SHAPING SMILES

Making Dentistry Digital with CAD/CAM

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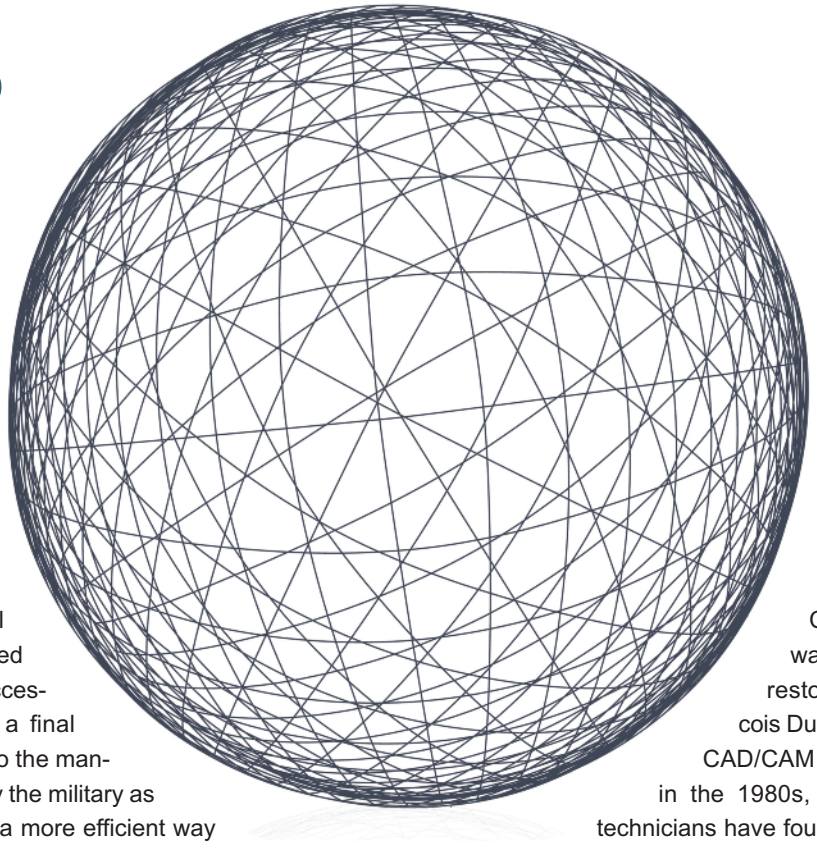

Back in the days before CAD/CAM technology, most all manmade products began with ink and paper. The initial concept flowed through the hand of a skilled draftsman who painstakingly rendered successive iterations until ultimately arriving at a final design, which was given in blueprint form to the manufacturer. In the 1960s and 70s, demand by the military as well as the aircraft and auto industries for a more efficient way to model industrial products busied brilliant minds at MIT and other thinktanks.

Early versions of computer aided design software relied on massive mainframe computers that filled entire floors, required their own A/C systems, and munched miles of information punched into paper tape. Over three decades, the growth of CAD/CAM technology closely paralleled the development of the digital computer as computers evolved from clunky multi-million dollar monstrosities into affordable desktop necessities. Each step forward made CAD/CAM solutions smaller, cheaper, faster and vastly more powerful, and pushed industry through the looking glass into a world that was once unfathomable. The impact has rippled outward to every corner of product design.

The computer scientists who breathed life into those early applications probably didn't have time to imagine that their work would revolutionize manufacturing so completely that it would affect everything from aerospace to zippers, including the way dentists restore a patient's smile.

CAD/CAM Restorations

Even a minute discrepancy in fit between the tooth preparation and the crown can result in an increased chance of infection and shifting, so precision is critical.

To address the need for optimum precision, CAD/CAM technology was first introduced in restorative dentistry by Francois Duret in 1971. Since the first CAD/CAM restoration was created in the 1980s, dentists and laboratory technicians have found that it helps them reliably and efficiently fabricate all-ceramic crowns and bridges with great precision.

CAD/CAM has also dramatically impacted the patient experience. After the area is prepared, the dentist electronically captures an image of the preparation. Alternatively, images can be obtained by scanning a traditional model created from conventional impressions of the preparation. Newer systems are clinically and economically superior to first-generation systems, so more dentists are now choosing to completely replace traditional impressions with optical impressions taken with a digital scanner or camera. This can be a valuable marketing device since it is especially attractive to patients who prefer to avoid the sensory unpleasantness of the traditional impression process.

After the exact size and shape of the restoration required to fill the defect is precisely specified using an on-screen cursor to draw the design for the restoration on a three-dimensional image, the dentist relays the digital information to a CAM milling apparatus, located either in the office or in an off-site laboratory.

In about 20 minutes, the milling machine fabricates a ceramic restoration, which conforms to the defect within 50 microns, from a solid block of ceramic material that matches the surrounding teeth. When the

restoration is complete, it is sectioned from the unmilled ceramic block and tried in place in the patient's mouth. Depending on the material chosen, the restoration may be finished with stains and glazes to create a highly natural look.

A final seat is accomplished in about an hour, and the restoration is held in place by traditional bonding methods. Many experts believe that there is less risk of sensitivity or subsequent root canals following treatment since the leakage sometimes associated with a temporary restoration is eliminated.

Since there is no dark metal substructure, the result is highly natural and aesthetic. The restoration also does not block x-rays, so dentists can monitor the area for decay without the interference created by gold or porcelain-fused-to-metal crowns.

CAD/CAM and Dental Implants

In the early 1990s, CAD/CAM entered into the world of dental implants, bringing an alternative to stock or cast implant abutments and frameworks. CAD/CAM implant frameworks are milled from a homogenous block of material without waxing, investing, or casting so inaccuracies are eliminated and production costs are reduced. CAD/CAM also helps meet the challenge to correct unfavorable implant angulations and achieve a proper emergence profile.

CAD/CAM technology has enabled dentists to use special computer-controlled milling equipment to create completely customized implant abutments and gain precise control over the margin design, emergence profile, angulation and retention. Customized implant abutments provide a better fit and can offer greater durability since materials such as titanium, alumina and zirconium can be used. CAD/CAM ceramics offer highly natural optical properties so the result is predictable and esthetic.

In order to achieve the highest possible level of accuracy during implant placement, dentists sometimes use stereolithography to manufacture CAD/CAM surgical templates. In select cases, dentists with chairside CAD/CAM technology can place and complete the dental implant in a single visit, without impressions, temporary restorations, or a return visit. This allows the implant to be placed without a flap using minimally invasive surgery, and the prosthesis can then be delivered with immediate functional loading to the implants.

As with all new technologies, there are those who are reluctant to fully embrace CAD/CAM technology. There is a learning curve required to use CAD/CAM properly, and dentists make a significant capital investment to acquire CAD/CAM equipment. However, practitioners report that by eliminating laboratory fees and second appointments, overall restoration costs are actually reduced.

CAD/CAM dental technology is here to stay and growing numbers of practitioners find that the advantages far outweigh the drawbacks. The genie is unlikely to go back in the bottle and is probably the forerunner of further technological marvels that will continue to advance dentistry beyond the current bounds of our imagination. ■