

# DENTISTRY TODAY

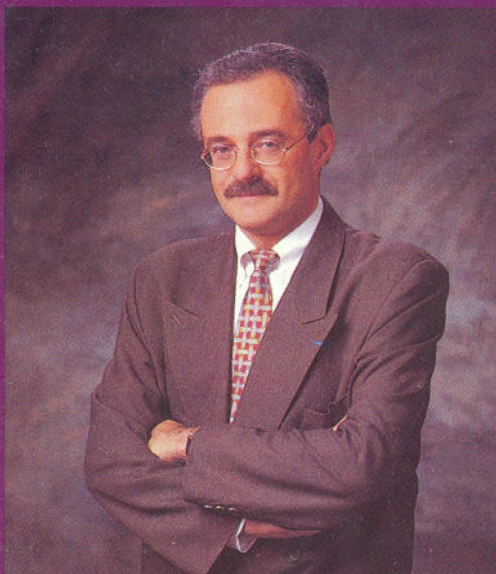
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AUGUST 1990

## INSIDE

**Exclusive Interview:**  
**CAD/CAM Pioneer**  
**Dr. François Duret**



# OSHA:

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# CAD/CAM and Beyond:

## An Interview with Dr. François Duret

By Dr. George Freedman

**W**hen can we expect to see the Duret system of CAD/CAM in the United States and what is the name going to be for the American market?

The system will arrive on the market this year. Although I almost hesitate to say, it will be called the Duret System CAD/CAM.

**How long does it take to make a crown with the Duret system?**

Approximately one hour, from the time that you take the impression with the CCD, that is the "video impression," to the time that you are ready to cement the crown onto the tooth. We are also working on a method for fabricating partial dentures with the CAD/CAM along the same principles and lines of thought we have used for crown fabrication.

**If you were a dentist, and didn't know anything about the CAD/CAM, what would you like to know?**

My first question would be: What does your machine do, what is its function? I would have to compare it to other systems on the market. The Duret system is a true design system where the computer helps to design by means of a number of tools. The computer creates both the internal surface, or the inlay surface, and the occlusal surface in the fashion similar to the way the laboratory would create an occlusal surface for a restoration.

My second question would be: What materials can your system work with? Our system can work with titanium, with Dicor, with resin materials along with any material available in dentistry. The Duret system can do inlays, onlays, full crowns, and three unit bridges and all are complete with the occlusal surface in an anatomic relationship with the opposing arch.

**Which part of the dental profession will be most likely to want to begin using the CAD/CAM at this time?**

Certainly group practices, specialists such as prosthodontists, and general dentists who do a large amount of restorative crown and bridge type dentistry in their practices. Much of the

information about CAD/CAM systems is conjectural and much of it is inaccurate. I have tried to present the CAD/CAM system to you as it is with all its advantages and its problems. The CAD/CAM system is functional, and today we are at the point where it can be utilized in dentistry. This technology was held back by the mechanical problems that were encountered, but the problems and the criticisms helped us to create a better and more complete unit.

We are perhaps asking too much when we ask dentists, especially those with less experience in occlusion and restoration, to compare CAD/CAM systems and to evaluate them. You really need quite a bit of background in occlusal theory, dental technology, and computers in order to evaluate the systems fairly. However, you do not necessarily need all these skills simply to use the system. The use of the system is not predicated upon understanding all the technology that goes into it. For example, it is not necessary to understand computer design and physics theory in order to use a word processor. It is also unfair to expect somebody to understand the thoughts behind a CAD/CAM system from a number of questions that are answered over the phone. And it is really only with practice and with actual utilization of the system that one can truly understand it and become familiar with it.

**What kind of precision can be expected from the CAD/CAMs on the market today or those that will be out in the near future?**

We have to differentiate between the systems that are out on the market today, and the systems that are not. For those that are, we can establish the precision (or estimated precision). The ones that are not on the market we cannot, of course, evaluate at all. What we would call precision is really a scientific study that is repeated over and over by observers who are not biased. I came to the University of Southern California with the advantages that it offered, and of course, the exigencies that it required of me with, literally, a machine in my hands. It had to work well

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### CAD/CAM AND BEYOND

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best crown and bridge tolerances that have been established in the course of dentistry over the last few years.

For example, Dr. Jack Preston required that we test 50 models for crowns to see the relative precision of the instrument. These are the measures

of precision that we have to consider. We have always stated the precision as closely and accurately as we could determine it. At the ADA in Washington, we stated that it was approximately 200 microns. Today, I can say with great confidence that we are at approximately 100 microns, and within three months we shall be

within 50 to 80 microns of accuracy. Science unfortunately goes slowly at times, and we cannot really rush it. It has to go at its own pace.

**Is there any way for the average dentist who doesn't have the means at his disposal to examine or to test these tolerances to be able to**

**fairly evaluate the relative accuracy of the various systems available on the market?**

Yes. This is an important question and it can be answered to everybody's satisfaction. We take cylinders in the usual way for studies of this nature, and we prepare them to a certain shape and a normal way for crown preparation. Then the CAD portion of obtaining the image is accomplished. Subsequently the CAM portion, or making the restoration, is done and thereupon the restoration is fitted on to the cylinder again. The restoration is replaced on the original preparation, and thereby the precision of the system and its accuracy can be verified and measured. The ultimate test of precision will be by the dentist in his own office who will verify how closely the restoration fits his own preparations.

Another way of considering it is to look at what the scientific literature says about precision and accuracy and how to evaluate it. Over the past five or six years I've been reading a lot of articles on what's happening with CAD/CAM and who's doing what. The articles are very interesting, even if some of them seem to lack certain information. Today the dentist really needs somebody other than the inventors and the developers of these systems to comment upon the utilization and the efficacy of these machines. And these people should not be chosen by those of us who are near the development of this new technology. I would suggest at this time the formation of an international commission composed of people, such as Miller, Ron Goldstein, Gerald Mc Laughlin, Peter Sherer, just to name several. I would also suggest Jack Preston from USC and Gordon Christensen. These people are all very competent and very able to understand the ideas and the needs that are involved in a CAD/CAM unit.

This group could possibly observe the fabrication of restorations with the various systems in a laboratory, or preferably, in a dental office from beginning to end so that no question can arise scientifically as to the accuracy and the nature of the system. Thus, it can be established how precise and accurate the systems are and whether the systems live up to their claims of accuracy that they publish and advertise.



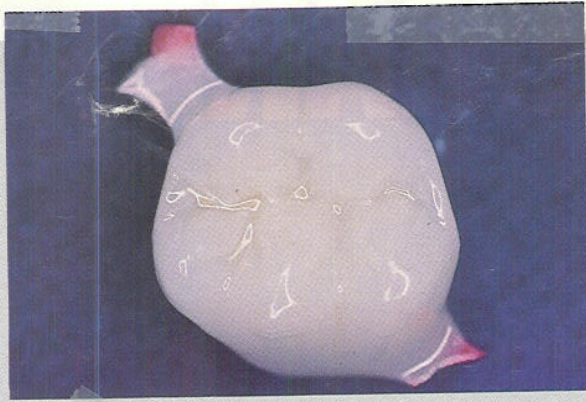


Fig. 1 CAD/CAM-produced crown (occlusal surface).

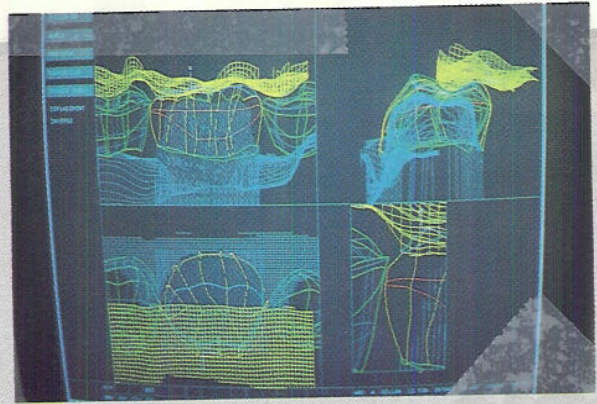


Fig. 2 Laser imaging is the first step in fabricating a crown using CAD/CAM.

Then, by evaluating the entire procedure and the fit and so on, they could provide an overall clinical evaluation of the value of such a system to the dentist. Certain general dentists who are familiar with the business and other aspects of the dental office could also form part of this group in order to evaluate the monetary impact of such a system in the dental office.

**What would you say is the most difficult part of a restoration to recreate?**

There is no question that the most difficult part of the restoration to recreate well is the occlusal surface. This is the surface that has to interact with the opposing dentition, and it must be in harmony and in balance, and must be functional in terms of biting. Furthermore, we have developed an electronic articulator which allows the operator to register the occlusal movements of the jaws and will permit the dentist to recreate the necessary surfaces and planes in the occlusal shape of the tooth. All the possible movements and excursions are integrated in the occlusal finished surface in the Duret crown or onlay. In effect, you can integrate the dynamic occlusal movements in the jaws onto the ideally designed occlusal surface of the restoration.

**What are the restorative materials that can be used with the Duret CAD/CAM system applicable to dental restorations?**

First of all, you can utilize some of the traditional materials such as titanium, Dicor and, of course, all types of resins in this type of restoration. Of the new materials, a very important one is Aristé, and this is important in that it is the first architecturally designed material in the dental profession. Aristé, which is manufactured by Spad, opens up a new classification in the dental lexicon. Today, we are learning about and teaching materials in dentistry in terms of their composition. Tomorrow we will have to discuss them in terms of composition and structure. You will have to discuss materials that are homogeneous and isotropic and other materials that are heterogeneous and non-isotropic. Aristé is the first material that falls into the heterogeneous and non-isotropic class. This is a new concept in the field of dental materials. If you are casting a material, you are destroying the structural orientation of the material. If you are using a CAD/CAM system and you are cutting into an already prepared block, you can respect the structural integrity of the material.

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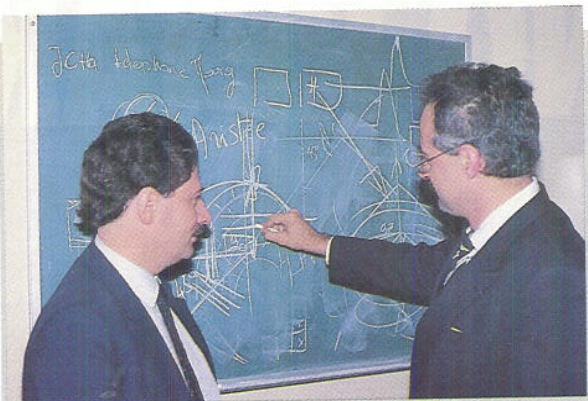


Fig. 3 Dr. François Duret with Dr. George Freedman.

**CAD/CAM AND BEYON**

**How can the dentist impart coloration to the restoration? Is it going to be like Dicor, where all the coloration is on the external surface or will it be a solid coloration?**

This is a subject where you may want to consult Dr. Jerry McLaughlin of Rocky Point, New York. One of the areas where we have been working together has been the mass coloration technique whereby, through the use of laser technology, we can impart a color into the restoration. Exposing the tooth to particular rays would begin a reaction which would create a color change in the place where the ray is focused. This could be a very interesting process. The main questions are where to color and how much to color.

**Will this be a bidirectional or a unidirectional system?**

Don't forget that the computer knows exactly where the color should arrive. It can calculate the exact ray that is going to expose the restorative material to the exact point that is required for the exact color. The technique will allow you to color to a depth of one millimeter within the restorative material. This gives a very natural color that comes from underneath, rather than just on the surface. I have developed a spectral colorimeter which can measure the degree and type of coloration within a tooth to a very precise point. Thus we have a complete system including the CAD/CAM, the spectral colorimeter, and the material itself that is sensitive to the coloration process. This can be called a complete or global system.



**When we are talking about the CAD/CAM, are we talking about a completely automated system?**

We are talking about a system that is mostly automated, but you cannot really speak of complete automation when we are dealing with a clinical crown. This would relegate the profession to the position of a robot that acts without thinking. If you read my articles around 1985, you will find that I sincerely believed that man can be replaced by the automatic or automated CAD/CAM system. Today, I am 100 percent convinced of the exact opposite. In developing the CAD/CAM, we have automated many of the functions that do not require thinking. For example, you almost never have to use the keyboard. The menu gives you five options, among which are the completely automated choices. These can give you a completed crown without any intervention. More often you would utilize the menu that's entitled corrections, where you make minor changes to the restoration to make it just so, just a little bit better, in terms of

**machine?**

No, absolutely not. You may see for example that for the past 100 or 200 years we have had refinements continuously on articulators in order to reproduce the motions of the job. But each time we have another new articulator and still another new articulator, and each

articulator is better than the one before except that some of them are completely useless from a practical point of view.

**Do you think the CAD/CAM will replace the dental laboratory, or the dental technician?**

No, of course not, but it may change the role that they play to a certain extent. In most cases, the dentist will take the CCD or image impression, and the CAM or the manufacturing process will be done entirely by the laboratory as it is done today, but the laboratory will service a number of dentists with a single CAM unit and then will ship the restorations directly to the dentist for cementation. If the laboratory is close to the dentist and can courier the restoration over to him, it's conceivable that, within an hour after the image was taken and transmitted, the dentist can see the restoration in his patient's mouth. This, of course, eliminates the need for temporary restoration, among other things. This system will be a boon, not a problem, for laboratories. I consider this to be the way of the future. Of course, there will be many changes. There will be many developments and improvements. But I am convinced that this is a step in the right direction. And a good one at that.

**What do you feel is the potential of CAD/CAM systems in the United States?**

The North American potential of the CAD/CAM is enormous. When you look at a structure, first of all, you have to remember that North American technology is very advanced. Eighty percent of the CAD/CAM is American in origin, although the actual integration of the unit occurred mostly in France. The potential among dentists in North America is very great because one has to remember that North American dentists are much more informed and comfortable with computers than dentists anywhere else in the world. American dentists are familiar with imaging and electronic tools in general.

These are very important considerations when one looks at the development and the early utilization of systems such as the CAD/CAM. Many American dentists also work in groups, and this is unlike dentistry elsewhere in the world. The cost of a CAD/CAM can and must be amortized over the number of units that it can fabricate. Therefore, if you can share the cost and amortize it over three dentists all fabricating restorations with a single CAD/CAM the cost becomes much lower, much more affordable.

**Do you foresee a single CAD/CAM unit in a city, or do you foresee 25-50 percent of the dentists in any area pos-**

**sessing CAD/CAMs and working with them at some point in the near future?**

There are two ways to look at the integration of CAD/CAMs into the dental practice. I wrote an article in 1983 about two possible modes of utilization. One was the integration of the CAD/CAM into an individualized or single dental practice of one or more practitioners. The other was the development of the CAD/CAM within a single centralized location such as a university, which would allow dentists to pick up the images in their offices without having the design unit, the unit that actually prepares the restoration, in their office. This electronic can be transmitted by phone lines by modem to the central location. But I don't think that the second or centralized concept will prevail. Too many users might create a problem. To go back, I don't really see the practicality of this or the affordability in having the CAD/CAM in a single dentist office. But when you have three or more dentists utilizing it, then the cost becomes immediately justifiable. In short, I really can foresee the entire system within a single office as the general rule.

**What should a general dentist know about CAD/CAM today?**

When I was teaching CAD/CAM in France we gave the necessary scientific background, but what interested the average dentist the most was the clinical and the practical aspects of the procedure. The dentist has to know how the apparatus works: what makes the camera work, what makes the computer image capturing part work, how the lathe con-

course, we have to know the chemistry of the restorative materials and the biochemistry of their attachment. There had to be some "computer literacy" in order to use the machinery involved with the CAD/CAM. There will have to be some sort of instruction in the use of the CAD/CAM. There are numerous buttons to push and you have to know which are appropriate. Like the electron microscope or the computer, this is easily learned, but you have to go through a stage of learning which options you need to utilize to maximize the benefit of the CAD/CAM. What I would suggest is to spend approximately a week learning the apparatus while being assisted by someone experienced in the use of the CAD/CAM and taking notes.

**Will the company marketing the CAD/CAM set up courses for this purpose?**

Even though these courses might be set up by the company, I have to insist that they be presided over by professionals, dentists, and computer professionals familiar with the use of the system. Furthermore this instruction should take place in a university setting. We want to keep this type of instruction within the profession and not in the industrial sector.

**How have you felt about the research time that you've put into CAD/CAM?**

Researchers always have their doubts, and I've certainly had my share. It's particularly difficult when one has to make a choice between spending a Sunday with one's family and working on some material, making sure that one has understood what someone else has written or said. But when one can see and cooperate with other professionals in making a system of this nature, the rewards are very satisfying.

**What do you see in the future of dentistry?**

I think the future of dentistry will see a decrease in the biological sciences and an increase in the physics and the mathematics that are applied to our field. I began my study of dentistry in physiology and then went on to biological, physical chemistry and in the process became a biochemist. In other words, in order to explain the physical properties of biology, we had to become biochemists. Then when I began my masters

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fit and shape.

But this represents to me the antithesis of the clinical function of the dentist. The questions that remain are: Have we chosen a good occlusal theory? Have we positioned the cusps right? Have we positioned the contacts correctly?

The manual intervention into the design process adds only five minutes to the entire procedure. It is certain that the patient will want a dentist to put this extra five minutes in, in order to make a great difference in a restoration that may last a lifetime. In short, we would like to automate or computerize many of the repetitive functions

in dentistry, but we do not want to transform the dentist into a "button pusher," somebody who does not or cannot think, cannot analyze, cannot function as a professional, making decisions for the benefit of his patients.

**So in other words, the dentist cannot be replaced by a**



still at least 70 percent dependent on having good manual dexterity.

Normally the fundamental sciences are there to service the basis of the clinical sciences. In dentistry, however, quite the reverse may be true. For example, all the clinical sciences and all the microbiology will not

help one to perform one root canal treatment, whereas a clinical presentation based on how to use the endodontic instruments will be invaluable. All in all, there has to be more clinical experience taught to dentists, more physics, more mathematics, less biology, less microbiology. I remember

teaching my students the theories of Watson and Crick and so on, but in truth, they would be much better off if I had taught them how to use and how to maintain their turbines!■

program in biochemistry, all the physical attributes were explained in terms of biochemistry. I had to become a chemist to explain the phenomena of biology. (Incidentally, my masters thesis was on the electrophoresis of saliva.) Then, in a manner of speaking, I had gone from studying the infinitely large to studying the infinitely small. Most biochemists in fact, work on a level of molecular physics in order to advance the field.

I believe that a similar pattern is occurring within dentistry from a study of microbiology and biochemistry. I was a professor of biochemistry on the dental faculty. I used to teach the Krebs cycle, glycolysis and so on, but in time this course began to focus more on molecular chemistry. The clinical aspect of dentistry is going to become more clinical but influenced by the study of physics, for example, radiovisiography and the CAD/CAM system. We can now design aesthetics on a screen with imaging systems. This allows us much greater latitude clinically than we ever had before. Dental research, as well, is going to orient itself in the direction of physics and mathematical analyses. The research today is, to a great

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## CAD/CAM AND B

extent, in the physical or physics area and not so much in the area of microbiology. The cutting edge of the profession is studying the physics of the dental, oral, and material interactions and conditions. This may also alter the choice of

## BEYOND *cont'd from pg. 38*

people who will be accepted into dentistry. The people will be more prepared with a physics background than with a chemistry background. But in all this, let us not forget that being good with one's hands is extremely important. Our work is



*Dr. George Freedman, who translated this interview with Dr. Duret from the French, is president-elect of the American Academy of Cosmetic Dentistry. A regular contributor to Dentistry Today, Dr. Freedman lectures frequently on cosmetic dentistry and dental technology. He may be reached at (514) 739-1411.*



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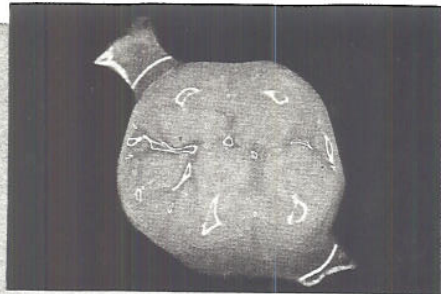


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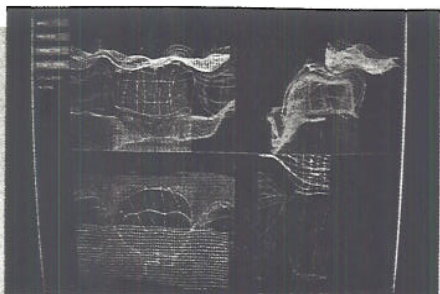


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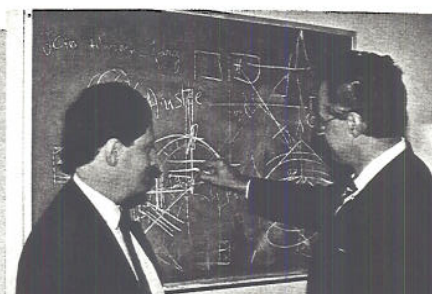


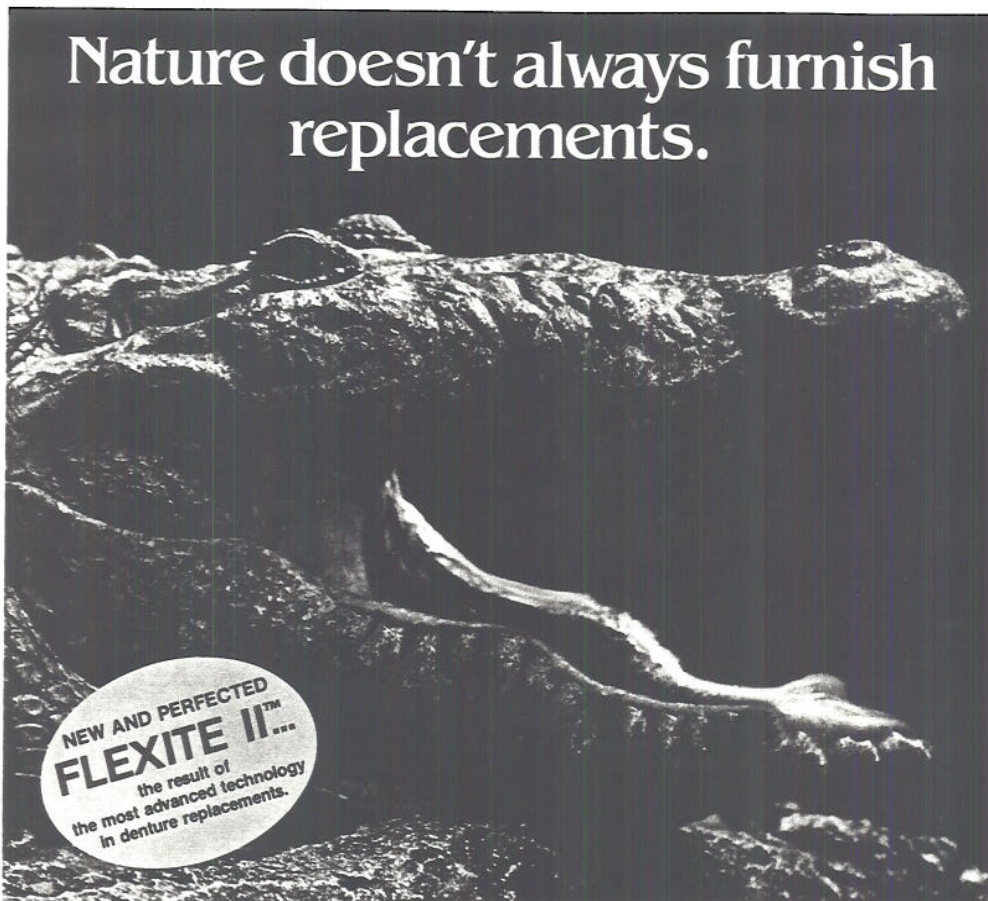
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There is no question that the most difficult part of the restoration to recreate well is the occlusal surface. This is the surface that has to interact with the opposing dentition, and it must be in harmony and in balance, and must be functional in terms of biting. Furthermore, we have developed an electronic articulator which allows the operator to register the occlusal movements of the jaws and will permit the dentist to recreate the necessary surfaces and planes in the occlusal shape of the tooth. All the possible movements and excursions are integrated in the occlusal finished surface in the Duret crown or onlay. In effect, you can integrate the dynamic occlusal movements in the jaws onto the ideally designed occlusal surface of the restoration.

**What are the restorative materials that can be used with the Duret CAD/CAM system applicable to dental restorations?**

First of all, you can utilize some of the traditional materials such as titanium, Dacor and, of course, all types of resins in this type of restoration. Of the new materials, a very important one is Aristé, and this is important in that it is the first architecturally designed material in the dental profession. Aristé, which is manufactured by Spad, opens up a new classification in the dental lexicon. Today, we are learning about and teaching materials in dentistry in terms of their composition. Tomorrow we will have to discuss them in terms of composition and structure. You will have to discuss materials that are homogeneous and isotropic and other materials that are heterogeneous and non-isotropic. Aristé is the first material that falls into the heterogeneous and non-isotropic class. This is a new concept in the field of dental materials. If you are casting a material, you are destroying the structural orientation of the material. If you are using a CAD/CAM system and you are cutting into an already prepared block, you can respect the structural integrity of the material.



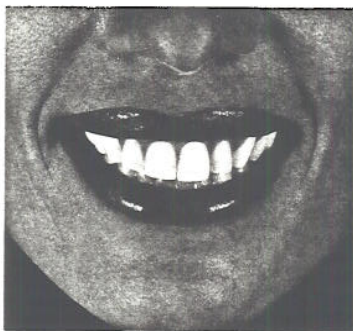
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## CAD/CAM AND BEYOND cont'd from pg. 33

**How can the dentist impart coloration to the restoration? Is it going to be like Dicor, where all the coloration is on the external surface or will it be a solid coloration?**

This is a subject where you may want to consult Dr. Jerry McLaughlin of Rocky Point, New York. One of the areas where we have been working together has been the mass coloration technique whereby, through the use of laser technology, we can impart a color into the restoration. Exposing the tooth to particular rays would begin a reaction which would create a color change in the place where the ray is focused. This could be a very interesting process. The main questions are where to color and how much to color.

**Will this be a bidirectional or a unidirectional system?**

Don't forget that the computer knows exactly where the color should arrive. It can calculate the exact ray that is going to expose the restorative material to the exact point that is required for the exact color. The technique will allow you to color to a depth of one millimeter within the restorative material. This gives a very natural color that comes from underneath, rather than just on the surface. I have developed a spectral colorimeter which can measure the degree and type of coloration within a tooth to a very precise point. Thus we have a complete system including the CAD/CAM, the spectral colorimeter, and the material itself that is sensitive to the coloration process. This can be called a complete or global system.

**When we are talking about the CAD/CAM, are we talking about a completely automated system?**

We are talking about a system that is mostly automated, but you cannot really speak of complete automation when we are dealing with a clinical crown. This would relegate the profession to the position of a robot that acts without thinking. If you read my articles around 1985, you will find that I sincerely believed that man can be replaced by the automatic or automated CAD/CAM system. Today, I am 100 percent convinced of the exact opposite. In developing the CAD/CAM, we have automated many of the functions that do not require thinking. For example, you almost never have to use the keyboard. The menu gives you five options, among which are the completely automated choices. These can give you a completed crown without any intervention. More often you would utilize the menu that's entitled corrections, where you make minor changes to the restoration to make it just so, just a little bit better, in terms of

fit and shape.

But this represents to me the antithesis of the clinical function of the dentist. The questions that remain are: Have we chosen a good occlusal theory? Have we positioned the cusps right? Have we positioned the contacts correctly?

The manual intervention into the design process adds only five minutes to the entire procedure. It is certain that the patient will want a dentist to put this extra five minutes in, in order to make a great difference in a restoration that may last a lifetime. In short, we would like to automate or computerize many of the repetitive functions

in dentistry, but we do not want to transform the dentist into a "button pusher," somebody who does not or cannot think, cannot analyze, cannot function as a professional, making decisions for the benefit of his patients.

**So in other words, the dentist cannot be replaced by a**

**machine?**

No, absolutely not. You may see for example that for the past 100 or 200 years we have had refinements continuously on articulators in order to reproduce the motions of the job. But each time we have another new articulator and still another new articulator, and each

*cont'd on pg. 38*

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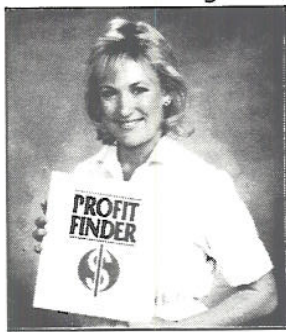
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## CAD/CAM AND BEYOND cont'd from pg. 37

articulator is better than the one before except that some of them are completely useless from a practical point of view.

**Do you think the CAD/CAM will replace the dental laboratory, or the dental technician?**

No, of course not, but it may change the role that they play to a certain extent. In most cases, the dentist will take the CCD or image impression, and the CAM or the manufacturing process will be done entirely by the laboratory as it is done today, but the laboratory will service a number of dentists with a single CAM unit and then will ship the restorations directly to the dentist for cementation. If the laboratory is close to the dentist and can courier the restoration over to him, it's conceivable that, within an hour after the image was taken and transmitted, the dentist can see the restoration in his patient's mouth. This, of course, eliminates the need for temporary restoration, among other things. This system will be a boon, not a problem, for laboratories. I consider this to be the way of the future. Of course, there will be many changes. There will be many developments and improvements. But I am convinced that this is a step in the right direction. And a good one at that.

**What do you feel is the potential of CAD/CAM systems in the United States?**

The North American potential of the CAD/CAM is enormous. When you look at a structure, first of all, you have to remember that North American technology is very advanced. Eighty percent of the CAD/CAM is American in origin, although the actual integration of the unit occurred mostly in France. The potential among dentists in North America is very great because one has to remember that North American dentists are much more informed and comfortable with computers than dentists anywhere else in the world. American dentists are familiar with imaging and electronic tools in general. These are very important considerations when one looks at the development and the early utilization of systems such as the CAD/CAM. Many American dentists also work in groups, and this is unlike dentistry elsewhere in the world. The cost of a CAD/CAM can and must be amortized over the number of units that it can fabricate. Therefore, if you can share the cost and amortize it over three dentists all fabricating restorations with a single CAD/CAM the cost becomes much lower, much more affordable.

**Do you foresee a single CAD/CAM unit in a city, or do you foresee 25-50 percent of the dentists in any area pos-**

**sessing CAD/CAMs and working with them at some point in the near future?**

There are two ways to look at the integration of CAD/CAMs into the dental practice. I wrote an article in 1983 about two possible modes of utilization. One was the integration of the CAD/CAM into an individualized or single dental practice of one or more practitioners. The other was the development of the CAD/CAM within a single centralized location such as a university, which would allow dentists to pick up the images in their offices without having the design unit, the unit that actually prepares the restoration, in their office. This electronic can be transmitted by phone lines by modem to the central location. But I don't think that the second or centralized concept will prevail. Too many users might create a problem. To go back, I don't really see the practicality of this or the affordability in having the CAD/CAM in a single dentist office. But when you have three or more dentists utilizing it, then the cost becomes immediately justifiable. In short, I really can foresee the entire system within a single office as the general rule.

**What should a general dentist know about CAD/CAM today?**

When I was teaching CAD/CAM in France we gave the necessary scientific background, but what interested the average dentist the most was the clinical and the practical aspects of the procedure. The dentist has to know how the apparatus works: what makes the camera work, what makes the computer image capturing part work, how the lathe constructs the restoration, and, of course, we have to know the chemistry of the restorative materials and the biochemistry of their attachment. There had to be some "computer literacy" in order to use the machinery involved with the CAD/CAM. There will have to be some sort of instruction in the use of the CAD/CAM. There are numerous buttons to push and you have to know which are appropriate. Like the electron microscope or the computer, this is easily learned, but you have to go through a stage of learning which options you need to utilize to maximize the benefit of the CAD/CAM. What I would suggest is to spend approximately a week learning the apparatus while being assisted by someone experienced in the use of the CAD/CAM and taking notes.

**Will the company marketing the CAD/CAM set up courses for this purpose?**

Even though these courses might be set up by the company, I have to insist that they

be presided over by professionals, dentists, and computer professionals familiar with the use of the system. Furthermore this instruction should take place in a university setting. We want to keep this type of instruction within the profession and not in the industrial sector.

**How have you felt about the research time that you've put into CAD/CAM?**

Researchers always have their doubts, and I've certainly had my share. It's particularly difficult when one has to make a choice between spending a Sunday with one's family and working on some material, making sure that one has understood what someone else has written or said. But when one can see and cooperate with other professionals in making a system of this nature, the rewards are very satisfying.

**What do you see in the future of dentistry?**

I think the future of dentistry will see a decrease in the biological sciences and an increase in the physics and the mathematics that are applied to our field. I began my study of dentistry in physiology and then went on to biological, physical chemistry and in the process became a biochemist. In other words, in order to explain the physical properties of biology, we had to become biochemists. Then when I began my masters program in biochemistry, all the physical attributes were explained in terms of biochemistry. I had to become a chemist to explain the phenomena of biology. (Incidentally, my masters thesis was on the electrophoresis of saliva.) Then, in a manner of speaking, I had gone from studying the infinitely large to studying the infinitely small. Most biochemists in fact, work on a level of molecular physics in order to advance the field.

I believe that a similar pattern is occurring within dentistry from a study of microbiology and biochemistry. I was a professor of biochemistry on the dental faculty. I used to teach the Krebs cycle, glycolysis and so on, but in time this course began to focus more on molecular chemistry. The clinical aspect of dentistry is going to become more clinical but influenced by the study of physics, for example, radiovisiography and the CAD/CAM system. We can now design aesthetics on a screen with imaging systems. This allows us much greater latitude clinically than we ever had before. Dental research, as well, is going to orient itself in the direction of physics and mathematical analyses. The research today is, to a great

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## CAD/CAM AND BEYOND cont'd from pg. 38

extent, in the physical or physics area and not so much in the area of microbiology. The cutting edge of the profession is studying the physics of the dental, oral, and material interactions and conditions. This may also alter the choice of

people who will be accepted into dentistry. The people will be more prepared with a physics background than with a chemistry background. But in all this, let us not forget that being good with one's hands is extremely important. Our work is

still at least 70 percent dependent on having good manual dexterity.

Normally the fundamental sciences are there to service the basis of the clinical sciences. In dentistry, however, quite the reverse may be true. For example, all the clinical sciences and all the microbiology will not

help one to perform one root canal treatment, whereas a clinical presentation based on how to use the endodontic instruments will be invaluable. All in all, there has to be more clinical experience taught to dentists, more physics, more mathematics, less biology, less microbiology. I remember

teaching my students the theories of Watson and Crick and so on, but in truth, they would be much better off if I had taught them how to use and how to maintain their turbines!■

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Dr. George Freedman, who translated this interview with Dr. Duret from the French, is president-elect of the American Academy of Cosmetic Dentistry. A regular contributor to *Dentistry Today*, Dr. Freedman lectures frequently on cosmetic dentistry and dental technology. He may be reached at (514) 739-1411.

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