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CAD/CAM

international magazine of dental laboratories

case report
The copyCAD 2: Complete success
for a complete denture

interview
"Digitalisation brings the patient to
the dental laboratory with 24/7 availability"

industry news
Empower your dental laboratory

dti] Dental Tribune International

Magda Wojtkiewicz

Managing Editor

Embrace changes and welcome challenges

We are witnessing various technological breakthroughs transforming dentistry and the growth opportunities of digital dental solutions. Digital technologies are finding more and more applications in dentistry and becoming as useful and common in dental offices as in dental laboratories.

The use of digital dental technologies has steadily increased in recent years, but the COVID-19 pandemic has accelerated it and undoubtedly contributed to the role played by digital solutions in dentistry and certainly their perception. Now more than ever, the benefits of digital solutions and emerging technologies are appreciated. Many dental practitioners and dental laboratory owners have realised that the conventional approach to dentistry is not sufficient to manage patients or offices. The possibilities offered by digital dentistry, such as diagnostic and restorative procedures, and especially CAD/CAM technology, are transforming the speed, quality and efficiency of dental procedures and fast becoming indispensable.

Moreover, digitalisation is not limited to chairside and laboratory procedures. Digitalisation also means collecting, transforming and storing data. Digital dentistry generates a great deal of data, which has to be properly managed and protected. This might be challenging and requires improving conventional ways of storing information and adopting more complex data management,

and the pandemic is certainly reinforcing e-transformation here as well.

The integration of technology in our lives is changing patients' expectations of how healthcare should be delivered. Almost unlimited access to information can be a blessing and a curse. More so than before, patients desire fast, accurate and complete treatment in the same way as they obtain other services, unfortunately often without understanding of biology. More patients than before expect that online or phone consultations can solve their health problems, and this can be quite limiting to treatment possibilities, especially in the case of dentistry.

With so much transformation going on, it is necessary to learn to embrace changes and welcome challenges. Digitalisation offers enormous possibilities of development, and while it is not always easy to adapt to these changes, especially since they often arise in many areas at once (chairside and laboratory procedures, and patient and practice management), it can help dental practitioners and dental technicians to be more accurate and more efficient.
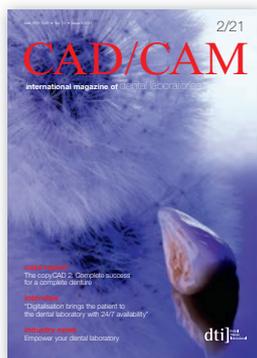
Sincerely,

Magda Wojtkiewicz
Managing Editor

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COVID-19 and the dental market:
The pandemic continues to bite

By Jeremy Booth, Dental Tribune International

Sales at major dental companies climbed in the second quarter of this year compared with the same period in 2020, during which the pandemic brought dentistry to a grinding halt. In the latest series of earnings reports, some dental company chiefs praised the recovery of the market, whereas others outlined falling discretionary spending, concerns about SARS-CoV-2 variants and sluggish vaccine rollouts in some geographic areas.

David Katzman, CEO of tele-orthodontics company SmileDirectClub (SDC), was candid when he spoke with analysts in August. SDC missed its earnings expectations for the quarter. Katzman pointed to SDC's newest international markets, Spain and Germany, where he said "lingering effects" of the COVID-19 pandemic had hampered earnings. He said that, at home in the US, the company's target demographic had been hit hard in the pocket by the health crisis.

He explained: "[Our] core demographic, which has a median household income of $68,000 (€58,000), likely experienced outsized pressures in their capacity to spend on discretionary items given the significant inflationary headwinds facing the non-discretionary categories like transportation, utilities and food."

SDC's target consumers, Katzman said, appeared to be favouring products over services owing to pent-up demand for apparel, automobiles and home-related goods. Joblessness was also having an impact. He explained: "Further contributing to the unfavourable condition of constrained capacity on spend on discretionary items and a general consumer preference for products over services, joblessness remains pervasive in four of our larger states, California, New York, Texas and Florida. Through 10 July 2021, these four states represent 40% of the nation's continuing jobless claims."

Total sales revenue at SDC for the quarter was $174.2 million, an increase of 62.7% year over year, and the company completed just over 90,000 unique aligner shipments, compared with 57,136 in the second quarter of last year.

Align Technology posts $1 billion in sales

Staying with orthodontics, leading clear aligner maker Align Technology fared better than SDC during the quarter, as it continued to break its own earnings records. The company sold $841 million worth of clear aligner trays during the period—a year-over-year increase of 181.9%—and its imaging systems and CAD/CAM services revenue was $169.8 million, a 214.7% year-over-year increase. Total sales therefore topped $1 billion for the first time. Compared with the first quarter of this year, the company's clear aligner and imaging services revenue streams were up 11.6% and 20.0%, respectively. Clear aligner volume for the second quarter increased by 200.0% year over year to reach 665,600 cases, and clear aligner volume for teenagers increased by 156.3% to reach 181,000 cases.

A look at the company's regional figures shows that dentists in most regions provided Invisalign treatment to more patients in the second quarter of this year than they did in the quarterly periods before the pandemic. In the Americas region, case volume was up 260.7% year over year. International shipments were up 149.2%, and those in the Europe, Middle East and Africa region (EMEA) were up 265%, led by Iberia, the UK and Italy. In the Asia Pacific region, clear aligner volume increased by 50%, led by Japan, China, Australia and New Zealand.

Straumann remarks on improved patient volumes in 2021

The results of another international player, Straumann Group, will give readers an impression of the state of global dental markets. In the EMEA region, total sales of CHF 230 million (€212.7 million) represented a 102% year-over-year increase, which Straumann credited to sales of premium and challenger implant brands, its orthodontics business, and strong sales in Germany, Iberia, France, the UK and Turkey. Straumann's organic sales growth in North America decreased by 42% during the second quarter of 2020; this year, it increased by 135% to reach CHF 152 million. Sales in the Asia Pacific region rebounded by 63% in the period to reach CHF 103 million. In Latin America, where Brazil is the largest contributor to regional revenue, CHF 31 million in sales represented a year-over-year increase of 174.4%.

Straumann's total revenue for the second quarter was CHF 516 million. This represented a year-over-year increase of around 92%—in the comparable period last year, Straumann's total revenue of CHF 248 million was down nearly 40%.

The company published a half-yearly report at the close of the second quarter, and in the report, the company said that dental practices had been operating with "healthy patient flows throughout the first half of 2021".

> "With the exception of Latin America, which is still in the eye of the storm, all of our regions report that more than 85% of dental practices are open"—Guillaume Daniellot, CEO Straumann Group

Guillaume Daniellot, Straumann CEO, reminded analysts in a conference call: "When we held our last media conference three months ago, our industry was in lockdown. COVID-19 had cut our monthly revenue by 70%, and we were initiating measures to reduce our headcount and cost base in preparation for the economic recession that the pandemic is expected to trigger." He added that the situation on the day of the latest media conference (12 August 2021) was more positive. "With the exception of Latin America, which is still in the eye of the storm, all of our regions report that more than 85% of dental practices are open. Correspondingly, between 85% and 100% of our facilities are open and our sales team are operating at similar levels. In short, both we and our customers are back to business."

Envista optimistic about continued recovery

Sales at Envista Holdings in the second quarter were $740.1 million, an increase of 104.4% year over year. The close of the period marked four consecutive quarters of growth for Envista's premium implant business—which achieved 90% core sales growth in the three-month period ended 30 June.

Envista CEO Amir Aghdaei said during the company's earnings call that Envista had seen solid demand for its infection prevention business, owing to the fact that enhanced disinfection protocols are now the new normal. Aghdaei said: "We're excited about the opportunities for a new CaviWipes 2.0 product. It features a two-minute universal contact time, shows efficacy against a broad
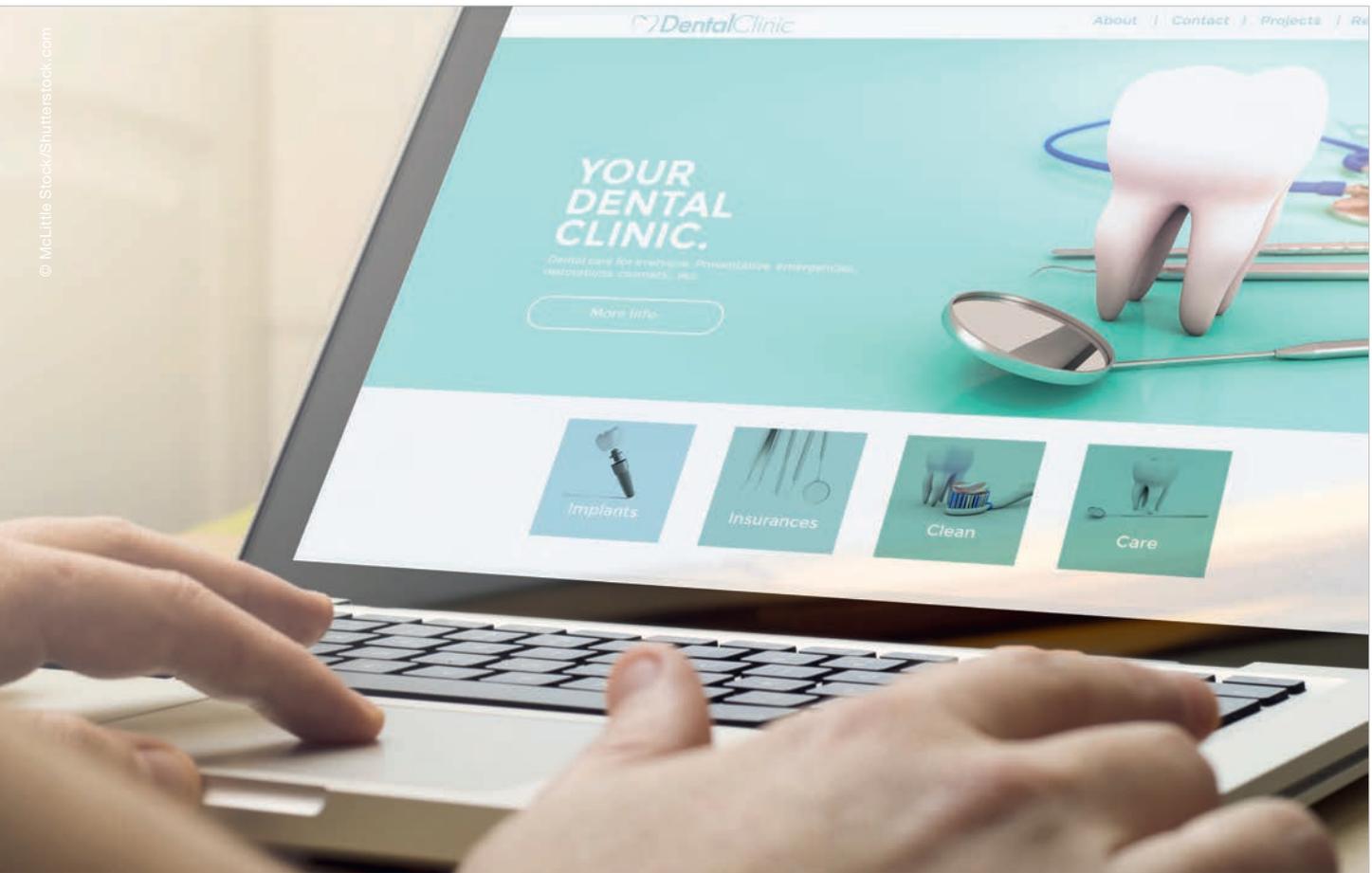
range of pathogens, including the COVID-19 virus, and increases our opportunity to penetrate the medical market further while enhancing our dental position."

Howard Yu, senior vice president and chief financial officer at the company, said: "While patient volumes have improved to pre-pandemic levels in our major markets, we continue to see inconsistent roll-outs of vaccines and spikes in COVID-19 variant infections in several geographic areas, including Western Europe and parts of the United States. Overall, we are mindful of the pandemic-related risks but remain optimistic for a continued recovery throughout the balance of 2021."

Aghdaei added: "While vaccination rates are increasing every day, we are mindful of the risk related to COVID-19 variance, continue to monitor reopening of economies and acknowledge that vaccination rollout worldwide [is] at different stages. However, we believe that patient demand will sustain at pre-pandemic levels, due to the industry's enhanced sanitation measures."

Envista owns more than 30 dental brands, including major names like KaVo Kerr, Nobel Biocare and Ormco.

Dentsply Sirona cautions over "ongoing impact"

Net sales at Dentsply Sirona for the second quarter were $1.067 billion, a 117.3% year-over-year increase. In the dental consumables segment, net sales of $445 million for the period represented a 138.0% increase. Sales of dental technology and equipment reached $622 million, a year-over-year gain of 104.6%.

US sales were $366 million, up 179.4% year over year, European sales of $431 million were up 99.5%, and sales in all other markets reached $270 million, an increase of 87.5%.

In a call with analysts, Jorge M. Gomez, executive vice president and chief financial officer at the company, commented: "Growth was strong across all regions and in all categories, most notably within the endo and [restorative] parts of our portfolio, which represent strategic priorities for our business."

CEO Donald M. Casey said that the dental market continues to recover and to demonstrate its underlying resilience, but that dentistry is not yet out of the woods. "The pandemic remains a key consideration for us as we evaluate our performance for the quarter and plan for the remainder of the year," he explained.

"At this point, we feel the market is operating slightly below 2019 levels with a continued recovery expected for the remainder of the year. As we navigate through the newest phase of the pandemic, we are mindful that there [continues] to be some ongoing impact in certain regions and some stresses to the supply chain."

Experts say that an ongoing trend in the digital dentistry market is the growth of dental 3D printers and intra-oral scanners.

Digital dentistry market: 3D printers and intra-oral scanners drive market growth in Europe

Dr Kamran Zamanian, Canada

The European digital dentistry market will be driven by the increased shift towards digital technologies in comparison with conventional analog impressions. This shift is also facilitated by the increased demand for better infection control offered by CAD/CAM technologies and 3D printing with the onset of the pandemic.

The European digital dentistry market, which includes CAD/CAM systems, CAD/CAM materials and dental 3D printers, is projected to experience double-digit growth reaching over €1.4 billion ($ 1.7 billion) by 2027, as digital technologies have begun to revolutionise the European dental prosthetics market reaching into the foreseeable future. This will be driven by strong market growth in the intra-oral scanner and dental 3D printing space.

One of the major drivers in the European digital dentistry market is the increasing preference for digital impressions rather than conventional ones. With the onset of the COVID-19 pandemic, safety has become a top priority in dental clinics and laboratories, forcing many businesses to introduce digital technologies for better control of infection risk. The adoption of CAD/CAM and 3D printing reduces human interaction and makes the process of sending impressions digitally easier. Furthermore, many of these technologies have the potential to offer seamless workflows, which can drive their faster adoption in the future.

Dental 3D Printer Revenue Shares

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Multi-Scenario Digital Dentistry Market Forecast, Europe, 2017 – 2027 (€M)

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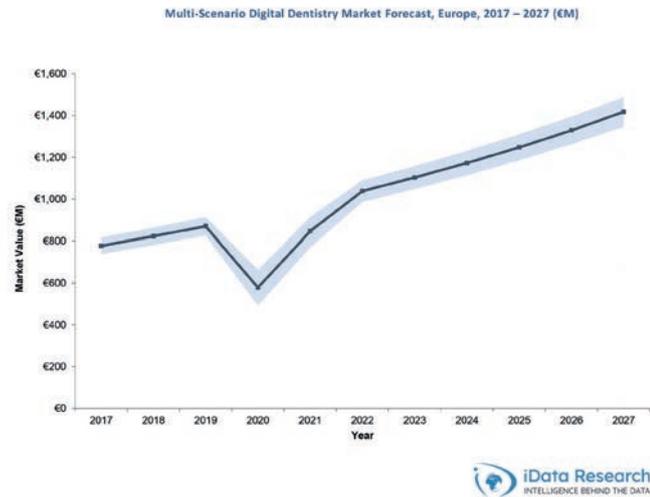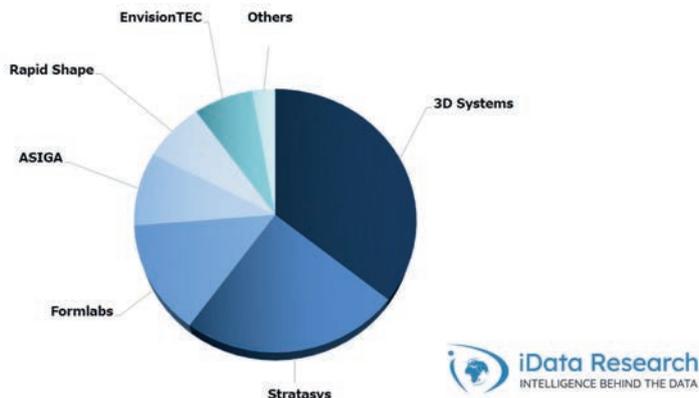
Although the majority of dental impressions are still fabricated using conventional methods, it is expected that the number of prostheses fabricated using these methods will decrease over the coming years. This decrease will give way to an increased use of digital technologies such as CAD/CAM for producing dental prostheses. Whereas dental prosthetic procedures in the past used to take several dental visits, it is now possible to complete dental treatments within the same day using chairside CAD/CAM systems. This flexibility and the increased efficiency provided by digital technologies are likely to accelerate its market growth over the coming years.

The global COVID-19 pandemic has had a significant impact across the European dental prosthetics and digital dentistry markets. Within the digital dentistry market, CAD/CAM materials have sustained the hardest hit owing to the pandemic. As elective dental procedures were postponed during the peak months of the pandemic, the ability of manufacturers to sell CAD/CAM blocks and discs was substantially reduced, leading to a drop in market revenue. Furthermore, the market for CAD/CAM systems led by companies such as Dentsply Sirona, 3Shape, Amann Girrbach, Ivoclar Vivadent, Straumann, Carestream and Envista declined over the last year owing to the suspension of major dental exhibitions, such as EXPODENTAL (in Spain).

The COVID-19 pandemic has also had an impact on the dental 3D-printing market. Although market growth slowed during the early onset of the pandemic, the sales of 3D printers are increasing rapidly now that the pandemic is getting closer to being stabilised. In addition, digital technologies, such as 3D printers and intra-oral scanners, offer better control of contamination risk, and this has already started to drive sales and will continue to do so in the near future.

There has been an increasing trend towards the adoption of 3D printing and intra-oral scanners in digital dentistry, and Scandinavian countries and Portugal have been the most aggressive countries in Europe to embrace the new technologies. Rapidly improving technology and enhancements in materials are expected to boost market growth in these areas. Moreover, growth in these areas is likely to slow down the milling system market.

In the past few years, there has been a surge of competitors, such as Formlabs, in the dental 3D-printing market space. These have introduced several affordable solutions, thereby depressing the average selling price (ASP) of prosthetics. Other notable competitors in this space are 3D Systems, Stratasys, Asiga, Rapid Shape, EnvisionTEC, among many others.

The demand for better quality and reliability continues to increase, stabilising the ASP over the foreseeable future, thereby driving the market value potential of dental 3D printers.

Overall, it is expected that the European digital dentistry market and the dental prosthetics market will continue to grow considerably over the foreseeable future. The increased sales of intra-oral scanners and dental 3D printers along with a rising elderly population are expected to drive the growth of the dental prosthetics and digital dentistry market in Europe.

With improvements in technology offering better reliability, it is likely that the demand for digital technologies in dentistry is going to be higher than in the past. Furthermore, better safety and infection control offered by digital technologies is likely to drive their adoption in the future. Ultimately, the European digital dentistry market is expected to grow at a cumulative growth rate of 13.6% between 2020 and 2027, with the total market value reaching €1.4 billion ($ 1.7 billion).

about

Dr Kamran Zamanian is CEO and founding partner of iData Research. He has spent over 20 years working in the market research industry with a dedication to the study of dental implants, dental bone grafting substitutes, prosthetics, as well as other dental devices used in the health of patients all over the globe.

The copyCAD 2: Complete success for a complete denture

Dr Yassine Harichane, France

Introduction

In our previous article (*The copyCAD*, CAD/CAM *2/2020*), we described a clinical case in which we used digital dental technologies to copy a patient's smile. In this article, we will describe another clinical case for which it was possible to make a copyCAD: a dental copy and paste using CAD/CAM technology.

The ageing of the population results in an increasingly older population in dental practices. These patients dream of regaining their former smiles without changing their habits too much. Once again, digital dentistry comes to the dentist's aid to offer tools combining performance and ingenuity. The technique of dental copy and paste has been described many times in the literature.

In this clinical situation, we will describe the digital copying of a maxillary complete denture. This type of prosthesis is very widespread in the population, and repair, relining or even replacement is often necessary. Because patients are living longer and longer, we are observing both an ageing of the prosthetic components and a maturation of the soft tissue. The practitioner must therefore give a facelift to the prosthesis and to the patient at the same time.

In analogue dentistry, the production of dentures involves numerous and meticulous steps. An alternative is to send the patient's prosthesis to the dental laboratory to be copied. In digital dentistry, it is possible to create a copy of this denture faster and better.

Clinical case

A patient with an immediate maxillary complete denture presented for consultation (Fig. 1). The extractions having been carried out six months before, we observed atrophy of hard and soft tissue in the upper jaw. In the lower jaw, the teeth were present and the restorations adapted. Since the aesthetics and the occlusion were validated over the long term by the patient, making a copy was proposed, taking the new clinical situation in the upper jaw into account.
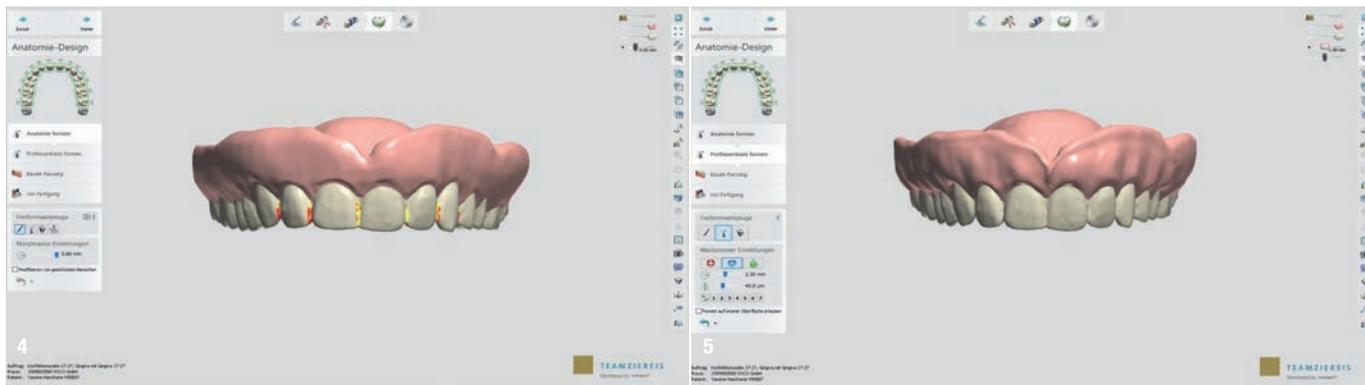

Fig. 1: Initial situation. **Fig. 2:** Relined maxillary denture. **Fig. 3:** Digital assessment of the denture.

Fig. 4: Virtual denture before gingiva carving. **Fig. 5:** Virtual denture after gingiva carving.

First dental appointment (30 minutes)

First, the denture is relined with a hard composite-based material (Ufi Gel hard C, VOCO; Fig. 2). The material allows an extension of the edges of the prosthesis for better retention. An adjustment of the occlusion can be done at this time in order to have a homogeneous distribution of the contacts and the absence of interference. The patient is photographed with the complete denture in the mouth to control the height of the lower third of the face, the support of the lips, the inclination of the occlusal plane and the aesthetics of the smile (Fig. 3). During this session, it is possible to scan the relined prosthesis with an intra-oral scanner in order to be able to return the denture to the patient during the session. The digital impression can accurately record the surface and upper surface of a prosthesis with impressive precision. If the practitioner does not have an intra-oral scanner, it is always possible to send the denture to a dental technician who owns a laboratory scanner. A digital or physical impression of the antagonistic arch and of the occlusion is also sent to the dental laboratory.

Dental laboratory (two to three days)

The dental technician receives digital files of the denture, antagonist and occlusion. It is possible to make all the changes by working on virtual models (3Shape Dental
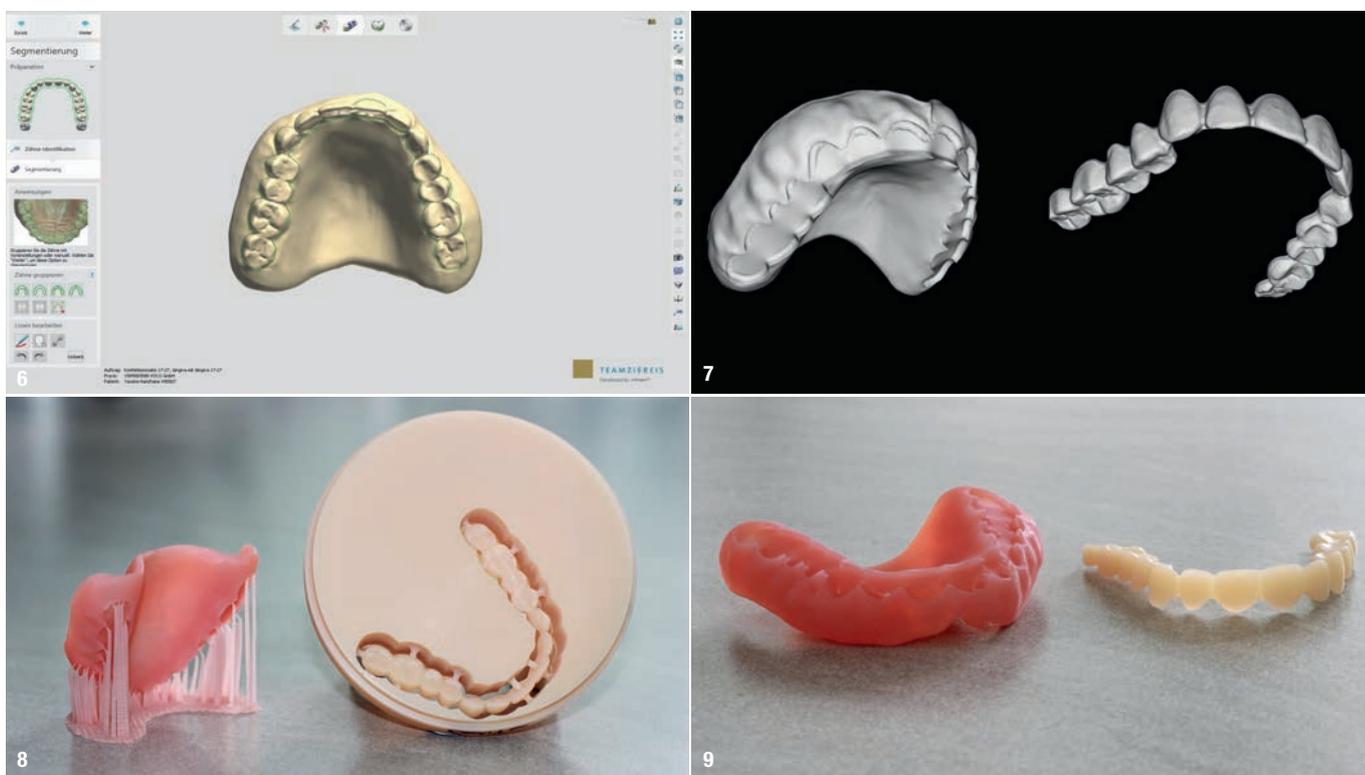

Fig. 6: Virtual model segmentation. **Fig. 7:** STL files of the base and the prosthetic teeth. **Fig. 8:** 3D-printed base and milled teeth with supports. **Fig. 9:** 3D-printed base and milled teeth without supports.
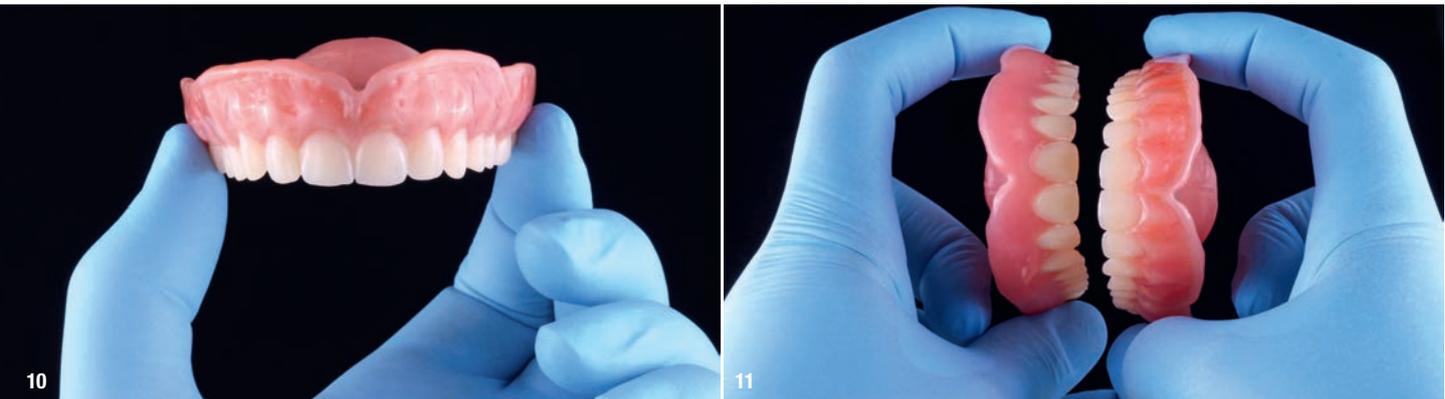
Fig. 10: Digital copy denture. **Fig. 11:** Comparison of relined denture (left) and digital denture (right).

System). From the photographs of the patient, the laboratory technician, with the guidance of the practitioner, is able to determine the changes to be made to the current denture: increase or decrease the incisal rod, modify the anatomy of the teeth, correct a possible defect of the occlusal plane inclination, but also improve the smile curve. The dental technician can also digitally improve the appearance of the false gingiva by creating a buccal bulge, simulating tooth roots (Figs. 4 & 5). All these modifications are submitted online to the dentist for approval of the virtual prosthetic project. As all these corrections can be made easily on the digital model, there is no need to reset the teeth or to add or remove wax like on a physical model.

In order to fabricate the denture, it is necessary to digitally separate the prosthetic teeth from the base (Fig. 6). From the STL files (Fig. 7), the laboratory then 3D-prints the base using a gingiva-coloured resin (V-Print dentbase, VOCO) and mills the teeth from a composite disc (CediTEC DT, VOCO; Fig. 8). A gingiva-coloured cement (CediTEC Adhesive, VOCO) is used to bond the prosthetic teeth to the base (Fig. 9). At this stage, characterisation is possible to yield a more natural look. This characteri-

sation can be performed on the teeth as well as on the false gingiva. The result is breathtakingly natural (Fig. 10), and the copy greatly surpasses the original (Fig. 11).

It should be noted that it is always possible to print a try-in. For this an STL file is designed by combining both the teeth and the base (Fig. 12a). The job is sent to a 3D printer loaded with a try-in resin (V-Print Try-In, VOCO). The try-in denture (Fig. 12b) physically confirms the function and aesthetics of the prosthetic project before moving on to the full procedure as described.

Second dental appointment (15 minutes)

The denture is delivered to the patient with careful control of function (retention, support, occlusion, phonation) and aesthetics (soft-tissue support, static and dynamic smile, tooth shade). An additional appointment should always be offered to the patient in order to make any necessary adjustments, but above all to reassess the clinical situation. In the case of this patient, she said that she was delighted to rediscover her smile again and noticed improved comfort in wearing the prosthesis (Figs. 13 & 14).

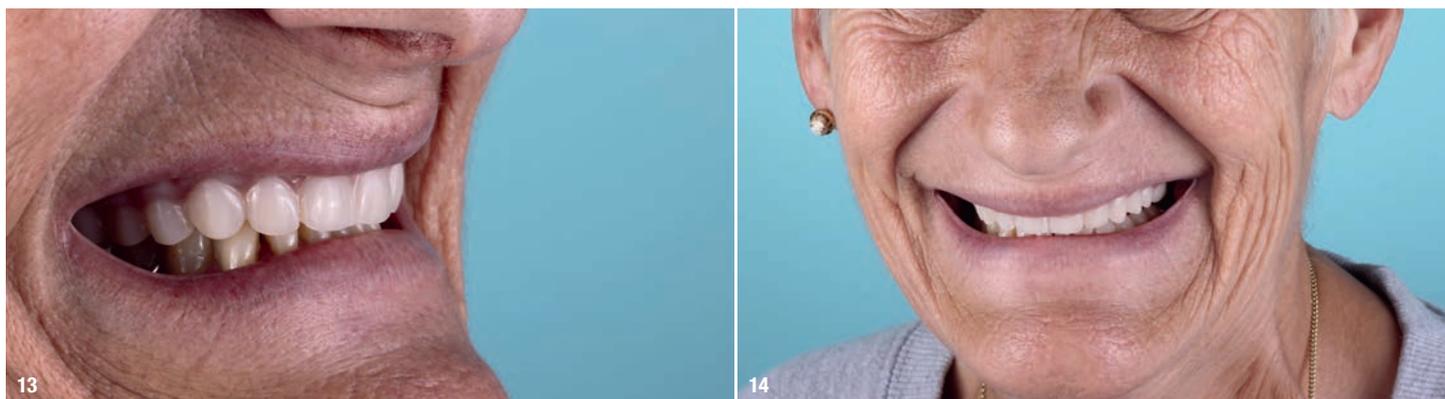**Figs. 12a & b:** STL file **(a)** and 3D-printed try-in denture **(b)**.

Fig. 13: Patient's smile. **Fig. 14:** Final situation.

Discussion

All dental disciplines benefit from digital advancements. The removable prosthesis is no exception thanks to the contributions of the digital impression and milling but especially of 3D printing. Indeed, it is possible to copy a removable prosthesis in great detail and add improvements. These changes can be minimal, such as the tooth shade or the prosthetic tooth anatomy, or major, such as the correction of the occlusal plane inclination or a sagging of the lower third of the face by wear of the prosthesis or bone atrophy.

Everybody benefits from a denture digital copy. The practitioner benefits from digital technology by integrating a workflow for the removable prostheses. Working time is reduced to two short clinical sessions when the patient already has a denture. Communication with the laboratory is optimised and patient satisfaction is visible. Producing complete removable prostheses becomes a simple, fast and profitable task.

The dental technician also benefits from this digital workflow. By copying the existing prosthesis, he or she can spend less time on the setting and more time on fine adjustments and creativity. By manipulating virtual models, validation of the prosthetic project by electronic communication with the practitioner is feasible and much faster. By using 3D printing, dental technician will be able to rationalise his or her production line and delegate time-consuming and unrewarding tasks to machines. The results are reproducible and allow easy and quick fabrication of a replacement prosthesis if the denture is lost or destroyed.

The patient is the main beneficiary of the digital copy and paste technique. Many patients with removable prostheses have often been disappointed by the end result, particularly in terms of aesthetics if the smile to which they were used was not restored. This feeling is all the stronger when it comes from those around them and confirms that the change is visible and noticeably unsightly. With copying of their dentures, patients can be sure of getting their smiles back in their original form but with the changes they have always wanted: whiter teeth, natural alignment and stronger retention. When the procedure is completed in just two straightforward sessions, patient expectations will be greatly exceeded.

Conclusion

The fabrication of a removable prosthesis has long been considered a difficult task. Indeed, the dentist–prosthetist duo have to follow tedious steps while often taking care of elderly patients. Digital dentistry has brought a wind of change by making it fast, efficient and profitable. CAD/CAM tools allow, after just one short clinical session, copying and delivery of an existing denture, after 3D printing, in record time back to the patient in an even shorter clinical session. The patient will be delighted with this experience at the dentist's practice because he or she will rediscover his or her smile literally and figuratively. Duplicating a complete denture requires ordinary technical skills; duplicating the positive emotions felt by a patient requires extraordinary human skills.

contact

Dr Yassine Harichane graduated from the former Paris Descartes University in France and conducted a number of research projects there. He is an author of numerous publications and a member of the cosmetic dentistry study group at the University of Paris. He can be contacted at yassine.harichane@gmail.com.

Magical All-on-4

Dr Stanko Miletic, Dr Ivan Miletic & Pavel Metelka, Croatia & Czech Republic

Fig. 1: Successful treatment results from the past with our aesthetic implant workflow.

Surgeon Stanko Miletic takes care of an effective implant treatment as a base for the prosthodontic treatment performed by dentist Ivan Miletic, who also registers the individual information of the patient for the dental technician Pavel Metelka, who digitally produces the final restoration. The digital data is stored in case of future patient services.

We have been performing full-arch or full-mouth restorations in this manner for the past eight to ten years. Just in the past three to five years, we have treated over 400 cases together in this way, most of them with the All-on-4 technique with an immediate loading protocol (Fig. 1). As material, we primarily use Ceramill PEEK White (Amann Girrbach) for the substructures, combined with single zirconia crowns made from Zolid FX Multilayer (Amann Girrbach). The crowns are cemented to the PEEK substructure, and for the anterior region, we always perform a little cut-back for an aesthetic flourish. The gingiva

is layered with pink composite. In some cases, we use a selective laser melted substructure veneered with composite.

In this article, we will present a prosthodontically driven case to demonstrate the importance of team communication between surgeon, prosthodontist and dental technician. Only good team communication leads to a functional and aesthetic result. The case involved a full-mouth All-on-4 rehabilitation with immediate loading using screw-retained bridges with a PEEK substructure combined with all-ceramic single crowns. We will present each phase of the aesthetic implant workflow, from surgery to prosthodontics and the laboratory work.

Initial situation

The patient came to our office with a denture in the maxilla which he had had for more than 30 years. His teeth

Figs. 2 & 3: The patient—photographic documentation of the initial situation.

and an old bridge in the lower jaw were failing owing to periodontal disease and massive bone loss (Fig. 2). The patient wished to be able to smile again with confidence and to have a fixed, functional and aesthetic treatment. We captured initial panoramic images and decided to restore both jaws with the All-on-4 surgical protocol with immediate loading of the dental implants.

The treatment of each All-on-4 case starts with image capture (Fig. 3) and planning of the definitive restoration. In this phase, we talk very intensely with the patient to see what problems he or she had in the past and what wishes he or she has for his or her future restoration. In this first phase, we also take the initial impressions, the facebow and bite registration of the initial situation, the height registration, digital panoramic images and CBCT scans in order to plan the surgery and prosthetic steps of the case.

Implant placement

In this case, we used the All-on-4 technique to restore the edentulous upper jaw. On the CT scan we captured before the surgery, we saw that the patient had very thin bone in the maxilla. Our initial plan was to start with bone augmentation of the maxilla and then proceed later with placement of dental implants. In our first consultation with the patient, he made clear that he was not willing to undergo bone augmentation surgery. He wanted a solution without bone augmentation and with the least possible amount of surgery. After a review of the bone situation in the maxilla, we decided to implement the All-on-4 approach with the NobelSpeedy Groovy implant system (diameter: 4.0 and 3.3 mm; Nobel Biocare) to solve this case.

The surgery is a very important part of this protocol. There are certain steps that need to be fulfilled to establish an ideal situation for the prosthodontist and for the dental technician, including during diagnostics and planning, bone and soft-tissue remodelling, implant placement, restorative and aesthetic space creation, placement of multi-unit abutments and suturing. Only

those who consider these steps will have a fast and easy surgery with great results and good long-term stability of the dental implants (Figs. 4 & 5). Similarly, choice of
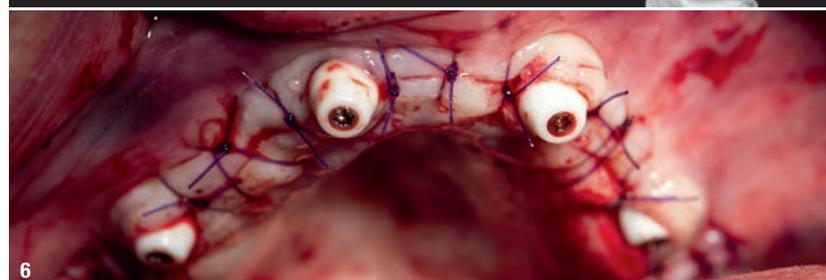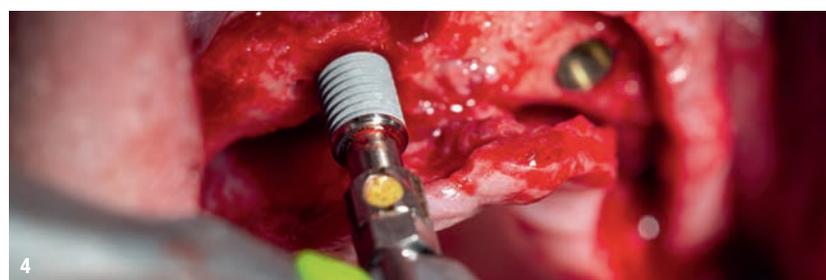

Fig. 4: Surgical procedure, placement of implants. Fig. 5: CT scan after the surgical insertion of the four implants. Fig. 6: Result immediately after surgery. Fig. 7: Alpha-bridge: initial temporary design.

Fig. 8: Facebow registration with the Artex facebow.

implant system and implant surface, considering how it affects primary stability and stress distribution, is very important for immediate loading of non-osseointegrated dental implants.

Prosthodontic planning

As soon as the surgery is finished (Fig. 6), we capture the impression, height and facebow registration immediately. We consider our design of the definitive restoration in the so-called alpha bridge, the initial—temporary—design (Fig. 7). This part is very important, as we can test the new height, function and aesthetics of the first design. We use Ceramill TEMP Multilayer (Amann Girrbach) for the alpha bridge; everything is done at the level of the multi-unit abutment.

After three to four months, we capture a digital panoramic scan for control and perform a percussion test of the dental implants. We then start to plan the definitive restoration. One important thing we consider in the planning is the feedback from the patient regarding the alpha bridge.

We perform the bite and facebow registration of the alpha bridge with the Artex facebow (Amann Girrbach; Fig. 8). Afterwards, we send the temporary bridge and bite and facebow registration to the dental laboratory for articulation and scanning.

Creating pictures of the patient is a great way to check the planned final aesthetics on the screen (Fig. 9). We first go through the aesthetic and functional checklist with the patient and review the aesthetics later in the pictures. Adjustments are made in the design software as needed to gain the optimum aesthetic result. After the CAD is done, we proceed to milling the beta bridge in the Ceramill Motion 2 (Amann Girrbach) using Ceramill TEMP Multilayer. We use the beta bridge as a final try-in before we start to design the definitive restoration. Also, in this process step, we take pictures of the patient and ask him or her about the look and feel of the adjusted restoration. If everything is fine, we proceed with the definitive restoration.

Definitive restoration

After the try-in of the beta bridge has been successful regarding function, aesthetics and, of course, patient approval, we start to design the definitive substructure using Ceramill PEEK as material. When designing the substructure, the basis for the later zirconia crowns is also created at the same time (Fig. 10). The substructure needs to be designed 1–2 mm deeper than we expect
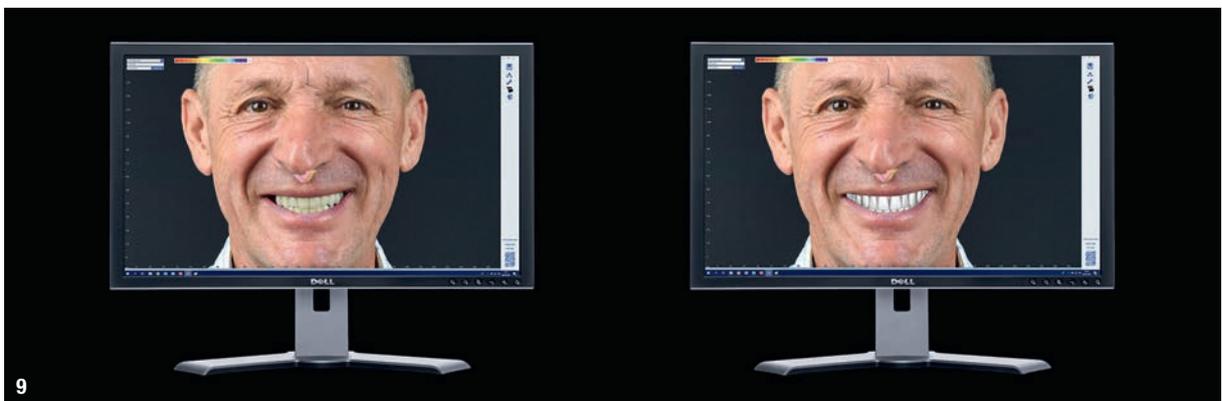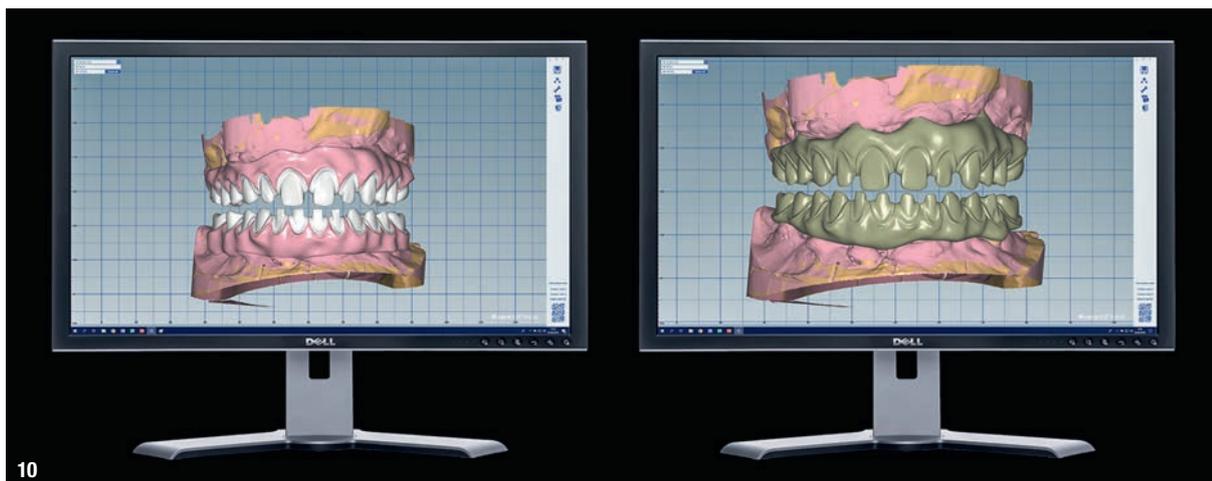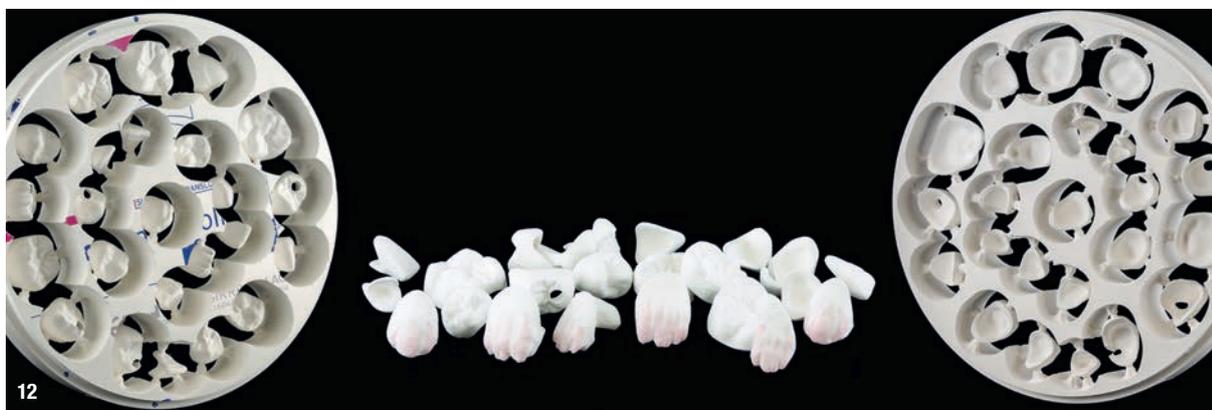

Fig. 9: Aesthetic check with patient pictures.

Fig. 10: CAD of the definitive restorations. **Fig. 11:** Finished milling result of the substructures made from Ceramill PEEK White.

Fig. 12: Finished milling result of the zirconia crowns made from Zolid FX Multilayer. **Fig. 13:** Zolid FX Multilayer crowns ready for the anterior veneering.

Fig. 14: Milled wax crowns and a silicone key as assistive devices for the later veneering process. **Fig. 15:** Final check of the Zolid FX Multilayer crowns.

CAM software (Amann Girrbach) and Ceramill Motion 2/Mikro milling machines.

For the crowns, we use the highly aesthetic zirconia material Zolid FX Multilayer (Fig. 12). Since it was a full-mouth rehabilitation and we did not have to orient ourselves on existing residual teeth, we decided to produce the crowns in Shade A2/A3. Zolid FX Multilayer brought us lifelike colour shades, adequate transparency and acceptable bending strength. For the posterior region, we use full-contour crowns, and in the anterior region, the crowns have been slightly anatomically reduced (cut-back) to make space for ceramic veneering (Fig. 13). To achieve the highest possible level of detail right after milling, we chose the HD milling strategy. With that strategy, the fissures are finished with a 0.3 mm bur.

The greatest benefit of PEEK-based screw-retained bridges is that we can place the crowns directly on the model during veneering. Because we used the cut-back library developed by dental technician Knut Miller in the CAD, it is easy to veneer the anterior region and at the same time keep a constant shade for all the crowns. The veneering process gives us the freedom to play with the aesthetics, transparency, colours and natural look of the patient's smile.

the final margin. We will overcover the cervical margin of the crowns with gingiva in the final step. The minimum height of the substructure needs to be 7–10 mm and the width 5–8 mm and can contain cantilevers, which can be no longer then the distance between the two neighbouring implants.

The milled result on the Ceramill Motion 2 DNA is smooth and precise thanks to the great milling strategies (Fig. 11). In this case, we used Ceramill PEEK White, which helped us keep the final colour of crowns without using any opaquer after luting them on the substructure. The milling strategy can be wet or dry, but only on a five-axis milling machine. By choosing the fine strategy for undercuts, the five-axis milling on the outside shape is precise without any manual correction.

For fitting on the implants, we decided to use the InCadCam solution. For multi-unit abutments, it is the best choice for a direct fit in combination with PEEK in the Ceramill Match 2

Since we knew from the interviews with the patient that he was very satisfied with the shape of the anterior teeth and the height of the smile line from the temporary bridge, we used this shape as the base for the veneering. For that reason, we copied the tooth shapes from the temporary anterior crowns in the CAD software and milled the crowns afterwards in Ceramill Wax White (Amann Girrbach; Fig. 14). In the second step, we produce a silicone key, which makes the veneering process as easy as it can be. It is an efficient and predictable aid. Digital systems have many benefits corresponding to manual process steps that we can use for our reliable workflow. After veneering, we need to finally check all the details of the crowns before we cement them on to the substructure (Fig. 15).

Fig. 16: Veneering of gingival parts with composite.

Figs. 17a & b: The final result and a happy patient.

As preparation for the gingival veneering, the PEEK substructure is sandblasted with 50 μm particles under 2 bar pressure and cleaned afterwards using dry air. In the second step, we apply the primer visio.link (bredent) and light-polymerise the layer for 5 minutes. Afterwards, the crowns are cemented using a resin-based cement on the PEEK substructure and covered in addition by composite opaquer. The gingiva is veneered using GC GRADIA (GC), which is a composite-based veneering material. We cover the ceramic margin of the crowns and the visible PEEK parts with the veneering composite. The contact points on the patient's gingiva are kept in PEEK and polished to a high gloss (Fig. 16).

The patient was extremely happy with the final result (Fig. 17). The definitive restoration perfectly corresponded to his facial attributes and had great function. Our digital protocol gives us the advantage of being able to design, see and test the envisioned result in the very early beginning of treatment. This is extremely important in today's dentistry, as we can precisely adjust every aspect of the planned definitive restoration.

Our protocol also benefits the patient. The patient is involved in the planning at a very early stage and can make aesthetic changes together with the prosthodontist before the definitive restoration is started. Thanks to this method, we can avoid unwanted surprises and stress with the definitive restoration for both the dentist and the patient.

If we think into the future, this type of restoration offers further great advantages. This type of restoration can easily be repaired in comparison with a monolithic zirconia restoration, for example. If there is chipping or fractures of the crowns, the stored data of the CAD construction can be retrieved and the broken part can simply be re-milled. After sintering, the dentist can remove the damaged crown and cement the new one to the PEEK structure.

In the end, the key to success is good teamwork between all interfaces, in this case between the surgeon, the prosthodontist and the dental technician. Of course, the selection of the right material is also important.

about

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The art of a personalised smile design

Dr Galip Gürel, Turkey; Drs Dimitar Filtchev & Georgi Iliev, Bulgaria; Dr Braulio Paolucci & Adriano Schayder, Brazil
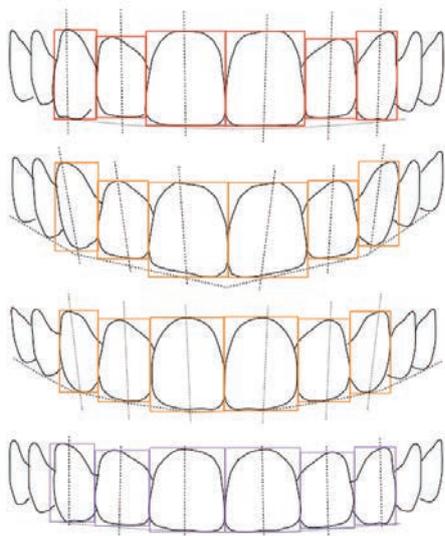

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Fig. 1: When the dentist first evaluates a new patient with aesthetic concerns, many critical factors may be overlooked. The verbal information exchange should be translated into a visual representation in order to aid in understanding what the final expectations should be at the end of the treatment, for the patient and the dentist. The basic means of this communication starts with a 3D preview of the design in the patient's mouth (APT: Aesthetic Pre-evaluative Temporaries) even before the rest of the treatment is planned. No matter what clinical difficulties a dentist will face and how problems will technically be solved, if the patient does not like the final aesthetic outcome, the treatment will be considered a failure.

Introduction

Aesthetics has become one of the most important outcomes of dental treatments. Regardless of the complexity of the case, patients are seeking better-looking smiles. For many years, we, as dentists or laboratory technicians, have been using all the basic aesthetic rules in order to properly create a smile design. These rules should be fundamental to the design. At the end of the treatment, the patients should feel happy. If one can evoke this feeling with a smile design, both the dentist and the patient will be satisfied giving and receiving more than standard, well-aligned teeth. However, the

final aesthetic results may often fail to meet the patient's expectations, owing to a disharmony between the smile design and the patient's identity. Patients' demands and the level of information needed have driven the profession to question itself regarding the customization of smile designs, which if ignored may lead to dissatisfaction with the aesthetic outcome, even though all the aesthetic principles and rules which tend to establish standards have been taken into account.

The mock-up

Visualisation of the smile design will have a great impact on the patient's understanding of the rest of the treatment. It is much more powerful than only verbally explaining what will be done. Prior to initiating any treatment, it is necessary to visualise the desired outcome. It then becomes possible to formulate the steps required to achieve this result.

Mock-ups facilitate significant improvement in communicating with the patient by showing him or her the potential final outcome of the treatment and allowing an easy comparison of the pre- and postoperative situations, and mock-ups allow the clinician to be able to check the functional aspects. Whether it is a case of worn dentition that requires altering the vertical dimension or just a straightforward veneer case, the aesthetic plane of occlusion and function will be based on the length—incisal edge position—and position of the anterior teeth. It is very difficult to convey the envisioned final length of the central incisors to the patient just by adding composite to the incisal edges of the central incisors; thus, the patient needs to see the whole smile, including the length and position of the posterior teeth. There are different ways to make the mock-up. It can be created directly in the patient's mouth or indirectly either through a wax-up or by using digital tools.

The personalised smile design

Every human being is unique and special and the design of his or her smile should reflect his or her personality. Shape, texture, colour and combination of teeth convey

Figs. 2a–d: The aim of this aesthetic treatment was to enhance the patient's smile. However, additional to all the aesthetic smile design basics, the facial analysis and the personality of the patient should be reflected in this design, in order to create the most natural, minimally invasive, personalised smile design.

direct messages, and when it comes to creating smile designs, dentists must consider the unity of the whole, which means bringing the biology, structure, function and aesthetics together with a fifth element, personality. Personality is the quintessential part here, because the other four elements are traditionally laid to balance it like a keystone. Through the large number of smile design elements, such as incisal edge, dominance of central incisors, tooth axis and shape, as well as subelements such as morphological details of each tooth, it is possible to establish, based on the dental scientific literature, which should be determined by the facial typology and which could visually represent the unique personality of each patient, beyond his or her personal preferences and expression of his or her will.

Visual language

Each type of line or shape has a specific emotional meaning.[1] Lines represent the most basic elements of visual language. Horizontal lines, because they conform to gravity, express stability, passivity and calmness, while vertical lines represent the movement of the point against gravity, expressing strength and power, just as inclined lines arouse the sensation of instability, tendency to movement and dynamism. Curved lines are associated with delicacy, sensuality and the feminine gender.[2]

The combination of lines generates the most basic forms, transferring to them their own expressions. Thus, the vertical rectangle expresses strength by the predominance of the vertical element on the horizontal, the triangle dynamism, the oval delicacy, the square stability and immobility with the balance between its vertical element and horizontal one. These basic shapes can be observed in the facial contour as well as in the incisors' shapes and 3D configuration of the dental arrangement, thus the incisal silhouette.

The visual language knowledge applied to the main expressive elements of smile design, such as dental shape, incisal edge, interdental ratio or dominance of central incisors, and 3D positioning of the teeth in the arch, determines four smile design types with primary expression (Fig. 1):

– Strong: composed mainly of rectangular dental shapes, strong dominance of the central incisors and canines over the lateral incisors (radial symmetry), as well as plane incisal edge and rectilinear 3D dental positioning on the arch from an occlusal view.

– Dynamic: triangular or trapezoidal dental shapes, standard dominance, inclined incisal edge and angled 3D dental positioning on the arch.

– Delicate: oval dental shapes, medium dominance, curved incisal edge and standard 3D dental positioning.

Fig. 3: Once the mock-up on the central incisor has been completed, it should be digitally scanned. It can be scanned with any intraoral scanner that can produce an STL file. Most intra-oral scanners convert the 3D scan into an STL file automatically. However, if the dentist does not have an intra-oral scanner in the dental practice, an analog impression of the upper jaw (preferably with the direct mock-up done on the central incisors) is taken and sent to the nearest dental laboratory that owns a scanner (laboratories that work with a CAD/CAM machine will have a digital scanner). The dental technician can digitalise this impression for the dentist and upload the STL file to Rebel, in order to complete the order via a provided link.

– Calm or stable: smoothly rounded square dental shapes, weak dominance (current symmetry), horizontal incisal edge and 3D rectilinear or standard dental positioning on the arch.

Case presentation

The patient had short teeth and was not happy with the narrow buccal corridors and the yellowish colour of her teeth (Figs. 2a–d).

Aesthetic analysis and Rebel Simplicity

Aesthetic design can be challenging for dentists. Rebel (Visagismile) is a recent digital previsualisation technique that allows the clinician to:

– efficiently design the new smile;
– improve the communication between the dental team members involved in the treatment;
– obtain better communication and achieve better patient motivation; and
– visualise the final aesthetic result even before the treatment is started.

3D Rebel smile design plays an important role in the entire treatment planning and will guide the actual clinical treatment. This approach makes it possible to share the treatment plan among team members and to create a 3D visualisation of the case in the patient's mouth. The digital project will be tested and approved even before starting the actual treatment. Accordingly, it will allow the dentist to present the treatment solution.

The Rebel workflow
Rebel offers probably the simplest steps for transferring all the necessary information to the Rebel digital laboratory.

These are the three mandatory steps:
1. a single mock-up on a central incisor to be digitally scanned;
2. a full-face photographic protocol; and
3. a simple questionnaire.

Single central incisor mock-up and intra-oral digital scanning
A composite mock-up is performed on one (or two) of the central incisors in order to identify the incisal edge position vertically and the position of the facial surface buccolingually (Fig. 3). This is no different from creating any direct mock-up; however, the greatest advantage of creating this mock-up for Rebel is that the dentist does not need to concern himself or herself with the perfect design of this mock-up, meaning that he or she does not need to choose the shape of the tooth (square, triangular, rounded, etc.), the angulations of the axes of the teeth, surface texture, etc. These details of the smile design will be provided by the Rebel artificial intelligence-based software, according to the facial analysis and the personality of the patient. Therefore, this will allow any dentist at any level to start working with mock-ups and end up with high-level wax-ups.

If the dentist does not wish to make a mock-up, then he or she can alternatively write down the additional length that would be needed to be added to the central incisors vertically, and the volume on the facial aspect (e.g., 0.3 mm thicker facially). In that case, the dentist can easily relate the existing length of the teeth to the upper lip position with the help of a periodontal probe. This information should be noted (the additional length that is needed to be added to the central incisors vertically and the volume on the facial aspect e.g., 0.3 mm thicker facially) and included in the file that will be sent to Rebel.

Full-face photographic protocol
The software requires five full-face photographs for facial analysis and classification of the patient and for
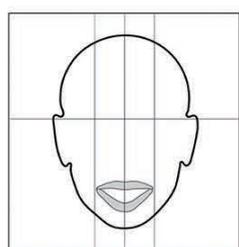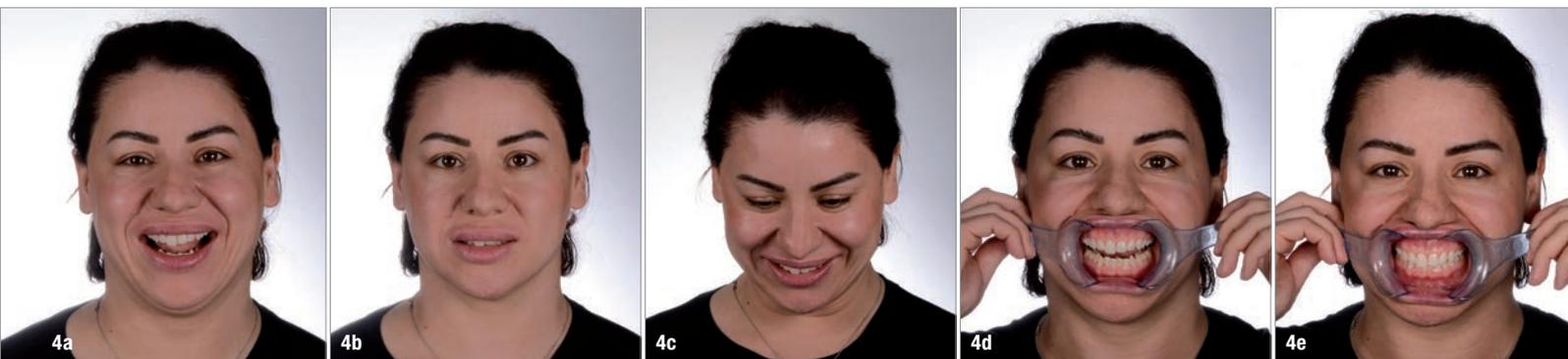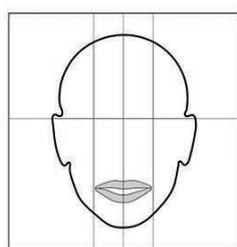
Figs. 4a–f: The forehead and the ears of the patient should be visible. It is crucial to keep the head upright (not tilted to the right or left, or up or down). The eyes should preferably be positioned parallel to the horizon.

relation of the 3D intra-oral digital scan to the facial features. The following are the five full-face photograph types needed (Figs. 4a–f).

I. Full-face photograph in rest position
This photograph is for the automatic facial recognition process of the software, and part of the new Rebel smile design will be based on this facial analysis of the patient. Technically, it is very important that the forehead and the ears of the patient are visible. If the patient has long hair, it should be held away from the face. It is crucial to keep the head upright (not 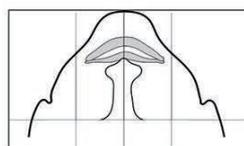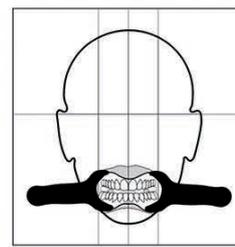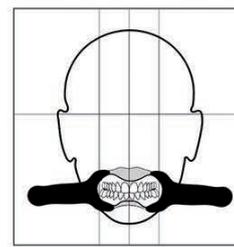tilted to the right or left, or up or down), preferably positioning the eyes parallel to the horizon and keeping the lips apart. The software automatically checks the required full-face photograph and sends a message immediately to the dentist if the necessary technical requirements have not been met so that he or she can retake the photograph.

II. Full-face photograph of patient smiling
Keep the patient in the same position with the eyes open and parallel to the horizon and the head upright (not tilted to the right or left, or up or down). This time, ask the patient to keep his or her lips apart in a soft smile (if possible, ensure the incisal edges of the maxillary incisors are displayed).

III. Photograph of face in 12 o'clock position
There are two simple ways of taking this specific photograph. An easy way is to keep the patient in the same position and ask him or her to incline his or her face 45° forward while giving a full smile, taking the photograph so that it shows the relationship to the maxillary central incisors and the displayed arch position to the lower lip line. The dentist can also move the patient to a supine position on the dental chair and to the 12 o'clock position, ask him or her to smile fully, and take the photograph from a 45° angle.

IV. Full-face photograph with mouth closed and lips retracted
The patient should be asked to hold the full-mouth retractors, again keeping the position of the eyes parallel to the horizon and his or her head upright (not tilted to the right or left, or up or down), and keeping his or her teeth closed and the occlusal plane parallel to the horizon.

V. Full-face photograph with mouth open and lips retracted
The same protocol as for the mouth closed should be repeated, but this time with the teeth (upper and lower jaws) separated.
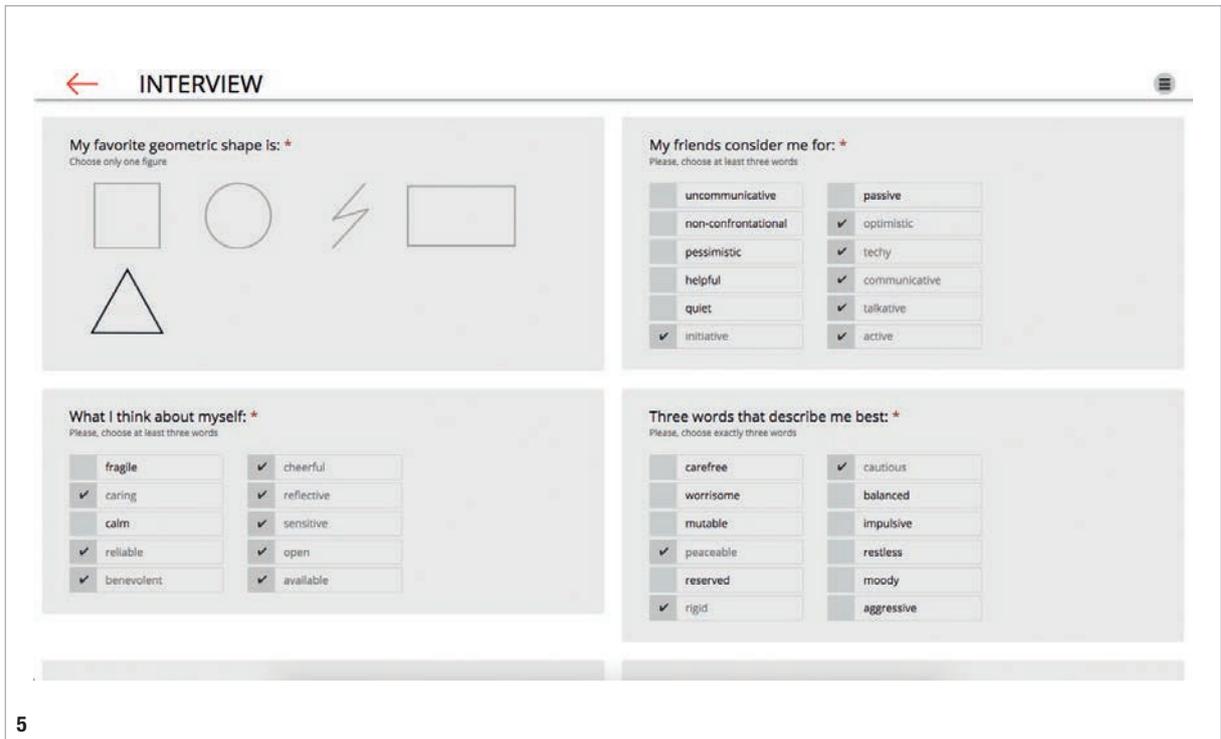
Fig. 5: The optimal tooth shape is determined with the help of the interview. The questionnaire is based on popular psychological tests of personal self-assessment. The first question is an adapted test by Dellinger[10] and the other three questions concern personality traits based on the theory and questionnaire by Eysenck and Eysenck.[11] The questionnaire is checked by a computer algorithm to classify the patient's personality. Based on the data from the interview, a software algorithm automatically calculates the temperament as perceived by the patient. The temperament is a combination of strong, dynamic, delicate and calm. After this procedure is done, the dentist and/or the technician will have a full idea of the facial analysis and the personality of the patient.

Questionnaire

An interview to reveal the character and the personality of the patient is completed through a questionnaire available in the software and gives the dentist the primary and complementary characters of the patient (Fig. 5). The temperamental type of each individual is defined by a unique combination of diverse characteristics of the four main temperaments, and therefore, for a precise and practical evaluation, it is necessary to apply a specific questionnaire.

As the dentist is about to send the three mandatory files, he or she will also be asked to include for the Rebel digital laboratory, a description of the clinical case regarding any specific designs, such as the buccal corridors and perfect imperfections, and the intensity of the surface texture, or choose some of the optional features provided if needed. When the entire Rebel workflow has been completed, the software will guide the dentist to exit, and at a click of a button, the file will immediately be sent to the Rebel digital laboratory via e-mail.

Rebel digital laboratory

It has a very sophisticated simplicity, owing to a very complex software behind it which enables the dentist to do the most simplistic, yet most predictable and personalised, 3D wax-up. For every level of dental practice, reproducible and accessible to all professionals, a concept for smile design customisation was developed by Paolucci[3] and Paolucci et al.[4] The concept, called "Visual Identity of the Smile," arose from the association of different knowledge such as aesthetic and functional dental fundamentals, artistic visual language, facial recognition and personality typology. For the objective application of this concept, the Rebel software was developed.

Rebel software is able to perform facial reading, personality assessment and personal preference evaluation of each patient and convert that information into mathematical language. Through pre-programmed algorithms, an initial 2D smile design is created. The software is capable of transforming this 2D smile design into a 3D customised model automatically. The model generation is performed by a custom 3D library, developed specifically for Rebel Simplicity. Every model is personalised according to the proposed tooth configuration.

The Rebel system is actually a virtual laboratory that converts the 2D design into 3D and creates a digital wax-up immediately. The 2D design is created by relating the facial perception and the personality of the patient to the smile design, by applying algorithms for
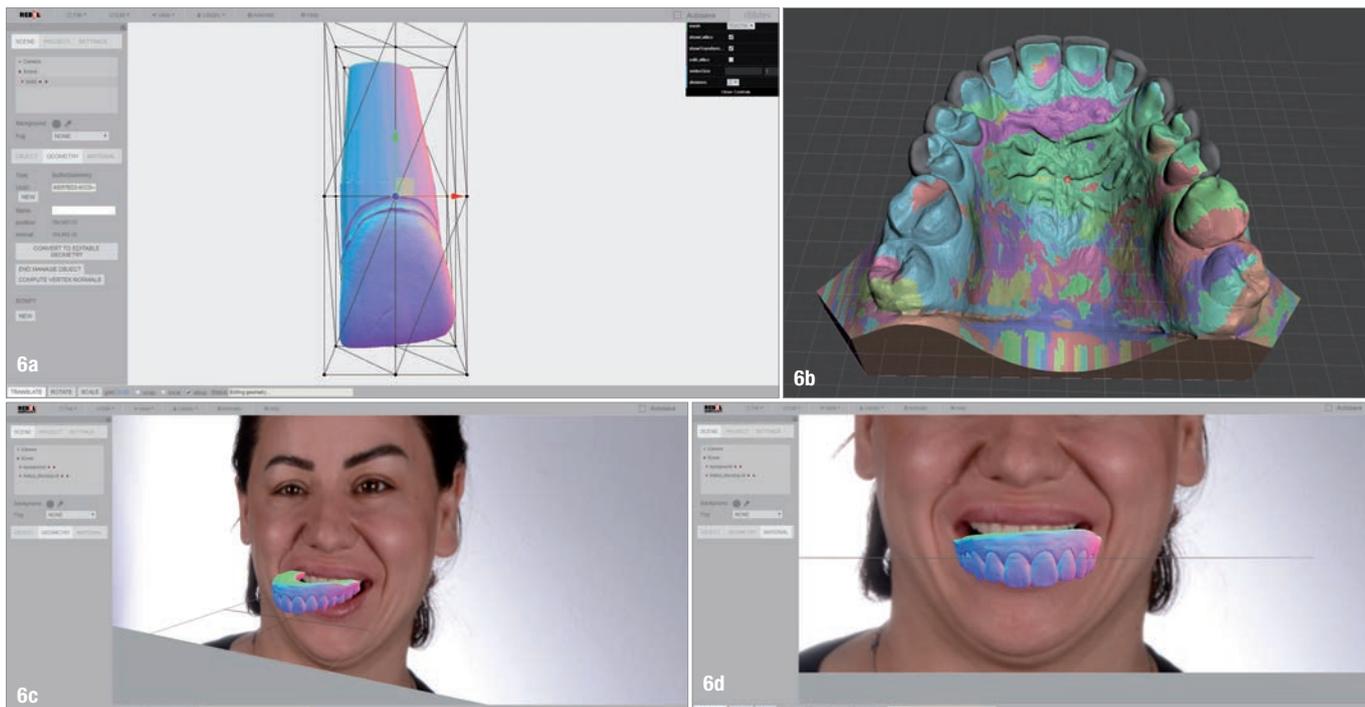
Figs. 6a–d: Rebel is a recent digital previsualisation technique that allows the clinician to efficiently design the new smile, improve the communication between the dental team members involved in the treatment, obtain better communication, and achieve better patient motivation thanks to the visualisation of the final aesthetic result even before the case has started. By the same token Rebel will enhance the predictability of the entire treatment and guide the actual clinical treatment. This approach allows the sharing of the treatment plan with team members and creates a 3D visual perception of the case in the patient's mouth. The digital project will be tested and approved before the actual treatment starts and allows the dentist to present the treatment solutions.
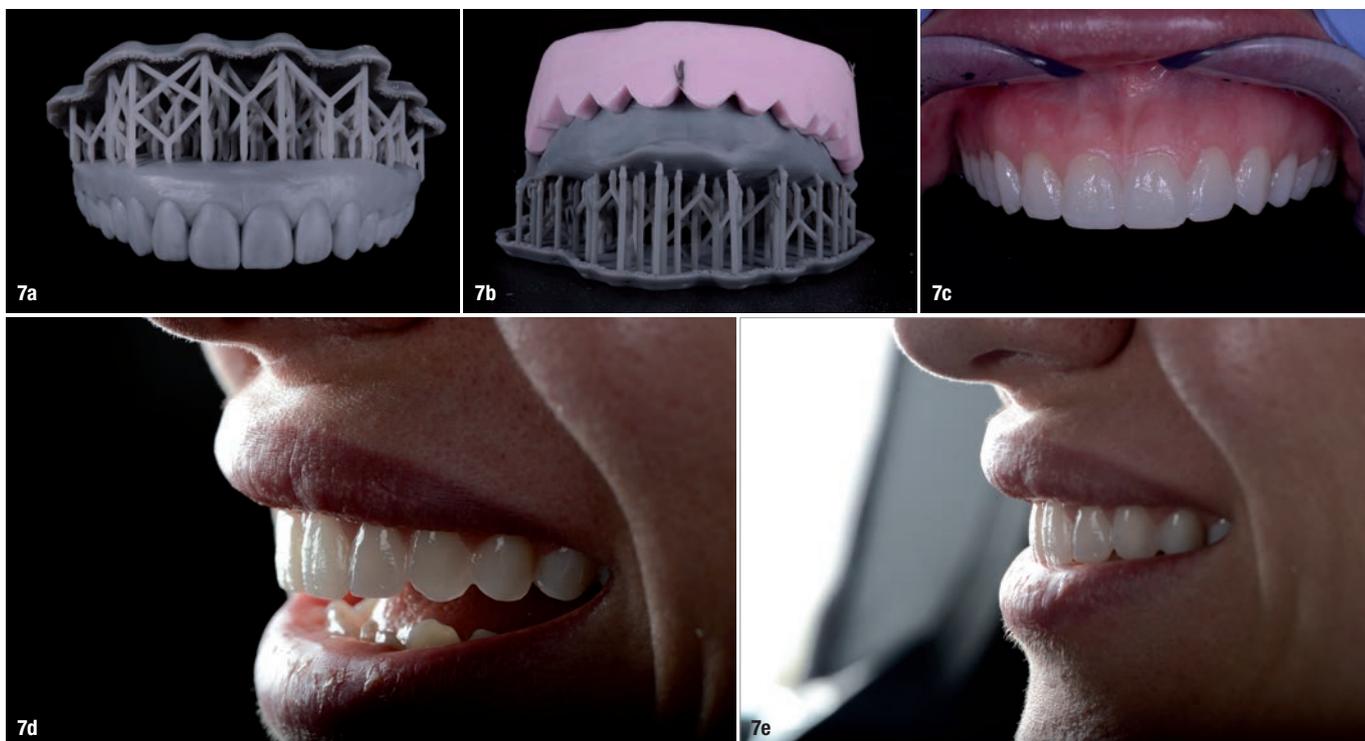
Figs. 7a–e: After the STL file has been 3D-printed **(a)**, the dentist can easily transfer this design to the patient's mouth by making a silicone impression of the digital wax-up **(b)**. The harder this silicone transfer impression, the more precise this transfer will be, in order to duplicate all the details, such as the line angles that give the ideal shape of the teeth, as well as surface texture. This transfer should be done prior to everything. The dentist should evaluate the new design well before starting the tooth preparation with the APT (Aesthetic Pre-evaluative Temporaries) or as the final mock-up. This way, not only the ideal 3D smile design, but also a great 3D communication opportunity, will be given to the dentist and the patient. The final aesthetic design should be approved at this time.

Figs. 8a–d: Once the final design has been approved by the dentist and the patient, the dentist can anesthetise the patient and start preparing the teeth through the APT (Aesthetic Pre-evaluative Temporaries). As soon as the teeth have been prepared, it is then the choice of the dentist to continue the case digitally, by taking an intra-oral digital scan, or to continue with the conventional analog way. The patient leaves with the provisionals.

computing the optimal combination of the incisal silhouette, tooth axis, dominance of the central incisors and the combination of individual tooth shapes out of thousands of possibilities. It may sound complicated; however, it is the simplest way of creating one of the best 3D digital wax-ups possible.

Rebel employs very sophisticated artificial intelligence-based software with algorithms; however, it provides great simplicity to the end users, the dentists and dental technicians (Figs. 6a–d).

Back to chairside/3D printing
This STL file is then sent to the dentist via e-mail, ready to be 3D-printed (Figs. 7a–e).

Tooth preparation through the Aesthetic Pre-evaluative Temporaries
The design of the APT (Aesthetic Pre-evaluative Temporaries). creates a very solid reference for the tooth preparation. With the use of a depth cutter, the dentist can start preparing the teeth through the APT. His or her work will lead to the most minimally invasive tooth preparation (Figs. 8a–d).[5,6]

Porcelain laminate veneers are tried-in and after the aesthetic acceptance of the patient and the dentist, they are bonded to the teeth under rubber-dam isolation (Figs. 9a–c, page 14).

Conclusion

The combination of the basic rules of aesthetics together with the reflection of the facial analysis and the personality of the patient in the smile design creates a more natural and personalised smile.[7–9] This principle presumes harmony between the smile design and the patient's personality. However, in the dental practice, its application has been limited owing to the lack of an objective method for assessing the patient personality and incorporating its results into the smile design.

Currently, Rebel can help the clinician to provide smile designs that consider patients' emotions, sense of identity, behaviour and self-esteem. Combining modern digital technologies with the classic treatment rules can be used to achieve predictable aesthetic results.

The Rebel concept, which can be applied very easily and rapidly, can help the dentist or ceramist to achieve this goal in the most simplistic, practical and personalised way. The authors' clinical experience shows a minimum of 80% success in the acceptance of the final smile design treatment. Finally, before any further investigation and research is done, if the result by applying this technique does not satisfy the patient owing to the subjectivity of the matter, the dentist can always make minor alterations in order to adopt this design according to the patient's desires.

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about

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Figs. 9a–c: In the same way, the laboratory can produce these veneers digitally by milling or using pressable ceramics or utilising feldspathic veneers. In this case, the material chosen was the IPS e.max Press pressable ceramic (Ivoclar Vivadent), after one-third incisal cut-back and feldspathic porcelain applied on top with the micro-layering technique and bonded to the teeth.

Digital vs. analogue workflow on ten ceramic veneers in the maxilla

Dr Michalis Diomataris, Dr Stavros Pelekanos & Michalis Papastamos, Greece

Fig. 1: Initial photograph of the anterior teeth prior to orthodontic treatment. **Fig. 2a:** Anterior teeth after orthodontic treatment. **Fig. 2b:** Extra-oral photographs after orthodontic treatment.

Introduction

Different materials and treatment options are available in aesthetic and restorative dentistry for the anterior region. The conventional protocol, including an analogue impression with polyether or polyvinylsiloxane, a master cast and die fabrication, waxing and pressing of ceramic materials, requires exceptional skills and is technique-sensitive. Intra-oral scanning and digital impression taking provide an accurate alternative method for transferring information from the mouth to the dental laboratory.[1] The digital file is always on the computer and can be immediately processed or at any time, unlike with the conventional procedure.

Regarding materials, various newer products, such as pressed or milled ceramics, offer enhanced strength and functionality; however, in thinner dimensions, they lack the inherent aesthetic beauty of conventional materials such as feldspathic porcelain. As patient demand for better aesthetics has increased in recent years so too has the need for restorative materials that closely mimic the patient's natural dentition. Initially used for the creation of porcelain dentures, feldspathic porcelain has emerged as the premier aesthetic material for custom veneer restorations. In recent years, the use of hand-layered powder/liquid feldspathic porcelain has been revived based on its highly aesthetic values and little to no preparation requirements. By keeping preparation to a minimum, less tooth structure is removed and procedures are much less invasive, which is exactly what patients desire.[2]
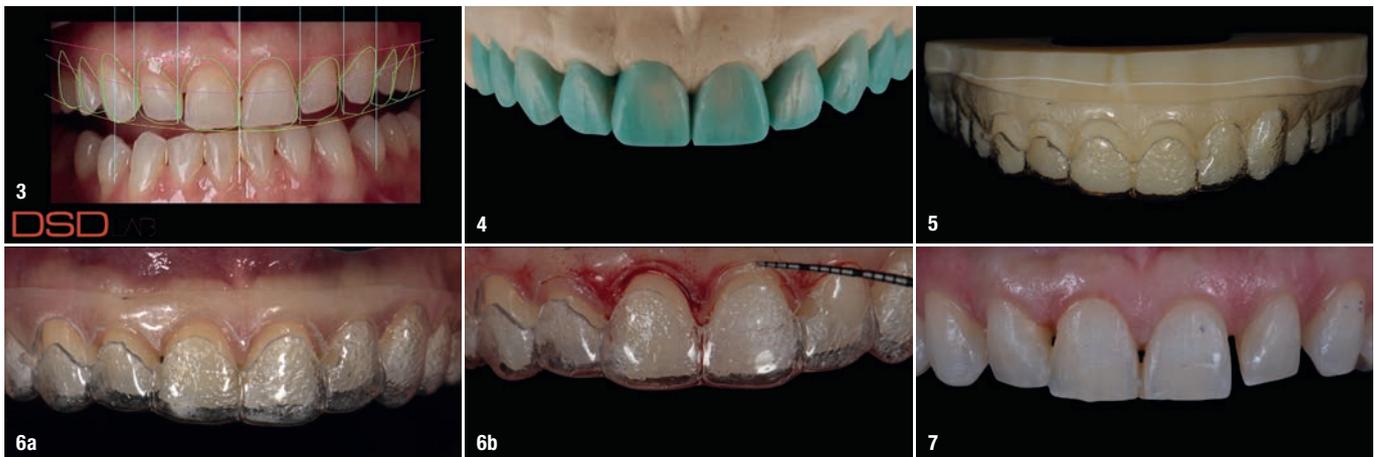
Fig. 3: Digital smile design indicating crown lengthening of teeth #13, 12, 11 and 21 and restorative treatment of the ten anterior teeth. **Fig. 4:** Wax-up on the stone model concerning the restorative treatment of the ten anterior teeth. **Fig. 5:** Three-dimensionally printed model of the digital smile design planning, bearing a mock-up shell. A cervical opening was introduced for surgical access and guidance for crown lengthening. **Figs. 6a & b:** Intra-oral fit of the surgical guide for crown lengthening. **Fig. 7:** Periodontal tissue of the anterior teeth six months after crown lengthening.

In contrast, the conventional methods of ceramic fabrication have been described as time-consuming, technique-sensitive and unpredictable owing to the many variables, and thus CAD/CAM may be a good alter-

native for both dentists and laboratories.[3] CAD/CAM may also reduce the fabrication time of high-strength ceramics by up to 90%.[1] Furthermore, industrially fabricated blocks are more homogenous, with minimal flaws, and CAD/CAM restorations have been found to compare favourably with other restorative options.[4, 5]

As far as optical properties and CAD/CAM are concerned, the fact of complex optical illusion phenomena in anterior aesthetics cannot always be met with monochromatic aesthetic materials without the need for final characterisation by a dental technician. In order to overcome such aesthetic disadvantages of a monochromatic restoration, multichromatic ceramic blocks have been developed to create a 3D layered structure. These ceramic blocks offer a gradient of chroma from the cervical to the incisal areas that replicate dentine and enamel in the same block.[6–8] The aim of this case report is to compare the analogue versus the digital workflow on ten ceramic veneers in the maxilla, in terms of aesthetic outcome, length of procedures and technical sensitivity for both the dentist and the dental technician.
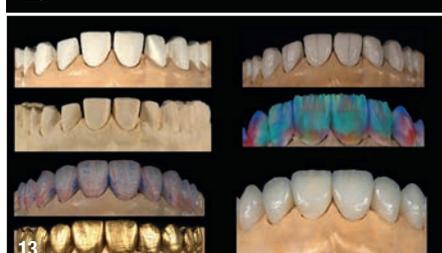
Fig. 8a: Mock-up silicone index. **Fig. 8b:** Intra-oral photograph of the mock-up. **Fig. 9a:** Preparation through the mock-up. **Fig. 9b:** Check of the preparation depth, with the use of the silicone guide, palatal aspect. **Fig. 9c:** Final preparation of the teeth. **Fig. 10:** Analogue impression with polyvinylsiloxane. **Fig. 11:** Digital impression with TRIOS. **Fig. 12a:** Digital planning of the provisional restorations. **Fig. 12b:** Provisional restorations intra-orally (Telio CAD). **Fig. 13:** Analogue workflow (refractory dies, built-up veneers, adjustments, staining/glazing). **Fig. 14:** Digital workflow (3D printed model, CAD/CAM veneers, adjustments, staining/glazing).

Fig. 15a: Feldspathic veneers with try-in paste. **Fig. 15b:** CAD/CAM veneers with try-in paste. **Fig. 15c:** First quadrant feldspathic veneers and second quadrant CAD/CAM veneers simultaneously with try-in paste.

Fig. 16a: Isolation field and try-in of the fit of the veneers on teeth #11 and 21. **Fig. 16b:** Etching of the enamel for 30 seconds with a 32% orthophosphoric acid. **Fig. 16c:** Application of the bonding agent. **Fig. 16d:** Final polymerisation of the veneers. **Fig. 16e:** Veneers *in situ* before finishing and polishing procedures. **Fig. 16f:** Final outcome immediately after removal of the rubber dam.

Case report

A 35-year-old patient presented at the office with the chief desire that the aesthetics in the anterior region be changed (Fig. 1). A diagnostic wax-up was performed, followed by mock-up fabrication, in order to obtain a preliminary visualisation of the final outcome. Orthodontic treatment was proposed in order to align the teeth in a more favourable position for veneers requiring minimal preparation and to reduce the overbite. One year after treatment, the patient returned for the final prosthetic rehabilitation (Figs. 2a & b).

Fig. 17a: Final outcome one week later. **Fig. 17b:** Final outcome one week later, frontal view. **Fig. 17c:** Lips at rest, exposure of the incisal edges. **Fig. 17d:** Wide smile. **Fig. 17e:** Extra-oral final photographs.

Methods and materials

Digital smile design according to Coachman and Calamita[9] was performed, from which a treatment plan of crown lengthening and veneers on teeth #15–25 (Fig. 3) was proposed. A conventional diagnostic wax-up was also produced (Fig. 4). Both digital and conventional mock-ups were applied, and agreement was attained concerning tooth shapes and proportions. Crown lengthening was performed, guided by the digital mock-up, with the use of an acrylic transparent double crown lengthening guide that indicated the borders of the gingivectomy and alveolectomy needed in periodontal surgery for aesthetic rehabilitation (Figs. 5 & 6).[10]

After six months of tissue stabilisation (Fig. 7), a mock-up was produced with Telio CS C&B (Ivoclar Vivadent) chairside (Figs. 8a & b), and tooth preparations with silicone guides were performed (Figs. 9a–c). Both conventional impressions with polyvinylsiloxane (Fig. 10) and digital impressions (TRIOS, 3Shape) were taken (Fig. 11).

Provisionalisation was executed digitally, using Telio CAD (Ivoclar Vivadent) in the Wieland Select CNC milling machine. The design was performed with the 3Shape DentalDesigner 2015 software (Figs. 12a & b). Two sets of final restorations were fabricated. The set of feldspathic veneers was fabricated on a stone model using IPS Style (Ivoclar Vivadent), while IPS Empress CAD Multi (Ivoclar Vivadent) was used for the digital set (Figs. 13 & 14). Both sets were examined intra-orally with a try-in paste to compare the optical properties of the feldspathic and the CAD/CAM veneers (Figs. 15a–c).

The subjective decision of the clinician and the patient was to cement the feldspathic veneers, owing to slight differences in the length
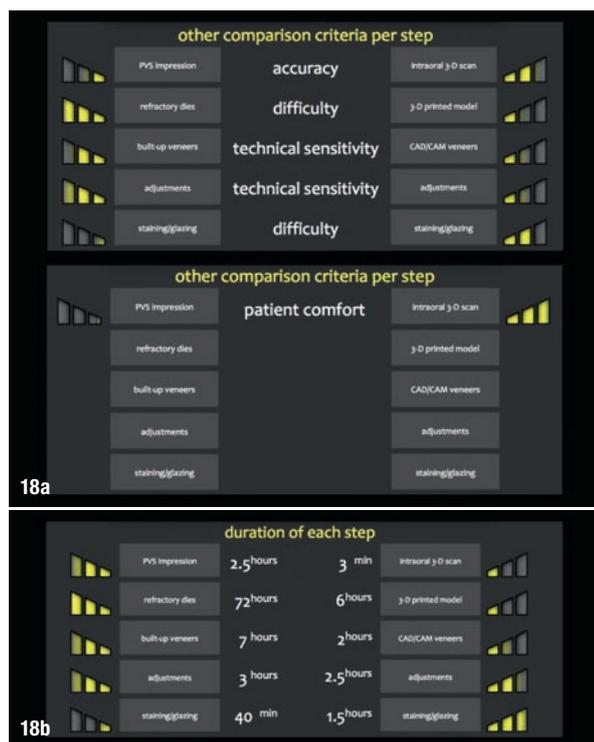
Fig. 18a: Subjective comparison criteria per step between analogue and digital workflows. PVS = polyvinylsiloxane. **Fig. 18b:** Laboratory duration per step between analogue and digital workflows. PVS = polyvinylsiloxane.

of the central incisors between the two sets. Adhesive procedures followed (Figs. 16a–f), and final intra-oral and extra-oral photographs were captured one week later (Figs. 17a–e).

Results

Intra-oral digital scanning is a perfect alternative clinical procedure compared with the conventional impression technique. The digital planning and mock-up procedure is a powerful communication tool for the dentist, although special skills in using computer software are required. Regarding the laboratory workflow, most of the analogue procedures require more time (refractory dies, built-up veneers, adjustments), except the staining/glazing (Figs. 18a & b). Although the aesthetic outcome of the feldspathic veneers was subjectively chosen in this case, the analogue workflow is much more demanding. The digital approach, because of the reduced difficulty, speed, complexity and patient discomfort, tends to be preferable (Figs. 18a & b).

Conclusion

Knowledge and application of virtual smile design procedures, coupled with innovative dental laboratory technologies, allow dentists to diagnose, plan, create and deliver aesthetically pleasing new dental compositions. Furthermore, advances in CAD/CAM technology have catalysed the development of aesthetic veneer restorations with industrially produced materials possessing superior biomechanical properties and good aesthetics.

about

Dr Stavros Pelekanos graduated School of Dentistry, National and Kapodistrian University of Athens in Greece and received Doctoral promotion Dept. of Prosthodontics, School of Dentistry, Albert-Ludwigs University of Freiburg, Germany. He was a clinical instructor, Dept. of Prosthodontics, School of Dentistry, National and Kapodistrian University of Athens from 1994–2001. He has published many scientific articles and abstracts, one chapter in a book, and received 2nd prize at the scientific award competition of the EAED in Madrid, Spain, 2008.

Dr Pelekanos is in private practice in Athens (AthinaSmile, www.athenasmile.gr) with emphasis on prosthodontics, aesthetic dentistry, pre-prosthetic periodontology and implantology. He is Asst. Professor, Dept. of Prosthodontics, School of Dentistry, National and Kapodistrian University, Athens.

Dr Michalis Diomataris received his DDS in 2009 from the University of Athens Dental School, Greece. In 2017 he received his master specialty from the postgraduate programme of Operative Dentistry of the University of Athens. Since 2011, he is supervisor in the education of the undergraduate dental students, in the contemporary principles of aesthetic and restorative dentistry.

In 2013 he received the first award of a national competition between the postgraduate students of Operative Dentistry of the national Dental Schools, presenting a case with the topic of "class IV restoration of a maxillary central incisor". Since 2014, he is a member of the team of Stavros Pelekanos' Dental Clinic—AthinaSmile, in Athens, Greece, practising in aesthetic and restorative dentistry and prosthodontics.

Michalis Papastamos completed his studies in 1983 and ever since he is active on the dental field. Since 1989 he is the owner of the "Dental Aesthetic" dental laboratory, which is specialised in aesthetic restorations. He attends seminars of well established dental technicians and dentists in Greece and abroad, investing in the upgrading of his knowledge and educational level. Moreover, he organises and delivers seminars and demonstrations himself and has participated, in collaboration with Greek and foreign dentists, in complete live dental rehabilitation programmes, being in charge of the dental part. He cooperates with the dental school of the National and Kapodistrian University of Athens, in the field of Prosthodontics.

Ivoclar Vivadent Live Experience Tour—coming together across Europe

By Claudia Duschek, Dental Tribune International

The global COVID-19 pandemic has partially shut down the global dental industry and restricted in-person meetings for over a year. As things are slowly getting back to normal, Ivoclar Vivadent, a leading international supplier of integrated solutions for high-quality dental applications for dentists and dental technicians, is embarking on a four-month tour through 15 European cities in order to bring its products and key opinion leaders to its customers' doorsteps.

The Ivoclar Vivadent Live Experience Tour will offer the company's customers a one-of-a-kind platform with educational and networking opportunities—all free of charge. "We understand from our customers that a regular exchange with their colleagues about the latest topics and trends in dentistry is vital for their business and personal development," said Ivoclar Vivadent Chief Marketing Officer Patric Frank, summarising the rationale behind the event series in a recent interview with Dental Tribune International.

"We took the decision not to participate in the International Dental Show in spring this year already. At that time, the pandemic situation for the rest of the year was still very much uncertain," Frank explained. "With the localised tour, we are providing our customers with a solution that is in line with the latest local health regulations and involves less

1

Fig. 1: "We can't wait to catch up with our customers all over Europe," said Patric Frank, chief marketing officer at Ivoclar Vivadent. **Fig. 2:** The Ivoclar Vivadent Live Experience Tour will include events in Austria, Denmark, France, Germany, Italy, the Netherlands, Poland, Portugal, Spain, Switzerland and the UK.

travelling, as cross-border travel is becoming increasingly difficult again. During the tour, we can meet customers in their own country at a location close to them."

The Live Experience Tour 2021

Tour planning

Leipzig	02.09. – 03.09.2021
Munich	09.09. – 10.09.2021
Lodz	17.09. – 18.09.2021
Vienna	30.09. – 01.10.2021
Montreux	08.10. – 09.10.2021
Lyon	14.10. – 15.10.2021
Dusseldorf	21.10. – 22.10.2021
Copenhagen	29.10. – 30.10.2021
Hanover	04.11. – 05.11.2021
Rome	12.11. – 13.11.2021
Porto	19.11. – 20.11.2021
Seville	26.11. – 27.11.2021
Zurich	03.12. – 04.12.2021
Cuijk	10.12. – 11.12.2021
Manchester	in 2022

2

Fig. 3: Dental professionals who would like to join the tour have to register online on the Ivoclar Vivadent website in advance. *(All images: © Ivoclar Vivadent)*

A roaming showcase with a strong focus on education

From September 2021 to early 2022, dental professionals across Europe will have the opportunity to learn first-hand from some of the most experienced experts in the dental field, reconnect with their peers and explore Ivoclar Vivadent's innovative workflows. With at least three sessions for each two-day event, the tour will have a strong education component—something that "has been and will remain a priority for Ivoclar Vivadent to support our customers," Frank confirmed.

The Live Experience Tour is Ivoclar Vivadent's platform for unveiling its latest products, software and services this year. "The new products will be launched within the matching workflow, as we believe that products need to be optimised within a dedicated workflow to enable our customers to achieve the highest aesthetics and efficiency," Frank said. At each tour stop, product presentations will be complemented by interactive educational sessions and products for customers to test, such as milling machines, scanners and printers. "While products remain at the core of our workflows, we are taking the bigger picture into account, linking them to the other important factors in the work of our customers," Frank clarified. "Ivoclar Vivadent has always considered itself as a vital link between the dental practice and the laboratory. The presentations and educational sessions therefore are also aimed at fostering collaboration between the two entities."

Among other topics, the following will be in focus:
– direct filling therapy with the Tetric line of four coordinated composites and 3s PowerCure, an innovative blue phase curing light system for intra-oral polymerisation;
– CAD/CAM chairside treatment with the recently launched PrograScan intra-oral scanners and Programat CS6 furnace, supporting fast crystallisation of IPS e.max CAD;
– the combination of pressing and printing with the recently launched Programat furnaces and PrograPrint PR5 3D printer; and
– the Ivotion denture system, which offers a complete digital manufacturing process, allowing laboratories to create top-quality removable dentures.

Frank further revealed that one highlight of the tour will be the global launch of two new products—one for dentists in the adhesion product portfolio and the other for dental laboratories in the zirconia restoration range.

Tour participants will learn about a number of updates, including the latest version of IvoSmile with CAD integration, for which they will receive an annual licence.

The right locations for a safe experience and intimate atmosphere

In order to safeguard the health and safety of its customers, Ivoclar Vivadent has worked closely with local experts at each location. The company has also chosen its tour stop locations wisely to provide enough space for a pleasant and relaxing atmosphere that will allow excellent networking opportunities.

Frank summarised: "The Live Experience Tour is the chance to meet in person again, not only with the wider Ivoclar Vivadent team, including product developers and sales representatives, but also with other dental professionals for business and informal conversation while enjoying great food and drinks in unique locations. Most importantly, each tour stop will be a chance for our customers to share their feedback and wishes with Ivoclar Vivadent as we strive to constantly improve our products and services for the benefit of the user. We can't wait to catch up with our customers all over Europe."

The number of participants per event is limited and in-advance registration is mandatory. However, at least three time slots per city will be offered. While safety protocols will be adapted to local regulations, wearing of face masks will be required in all indoor areas and all participants will be asked to provide a SARS-CoV-2-negative test.

More information about the different tour stops and the respective programmes, as well as the registration form, can be found at www.ivoclarvivadent.com/live-experience.

Correction of VDO: Fully digital workflow, integration of dental scanner, DSD and CAD/CAM

Drs Miguel Stanley, Ana Gomes Paz & Inês Miguel, Portugal, & Dr Christian Coachman, Brazil

Fig. 1: Intra-oral photograph prior to treatment, frontal view. **Fig. 2:** Intra-oral photograph prior to treatment, occlusal view of maxilla. **Fig. 3:** Intra-oral photograph prior to treatment, occlusal view of mandible.

Introduction

The digitalisation of the workflow in dentistry has gained ground in recent years owing to the technical advances as regards intra-oral scanners and software programmes. This development has also resulted in improved communication between the dentist and dental technician. Digital Smile Design (DSD) is a digital tool for planning the aesthetic restoration of facial symmetry. It not only aids communication between specialists, but also improves the treatment results which can be expected.[1] Dynamic documentation of the smile is an important step in the 2D/3D DSD process. The process can be fully digitalised and also supports the rehabilitation procedure. The advantages of video documentation lie

in the fact that this renders documentation, the smile design, the analysis of the facial symmetry, treatment planning, team communication and patient education both simpler and more effective.[2] The DSD can be converted into a conventional or virtual diagnostic model to simplify the subsequent clinical treatment, for example, CAD/CAM restoration.[3–7] The combination of the adhesive technique with light-transmissive restoratives makes preparing for minimally invasive restorative dentistry intervention simpler. Materials such as lithium disilicate ceramic[8–11] boast similar properties to those of natural teeth, which, in turn, enable positive results to be achieved.[12, 13]

Intra-oral scanners are an important tool in the digital workflow. These handy devices allow the impression quality to be checked directly and the models to be transferred simply, cost-effectively and quickly via e-mail to the laboratory.[14] However, there is little information in the literature about the ability of intra-oral scanners to produce high-quality impressions.[15–24]

CAD software is invaluable, as it controls the fully automated devices which create the objects and assemblies in a virtual environment.[25]

In this report, a clinical case is represented in which the workflow was fully digitalised. After minimally invasive preparation, the DSD protocol and the monolithic veneers and crowns made from lithium disilicate ceramic by means

Fig. 4: Initial situation, panoramic radiograph (2015).

of CAD/CAM were used to remedy the loss of vertical dimension of occlusion (VDO), as well as the associated aesthetic and temporomandibular joint (TMJ) impairments.

Case presentation

In 2015, a 47-year-old male patient presented complaining of pain in the TMJ. He also had an aesthetic request, since part of the veneer on one of the maxillary central incisors had broken off (Figs. 1–3). The clinical and radiographic analysis (Fig. 4) indicated a loss of VDO and tooth substance due to bruxism.

Digital intra-oral photographs were taken of the frontal view under retraction and from the occlusal and lateral perspectives. Further photographs were also taken using a digital single-lens reflex camera (frontal, lateral and 45°). A diagnostic impression of both jaws was produced with an intra-oral scanner (Carestream 3500). The maximum intercuspal position was determined intra-orally using the Carestream 3500 intra-oral scanner, and the new vertical dimension of occlusion (VDO) was obtained by opening the virtual articulator to the desired width in the CAD/CAM software.

The dynamic documentation protocol of the DSD was used. Videos were recorded with a smartphone from four different calculated angles to achieve harmonious facial symmetry for the smile: a frontal video of the smiling face with and without the lip and cheek retractor, a profile video, a 12 o'clock video and an anterior occlusion video perpendicular to the occlusal level without a mirror.

Four supplementary videos were recorded for the functional, structural and facial analysis: a consultation as to the patient's expectations, a 180° phonetic video, an intra-oral functional video and intra-oral structural video with lip and cheek retractor (Fig. 5). The information was transmitted to the DSD laboratory. The main goal of the DSD technique is to combine the photographs from
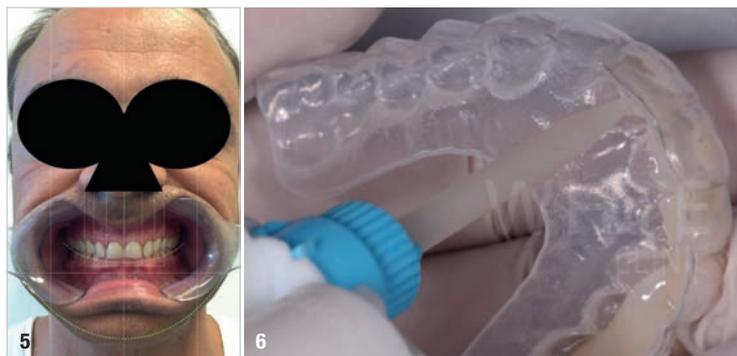

Fig. 5: DSD protocol: image of patient smiling wearing a lip and cheek retractor. **Fig. 6:** Motivational mock-up made of bis-acryl (Structur 3).

the three views (occlusal, frontal and 12 o'clock) with a digital ruler in order to recreate the correct smile proportions by means of a video analysis (smile frame).

The smile frame was then created as follows, taking the facial symmetry into account: digital facebow, form and position of the smile curve, determination of width using the recurring aesthetic dental proportion, tooth length proportions, gingival margin papillary curve, vermilion border and jaw curve. The 2D proportions of the smile were converted in the CAD software into a digital 3D simulation model. The resulting 3D file in STL format was transmitted to a printer, which created the model with the new design. It was then used to produce a matrix made of bis-acryl (Structur 3, VOCO) for the motivational mock-up (Fig. 6).

The vertical dimension (VD) was increased in the new model, and for this reason, the patient tested the mock-up over the course of two weeks to ensure that the new VDO met his expectations. The bite trial showed no stability problems, and the patient was happy with the result. As such, there was no need for further deprogramming of the occlusion and definition of a new centric relation. The patient felt comfortable with this new VD and experienced no pain in

Fig. 7: Two years later, prior to treatment (2017). **Fig. 8:** No preparation of the posterior teeth and minimal preparation of the mandibular anterior teeth. Teeth #11–13 and 21–23 had already been prepared.
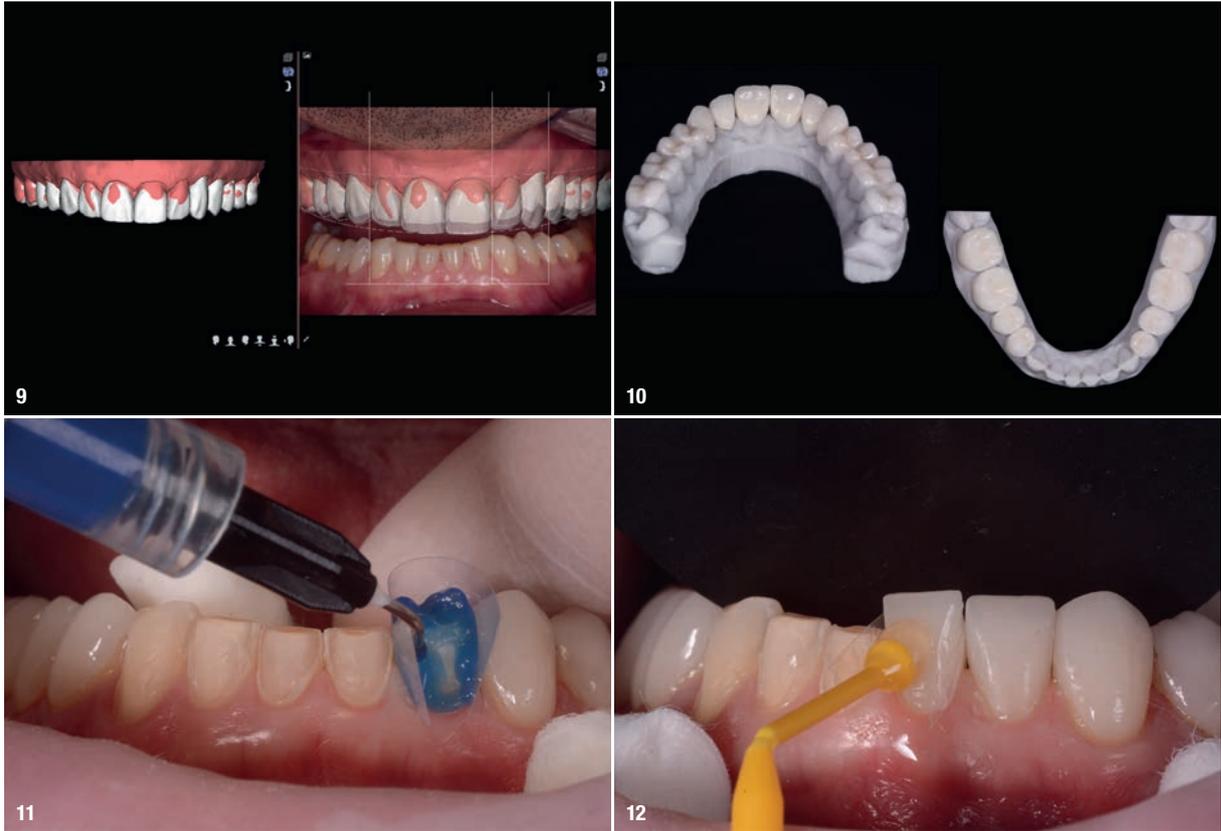
Fig. 9: DSD planning. **Fig. 10:** Final veneers and crowns digitally prepared using the Ceramill Mind design software and produced in a milling machine (Ceramill Motion 2) from machinable lithium disilicate ceramic blocks (VITABLOCS TriLuxe forte). **Figs. 11 & 12:** The crowns (#11–13 and 21–23) and veneers (#14–17, 24–27, 31–37 and 41–47) were secured to the abutments using a light-cured resin adhesive (Futurabond U and Bifix QM).

the TMJ. The treatment plan was presented, yet the patient chose not to continue treatment for financial reasons.

The patient returned to the practice in 2017 to resume treatment (Fig. 7), and a new intra-oral scan (Carestream 3600) was produced. A new mock-up for the tooth preparation was printed on a 3D printer (SolFlex, VOCO) with bis-acryl (Structur 3) using a vacuum-formed matrix (V-Print ortho, VOCO). The abut-

ment teeth were minimally prepared on the basis of the mock-up (Fig. 8).

The old tooth preparations in the second sextant were retained. The maxillary posterior teeth (#14–17 and 24–27) and the mandibular posterior teeth (#34–37 and 44–47) were not prepared, and the mandibular anterior teeth were minimally prepared. A new intra-oral scan was produced. The information was transmitted to the DSD laboratory (Fig. 9), which created an

Figs. 13 & 14: Intra-oral photographs after treatment.

STL file with virtual models produced in the laboratory (Anatomic Lab). These 3D models (V-Print model, VOCO) were created in a 3D printer (SolFlex 650, VOCO).

The final veneers and crowns were digitally prepared using the Ceramill Mind design software (Amann Girrbach) and produced in a milling machine (Ceramill Motion 2, Amann Girrbach) from machinable lithium disilicate ceramic blocks (VITABLOCS TriLuxe forte for Ceramill Motion 2, Amann Girrbach; Fig. 10). After confirming the marginal seal and the visual properties through trial insertion, a lip and cheek retractor (OptraGate, Ivoclar Vivadent) was placed in the patient's mouth.

The abutment teeth and ceramic veneers and crowns were prepared in accordance with the manufacturer's recommendations: The ceramic surface was prepared with 50 µm aluminium oxide and for 20 seconds with 5% hydrofluoric acid. It was then rinsed for 20 seconds before being treated with 37% phosphoric acid (Total Etch, Ivoclar Vivadent) and 96% alcohol in order to be cleaned and finally conditioned for 20 seconds with silane (Monobond Plus, Ivoclar Vivadent).

The crowns (#11–13 and 21–23) and veneers (#14–17, 24–27, 31–37 and 41–47) were secured to the abutments using a light-cured resin adhesive (Futurabond U and Bifix QM, VOCO). A high-performance LED light-curing device (Celalux 3, VOCO) was used for polymerisation (Figs. 11 & 12).

Excess luting material was removed, and the occlusion was adapted and checked with the T-Scan technology (Tekscan). A removable acrylic resin splint was used to protect the final restorations. The final restorations were checked after six months. The restorations were still stable and showed no signs of fracture (Figs. 13–15). The patient also reported that he no longer suffered from headaches with the new VDO.

Conclusion

Thanks to dental technological developments, fully digitalised treatment is possible, which can solve problems such as a loss of VDO successfully. However, further clinical studies are necessary in order to achieve reliable results as regards the digital work process compared with conventional techniques in the event of a loss of VDO. The functionality of permanent restorations must also be assessed in the long term.

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

Fig. 15: Panoramic image at the end of treatment.

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"Even the most experienced clinician is inconsistent—AI is not"

An interview with Dr Kyle Stanley

By Franziska Beier, Dental Tribune International

Dr Kyle Stanley is a specialist in implantology, founder of a company transforming patient care through artificial intelligence (AI) and a passionate advocate for mental health in the dental profession. He lectured on the future of dentistry powered by AI at the Osstell ISQ Online Symposium, which took place in September.

In this interview, the expert discusses how AI supports dental professionals in different areas such as radiology, practice management, smile design, the laboratory and dental insurance. He also talks about how AI is going to help individualise treatment plans in the future and how it can benefit the mental well-being of dentists.

> ## "I stand behind AI because I am always looking for ways to improve the quality of the work I do."

diagnostic consensus on any given tooth. They also produced widely divergent full-mouth treatment plans, ranging in cost from US$300 to US$36,000.

These inconsistencies can be attributed to factors such as differences in training, experience and state of mind—but whatever the cause, it's quite clear that even the most experienced clinician is inconsistent—AI is not. Once trained, computer vision systems for diagnostics will perform the same job the same way every time. They are consistent above all else. Because a computer vision diagnostic system's intelligence is so narrowly focused, its performance is unaffected by the preconceptions, bias or fatigue that affect even the most expert human radiologist. This makes them ideally suited to providing practitioners with chairside diagnostic second opinions—validation that delivers cascading benefits that have an impact on everything, including treatment planning, patient trust, insurance claim approvals and medical liability.

Of course, these systems are also very fast. In just a few seconds, a computer vision system can deliver diagnoses on thousands of radiographs. Although that kind of

Dr Stanley, in your Osstell ISQ Symposium lecture, you spoke about different applications of AI in dentistry. Could you please explain how AI is enhancing different aspects of dental care and what the benefits for dental professionals and their patients are?
Patient care begins with diagnosis, and in dentistry, diagnosis starts with radiographs. Computer vision AI has proved a potent dental diagnostic tool—and diagnostic consistency is the source of much of AI's potency. That's because dentists have an unfortunately large consistency deficit. Many will be familiar with a 1997 *Reader's Digest* story written by an investigative journalist who visited 50 different dentists across the US over four months, showed them each the same radiographs of his teeth, and received 50 different diagnoses and treatment plans. That experience has been validated in numerous studies over the years, including one recently by the Dental AI Council, in which 136 dentists reviewing the same full-mouth radiographs never delivered better than 50%

Dr Kyle Stanley

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speed may not be particularly necessary in a one-on-one patient consultation, it becomes very useful in tasks like evaluating every historical radiograph in an office's practice management system to pinpoint the provider's diagnostic strengths and weakness, surfacing missed diagnoses in a patient population and, over time, establishing a clear, elevated standard of care. These sorts of systems are on the verge of entering patient-facing clinical environments, but are presently pending U.S. Food and Drug Administration (FDA) approval.

"It's not doctor versus AI."

Since practice management is not a patient-facing area, however, FDA approval is not required, and diagnostic radiology AI systems are already delivering noticeable benefits in that arena. Computer vision diagnostic systems are converging with practice management systems, where historical radiographs deliver a wealth of actionable insights into both patient health and practitioner performance. This application is useful in solo practices and especially in larger groups and dental service organisations, where the high volume of data being generated makes it particularly useful.

The same diagnostic AI technology is being employed by insurance carriers to review radiographic claims evidence. Historically, carriers have always received far too many claims with radiographs to be able to actually validate them all. Applied in utilisation management, computer vision made it much easier to diagnostically validate every claim. These systems review all radiographic attachments and compare their diagnostic findings with diagnostic codes listed in the claim. If everything matches up, the claim is paid. If the AI system's findings and codes don't align, then the claim is passed to an expert human reviewer. This means that investment in human capital goes only towards claims actually worthy of review, vastly reducing the chances that a bogus claim will be approved.

Of course, as a practitioner with an interest in aesthetic dentistry, one of the areas of AI development in dentistry that excites me most is smile design. Systems employing generative neural networks, like those used to create deepfakes and Snapchat filters, are entering deployment, not only allowing doctors to automatically create a realistic rendering of an ideal smile that they can show to patients, but also translating the approved rendering into practical restorative prosthetic designs for milling within the CAD/CAM workflow.

To be honest, in the examples and explanations I have outlined, I have only just scratched the surface in ad-

dressing the ways that AI is going to have an impact on the dental workflow. And as AI continues to prove its value, there will be increasing pressure on every kind of enterprise operating within the web of dental business operations to adopt new methods and processes specifically tailored to serve AI systems and maximise the production of data from which the AI can draw insights to drive efficiency, consistency and quality across every aspect of dentistry.

The COVID-19 pandemic has made digital solutions even more important for dentistry. Have you noticed an increase of AI usage in the dental community since the onset of the pandemic?
Certainly. With many dental offices closed, many of the practice owners I saw went from working in their practices to working on them—looking for efficiencies and developing a more open mind towards technologies, including AI, as well as towards teledentistry.

What would you tell dental professionals who are still hesitant to jump on the AI bandwagon?
Whether we want to accept it or not, AI is already here—and it is absolutely certain to play a critical role in the future of dentistry. Those people who don't want to jump on the bandwagon tend to be people who view it as a threat or who think they are infallible or perfect at their jobs. The "infallible" dentists cannot be swayed, but to those who view it as a threat, I would start first by saying that I come from a family of dentists, and I would never stand behind anything that would jeopardise our livelihood. I stand behind AI because I am always looking for ways to improve the quality of the work I do—and AI will allow me to do that. It is not taking away my livelihood. If anything, it is making me a better dentist—someone my patients should put more trust in, because the work I do is being assisted by a device that prevents me from making mistakes that every human is subject to making.

And that's really the key: AI is an assistive tool. It's not doctor versus AI. It is doctor together with AI. By working together, we get better. I like to compare it to intelligent cruise control in modern cars: it will help keep you in the lane, it may tap your brakes if you're distracted and approaching a stopped car too fast, but you hold the steering wheel and you have the final say when it comes to where you're going and what route you take to get there. And along the way, AI will help limit your liability, build your patients' trust, and help you do more and better dentistry.

Together with two partners, you have founded your own company—named Pearl—which specialises in AI solutions for dental professionals. What is your role within the company, and how do your products support dental professionals in their everyday practice?
At Pearl, I am the chief clinical officer. What this means is that I am the dental brain on the team. When products are

being created, I make sure they are clinically sound and make sense for the business of dentistry. I also manage a team of doctors who help annotate images that help train AI models. In addition, I represent the company when interfacing with members of the dental community, speaking to doctors, group practice owners and office staff on podcasts, at conferences and in person. Pearl has an array of products which serve different industry constituents: Practice Intelligence is our clinical performance management solution, Claims Review and Pearl Protect

"We can expect AI to touch every aspect of dentistry."

are our solutions for the insurance market, Smart Margin and Prep Assess serve practices and dental laboratories with efficiencies within the restorative fabrication workflow, and Second Opinion is our patient-facing radiological assistive software, which is set to launch in the EU as we await FDA approval in the US. We also have an educational tool which is beginning to be deployed at various dental schools.

Even though AI is already widely used in dentistry and many other aspects of our daily life, surely we have not exploited its full potential yet. In your opinion, what can dental professionals look forward to in the years to come?
We can expect AI to touch every aspect of dentistry. In the future, all diagnoses and treatment planning will be assisted with AI, but more importantly our treatment plans will become increasingly individualised. What this means is that two people with the same diagnosis could get different treatment plans based on their genetics, musculature, bacteria flora, bone density, tooth shape and any other input that we can measure. We can also expect to see AI helping to make dentistry more predictive and, therefore, more preventive.

Is there anything else you would like our readership to know?
Those that know me from social media (@drkylestanley) know that I am a huge proponent of fostering mental health within dentistry. People rarely mention it, but I believe AI will have a real benefit in that area, because it will decrease liability, increase consistency of diagnosis and treatment planning, and tackle many of the mundane tasks that contribute to doctor decision fatigue in our industry. It is a pleasure for me to be able to help introduce new technology that may help reduce dentist burn-out and create a better future for this great profession.

"Digitalisation brings the patient to the dental laboratory with 24/7 availability"

An interview with Dr Daniel Edelhoff, dean of studies in dental medicine and director and chair of the Department of Prosthetic Dentistry at the University Hospital of Ludwig-Maximilians-Universität München in Germany

By Jeremy Booth, Dental Tribune International

Dr Daniel Edelhoff

How can dental teams intelligently integrate digitalisation into everyday routines? Dental Tribune International spoke with Dr Daniel Edelhoff, dean of studies in dental medicine and director and chair of the Department of Prosthetic Dentistry at the University Hospital of Ludwig-Maximilians-Universität München in Germany.

There are different strategies with which dental teams can approach digitalisation. What strategies are available to dental teams when it comes to communicating with laboratories?

As I am also a trained dental technician, I always think from both perspectives. Appropriate strategies for cooperation within the restorative team and, especially, strategies for cooperation with the patient were developed early on. I think of the concepts professed by Dr Carl Rieder, who is located in Newport Beach in the US, for example. Those who strive for success in their dental treatment need an intensive exchange of information. This is where today's digital possibilities play into our hands on various levels. Through technologies such as 3D facial scanners, intra-oral scanners, transfer forks, digital recording of dynamic occlusion and the combination of STL files with Digital Imaging and Communications data, digitalisation brings the patient to the dental laboratory with 24/7 availability.

The strategies are of course highly dependent on the digital equipment available to the partners and can vary accordingly. Photographs, videos and 3D facial scans can now be created with sufficient quality with a smartphone, which is an incredible and fascinating development. We have developed a well-functioning concept of synchronising individual steps of the cooperation on an analogue level, which is now increasingly substituted by digital possibilities. This increases predictability and, in some cases, such as in implant prostheses or total prostheses, can make certain treatment sessions superfluous. Digital technologies have very clear "killer applications" compared with the analogue approach. The planning and predictability of complex rehabilitations with a multidisciplinary approach can now be done with more certainty, as members of the treatment team always have access to the same wealth of information. This makes planning much more precise, and misunderstandings as well as mistakes are avoided, to the benefit of the patient.

As an expert in this field, you are familiar with the results of digitised communication with laboratories.
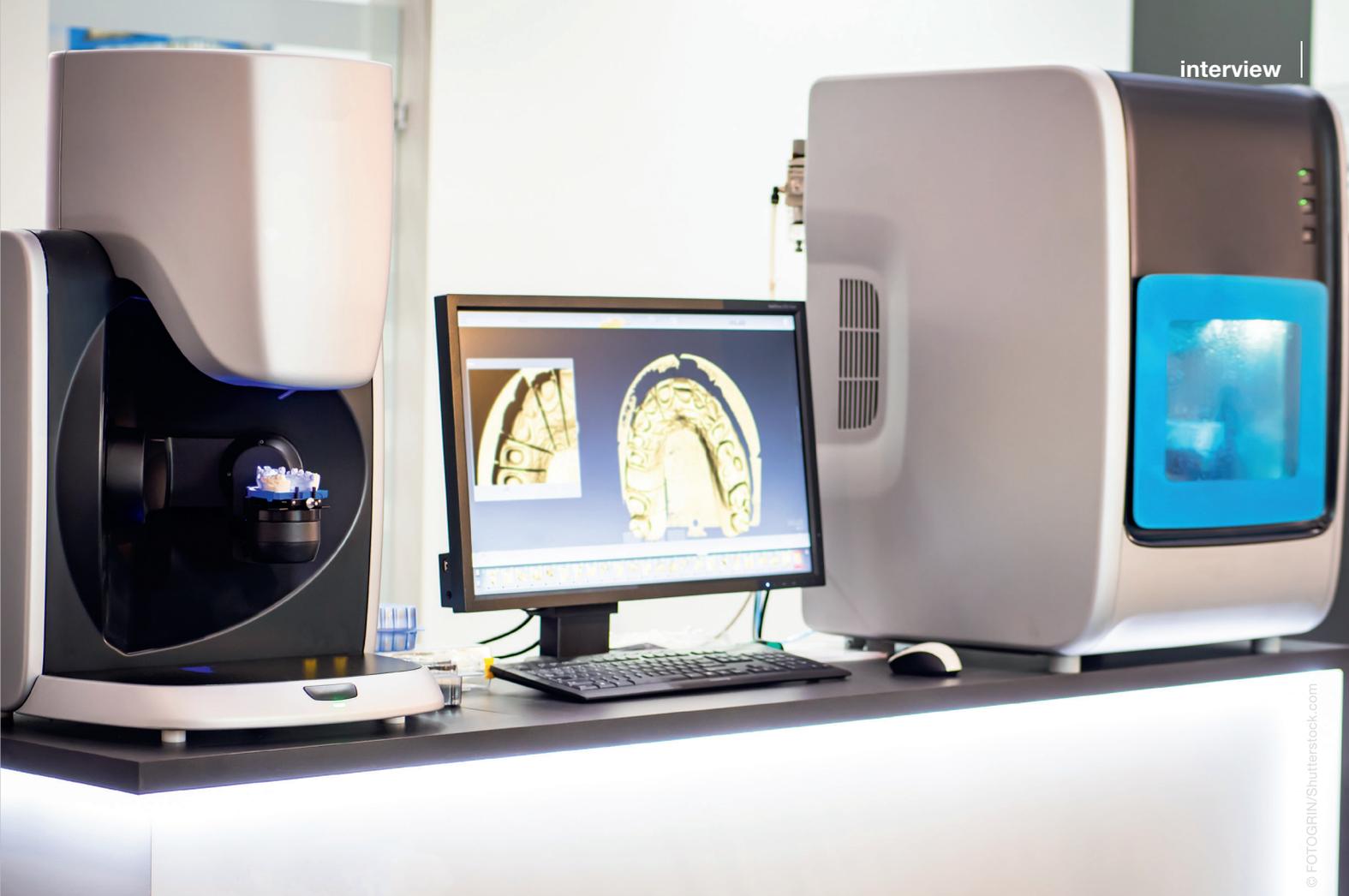
What are some of the challenges and advantages associated with this?

The individual components that I have already mentioned usually work excellently. The weak point lies more in the interfaces and in the further processing of the acquired data in the software. For example, it makes no sense to generate precise data if it cannot be converted 1:1 into the CAD software. The data compatibility of different systems in the laboratory and practice is one of the greatest challenges for me; however, this can certainly be mastered. Ultimately, the advantages of digital technologies outweigh the disadvantages. These advantages include more precise and more efficient reporting, analysis and diagnosis, which will be supported by artificial intelligence in the future. This facilitates treatment planning with accurate selection of the restoration material, virtual try-ins and real clinical "test drives" with direct communication both within the restorative team and with the patient. For open questions and multidisciplinary collaboration, online expert platforms would be desirable in order to produce synergistic results.

We often hear that digitalisation can lead to improvement in dentistry. What does improvement mean to you and how can digitalisation get us there?

Apart from the already mentioned advantages of better information exchange and communication, digitalisation results in safer planning, the use of higher quality

> "The data compatibility of different systems in the laboratory and practice is one of the greatest challenges for me; however, this can certainly be mastered."

standardised manufactured materials with higher biocompatibility, better precision (such as with milled polymers), better time-saving and better reproducibility. The new manufacturing possibilities have already brought us many interesting new classes of materials that are otherwise not available in the analogue world. Digital patient records make important data available much faster. We live in a high-performance culture today, and time has become a very precious commodity. As already mentioned, there are new digital possibilities in communication that will reduce analogue contact times with patients. This is to be welcomed against the background of the pandemic, but in the longer term, we must not displace empathy from our treatment concept.

Thank you for the interview.

Can we use the word "permanent" when it comes to what we do in dentistry?

Dr Scott D. Ganz, USA

As we all know, dentistry is dedicated to understanding the workings of the oral cavity, the maxillomandibular relationship, the repair of tooth decay, the reconstruction of partially or completely fractured teeth, the replacement of missing teeth, aesthetics, smile design, the creation of proper tooth alignment, the fixing of bite discrepancies, and much, much more. Regardless of what we as clinicians do for our patients, are there any solutions that should necessarily be described as being permanent?

We are all aware that the oral cavity is constantly under attack from the foods we eat, the liquids we drink, abrasive toothbrushes, parafunctional habits, accidental trauma, etc. And as a result of these constant attacks, teeth can break, decay can occur, and teeth can be lost. If we do a full coverage crown on a second molar, how long should it last our patient? How about a denture? Cosmetic bonding or porcelain laminate veneers? What about a dental implant? How long should these restorative solutions last?

If you read advertisements for dental services, listen to the radio, read the newspaper, or watch cable TV, the word "permanent" is often applied to what we as dentists do for our patients. Therefore, with all due respect my colleagues around the globe, why do we often see dental professionals advertising services that are permanent? In the world of dental implants, the concept that dental implants are a permanent replacement for missing teeth is a common one that has inhabited print media, social media, television commercials, websites and radio advertising. A simple online Google search for dental implants using the word "permanent" will reveal an almost endless list of entities who promote this concept. While we all know that dental implants are perhaps the most predictable biological replacement in all of medicine, they are not truly permanent replacements. In today's world of misinformation, is the dental industry being prudent when promoting services that are permanent? This is some food for thought.

The use of technology and our digital workflow have created methods which can aid clinicians in providing an extended timeline for the care delivered to their patients. Digital dentures are an example. Once the digital STL file has been designed and finalised, it can be stored on a local or remote computer server to fabricate the definitive prosthesis that will be provided to the patient. In the past, we would need to start over again if the patient accidentally dropped the denture and it fractured or lost the prosthesis, as the analogue process often destroyed the working cast used for the fabrication of the denture. Using today's digital workflow, we can retrieve the STL file and fabricate a new prosthesis without the need for additional impressions or many office visits. The same can be stated for implant-supported restorations fabricated with an intra-oral scanner and designed using CAD software and milled with CAM technology. If we can hang on to the files, when unforeseen events happen, we can recreate a lost implant crown with clicks of a mouse instead of many patient visits.

Therefore, as the profession of dentistry has been highly successful in providing long-lasting treatment to our patients, the digital workflow has provided new and exciting opportunities to extend the true lifetime of restorations, saving both time and money for the clinician and the patient. While still not permanent, digital technology does give us additional and important solutions to the potential lifespan of the restorations we provide to our patients.

contact

Dr Scott D. Ganz is on the teaching staff of the Rutgers School of Dental Medicine in Newark in New Jersey and maintains a private practice in Fort Lee in New Jersey. He can be reached at drganz@drganz.com.
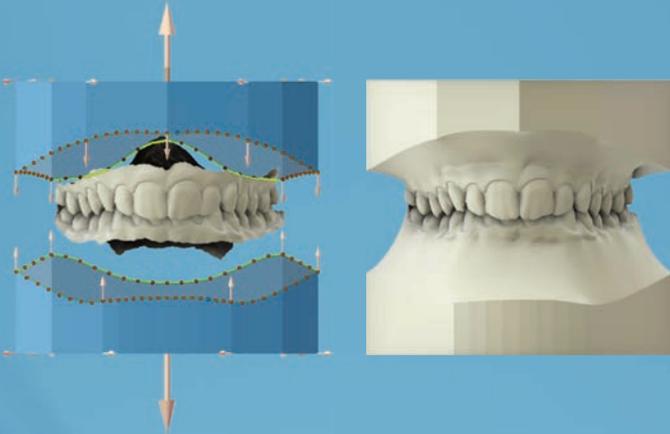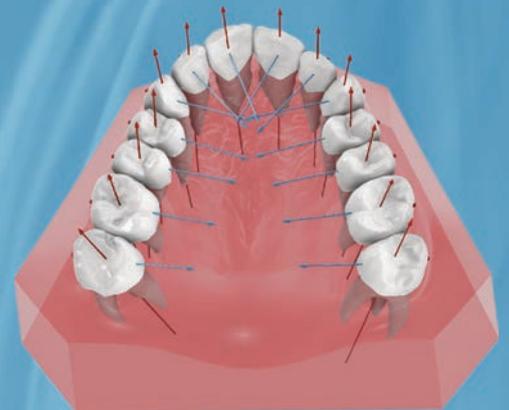
"Our booth will be the meeting point for the exocad community"

An interview with exocad chief commercial officer Novica Savic

By Dental Tribune International

Novica Savic has been working in the dental industry for 30 years and joined exocad in November 2017. *(All images: © exocad)*

While some companies are not present at all or only have smaller booths, exocad opted for a significantly larger presence than ever before. In this interview, Novica Savic, chief commercial officer at exocad, explains why the company's commitment to IDS remains unchanged and what visitors can expect.

Why did exocad decide to make its biggest IDS appearance yet at this year's event?
After IDS 2019, exocad had already decided that we needed a larger booth space. Two years ago, large crowds formed around the software demonstrations because so many users, technology and sales partners visited our booth. To ensure that visitors now have a better view of the demonstrations and that hygiene regulations can be complied with, we have enlarged the booth by over 50%.

There was never any question of whether exocad would participate in IDS. I see the trade fair as a driver for inno-

vation; many companies are aligning their development and innovation cycles with IDS, which underlines its function as the world's leading trade fair of our industry.

How is exocad adapting the booth concept to the current situation?
Exocad will still have a very open presence at the trade fair booth, in line with our philosophy of an open software platform. We will have a total of 12 different software demo stations with plenty of space between them. Visitors will still be able to move freely around the booth to find out about our products and talk to our software specialists. After all, it is precisely this personal exchange that makes the trade fair so appealing.

Owing to the pandemic, however, the booth will have a transparent glass railing at the aisles. If necessary, we will measure the flow of visitors to the booth and adapt the respective distancing measures. Transparent protec-

tive walls, disinfection facilities, mandatory face masks and distancing will provide a safe experience at the booth for both our employees and visitors.

We are also working closely with the organiser Koelnmesse to comply with the necessary hygiene requirements.

What can IDS visitors expect at the exocad booth?
Our booth will be the meeting point for the exocad community. After all, IDS provides one of the few opportunities for users to engage in direct, personal exchange with our software specialists and developers, who are also looking forward to engaging with customers. Getting direct feedback from users motivates and inspires them to improve and enhance our products even further.

Exocad has three core products: DentalCAD, ChairsideCAD for single-visit dentistry and exoplan for implant planning. New features for individual software products are planned, as well as some surprises, which we can't reveal just yet.

In addition, exocad will use the IDSconnect platform to interactively attract online visitors. Offering such an online option is, of course, a new challenge, but we have already had a very positive experience with our hybrid congress, exocad Insights 2020.

What do you personally expect from IDS 2021?
I think that many dental technicians and dentists are looking forward to attending IDS in order to see colleagues and their contacts at companies in person again. I expect an amazing event and a great atmosphere.

Exocad's Booth A020 in Hall 3.2 will be the meeting point for the exocad community at IDS 2021.

"We will have 12 different software demo stations with plenty of space between them."

Of course, IDS will be different this year than before, but one thing remains: we will definitely see many new products in Cologne.
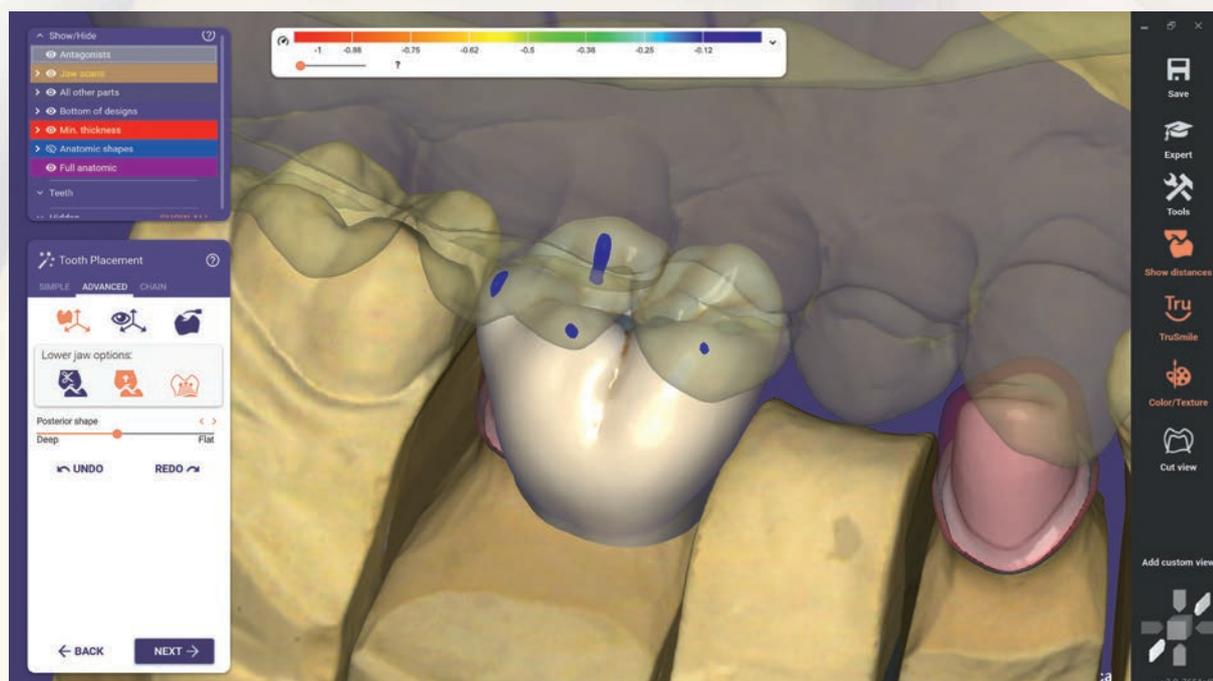
Evolutions in imaging with hybrid scanning
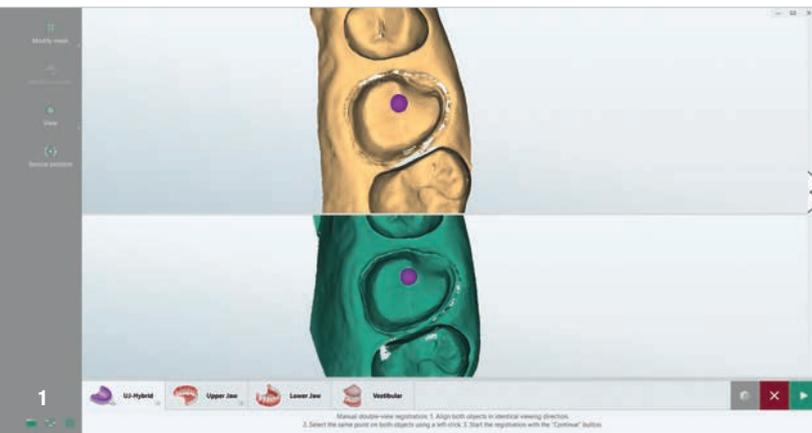
An interview with Stephen Lusty, UK

By GC Europe

Fig. 1: The Aadva Lab Scanner 2 is a fully automated laboratory scanner that uses sophisticated sensor technology based on stripe light triangulation of blue light LED.

In this interview, Stephen Lusty, an experienced dental technician specialised in aesthetic dentistry, talks about his experiences with the Aadva Lab Scanner 2 (ALS2) from GC.

With your experience in digital techniques using a variety of systems over the years, why did you choose the ALS2?
I had many other systems in the past, and they had flaws ranging from closed scan and design software to soft-ware with bugs and glitches. I had to be sure that I was purchasing a unit from a reputable company, that I could work with the device properly and that the software that came with the scanner was as open as possible.

Hence in 2012, I decided to purchase the original GC Aadva Lab Scanner. GC being a well-respected materials manufacturer and working alongside exocad, a new software company at the time but offering the most open software available for design, made me feel comfortable with my choice of purchasing the Aadva scanner. As an extra bonus, it was highly accurate for 2012, claiming an accuracy of less than 10 µm. The purchase of this scanner was the point in my lab that finally made me completely comfortable with digitalising full-arch cases first in titanium and cobalt–chromium and owing to the accuracy of fit even evolving to zirconia for certain cases.

As I mentioned, the Aadva Lab Scanner was my first introduction to the Aadva CAD software powered by exocad—a new player at that time but stable, easy and intuitive to use—and design-friendly! GC kept the original scanner on the market for over six years and in that time collected user feedback to create a wish list of what they deemed to be necessary to create a new even more user-friendly and accurate scanner. However, when I came to the point of deciding on a future device for my lab, I did not automatically go straight to GC. I tested the
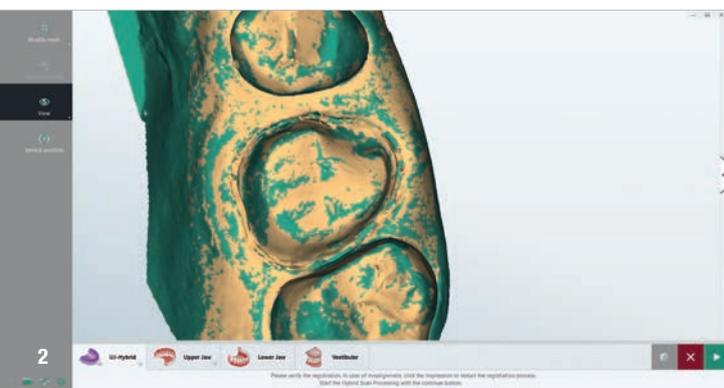
Figs. 2–9: Use of the Aadva Lab Scanner 2 in combination with GC's Hybrid scan workflow step by step. **Fig. 2:** A manual double view registration is achievable by selecting the same point on both objects to perform the alignment of the impression and model scan. **Fig. 3:** Visual alignment control, ensuring constant accuracy.
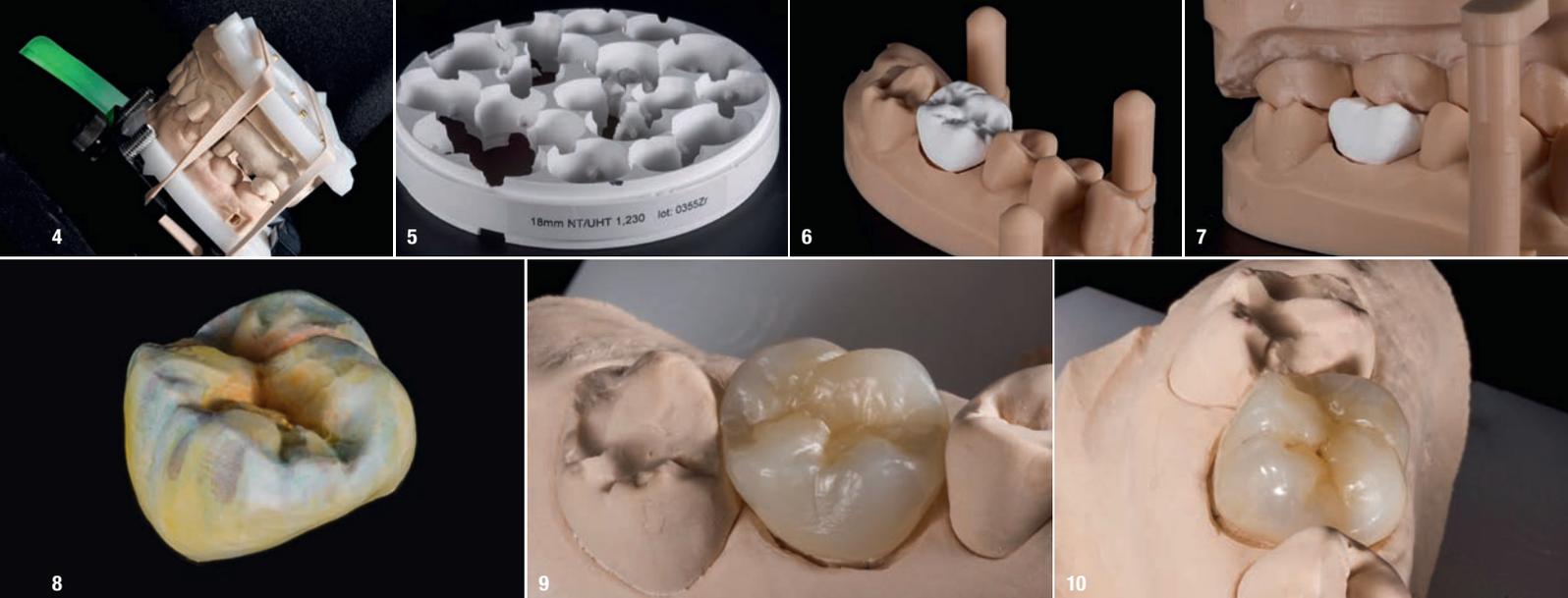
Figs. 4 & 5: Simple and reliable bite scan procedure with fully automated software alignment. **Fig. 6:** Milled zirconia crown seated on the equally enlarged 3D-printed model. This allows accurate controlling of the contact points and occlusion. **Fig. 7:** Colouring liquids are used on the green state zirconia just before sintering. This will give the definitive restoration a very lifelike effect. **Figs. 8 & 9:** Zirconia restoration directly after sintering. Some additional staining was done with GC Initial Lustre Pastes and Spectrum Stains for the final touch. **Fig. 10:** GC offers a wide portfolio of ceramic materials for different clinical and economic considerations, such as cost and ease of processing.

scanner first and created my own list of requirements for myself and my own wish list to make an educated selection. As it turns out, my list was easily covered by the ability and features of the ALS2, and it even has features that I did not realise that I needed until I had the opportunity to try them, such as the hybrid scanning feature. The new ALS2 is an absolute workhorse, featuring speed, accuracy and high definition, as well as some pretty amazing additional features, and it is absolutely the right choice for my lab.

What are the main benefits of the ALS2 in your daily routine?
For sure, one of the main features, the accuracy of 4 µm according to ISO standards, is a big advantage for my daily work. On top of that, the speed of 22 seconds per arch is very impressive. With this software, you experience a fully flexible scan flow generating open STL or PLY files.

The full articulator scan possibility, for which multiple articulator types are already included in the system, is also an asset for my daily routine.

The ability to scan an impression and the model and merge the scans accurately within the scan software, known as hybrid scanning, is also possible with the ALS2. This is the most unique feature of the device.

Could you explain from your perspective the hybrid scan flow?
Hybrid scanning is a unique workflow that combines an impression scan with a model scan. This allows us to work on a model without having the need to section it or ditch the dies and therefore avoids us introducing errors during scanning and keeps the true and accurate information. This workflow allows for predictable contact points and a perfect occlusion and allows us to design with the soft-tissue information in place for an optimal emergence profile. All this leads to reduced work time, less model prep and less scanning, and it is as predictable and accurate as the conventional flow.

Why and how does the hybrid scan workflow bring value to your practice?
I mostly use this technique on subgingival preparations and especially on vertical (biologically oriented preparation technique) preparations, as there is always a high risk of destroying the impression margin when pouring these cases, rendering a second pour impossible. Hence, by scanning the impression first, I have this information saved before even casting the model. I have also used this technique to design post and cores.

How do you make use of digital techniques in your lab?
Every case I do involves some sort of digital workflow, whether it is scanned intra-orally or not. The ALS2 is simply another tool and an integral part of my workflow. I always choose to have the best possible tools at my disposal, as this allows me to offer the best work that I am capable of. By using a mix of digital and analogue techniques on every case, I can create a much more predictable outcome while optimising the aesthetics and function through my years of hands-on experience.

about

Stephen Lusty qualified in Cape Town in South Africa. Since 2008, he has been running his laboratory in Cornwall in the UK, specialising in aesthetic dentistry. His passion for the art of dentistry is what drives him to continue to strive for perfection. He works closely with his clients, seeing patients for custom shade matching and finishing.

Empower your dental laboratory

An interview with Mathias Fernandez y Lombardi, EU scientific manager of dental ceramics and CAD/CAM materials at Kuraray Europe

By Kuraray Europe

Kuraray Noritake Dental has reinvented its original zirconia multilayer technology by integrating newly developed raw materials with different yttria content into the proven multilayer colour structure. The material that is based on this innovative technology, KATANA Zirconia YML, offers a well-balanced flexural strength, chroma and translucency gradation throughout the blank.

According to pilot users of the new zirconia discs, the greatest benefit of using KATANA Zirconia YML is in the true empowerment of the laboratory. In this interview, Kuraray Europe's EU scientific manager of dental ceramics and CAD/CAM materials, Mathias Fernandez y Lombardi, explains how the new material is able to positively affect work routines in the dental laboratory.

Mathias Fernandez y Lombardi is EU scientific manager of dental ceramics and CAD/CAM materials at Kuraray Europe.

Mr Lombardi, who should consider working with KATANA Zirconia YML?

KATANA Zirconia YML is designed for laboratories and milling centres with a strong focus on simplification. With its strong body and highly translucent enamel layer, it offers exactly the properties required for an unlimited indication range. Being perfectly suited for the production of durable monolithic long-span posterior bridges and of highly aesthetic anterior crowns or partial restorations, KATANA Zirconia YML is a true all-rounder that eliminates the need for another zirconia or even ceramic CAD/CAM material. At the same time, it supports highly automated production procedures and requires minimal hand work.

Fig. 1: Aesthetic outcomes are easily and efficiently achieved with KATANA Zirconia YML for all kinds of restorations, even for long-span bridges.

What are the benefits of using a single material for every indication?

Several benefits are related to the use of a single all-rounder material. It leads to a reduced number of blanks to be stored, which simplifies inventory management and minimises the storage space needed. Moreover, it facilitates standardisation of laboratory workflows. Using the same material every time means that there are no differences in the basic design and milling parameters, like minimum wall thicknesses and connector strengths, in the sintering protocols and in the finishing options to be taken into account. Hence, errors are less likely to occur and routines are easily established. Finally, the risk of cross-contamination is eliminated when a single material is processed with the available equipment (milling machine, milling and finishing tools, and sintering furnace). Predictable outcomes and flawless aesthetics are usually the result.

What are the benefits related to the use of KATANA Zirconia YML as the only ceramic CAD/CAM material?

I guess that the most important argument is that aesthetic outcomes are easily and efficiently achieved with KATANA Zirconia YML for all kinds of restorations, even for long-span bridges. It is usually sufficient to produce monolithic restorations for the posterior region which are just polished or glazed. Anterior restorations may be designed monolithically or with minimal cut-back, and the user may choose between CERABIEN ZR FC Paste Stains and CERABIEN ZR Internal Stains plus glaze to obtain a natural look. Another benefit of KATANA Zirconia YML is its seamless multilayer structure combined with an extraordinary blank quality.

Why is this seamless structure and high blank quality important for users?

The seamless multilayer structure, which provides a smooth transition from one layer to the next, is a precondition for structural integrity and flawless aesthetics. It ensures that the material is free of transition lines, offers accurate dimensions after sintering (owing to uniform shrinkage) and shows a reliable long-term performance not compromised by internal tensions. In KATANA Zirconia YML, a completely homogeneous composition, with carefully aligned coefficient of thermal expansion values and shrinkage ratios in all parts of the blank, is responsible for this benefit.

Table 1: Sintering programmes chart.[*, †, ‡]

	Temp 1	Rate of temp increase (°C min)	Temp 2	Rate of temp increase (°C min)	Temp 3	Rate of temp increase (°C min)	Temp 4	Hold time	Rate of temp increase (°C min)	Temp 5
54-minute	Room temp	120 °C	1,450 °C	10 °C	1,600 °C	–	–	20 min	−120 °C	800 °C
90-minute	Room temp	50 °C	1,400 °C	4 °C	1,500 °C	10 °C	1,560 °C	16 min	−50 °C	800 °C
7-hour	Room temp	10 °C	1,550 °C	–	–	–	–	2 h	−10 °C	Room temp

* The sintering recommendations represent only a guideline; depending on each individual furnace and condition, some adjustments might be necessary.
† If the 54- or 90-minute sintering programme is not programmable in your furnace, it is not possible to set the furnace according to one of these schedules.
‡ The material is removed from the furnace at 8,000 °C. A furnace with a configurable KATANA Zirconia YML sintering programme is required.

For its development, Kuraray Noritake Dental leveraged its long-standing expertise in dental ceramics and the advantages of an end-to-end in-house blank production process, without which it would have been impossible to reach the requested quality level. As the material is so well aligned, it was even possible to develop a 54-minute sintering programme that produces equally good results to the proven 90-minute or 7-hour programmes and is the go-to option for all rush cases. With this feature, KATANA Zirconia YML is an all-rounder material: it offers the highest comfort and security like an SUV, but when it comes to speed, it is in no way inferior to a sports car.

Users who have already tested ceramic materials with a strength gradient know that positioning of long-span restorations in the blank can be tricky. What are the rules to be respected when positioning a long-span bridge in a KATANA Zirconia YML blank?

Positioning of restorations in KATANA Zirconia YML discs is extraordinarily easy. The reason is that the gap between the lowest flexural strength found in the enamel area and the highest flexural strength found in the lowest body layer is comparatively small. Moreover, the Body Layer 1 that is found adjacent to the enamel layer already offers a flexural strength that is higher than the 800 MPa requested for bridges of four or more units. Consequently, users are on the safe side whenever they place their long-span restorations in the middle of the blank. More specifically, half of the connector cross section needs to be in the lower half of the disc, which is quite different from other materials with strength gradation that allow for connector positioning in the body area only. KATANA Zirconia YML restorations of a maximum of three units may be positioned in any layer. In this context, the fact that the thickness of each layer increases proportionally with the height of the disc comes as a benefit: the enamel layer is large enough to exploit its aesthetic potential in single-unit or small bridge cases.

What would you recommend to dental technicians regarding the use of KATANA Zirconia YML in their laboratory or milling centre?

I can truly recommend testing KATANA Zirconia YML in the laboratory environment to see how it handles and to assess its potential. The exceptional blank quality, seamless integration of the different layers, ease of positioning and processing e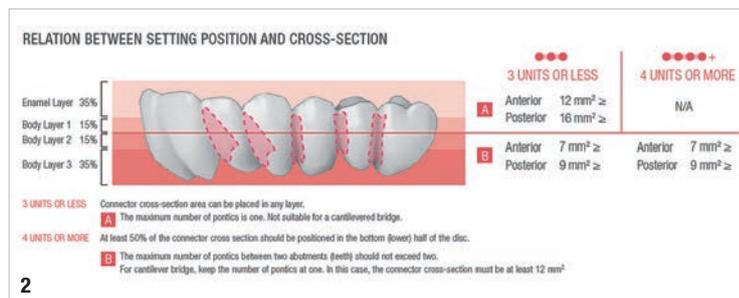fficiency are factors potential users need to experience in real life to understand what they mean for their daily work. Similarly, the aesthetic outcomes need to be assessed in the clinical environment for an authentic impression of the natural look and feel obtained. I am sure that KATANA Zirconia YML will be able to convince virtually everyone who wants to empower the laboratory with an easy-to-use, efficient universal zirconia solution that fits virtually every patient's and every dentist's needs! Kuraray Noritake Dental knows that dental technicians and practitioners are in need of products that support their striving for simplification, standardisation and increased efficiency so urgently needed in present times. Therefore, our product innovations are all focused on delivering more performance with less effort. KATANA Zirconia YML is the latest addition to a whole series of materials pursuing this goal.

Fig. 2: Positioning of long-span restorations in the middle of the disc.

Table 2: Minimum connector cross-sections are to be respected during CAD of KATANA Zirconia YML restorations.

Multilayered zirconia reinvented

Unveiling the secrets behind KATANA Zirconia YML

An interview with Atsushi Matsumoto and Yuta Tajima, Kuraray

By Olivia Besten

Fig. 1: KATANA Zirconia YML discs.

The KATANA Zirconia family of multilayered CAD/CAM blanks has a new member: KATANA Zirconia YML (yttria multi layered). Based on Kuraray Noritake Dental proprietary multilayer technology, this new material offers multiple layers with different levels of chroma and translucency plus different concentrations of yttria in a single blank. In this interview, two experts from Kuraray's research and development department in Japan, Atsushi Matsumoto and Yuta Tajima, talk about the new product and its specific features.

Atsushi Matsumoto

Yuta Tajima

Kuraray already offers a broad range of zirconia materials covering virtually every indication. Why did you decide to develop yet another dental zirconia?

The KATANA Zirconia series has indeed received high praise and great feedback from the market. Users particularly appreciate the remarkably high strength of HTML, the well-balanced aesthetic and strength properties of STML, and the high translucency of UTML. Although there has been a large increase of zirconia materials in the dental market recently, we have received many requests from our customers for a more universal material that offers the excellent properties of all variants of KATANA Zirconia in one product. Such a product should allow them to fabricate all kinds of restorations from a single disc, from single crowns to long span bridges, while maintaining high aesthetic and mechanical properties for both anterior and posterior restorations. KATANA Zirconia YML is our response to these desires expressed by our customers.

What is the main difference between KATANA Zirconia YML and the other available products of the KATANA Zirconia series?

All layers of KATANA Zirconia UTML, STML and HTML are produced from the same basic powder composition and therefore offer the same strength throughout the whole blank. Depending on the case-specific requirements, users need to select the most suitable type of material, either a high-strength zirconia or a highly translucent variant. KATANA Zirconia YML is an all-in-one zirconia suitable for all cases: it consists of a high-translucency enamel layer, an intermediate layer offering well-balanced strength, translucency and colour, and a high-strength body layer. The raw materials used for this product were developed and are produced by Kuraray exclusively for YML. This is another milestone in advanced product development for KATANA Zirconia.

In general, many dental technicians and specialists do not regard the currently available zirconia materials with an integrated strength gradient favourably,
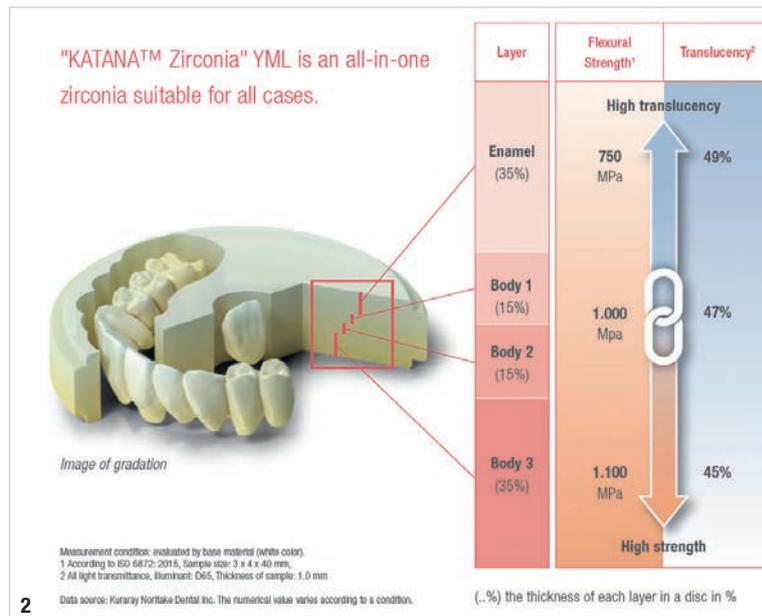

Fig. 2: KATANA Zirconia YML offers well-balanced combination of color, translucency and flexural strength gradation.

because the materials seem to be insufficiently strengthened in the incisal area. This can lead to fractures in long-span restorations, especially if they are inadequately positioned within the blank. How carefully did Kuraray focus on these problems and how did it try to solve them in order to stand out from the competition?

The current yttria-based multilayer products on the market face complicated limitations in connector position in large cases, such as full-arch restorations, owing to the lack of an ideal combination of aesthetics and strength. To overcome this challenge, Kuraray developed well-balanced raw materials of high strength and high aesthetics and included these raw materials in the intermediate layer between the enamel and body layers. The result is that, even for long-span restorations, it is very simple to position the connectors thanks to the excellent balance between high strength and high
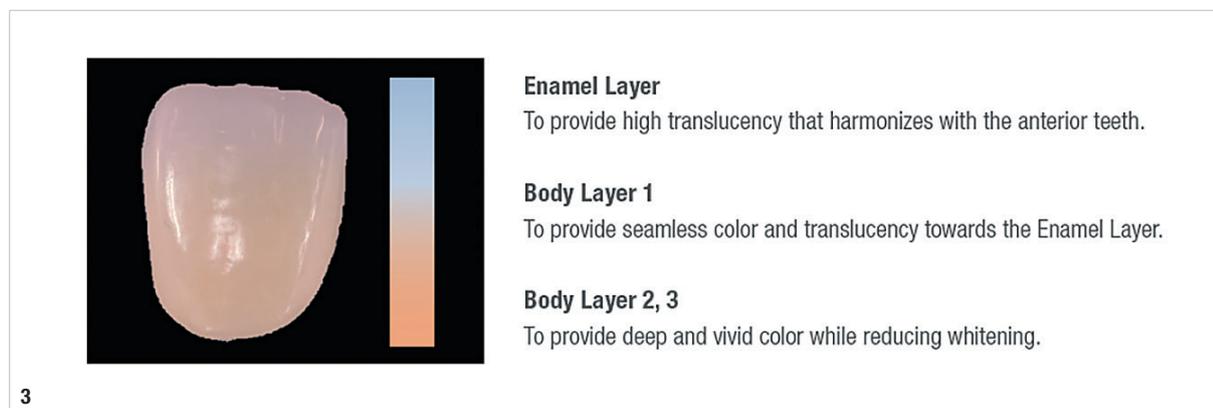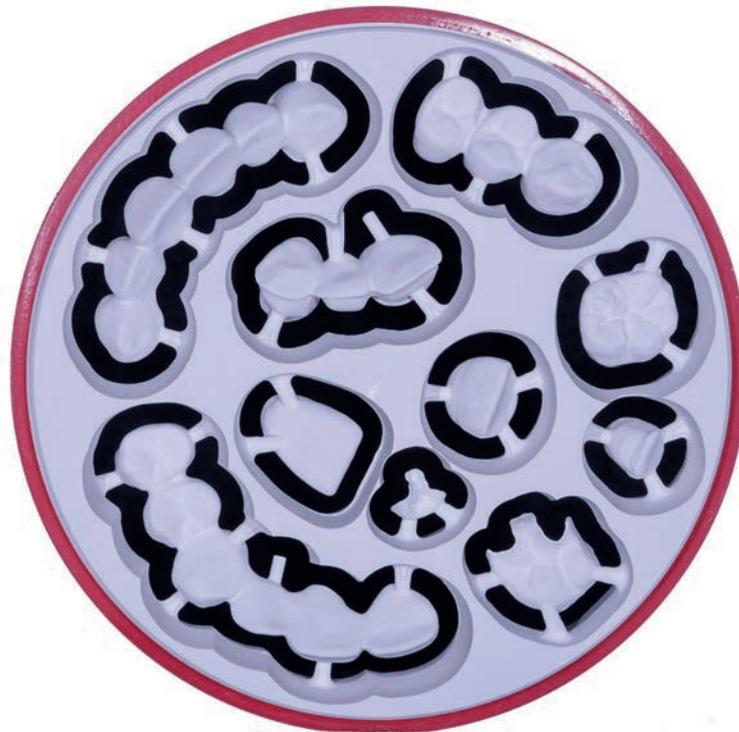

Fig. 3: KATANA Zirconia YML.

Fig. 4: KATANA Zirconia YML disc—versatility of application range.

aesthetics. Owing to these unique attributes incorporated in our new product, the risk of deformation and breakage is avoided.

Another problem is the often clearly visible line between the different layers containing different amounts of yttrium oxide. How did you address this issue?

At Kuraray, we achieved both adequate translucency gradation and invisible transition lines, even for zirconia layers with different yttria content. This has been accomplished thanks to our multilayer zirconia manufacturing technology refined over many years, which includes mixing the appropriate amount at each layer's boundary to intentionally avoid transition lines. In addition, the newly developed interlayer raw materials and a newly designed sintering schedule were the keys to success.

How is it possible to have a sintering protocol that works for different zirconia components within the KATANA Zirconia YML blank and allows for the shortest sintering times ever?

The amount of shrinkage during sintering is determined by different factors, such as the number and quantity of additives (yttria, alumina, etc.) it contains. If the shrinkage ratio of each layer is different, transition lines are likely to appear between the layers, which might produce tensions in the material structure. The newly developed raw material for KATANA Zirconia YML enables us to control and unify the shrinkage ratio for all layers, even for raw materials with different yttria content.

The use of proprietary raw materials produced in-house with excellent properties suitable for high-speed sintering was the main precondition that allowed for the

development of Katana's high-speed sintering schedule (54 minutes for restorations of up to three-unit bridges), which is available for all products of the KATANA Zirconia multilayered series. This option improves the efficiency of the dental technician's work and simplifies the workflow.

Are there any differences in milling and adjusting KATANA Zirconia YML compared with competitor products?

All KATANA Zirconia products have an appropriate hardness and thus less chipping during the milling process thanks to the raw materials manufactured and refined in-house. Also, after the sintering procedure, KATANA Zirconia offers excellent chipping resistance, especially during very challenging marginal adjustments.

Is there anything else that sets KATANA Zirconia YML apart from other products with an integrated strength gradient?

Yes, KATANA Zirconia YML offers reduced sintering deformation, thanks to in-house developed raw materials, based on proprietary technology to control shrinkage rate. Moreover, we offer a wide range of shades (14), which is another important aspect (apart from the material's well-balanced aesthetic properties and absence of transition lines) for the creation of lifelike restorations. Finally, since three out of four layers meet the conditions for an ISO Class 5 classification, there are few restrictions on the design variation of the prosthesis.

Why should a dental technician consider using KATANA Zirconia YML instead of any other dental zirconia, in your opinion?

It is now possible for dental technicians to produce strong and aesthetic restorations with just one material,

Figs. 5 & 6: Even if the restoration margins have been milled to a very thin profile, they still show smooth margins without any chipping.

KATANA Zirconia YML. This allows for a reduced inventory and significantly shortens working time owing to the possibility of high-speed sintering.

The most convincing properties are excellent firing accuracy owing to well-balanced material properties across all layers, the wide range of shades available and the great design flexibility even when designing long-span bridges. Last but not least, the trusted quality of the Katana brand and the label "Made in Japan" are reasons to opt for this new product.

All blanks from the KATANA Zirconia series stand out from other dental zirconia materials owing to their particularly fine-grained, densely pressed microstructure, which is the basis for a superior surface quality and edge stability and the resulting accuracy of fit. What is the secret behind this exceptionally high blank quality?
Since we do not know the correlation between marginal stability properties (chipping etc.) and material compositions, structures, etc., it is very difficult to answer this question. It may depend on the structure of the zirconia crystals, the raw material itself, the correct strength level after pre-sintering or any other minor factor during the manufacturing process of the disc. All these factors together, of course, are important.

A clear advantage of the KATANA Zirconia series, much praised by Katana's key opinion leaders, is its colour stability and shade match to the VITA classical shade guide. Can you explain the importance of the in-house addition of additives and colour pigments in the form of metal oxides to satisfy the user and distinguish KATANA Zirconia from competitors' products?

We use pigments developed by Katana which have an excellent colour stability without fading even after the final sintering procedure. The particle size is appropriately controlled. In addition, our professional colour mixing staff, reflecting the opinions of clinically experienced dental technicians both inside and outside the company, have achieved a pigment mixture that shows only a slight change in shade even in cases with different thicknesses.

What is your vision with regard to future developments in dental zirconia?
Since the introduction of zirconia on the dental market, many significant material advances have been achieved. Today, there are high-strength, low light-transmitting zirconia materials up to low-strength, high light-transmitting zirconia materials available on the market. Furthermore, there are now also low-strength, high light-transmitting zirconia materials in mixed systems (YML series). Our foremost goal is to develop the ultimate zirconia in the near future, combining both high strength and high light transmission, which breaks the general expectation of a compromise between strength and translucency within zirconia materials.
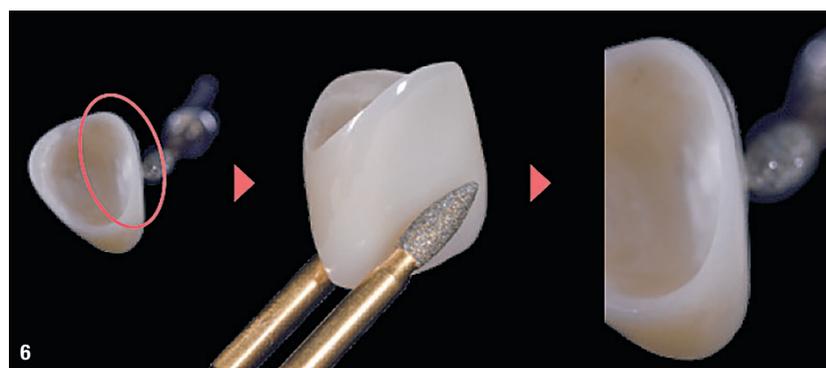
3Shape Dental System 2021: Revolutionising the technician's work through AI

By Brendan Day, Dental Tribune International

Ever since it was launched in 2005, 3Shape Dental System has been the software of choice for dental laboratory technicians who want to stay at the forefront of technological advancement. With the release of Dental System 2021, 3Shape is now allowing technicians to harness the power of artificial intelligence (AI) and enhance their productivity through its new and improved integrated workflows.

One of the highlights of the latest version of this software is the creation of a new workflow that allows both partial and complete dentures to be designed at the same time. All complete denture design tools such as Gingivator 3.0 and tooth libraries are now also available for designing partial dentures, giving technicians an unprecedented level of flexibility and potential for customisation.

> "Dental System 2021 is a software made for and inspired by dental laboratory technicians."

3Shape has also optimised the implant bridge workflow in Dental System 2021 with the goal of improving productivity as well as final restoration quality and aesthetics. By starting out with anatomy design and finishing with the adjustment of exit profiles, this all-in-one approach allows for faster and more predictable implant bridge designs.

3Shape Dental System 2021 offers a disruption to traditional dental laboratory workflows through its integration of artificial intelligence.

3Shape Dental System 2021 offers new and improved digital workflows. *(All images: © 3Shape)*

Leveraging AI for design acceleration

Through its use of AI technology, 3Shape Dental System 2021 marks a radical shift in how dental laboratories perform their regular tasks. Tooth segmentation and occlusal plane adjustment are just two of the technician's responsibilities that can now be conducted by AI tools, whereas lines for both temporary indications and dies are now placed automatically during the segmentation step of intra-oral cases.

3Shape Dental System 2021 also offers pre-installed integration with the recently launched 3Shape Automate—the world's first AI-powered digital dental design platform for single unit monolithic molar and premolar crowns. The speed, consistency and scalability that 3Shape Automate offers make it easier than ever for dental laboratories to outsource restorative design when dealing with rushes and to modify these designs to add the technician's own personal touch.

"Our goal is to make every laboratory technician's job easier," said Dr Rune Fisker, senior vice president for product strategy at 3Shape. "We spend a great deal of resources working with technicians, listening to them and developing the tools they need to succeed."

"From optimising workflows and the user interface and introducing AI power to open integration with production

and laboratory management solutions, partners, libraries and components, Dental System 2021 is a software made for and inspired by dental laboratory technicians," he added.

> "We spend a great deal of resources working with technicians, listening to them and developing the tools they need to succeed."

According to Fisker, 3Shape has "already received some extremely positive end-user feedback from dental technicians who have integrated Dental System 2021 into their workflows".

Try 3Shape Dental System 2021 today

3Shape Dental System 2021 is available now—just contact your local reseller or request a demo from 3Shape. Learn more about this and all the other latest updates from 3Shape at the company's website (www.3shape.com).

Virtual platform AG.Live

Freedom, more efficient processes and greater customer proximity

Amann Girrbach is all about supporting laboratories in the organisation of digital dental workflows. With the AG.Live digital platform, this project reaches a new dimension. AG.Live helps dental technicians to manage all digital activities locally and to connect with an ever-expanding global network of digital dental professionals.

Patient case management is at the core of the platform, which replaces the previous C3 customer portal. This is where the patient case is created, managed and processed digitally. Patient cases can be shared with partner laboratories for further processing and will, in the foreseeable future, also be exchanged between the dentist and the laboratory.

Not only will laboratories and clinicians be networked, but also machines and materials—in order to access material availability or, in the future, to access the operating modes of milling machines and many other relevant factors of a dental fabrication process.

Thus, AG.Live will enable the monitoring of all digital activities—from one place or from anywhere, and at any time. In doing so, it is Amann Girrbach's intention to create a network of optimised existing partnerships as well as new ones. Network participants will be able to work and collaborate more efficiently and to focus on their strengths and thus better position themselves in the market.

This management portal, which is unique on the market in terms of scope, breaks down the linearity of dental restoration processes. Cross-linking into patient cases is now possible in a simple and straightforward manner by making patient data centrally accessible and editable. The linking of previously separate data sources creates synergistic effects from which AG.Live users can profit sustainably and gain a noticeable competitive advantage. In a further step, Amann Girrbach will implement access to the company's own Amann Girrbach Academy training portal with numerous training and further education opportunities as well as an extensive archive of webinars and tutorials.

Free online presentation about AG.Live:
360-degree service for your digital infrastructure
Digitisation has fundamentally changed dental technology in the last ten years. The digital fabrication of dentures has become the standard in dental laboratories. In his exciting presentation recorded at the AG.Live CON at the end of April, Christian Ermer, chief marketing officer at Amann Girrbach and responsible for the company's digital transformation, explains how the newly developed AG.Live platform from Amann Girrbach is now taking digital dental technology to a new level and enabling seamlessly integrated and interdisciplinary collaboration.

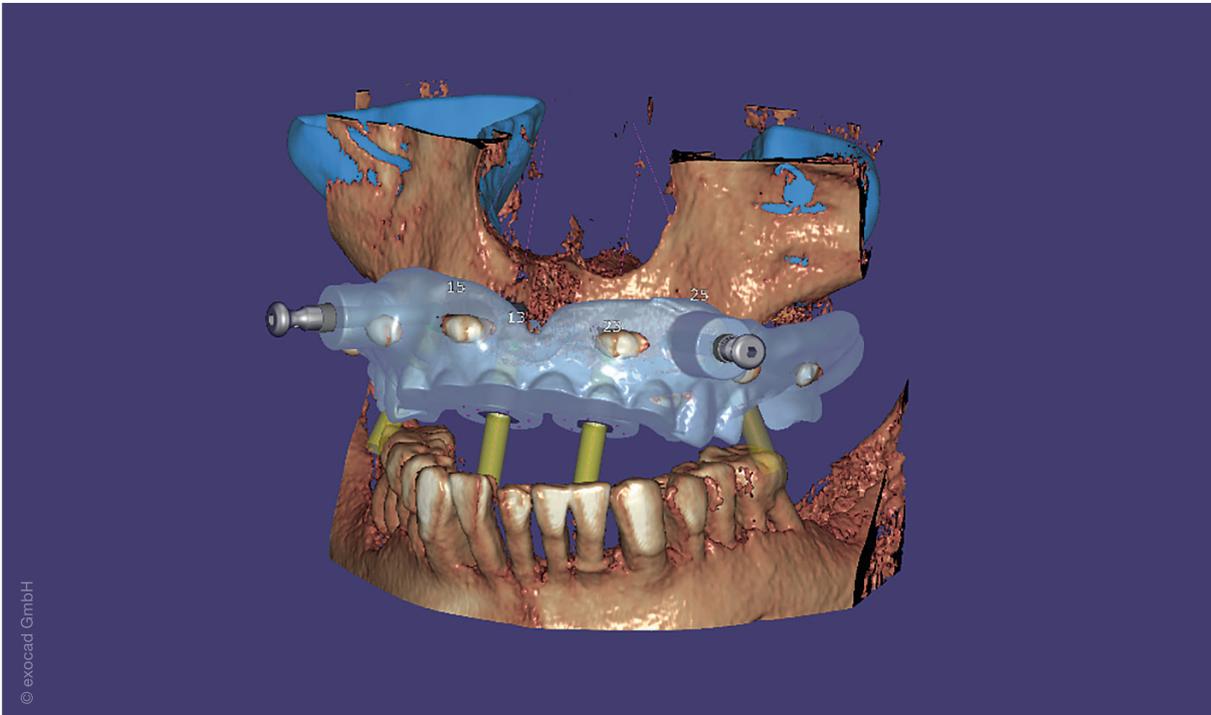The full presentation is available free of charge in various languages at **https://bit.ly/3uYjIQ4**.

exocad

New exoplan 3.0 Galway now available

© exocad GmbH

At the end of last year, exocad announced the availability of exoplan 3.0 Galway, the latest version of its implant planning software. The new release supports planning of edentulous cases, including design of surgical guides.

"We are excited to announce the release of exoplan 3.0 Galway and enthused about the new possibilities it presents for guided surgery," said Tillmann Steinbrecher, exocad CEO. "Exoplan 3.0 Galway will provide dental practices and laboratories with a digital workflow that offers maximum flexibility and builds on exocad's mission to make CAD design as easy as using an app on a cell phone."

Exoplan 3.0 Galway is a powerful, open, and efficient software package for virtual implant planning. Customised surgical guides can be designed using the Guide Creator software module, and then produced on site—in a laboratory, dental practice, or an external production centre. The software comes in a new, modern user interface, inspired by the Google Material Design system. With more than 40 new features, as well as enhancements to over 60 existing functionalities, the Galway release represents a major expansion of capabilities in guided surgery and improved integration with DentalCAD, exocad's dental CAD software.

Key highlights of exoplan 3.0 Galway include: Planning of edentulous cases and design of the respective surgical guides, including necessary tools, such as dual scan protocol, anchor pin placement, and fixation guide; surgical and fixation guides can

be freely designed or based on a prosthesis scan; new tools to speed up the entire planning process; improved implant selection dialog; automatic panoramic curve detection; more implant libraries, now with over 500 implant systems and over 8,500 implants from more than 80 manufacturers; virtual tooth extraction on optical scans; possibility to easily mark sinus cavity and check if implants are intruding.

All exocad solutions are based on the same technical platform with an open architecture, ensuring the seamless functionality of the digital workflow: from virtual prosthesis-oriented implant planning with exoplan and designing surgical guides with Guide Creator, to planning and producing the implant-supported, temporary, and final restorations with DentalCAD, exocad's dental CAD software.

"As the world's premier OEM supplier of dental CAD software, we provide the symbiosis of prosthetic and implant planning," said Steinbrecher. "Users can achieve predictable results in a cost- and time-efficient manner, which can ultimately result in increased customer satisfaction." Exoplan 3.0 Galway is now available in the EU and other select markets.

exocad.com
exocad.com/exoplan-galway

MIS announces new dates for its fifth global conference

By MIS Implants Technologies

After the long-awaited announcement of the new dates for the fifth MIS Global Conference, the MIS team is hard at work getting ready for this global meeting. As major global events were affected by the COVID-19 pandemic, which led to uncertainty and rescheduling, the conference is now planned to be held from 19 to 22 May 2022 in Marrakech in Morocco and will include a three-day scientific programme of lectures by world-renowned experts, hands-on workshops and exciting social events.

World-class speakers and experts in their fields

Like for previous global conferences, the scientific committee is determined to present the most relevant and important topics and cases as part of the scientific programme. Speakers have been carefully selected to share new concepts, breakthroughs and a view into their vast collective experience and knowledge.

Exotic views and spellbinding entertainment

With a location such as Marrakech, conference guests can count on being met with a rich pallet of beautiful and colourful sights, exotic tastes and smells, and unique experiences to be remembered. The meticulously planned and spectacular evening affairs, which characterise every MIS Global Conference, are sure to be part of this highly anticipated event.

Twenty-five years of making it simple

Last year, MIS Implants Technologies celebrated its 25th anniversary. During these two and a half decades, the company has taken on countless challenges, explored many developments and celebrated numerous breakthroughs. Today, MIS is an established global business and one of the major competitors in the dental implant market.

For further info and details, please visit the MIS website www.mis-implants.com.

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International events

IDS—International Dental Show

22–25 September 2021
(on-site and online event)
Cologne, Germany
www.ids-cologne.de

FDI World Dental Congress

26–29 September 2021 (online event only)
Sydney, Australia
www.fdiworlddental.org/fdi-world-dental-congress

Dental-Expo

27–30 September 2021
Moscow, Russia
www.en.dental-expo.com/dental-expo-en

CEDE—Central European Dental Exhibition

7–9 October 2021
Łódź, Poland
www.cede.pl/en

31st Annual NYU/ICOI Implant Symposium

9–10 October 2021
New York, US
www.icoi.org/events

EAO Digital Days

14–16 October 2021 (online event)
Italy
www.eao.org/congress

Dentex—International Dental Equipment Exhibition

21–23 October 2021
Brussels, Belgium
www.dentex.be/en

AAP Annual Meeting

4–7 November 2021
Miami, US
www.perio.org

ADF—Conference and Exhibition

23–27 November 2021
Paris, France
www.adfcongres.com/en

GNYDM

28 November–1 December 2021
New York, US
www.gnydm.com

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Please note that all the textual components of your submission must be combined into one MS Word document. Please do not submit multiple files for each of these items:

· the complete article;
· all the image (tables, charts, photographs, etc.) captions;
· the complete list of sources consulted and
· the author or contact information (biographical sketch, mailing address, e-mail address, etc.).

In addition, images must not be embedded into the MS Word document. All images must be submitted separately, and details about such submission follow below under image requirements.

Text length

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.

In short, we do not want to limit you in terms of article length, so please use the word count above as a general guideline and if you have specific questions, please do not hesitate to contact us.

Text formatting

We also ask that you forego any special formatting beyond the use of italics and boldface. If you would like to emphasise certain words within the text, please only use italics (do not use underlining or a larger font size). Boldface is reserved for article headers. Please do not use underlining.

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.

Should you require a special layout, please let the word processing programme you are using help you do this formatting automatically. Similarly, should you need to make a list, or add footnotes or endnotes, please let the word processing programme do it for you automatically. There are menus in every programme that will enable you to do so. The fact is that no matter how carefully done, errors can creep in when you try to number footnotes yourself.

Any formatting contrary to stated above will require us to remove such formatting before layout, which is very time-consuming. Please consider this when formatting your document.

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Please number images consecutively throughout the article by using a new number for each image. If it is imperative that certain images are grouped together, then use lowercase letters to designate these in a group (for example, 2a, 2b, 2c).

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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· These image files must be no smaller than 80 KB in size (or they will print the size of a postage stamp!).

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Questions?

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CAD/CAM

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