The new NobelProcera system for clinical success: The next level of CAD/CAM dentistry

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Introduction

While implant dentistry has broadened the range of treatment options available for patients, CAD/CAM technology is changing the restorative quality and concepts of the future. Advantages related to material and manufacturing will promote the continued preference of CAD/CAM systems to conventional casting techniques. The advantages new technologies offer include standardised quality guaranteed by industrial fabrication methods, excellent precision of fit, and outstanding biocompatibility, combined with adequate mechanical strength and provisions for aesthetic design. While there are many CAD/CAM systems on the market, only very few actually provide a broad range of products for different indications. The NobelProcera system advances digital dentistry to the next level in that it provides the ability to manufacture high-quality conventional restorations and implant-retained restorations from various materials.
The impact of advanced materials and manufacturing techniques on dentistry is significant. Owing to their many advantages, CAD/CAM technology and industrial fabrication of prosthetic components will replace several conventional laboratory fabrication processes in the future. Today, almost any clinical situation from conventional tooth-supported to implant-retained superstructures can be manufactured. This broad versatility and a guarantee of the highest quality material and precision of fit ensure reliable and safe solutions for any clinical indication irrespective of the type of finishing (Fig. 1). Moreover, industrialised fabrication methods reduce cost-intensive manual labour and provide cost-efficiency in the dental laboratory and practice.

The CAD/CAM system is able to minimise material incompatibilities, corrosive phenomena due to dissimilar metal alloys, interfaces between cast and machined components, and inadequate precision of fit.

This influences both the long-term success of a restoration and the aesthetic outcome. However, the predominant criteria for success are adequate treatment planning and the precise transfer of the intraoral situation into a digital data set.

Fig. 2. The working principle of a conoscopic laser scanner. The significant difference to conventionally used non-contact triangulation scanners is the co-linearity of the laser beam.

Fig. 3a. Schematic illustration of the conoscopic holography (left) and triangulation working principle (right).

Fig. 3b. General set-up of triangulation scanners prevents scanning of deep cavities due to shadowing effects (left). Co-linearity of the beam in conoscopic holography (right) allows for scanning of deep cavities (e.g. impressions).

Fig. 4. The new NobelProcera scanner (Nobel Biocare) based on conoscopic holography provides high accuracy for both impression-scanning and conventional cast-scanning.
Conoscopic holography: The next level in non-contact digitisation in dentistry

Currently the majority of scanners utilised in dentistry apply the triangulation principle. The configuration consists of two sensors (one a digital sensor and the other a camera or light-projector) observing the object. The triangulation sensor projects light onto the object, which is reflected back to a detector that is at an angle to the emitted light. The position of the illuminated pixel creates a triangle (light, object, detector) that allows the calculation of the distance from the sensor to the object. Owing to the working principle, this technique is adequate for scanning conventional dental casts predominantly. Although initial attempts to scan cavities were made, the general set-up has distinct limitations (shadowing effect). A variation of triangulation is structured light (projected fringes) projected onto the object. A camera, offset slightly from the pattern projector, looks at the shape of the light and uses a triangulation technique to calculate the distance of every point on the line.

An innovative technology introduced with the new NobelProcera non-contact scanner is conoscopic holography. The most significant difference to triangulation is the co-linearity of the laser beam: the light is emitted and reflected in the same axis, allowing for a whole new range of applications. In conoscopic holography—unlike triangulation—the measurement is not based on the geometry of the sensor and the system. Conoscopic holography creates a special fringe pattern and signals proportional to the distance from the object, and obtains a large amount of quality data reflected back from the surface, increasing measurement capability and precision. The scanner can digitise any convex (positive) or concave (negative) geometry that the laser beam is capable of ‘seeing’ with coverage of up to 240° (180° + 60° undercuts). This setup combined with the co-linearity also allows for the scanning of impressions, eliminating a potential step for inaccuracies, such as model fabrication (Figs. 2–4).

Ease of use and additional safety features with improved design software

In order to ensure efficient workflow, the digitisation and manufacture of components is needed, as well as a user-friendly software interface and intuitive handling.

Current scientific findings and clinical experience underscore the need for adequate material manufacture and framework design to minimise clinical failures, such as the chipping of veneering ceramics or fracture of frameworks. The most important request—especially when
working with zirconia substructures—is that the framework is anatomically designed and no manual post-processing adjustments are needed. Previously, double-scans were performed to achieve this goal. However, with new software design tools, these time-consuming and cost-intensive steps are unnecessary, as ‘anatomic tooth-libraries’ support the user in optimal restoration and framework design. Automatic cutback functions increase the ease of use and provide an additional margin of safety by ensuring homogenous veneering material thickness.

An equally important aspect to consider is the design and dimension of the connector cross-section for fixed dental prostheses. Long-term clinical success is ensured only if minimum connector dimensions are respected. Newly developed software tools support the user in virtual design of the frameworks and provide immediate feedback on cross-sectional area, connector height and width, as well as coping thickness (Figs. 5a–d).

Versatility for patients’ demands and expectations: Material selection

A wide range of materials can be used in CAD/CAM manufacturing. Important aspects to consider include long-term stability in the oral cavity, biocompatibility, and post-processing options (for example, the type of veneering material).

Advancements in ceramic materials research have led to the development of high-strength, non-silica-based ceramics that have beneficial properties, including biocompatibility, aesthetics and long-term function. Aluminium oxide (Al₃O₃) and zirconium oxide (ZrO₂) ceramics are the most common materials for copings, FPD frameworks, and implant abutments. It is often wrongly assumed that CAD/CAM technology is only applicable to zirconium ceramics. Actually, CAD/CAM technology can be applied to a variety of materials. Aluminium oxide ceramics are the material of choice in aesthetically demanding areas, for example the anterior dentition, owing to their beneficial light optical properties.

In addition, the clinical applicability of Al₃O₃ in single-tooth and short-anterior FPD has been clinically proven, and Al₃O₃ surpasses zirconium in terms of long-term clinical success and aesthetic outcome. In contrast, for large-span and posterior restorations, yttria-stabilised zirconium dioxide (Y-TZP) is the material of choice. The material fracture strength properties of Y-TZP allow its application in any area of the oral cavity where strength and stability are more important than aesthetics. Additionally, the
The material properties of zirconium make it a reliable alternative to cast alloys for implant-retained superstructures, including implant abutments and multi-unit implant-retained bridge frameworks. The availability of shaded zirconia is yet another step towards extensive and highly aesthetic solutions for the patient (Fig. 6).

Alternative materials are titanium and non-precious alloys, such as cobalt-chrome (CoCr). If centrally manufactured, these materials ensure excellent precision and long-term function in the oral cavity (Figs. 7a & b).

Additionally they may be applied whenever space requirements or expected biomechanical forces prohibit the use of ceramic materials or as long-term provisional restorations. With the new NobelProcera software, deciding on the appropriate material needs merely a click of a button.

Clinical versatility through solutions for natural teeth and implants

A basic requirement of a modern CAD/CAM system is providing solutions for natural teeth and implants. In the future, implant-retained restorations for missing teeth will become the predominant form of restoration. The clinical
success rates, the high predictability and a re-
duction of costs, as well as the implementation
of implantology in dental school curricula will
lead to more frequent and earlier implant place-
ment when a tooth is deemed non-restorable.

The abutment design and material to restore
implant-retained single-tooth or implant-
retained FPD restorations must fulfil some basic
requirements. Today, multiple abutment types
are available. Various studies have demon-
strated the successful application of ceramic
and titanium abutments in terms of acceptable
soft-tissue and marginal bone stability.

A study examining different abutment mate-
rials and their influence on soft-tissue barriers
surrounding dental implants found that the type
of material used affected both the height and the
quality of the tissue. Titanium and ceramic abut-
ments permitted the formation of a mucosal
attachment, while gold-alloy and metal-
ceramic abutments led to soft-tissue recession
and crestal bone resorption. Similar findings
were observed through in vitro studies that val-
did the finding of reduced plaque and bacte-
rial adhesion on titanium or zirconia abutments.

An indispensable factor of the long-term
clinical success of implant-retained superstruc-
tures is the precision of fit. Depending on the
complexity of a restoration, poor fit can have a
significant impact on function and stability in
the oral environment. When it comes to repro-
ducible precision, CAD/CAM technology clearly
outperforms conventional framework manufac-
turing techniques. New generation software
tools eliminate the need for time-consuming
framework design on the master cast. Instead, a
scan of the implant position can easily be
matched to a scan of a wax-up, followed by a
virtual framework design in the CAD tool. Ad-
justing the design and dimensions according to
the anticipated final contour of the definitive
restoration is done in a few minutes instead of
several hours with conventional fabrication pro-
tocols (Fig. 8).

Eliminating time-consuming and cost-inten-
sive fabrication steps in the laboratory is not
only beneficial for economic considerations, but
also leads to an overall increase in precision and
component quality through industrial manufac-
turing processes.

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