

Does CAD/CAM pay off?

An interview with Prof Albert Mehl, University of Zürich, Switzerland



Prof Dr Dr Albert Mehl

_IDS 2009 showcased the impressive advancements in CAD/CAM dentistry. For private dentists, however, there is much uncertainty regarding response to these developments. **cosmetic dentistry** spoke with Prof Albert Mehl, currently Guest Professor at the Centre for Dentistry and Oral Medicine at the University of Zürich, about whether investing in CAD/CAM pays off and for whom.

_cosmetic dentistry: *Most failures with conventional technology occur during impression preparation (insufficient illustration of the preparation margins, insufficient drainage). What advantages do CAD/CAM systems offer for the dental practice?*

Prof Mehl: Most importantly, treatment times are reduced because the dental restoration can be manufactured in the same session as the preparation (chairside method). Temporaries become obsolete, thus making uncomfortable and unaesthetic transition times a thing of the past. Owing to adhesive technology, sufficient retention for a temporary is in some cases not available because of the minimally invasive preparation. Furthermore, the latest studies demonstrate improved bonding to teeth with freshly cut dentine and enamel. Computer-aided milling and polishing allows the use of high-quality materials, which are manufactured industrially under optimal conditions, resulting in longer-lasting restorations compared to conventionally manufactured restorations. This has already been documented in numerous scientific studies. Through the combination of time saving, cost reduction and increased quality, the chairside method offers an interesting perspective for modern dentistry. This pertains mainly to single-tooth restorations but we can expect new possibilities in the production of fixed partial dentures with small span widths in the near future.

_How does the significant investment in digital impression technology pay off?

When considering concepts that entail the sending of data of a digital impression to a decentralised production site via the Internet, one can say that the time-frame equals that of conventional impression techniques. The extent to which the accuracy of digital technology is comparable to conventional impression techniques (including preparation of models) has not yet been determined, particularly in larger span widths. Comparative studies are now being conducted, and it is upon this issue that the further expansion of these concepts is dependent. However, first experiences suggest that this is indeed possible. Digitalisation would then enable the same advantages in other areas. The virtual 3-D model is important not only for the computer-aided fabrication of dental restora-

tions, but also for every other kind of diagnostic, such as the exact 3-D determination of tooth movements, archiving of virtual models and the documentation of 3-D changes to the tooth and surrounding soft tissue. According to the industry, amortisation could be achieved through the cost savings of computer-aided production in production centres, software updates and systems for the chairside production of single-tooth restoration, and extension to diagnosis and treatment planning software. The enormous potential of digital scanning has been recognised by the industry and thus is currently in heavy development. As soon as quality and practicability have been demonstrated within clinical environments, amortisation will no longer be an issue.

_How can the aesthetic disadvantages of the single-session treatment (CEREC/E4D) be solved in the future?

Sophisticated, aesthetic single-session treatments in the anterior region are difficult and achievable only with much experience. Hence, most dentists will probably prefer the conventional veneer layered crowns. However, aesthetically pleasing results can be obtained using multi-coloured blocks. It is expected that these blocks will be improved by optimising the form and position of the layers and that the software will position the restoration within the block for optimum colour effects. In order to standardise this process, the use of tooth colour measurement systems may also be relevant.

_Are you referring to integrating digital colour measurement systems with CAD/CAM?

This is an interesting aspect. This kind of integration is likely to be available soon. In my opinion, this is another major advantage of CAD/CAM technology. Through the means of standardised calculation processes, the ideal layer thickness of frames and veneers for every required shade can be obtained individually for each combination of materials and type of restoration. A systematic analysis of these combinations and the resulting colour effects through large test series are essential though. Such tests have not been available thus far.

_Does the extended workflow—from practice to centre to laboratory and back to the practice—offset the time-saving factor?

This is the case and certainly a disadvantage of a centralised production process. The advantage, however, is that such centres can invest in high-quality and highly precise production technologies. These machines are maintained by specialists and ensure high capacity. The storage of many different materials including a variety

of shades and implant systems is easier and more economical as well. Overall, production costs are very low and theoretically offer superior quality at the same time, which is something that needs to be considered when we speak of the time disadvantage. I anticipate that decentralised production will play a vital role in dentistry for larger restorations such as fixed partial crowns and implants.

The first IT systems that were available to dentists at the end of the 1970s/beginning 1980s were expensive mini-computers (VAX) that were never actually amortised. Will it be the same with CAD/CAM? What do you foresee price development to be?

An amortisation of CAD/CAM systems depends not only on the possibilities and range of indications, but also on clinical concepts and the patient base (for example, the number of ceramic restorations produced and the extent of the potential for this kind of treatment). This needs to be analysed case by case. Generally speaking, we have already undergone the introduction phase and many CAD/CAM practices now demonstrate impressively that the system can actually be amortised quite well. Many companies have found CAD/CAM technology to be one of the key technologies in dentistry today, and large sums are invested in research and development, which will boost development processes. Many of these improvements can be incorporated into the systems later, as a large part of the expertise is incorporated into software. There are likely to be changes in the hardware as well, but those will take much longer. Dentists thinking about investing in a CAD/CAM system should make their decision regardless of such considerations. After all factors—range of indication, user friendliness, testimonies of fellow colleagues, economic efficiency, and scientific approval—have been analysed, entry into the CAD/CAM world clearly does make sense. In the short and intermediate term, we do not expect a significant decrease in price. But as a scientist, I always look far into the future and am convinced that after the high development costs have been amortised, prices will have the potential to decrease in the long term. The vision is that someday every dental practice will own such a system. IT technology is a good example and CAD/CAM technology, which is based on this IT technology, will follow suit.

iTero, 3M ESPE Lava COS, CEREC, E4D—How many points of laser light are technically required?

For dental restorations, an accuracy of 50 µm is demanded. Surprisingly, little is known about how critical this level really is, but we apply this standard, and surfaces should be scanned with a grid of at least comparable size. Double resolution (25 µm) would be even better. An average molar surface of 2 cm², for example, would yield 320,000 measuring points. The ideal number then depends on the data processing. By combining several scans, these numbers can be increased significantly. The software can then calculate the optimum

distribution of measuring points, thereby improving the results even more.

LED (CEREC) versus laser (3M ESPE, iTero, E4D), parallel confocal imaging (iTero) versus triangulation (CEREC, 3M ESPE, E4D)—what are the advantages and disadvantages? How much interpolation is acceptable?

These technical details principally influence accuracy and clinical adaptability. However, we cannot fully evaluate the quality of intra-oral scanners based on these details because they only constitute a small percentage of the overall complex measurement systems. In addition, there is the decisive factor of software interplay. Clinical and scientific experiences of each measuring system are far more important.

What are the advantages and disadvantages of digital bite registration versus traditional bite registration with subsequent manual adjustment?

The software allows a more precise positioning of the jaw and a superior analysis of the occlusion compared to the conventional, manual procedure on the plaster model, on condition that the digital impression ensures a high degree of measurement accuracy for the jaw impression. In addition to the controlling of the restoration material thickness, contact patterns can be analysed, 2-D slices can be adjusted for visualisation in different areas, and articulation movements can be measured. Using software, the resilience of teeth can be simulated, enabling new possibilities for diagnosis of the contact situation.

iTero and E4D do not require powder coating. Why isn't this possible with CEREC and 3M ESPE?

Powder-free impressions are the preferred option. However, they still are a significant challenge in intra-oral scanning technology. Based on my experience, I am not able to evaluate whether this is possible with sufficient accuracy at the present stage. There are many different approaches to analysing the light reflected from tooth surfaces without using powder; however, the accuracy of the measurement is dramatically reduced. At the end of the day, it is the results that count and it is up to us to analyse these closely.

Do you believe that prostheses manufactured via rapid prototyping can be done in practice with better aesthetic quality and without the assistance of a dental technician?

There is debate about whether this is possible. While this procedure has become common in some milling centres with regard to metal and acrylic resins, restorations with aesthetic materials such as dental ceramics and composites have shown some principal and unresolved issues. Basic research is needed in this field. As a second step, production devices should be made compact so they become more cost-efficient for dental practices. In conclusion, this technology is unlikely to experience a major breakthrough in the medium term.

