



**Research Article**

## **CAD/CAM IN PROSTHODONTICS: AN ERA OF DIGITAL DENTISTRY**

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### **ARTICLE INFO**

#### **Article History:**

Received 11<sup>th</sup> January, 2017

Received in revised form 19<sup>th</sup> February, 2017

Accepted 22<sup>nd</sup> March, 2017

Published online 28<sup>th</sup> April, 2017

#### **Key words:**

CAD/CAM, materials used, history, applications

### **ABSTRACT**

CAD/CAM (computer-aided design and computer-aided manufacturing) is being increasingly used to improve the design and creation of dental restorations, especially dental prostheses, including crowns, crown lays, veneers, inlays and onlays, fixed bridges, dental implant restorations, dentures (removable or fixed), and orthodontic appliances. CAD/CAM increases the speed of design and creation, the convenience or simplicity of the design, creation, and insertion processes and makes possible restorations and appliances that otherwise would have been infeasible. This revolutionary technology has facilitated chair side dentistry, where the restorations are fabricated in the same sitting, increasing the efficiency and quality of the dental practice.

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## **INTRODUCTION**

The latest innovations in TECHNOLOGY made almost all things possible. High quality dental devices can routinely be fabricated through the collaboration of dentist and dental technicians. As dentistry evolves into the digital world of image capture, computer design, and the creation of dental restorations through robotics, the dental laboratory must evolve as well. All Computer-aided design/Computer-aided manufacturing (CAD/CAM) systems consist of three components:

1. A digitalisation tool/scanner that transforms geometry into digital data that can be processed by the computer
2. Software that processes data and, depending on the application, produces a data set for the product to be fabricated
3. A production technology that transforms the data set into the desired product. [1] CAD/CAM may also reduce the fabrication time of high strength ceramics by up to 90% [2].

### **History of Cad/Cam**

Though computer-aided design/computer-aided manufacturing (CAD/CAM) for dentistry has been available for the past 25-30 years, it's only been within the past decade that the technology has moved from the lab to chairside. Much like radiovisiography technology, dental CAD/CAM technology got its start in Europe in the 1970s and 1980s.

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However, early versions of CAD/CAM systems were so cumbersome and complicated that they were considered more of a hindrance and confined to the laboratories alone. Research and development of dental CAD/CAM systems has been actively pursued world-wide since 1980's due to continuous efforts of three pioneers namely, Dr. Francois Duret, Dr. Werner Mormann and Dr. Andersson.[2] Dr. Duret was the first to develop dental CAD/CAM.[3] From 1971, he began to fabricate crowns with an optical impression of abutment followed by designing and milling. Later he developed Sopha system. Dr. Mormann developed CEREC System, an innovative approach to fabricate same day restorations at the chair side in the dental office.[4] Dr. Anderson developed Procera System[5] He attempted to fabricate titanium copings by spark erosion and introduced CAD/CAM technology into the process of composite veneered restorations.[6] This system later developed as a processing center networked with satellite digitizers around the world for the fabrication of all ceramic frameworks. [7-14] CAD/CAM initially started out as a system with single axis for milling, it has developed into systems with multiple axes for a faster and more accurate result.

### **The Process**

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),

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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 smoothing, 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).

### ***Applications of CAD/CAM***

#### ***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.[15, 16]

#### ***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 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.[17]

### ***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.[18]

#### **Advantages of CAD/CAM system**

- No Traditional Impressions.
- High Precision and Accuracy.
- Eliminates the Use of the Laboratory Equipments
- Improved restoration quality.
- Reduced appointment time
- Chair-side Restorations.
- Conventional LOST-WAX technique.

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

- Initial High Cost of CAD/CAM Systems.
- Need to Master using the technology

## **CONCLUSION**

CAD/CAM has been in use extensively for the past two decades, in prosthodontics. From a time where the work was restricted to the laboratory alone, now it has been used even in dental clinics facilitate 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. Even though the CAD/CAM systems are expensive, the accuracy and the quality of restoration definitely outweighs the disadvantage and it is already one of the leading technologies that has changed the face of prosthodontics.

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**How to cite this article:**

Prema Sivakumar and Preetham Prasad Nittla (2017) ' CAD/CAM In Prosthodontics: An Era of Digital Dentistry', *International Journal of Current Advanced Research*, 06(04), pp. 3045-3047.  
DOI: <http://dx.doi.org/10.24327/ijcar.2017.3047.0176>

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