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Reducing surgical morbidity with CBCT-guided implant surgery

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Moving the dental world from analogue to digital: 3Shape’s success story continues

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August Bruguera, Dental Technician, Spain.

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Dear Reader,

At IDS 2009, we had already caught a glimpse of how dentistry would be changing in the future. This year's show affirmed what many were expecting: the digitisation of dentistry is in full swing or, as Daniel Wismeijer, Professor of Oral Implantology and Prosthetic Dentistry at the Academic Centre for Dentistry in Amsterdam, put it: "Digital dentistry is like a bullet train coming at us and its impact will be significant."

These developments are leading to substantial changes, affecting how dentists and dental technicians will carry out their profession in the future. It seems safe to say that intra-oral scanners, for example, are going to replace traditional impression-taking methods completely. With this scanning technology, patient data is gathered more comfortably and precisely, easily, faster and, as a result, at a lower cost. Diagnosis and treatment planning are now possible in 3-D, suggesting the real possibility of a virtual patient.

Since its launch in 2010, CAD/CAM has been committed to accompanying these developments by informing its readers about the latest treatment concepts and technologies and how these can be integrated into today's treatment concepts for the benefit of everyone involved—the patients and the dental professionals. It is absolutely essential that dentists and dental technicians become acquainted with these new technologies, and CAD/CAM thus strives to serve as a platform for information exchange.

In order for the magazine to achieve its full potential, we need your input and encourage you to participate in this exchange. Please feel welcome to submit scientific articles, case reports, industry reports, reviews (meetings, products, etc.) and news for publication.

We appreciate your feedback greatly and are eager to engage with you about your views on digital dentistry.

Best wishes,

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Managing Editor
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Healthy and harmonised function via computer-guided occlusal force management

Author: Dr Robert Kerstein, USA

The minimally invasive (MI) concept was initially introduced in physical medicine and adopted into dental medicine in the early 1970s with the application of diamine silver fluoride to teeth.1 This was followed by the development of preventive resin restorations (sealants) in the 1980s2 and the atraumatic restorative treatment (ART) approach3 with Carisolv (MediTeam) in the 1990s.4 Since its inception, the focus of MI dentistry has been caries detection and treatment.5 It has not yet been comprehensively adopted in other fields of dental medicine; however, the comprehensive concept of minimally invasive cosmetic dentistry (MICD) and its treatment protocol were introduced in 2009 with the basic aim of a clinician effecting optimum clinical therapeutic improvements in smile enhancement, while performing corrective procedures that require as little clinical intervention as possible.6 Additional guidelines for MICD treatment are:

- the adoption of the “Do No Harm” philosophy to maximise possible preservation of healthy oral tissues;
- the proper selection of appropriate dental materials;
- the use of supportive procedure methodologies that offer clinicians an “evidence-based” treatment approach that will reliably improve treatment outcomes.

With respect to smile design, the intervention level of a selected MICD treatment will depend on the types of smile defects present, combined with the subjective perception of the patient’s own pre-treatment smile condition (Figs. 1a & b). Some of the more common smile defects are:

- presence of diastemas;
- discoloured teeth;
- worn and flattened incisal edge contours;
- missing teeth;
- rotated and misaligned teeth;
- teeth internally stained by fluoride or through childhood disease;
- gingival absence, leading to visible “black triangles”;
- uneven crestal gingival heights;
- maxillary and/or gingival excesses resulting from altered passive eruption;

Fig. 1a. A smile defect of discoloured teeth and presence of a diastema.
Fig. 1b. Four anterior veneers placed to improve smile defects.

Fig. 2. Smile Design Wheel that incorporates patient psychology, health, function and aesthetics.
malocclusion according to Angle’s classification; and
 reverse smile curve.

Contemporary aesthetic dentistry can correct most of these defects utilising a simple, comprehensive, MI approach that places equal emphasis on patient psychology, health, function and aesthetics. Each of these aspects of treatment consideration can be best analysed using the decision-making system of the Smile Design Wheel, which includes each individual aspect as a continuum (Fig. 2).6

_Smile design with all-ceramic, partial coverage restorations_

All-ceramic, partial coverage adhesive restoration (porcelain veneers, inlays and onlays) is considered one of the MI treatment options in MICD treatment as opposed to placing complete coverage restorations (full crowns) that require significantly more tooth preparation. In certain situations, no-preparation veneers may be placed but only if the final aesthetics will not be compromised by the added thickness of the labio-lingual restorative material that a no-preparation veneer creates.

Adhesive restorations conserve tooth structure because less tooth preparation is required for mechanical retention of the restoration when porcelain-enamel adhesion is employed (Fig. 3). Less mechanical retention preparation is required to stabilise a bonded porcelain restoration in comparison with a non-bonded restoration. The chemical adhesion between etched porcelain and etched enamel provides increased retention. Less tooth preparation can minimise untoward pulpal responses that frequently result when a vital tooth is prepared for full coverage.

Another significant patient benefit of employing adhesive restorations is that treatment time is usually shortened to only two visits:

- _first visit:_ partial coverage preparation, provisionalisation that incorporates the desired smile design improvements, and one inter-occlusal registration;
- _second visit:_ porcelain try-in, enamel adhesion, occlusal adjustments and case finishing.

During the second visit, the clinician cannot perform any insertion occlusal adjustments prior to bonding these very brittle restorations in place, as they cannot safely withstand any occlusal alterations without introducing the possibility of restoration fracture.

Shortened treatment times can introduce occlusal errors

However beneficial these short treatment times may be for the patient, they may have two potentially problematic post-insertion results:

[Fig. 3] Veneer preparations conserve tooth structure compared with full coverage crowns.

[Fig. 4] Articulated casts require remounting to ensure minimal spatial distortions at case delivery.

[Fig. 5] Articulating paper markings do not measure occlusal force by paper mark appearance, regardless of their depth of colour, mark size or shape. Paper markings cannot determine tooth contact timing sequences either.

[Fig. 6a] T-Scan III recording handle with USB connection.

[Fig. 6b] T-Scan III desktop.
case report _ occlusal force management

These sequelae result from the lack of repeated inter-occlusal remounts, which conventional prosthetic cases commonly undergo. Remounting at metal try-in, porcelain bisque try-in and possibly once more prior to prosthesis installation greatly improves the accuracy of the true maxillo-mandibular, inter-arch spatial relationships (Fig. 4). This reduces the number of occlusal adjustments required at insertion, thereby preserving restorative material thickness and restoration strength.

Adhesive restorations are almost incapable of being reliably remounted. Because of the minimal preparation configuration of partial coverage, non-bonded, all-ceramic restorations, they are unstable on their supporting teeth. Mousses, waxes, silicone putty, injected impression materials and impression tray seating can all easily dislodge the non-bonded restorations from their supporting teeth when taking inter-occlusal records. The movement of non-bonded restorations can also occur during a “pick-up” or transfer impression. The instability of non-bonded restorations complicates all aspects of any remounting procedure greatly.

Without the series of laboratory remounts that a cemented prosthesis often undergoes, the all-ceramic restoration is susceptible to significant spatial misalignment and excessive occlusal force that can go undetected clinically until after the insertion has been started. This lack of proper detection of the location of problematic force is worsened by the fact that articulating paper markings do not measure the occlusal forces or the occlusal contact timing sequence in any quantifiable way, regardless of the false and often-advocated paper marking beliefs (Fig. 5).7–16

Poor maxillo-mandibular spatial relationships and occlusal force detection can be reliably overcome when an MI clinician employs computer-guided occlusal analysis technology at restoration insertion (T-Scan III, Tekscan; Figs. 6a & b). When properly used after the completion of bonding procedures, this digital occlusal technology helps to locate regions of excessive occlusal force accurately within the occlusal surfaces and incisal edges of the newly placed restorations. The clinical reduction of these excessive forces leads to easier post-insertion acceptance of the new occlusion and increases the restoration’s lifespan.

Computer-guided occlusal analysis system

The T-Scan III Computerized Occlusal Analysis System offers precision technology that analyses occlusal contact force and time sequences in 0.003-second increments and graphically displays them in movie form.17,18 The system simplifies occlusal adjustments at aesthetic prosthesis insertion, as it quickly isolates excessive force concentrations and time-prefatute contacts, so their eradication is predictable and effective (Fig. 7). The preservation and longevity of ceramic restorations are enhanced, as any potentially destructive occlusal forces are isolated at delivery, and then removed prior to the patient’s long-term use of the new smile design prosthesis.
The occlusal force and time-sequence data are relayed to a PC through a high-definition recording sensor that measures contact-varying relative force sequentially as differing tooth contacts interact at the occlusal surfaces (Figs. 8a & b). During a turbo-mode recording, the sensor is scanned 3,000 times per second, resulting in a dynamic movie of changing occlusal forces that can be incrementally viewed in a slow-motion playback.

This dynamic playback separates all the force variances into their contact order, while simultaneously grading their relative occlusal force, so that a clinician can observe them for diagnosis and possible treatment. In two or three dimensions, the contact timing sequence can be played forwards or backwards continuously or in 0.003-second increments, to reveal an occlusal "movie" that describes the occlusal condition. In the 3-D playback view, the force columns change both their height and colour designation. In the 2-D contour view, the colour-coded force concentration zones alter size, shape and colour as the occlusal forces change (Fig. 7). Warmer colours indicate forceful contacts, while darker colours indicate lower force contacts (Fig. 9).

Limitations of articulating paper markings

Clinicians routinely employ articulating paper to visualise the presence of occlusal contacts, their force and their time simultaneity. They determine whether contacts are forceful by subjective judgement of the paper markings for their supposed force content.

In dental medicine, it is strongly advocated and strongly believed by many clinicians that the characteristics of the paper markings indicate occlusal forces. The appearance characteristics of the paper markings are based upon:

a) the size of the mark: large marks supposedly indicate higher forces; small, light markings indicate lesser forces;
b) the relative colour depth and intensity of the ink mark: the darker the mark and/or its colour intensity, the higher the force content; the lighter the mark, the less force content present;
c) the presence of doughnut and halo shape(s): these shapes indicate that the contact is forceful because these contacts do not have ink in the middle (Fig. 10).

Despite the persistence of the "clinical beliefs" listed above, there is no published scientific evidence that supports that these appearance characteristics actually indicate the relative force of occlusal contact. Studies on articulating paper markings demonstrate consistently that occlusal forces cannot be reliably determined based upon their size or colour. Additionally, paper markings have never been shown in any study to be able to describe contact-timing sequences.

Figure 11a clearly illustrates the limitations of the articulating paper in describing force and that...
The clinical belief that the appearance of paper markings can indicate forceful contacts is flawed. Three large marks are present on tooth #16 and small scratchy marks on the mesial of tooth #17. Visual inspection of the dark marks on tooth #16 is believed to indicate that high force contacts are present there. The clinician has been indoctrinated to believe that this is the case. Figure 11b shows the counter-arch paper marks with large black marks on tooth #46 and lighter marks on tooth #47. The T-Scan data shows that the small contacts present on the mesial aspect of tooth #17 are actually a region of extreme occlusal force and the neighbouring three large dark marks on tooth #3 are actually three regions of very low occlusal force (Fig. 12). Notice that tooth #17 makes up 48% of the patient’s right arch, half of the total occlusal forces. This explains why there is visible exposed dentine. Years of unseen occlusal overload on this tooth (and the opposing tooth #47) have worn the enamel, whereas tooth #16 with its very big, dark marks has intact enamel.

Compared with the results of the T-Scan III, it becomes clear that the characteristics of paper markings do not in any way describe the occlusal forces. Computer-guided occlusal analysis illustrates the true nature of the occlusal contact force patterns. This offers clinical insight about the degree of occlusal force demonstrated by articulating paper markings.

Therefore, T-Scan III technology represents the essence of MI dentistry with respect to dental occlusion. A clinician treats only what needs to be treated and should not perform random occlusal adjustments judged with the naked eye according to paper markings. This method of judging force is so prone to error that it will always have more invasive results than when properly performed computer-guided occlusal adjustment is employed.

Computer-guided occlusal analysis for a case of six anterior veneers

Improved force and timing of all tooth contacts, both static and functional, can be precisely adjusted when corrections to the paper labelling are guided by computer analysis. The following case illustrates the utilisation of computer-guided occlusal analysis to refine the protrusive movement on six anterior veneers.

A 21-year-old female patient presented for replacement of six anterior veneers owing to visible material fractures (Fig. 13). The old veneers were removed, the teeth were slightly re-prepared, and six new Empress II veneers (Ivoclar Vivadent) were placed (Fig. 14).

After the veneers had been cured and the excess bonding material trimmed, gross occlusal adjustments were performed to return the patient to the pre-treatment vertical dimension of occlusion. Although the lingual veneer margins were

Lastly, had the advocated “beliefs” about the characteristics of paper markings been used as a guide for the clinician who, in this case, was attempting to make decisions regarding occlusal adjustment to control force, the clinician would have clearly chosen the wrong teeth to adjust, despite seeking to diminish the occlusal overload. This example illustrates that clinicians’ eyes and the articulating paper markings do not illustrate occlusal forces reliably. Computer-guided occlusal analysis clarifies which articulating paper markings should be treated so that the operator makes appropriate treatment decisions as to which tooth contacts truly require force lessening.
incisal to the original vertical stops on the anterior teeth, some excess bonding cement required removal to maintain the vertical dimension.

Next, protrusion and laterotrusive excursions were analysed with the T-Scan III system to determine whether extreme forces were present at the incisal edges or on the lingual functional inclines of the veneers. The maxillary anterior lingual surfaces provide toothborne ramps for the lower anterior teeth to glide over during mandibular excursions. Controlling any extreme forces on the lingual veneer ramps will aid in ceramic material longevity.

Dynamic excursive functions are recorded by instructing the patient to occlude through the T-Scan III sensor into his/her maximum inter-cuspal position (MIP), holding the teeth together for one to two seconds, then commencing an excursive movement across the guiding teeth.20–22 Right–left and protrusive excursions can be recorded for force analysis. Only the protrusive excursion will be discussed here. Figure 15a illustrates the first articulating paper labelling of the protrusive movement made as the mandibular incisors leave the MIP and travel towards the incisal edge. Note that there is a dark long protrusive track line on the distal-incisal aspect of tooth #12, a shorter line on the distal of tooth #11 and a horizontal line on the incisal edge of tooth #11. Despite the appearance of these ink representations, the paper labelling offers no indication as to whether any high force region even exists.

Figures 15b and c describe the movement as recorded by the T-Scan III. As the excursion progresses after the patient leaves the MIP position (Fig. 15b) and transitions onto the anterior teeth, tooth #11 becomes very forceful near the incisal edge (tall pink force column) as the protrusive movement advances to include only the incisors (Fig. 15c). If left untreated, possible fracture of the distal incisal edge of this veneer could result from the extreme force applied each time the mandible protrudes.

To correct this excessive protrusive force, adjustments guided by the recorded force data were employed. The disto-incisal paper track line was occlusally adjusted with a medium coarse diamond bur with water spray. Following this first adjustment sequence, a new recording was made to ascertain new force and time changes resultant from the previous adjustment. These new force and time aberrations were isolated, labelled and adjusted. This was repeated until no extreme occlusal forces were present throughout the duration of the protrusive excursion and moderate to low forces were shared between the guiding inclines and incisal edges.

Figures 16 and 17a show the mid-treatment and final articulating paper markings of protrusive movement. Note that in Figures 15a, 16 and 17a, the paper markings offer no quantifiable force or time information to guide corrective adjustments. Figures 17b to d illustrate that in the corrected final protrusive movement there are shared force transitions between teeth #11 and 21 all through the movement. The computer-guided result has protrusive contacts that never reach the potentially damaging force levels seen preoperatively (Fig. 15b).

This case illustrates the use of computer-guided occlusal analysis with adhesive restorations to minimise excessive occlusal forces that result from the all-ceramic restoration placement, where the bonding process must precede all occlusal adjustments. This reversal of the conventional placement process (absent of inter-occlusal remounts) can introduce significant occlusal errors that are poorly discerned with articulating paper.

Fig. 17a_End of treatment paper markings of protrusive movement.
Fig. 17b_Corrected post-op early protrusion.
Fig. 17c_Corrected post-op mid-protrusion.
Fig. 17d_Corrected post-op end protrusion.
Computer-guided occlusal analysis affords the operator precision, occlusal force isolation and predictable control of restorative occlusal error, which aids in prolonging the longevity of the all-ceramic restorations.

**Conclusion**

For MICD, computer-guided occlusal analysis systems offer data on quantifiable pressure, force and contact time sequence that can be employed to guide the occlusal adjustment of the restoration to precise measurable endpoints. These endpoints establish uniform force distribution, bilateral simultaneity and measurable immediate disclusion, and minimise the damaging effect of concentrated, excessive, isolated occlusal force. Avoiding potentially destructive intra-oral use, the overall prosthetic occlusal scheme preserves the ceramic materials utilised in the procedure, ensuring long-term survival.

Lastly, occlusal adjustments that are guided by T-Scan III technology represent the essence of MICD because a clinician treats only what needs to be treated and does not perform random subjective occlusal adjustment based on mere judgement of paper markings with the naked eye. Measured occlusal force and timing data direct the MI clinician to adjust only the locations of excessive force, while leaving the areas of measured low occlusal force untouched. Cosmetic restorations and tooth structure are therefore preserved and overtreatment is minimised. The clinical implementation of this technology mirrors the core message of the “Do No Harm” philosophy...

**References**


**About the Author**

Dr Robert Kerstein works in private practice in Boston, Massachusetts. He was Assistant Clinical Professor at the Department of Restorative Dentistry, Tufts University School of Dental Medicine from 1983 to 1998.
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Reducing surgical morbidity with CBCT-guided implant surgery

Author: Dr. Daniel J. Velinsky, USA

The patient, a 62-year-old woman, was referred by a local periodontist for an implant evaluation. Her record stated that she was a “difficult patient owing to medical complications”. Her stated desire was that she wanted “to be able to chew”.

Medical history

The review of systems was negative. The patient was a non-smoker and drank alcohol socially. She was allergic to iodine and took only hormone replacement medication. She used organic products in her life whenever possible. She stated that she suffered from persistent, recurring yeast infections, which were exacerbated by any antibiotic use. She therefore refused antibiotics for any elective dental treatment.

Diagnostic findings

The patient was healthy, her oral hygiene excellent and there was no evidence of active periodontal disease. Her cancer screening was negative. The temporomandibular joint was quiet with normal range of motion, and she was missing teeth #1 to 4. Her initial radiographic assessment revealed a relatively low maxillary sinus in the area of the prospective implants.

Initial actions: December 2002

The patient was referred to an oral surgeon for an evaluation of her upper right maxilla. With a relatively low sinus, we determined that the patient would need a unilateral maxillary sinus lift and augmentation. This was discussed with the patient, who subsequently refused treatment owing to the need for perioperative antibiotic coverage for these procedures. She would also not accept a removable partial denture. She opted to initiate no further treatment at this time and desired only a regime of routine maintenance.
Secondary presentation: August 2006

The patient was re-examined this time with guided implant surgery in mind. She stated that she would accept surgery if it could be done without antibiotics. We conceived a team approach that included me (restorative dentist), Dr William E. Lippisch (oral surgeon) and dental technician Michael Hennessy.

Treatment goal

The patient's treatment goal was to have posterior teeth that would enable her to chew. Furthermore, she wanted treatment performed without the use of systemic antibiotics. Our team's goal included a treatment plan that would result in integrated implants, restored with single, non-splinted crowns, performed with a flapless, minimally invasive guided surgical technique. We planned a one-stage approach without temporisation. The patient agreed to one preoperative antibiotic dose of 2,000 mg amoxicillin and a five-day course of Peridex oral rinse.

Scan-guide construction

An appointment was set up and a polyvinylsiloxane impression of her upper arch, a polyvinylsiloxane bite registration and an impression of the lower arch were taken. Models were mounted and a wax-up constructed, giving ideal placement of future implants for area #2, 3 and 4. From this wax-up, a scan guide (Fig. 1) was constructed with implants for area #2, 3 and 4, according to the Nobel Biocare design. Gutta-percha markers were placed in the guide for the dual-scan technique. A flange was designed to hold the prospective anchor pin.

Inspection windows were produced in the guide to ensure its proper and complete seating in the mouth. This is paramount for a proper relationship of the radiographic guide to the present dentition in the CBCT scan, which helps to verify that the laboratory-fabricated surgical guide was properly seated in the mouth during the surgical phase.

Prior to the CBCT, a polyvinyl-siloxane bite (Fig. 2) was taken with the scan guide in place to be used during the CBCT and for subsequent mounting of the case on a semi-adjustable articulator. This would then replicate the surgical plan.

Surgical-guide fabrication

A CBCT scan was taken using Nobel Biocare's 'double scan' technique. This allowed for a combination of the radiographic scan guide to the patient's Dicom CT information in the Nobel Guide Software. A virtual surgery was performed with the Nobel Guide Software (Figs. 3 & 4). We decided that implants could be placed in such a manner as to avoid the sinus lift and augmentation.
As a team, we decided upon the final scenario. Restorative, surgical and laboratory issues were discussed and common conclusions decided. A Nobel Guide surgical guide was ordered through the software and subsequently produced via stereolithographic rapid prototyping. The guide was tooth borne with one surgical pin included to aid stabilisation (Fig. 5). Inspection windows were placed in the guide to ensure full seating during implant surgery.

**Surgery: December 2006**

The patient was anaesthetised using local anaesthesia. The Procera Surgical Guide was placed, ensuring complete seating using the inspection windows. We determined that the patient had maximum attached gingiva. A tissue punch was used through the guide, while it was held in place by finger pressure. The guide and the tissue plugs were removed. Then, the guide was replaced. The Nobel Biocare Guided Surgery protocol (Fig. 6) was followed, including placement of a stabilisation pin and use of a guided template abutment. After all three implants had been placed, the guide and any tissue tags present were removed, and healing caps placed on each implant (Fig. 7). In accordance with the plan, no temporary crowns were placed.

At four months, a standard open-tray impression was taken to produce a mounted master model with a gingival mask. Stock abutments were chosen and modified by me and single-unit porcelain veneer crowns were constructed in the laboratory. At a secondary appointment, the healing caps were removed and the modified abutments placed and torqued (Fig. 8) according to the manufacturer’s specifications. The crowns were tried in, cemented and the occlusion adjusted (Fig. 9).

**Conclusion**

By adopting a team approach with a restorative dentist, oral surgeon and laboratory technician, we were able to design a biologically sound and supportive prosthesis. Using CBCT technology, we were able to maximise our diagnostic skills in order to idealise the surgical and restorative results. Using minimally invasive techniques, we were able to address the patient’s medical needs and desires by reducing the need for antibiotics and open surgical techniques.

By looking at the placement of the implants in the post-operative CBCT (Fig. 10), the level of accuracy was achieved with guided surgery. A 3.5-year follow-up appointment revealed optimal gingival and osseous health (Figs. 11 & 12).

**Acknowledgments**

I would like to thank my team members Dr William E. Lippisch and Michael Hennessy of Hennessy Dental Laboratory for assisting me during all stages of the case.

**Discussion**

This case was not about the design and success of implant placement procedures, but about patient management, using a team approach and a state-of-the-art technique (Nobel Guide) to achieve a patient’s desired request.
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Implant-prosthetic troubleshooting — When dental technicians and dentists break into a sweat!

Authors: Dr Georg Bach & Christian Müller, Germany

Implant-prosthetic troubleshooting usually starts at an advanced stage of the implant-prosthetic treatment, i.e. when implants have already been inserted, and the next step is the insertion of prostheses on the artificial abutment teeth. This point in time is extremely unfavourable for several reasons, one being that—owing to the already completed surgical phase—there is no opportunity for intervention and modification of the implant placement, and the other reason being that the patient feels he or she is on the verge of a successfully completed treatment and does not realise that difficulties may now arise, which in extreme cases could result in failure of the entire treatment. This development usually ends in mutual accusations and forensic disputes.

"Incorruptible"—The dental master model

In a worst-case scenario, it will not become apparent that the inserted implants cannot be...
treated dentally, or only with extreme difficulty, owing to unfavourable placement in the jawbone until the dental master model has been created by the dental technician after casting or after the check-bite at the very latest.

"Plaster is incorruptible!". This conclusion, attributed to Freiburg dental surgeon Prof Eschler, was deliberately kept trivial; however, it is simply and utterly true. The dental master model shows the realities concerning placement of the implant, its axis, also with regard to abutment teeth and the transition to the gingiva.

Exemplary patient cases

Our report will demonstrate, based on a few exemplary patient cases, the solution possibilities, but also the limits of implant-prosthetic troubleshooting—especially in terms of achieving a sustainable result for patient, dentist and dental technician.

Unidentified jaw misalignment

(Figs. 1–8)

The problem

Two years ago, a male patient (in his mid-70s) had received two implants in the maxilla, followed by treatment with telescopes and a partial prosthesis. The patient stated that "the work did not agree with him right from the start". Aside from functional problems, he disliked the fact that the maxillary front teeth were not visible even when he opened his mouth half-way.

Just by looking at the maxillary prosthesis it was easy to notice the metal portions of the prosthesis, which were placed extremely palatinally, showing through. An examination of the oral cavity revealed a considerable discrepancy between the implant placement and the axis of the plastic front teeth!

Our solution

A wax-up marked the beginning of the actual treatment. It was modified until the patient was satisfied with the placement of his teeth and his subsequent appearance. Based on the results of this treatment planning, we were able to determine which position and alignment would be required for two additional implants (distally of the existing ones).

This in turn resulted in the creation of a drilling template, which was used during the insertion of the two additional artificial abutment teeth. After osseointegration of these two implants in regions #14 and 24, the new partial prosthesis (now supported by four implants (two existing and two new ones) was produced and integrated step by step.

Aside from cases like the one mentioned above, which are usually the result of design errors and/or
design flaws, there is additional, yet different implant-prosthetic troubleshooting—covering primarily implant fractures or failure of individual implants within an extensive supra-structure. This considerably smaller part of implant-prosthetic problem areas, as compared with the group of design errors mentioned above, will be covered and evaluated in this article. The purpose of this is to demonstrate solutions so that the patients affected receive a modified solution in order to preserve the existing and very expensive work.

_Loss of implant due to peri-implantitis_
(Figs. 9–18)

_The problem_

A bridge structure in the second quadrant had been in place without any problems in a 50-year-old female patient for 10 years. Therefore, she only came to recall and follow-up examinations sporadically. The problem-free period ended abruptly when swelling and bite pain occurred in the left half of the maxilla. A panoramic tomography revealed radiological indications of a profound osseous defect around the mesial implant, which had to be removed on the same day. The issue then was the entire supra-structure. The patient insisted that this structure be preserved owing to the financial cost of having a new structure created after re-implantation.

_The solution_

A new implant was inserted after the soft tissue and bone had healed in the area where the lost implant had previously been in place. The bridge structure that had been temporarily affixed on the remaining implant was used as guidance for

_Figs. 13 & 14_, We were able to preserve the bridge in the left maxilla.
incorporation of a replacement implant and then removed for the actual implant procedure.

After osseointegration of the artificial abutment tooth, we inserted a plastic abutment and made a casting of the integrated bridge structure with polyether casting material. This customised abutment was transformed into metal and the bridge structure finally cemented in place after a trial insertion.

**Implant fracture** (Figs. 19 & 20)

Diameter-reduced implants can often be implanted even in a reduced osseous bed and aid in the avoidance of augmentations. However, when introduced into the market, diameter-reduced implants were frequently used for other indications as well; some clinicians even recommended using them as standard implants. Stress phenomena caused a considerable number of implant fractures, resulting in markedly restricted indications for diameter-reduced implants.

**The problem**

The case presented here reflects the typical progress of this early phase. A purely implant-supported (two abutments) extension bridge was incorporated into the fourth quadrant. A diameter-reduced implant was used in spite of an orovestibular bone dimension that would have been sufficient for supporting a standard implant. The result was that the distal implant fractured after eight years.

**Our solution**

In one surgical session, we removed both the implant fragment remaining in the bone by way of an osteotomy and placed a further distal implant.

**Fig. 15** Three implants had originally been inserted to treat anodontia in the second quadrant.

**Figs. 16 & 17** The distal implant was lost; the detailed view shows the non-functional crown #25.

**Fig. 18** Condition after re-implantation distally of the implant localisation.

**Fig. 19** The distal (diameter-reduced) implant of a bridge supported entirely by fractured implants.

**Fig. 20** An additional implant was inserted distally after removal of the fragment that had remained in the bone. After integration of the implant, a new bridge supported entirely by implants was created, while incorporating the former implant.
After its osseointegration, we incorporated a completely new bridge using the existing mesial implant. The results achieved here can help us learn from design errors and select a different approach for future cases, so that we can also treat patients who have had failure of a comprehensive prosthetic restoration. Our last case will illustrate this situation.

_The unsuccessful conventional treatment versus the successful, well-planned implantological procedure (Figs. 21–34)_

**The problem**

Finally, we would like to present an unusual case: an unsuccessful conventional treatment that was replaced with implantological treatment carried out in close collaboration between the dentist and dental technician. The patient had experienced considerable complications during prosthetic treatment (the goal being a telescopic partial prosthesis supported by teeth #43 and 33, while preserving the front teeth #42 to 32, which had been caries-free and without fillings until then, and replacement of teeth #47 to 44 and 34 to 37). First, tooth #33 fractured and had to be extracted, in spite of the fact that preparation and casting had already been done. Treatment was replanned after this event, and teeth #42, 41, 31 and 32 were also prepared (the goal being telescopic crowns). Shortly before implementation, tooth #43 also had to be extracted. The patient was unable to give the exact reasons for this. This left her with four teeth—#42, 41, 31 and 32—which all had telescopic crowns.

**Figs. 21–25.** Owing to the loss of prospective abutment teeth #43 and 33 during the prosthetic treatment phase, the remaining front teeth #42, 41, 31 and 32 received telescopic crowns. **Fig. 26.** The partial prosthesis showed insufficient mounting.

**Figs. 27–29.** With the aid of 3-D imaging and planning, four implants were inserted in regions #46, 43, 33 and 36—without any augmentative treatment. **Fig. 30.** After osseointegration of the artificial abutment teeth, two side-tooth bridges entirely supported by implants and four individual crowns were integrated with the remaining mandibular teeth.

**Figs. 21**

**Figs. 22**

**Figs. 23**

**Figs. 24**

**Figs. 25**

**Figs. 26**
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Anchoring of the partial prosthesis was poor; the patient was able to loosen it with minimal tongue-applied pressure. The pronounced tendency of the prosthesis saddles to cave in also resulted in complications in the form of multiple recurrent pressure sores. The reason for this according to her dentist was that implants, which the patient had inquired about, could be inserted neither in the extended front-tooth area nor in the side-tooth area owing to the narrow and atrophied alveolar ridge.

**Our solution**

It was true that the alveolar ridge on both sides, starting with the cuspid region and extending to the area where the molars had been previously, was fairly pointed, and the course of the osseous limbus alveolaris displayed a pronounced sagging distally of the previous pre-molar zone.

The patient thus showed considerable osseous deficits in both the oro-vestibular and horizontal dimension. In order to assess the basic possibilities of oral implants, we decided to perform 3-D imaging, which proved extremely helpful in this complex patient case. After illustration of the osseous situation, there were indications that implantation would be possible without carrying out augmentation procedures. We then prepared a virtual implant plan, the results of which led us to prepare a drilling template.

The remaining front teeth proved very helpful as a place for securely anchoring the template. By opting for a shortened row of teeth with one implant each in the region of the former six-year molars and an additional artificial abutment in each of the former cuspid areas, we were able to keep the dimensions of the template relatively small.

The insertion of four implants in the regions of teeth #46, 43, 33 and 36 and their osseointegration were followed by treatment with the supra-structures, which consisted of two bridges in regions #46 to 43 and 33 to 36, entirely supported by implants, and four individual crowns on the front teeth. The restorations were temporarily affixed for six months and then cemented in place.

**Fig. 31–33** Three-dimensional diagnosis and planning (see dental pins) of the third and fourth quadrant.

**Fig. 34** Orthopantomogram after incorporation of four implants, three of which were diameter-reduced Roxolid (Straumann) implants.

**Fig. 32**

**Fig. 33**

**Fig. 34**
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“Patient education needs to be part of the daily activities of a practice”

An interview with Dr Reena Gajjar, Canada

My Dental Hub is premier web-based dental patient education software. Accessible via your computer or mobile device, including the iPad, it provides patients with informative material on major areas in dentistry, including 3-D animations. Patients are then empowered to make educated decisions about the proposed treatment. CAD/CAM spoke to Dr Reena Gajjar about the idea behind and the benefits of the software.

CAD/CAM: How did the idea for My Dental Hub evolve?

Dr Gajjar: My Dental Hub (formerly Click & Print) started back in 1996, when I joined my husband’s prosthodontic practice. Having a background in computer graphics, I developed educational printable materials using images and simple explanations for our practice. These were used exclusively during patient consultations.

It soon became apparent that the treatment plan acceptance rate was increasing dramatically with these materials.

My husband, Dr Ken Hebel, began employing these materials and experienced the same response. Patients asking about treatment options were presented with the printable materials to review and take home. We both found that in addition to enhanced case acceptance, this material was a referral driver.

This digital educational tool, facilitation of patient comprehension and acceptance of proposed treatment manifested in a software program, was originally called Click & Print, which contained printable forms and a few animations that demonstrated dental procedures. Click & Print was sold on a disk for several years. Four years ago, we started to notice a shift in the way that companies were doing business—becoming cloud based—and we made the investment to convert our disk-based product to a web-based product. The development took over a year, but the investment proved to be a smart decision, since we emerged as My Dental Hub—the first cloud-based patient education and practice-marketing solution.

As a cloud-based company, we have the ability to constantly upgrade and update our product offering, and customise our solutions to the needs of our clients. As the dental industry starts moving towards cloud-based solutions, we are well positioned to offer solutions to meet the needs of the individual dental practice, as well as the collaborative needs of dental organisations.

CAD/CAM: How do/did you obtain the information used in the software? Do you collaborate with universities and/or companies?

Patient education needs to be part of the daily activities of a practice”
Most of the software content was written and developed by Dr Hebel and me. We collaborated with dental colleagues for some of the clinical content; however, all the 3-D animations are designed and created in-house. The users of our program play an important role in the development of our content, since we develop content based on what our clients need.

Clients submit requests for content they would like to see, and based on popularity and demand, we develop the content. So, in fact, it is actually our users that have guided the direction of the content in the software. This is one of the tremendous advantages of being a web-based company. As we develop new content, we upload it to the program, and it is immediately available to our users. No need to wait for next year’s disk upgrade!

Convincing patients to invest in dental treatment, e.g. an implant treatment, is a challenging task. How will My Dental Hub help?

We believe that there are three primary components to case acceptance. Patients will invest in dental treatment if they understand the problem and understand the treatment that is being offered, but more importantly, patients must understand the value of the treatment and how that treatment will improve the quality of their life (whether it is related to improving function or aesthetics). The content in My Dental Hub has been specifically developed to address these components of patient education in a language that patients will understand. The 3-D animations are used to visually explain the procedure and the benefits of the treatment, and the printable (e-mailable) documents serve as reinforcement of the animations and as a resource for patients to review at home.

What are some of the additional features the software offers?

One of the key features of the software is the ability to e-mail the animations and documents to patients. This allows the dental practice to extend their consultation from their office into the patient’s home, where patients can share and discuss the recommended treatment with those involved in the decision-making process.

My Dental Hub has several modules within the program. We offer animations, image documents, narrated slide shows, customisable text documents, a document creator, a patient and photo management section allowing the practice to upload and store patient images, as well as a presentation-creation module. Our newest module, Easy Consult, has been extremely popular and is currently our most-used module. Easy Consult allows the busy practice to do a consultation in three simple steps and then e-mail the entire consultation to their patients. It automates the consultation process. It’s very simple and highly effective!

Users can link their practice website to the Website Content template, which is personalised with the doctor’s logo and contact information.

My Dental Hub also offers mobile applications (apps), available on iPad, iPhone and Android tablets, containing all our animations and slide shows. The iPad app is extremely popular in dental practices as an easy way to explain treatment to patients. It provides an exceptional presentation on oral-hygiene instruction, which invariably is a significant driver in any dental practice.

Users can also embed any of the narrated animations or slide shows directly in their practice website to maintain branding and consistency.
In addition, we offer a product called Web Site Content that allows users to place any of our animations and slideshows on their websites or linked to their website. High-quality animations on a website allow patients to obtain information about the procedures offered by the practice and facility. External marketing includes websites, advertising, mailings, etc. that are done virally through e-mail or regular mail. Many dentists are not trained in marketing and find it inherently difficult to embrace marketing to grow their business. Many do not know how, many just don’t think they need to.

Many dentists do not take the time to educate their patients or understand the value of patient education. Many feel that patients will accept treatment on the sole basis that the dentist told them they need it. That may have been the way it was, but we now live in an information-based society, and if patients do not receive adequate information from their dentist, they will seek it elsewhere. (Hopefully, that won’t be the competitor down the street!)

We did a survey of our My Dental Hub clients to determine how effective patient education was in their practices. Our end users told us that they had experienced an increased case acceptance of 53%! This number indicates the importance of educating patients, and the impact it has is apparent in any business, including the business of dentistry.

The process of patient education needs to be woven into the daily activities within a practice. This requires enhanced staff training and implementation. Many dentists do not invest the time to integrate the process into their practice procedures. Acceptance of a practice philosophy mandates that training for implementation is as important as training in the procedure.

Can My Dental Hub also be a helpful tool for cutting through language barriers or communicating with disabled patients?

Absolutely! A picture is worth a thousand words. Visual images and especially animations tell a story, even if the words cannot be understood. Many of our dentists use our iPad app for that reason. Even with the narration turned off, patients use the iPad to browse the animations and learn about the different dental procedures offered by the practice. Most of us are visual learners. In situations in which there may be a communication barrier, we find that our client base uses the animations as a component of informed consent.

Is the software available in different languages?

The software is currently only available in English; however, we are working on translating the software into Spanish and French. We have
many international practices that have requested translations and our goal is to offer the program in multiple languages, thus catering to an international clientele.

**How much does the software cost? Are updates available free of charge?**

My Dental Hub is a suite of products and is subscription based. All updates are included in the subscription fee. The full package includes animations, slideshows, documents, patient and photo management, presentations, and Easy Consult. The software comes with an unlimited licence, which means that within a practice, there can be an unlimited number of computers and users. The subscription also includes unlimited training, unlimited support, all updates and upgrades, all new content, an unlimited number of e-mails, unlimited storage of patient data, photos and documents and daily backup. We offer special pricing for American Academy of Periodontology members (we were chosen as their exclusive patient-education provider), and other organisations. Pricing can be found on our website. We also offer a “lite” version of the software that provides access to all of our animations and narrated slideshows on both computers and mobile devices.

Web Site Content allows the practice to link their website to the entire library of narrated animations and slideshows so patients can browse through all the content and/or they can embed specific content directly into their website. We also offer a free ten-day trial that can be requested on our website.

**In your opinion, how will digital tools change the dental practice and the way in which doctors communicate with their patients?**

In terms of communication, digital tools enable a dental practice to communicate quickly, easily and effectively with patients or referrals. No more printing, no more mailing, diminished expense and waste.

Society is changing. People are more aware of their environment and doing their part to go “green”. With simple tools, a dental practice can deliver high-quality education directly and exemplify “environmental friendliness” as well. Ten years ago, if you had told people you could e-mail animations to patients to show them a dental procedure, no one would have believed it possible. Today, this is the way of the world and the way business is being done.

I believe that with the incorporation of digital tools into a dental practice, “elegant simplicity and seamless connectivity” with patients and colleagues will become the standard. Those who embrace today’s technology will be tomorrow’s industry leaders.

We all live in a connected world. My Dental Hub is about being at the epicentre of that connection in the dental world.

For more information please call +1 877 789 4448 or visit www.mydentalhub.com.

Hunderts of videos with narration can be accessed easily. Industry leading, stunning animations explain dental procedures in a clear, concise manner.
"Sirona products function like the pieces of a puzzle"

Mr Jost Fischer: IDS 2011 was absolutely fantastic! The spirit of the visitors, our staff and distribution partners was unbelievably high. It absolutely showed that the economy in Germany is doing well, which for us as market leader is always a very good sign.

You introduced a large number of new products at IDS. Which of these is your personal favourite?

I consider all of our products my favourite. Everything we do makes sense and is a vital contribution to Sirona’s success. At the end of the day, what is important to us is that our customers invest not only in a product or device, but also in their future.

We are an innovator in our industry and continuously strive to improve. Our systems are upgradeable, meaning that additional features and future technologies can be added on. Furthermore, every single one of our products integrates into the digital workflow of the dentist or laboratory technician. Sirona products function like the pieces of a puzzle. All our offerings fit into this concept.

CAD/CAM: What was your experience of this year’s show?

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CAD/CAM: With more than 1,000 m², Sirona had a strong presence at IDS 2011. What was your experience of this year’s show?
only specialists, but also GPs will be able to take 3-D images.

We also introduced SINIUS, a new treatment centre. SINIUS is the star of our new efficiency class. This unit saves the dentist time. It is compact, very design oriented and, according to the feedback we have received thus far, very appealing to female dentists.

In our instrument division, we launched SIROBoost, a powerful turbine that allows for uninterrupted workflow.

In our CAD/CAM division, we gave visitors a preview of our new software CEREC 4.0, which will be launched this summer. It offers a new interface and additional features, more fun, creativity and ease of use. We have already received enthusiastic feedback on our preview model from the CEREC community and intend to perfect the software over the next few months.

And finally, as patient marketing is a very important aspect of dentistry today, we launched an integrated face scanner. Thanks to the integration of a 3-D scanner into GALILEOS, X-rays and surface anatomy scans can be taken simultaneously. The result is a lifelike depiction of the anatomical structures of the face, teeth and bones. This accurate image of the patient’s face assists the dentist in planning treatment and makes it easier for the patient to understand the treatment proposed.

That is quite a large number of new products!

Yes, we have a constant flow of innovations. Over the past six years, we have spent more than US$250 million on R&D. More than 220 engineers are employed by Sirona and a lot more work throughout our network. In order to enhance communication and innovation, we have just opened the Sirona Center of Innovation in Bensheim, Germany, where we have the largest dental plant in the world. The Center of Innovation is at Sirona’s campus, where we aim to foster innovation and bring the dental community together. Everyone is invited to visit us there to see the latest developments in dentistry and to get a glimpse of the future.

Two Sirona products, inEos Blue desktop scanner and CEREC and inLab Biogeneric software, were named amongst the 2010 WOW! winners for 2010’s most innovative tools in the dental laboratory industry by the Journal of Dental Technology. Did these products still create a buzz at IDS?

Both products were very prominently exhibited at IDS 2011 and did not only receive the honours of this award, but also the approval of the market. InEos was developed for dental technicians and they love it! It is intuitive, and scanning with this device is fast, precise and efficient. It has met with great success and is a cornerstone of our lab offerings.

The CEREC Biogeneric software is the most intuitive software out there. It analyses the patient’s individual dentition as basis for the
restoration, which will consequently have a perfect, natural fit. With it, we have eliminated the need for a tooth library. The method is extremely simple: with a single click of the mouse, the user is able to create crowns, veneers, inlays and onlays, as well as anatomically sized bridges.

**What is the size of each Sirona division and how are they linked?**

Of our four divisions, our CAD/CAM division, led by our chairside system CEREC, is the largest, followed very closely by our imaging division. The CAD/CAM- and the imaging divisions create innovative technologies that can even be linked through CEREC meets GALILEOS. They are the drivers of today’s digital dentistry.

The third largest division is our treatment centre division. We are global market leader here as well. This is the area in which we have our roots and it’s still a brand shaper for Sirona. Finally, our instrument division is our forth and smallest division. That’s Sirona.

We are very happy with our position on the market and are continuously growing. Last year, we recorded growth of 7.9%. For the first quarter of this year, we registered 15.8% growth.

**What activities is Sirona involved in regarding giving back to the community?**

We take our social responsibility very seriously. Giving back to the community is an important part of Sirona’s activities. We believe that we have a responsibility towards the needy and thus engage in corporate-wide and local activities. For example, we supported clinics in Peru, Tanzania and Ghana with equipment donations. Some of these activities are a joint effort between Sirona and our distribution partner Henry Schein, such as our support of the largest non-profit organisation SCO Family of Services in New York, for which Henry Schein and Sirona held a combined charity event.

We also set up a relief fund immediately after the catastrophe in Japan. The purpose of the fund was to provide support and aid to colleagues affected by the disaster. About €8,200 was collected through fundraising events at Sirona’s Bensheim and Salzburg locations, as well as at IDS. Sirona subsequently increased this donation to €20,000.

**What is Sirona’s vision of dentistry of the future?**

Certainly, we see digital dentistry, including CAD/CAM, becoming central to the dental office. We have worked hard to make this happen over the past years and are well on our way. If you were to fast-forward five years, you would most likely see CAD/CAM and digital dentistry in every office, certainly in the more developed countries. That’s what we believe in, and it would be a great reward for Sirona to be the top brand driving this development.
“Online learning is not the next big thing, it is the now big thing.”
Donna J Abernathy
Training and Development Editor

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Moving the dental world from analogue to digital:
3Shape’s success story continues

Authors_Bernhard Moldenhauer & Matthias Diessner, Germany

During SCANDEFA, a major dental fair in Scandinavia, DTI recently visited the 3Shape headquarters in the heart of down-town Copenhagen to learn about the company’s new products and future strategies. The historical building alongside Køn gens Nytorv square and the Royal Danish Theatre has light and airy rooms, a perfect environment for a young, passionate and ambitious organisation driven to develop the best technological solutions in 3-D scanning and CAD/CAM.

Often referred to as the “Google of the Dental Industry”, 3Shape was launched eleven years ago in a one-room apartment by two young and ambitious graduate students from the Technical University of Denmark and Copenhagen Business School—Tais Clausen and Nikolaj Deichmann. At the time, Clausen was completing his master’s thesis on a groundbreaking 3-D scanning technology and Deichmann was finalising his Master’s degree in Finance and Economics. Having met through friends, they joined forces to participate in the prestigious Venture Cup business plan competition, established by McKinsey and Co., in which they finished second. Throughout the competition, they constantly considered the manner in which the technology could be commercialised and thus the idea of launching 3Shape was born.
Initially, Clausen and Deichmann approached companies in the hearing-aid industry with the idea of developing a quality-control system for hearing-aid shells and ear moulds. Similar to a dental restoration, the devices need to be custom fitted to the patient’s hearing canal and are traditionally made by taking an ear impression that is then manually sculpted, cut and used to make a mould—a time-consuming, manual procedure.

“During these first meetings, we realised that we could actually create a mass customisation production system,” Deichmann remembered. “So instead of just checking the quality we decided to go directly for changing the workflow completely, from a manual process, where you spend several hours shaping the hearing-aid shells, to a completely digital workflow.”

3Shape digitised the entire manufacturing process by introducing a 3-D scanner for ear impression taking, as well as the management software and CAD software needed to simulate the position of all the electronic components that need to fit into the patient’s ear along with the shell, taking up minimal space and using CAM software for controlling the manufacturing equipment. They developed the system for a specific hearing-aid manufacturer but retained the rights to sell the technology to others. At the time, there were only six companies that controlled approximately 90% of the global hearing-aid market and within a period of three years, all of them went from a completely manual to an entirely digital production. Today, about 90% of all hearing-aid devices are produced using 3Shape’s technology.

Clausen and Deichmann were always aware of the 3-D scanning technology’s enormous potential so they soon looked to other industries where the manufacturing processes are similar to the hearing-aid industry, such as dental laboratories. In 2004, 3Shape began to receive an increasing number of requests from dental companies interested in the technology.

“We quickly decided that if we wanted to replicate our success in the hearing-aid industry, we needed to go for the full solution to have a very user-friendly system that the dental laboratories would adopt. Therefore, we went to a lot of laboratories, small ones and big ones, and tried to figure out how we could optimise the processes instead of just finding a better way to make zirconia copings. From the very beginning, our vision was to achieve a complete switch from analogue to digital,” Deichmann explained.

3Shape introduced its first 3-D dental scanner and CAD/CAM software for virtual restoration design at the International Dental Show (IDS) in Cologne in 2005 and the system became a raving success. In the following years, the company extended and enhanced their dental laboratory product range by continuously responding to and involving their customers from the early stages of the product development process.

“Perhaps the most important lesson we have learned is that innovation is only successful if it moves and is guided in directions that truly benefit professionals in their daily work,” Clausen, CTO and head of the 3Shape development team, pointed out.

Today, CAD/CAM has conquered dental laboratories and clinics, ensuring high profitability by maintaining top-level quality through standardised and controlled treatment and production processes that also benefit the patient. In Germany, traditionally an early adopter of new technologies, approximately 82% of all ceramic restorations are already produced using CAD/CAM technology. “The question today is no longer if CAD/CAM will endure in the industry, but rather when all dental professionals will be taking advantage of it,” Clausen said.

After having conquered the dental laboratory industry, 3Shape also extended the proven technologies to dental clinics. “We analysed all existing scanning systems on the market and defined what we like and what we didn’t like about them. We wanted to create a system that incorporated all the advantages and eliminated all the drawbacks of the existing systems. Our solution really needed to be faster, easier, more accurate and more reliable,” Deichmann said.

At the opening day of IDS 2011, 3Shape launched its newest achievement, the TRIOS intra-oral scanning solution, which aims to revolutionise the dental
feature _ home story

practice. The 3Shape booth was literally flooded with dentists trying to get a glimpse of the sleek and elegantly designed scanner.

One of the TRIOS 3-D scanner’s notable features is that it does not require dentists to apply spray or powder to coat the patient’s teeth, making scanning an easy, fast and comfortable process that does not ruin scan accuracy by adding material to teeth surfaces. In addition, it can scan any material, such as metals, semi-transparent materials and skin. It only requires minimal training for use in clinical practice. The scanner captures over 3,000 2-D images per second, which is 100 times faster than a conventional video camera. Dentists who viewed the presentations at IDS stated that an “impression-free” dental practice seems to be just around the corner.

An open communication interface allows dentists to send the scanned data via the Internet directly to the laboratory of their choice, where the technician can start designing the restoration immediately using 3Shape Dental System software or the appropriate interface to third-party software. The TRIOS communication software includes a tool to visualise the technician’s solutions for the patient, for example on an iPad, while the patient is still in the chair, which is especially important for anterior cases.

The system is designed to give dentists high-quality restorations and treat more patients rather than spending time and money on chairside milling. It handles a wide range of indications and produces quality 3-D data that can easily be realised by any laboratory.

Generally, digital data is controllable, predictable and available any time, requiring only minimal space. This guarantees that the dentist owns and is able to use patient data without limitation and can potentially export virtual set-ups to other systems, such as for appliance manufacturing.

Surprisingly, 3Shape is the only major dental company that offers easily integrable solutions. All products are designed as plug-and-play solutions and feature open interfaces for connection to third-party applications. 3Shape has won Ernst & Young’s Entrepreneur of the Year in the Innovation category in Denmark three times. This prestigious award recognises innovation, leadership, state-of-the-art products, an international network and a clear strategy to pursue continuous growth.

Today, 3Shape’s development team consists of more than 100 developers of 22 different nationalities, with at least 30 PhDs amongst them. All their products and solutions are born from the union of cutting-edge technology with the latest trends in the industry and the markets. 3Shape product managers and key developers have regular meetings with distribution partners around the world to keep each product at the top of its class. During the life cycle, the products are developed in close collaboration with partners who understand and continue to gather the needs of their customer base and the market.

But even with ten years of outstanding history, 3Shape never stops looking ahead. The company believes that the age of fully digital dentistry is only a few years down the road (of course there will always be smaller, traditional dental practices).

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Intraoral impression-taking:
Digital datasets soon to catch on everywhere

Author: Manfred Kern, Germany
Now that producing all-ceramic restorations without CAD/CAM has become almost unthinkable, the next step has already been taken towards complete digitisation of the process from preparation to seating the prosthesis: optical scanning to create a digital, intraoral impression. In terms of clinical use, the devices—CEREC AC (Sirona), C.O.S. Lava (3M ESPE), iTero (Cadent-Straumann)—are similar, but they function according to different principles. Technically, the systems are similarly constructed, but the procedures for acquiring the 3-D datasets differ.

The acquisition unit of CEREC AC uses short-wave blue light and functions according to the principle of structured-light projection (Fig. 1). The scanning procedure captures single images; the angled imaging function acquires tooth areas below the equator and thus increases accuracy. Through matching, several images are computed of a quadrant or whole arch (Fig. 2), as are the antagonist dentition and bite record.

The wavefront sampling of C.O.S. Lava captures the tooth shape by moving the video camera over the teeth. The distance to the camera can be calculated from the changing position of individual pixels during filming, giving rise to a 3-D image of the dental arch (Figs. 3 & 4).

The functioning of the iTero scanner is based on the principle of laser triangulation. The image captures the tooth and vertically scans 300 levels, each 50 µm deep (Figs. 5 & 6).

According to Prof Wöstmann, the scanning accuracy of CEREC AC and C.O.S. Lava corresponds to a conventional hydrocolloid or polyvinyl-siloxane impression. The differences were not significant. Measurements of crown copings fabricated with C.O.S. Lava yielded an average of 33 µm (± 16 µm) for all marginal gaps. Copings produced using the conventional impression-taking technique had a mean marginal gap of 69 µm (± 25 µm). Syrek et al. found comparable results in a clinical study. The mean marginal gap of conventionally manufactured crowns was 71 µm, as compared with 49 µm for the C.O.S. Lava crowns. For CEREC 3D, the literature cites a tolerance of 40 µm (± 21 µm).

Another advantage of digital impressions is that the scanned preparation can be checked directly on the screen, where imperfections can also be immediately corrected (Figs. 7 & 8). For patients with an easily triggered gag reflex, these scanning methods greatly improve treatment comfort. Further benefits result from fewer working steps involved, especially in the practice. Choosing an impression tray, mixing the elastic impression compound, waiting during setting and disinfection, as well as producing a model are no longer necessary.

Fewer treatment and working steps also mean fewer sources of error and better standardisation, which in turn can improve the predictability of treatment outcome. Prof Wöstmann cautioned that with crown margins that are clearly subgingival, the optical systems reach their limits; thus, conventional impression-taking techniques are still used in such cases.
Digital impressions are more accurate

At the 12th annual meeting of the International Society of Computerized Dentistry, Prof Gerwin Arnetzl, University of Graz, compared the accuracy of digitally generated impressions with that of conventional elastic impressions. When conventional impressions demonstrate an elastic recovery of 98.5% after deformation, a fitting accuracy of 35 to 75 µm for an inlay cavity can be expected. For cast pieces, additional tolerances of up to 46.5 µm accumulate, so that indirectly manufactured crowns can attain deviations of up to 114 µm. Different elastomeric impression techniques can cause considerable deviations. For instance, in analogue impression-taking using different impression materials and trays, dimensional changes compared with the reference (a cast metal control) varied between 0.32 and 1.17%. A deviation of 49 µm was found for standard and 122 µm for control impression-taking. As a rule, however, the studies on analogue impression-taking techniques were performed using 2-D measurements; the new studies on the imaging accuracy of optical methods were conducted with 3-D volume difference analyses.

Digitally or optically produced images by different operators exhibited a measurement accuracy of 11 µm. With the analogue impression-taking technique, the deviations for a whole quadrant ranged from 72 to 101 µm, while the measurement error tolerance of digital images is only about 35 µm, thanks also to the enhanced accuracy made possible by angled images. Potential sources of error in the digital impression-taking technique are scanner adjustment, magnetic interference fields during image processing, image noise and the software. According to Prof Arnetzl, these results prove that given the correct use of a camera or scanner, digitally generated data exhibits fewer errors and greater accuracy than the conventional impression-taking technique with elastomeric impression materials.

A virtual model of the maxilla/mandible is computed from the scans of the quadrants or complete dental arch with the antagonist dentition. Via the Internet, the dentist sends the datasets from C.O.S. Lava or iTero to the manufacturer, where they are checked before being used to produce a resin model (Figs. 9 & 10). After CAD construction of the restoration, the dental technician can either mill the framework in his/her own laboratory or have it done at the milling centre. The resin model is needed to layer on the veneers and perform articulation. CEREC AC also computes a virtual model (Fig. 11). Framework-free crowns and short-span FDPs can be milled immediately, directly from the dataset, in the practice’s laboratory or in another dental laboratory with an online connection to the practice. For veneered crowns and multi-unit bridges, a stereolithographically produced resin model (SLA) is necessary, which is provided by InfiniDent (Sirona) and makes veneering the framework and articulation possible (Figs. 12–14).

Optoelectronic impression-taking systems are extremely promising. Owing to the offered advantages in standardisation, quality assurance and patient comfort, digital intraoral impression-taking systems have great potential for the future. In the coming years, they will be seen in ever-increasing numbers in daily dental practice. The datasets they create, thanks to the exchange of information online, simplify communication between the dentist and the dental technician, regardless of distance. Supplemental facial photos, information on tooth colour, individualisation, material, occlusal concept, etc. can also be attached. All of this happens without conventional impression-taking and the associated gag reflex, wax check-bite and stone model.

Editorial note: A complete list of references is available from the author at kern.ag-keramik@t-online.de.

FIGURES

Fig. 12: SLA model (acrylic) for trying in the framework.
Fig. 13: Trying in the Zr0 framework.
Fig. 14: Veneering and articulation. (Figs. 11–14 courtesy of Baltzer)

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Dental Wings collaborates with absolute Ceramics

_Dental Wings_, Canadian provider of dental CAD/CAM solutions, has signed a broad cooperation agreement with absolute Ceramics (biodentis GmbH), an industrial manufacturer of dental prosthetics based in Leipzig, Germany. According to Dental Wings, the agreement will enable absolute Ceramics to integrate Dental Wings’ DWOS software platform into its CAD/CAM system, broadening functionality considerably.

DWOS is a commercially available open-software system that offers dental laboratories the flexibility to use data from multiple systems and sources in designing prosthetics. With DWOS installed at its production centre and in its matchpoint Scan/Design system, absolute Ceramics will be able to offer custom abutments for all leading implant systems, in addition to its own Infix technology. The common software platform will also make absolute Ceramics’ digital workflow compatible with the LAVA COS intraoral scanner sold by 3M ESPE, which absolute Ceramics offers to its customers.

“A shared standard software platform enables fast moving companies like biodentis to offer a new level of flexibility and functionality to customers—which was unthinkable just a few months ago,” Meinhard Schmidt, Dental Wings Chairman, commented. “Using DWOS allows absolute Ceramics to provide integrated workflows to their customers. At the same time, it does not prevent them from competing for prosthetic business with other partners in our collaboration. That shows that we are offering a truly open platform with benefits for large and small players across the dental arena. Interest in our initiative with Straumann and 3M ESPE to establish and shape global standard software is growing and we are working with a number of companies who have responded to our open invitation to join us,” Schmidt added.

Frank Preuss, founder and CEO of biodentis, the company behind the absolute Ceramics brand commented, “The collaboration not only allows us to offer a full product portfolio to our customers but helps us to support truly digital workflows between dentists and dental technicians even across so far closed system boundaries.”

According to Dental Wings, the need for standardisation in digital dentistry is acute, as the number of different systems has risen considerably, adding complexity for dentists and dental laboratories. Standardised software could resolve this situation and is expected to be the main driver of the digital market in the coming years.

In March 2011, Dental Wings joined forces in a collaborative partnership with 3M ESPE and Straumann to create an open-standard software platform for use across a range of dental applications. At the same time, 3M ESPE and Straumann announced their intention to adopt Dental Wings’ DWOS platform as the core operating software in their CAD/CAM solutions. Biodentis is the fourth company to join the initiative. 

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A sharp focus on essentials, attractive and modern design, plus the streamlined production of clinically and aesthetically perfect dental restorations—these are the defining features of Sirona’s innovative CEREC SW 4.0 software, which is now poised to make its market debut. A key highlight is the intuitive user interface, which has been redesigned using the latest software development tools. All the settings and processing steps can now be visualised with the aid of self-explanatory icons and photorealistic images. As a result, newcomers will find it easy to get to grips with the CEREC system and experienced users will be able to achieve even more convincing results than in the past.

The CEREC system enables dentists to create all-ceramic restorations directly in-house. During a single treatment session, they can acquire digital impressions of the patient’s teeth as a basis for designing patient-specific crowns, inlays, onlays, veneers and temporary bridges. In just a few minutes, these restorations can be machined out of ceramic blocks with the aid of the CEREC MC XL milling unit, ready for immediate placement. The new software provides clear and comprehensible guidance at all times.

Intuitive user guidance via the phase and step bars

The new software generation goes a step further towards streamlining the design process. The system guides the user step-by-step through the entire production process. For this purpose, the software employs a clearly structured graphical element, the phase bar, that indicates exactly which design phase the user has reached. The software functions and options adapt themselves dynamically as the work proceeds. The user interface remains clear and uncluttered, and only those items that are relevant are displayed at any given time.

Manually adjustable biogeneric occlusal surfaces

It goes without saying that the new-generation software automatically creates patient-specific occlusal surfaces. Based on an intact tooth, the patented biogeneric design function identifies the patient’s typical morphological characteristics and then generates an initial restoration proposal. The user can then modify this proposal with the aid of the new biogeneric variation tool. For cases in which the user wishes to make manual adjustments, Sirona has developed a completely new and intuitive interface concept: CEREC SW 4.0 anticipates the user’s needs and projects the relevant design tools directly onto the restoration. This minimises search times and mouse movement. By simply clicking the appropriate tool and holding down the mouse button, the user can work directly on the tooth. The modifications to the restoration are immediately visible.

Multiple restorations created in parallel

To cater for patients with multiple clinical indications, the new software allows dentists to work in parallel on several different restorations during a single treatment session. As a result, they are ideally placed to offer their patients a complete portfolio of aesthetic and functionally effective therapy solutions. Depending on the specific therapy requirements, dentists can combine various indications and design modes, and thus master clinical challenges that are routinely encountered in everyday practice with ease.

Appealing to experienced and new users alike, the software upgrade is available free of charge to CEREC Club members. CEREC Connect users will likewise enjoy the benefits of the new features, and welcome the new design and intuitive mode of working. The new user interface has been implemented on a one-to-one basis in the CEREC Connect 4.0 software.

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With 115,000 visitors and nearly 2,000 exhibitors, this year’s International Dental Show (IDS) was the biggest dental trade show ever. The show boasted a 9% increase compared with 2009. People from 148 countries travelled to Cologne to see new products, learn about innovative treatment methods and network with other dental professionals. Exhibitors from 85 countries seized the opportunity to establish and further contacts, win new customers and open up new markets.

"The world’s leading dental trade fair IDS closed, having achieved outstanding results," the organisers summed up after five busy days. Organisers and exhibitors were especially pleased with the large number of visitors from abroad. "The most customers we’ve had so far are from abroad," Marian Tempel, responsible for marketing at Korean company Neobiotech, told CAD/CAM on the third day of the exhibition. IDS visitors came mainly from Latin America and South America, Australia, the US and Canada, but also from Italy, France, the Netherlands, Spain, the UK, Switzerland, Russia, Ukraine, Turkey, Israel, China and India. The exhibition halls were constantly busy and booths extremely well visited. According to the exhibitors, 66% of which came from outside
Germany, representatives of everything related to dentistry—dental practices and laboratories, trade, the higher education sector—visited their booths. The trade show meant a huge financial success for many exhibitors. Many companies took numerous orders, both domestically and internationally.

“We have succeeded in making IDS even more attractive, both domestically and internationally. The strong increase in international participants especially shows that IDS is the world’s leading dental trade show,” Dr. Martin Rickert, Chairperson of the Association of German Dental Manufacturers, said. “Participants were able to forge high-quality business contacts between industry and trade professionals as well as between the industry, dentists and dental technicians. Thus, the trade fair once again signalled better times ahead and generated momentum that will help the dental sector stay on course for a successful business year.”

Koelnmesse Executive Vice-President Oliver P. Kuhrt added: “IDS more than satisfied everyone’s expectations. Once again, IDS offered a whole range of new products and excellent opportunities to exchange information, communicate with partners and place orders. That’s why exhibitors, visitors and media representatives were all delighted with the trade fair.”

A visitor survey carried out during IDS found that not only exhibitors, but also trade visitors considered the exhibition a success. According to the organisers, 95% of the respondents indicated that they were satisfied/very satisfied with the event. They were pleased with the range of products and had achieved their goals at the trade fair. Furthermore, 93% would recommend a visit to IDS to a close business associate. “It’s my first time at the IDS and this is the biggest dental trade fair I have ever been to. I have scheduled three days to see everything,” Dr. Dusan Dimitrijevic told CAD/CAM. This dentist from Serbia brought his son and second-year dental student Lazar with him to Cologne.

_Focus on digital innovation_

This year, the focus of interest was on the innovative new products and technologies on display. According to Dr. Rickert, the trade fair demonstrated that digital processes and technologies are becoming increasingly popular, since they facilitate even more efficient and higher quality treatments. In particular, products and systems that offer users and patients improvements in preventative care, diagnostics and dental treatment were in high demand. Those include ultrasound systems with expanded capabilities that enable painless and professional preventative care, digital intra-oral scanners, improved root-canal treatment methods, new dental filling materials, aesthetic dental crowns and bridges that look most natural, as well as improved digital X-ray diagnostics that are especially useful in the field of implantology.

“As far as we are concerned, the trade fair was very successful,” said Jost C. Fischer, Chairperson and CEO of Sirona Dental Systems, leader in CAD/CAM technology. “The number of visitors was amazing. In fact, all of our employees were in dialogue around the clock. You could clearly see that the economy has picked up again. As a result, the atmosphere at the fair was extremely positive. In my opinion, it was the best IDS ever.”

Jürgen Schichtenberg, President of the Association of German Dental Technicians’ Guilds (VDZI), an IDS partner, was also very pleased with the trade fair. “From the point of view of the dental technician trade, the IDS 2011 once again proved the dental sector’s innovative power. Considering the variety of products on display in Cologne and the rapid development of new, particularly digital technologies, it will be even more important in the future for dental technicians to actively supplement these new technologies and solutions with their expert knowledge and to put these into practice in their laboratories in order to ensure an all-round high-quality treatment. Our partners in the dental industry in general and dentists in particular will be able to continue to rely on these important services.”
One partnership that was started at IDS is becoming an important political aspect of the profession: collaboration between the VDZI and the European Association for Dental Technology. The aim of the collaboration is to combine dental technology expertise and provide further training of the highest standard in both theory and practice so that practitioners can learn about the latest state-of-the-art dental technology.

_Speakers’ Corner well visited_

Many IDS visitors took advantage of the Speakers’ Corner feature to gather information on the latest developments in science and research. Around 80 exhibitors presented their new products and technologies. The presentation topics included implant systems, digitisation, dental aesthetics, laser technology, dental anaesthesia and the benefits of modern stress management for dentists.

Dr Peter Engel, President of the German Dental Association (GFDI), one of the IDS organisers, is happy with the positive outcome of the trade fair: “Even more visitors and exhibitors than in previous years can mean only one thing: The profession is progressive and medium-sized German businesses are fostering innovation—and they’re attracting enormous interest internationally.”

At the exhibition, the GFDI held a coordinating conference for aid organisations, at which over 40 participants presented aid projects seeking to improve the dental health of the world’s poor. The projects were developed by dentists and dental students who work in impoverished regions all over the world. Some of them also work in Germany. They provide dental services to a range of disadvantaged patients, including orphans, homeless people, disabled patients, drug addicts and inhabitants of remote areas, who would not receive treatment otherwise. To do this work, dentists and students often have to overcome enormous challenges. The coordinating conference offered participants a special opportunity to share their experiences in organising aid efforts.

In collaboration with the VDZI, the GFDI will also organise the 35th IDS, which will take place from 12 to 16 March 2013.
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