

# CAD/CAM IN PROSTHODONTICS - A FUTURISTIC OVERVIEW

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## Abstract

CAD/CAM technologies are being extensively used in engineering field because of their high precision and accuracy. These systems have been introduced to dental field in late 1980s and have started being used in various fields of dentistry. This is an attempt to provide an overview for the application of CAD/CAM in the various branches of prosthodontics.

**Key Words:** - CAD/CAM technology, Restoration, Dental prosthesis

## Introduction

CAD/CAM is an acronym for Computer-Aided Designing and Computer-assisted Manufacturing. Over the past 25 years, CAD/CAM technology has become extremely popular. It is widely being used, in dental laboratories and in dental offices, to design and machine various restorations viz. veneers, inlays, onlays, crowns, fixed dental prostheses, implant abutments, cast removable partial dentures and even full-mouth rehabilitation.<sup>1</sup>

CAD/CAM technology was introduced in dentistry in the year 1989, by Mormann & Brandestinni in Germany and today it is widely used in all the branches of prosthodontics. Using these CAD/CAM technologies, various types of restorations and dental prostheses can not only be designed but also machined with accuracy and precision.<sup>2</sup>

## Objectives and potentials of the CAD/CAM technology

It aims towards eliminating the traditional impression methods by designing and machining the restoration with the aid of computer; to produce chair-side restorations and finally to improve the qualities of restoration.

## Stages in prostheses fabrication with CAD/CAM technology

There are various stages in fabrication of the prostheses with CAD/CAM technology.

1. Computer surface digitization
2. Computer-aided designing
3. Computer assisted manufacturing

The first stage is the Computer surface digitization. This technique can be broadly divided into two categories:

1. Mechanical scanning devices.
2. Optical scanning devices.

Optical camera, LASER surface scanning device, three dimensional (3-D) scanning device (digitizer), photogrammetry, Moiré fringe displacement, computed tomography (CT-Scan), magnetic resonance imaging (MRI), 3-D ultrasonography etc. are some of the technologies used for computer surface digitization.

The next stage in CAD/CAM is Computer-aided designing (CAD). Once the 3-D image is captured through any of the computer surface digitization techniques, 3-D image

processing is done and the digitized data is entered in the computer. Finally, curve smoothening, data reduction and blocking of undercuts can be done at this stage. Designing of the restoration is done using CAD software, which in turn send commands to the CAM unit, for fabricating the restoration.

Third and the final stage is Computer-aided manufacturing (CAM). In this stage the milling is done with computerized electrically driven diamond disks or burs which cut the restoration from ingots. This process is commonly known as "subtractive method".

Other CAM methods are "additive", for example rapid prototyping or selective laser sintering. Here, material wastage can be prevented since there is no remaining excess material. Some CAD/CAM systems have been developed which utilize a combination of these two methods (additive and subtractive methods).

Another different rapid prototyping method is 3-D printing, in which after computer-aided designing, the machine is used to build (print) a wax pattern of the restoration. Then this wax pattern is cast similar to normal lost-wax technique. Advancement has taken place in such a way that instead of wax, resin-type material is being used to fabricate patterns. Rapid prototyping can also be used to fabricate auricular prostheses.<sup>2,3</sup>

## CAD/CAM technology in fixed prosthodontics

CEREC in Lab system - The tooth preparation die is secured in the scanning platform and data is captured with a non-contact laser. A Ceramic block (ingot) is placed in the milling chamber. Two milling diamonds create the precise restoration. Porcelain build-up is done which results in an aesthetically pleasing restoration. Then the fit is confirmed in the patient's mouth and required adjustments are done.

## CAD/CAM technology in maxillofacial prosthodontics

CAD/CAM is widely used for the fabrication of maxillofacial prostheses, extraoral radiation devices, individual respiratory masks and facial protection devices etc.

Three dimensional surfaces imaging is done by using CAD software. This 3-D surface image aids in the fabrication of resin model with Lithographic technique and then wax

pattern is made. Of this completed wax pattern, once again computer assisted three dimensional imaging is done. Data is entered in computer and prosthesis is milled by computer aided milling machine. Thus, a silicone maxillofacial prosthesis is fabricated using CAD/CAM technology.

#### **CAD/CAM technology in removable partial denture prostheses**

Fabrication of cast partial dentures can be done using Co-Cr Alloys or commercially pure Titanium and Ti-6Al-4V Alloy by utilizing CAD-CAM technologies.

William *et al* have demonstrated a method of fabrication of removable partial denture framework design using CAD/CAM technologies. Using CAD/CAM software the removable partial denture framework design is built on a three-dimensional scan of the patient's cast.<sup>4,5</sup>

#### **CAD/CAM technology in implant prosthodontics**

Computer usage in implant placement (Navigational technique) has increased in the past decade. Recently with the use of CAD/CAM application patient-specific abutments can be fabricated. These CAD/CAM fabricated custom abutments are designed by computer and manufactured by computer operated machines for obtaining unsurpassed accuracy and precision. As they are milled from medical-grade Titanium, they have superior biocompatibility and best possible integration with implant fixture.

The CAD/CAM fabricated custom abutments carries advantages like: - precision, milled from titanium, ideal coronal preparation, correct path of insertion, perfect emergence profile, 6° angled implant axis, shaped like a natural tooth and reduced chair time.

Computerized designing of abutment is done and primary abutment is fabricated from commercially pure titanium via computerized-milling technique. Another duplicate abutment is milled, which is functionally identical to primary abutment, thus reducing chair time.<sup>6</sup>

#### **CAD/CAM technology in fabrication of surgical guides for implant placement**

Bibb *et al* described the fabrication of stainless steel surgical guides for the placement of dental implants for prosthetic retention using SLM technology. It was first reported for the manufacture of custom-fitting surgical guides.<sup>7</sup>

#### **Advantages of CAD/CAM systems**

- No Traditional Impressions.
- Produce Chair-side Restorations.
- Less appointment.
- High Precision and Accuracy.
- Improve the Qualities of Restoration.
- Eliminates the Use of the Laboratory Equipments required for Conventional LOST-WAX technique.

#### **Limitations of CAD/CAM systems**

- Initial High Cost of CAD/CAM Systems.
- Time and Cost Investment to Master the technique.
- Presently available dental CAD/CAM systems are unable to incorporate esthetic veneers with strong cores and frameworks.<sup>2</sup>

#### **Discussion**

The uses of CAD/CAM in various field of Prosthodontics are continuously increasing for past two decades. This technology is not only used in the dental laboratory but with recent advancements it is also being used in the dental clinics in making chair-side restorations. This technology is used to fabricate not only smaller restorations like inlays, onlays, veneers, crowns, but also larger restorations like fixed partial dentures, removable partial dentures, maxillofacial prostheses, implant abutments and full-mouth restorations.

#### **Conclusion**

CAD/CAM systems, though costly in the initial phase however the accuracy and the quality of restoration definitely outweighs its economic factor and undoubtedly the future of prosthodontics will be led by these CAD/CAM technologies.

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