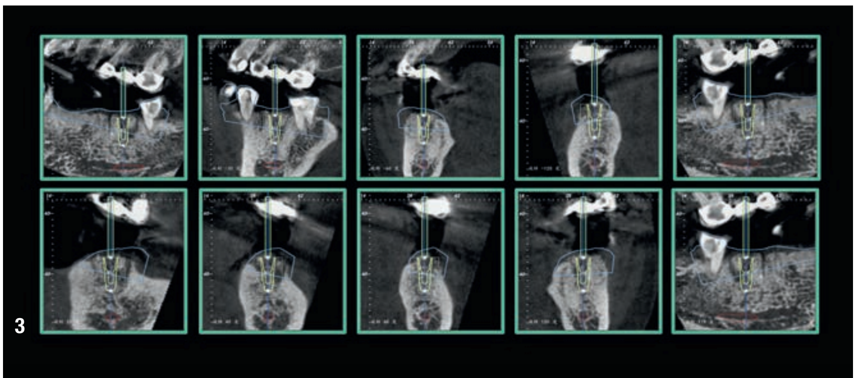
Its design system is user-friendly, time-saving and efficient for dentists, offering a complete set of design functions. The service package, chairside service and case management provided by this solution effectively connect a series of steps, such as ordering, communication, treatment plan confirmation, preoperative preparation, intraoperative products or services, and postoperative evaluation, which all further enable dental practices to save on time and labour.

JC Dental Technology: UnionTech's 3D-printing technology brings transformation to denture manufacturers

According to JC Dental Technology, when the company was first established, all the professional technicians

Fig. 2: CBCT image data. Fig. 3: Planning and designing process.

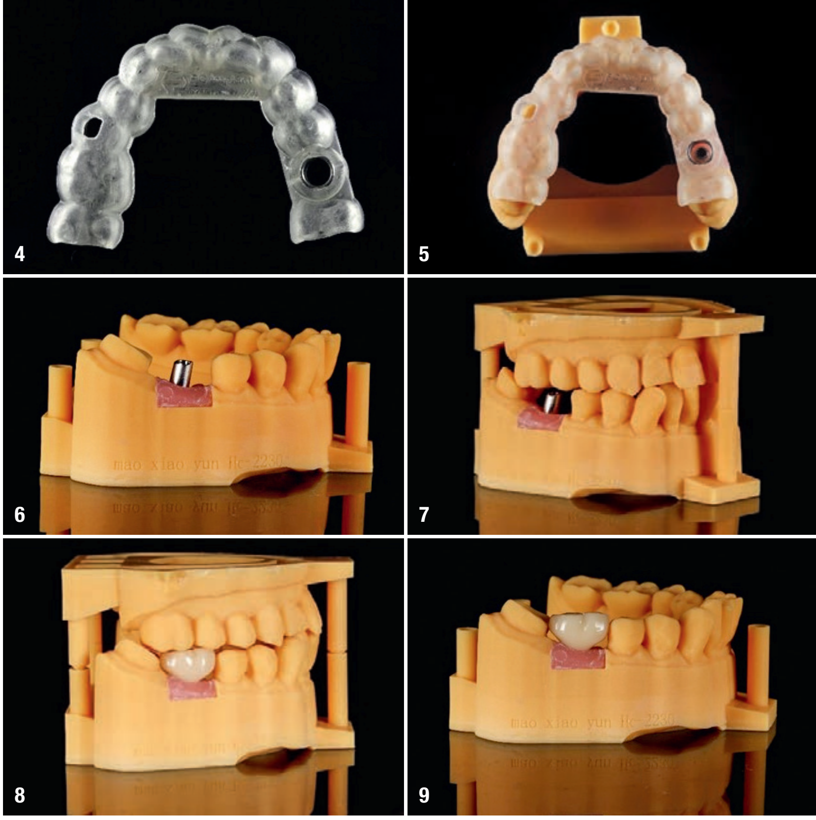




were dental graduates. Denture manufacturing was time-consuming and labour-intensive, relying entirely on the skills and experience of dental technicians. As the process was often prone to quality defects, the entire manufacturing process was affected.

In 2008, JC Dental Technology introduced several pieces of imported digital dental equipment, improving manufacturing efficiency to a certain extent. However, owing to immature technology and after-sales services, the company faced many problems.

In 2016, JC Dental Technology officially cooperated with UnionTech to widely apply UnionTech's professional dental 3D-printing technology to denture manufacturing, providing digital turnkey solutions for dental practices. 3D-printing technology not only simplifies the traditional 20 or more production processes to just three to five processes, greatly saving on time and labour costs, but also changes the traditional process of manufacturing silicone aligner tray seaters, enabling precise customisation and improving patients' comfort.



Figs. 4 & 5: Surgical guide and model manufactured using 3D-printing technology. **Figs. 6 & 7:** Custom temporary abutment on a 3D-printed model. **Figs. 8 & 9:** Temporary crown on 3D-printed model.

Digital dental application scenarios

Image data is transmitted via the cloud to accurately determine design plans. After an order is placed on the JC Dental Technology FC Implant supply chain platform, a dental mock-up is designed on the FC Implant software using the patient's CBCT data to precisely restore the patient's intra-oral condition. Data can be quickly saved to the platform after transfer, greatly shortening the impression taking process.

Based on the data, dentists can design and make the most accurate implant plan and confirm the best position to install the virtual implant into the patient's alveolar bone, providing predictive guidance for the actual procedure.

With the help of 3D-printing technology, the dental treatment quality is improved. The digital dental application system developed by UnionTech has transformed the manufacturing of JC Dental Technology. 3D-printing technology enables JC Dental Technology to precisely and efficiently manufacture dental surgical guides, mock-ups, temporary crowns, dentures, custom temporary abutments and other dental appliances.

The high-quality products provide double insurance for dentists and patients

The surgical guides printed by UnionTech's dental 3D printers and the dedicated surgical kits provided by JC Dental Technology FC enable precise implant placement. According to previous findings, the actual position of an implant in the alveolar bone deviates from the position planned in the preoperative design by no more than 1.2 mm. With a high-precision surgical guide, a temporary abutment and a temporary prosthesis can be placed in the same session as the implant placement.

According to Qian Yuan, general manager of JC Dental Technology, UnionTech's 3D-printing technology completely digitises the JC Dental Technology FC Implant platform into a one-stop implant solution for dentists and patients. This solution offers unprecedented convenience for both dentists and patients: dentists can design surgical guides and accessories and complete plan communication and confirmation in the supply chain, and the patient benefits from immediate restoration.

Fig. 10: UnionTech's dental 3D printers.

The 3D revolution is here—and dental laboratories are leading the way

By Glidewell

In the late 2000s, dentistry transitioned from porcelain fused to metal to monolithic zirconia as its preferred restorative material. This monolithic revolution reverberated throughout the industry, proving that laboratories were working hard to develop new standards that could shake up long-standing traditions.

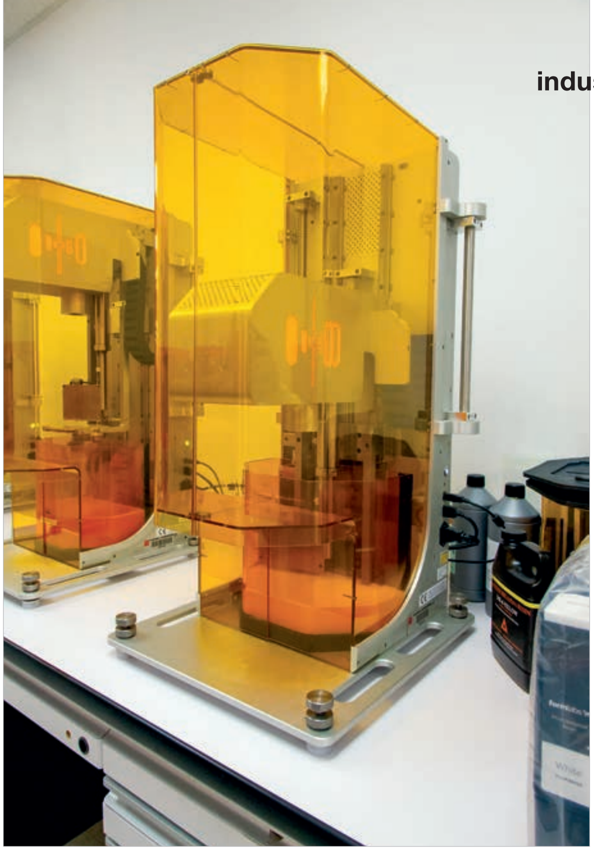
Today, a similar revolution is taking place, this time a 3D revolution. According to an article published by Dental Tribune International this year, the market for 3D printers is expected to grow from US$3.2 billion in 2022 to nearly US$8.0 billion in the next five years. More and more dental offices are adopting a digital workflow that allows them to create their own self-sustaining ecosystem in which same-visit dentistry is the norm, not the exception.

However, many practices still prefer to follow a traditional workflow, in which appliances are delivered by the laboratory rather than printed in-office. This preference may involve concerns about training employees in the new technology or adjusting to a new workflow. However, those who wish to retain a traditional relationship with the laboratory do not have to miss out on the benefits of 3D printing, as laboratories continue to develop high-quality 3D-printing services.

At first, simple products such as impression trays and surgical guides were the main focus of 3D-printing capabilities, but as the technology advanced, the collective imagination of dental laboratories advanced with it. Laboratories like Glidewell are at the forefront of searching for new and exciting ways to utilise 3D printers. As the market for 3D printing grows, a large dental laboratory like Glidewell can harness the true advantages of 3D printing without forcing clinicians to heavily invest in one for their office.

Leading the way

Today, the differences between in-office 3D printers and the industrial 3D printers used by laboratories are mainly their size, speed and capabilities. Large-scale laboratories are able to absorb the high upfront costs of industrial printers, taking advantage of their size and power to



produce highly accurate and reliable appliances that previously had been possible only with traditional fabrication methods.

Glidewell has been steadily advancing its 3D-printing capability from top to bottom. The laboratory's workflow improves case success rates by using proprietary software to streamline the 3D-printing process. This software enhances every aspect of the process, including impression taking, design and fabrication. It has been tweaked and optimised, eventually reaching the point of self-automation, which has contributed to more accurate, consistent results.

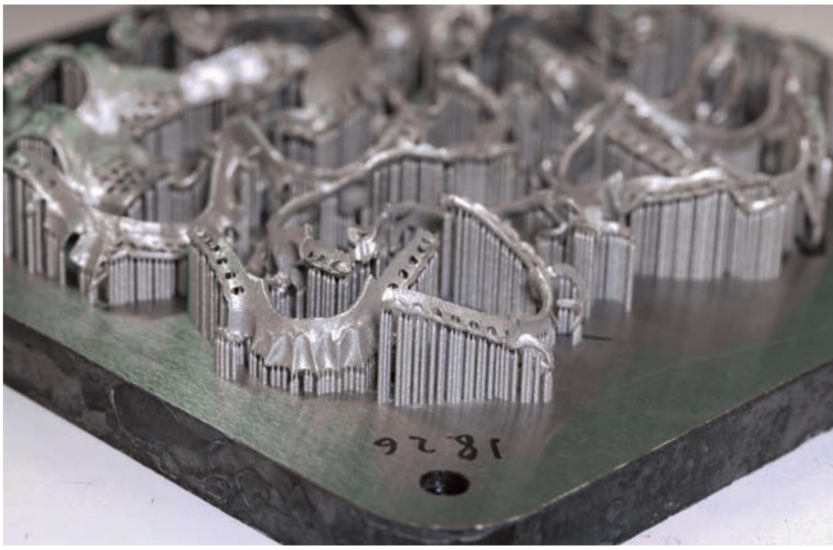
Glidewell is committed to increasing production using 3D-printing technology, aiming for the optimal combination of speed and affordability. As part of its initiative to expand on the assortment of 3D-printable resins, products such as the Comfort3D Bite Splint especially stand out. The splint offers a more precise fit than splints produced with traditional techniques, and because it is 3D-printed, there is no excess material left on the appliance, resulting in a more comfortable fit for patients.

Additionally, Glidewell has invested in printers that can print using different materials. Selective laser sintering (SLS), for example, has a promising future. By utilising the cutting-edge SLS technology to print high-quality metal frameworks for partial dentures, Glidewell showcases its capability of exploring new options and extending the scope of 3D-printed products.

The most exciting part of Glidewell's ambitious 3D transformation is that it allows clinicians to benefit from technological advances without the need to invest their own time or money. Jason Song, director of laboratory operations, discussed the company's goal: "We disrupt ourselves for the betterment of the customer. We never want to get comfortable and miss out on utilising the newest technology just because what we've done has worked out so far. We always have a progressive mindset, advancing dentistry and making it more consistent as well as more accessible."

The goal for Glidewell is not to deter clinicians from utilising in-office 3D printers. Rather, Glidewell is seeking to improve materials, design software and workflows so that when in-office printers become more prominent and realistic for practices Glidewell can offer clinicians better solutions at an affordable price, in line with its goal of democratising dental technology.

"We trust the technology," said Song, "and we believe that it can improve dentistry as a whole. Our ultimate goal is to broaden the imagination of what can be achieved with 3D printing. And we are excited to be at the forefront."



Working together to create perfect smiles

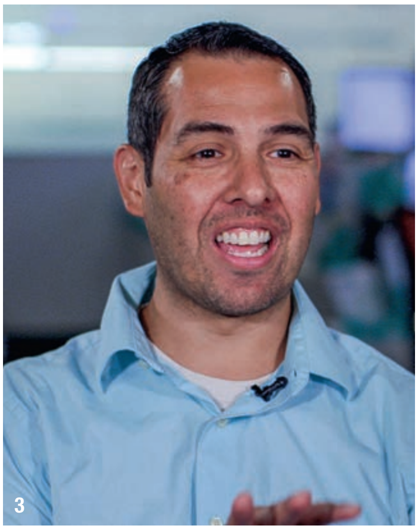
NEOLab pushes the limits on 3D-printing products

By 3D Systems

New England Orthodontic Laboratory (NEOLab) was started in 1976 as a family-owned organisation. Its president, Bill Saurman, who was the original master technician and founded NEOLab, has always been passionate about maintaining the human aspect and the knowledge of hand-crafted appliances in a world gone digital. Over the years, the NEOLab team has continued to grow with a strong focus on innovation. Today, NEOLab, based in Andover in Massachusetts in the US, is still family-owned and has developed into a fully digital laboratory offering a wide range of dental orthodontic appliances.

Fig. 1: President Bill Saurman (left) and Christian Saurman, CEO of NEOLab.

NEOLab's CEO, Christian Saurman, is dedicated to keeping the company running smoothly and at the forefront of the latest technological advances. He explained: "We like to be forward thinkers and do things differently. We produce over 100,000 cases a year, and our company is growing across the country. When our clients ask us whether we can develop a specific appliance, our reply is that we've been at it for years." Zachary Breeze, supervisor of the laboratory's digital department, added: "Here at NEOLab, we take each case and put a personal touch to it."



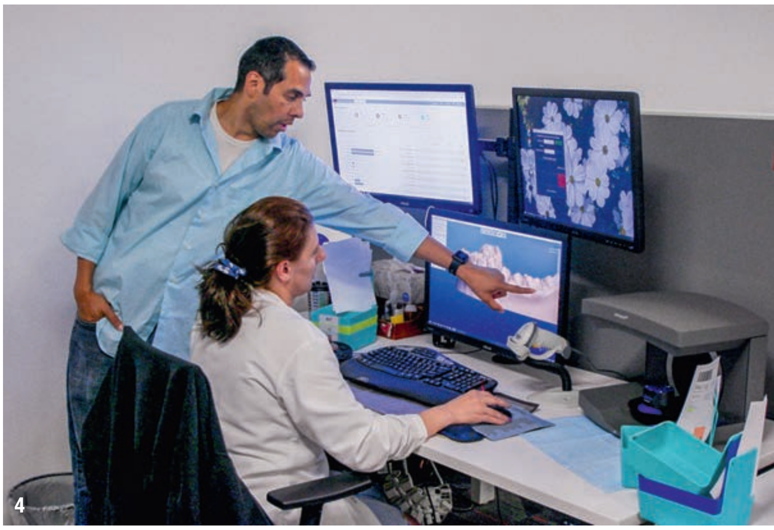


Fig. 2: Christian Saurman, CEO of NEOLab. **Fig. 3:** Zachary Breeze, supervisor of the laboratory's digital department at NEOLab. **Fig. 4:** NEOLab team at work.

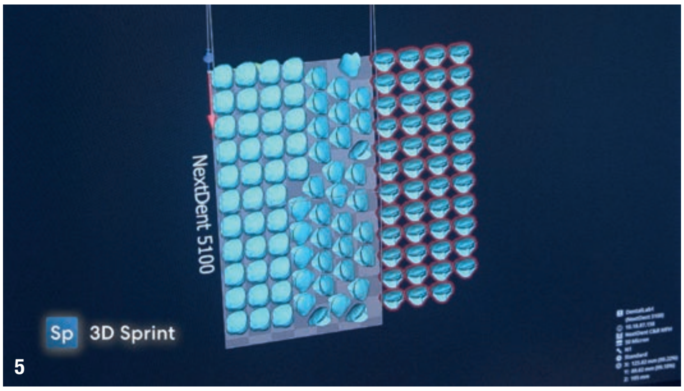


Fig. 5: Design in 3D Sprint software. **Fig. 6:** NextDent C&B MFH material for crowns and bridges.

Designing customised appliances

At NEOLab, the team works together closely with many dentists who submit their cases digitally. Utilising digital workflows allows the appliances to more quickly reach the technicians, saving valuable time. This creates extra floor time, allowing the team to make even higher quality appliances.

Breeze explained: "I have a team of three 3D-printing technicians. They all use 3D Systems' 3D Sprint nesting software. The software is so user-friendly and consistent that I am unable to determine who did the nesting."

3D-printed pontics

NEOLab is one of the few laboratories that utilises 3D-printed pontics. 3D Systems' NextDent 5100 has proved to be a reliable printer for NEOLab, accurately printing teeth with the necessary cleanliness and durability. Christian Saurman said that he has seen increasing numbers of 3D-printed teeth, and he expects the market to expand further.

According to the 3D pontic designer at NEOLab, Kim Jordan, 3D-printed pontic teeth allow her to mirror or copy other teeth in a way that looks more natural than other methods can achieve. During the process, she also designs a ridge at the patient's gingival margin that allows the pontic to click consistently into the correct position and eliminates the need for adjustments to create a perfect fit by the next department.

Bringing it all together

At NEOLab, the team pushes the limits of digital technology. Speaking from experience, Breeze said, "We're glad to have a printer that quickly and reliably produces our appliances and are proud to send them out to our dentists and their patients. We put our passion and dedication into our work and when they receive our printed products, it makes them both smile."

Jordan summed it up beautifully: "When I design teeth, I am shaping someone's confidence, and the end result is going to be a smile—a perfect smile!"

www.neolab.com

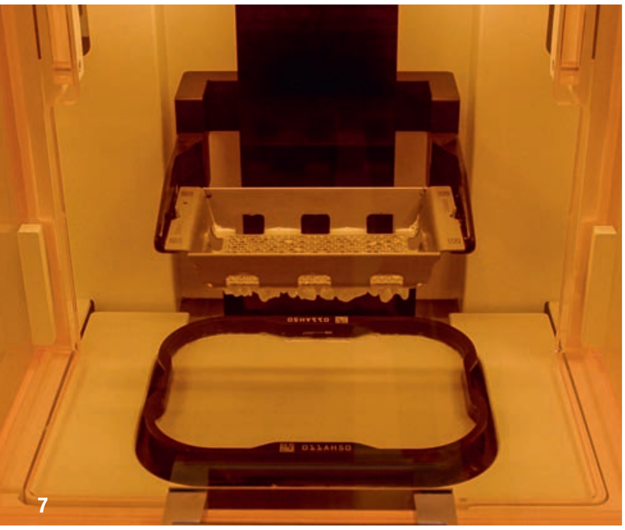


Fig. 7: Printed pontics. **Fig. 8:** Kim Jordan, 3D pontic designer at NEOLab. **Fig. 9:** 3D-printed pontic teeth on the model.

How Impress became the European leader in invisible orthodontics in just three years

By Impress

Impress is the No. 1 European digital orthodontic brand. The company was established in Barcelona in Spain in 2019, and since then it has revolutionised the invisible orthodontic segment with a team of professionals specialised in making people smile and the latest technology applied to the diagnosis, treatment and follow-up of all cases. In three years, Impress has managed to position itself as the European leader in the orthodontic segment with its award-winning invisible orthodontic treatment and already has a presence in more than 130 cities across nine countries.


Dr Khaled Kasem, co-founder and chief orthodontist at Impress.

How does it work?

As Europe's first full-service aligner specialist, Impress provides 24/7 professional customer care via its app, regular treatment oversight based on remote assessment and aligner reviews, all with a high rate of customer satisfaction.

Pretreatment

In the first phase, diagnosis and pre-orthodontic dental treatment are carried out. In the first consultation, the patient undergoes a complimentary full oral examination, a radiograph and a 3D scan, allowing the medical team to diagnose the case and create a virtual simulation of the entire treatment process. After just a few days, the patient will receive a video simulation of what his or her future smile will look like.

Treatment

Once the aligners have been created specifically according to the needs of the patient, they are sent directly to the patient's home. From then on, the patient will be able to continue with his or her daily routine without the treatment interfering with it. Thanks to the mobile application, the patient can upload photos of the progress of their treatment so that the medical team can evaluate it. In this way, the patient will avoid coming to the clinic in person unless requested by the orthodontist, saving time and money.

Post-treatment

After completing the treatment phase, the patient will move on to the retainer stage. By using Impress retainers every night and following the instructions of the medical team, the patient will be able to maintain a healthy, aligned smile for life.

What makes Impress different?

At Impress, all vital services are carried out by expert teams in the company's own clinics, which are now

in major cities throughout Europe (including in the UK, Spain, France and Italy). Although some competitors can provide the same services, none do so from their own clinics, leaving patients under the care of third-party dental services and therefore open to unnecessary risk.

Impress prides itself on its unique value proposition, being the only invisible aligner provider to offer in-depth medical examinations and treatment monitoring led by in-house orthodontists. Because direct-to-consumer models continue to lose credibility, Impress employs a hybrid model, having its own technology-enabled orthodontic clinics since the very beginning. This has led to industry-leading sales conversion rates, an exceptional customer experience and best-in-class clinical outcomes, all driven by a combination of technologies that is becoming more difficult to replicate. The company also has its own digital treatment planning and mass aligner production facility, elevating the business to true full-service status.

Technology is one of the main pillars of Impress. It has strategic partnerships with 3D-printing technology company Carbon and with HP, taking advantage of the capabilities of the latter's Multi Jet Fusion technology. The digital orthodontic brand's growing network of hybrid clinics is supported by practice management software and a best-in-class treatment monitoring app that make use of artificial intelligence.

"At Impress, all vital services are carried out by expert teams in the company's own clinics, which are now in major cities throughout Europe."

Impress takes the top spot

In just three years, Impress has become the No. 1 brand and category leader in Europe. With more than 130 clinics in nine countries, Impress has a global team of over 1,000 employees, of which 500 are medical professionals specialised in orthodontics.

For more information, visit www.smile2impress.com or contact impress@fullvolumepr.co.uk.

Resins in 3D printing in dentistry: A buyer's guide

By Dr George Freedman, Canada

3D printing is the fastest developing and growing technology in the dental market today. It returns complete operational control to the clinical practitioner and simplifies treatment planning and delivery. Real-time optimisation of therapy management and restorative adjustments are available, literally at the touch of a button.

For the patient, treatment times are significantly reduced, and the lag intervals between tooth preparation and appliance delivery are largely eliminated. This decrease of required chair time and outsourcing laboratory work may eventually lead to significant cost reductions in therapy costs.

There are various materials that are used extensively for dental 3D printing. They include resins, ceramics and metals. Ideally, all should be compared for any task at hand, side by side, to determine the best clinical solution. From a publication perspective, that represents an unwieldy aggregate of data to present effectively on the printed page. Thus, this buyer's guide focuses on resins in the dental 3D-printing domain. Dental Tribune's "3D-printing buyer's guide" is the go-to platform on which interested clinicians, researchers and manufacturers can interact rapidly and openly to exchange and evaluate new ideas, technologies and techniques.

It is important to be able to scan the "3D-printing buyer's guide" in order to quickly assess the suitability of a product for a particular procedure, patient or practice. The following paragraphs offer a simplified explanation for the questions that were put to the manufacturers.

- *The product name, manufacturer* and *photograph* simply serve to rapidly identify the resin in question.
- *Certification* is, of course, mandatory. Dentists using a product must ensure that it has been approved for clinical use within their jurisdiction. However, the similarity and redundance of many national and regional regulatory bodies seem more pointed to providing employment than safety.
- *Device classification* is a significant point. Different classes of products are governed by different certification, largely depending on whether they are in the mouth permanently or temporarily.
- *Regional availability* is a supply issue matter. Not all manufacturers have sales activities and after-purchase support in all regions. However, it may be legally possible, although somewhat cumbersome, to import products from regions where they are marketed.
- *Material applications* refer to the specific clinical and laboratory situations for which the product is indicated.
- *Material shades* are obviously important for tooth restorative indications. They are also essential for denture bases. From a cosmetic perspective, orthodontic splints may be tinted as well.
- *Viscosity* concerns resin flow for manufacturing.
- *Flexural strength* is particularly relevant for longer-span, load-bearing restorations and prostheses.
- *Water sorption* is an indicator of the potential of long-term staining and discoloration.
- *Density* may predict long-term restorative strength, stainability and polishabilty.
- *Hardness* is a good gauge for material wear over time and/or its ability to abrade opposing structures.
- *Sterilisation* may or may not be necessary for a specific material or end product.
- *Radiopacity* is important for permanent and temporary restorations. Non-invasive post-cementation evaluation of the restorative interface is mandatory.
- *Additional* pre- or post-printing requirements add time and effort to the procedure, making it less cost-effective.
- *Printers* may be *compatible* by technology or specific unit. It is obviously beneficial for a material to be universally compatible with *all* printers, but the clinician must know beforehand whether the material and the manufacturing tool are compatible.
- *The material price range* per mg/per ml is indicative of how this will impact on overall treatment cost and will vary from one market to another. The typical material cost for 3D-printed dentistry is low compared with the overall treatment charge.

3D dental printing is a marvellous addition to existing clinical options that is transforming the practice and delivery of dentistry.

It is already generating an increased demand for temporary, transitional, and permanent restorations and appliances.

3D resins

			
Material name	**CROWNTEC by NextDent**	**NextDent Denture 3D+**	**NextDent Ortho Flex**
Manufacturer	**3D Systems (Saremco/NextDent)**	**3D Systems (Vertex-Dental B.V.)**	**3D Systems (Vertex-Dental B.V.)**
Certification	○ US FDA ◉ USA FDA 510(k) ○ USP Class VI ○ MDR ○ KFDA ◉ Other: MDD 93/42/EEC	○ US FDA ◉ USA FDA 510(k) ○ USP Class VI ○ MDR ○ KFDA ◉ Other: MDD 93/42/EEC	○ US FDA ◉ USA FDA 510(k) ○ USP Class VI ○ MDR ○ KFDA ◉ Other: MDD 93/42/EEC
Device class according to respective market regulations (e.g. EU Class I, IIa/b or III; or US Class I, II or III)	◉ Europe: Class IIa ◉ US: Class II	◉ Europe: Class IIa ◉ US: Class II	◉ Europe: Class IIa
Regions in which the material is available	◉ Africa ◉ Asia Pacific ◉ Europe ◉ Latin America ◉ Middle East ◉ North America	◉ Africa ◉ Asia Pacific ◉ Europe ◉ Latin America ◉ Middle East ◉ North America	◉ Africa ◉ Asia Pacific ◉ Europe ◉ Latin America ◉ Middle East ◉ North America
Material applications	◉ Temporary restorations ◉ Definitive restorations ○ Models ○ Surgical guides ○ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ◉ Other: Crowns, inlays, onlays, veneers, denture teeth	○ Temporary restorations ○ Definitive restorations ○ Models ○ Surgical guides ○ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ◉ Other: All types of removable denture bases	○ Temporary restorations ○ Definitive restorations ○ Models ○ Surgical guides ◉ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ◉ Other: Splints, retainers
Material shades	◉ Dental shades: 5 shades: A1, A2, A3, B1, SW ○ Gingival shades ○ Other	○ Dental shades ○ Gingival shades ◉ Other: 6 shades (dark pink, light pink, opaque, red pink, translucent pink, classic pink)	○ Dental shades ○ Gingival shades ◉ Other: Clear
Mechanical properties	Viscosity: 2,500–6,000 mPa·s Flexural strength/modulus: > 130 MPa/> 4,000 MPa Water solubility/sorption: n.a. Density: ca. 1.4–1.5 g/cm³ Hardness: n.a.	Viscosity: 690 mPa·s Flexural strength/modulus: 84 MPa/2,383 MPa Water solubility/sorption: 0.1 µg/mm³/28 µg/mm³ Density: n.a. Hardness: n.a.	Viscosity: 370 mPa·s Flexural strength/modulus: 67 MPa/1,721 MPa Water solubility/sorption: 3 µg/mm³/15 µg/mm³ Density: n.a. Hardness: Shore D 78
Can this material be sterilised? If so, please specify the methods.	○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ◉ No	○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ◉ No	○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ◉ No
Radiopacity if applicable (please provide aluminium equivalent in mm Al)	n.a.	n.a.	n.a.
Are there any additional pre- or post-printing requirements? (please provide required steps)	Follow supplied instructions for use by manufacturer for necessary steps (cleaning, processing, post-curing and finishing).	Follow supplied instructions for use by manufacturer for necessary steps (cleaning, processing, post-curing and finishing).	Follow supplied instructions for use by manufacturer for necessary steps (cleaning, processing, post-curing and finishing).
All compatible printers (name the technology and the printer model; e.g. LFS: Form 3B+ and Form 3BL)	○ All printers ◉ Specific printers: ◉ Nextdent 5100 Figure 4 (405 nm) ◉ Asiga MAX UV & PRO 4K (385 nm) ◉ Rapid Shape D20 II, D30 II, D40 II, D10+, D20+ cartridge, D20+, D30+ & D50+ (385 nm) ◉ SprintRay K55 & K95 (405 nm) ◉ Phrozen Sonic XL 4K & Sonic 4K ◉ Accuretta Sol & Dentic (405 nm)	○ All printers ◉ Specific printers: ◉ NextDent 5100 DLP 3D Printer	○ All printers ◉ Specific printers: ◉ NextDent 5100 DLP 3D Printer
Price range (per ml or mg)	○ € .... /mg ○ € .... /ml ◉ For prices please contact your local authorized NextDent dealer or NextDent directly.	○ € .... /mg ○ € .... /ml ◉ For prices please contact your local authorized NextDent dealer or NextDent directly.	○ € .... /mg ○ € .... /ml ◉ For prices please contact your local authorized NextDent dealer or NextDent directly.

The market overview does not claim to be complete. Status: October 2022.

NextDent Surgical Guide	**FREEPRINT CAST 2.0**	**FREEPRINT CROWN**	**FREEPRINT DENTURE**
3D Systems (Vertex-Dental B.V.)	**DETAX**	**DETAX**	**DETAX**
○ US FDA ○ USA FDA 510(k) ○ USP Class VI ◉ MDR ○ KFDA ○ Other	○ US FDA ○ USA FDA 510(k) ○ USP Class VI ○ MDR ○ KFDA ◉ Other: Non-medical device	○ US FDA ◉ USA FDA 510(k) ○ USP Class VI ◉ MDR in progress ○ KFDA ◉ Other: Worldwide in progress	○ US FDA ◉ USA FDA 510(k) ○ USP Class VI ◉ MDR ○ KFDA ◉ Other: Worldwide
◉ Europe: Class I	Non-medical device	◉ Europe: Class IIa ◉ US: Class II (510k)	◉ Europe: Class IIa ◉ US: Class II (510k)
◉ Africa ◉ Asia Pacific ◉ Europe ◉ Latin America ◉ Middle East ◉ North America	◉ Africa ◉ Asia Pacific ◉ Europe ◉ Latin America ◉ Middle East ◉ North America	◉ Africa ◉ Asia Pacific ◉ Europe ◉ Latin America ◉ Middle East ◉ North America	◉ Africa ◉ Asia Pacific ◉ Europe ◉ Latin America ◉ Middle East ◉ North America
○ Temporary restorations ○ Definitive restorations ○ Models ◉ Surgical guides ○ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ○ Other	○ Temporary restorations ○ Definitive restorations ○ Models ○ Surgical guides ○ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ◉ Other: Casting material	◉ Temporary restorations ◉ Definitive restorations ○ Models ○ Surgical guides ○ Occlusal splints ◉ Complete dentures ○ Custom trays ○ Indirect bonding trays ○ Other	○ Temporary restorations ○ Definitive restorations ○ Models ○ Surgical guides ○ Occlusal splints ◉ Complete dentures ○ Custom trays ○ Indirect bonding trays ○ Other
○ Dental shades ○ Gingival shades ◉ Other Translucent orange	○ Dental shades ○ Gingival shades ◉ Other Red	◉ Dental shades: 8 shades ○ Gingival shades ○ Other	○ Dental shades ◉ Gingival shades: 2 shades ○ Other
Viscosity: 1,000 mPa·s Flexural strength/modulus: 85 MPa/2,118 MPa Water solubility/sorption: n.a. Density: n.a. Hardness: n.a.	Viscosity: 125 mPa·s Flexural strength/modulus: 70 MPa/1,700 MPa Water solubility/sorption: n.a. Density: 1.1 g/cm³ Hardness: Shore D 80	Viscosity: 1,750 mPa·s Flexural strength/modulus: 115 MPa/3,500 MPa Water solubility/sorption: < 40 µg/mm³/< 7.5 µg/mm³ Density: 1.3 g/cm³ Hardness: Barcol 50	Viscosity: 1,300 mPa·s Flexural strength/modulus: 110 MPa/2,700 MPa Water solubility/sorption: < 32 µg/mm³/< 1.6 µg/mm³ Density: 1.1 g/cm³ Hardness: Shore D 83
◉ Yes: ◉ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ○ No	○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ◉ No	○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ◉ No	○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ◉ No
n.a.	n.a.	n.a.	n.a.
Follow supplied instructions for use by manufacturer for necessary steps (cleaning, processing, post-curing and finishing).	Washing with isopropyl alcohol and post curing.	Washing with isopropyl alcohol and post curing.	Washing with isopropyl alcohol and post curing.
○ All printers ◉ Specific printers: ◉ NextDent 5100 DLP 3D Printer	○ All printers ◉ Specific printers: Please check the latest list on www.DETAX.com	○ All printers ◉ Specific printers: Please check the latest list on www.DETAX.com	○ All printers ◉ Specific printers: Please check the latest list on www.DETAX.com
○ € .... /mg ○ € .... /ml ◉ For prices please contact your local authorized NextDent dealer or NextDent directly.	○ € .... /mg ○ € .... /ml ◉ For price range please contact your local authorized DETAX dealer.	○ € .... /mg ○ € .... /ml ◉ For price range please contact your local authorized DETAX dealer.	○ € .... /mg ○ € .... /ml ◉ For price range please contact your local authorized DETAX dealer.

3D resins

Material name	**FREEPRINT GINGIVA**	**FREEPRINT MODEL 2.0 / MODEL T**	**FREEPRINT ORTHO**
Manufacturer	**DETAX**	**DETAX**	**DETAX**
Certification	○ US FDA ○ USA FDA 510(k) ○ USP Class VI ○ MDR ○ KFDA ◉ Other: .... Non-medical device	○ US FDA ○ USA FDA 510(k) ○ USP Class VI ○ MDR ○ KFDA ◉ Other: .... Non-medical device	◉ US FDA ○ USA FDA 510(k) ○ USP Class VI ◉ MDR ○ KFDA ◉ Other: .... Worldwide
Device class according to respective market regulations (e.g. EU Class I, IIa/b or III; or US Class I, II or III)	Non-medical device	Non-medical device	◉ Europe: .... Class IIa ◉ US: .... Class I
Regions in which the material is available	◉ Africa ◉ Asia Pacific ◉ Europe ◉ Latin America ◉ Middle East ◉ North America	◉ Africa ◉ Asia Pacific ◉ Europe ◉ Latin America ◉ Middle East ◉ North America	◉ Africa ◉ Asia Pacific ◉ Europe ◉ Latin America ◉ Middle East ◉ North America
Material applications	○ Temporary restorations ○ Definitive restorations ◉ Models ○ Surgical guides ○ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ◉ Other: .... Gingival mask for models	○ Temporary restorations ○ Definitive restorations ◉ Models ○ Surgical guides ○ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ◉ Other: .... Models for thermoforming technology	○ Temporary restorations ○ Definitive restorations ○ Models ◉ Surgical guides ○ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ○ Other
Material shades	○ Dental shades ◉ Gingival shades: .... 1 shade ○ Other	○ Dental shades ○ Gingival shades ◉ Other: .... 6 model shades	○ Dental shades ○ Gingival shades ◉ Other: .... Clear
Mechanical properties	Viscosity: .... 800 mPa·s Flexural strength/modulus: .... n.a. Water solubility/sorption: .... n.a. Density: 1.1 g/cm^3; Tensile strain: 90%; Tensile strength: 3 MPa Hardness: .... Shore A 70	Viscosity: 1,600 mPa·s [model 2.0]; 1,300 mPa·s [model T] Flexural strength/modulus: .... 85 MPa/1,800 MPa Water solubility/sorption: .... n.a. Density: .... 1.1 g/cm^3 Hardness: .... Shore D 85	Viscosity: .... 1,100 mPa·s Flexural strength/modulus: .... 75 MPa/1,650 MPa Water solubility/sorption: .... < 32 $\mu g/mm^3$/< 5 $\mu g/mm^3$ Density: .... 1.1 g/cm^3 Hardness: .... Shore D 82
Can this material be sterilised? If so, please specify the methods.	○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ◉ No	○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ◉ No	◉ Yes: ◉ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ○ No
Radiopacity if applicable (please provide aluminium equivalent in mm Al)	n.a.	n.a.	n.a.
Are there any additional pre- or post-printing requirements? (please provide required steps)	Washing with isopropyl alcohol and post curing.	Washing with isopropyl alcohol and post curing.	Washing with isopropyl alcohol and post curing.
All compatible printers (name the technology and the printer model; e.g. LFS: Form 3B+ and Form 3BL)	○ All printers ◉ Specific printers: Please check the latest list on www.DETAX.com	○ All printers ◉ Specific printers: Please check the latest list on www.DETAX.com	○ All printers ◉ Specific printers: Please check the latest list on www.DETAX.com
Price range (per ml or mg)	○ € .... /mg ○ € .... /ml ◉ For price range please contact your local authorized DETAX dealer.	○ € .... /mg ○ € .... /ml ◉ For price range please contact your local authorized DETAX dealer.	○ € .... /mg ○ € .... /ml ◉ For price range please contact your local authorized DETAX dealer.

The market overview does not claim to be complete. Status: October 2022.

			
FREEPRINT SPLINT 2.0	**FREEPRINT SPLINTMASTER**	**FREEPRINT TEMP**	**FREEPRINT TRAY 2.0**
DETAX	**DETAX**	**DETAX**	**DETAX**
◉ US FDA ○ USA FDA 510(k) ○ USP Class VI ◉ MDR ○ KFDA ◉ Other: .... Worldwide	○ US FDA ◉ USA FDA 510(k) in progress ○ USP Class VI ◉ MDR in progress ○ KFDA ◉ Other: .... Worldwide in progress	○ US FDA ◉ USA FDA 510(k) ○ USP Class VI ◉ MDR ○ KFDA ◉ Other: .... Worldwide	◉ US FDA ○ USA FDA 510(k) ○ USP Class VI ◉ MDR ○ KFDA ◉ Other: .... Worldwide
◉ Europe: .... Class IIa ◉ US: .... Class I	◉ Europe: .... Class IIa ◉ US: .... Class II (510k)	◉ Europe: .... Class IIa ◉ US: .... Class II (510k)	◉ Europe: .... Class I ◉ US: .... Class I
◉ Africa ◉ Asia Pacific ◉ Europe ◉ Latin America ◉ Middle East ◉ North America	◉ Africa ◉ Asia Pacific ◉ Europe ◉ Latin America ◉ Middle East ◉ North America	◉ Africa ◉ Asia Pacific ◉ Europe ◉ Latin America ◉ Middle East ◉ North America	◉ Africa ◉ Asia Pacific ◉ Europe ◉ Latin America ◉ Middle East ◉ North America
○ Temporary restorations ○ Definitive restorations ○ Models ○ Surgical guides ◉ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ○ Other	○ Temporary restorations ○ Definitive restorations ○ Models ○ Surgical guides ◉ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ○ Other	◉ Temporary restorations ○ Definitive restorations ○ Models ○ Surgical guides ○ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ○ Other	○ Temporary restorations ○ Definitive restorations ○ Models ○ Surgical guides ○ Occlusal splints ○ Complete dentures ◉ Custom trays ○ Indirect bonding trays ○ Other
○ Dental shades ○ Gingival shades ◉ Other: .... Clear	○ Dental shades ○ Gingival shades ◉ Other: .... Clear	◉ Dental shades: .... 3 shades ○ Gingival shades ○ Other	○ Dental shades ○ Gingival shades ○ Other
Viscosity: .... 800 mPa·s Flexural strength/modulus: .... 80 MPa/2,000 MPa Water solubility/sorption: ...... < 32 µg/mm³/< 5 µg/mm³ Density: .... 1.1 g/cm³ Hardness: .... Shore D 83	Viscosity: .... n.a. Flexural strength/modulus: .... n.a. Water solubility/sorption: ...... < 32 µg/mm³/< 5 µg/mm³ Density: 1.1 g/cm³; Tensile strain: 20%; Tensile strength: 40 MPa Hardness: .... Shore D 75	Viscosity: .... 1,300 mPa·s Flexural strength/modulus: .... 100 MPa/2,300 MPa Water solubility/sorption: ... < 40 µg/mm³/< 7,5 µg/mm³ Density: .... 1.1 g/cm³ Hardness: .... Barcol 44	Viscosity: .... 750 mPa·s Flexural strength/modulus: .... 95 MPa/2,300 MPa Water solubility/sorption: .... n.a. Density: .... 1.1 g/cm³ Hardness: .... Shore D 83
○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ◉ No	○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ◉ No	○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ◉ No	○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ◉ No
n.a.	n.a.	n.a.	n.a.
Washing with isopropyl alcohol and post curing.	Washing with isopropyl alcohol and post curing.	Washing with isopropyl alcohol and post curing.	Washing with isopropyl alcohol and post curing.
○ All printers ◉ Specific printers: Please check the latest list on www.DETAX.com	○ All printers ◉ Specific printers: Please check the latest list on www.DETAX.com	○ All printers ◉ Specific printers: Please check the latest list on www.DETAX.com	○ All printers ◉ Specific printers: Please check the latest list on www.DETAX.com
○ € .... /mg ○ € .... /ml ◉ For price range please contact your local authorized DETAX dealer.	○ € .... /mg ○ € .... /ml ◉ For price range please contact your local authorized DETAX dealer.	○ € .... /mg ○ € .... /ml ◉ For price range please contact your local authorized DETAX dealer.	○ € .... /mg ○ € .... /ml ◉ For price range please contact your local authorized DETAX dealer.

The market overview does not claim to be complete. Status: October 2022.

3D resins

Material name	FREEPRINT TRYIN	Dental LT Clear Resin (V2)	Digital Dentures [Teeth & Base]
Manufacturer	**DETAX**	**Formlabs Dental**	**Formlabs Dental**
Certification	◎ US FDA ○ USA FDA 510(k) ○ USP Class VI ◎ MDR (in progress) ○ KFDA ○ Other	◎ US FDA ○ USA FDA 510(k) ○ USP Class VI ◎ MDR ○ KFDA ○ Other	◎ US FDA ○ USA FDA 510(k) ○ USP Class VI ◎ MDR ○ KFDA ○ Other
Device class according to respective market regulations (e.g. EU Class I, IIa/b or III; or US Class I, II or III)	◎ US Class I	◎ Europe: Class IIa ◎ US: Class I	◎ Europe: Class IIa ◎ US: Class II
Regions in which the material is available	○ Africa ○ Asia Pacific ◎ Europe ○ Latin America ○ Middle East ◎ North America	◎ Africa ◎ Asia Pacific ◎ Europe ◎ Latin America ◎ Middle East ◎ North America	○ Africa ○ Asia Pacific ◎ Europe ○ Latin America ○ Middle East ◎ North America
Material applications	○ Temporary restorations ○ Definitive restorations ○ Models ○ Surgical guides ○ Occlusal splints ◎ Complete dentures ○ Custom trays ○ Indirect bonding trays ◎ Other: Functional try-ins	○ Temporary restorations ○ Definitive restorations ○ Models ○ Surgical guides ◎ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ○ Other	○ Temporary restorations ○ Definitive restorations ○ Models ○ Surgical guides ○ Occlusal splints ◎ Complete dentures ○ Custom trays ○ Indirect bonding trays ○ Other
Material shades	◎ Dental shades: 1 shade (A2) ○ Gingival ○ Other	○ Dental shades ○ Gingival shades ◎ Other: Clear	◎ Dental shades: … 6 shades (A1, A2, A3, A3.5, B1, B2) ◎ Gingival shades: 4 shades (RP, LP, DP, OP) ○ Other
Mechanical properties	Viscosity: 1,350 mPa·s Flexural strength/modulus: 100 MPa/2,500 MPa Water solubility/sorption: n.a. Density: 1.1 g/cm³ Hardness: Shore D 85	Viscosity: n.a. Flexural strength/modulus: 84 MPa/2,300 MPa Water solubility/sorption: n.a. Density: n.a. Hardness: Shore D 78	Viscosity: n.a. Flexural strength/modulus: [Teeth] > 65 MPa; [Base] > 50 MPa Water solubility/sorption: n.a. Density: [Teeth] 1.15 g/cm³<X<1.25 g/cm³; [Base] 1.15 g/cm³<X<1.25 g/cm³ Hardness: n.a.
Can this material be sterilised? If so, please specify the methods.	○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ◎ No	○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ◎ No	○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ◎ No
Radiopacity if applicable (please provide aluminium equivalent in mm Al)	n.a.	n.a.	n.a.
Are there any additional pre- or post-printing requirements? (please provide required steps)	Washing with isopropyl alcohol and post curing.	Once resin product is completed: Two wash cycles in Form Wash. Allow parts to dry and remove supports. Final post-curing in Form Cure. Polishing and finishing.	Once resin product is completed: Wash in Form Wash. Assemble and remove supports. Post cure in 2 cycles in Form Cure. Polish and characterise.
All compatible printers (name the technology and the printer model; e.g. LFS: Form 3B+ and Form 3BL)	○ All printers ◎ Specific printers: Please check the latest list on www.DETAX.com	○ All printers ◎ Specific printers: ◎ Form 2, Form 3B, Form 3B+	○ All printers ◎ Specific printers: ◎ Form 2, Form 3B, Form 3B+
Price range (per ml or mg)	○ € … /mg ○ € … /ml ◎ For price range please contact your local authorized DETAX dealer.	○ € … /mg ◎ € 0.349/ml	○ € … /mg ◎ [Teeth] € 0.399/ml ◎ [Base] € 0.299/ml

The market overview does not claim to be complete. Status: October 2022.

Model Resin (V3)	**Permanent Crown Resin**	**Surgical Guide Resin**	**Temporary CB Resin**
Formlabs Dental	**Formlabs Dental**	**Formlabs Dental**	**Formlabs Dental**
○ US FDA ○ USA FDA 510(k) ○ USP Class VI ○ MDR ○ KFDA ◎ Other: .... Non-medical device	◎ US FDA ○ USA FDA 510(k) ○ USP Class VI ◎ MDR in progress ○ KFDA ○ Other	◎ US FDA ○ USA FDA 510(k) ○ USP Class VI ◎ MDR ○ KFDA ○ Other	◎ US FDA ○ USA FDA 510(k) ○ USP Class VI ◎ MDR ○ KFDA ○ Other
Non-medical device	◎ Europe: .... Class IIa ◎ US: .... Class II	◎ Europe: .... Class I ◎ US: .... Class I	◎ Europe: .... Class I ◎ US: .... Class I
◎ Africa ◎ Asia Pacific ◎ Europe ◎ Latin America ◎ Middle East ◎ North America	◎ Africa ◎ Asia Pacific ◎ Europe ◎ Latin America ◎ Middle East ◎ North America	◎ Africa ◎ Asia Pacific ◎ Europe ◎ Latin America ◎ Middle East ◎ North America	◎ Africa ◎ Asia Pacific ◎ Europe ◎ Latin America ◎ Middle East ◎ North America
○ Temporary restorations ○ Definitive restorations ◎ Models ○ Surgical guides ○ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ○ Other	○ Temporary restorations ◎ Definitive restorations ○ Models ○ Surgical guides ○ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ○ Other	○ Temporary restorations ○ Definitive restorations ○ Models ◎ Surgical guides ○ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ○ Other	◎ Temporary restorations ○ Definitive restorations ○ Models ○ Surgical guides ○ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ○ Other
○ Dental shades ○ Gingival shades ◎ Other: .... Light yellow	◎ Dental shades: .... 4 shades (A2, A3, B1, C2) ○ Gingival shades ○ Other	○ Dental shades ○ Gingival shades ○ Other	◎ Dental shades: .... 4 shades (A2, A3, B1, C2) ○ Gingival shades ○ Other
Viscosity: .... n.a. Flexural strength/modulus: .... 85 MPa/2.2 GPa Water solubility/sorption: .... n.a. Density: .... n.a. Hardness: .... n.a.	Viscosity: .... 2,500–6,000 mPa·s Flexural strength/modulus: .... 116 MPa/4,090 MPa Water solubility/sorption: .... 0.23 µg/mm³/3.6 µg/mm³ Density: .... 1.4–1.5 g/cm³ Hardness: .... n.a.	Viscosity: .... n.a. Flexural strength/modulus: .... > 102 MPa/>2,400 MPa Water solubility/sorption: .... n.a. Density: .... n.a. Hardness: .... Shore D 76	Viscosity: .... 2,500–6,000 mPa·s Flexural strength/modulus: .... ⩾ 100 MPa Water solubility/sorption: .... n.a. Density: .... 1.4–1.5 g/cm³ Hardness: .... n.a.
○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ◎ No	○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ◎ Other: Disinfection with isopropyl alcohol or ethanol is possible. ◎ No	◎ Yes: Steam sterilisation (autoclaving): .... Autoclave at 134°C for 20 minutes or at 121°C for 30 minutes. ◎ Gamma irradiation: ... 29.4–31.2 kGy gamma radiation. ◎ Electron beam irradiation: ... 35 kGy E-beam radiation. ◎ Ethylene oxide sterilisation: 100% ethylene oxide at 55°C for 180 minutes. ◎ Other: Chemical disinfection 70% isopropyl alcohol for 5 mins. ○ No	○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ◎ Other: Disinfection with isopropyl alcohol or ethanol is possible. ◎ No
n.a.	Yes	n.a.	Yes
Once resin product is completed: Wash in Form Wash. Cure in Form Cure.	This material requires the use of Formlabs' Stainless Steel Build Platform. Once resin product is completed: Wash in Form Wash. First curing cycle in Form Cure. Support removal and sandblasting. Second curing cycle in Form Cure. Polishing & characterization.	Once resin product is completed: Wash in Form Wash. Dry parts completely. Cure in Form Cure.	This material requires the use of Formlabs' Stainless Steel Build Platform. Once resin product is completed: Wash in Form Wash. First curing cycle in Form Cure. Support removal and sandblasting. Second curing cycle in Form Cure. Polishing & characterization.
○ All printers ◎ Specific printers: ◎ Form 2, Form 3B, Form 3B+, Form 3BL	○ All printers ◎ Specific printers: ◎ Form 3B, Form 3B+	○ All printers ◎ Specific printers: ◎ Form 2, Form 3B, Form 3B+, Form 3BL	○ All printers ◎ Specific printers: ◎ Form 2, Form 3B, Form 3B+
○ € .... /mg ◎ € 0.135/ml	○ € .... /mg ◎ € 1.92/ml	○ € .... /mg ◎ € 0.249/ml	○ € .... /mg ◎ € 0.712/ml

The market overview does not claim to be complete. Status: October 2022.

3D resins

			
Material name	**UltraPrint-Dental Cast UV 3.0**	**UltraPrint-Dental Denture Teeth UV**	**UltraPrint-Dental Gingiva UV 2.0**
Manufacturer	**HeyGears**	**HeyGears**	**HeyGears**
Certification	◉ US FDA ○ USA FDA 510(k) ○ USP Class VI ○ MDR ○ KFDA ◉ Other: CE NMPA	◉ US FDA ○ USA FDA 510(k) ○ USP Class VI ○ MDR ○ KFDA ○ Other	◉ US FDA ○ USA FDA 510(k) ○ USP Class VI ○ MDR ○ KFDA ◉ Other: CE NMPA
Device class according to respective market regulations (e.g. EU Class I, IIa/b or III; or US Class I, II or III)	◉ Europe: Non-medical device ◉ US: Class I	◉ US: Class II	◉ Europe: Non-medical device ◉ US: Class I
Regions in which the material is available	○ Africa ◉ Asia Pacific ◉ Europe ○ Latin America ○ Middle East ◉ North America	○ Africa ○ Asia Pacific ○ Europe ○ Latin America ○ Middle East ◉ North America	○ Africa ◉ Asia Pacific ◉ Europe ○ Latin America ○ Middle East ◉ North America
Material applications	○ Temporary restorations ○ Definitive restorations ○ Models ○ Surgical guides ○ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ◉ Other: Diagnostic wax-ups	○ Temporary restorations ○ Definitive restorations ○ Models ○ Surgical guides ○ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ◉ Other: Denture teeth	○ Temporary restorations ○ Definitive restorations ○ Models ○ Surgical guides ○ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ◉ Other: Gingiva masks
Material shades	◉ Dental shades ○ Gingival shades ◉ Other: Clear red	◉ Dental shades: 8 shades (A1, A2, A3, A3.5, B1, B2, B3, BL) ○ Gingival shades ○ Other	○ Dental shades ◉ Gingival shades: Pink ○ Other
Mechanical properties	Viscosity: n.a. Flexural strength/modulus: 72.3–84.5 MPa Water solubility/sorption: n.a. Density: n.a. Hardness: n.a.	Viscosity: n.a. Flexural strength/modulus: 90.5–97.2 MPa/2,056.5–2,230.7 MPa Water solubility/sorption: 0.8–1.3% Density: n.a. Hardness: Shore D 80	Viscosity: n.a. Flexural strength/modulus: n.a. Water solubility/sorption: n.a. Density: n.a. Hardness: Shore A 38
Can this material be sterilised? If so, please specify the methods.	○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ◉ No	○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ◉ Other: Ethyl alcohol, hydrogen peroxide, glutaraldehyde, quaternary ammonium salt	○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ◉ No
Radiopacity if applicable (please provide aluminium equivalent in mm Al)	n.a.	n.a.	n.a.
Are there any additional pre- or post-printing requirements? (please provide required steps)	Post-processing: isopropyl alcohol.	Post-processing: isopropyl alcohol.	Post-processing: isopropyl alcohol.
All compatible printers (name the technology and the printer model; e.g. LFS: Form 3B+ and Form 3BL)	○ All printers ◉ Specific printers: ◉ HeyGears UltraCraft A2D, A2D 4K, A3D, ChairSide Pro	○ All printers ◉ Specific printers: ◉ HeyGears UltraCraft A2D, A2D 4K, A3D, ChairSide, ChairSide Pro	○ All printers ◉ Specific printers: ◉ HeyGears UltraCraft A2D, A2D 4K, A3D
Price range (per ml or mg)	○ € .... /mg ○ € .... /ml ◉ For price range please contact the manufacturer.	○ € .... /mg ○ € .... /ml ◉ For price range please contact the manufacturer.	○ € .... /mg ○ € .... /ml ◉ For price range please contact the manufacturer.

The market overview does not claim to be complete. Status: October 2022.

			
UltraPrint-Dental Model TF UV 2.0	**UltraPrint-Dental Temp C&B UV 2.0**	**V-Print cast**	**V-Print dentbase**
HeyGears	**HeyGears**	**VOCO**	**VOCO**
◉ US FDA ○ USA FDA 510(k) ○ USP Class VI ○ MDR ○ KFDA ◉ Other: .... CE NMPA	○ US FDA ◉ USA FDA 510(k) ○ USP Class VI ○ MDR (in progress) ○ KFDA ◉ Other: .... MFDS ANVISA NMPA	○ US FDA ○ USA FDA 510(k) ○ USP Class VI ○ MDR ○ KFDA ◉ Other: .... Technical resin – not necessary	○ US FDA ○ USA FDA 510(k) ○ USP Class VI ○ MDR ○ KFDA ◉ Other: .... CE notified body
◉ Europe: .... Non-medical device ◉ US: .... Non-medical device	◉ Brazil: .... Class II ◉ South Korea: .... Class II ◉ US: .... Class II	◉ Europe: .... Technical resin ◉ Middle East: .... Technical resin ◉ North America: .... Technical resin	◉ Europe: .... MD Class IIa ◉ Middle East: .... Class B
○ Africa ◉ Asia Pacific ◉ Europe ○ Latin America ○ Middle East ◉ North America	○ Africa ◉ Asia Pacific ○ Europe ◉ Latin America ○ Middle East ◉ North America	○ Africa ○ Asia Pacific ◉ Europe ○ Latin America ◉ Middle East ◉ North America	○ Africa ○ Asia Pacific ◉ Europe ○ Latin America ◉ Middle East ○ North America
○ Temporary restorations ○ Definitive restorations ◉ Models ○ Surgical guides ○ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ◉ Other: .... Clear aligner models	◉ Temporary restorations ○ Definitive restorations ○ Models ○ Surgical guides ○ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ◉ Other: .... Crowns, bridges	○ Temporary restorations ○ Definitive restorations ○ Models ○ Surgical guides ○ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ◉ Other: .... For casting and pressing processes	○ Temporary restorations ○ Definitive restorations ○ Models ○ Surgical guides ○ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ◉ Other: .... Denture base
○ Dental shades ○ Gingival shades ○ Other	◉ Dental shades: 8 shades (A1, A2, A3, A3.5, B1, B2, B3, BL) ○ Gingival ○ Other	○ Dental shades ○ Gingival shades ◉ Other: .... Blue	○ Dental shades ○ Gingival shades ◉ Other: .... Pink
Viscosity: .... n.a. Flexural strength/modulus: 104.2–119.16 MPa/2,020–2,214 MPa Water solubility/sorption: .... 0.35–0.48% Density: .... n.a. Hardness: .... Shore D 85	Viscosity: .... n.a. Flexural strength/modulus: 93.6–104.5 MPa/1,846–2,021 MPa Water solubility/sorption: .... ≤ 40 µg/mm³ Density: .... n.a. Hardness: .... Shore D 84	Viscosity: .... 1,550 mPa · s Flexural strength/modulus: .... 78 MPa/2,470 MPa Water solubility/sorption: .... n.a. Density: .... n.a. Hardness: .... n.a.	Viscosity: .... 1,700 mPa · s Flexural strength/modulus: .... 90 MPa/2,450 MPa Water solubility/sorption: .... > 0.1/24 µg/mm³ Density: .... n.a. Hardness: .... n.a.
○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ◉ No	○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ◉ Other: .... Ethyl alcohol, hydrogen peroxide, ... glutaraldehyde, quaternary ammonium salt	○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ◉ No	○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ◉ Other: .... Not necessary for prostheses bases ○ No
n.a.	n.a.	n.a.	n.a.
Post-processing: isopropyl alcohol.	Post-processing: isopropyl alcohol.	Post-printing: washing and curing in accordance with the manufacturer's recommendations.	Post-printing: washing and curing in accordance with the manufacturer's recommendations.
○ All printers ◉ Specific printers: ◉ HeyGears UltraCraft A2D, A2D Ortho, A2D 4K, A3D, ChairSide, ChairSide Pro	○ All printers ◉ Specific printers: ◉ HeyGears UltraCraft A2D, A2D 4K, A3D, ChairSide (US), ChairSide Pro (US)	○ All printers ◉ Specific printers: An up-to-date list of printer partners is available at www.voco.dental/3dprintingpartners	○ All printers ◉ Specific printers: An up-to-date list of printer partners is available at www.voco.dental/3dprintingpartners
○ € .... /mg ○ € .... /ml ◉ For price range please contact the manufacturer.	○ € .... /mg ○ € .... /ml ◉ For price range please contact the manufacturer.	○ € .... /mg ○ € .... /ml ◉ For price range please contact the manufacturer.	○ € .... /mg ○ € .... /ml ◉ For price range please contact the manufacturer.

The market overview does not claim to be complete. Status: October 2022.

3D resins

			
Material name	**V-Print model 2.0**	**V-Print model fast**	**V-Print SG**
Manufacturer	**VOCO**	**VOCO**	**VOCO**
Certification	○ US FDA ○ USA FDA 510(k) ○ USP Class VI ○ MDR (in progress) ○ KFDA ◎ Other: .... Non-medical device	○ US FDA ○ USA FDA 510(k) ○ USP Class VI ○ MDR (in progress) ○ KFDA ◎ Other: .... Non-medical device	○ US FDA ◎ USA FDA 510(k) ○ USP Class VI ○ MDR (in progress) ○ KFDA ◎ Other: .... CE notified body
Device class according to respective market regulations (e.g. EU Class I, IIa/b or III; or US Class I, II or III)	Non-medical device	Non-medical device	◎ Europe: .... MD Class IIa ◎ Middle East: .... Class B ◎ North America: .... Class II
Regions in which the material is available	○ Africa ○ Asia Pacific ◎ Europe ○ Latin America ◎ Middle East ○ North America	○ Africa ○ Asia Pacific ◎ Europe ○ Latin America ◎ Middle East ◎ North America	○ Africa ○ Asia Pacific ◎ Europe ○ Latin America ◎ Middle East ◎ North America
Material applications	○ Temporary restorations ○ Definitive restorations ◎ Models ○ Surgical guides ○ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ○ Other	○ Temporary restorations ○ Definitive restorations ◎ Models ○ Surgical guides ○ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ○ Other	○ Temporary restorations ○ Definitive restorations ○ Models ◎ Surgical guides ○ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ○ Other
Material shades	○ Dental shades ○ Gingival ◎ Other: .... Beige	○ Dental shades ○ Gingival ◎ Other: .... Blue	○ Dental shades ○ Gingival ◎ Other: .... Clear
Mechanical properties	Viscosity: .... 1,270 mPa·s Flexural strength/modulus: .... 96 MPa/2,600 MPa Water solubility/sorption: .... n.a. Density: .... n.a. Hardness: .... n.a.	Viscosity: .... 1,500 mPa·s Flexural strength/modulus: .... 95 MPa/3,300 MPa Water solubility/sorption: .... n.a. Density: .... n.a. Hardness: .... n.a.	Viscosity: .... 1,550 mPa·s Flexural strength/modulus: .... 95 MPa Water solubility/sorption: .... 1.9 µg/mm^3/16 µg/mm^3 Density: .... n.a. Hardness: .... n.a.
Can this material be sterilised? If so, please specify the methods.	○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ◎ No	○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ◎ No	◎ Yes: ◎ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ○ No
Radiopacity if applicable (please provide aluminium equivalent in mm Al)	n.a.	n.a.	n.a.
Are there any additional pre- or post-printing requirements? (please provide required steps)	Post-printing: washing and curing in accordance with the manufacturer's recommendations.	Post-printing: washing and curing in accordance with the manufacturer's recommendations.	Post-printing: washing and curing in accordance with the manufacturer's recommendations.
All compatible printers (name the technology and the printer model; e.g. LFS: Form 3B+ and Form 3BL)	○ All printers ◎ Specific printers: An up-to-date list of printer partners is available at www.voco.dental/3dprintingpartners	○ All printers ◎ Specific printers: An up-to-date list of printer partners is available at www.voco.dental/3dprintingpartners	○ All printers ◎ Specific printers: An up-to-date list of printer partners is available at www.voco.dental/3dprintingpartners
Price range (per ml or mg)	○ € .... /mg ○ € .... /ml ◎ For price range please contact the manufacturer.	○ € .... /mg ○ € .... /ml ◎ For price range please contact the manufacturer.	○ € .... /mg ○ € .... /ml ◎ For price range please contact the manufacturer.

The market overview does not claim to be complete. Status: October 2022.

V-Print splint	**V-Print splint comfort**	**V-Print tray**	**V-Print Try-In**
VOCO	**VOCO**	**VOCO**	**VOCO**
○ US FDA ◉ USA FDA 510(k) ○ USP Class VI ○ MDR (in progress) ○ KFDA ◉ Other: CE notified body	○ US FDA ◉ USA FDA 510(k) ○ USP Class VI ○ MDR (in progress) ○ KFDA ◉ Other: CE notified body	○ US FDA ○ USA FDA 510(k) ○ USP Class VI ○ MDR (in progress) ○ KFDA ◉ Other: CE	○ US FDA ○ USA FDA 510(k) ○ USP Class VI ○ MDR (in progress) ○ KFDA ◉ Other: CE
◉ Europe: MD Class IIa ◉ Middle East: Class B ◉ North America: Class II	◉ Europe: MD Class IIa ◉ Middle East: Class B ◉ North America: Class II	◉ Europe: MD Class I ◉ Middle East: Class A ◉ North America: Class I	◉ Europe: MD Class I ◉ Middle East: Class A ◉ North America: Class I
○ Africa ○ Asia Pacific ◉ Europe ○ Latin America ◉ Middle East ◉ North America	○ Africa ○ Asia Pacific ◉ Europe ○ Latin America ◉ Middle East ◉ North America	○ Africa ○ Asia Pacific ◉ Europe ○ Latin America ◉ Middle East ◉ North America	○ Africa ○ Asia Pacific ◉ Europe ○ Latin America ◉ Middle East ◉ North America
○ Temporary restorations ○ Definitive restorations ○ Models ○ Surgical guides ◉ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ○ Other	○ Temporary restorations ○ Definitive restorations ○ Models ○ Surgical guides ◉ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ○ Other	○ Temporary restorations ○ Definitive restorations ○ Models ○ Surgical guides ○ Occlusal splints ○ Complete dentures ◉ Custom trays ○ Indirect bonding trays ○ Other	○ Temporary restorations ○ Definitive restorations ○ Models ○ Surgical guides ○ Occlusal splints ○ Complete dentures ○ Custom trays ○ Indirect bonding trays ◉ Other Try-In
○ Dental shades ○ Gingival ◉ Other: Clear	○ Dental shades ○ Gingival ◉ Other: Clear	○ Dental shades ○ Gingival ◉ Other: Blue	○ Dental shades ○ Gingival ◉ Other: Beige
Viscosity: 1,000 mPa·s Flexural strength/modulus: 75 MPa/2,100 MPa Water solubility/sorption: < 0.1 µg/mm³/27.7 µg/mm³ Density: n.a. Hardness: n.a.	Viscosity: 1,250 mPa·s Flexural strength/modulus: 115 MPa Water solubility/sorption: 2.5 µg/mm³/15 µg/mm³ Density: n.a. Hardness: n.a.	Viscosity: 1,500 mPa·s Flexural strength/modulus: 100 MPa Water solubility/sorption: 3 µg/mm³/30 µg/mm³ Density: n.a. Hardness: n.a.	Viscosity: 850 mPa·s Flexural strength/modulus: 85 MPa/2,500 MPa Water solubility/sorption: 0.1 µg/mm³/17.5 µg/mm³ Density: n.a. Hardness: n.a.
○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ◉ No	○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ◉ No	○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ◉ No	○ Yes: ○ Steam sterilisation (autoclaving) ○ Gamma irradiation ○ Electron beam irradiation ○ Ethylene oxide sterilisation ○ Other ◉ No
n.a.	n.a.	n.a.	n.a.
Post-printing: washing and curing in accordance with the manufacturer's recommendations.	Post-printing: washing and curing in accordance with the manufacturer's recommendations.	Post-printing: washing and curing in accordance with the manufacturer's recommendations.	Post-printing: washing and curing in accordance with the manufacturer's recommendations.
○ All printers ◉ Specific printers: An up-to-date list of printer partners is available at www.voco.dental/3dprintingpartners	○ All printers ◉ Specific printers: An up-to-date list of printer partners is available at www.voco.dental/3dprintingpartners	○ All printers ◉ Specific printers: An up-to-date list of printer partners is available at www.voco.dental/3dprintingpartners	○ All printers ◉ Specific printers: An up-to-date list of printer partners is available at www.voco.dental/3dprintingpartners
○ € .... /mg ○ € .... /ml ◉ For price range please contact the manufacturer.	○ € .... /mg ○ € .... /ml ◉ For price range please contact the manufacturer.	○ € .... /mg ○ € .... /ml ◉ For price range please contact the manufacturer.	○ € .... /mg ○ € .... /ml ◉ For price range please contact the manufacturer.

The market overview does not claim to be complete. Status: October 2022.

Resin for high-end flexible splints

Welcome to the next level: FREEPRINT splintmaster

The new FREEPRINT splintmaster is a resin for 3D-printing high-end flexible splints. It is available in two levels of flexibility: TAFF for functional splints and FLEX for soft night guards.

The biocompatible material is characterised by the highest impact strength. Splints made of FREEPRINT splintmaster are robust and flexible, without becoming brittle. Thanks to the material's memory effect, the splints always return to their original shape. The perfectly combined properties guarantee the highest wearing comfort, easy insertion and removal. The clear, transparent resin is colour-stable, tasteless, and free of methyl methacrylate and tetrahydrofurfuryl methacrylate.

The DETAX FREEPRINT line offers more than 30 high performance 3D resins for all dental applications. All materials are validated for more than 35 printers and curing devices, and the validation portfolio is growing rapidly (the latest list is available on DETAX's website). FREEPRINT medical devices are certified under European Parliament and Council Regulation (EU) 2017/745 and feature an extended shelf life of 36 months. Most products, like FREEPRINT crown, temp and denture, have already received U.S. Food and Drug Administration clearance.

Make the switch and join the masterclass!

www.DETAX.com

The highest surface quality and precise processability

Versatility in the laboratory and practice: VOCO's V-Print model 2.0

From working and presentation models to models for the thermoforming technique—with V-Print model 2.0, high-quality models of modern dental technology can be produced quickly and precisely using additive manufacturing. V-Print model 2.0 can be printed in high layer thicknesses and provides the highest surface quality and precise processability.

Fast and precise

Even with layer thicknesses of 100 µm, models made of V-Print model 2.0 have very high accuracy, proved by heat map analysis. The high layer thickness also ensures time-savings: print twice as fast in 100 µm layers as opposed to 50 µm without forfeiting precision. The scratch-resistant and dimensionally stable surface allows reliable fitting of the restoration on the printed model, even at the edges.

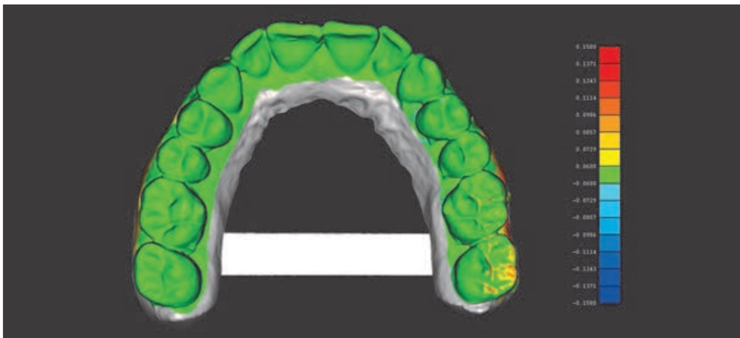
Models for thermoforming production of aligners and retainers

In addition to use for working and presentation models, V-Print model 2.0 can be used to digitally produce aligner and retainer models. This again saves time compared with conventional fabrication. A change of material and thus a vat exchange is not necessary.

Practical use

In addition to its impressive technical performance parameters, V-Print model 2.0 offers excellent handling. The beige-coloured matt models are particularly practical for prosthetic work. The strong contrast enables the best possible optical control of the restorations.

Like all materials of the V-Print family, V-Print model 2.0 can be grinded precisely without chipping and with good chip formation. The instruments remain clean without smearing.


Heat map showing digital precision.

All V-Print materials, including V-Print model 2.0, are immediately ready for printing and do not have to be shaken up. No nitrogen is required for post-exposure, which not only supports occupational safety but also contributes to further process optimisation.

V-Print model 2.0 is available in 1,000 g bottles.

Other V-Print printing materials as well as a detailed, updated list of all printer partners can be found online.

www.voco.dental/3dprintingpartners

Accessible and easy to use

SprintRay Cloud Design service now available in Europe!

You scan, we plan. A frictionless design workflow.

The best design software is the one you do not have to learn how to use. SprintRay Cloud Design was created to fuel the next 100 years of digital dentistry by removing the friction of dental CAD from your workflow.

The SprintRay Europe Cloud Design service is completely integrated into the 3D-printing solution from SprintRay and can be accessed by any new or existing user. It is compatible with any intra-oral scanner and delivers custom printable files produced by expert design teams. Dental 3D printing has never been easier.

Additional applications will be added continuously to the platform. Find out more about the available design services on Sprint Ray website: https://sprintray.com/en-uk/sprintray-cloud-design-dental-applications-design-service.

Occlusal guards
Nearly every patient can benefit from an occlusal guard. Drastically reduce the delivery time of this useful appliance by fabricating it in your dental practice or laboratory with minimal labour and lead time. Leverage the innovative SprintRay EU Splint material to deliver high-quality, comfortable guards of high strength and durability. With SprintRay Cloud Design, you can receive a design straight to your printer.

Crowns
SprintRay Cloud Design makes in-house production of aesthetic, custom temporary or definitive crowns truly frictionless. With a variety of shades in our SprintRay EU Temporary Crown & Teeth or SprintRay Crown materials to choose from, your patient will leave with a confident smile.

Models for clear aligners
Give patients the treatment they want at a price they can afford with SprintRay Cloud Design. Upload patient data and let our team of experts design ready-to-print aligner models that you can fabricate in your dental practice or laboratory.

If you are interested in learning more about the SprintRay 3D-printing system and the SprintRay Europe Cloud Design service, visit our website, or contact us directly.
www.sprintray.com

Integrated 3D-printing solutions

HeyGears builds first Dream Factory in US—for Integrity Dental Services

HeyGears, a provider of integrated 3D-printing solutions, has designed what it calls a Dream Factory for Integrity Dental Services, a large-scale laboratory in the US. Integrity will use the new 3D-printing workspace to print dental products such as models, custom trays, night guards, temporary restorations, implant models and surgical guides and to introduce its clients to the possibility of 3D-printing services.

Reliance on digital production in dentistry has steadily increased in recent years. Dental laboratories worldwide continue to expand their use of 3D printing because of its efficiency and mass production scalability. In response, HeyGears has developed its innovative Dream Factory offering to streamline a customer's production workspace. With this service, HeyGears designers assess the existing laboratory space and redesign the 3D-printing area into a futuristic, more efficient 3D-printing workspace for fast and efficient dental 3D-printing production, as well as education. HeyGears' Dream Factory project with Integrity is the first in the US.

Integrity uses three HeyGears' UltraCraft A2D printers and one HeyGears UltraCraft A2D 4K printer to produce dental products. The A2D can print more than 50 dental application types using HeyGears' certified UltraPrint-Dental materials. The A2D 4K is an ultra-high-precision 3D printer that HeyGears pairs with its HiVE module, an automated add-on for higher volume throughput, to enable continuous, unmonitored production for up to 16 hours, making 24/7 production a reality. HeyGears' UltraPrint-Dental materials are known for their application-centric properties for excellent printing results. The HeyGears Cloud service allows dental technicians to oversee the entire production process and ensure that the final products are made accurately and consistently. With its Dream Factory, Integrity will be able to simplify its workflow and increase production.

Integrity produces dental products and offers additional services to customers in over 35 states. It opened in 2019 and has already grown to more than 170 employees. Delivering quality dental products quickly and efficiently is key to maintaining great relationships with dentists and dental clinics. HeyGears has also grown swiftly, providing digital production solutions to customers worldwide. With the increased adoption of digital production within dentistry, HeyGears has positioned itself to offer large-scale full-chain production capabilities through its 3D printers, software and dental materials.

Innovation is key for HeyGears and Integrity. Both companies foresee the dental industry increasing its reliance on digital production. By partnering to create a Dream Factory workspace, they can work closely and push the dental industry towards an exciting and new way of dental production.

www.heygears.com

For laboratories looking to boost their production capabilities

HeyGears launches new UltraCraft A3D 3D printer for fully automated intelligent mass production

HeyGears has recently launched its latest A-series 3D printer for dental laboratories, the UltraCraft A3D. As dental laboratories have an ever-growing need for efficient, automated and easily scalable production solutions, HeyGears has developed the A3D for laboratories looking to boost their production capabilities.

Greater build volume for larger batch production

Featuring a build volume of 159 × 144 × 110 mm—double the size of that of the UltraCraft A2D—while maintaining printing precision, the A3D enables dental technicians to print more dental applications in a single batch.

Fully integrated automation options

The A3D 3D printer has a variety of automation options for the specific requirements of each dental laboratory. For example, integrated automatic printed part removal, along with an internal storage bin capable of holding nearly 250* full-arch models, enables 3D printing of batches overnight, ready for collection the next day. The printer's 1 l or 3 l automatic resin refill options can refill the printing tray in 2.5 minutes. This means that the printer can operate continuously and efficiently for up to 8 hours unattended. Dental technicians can print nearly 500* clear aligner models with the A3D every 24 hours.

Powerful software and smart features

To make this intelligent automation possible, HeyGears Cloud simplifies production process management, from dental application design to 3D printing. With complete process monitoring and regular business intelligence reports and insights, laboratories can optimise their production strategically. Over-the-air updates ensure that the A3D is running the latest system and features.

The A3D includes useful and smart features such as a thermostatic printing chamber to ensure high-quality printing results, a passive infrared sensor to automatically detect whether a user is nearby and near field communication recognition for key parts to track the remaining usage lifespan.

Scale up with ease

For dental laboratories with larger production needs, the A3D can connect with the Resin Station to enable full-scale automated mass production. The Resin Station can connect with and automatically refill up to four A3D printers with its ultra-large 24 l resin storage capacity, distributed across four 6 l resin bottles. Each bottle can contain a different resin type. With the resin station connected, four A3Ds together are able to 3D-print nearly 2,000* clear aligner models over 24 hours.

With these capabilities, HeyGears' UltraCraft A3D can meet the needs of a wide variety of dental laboratories looking to bring automated flexibility and scalability to their digital dental production.

** depending on printed model thickness and size*

www.heygears.com

A smart hardware and software solution

Primeprint Solution: Medical-grade 3D-printing system from Dentsply Sirona

Dentsply Sirona's Primeprint Solution, launched in March 2022, is a highly automated, end-to-end, medical-grade 3D-printing system for dentists and dental technicians who want to expand their treatment and service offerings. It is a smart hardware and software solution that is optimised for dental applications and can run the entire printing process, including post-processing. The high level of automation helps reduce handling times, allows delegation and enables maximised productivity. Primeprint Solution enables practitioners to print biocompatible appliances with reproducible and accurate results.* The printing process has been developed in line with U.S. Food and Drug Administration guidelines for additive manufacturing medical devices, and outputs from the device are medical products.

Dr Mike Skramstad, a dentist from Orono in Minnesota in US, said: "3D printing has just taken the next leap forward with Primeprint. With the combination of complete integration, enclosed automated workflow and industry-defining efficiency, Primeprint gives me and, most importantly, my staff confidence that we are delivering high-quality and safe 3D-printed parts to our patients. Furthermore, the automation supports that every appliance we 3D-print is processed, cleaned and cured to a very high standard."

The printer uses digital light processing technology, polymerising resins using UV light. The light projector hardens the resin layer by layer. Primeprint as a 3D-printing solution also automates the post-processing of printed objects, which previously would have required complex, messy and time-consuming manual work. With a printing process that is simplified and automated, this new 3D-printing solution makes it easy to manufacture patient-specific and biocompatible appliances.

"For us dentists, Primeprint Solution turns 3D printing into an efficient application for everyday use, and that's also great for my patients," said Dr Skramstad. "The workflow is simplified, end to end, so I can get the best possible results."

Primeprint Solution is also equipped with dental intelligence through the entire process: from software to 3D printing and post-processing. Regulated parameters ensure the high quality of printed appliances for excellent treatment outcomes. Primeprint's process protocol, involving automated process times, supports a high level of safety based on medical device compliance and automatic case documentation.

"Primeprint Solution is the first of a new generation of Dentsply Sirona devices that will transform digital dentistry—as an integral part of a new digital environment for dentistry," said Dr Cord Staehler, chief technology officer at Dentsply Sirona. "This system now enables 3D printing to be the professional solution of choice for dental practices and labs. Working with it, you will be surprised how easy it is to use. And of course, this is just the start. As materials continue to evolve, so will the treatment opportunities that can be solved with 3D printing. Some of our beta testers have called Primeprint the easiest way to get into 3D printing in dentistry."

** Reich S, Berndt S, Kühne C, Herstell H. Accuracy of 3D-printed occlusal devices of different volumes using a digital light processing printer. Appl Sci. 2022;12(3):1576. doi: 10.3390/app12031576.*

www.dentsplysirona.com

Higher productivity and model accuracy

Nexa3D announces professional series upgrade for its ultra-fast dental 3D printer

Nexa3D, the maker of ultra-fast polymer 3D printers for industrial and dental applications, has announced the immediate availability of its new professional series upgrade for its NXD 200 dental 3D printer. Based on Nexa3D's ultra-fast Lubricant Sublayer Photo-curing (LSPc) technology, the pro series delivers higher productivity and model accuracy with greater print success. The pro series accommodates a broader range of dental materials, including Keystone Industries' KeyOrtho IBT and KeySplint Hard. Nexa3D showcased its new NXD 200Pro at LMT LAB DAY East in October.

"We are thrilled to release this significant upgrade to our NXD 200 dental 3D printer," said Nina Swienton, chief marketing officer at Nexa3D. "We recognise the pressing need for higher productivity and lower operating costs that dental laboratories are faced with, and that is exactly why we enhanced the NXD 200 printer in order to deliver even better throughput with greater reliability, accuracy and repeatability. Additionally, the new pro series opens the materials portfolio of the NXD platform to accommodate new dental materials that are tailored for ultra-fast printing of dental parts."

The NXD 200Pro is an industry-leading production platform for same-day production of orthodontic models, surgical guides, splints, impression trays and night guards. The printer is powered by the company's proprietary LSPc technology and patented structured light matrix that delivers up to 20× productivity gains over other stereolithographic and digital light processing 3D printers. It is the ideal solution for high-throughput dental laboratory applications given its large 8.5 l build volume measuring 275 × 155 × 200 mm.

Designed specifically for dental laboratories, the NXD 200Pro offers world-class dental model manufacturing capabilities at ultra-fast speeds with validated Keystone performance dental resins. The NXD 200Pro offers high throughput to keep dental operations productive, being capable of producing up to 20 flat 3D-printed dental models in less than 30 minutes. "At Key Dental Technologies, precision and high quality define our aligners, MyClearALIGN!, and Nexa3D's dental 3D-printing solutions enable us to deliver our product with incredible speed, high definition and affordability," said Christina Montiel, laboratory technician at Key Dental Technologies.

Nexa3D's growing dental customer base includes large and small dental laboratories as well as dental practices looking to increase their 3D-printing throughput with ease and affordability. Tyler Dowdle, director of operations at Excel Orthodontics, said: "At Excel Orthodontics, our priority is providing exceptional orthodontic laboratory services, and Nexa3D's LSPc technology with the NXD 200Pro enables us to deliver those services with accuracy, affordability and twice the throughput of our previous 3D-printing solution."

NXD 200Pro series features

- *High throughput:* the pro series prints up to 8.5 l of volume in a single build, delivering up to 20× productivity gains over comparable dental 3D printers.
- *Advanced printability:* the pro series is powered by an armoured light engine that improves print repeatability, consistency and reliability.
- *Greater print success:* the pro series printing leverages Nexa3D's latest light engine and Everlast membrane interface technology and enhanced auto-homing capability to reduce first-layer gap and substantially increase first-print success.
- *Higher consistency:* the pro series reduces the variation in parts across a single build, delivering reliability, consistency and higher production yields.
- *Cost-effectiveness:* the pro series build plates are designed to maximise part-nesting capabilities while enabling efficient resin drainage and easier cleaning between print jobs, increasing part output while reducing waste and lowering operating time and costs.
- *Compatibility:* the pro series is fully compatible with Nexa3D's post-processing solutions, including xWash, xCure and xCLEAN, which together reduce the time to produce ready-to-use models from hours to just minutes.
- *Upgradability:* delivering on the company's long-standing promise of upgradeability, the pro upgrade kit is available for sale to all current NXD 200 users.

Coupled with the pro series upgrade are enhancements to the NexaX software, including features like auto-stacking, improved automatic part nesting and cupping avoidance. Additionally, the new settings profile manager supports the entire workflow by combining validation, customisation, reusability and shareability to create a powerful and adaptive tool for any application, Nexa3D printer model or resin type.

The NXD 200Pro printer is available for order now. Customers wishing to upgrade their current model can do so by ordering an upgrade kit from Nexa3D or from its growing reseller network. For pricing or reseller information, please visit Nexa3D website.

www.nexa3d.com

From CAD to finished 3D-printing products

UnionTech dental 3D-printing solutions

UnionTech is a provider of digital light processing (DLP) and stereolithography 3D printers. Its dental 3D-printing solutions include 3D printers, printing materials, the preprocessing software Polydevs and the cloud platform Unionfab ONE. More than 1,000 UnionTech dental 3D printers are installed in dental labs around the world.

A leader in the 3D-printing industry, UnionTech has been deeply involved in and grown rapidly in dentistry in recent years. It launched its dental 3D-printing brand, EvoDent, in July 2017. EvoDent was developed to revolutionise dental processing, help with the transition from traditional manufacturing to digitalisation, and define the standard of 3D printing for various dental applications.

Building solid, complete digital dentistry system

Digital technology has become the core factor in developing the dental industry. Recently, EvoDent released comprehensive 3D-printing solutions that range from CAD to finished 3D-printing products. These solutions aim to revolutionise dental processing, chairside restoration, orthodontics and implant dentistry through professional 3D-printing technology and to define the standard of 3D printing in dentistry.

Full range of dental 3D printers

As early as 2013, UnionTech established a DLP team to conduct research and development, and it launched its first DLP product for dentistry in 2015. UnionTech contributes significantly to the dental industry, covering every process, from research and development to function configuration, guided by the dental market and user demand. In developing each product and technology for its full range of 3D printers for dentistry, UnionTech performs a series of processes, including internal testing, process refinement and product optimisation.

E140 printer

The E140 3D printer offers high accuracy, up to 50 µm, and prints quickly, taking only 20 minutes to print six appliances. Restorations, surgical guides and clear aligners can all be created chairside using the E140.

S300 printer

A precise, high-quality and reliable 3D printer for dentistry with a 4K laser projector, the S300 was developed to meet the needs of dental laboratories and dental clinics. It offers many kinds of process design packages to easily print a wide variety of dental appliances up to a build envelope capacity of 250 × 140 × 240 mm. It uses professional intelligent algorithms to ensure precise fabrication and has a uniformity of light intensity of > 95%.

D800 printer

A fully automated orthodontic DLP printer with four 4K laser projectors, the D800 offers four applications including: automatic resin recycling, resin refilling, batch optimisation, printing and appliance removal—all employing intelligent precision technology independently developed by UnionTech. The mechanical structure, based on principles of bionics, reduces the peeling force to ensure the safety and stability of dental appliances and clean appliance removal. The excellent design also guarantees reliability and easy maintenance.

Specialised materials for dentistry

As a leading company in industrial 3D-printing technology, UnionTech aims to meet customer needs with materials offering precision, efficiency, stability and quality. It has developed several dental 3D-printing materials, such as Model V2.0, Model V6.0 and EvoDent Cast.

Standardised, systematised and intelligent

UnionTech promotes the development of additive manufacturing technology for dentistry. Dental products have a high demand for customisation, and 3D-printing technology has the advantage of being able to achieve batch customisation production. As a new digital technology, 3D printing can be integrated with the processes of dental digitalisation to achieve accurate and efficient production. UnionTech has always maintained its professionalism in the field of 3D printing, drawing from different industries to promote the development of the field, and provides professional support to dental clinics and technical laboratories.

www.uniontech3d.com

HeyGears

FULLY AUTOMATED

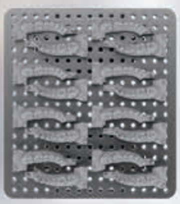
INTELLIGENT MASS PRODUCTION

ULTRACRAFT A3D

Integrated Automation Options

1. **Automated Resin Refill**
   Compatible with **1 L/3 L** resin bottles
2. **Automated Part Removal**
   Collection bin capacity: **250** printed models

Large Build Volume



Quadrant Model

Full Denture Base

Splint

Large Scale **24/7** Production Capability With **Resin Station**

1. 24 L Ultra-high Resin Capacity
2. Resin Refill for up to 4 Printers

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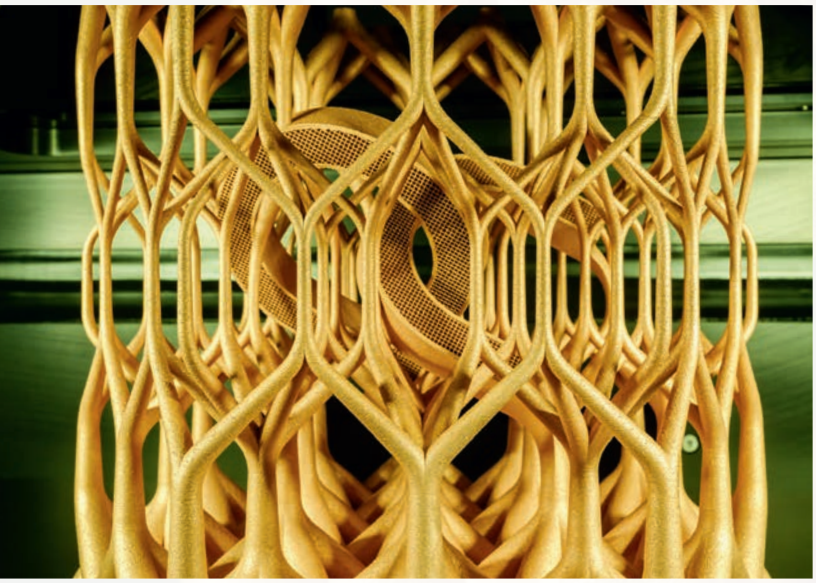
Continued success for Formnext with considerably more exhibitors this year

By Dental Tribune International

After its successful return last year as an in-person event, Formnext, the world's leading trade fair dedicated to additive manufacturing (AM) and modern industrial production, will take place in 2022, from 15 to 18 November. It promises an extensive programme of supporting events that will contain both new and familiar highlights thanks in particular to this year's partner country, France. Formnext 2022 will take place in Germany in the most modern part of the Frankfurt exhibition grounds, Halls 11 and 12.



Several months prior to the 2022 event, Formnext had already exceeded the final number of exhibitors and has therefore increased the gross exhibition space by more than 34% this year, to over 50,000 m². By the end of October, almost 800 exhibitors had registered for Formnext 2022, 60% of which are international.

The global elite of AM has already registered to exhibit, including Additive Industries, Arburg, BigRep, Carbon, Desktop Metal, DMG MORI, DyeMansion, EOS, Evonik, Farsoon Technologies, Formlabs, GE Additive, HP, Keyence, Markforged, Materialise, Renishaw, Ricoh, Siemens, SISMA, SLM Solutions Group, Stratasys, 3D Systems, TRUMPF, voxeljet, Xerox, XJet and ZEISS. In addition, numerous well-known international corporations, among them BASF, Covestro, GKN Sinter Metals Components, Höganäs, Linde, Mitsubishi Chemical, Oerlikon and Sandvik, will be showcasing their solutions along the entire process chain.

"This successful development shows that exhibitors continue to see Formnext as the most important industry meeting point and an extremely valuable trade show platform, and also underscores the fact that, for many companies in the AM industry, in-person interaction is essential to successfully conduct business, drive developments or find partners and investors," commented Sascha F. Wenzler, vice president for Formnext at event organiser Mesago Messe Frankfurt.

France: A versatile, innovative and diverse partner country

Being particularly active in AM, France has had a strong presence at Formnext for many years now. This year, more than 40 French companies, associations and research institutes—such as France Additive, Cimes, CCI Nouvelle-Aquitaine and the Carnot network for AM—

will be participating in Formnext. In France, the strong aerospace and automotive industries offer promising applications for AM, as does construction and architecture, viticulture, medicine and many more.

Among the French companies that will be showcasing a diverse portfolio of products and services along the entire process chain are internationally established AM giants such as AddUp, numerous highly innovative young companies such as Lynxter and Pollen AM, and renowned industrial companies such as Arkema, BINC Industries, Constellium and Granges, for which AM is playing an increasingly important role.

The second day of Formnext 2022 will be dedicated to France, involving partner presentations by Cimes and France Additive and a visit by a French delegation, among other events.

A diverse programme of supporting events

The programme of supporting events will continue some established events and expand upon them. For example, the start-up challenge, which recognises innovative and viable business ideas from young companies, will take place for the eighth time. The up-and-coming companies exhibiting in the start-up area will pitch their products and services on the AM4U stage. There will also be interesting contributions on the topic of investment and funding.

The ideas competition known as the purmundus challenge will celebrate its tenth anniversary with a reception and special showcase of the highlights of the last ten years.

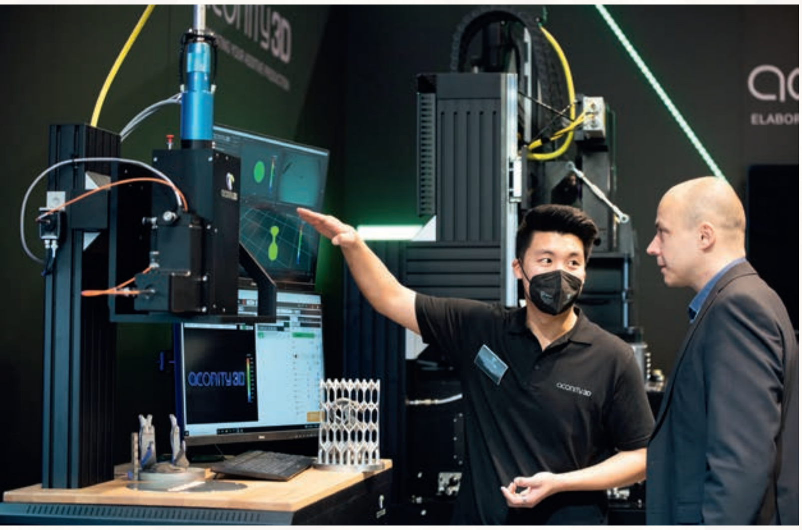
Alongside the established Discover3Dprinting seminars (in German and English), attendees can visit the AM4U area to learn about the wide range of career opportunities within the AM industry. The high-quality conference programme organised by Formnext's content partner, TCT, will address current trends and developments in AM in 2022. The VDMA will present a showcase on valuable AM applications from the world of mechanical engineering and provide further insights through presentations on the AM4U stage.

The BE-AM showcase will demonstrate advanced developments in relation to the increasingly important topic of 3D printing in the construction industry, and the BE-AM symposium will present significant background and information on future developments in this field.

The topic of standards, important for the entire AM industry and all users, will once again be discussed by experts and decision-makers from around the world at the renowned Standards Forum, organised by ASTM, U.S. Commercial Service and ISO—International Organization for Standardization, on 14 November, the day before the trade fair commences.

On the same day the Wohlers Report Team, will host an evening event giving attendees an overview of the most interesting findings and trends in additive manufacturing. On top of that, you have the unique opportunity to speak to the Wohlers Report team in person and learn more about the future of AM.

Further information is available at www.formnext.com.



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Exhibitors stack up for IDS's centennial event in 2023

By Dental Tribune International

The International Dental Show (IDS) will take place from 14 to 18 March next year, and more than 1,000 exhibitors have already registered for the event. The organisers say that the growing exhibitor list already includes some of the key players in dentistry, such as Dentsply Sirona, which opted not to attend the event in 2021 owing to concerns relating to the SARS-CoV-2 pandemic.

IDS 2023 is set to be a jubilee event. It will be the 40th iteration of the trade fair and will mark 100 years since the first IDS took place in 1923. The organisers—the Association of the German Dental Industry (VDDI) and Koelnmesse—say that these milestones are a testament to the strength of the international dental industry, and dentists from around the world are no doubt looking forward to seeing their industry return to Cologne in full force.

Owing to the pandemic, the 39th IDS was postponed by six months and took place without a number of its stalwarts. Dentsply Sirona and Ivoclar opted not to attend the event in 2021 and have now both returned to the preliminary exhibitor list (the list is available on IDS website).

Dentsply Sirona said in a press release that the company will showcase its latest innovations in digital dentistry at the event. Walter Petersohn, chief commercial officer at the company, stated: "We are very excited to join IDS 2023 and reconnect with dental professionals from all over the world for a week of knowledge sharing and networking." He added that a full programme of events will take place at the company's booth.

Norbert Wild, managing director at Ivoclar Germany, said in a VDDI and Koelnmesse press release that participating in the event will allow the company "to present products and solutions and engage in a targeted exchange with dentists, dental technicians and dental hygienists at one location".

VDDI and Koelnmesse said that 400 companies from 11 countries have already registered for IDS 2023. Registrations from China, Japan, South Korea and Singapore indicate that companies from the Asia Pacific region are poised to make their mark on the event, and those from Argentina, Brazil, Israel, Italy and the US suggest that next year's IDS will live up to the event's reputation as a truly international snapshot of the contemporary dental industry.

IDS 2023 will be staged across 7 halls of the Koelnmesse trade fair grounds in Cologne, and a total exhibition space of 180,000 m² will make it larger than pre-pandemic events. In 2019, the 38th IDS covered 170,000 m² of exhibition space and featured 2,260 vendors from more than 60 countries. In 2021, the 39th IDS was downsized to 115,000 m² and featured 830 exhibitors from 59 countries.

More information about IDS 2023 is available online at www.ids-cologne.de.

International events

ADF 2022

22–26 November 2022
Paris, France
https://adfcongres.com

GNYDM 2022

25–30 November 2022
New York, USA
www.gnydm.com

AEEDC Dubai 2023

7–9 February 2023
Dubai, UAE
https://aeedc.com/see-you-at-aeedc-dubai-2022

158th Chicago Dental Society Midwinter Meeting

23–25 February 2023
Chicago, USA
www.cds.org/midwinter-meeting

IDS 2023

14–18 March 2023
Cologne, Germany
www.ids-cologne.de

BDIA Dental Showcase 2023

24–25 March 2023
London, UK
www.dentalshowcase.com

ICOI World Congress

13–15 April 2023
Sydney, Australia
www.icoi.org/events

18th IDENTEX—International Oral and Dental Health Exhibition

4–7 May 2022
Antalya, Turkey
https://cnridentex.com

4th EAS Congress

11–13 May 2023
Torino, Italy
www.eas-aligners.com

The British Dental Conference & Dentistry Show

12–13 May 2023
Birmingham, UK
https://birmingham.dentistryshow.co.uk

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- the complete list of sources consulted and
- the author or contact information (biographical sketch, mailing address, e-mail address, etc.).

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Article lengths can vary greatly—from 1,500 to 5,500 words—depending on the subject matter. Our approach is that if you need more or fewer words to do the topic justice, then please make the article as long or as short as necessary.

We can run an unusually long article in multiple parts, but this usually entails a topic for which each part can stand alone because it contains so much information.

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Please use single spacing and make sure that the text is left justified. Please do not centre text on the page. Do not indent paragraphs, rather place a blank line between paragraphs. Please do not add tab stops.

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Please place image references in your article wherever they are appropriate, whether in the middle or at the end of a sentence. If you do not directly refer to the image, place the reference at the end of the sentence to which it relates enclosed within brackets and before the period.

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- We require images in TIF or JPEG format.
- These images must be no smaller than 6 x 6 cm in size at 300 DPI.
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