by Gerald McLaughlin, D.D.S.*

The Reality of Dental CAD-CAM: Hype or Hope?

ABSTRACT

Dental CAD-CAM has become a clinical reality. It holds great promise to help provide a higher level of service to the patient, while allowing the dentist to spend more time on patient needs than on the mechanics of restoration production. Still, this technology is not suited for every dental office. This paper discusses the technique of CAD-CAM, its potential and its limitations so the dentist can better evaluate the appropriateness of this new modality for his or her own office.

KEY WORDS

CAD-CAM, computer, laser

INTRODUCTION

CAD-CAM is not a new concept. It stands for computer assisted design and computer assisted manufacture. It has so ingrained itself in the general workplace that whole industries are dependent upon it to help design things from automobiles to can openers.[1] It is widely recognized that CAD-CAM is the quickest method of going from the conception of a design to its actual manufacture.

Even though we are a service profession, most dentists spend the majority of their time literally manufacturing dental restorations. Any method which increases the speed and accuracy of this manufacturing would certainly advance dentistry by freeing up dentists to concentrate on the other requirements of their practices.

In 1971 Dr. Francois Duret first conceived of applying CAD-CAM to the art of dentistry.[2] Following Dr. Duret's lead, several other researchers joined his search for a method to put the power of the computer into a clinically beneficial role.[3-6] At this time there are several different approaches which are available to the dentist, each with its own limitations and strengths. In order to address the question of whether this new modality provides new hope or merely marketing hype, we must first examine just exactly what CAD-CAM

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Figure 1: The Sopha Bioconcept CAD/CAM unit is modular in design, with three stations corresponding to the optical impression of the prepared tooth, a CAD(design) station, and a micro-milling machine.

is and what it can do for the dentist. While there are several brands of dental CAD-CAM on the market, this article will use the Sopha Bioconcept CAD-CAM for illustration.[7] This article will also use the example of manufacturing a crown, although many of the principles demonstrated here could apply to other restorations as well as to other units.

DENTAL CAD-CAM TECHNIQUE

The use of the CAD-CAM to produce dental restorations in the broadest of terms mimics the method used by conventional methods. In both cases the technique uses three basic steps. These are impression, design, and fabrication. The Sopha Bioconcept CAD-CAM is divided into three distinct stations, each one corresponding to the basic steps in producing the restoration. (Figure 1).

The first step in both traditional and CAD-CAM technique is to acquire a representation of the prepared tooth. In traditional dentistry, this is done by taking an impression and pouring a model. At the present time, the same is still done using the Sopha Bioconcept CAD-CAM, although the need for the traditional impression will soon be eliminated when the optical probe is used directly in the mouth.

Once the model is poured up, the differences between the traditional method and CAD-CAM become enormous. The conventional steps of preparing a wax-up of a coping, sprueing, investing, casting, devesting, and porcelain buildup through multiple bakes are well known. In the case of CAD-CAM, the steps are much different.

The impression then is entered into the computer by an assistant or technician. This is done by taking a series of photographs of the model using a special laser camera. One picture is also taken of the impression of the bite. A special motorized platform has been devised to simplify and accelerate the process. (Figure 2) Once the pictures have been taken, they are displayed on

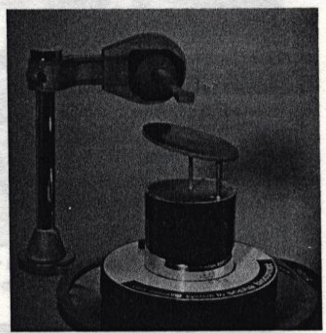

Figure 2: The model of the prepared tooth is placed on this motorized platform underneath the laser camera while several pictures are taken.

a computer screen. (Figure 3) The technician then points out the important landmarks to the computer using a mouse. (Figure 4)

The computer correlates all of the photographs to create a single three-dimensional computer model of the preparation which is then transferred to a second computer. It is at the second computer that the actual design takes place.

The basic approach of the computer for crown design is to first define the limits of the intended crown. Where, for instance will the contact points be? What is the greatest diameter mesiodistally, bucco-lingually, and occlusally. Then it goes into its memory banks and chooses a "theoretical crown" which matches the tooth number of the intended crown. This theoretical crown does not really fit any particular case, but it has all the distinguishing characteristics of the intended crown. (Figure 5) Once selected, the computer then adjusts the dimensions of the theoretical crown to exactly fit in the space provided for it. (Figure 6)

While much of this is automatic, the operator guides the computer by inputting such information as the desired relief for cement space. The degree of control is quite impressive. For instance the operator can instruct the computer to create anywhere from 0 to 800 microns clearance for the cement. In addition, the operator can specify the distance from the margin at which the cement space should begin.

The operator can also indicate his or her own preferred approach to occlusal theory. For instance, is the operator basically a functionalist at heart, or more of a gnathologist? Either approach is already built into the software, but the operator can modify the results to become even more personalized.

Once the crown is designed, the computer makes a last check to be certain that there are no high spots, and to be sure that there is no place where the crown might be too thin.

When the operator is satisfied, the computer sends the completed design to a milling machine which carves the crown out of a solid block of advanced ceramics, although other materials may be used.

The whole process can be handled by an assistant, rather than the dentist, and the completed crown can be ready to seat even before the Novocain wears off.

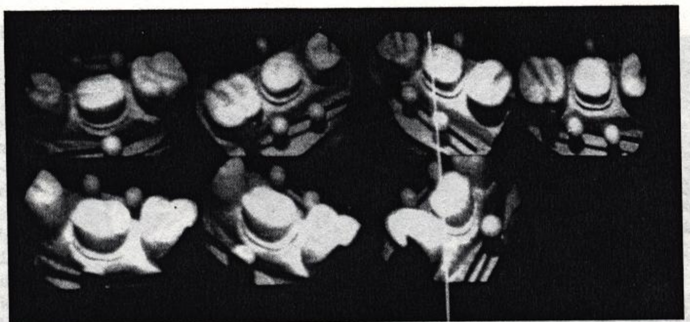

Figure 3: The laser photographs are displayed on a video screen.

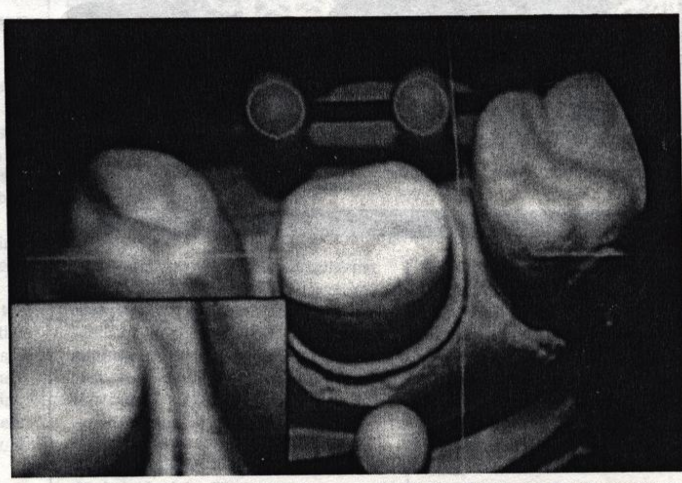

Figure 4: Landmarks are entered into the computer by use of a mouse. In this case the margin is being entered, and the operator has asked for a close-up view (on the bottom left of the screen) to increase the accuracy.

CLINICAL AND FINANCIAL CONCERNS

Naturally, our first concern as dentists is the welfare of our patients. It is for this reason that the Sopha Biocon-cept unit has been tested for accuracy at the University of Southern California School of Dentistry for the last three years. The accuracy has rapidly improved until at present the machine can deliver a consistent crown with less than 50 microns defect at the margin. This compares favorably with the traditional method of production, where acceptable accuracy is between 50 and 100 microns.[8,9]

Another obvious consideration is the financial impact. As would be expected, a CAD-CAM unit with two high-powered computers, a laser scanner, motorized turntable, and super-accurate milling machine is not inexpensive. Such an investment must be used to be worthwhile, but simply counting how many restorations made each day is not enough to evaluate the feasibility for any given dental office. Each office must take into consideration several factors when determining the advisability of owning such an impressive system.

Certainly the average number of crowns produced each day is the most obvious consideration. It is probable that when patients become aware that crowns can be made in this office in a single visit, the number of new cases will grow, but the dentist must still be realistic in his expectations.

Another major factor is to determine exactly how much time and resources are presently being taken up by the temporary crown? In some parts of the country, for instance, the temporization is a delegated task. In other locations, it is the dentist himself who spends the time making the temporary, cementing it, removing it and cleaning the cement remnants from the tooth. Obviously, if these are tasks which the dentist is presently performing, the value of avoiding the temporary is even greater than if the job is done by the assistant.

Another variable involves the use of anesthesia during the cementation visit. In some offices time is spent gaining anesthesia for removing the temporary and cementing the permanent crown. This time would be saved if the crown were seated on the first visit.

The dentist must ask, in his or her own situation, whether the acquisition of a CAD-CAM machine will require new staff or if existing staff can be utilized. Certainly the training required is minimal, but the doctor must be able to spare someone for the half hour or so required for each crown. If not, this expense must be considered in the final equation.

The dentist must also think about the fee schedule. Obviously a single-visit crown can easily command a premium fee over a traditional two-visit crown. The advantages to the patient are great. In fact, for many patients, the cost of coming for a second visit exceeds the total cost of the crown! Still, fees are a personal decision to be made by each dentist.

The dentist must also compare the fee presently being paid by the office to a dental lab and the cost of the materials necessary for producing the crowns in-house.

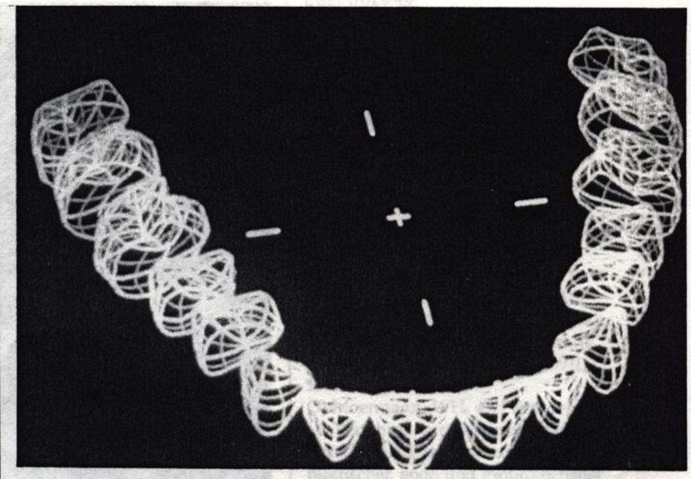

Figure 5: In the computer's memory are thirty-two ideal teeth. It is from this library that the actual crown design will begin.

CONCLUSION

With all these factors to consider, it is impossible to make a sweeping statement of exactly where the break-even point would be. As a point of reference, however, I have calculated that it is probably somewhere between one and two crowns per day. I have based that number on the following assumptions:

1) The office has only one dentist and that dentist treats patients only 20 days per month
2) The present laboratory bill is $90 per unit
3) The dentist will hire a full-time technician who will not do anything productive when not operating the CAD-CAM
4) The dentist will only charge a premium of 10% per crown for the single-visit service

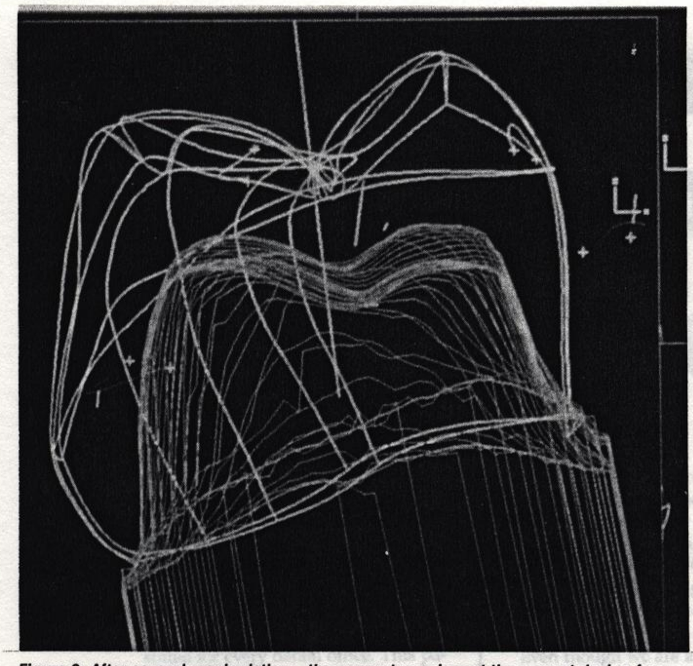

Figure 6: After several manipulations, the computer arrives at the correct design for each individual crown taking into account the exact parameters for that tooth.

5) The dentist presently makes his own temporaries, but the assistant cements them on.
6) The dentist has leased the equipment for five years with no money down.

Using these assumptions, the dentist who uses CAD-CAM for an average of 3 crowns per day will have a net gain of $5,530 per month, while an average of five crowns per day results in a gain of $13,771 per month.

Conversely, of course, if the equipment is never used at all, the dentist could lose up to $6,840 per month, so like any big purchase, it must be considered carefully. Obviously such a purchase is not for everyone.

That having been said, it is easy to imagine the effect on a practice when crowns, inlays, onlays, and other such restorations are completed in a single visit. It is also easy to imagine the effect that the presence of such sophisticated technology will have on the patient's perception of the office itself. For those whose practices are appropriate, it will certainly become a powerful tool to allow the dentist to produce dentistry in shorter time. This will allow the dentist to concentrate on those skills which no computer and laser instrument can ever duplicate — patient caring and concern. ■

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