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CAD/CAM – MANUFACTURE OF ORTHOPEDIC STRUCTURES

Khojimuradov Burkhan Ravshanovich
Assistant Department of Orthopedic Dentistry
Samarkand State Medical University Samarkand, Uzbekistan

Abstract
Imagine that in one step you make an impression, simulate a restoration and install a crown for the patient. Fiction? No, this is the same CAD/CAM system — Computer Assisted Design/Computer Aided Manufacturing or a system for computer modeling and manufacturing dentures.

Introduction

CAD/CAM technologies and system components

In CAD/CAM, CAD technologies are computer programs that are involved in creating a 3D model of a tooth or dental system. CAM is a software program that works on creating a physical object — a crown of the same tooth and restoration of the dental system.

According to CAD/CAM technology, prosthetics are performed in four stages.

• Scanning of the oral cavity to create a virtual 3D model. At this stage, the main component of the system is an intraoral scanner. It reads the geometry of the prosthetic section of the dentition and converts it into a digital model.

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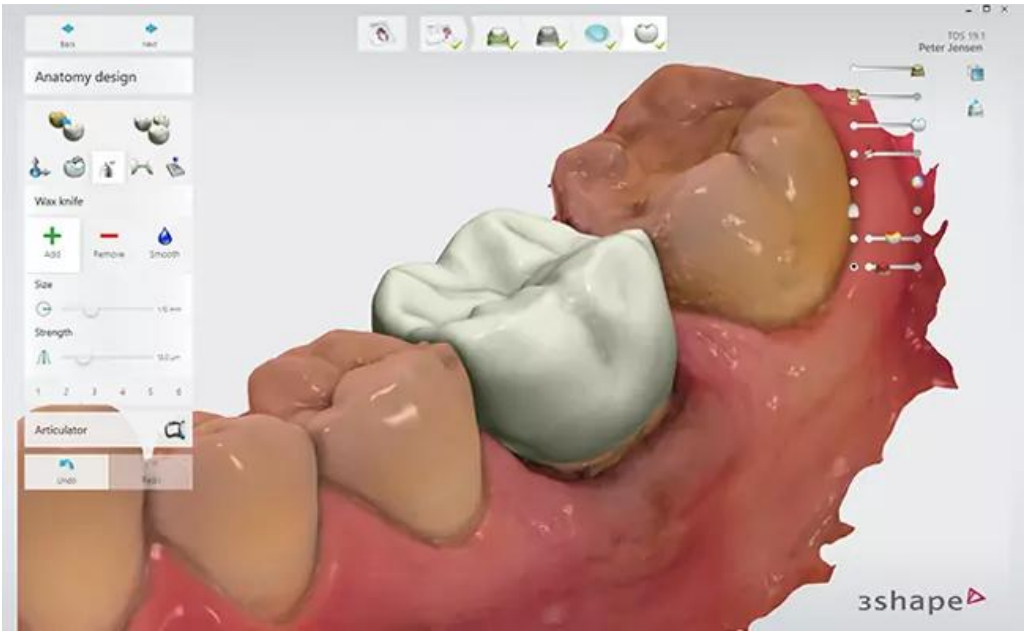
• Prosthetic modeling. At this stage, the dentist sees a 3D model of the prosthetic area on the monitor, selects restoration options and corrects their shape, curvature, wall thickness and appearance. The intermediate and final results can be compared and agreed with the patient.



• Milling. The 3D model is transferred to the CAM module of the milling machine, which grinds out the restoration, polishes and grinds it. The functionality of the machine depends to a certain extent on the number of axes. The more of them there are, the more complex restorations can be made. For example, the VHF N4+ four-axis milling machine processes the workpiece along the XYZ axes and simultaneously rotates it 360° along the A axis. In the VHF K5 model, a rotational B axis with a machining angle of ± 35° is also added to the XYZ and A axes.

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• The finished prosthesis can be tried on or immediately installed, for example, during simultaneous implantation.

CAD/CAM systems in dentistry are divided into closed and open. The closed ones interact with the scanner and the machine as part of a common software, use a single, encrypted file format, and work with specific types of materials. As an example, the Italian Zirkonzahn system.

Open CAD/CAM technologies integrate with different modules and components, work with files of several formats. Simply put, a doctor can scan the dentition with an intraoral scanner 3Shape TRIOS 3 Basic Pod, save the file in the format.STL, using the Model Builder module, create a laboratory crown model and send it to the VHF N4+ milling machine. Thus, for open systems, a dentist can choose a scanner from one manufacturer, and a milling machine from another — everything will work. Open CAD/CAM technologies include Exocad Dentalcad, InLab SW, Planmeca, Dental System, etc.

How to switch to CAD/CAM technologies and calculate the payback of the system

The simplest way to evaluate the payback of the system is to calculate the ROI, that is, the difference between income and investments. ROI (return on investment) is calculated using the formula:

(income — investment) / investment × 100%

Revenue is taken as revenue for the amount of restorations that you can do with CAD/CAM systems in the clinic. Let's say orthopaedists are currently sending X veneers and Y single crowns per month to milling centers and laboratories. With CAD/CAM, you can do this amount yourself. The proceeds from metal restorations, which can be milled on a machine, will also go to the income. The projected increase in the volume of restoration work can also be attributed to income. For example, when there is demand, but due to a lack of opportunities, patients were redirected to other clinics. In addition, with CAD/CAM, you can expand the range of restorations and this should also be taken into account in the projected income.

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Investments include the cost of the CAD/CAM system itself, additional training for doctors, materials (blocks and discs, milling cutters, ceramic masses), small consumables, scheduled maintenance.

To figure out the costs directly for CAD/CAM, evaluate the current and projected types of restorations. For veneers, bridges, onlays, inlays, crowns, abutments and most dental frameworks, the functionality of four-axis machines is sufficient. Five-axis ones are needed for complex beam structures on screw-mounted implants. If such restorations are rare in your clinic, you can use a four-axis milling cutter, and install complex prostheses in a dental laboratory as before.

As for the type of system, it's better to start with an open one. It allows gradually and without large-scale one-time investments to transfer orthopedics to CAD/CAM technology. For example, you can start with an intraoral scan, sending the models to the laboratory. Then buy a milling machine for the manufacture of metal-free structures, glass ceramics and composite prostheses. Further, as the customer base grows and demand for rare or expensive prostheses increases, we will launch a full-cycle system with the production of titanium and cobalt-chromium structures.

Scanner

The scanner is needed to create a virtual 3D model of the patient's teeth. There are both intraoral scanners that "digitize" the situation in the oral cavity directly, and conventional ones that scan pre-made plaster models of the patient's jaws.

Computer with software

The resulting three-dimensional model of the patient's teeth is processed in a computer program, where a virtual model of future restoration (inlays, crowns, or veneers) is created in automatic (or semi-automatic) mode for the destroyed tooth, which is necessary to repair

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the defect. The interface of the CAD/CAM program is similar to a three—dimensional editor. The doctor has the opportunity to create or change any element of the simulated restoration: the height of the bump, the severity of the relief, the curvature of the walls, etc. When the modeling is completed, the file with the restoration model is sent to the milling machine.

Milling machine

The restoration, which was modeled at the previous stage, is automatically turned out on a milling machine. Standard blanks are used as the material.

Currently, the technique of modeling and manufacturing precision parts for various purposes using CAD/CAM technologies has found wide application in dentistry all over the world.

The main advantage of the CAD-CAM system is the high quality of the manufactured prostheses with maximum accuracy. The prostheses obtained in this way have a deviation of 15-20 microns compared to 50-70 microns during casting.

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