Hundreds witness dental history

CAD/CAM innovator Francois Duret and commentator Gerry McLaughlin performed North America's first live demonstration of the CAD/CAM system to a packed house Sunday afternoon in the Marriott's Grand Ballroom.

As part of the closed-circuit television program, Duret and McLaughlin, who were introduced by Peter J. Lio, chairman of the Closed-circuit Television Division, demonstrated the CAD/CAM innovation live from Northwestern University Dental School. The three procedures which constitute the CAD/CAM system of restoration were presented.

First, using a camera-like prong, Duret input the existing dental shapes into the system. This device included a laser source (diode) which, through the first endoscope, projected light on the desired picture area. A second endoscope, adjacent to the first, allowed the camera to take pictures in the mouth.

Duret took many pictures of the area in question, each providing him with a different viewpoint. The objective of the multi-picture process, in Duret's opinion, increased the computer's ability to recreate a more

Capacity crowd witnesses the USA TV premiere of Duret's CAD/CAM system on Sunday.

new boundaries for the computer to take into consideration. Taking all information into account, including adjacent teeth, school of occlusion, etc., the computer designed a replacement prothesis to the exact specifications Duret proposed.

McLaughlin entertained questions from the audience. In response to an inquiry on how much training was necessary to utilize the CAD/CAM system, McLaughlin said, "If I can learn it, anyone can. I had a total time training of about 10-12 hours,

method. In France, the breakthrough point of the CAD/CAM system is six restorations per day."

McLaughlin said, "The real question is: Is it worth the price? What is the value of the system? It is an individual question. What does it mean to your prac-

Television Gives MWM Edge on Excellence

The 1989 Midwinter Meeting of the Chicago Dental Society will mark the 22nd consecutive year that live clinical demonstrations will be shown through the use of closed circuit television.

Two and a half days of programming have been scheduled with this year's theme "United Through Knowledge" in mind. Clinicians will operate on selected patients at the facilities of Northwestern University School of Dentistry facility. The audience will view the program before television monitors at the Marriott Hotel. A two-way audio hook-up between the Marriott and the dental school will allow the audience to address questions to the clinician, through the moderator, and then see and hear the response.

According to Calvin Akal, DDS, Midwinter Meeting program chairman, the Midwinter Meeting's television program is unique because it is live. "It is the only live presentation program, anywhere in the world. It is also the best means of continuing education that I can think of. The dentist learns more about the subject from seeing it live, watching it happen and asking questions. We have one requirement of the clinicans: Do not lecture. We assume the audience already knows the subject matter. They are there to learn something new."

Akal indicates that he travels throughout the U.S. in search of the best and most qualified clinicians for the television program. He says that the chosen clinicians are quite honored to give television presentations at the Midwinter Meeting. "Because we are known for having the finest clinicians in the world at our meeting, they (the clinicians) see it as their springboard to fame. The Midwinter Meeting is definitely the most prestigious of all annual meetings."

The Midwinter Meeting's television program has gained such prominence that world-renowned clinicians, who wish to give presentations, confront the program chairman. "This year, Francois Duret who is giving the first ever live demonstration of the CAD/CAM system of dentistry in the U.S., came to us and asked to be on the program. I think this shows the great respect the television program has within the international dental community." (see accompanying story on Duret and CAD/CAM on p. 1)

The continued success of the television programs is due to the efforts of the members of the closed circuit television committee who have been working the past year with the clinicians and television crew in preparation for the Midwinter Meeting. Akal has long recognized the importance

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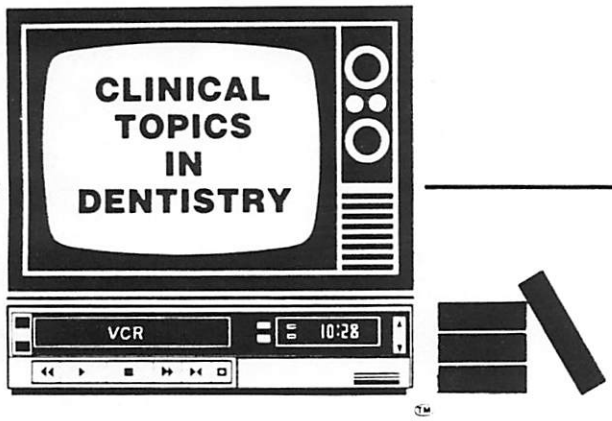

Chicago Dental Society
Television/Video

CAD/CAM LIVE!

Francois Duret, D.D.S.
Director of Research and Education
University of Marseilles, France

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Duret, CAD/CAM U.S. Television Debut Today

For the first time in the United States, Francois Duret will perform a live television demonstration of his CAD/CAM System of restoration fabrication at the 124th Midwinter Meeting.

Computer-aided-design and computer-aided-manufacturing (CAD/CAM) has revolutionized the field of dentistry. After many years of research and trial, the CAD/CAM system has become clinically applicable to dentistry. This revolutionary technology will allow preparation and installation of a finished crown or bridge in a single visit. Such a system will eliminate the need for impressions, temporary crowns, waxing and casting and the need for further adjustments.

The man behind the idea, Francois Duret, DDS, of France has been dedicated to the CAD/CAM effort for over 20 years. With his discoveries, Duret has created a revolution in the international dental profession.

Duret who, in addition to his degree in dentistry holds an MS in physiology, a PhD in human biochemistry and a PhD in dental biochemistry, is the director of the CAD/CAM Laboratory and director of research and education at the University of Marseilles, France.

According to Duret, in an article published in the November 1988 issue of the Journal of the American Dental Association (JADA), CAD/CAM technology was initially considered a trouble-shooting device and alternative to the "tedious" method already in existence. "Regardless of the advanced state of this 300-year-old technique, information must still be transferred by hand from the impression to the finished crown via a series of materials, each of which may induce error in the final casting. This system of casting does not allow us to take advantage of tremendous advances in computers and robotics. For these reasons, we introduced CAD/CAM technologies to the dental profession in 1971."

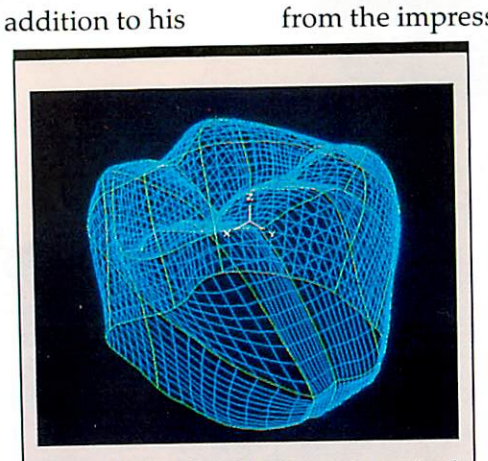

Fig 8 ■ Mandibular right first molar retrieved from the library of theoretical teeth.

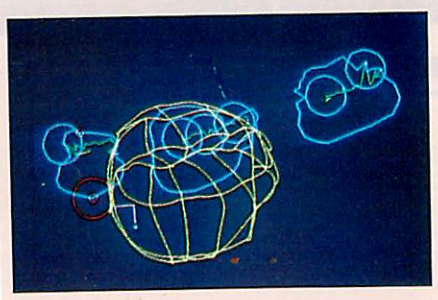

Fig 9 ■ Optical wax-up evaluation of the occlusal surface.

The first dental CAD/CAM prototype was introduced to the public in 1983 at the Caranciere conference, France. Two years later the dental profession witnessed for the first time a crown milled and installed in a mouth without the assistance of an outside laboratory.

In his presentation at 2-4 pm today in Grand Ballroom I on the Seventh floor in the Marriott, Duret will demonstrate the Duret System of CAD/CAM already in use in dental offices throughout France.

For many, the thought of using a computer can be an intimidating idea. However, the CAD/CAM process as it is applied to dentistry is relatively simple. By using a laser "probe" placed within the mouth, a picture is taken of the area to be restored. The images are transferred into a computer, which uses the image to create a crown that can be adapted perfectly to the patient's mouth. After studying the "replica" image and making necessary modifications, the dentist begins the manufacturing process. Using a micro-milling machine, the crown is automatically shaped out of a solid block of material. The finished

Continued on page 4

DAY by DAY

SUNDAY, FEBRUARY 19, 1989

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CHICAGO DENTAL SOCIETY
PRESS MATERIAL

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FACT SHEET

124th Annual Midwinter Meeting
Chicago Dental Society

February 19-22, 1989

"United Through Knowledge"

Background

- Sponsored by the Chicago Dental Society
- One of the oldest and largest dental conclaves in the world
- More than 27,000 Dental and Auxiliary personnel from 26 countries will attend
- More than 150 lectures and panels presented over four days

Closed Circuit Television

Live, closed circuit television will broadcast from the clinical facilities of Northwestern University Dental School directly to an audience at the Marraiott Hotel.

Internationally prominent clinicians presenting via the closed circuit medium include: Francois Duret of Marseilles, France presenting, for the first time live in the United States, his "CAD/CAM System" of tooth restoration; Myron Nevins of Boston, Massachusetts demonstrating periodontal techniques; David Garber of Atlanta, Georgia demonstrating esthetic and

more than 150 lectures and panels are: Implants - an alternative to dentures; Computer assisted [illegible]

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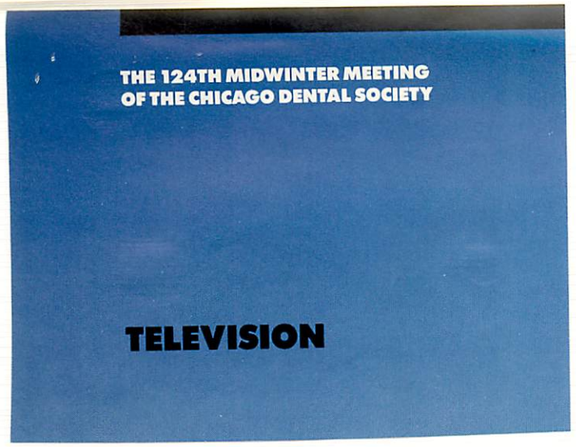
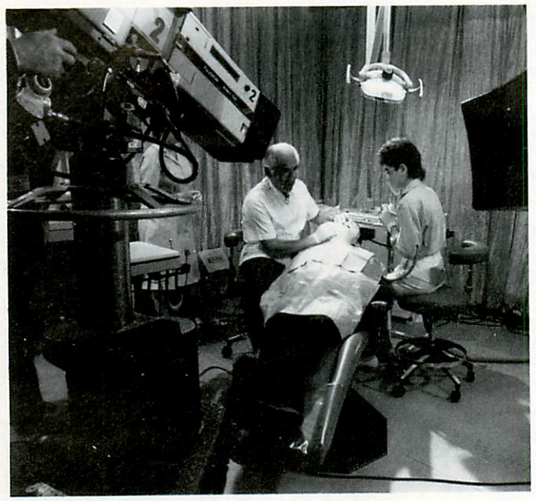


Live closed-circuit television has been a special part of the Chicago Midwinter Meeting for 22 years, where skilled clinicians demonstrate techniques and procedures for general practitioners. Television programs are scheduled Monday and Tuesday mornings and afternoons and Wednesday evenings. Only your registration badge is required for admittance.



CAD/CAM Live!

Francois Duret

Director of Research and Education, University of Marseilles, France

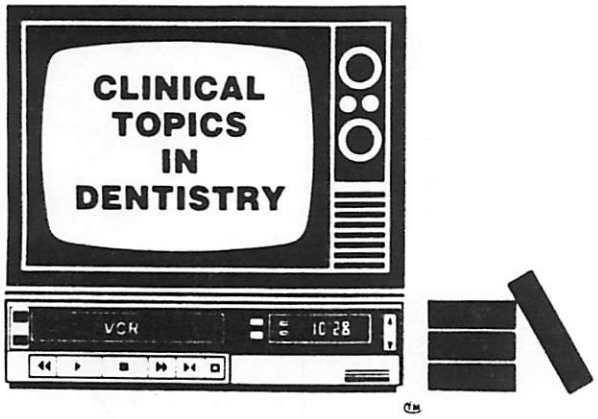
Grand Ballroom I, Marriott, Seventh floor
Sunday, 2-4p

Francois Duret has selected the Chicago Midwinter Meeting for the first live television demonstration in the U.S. of his CAD/CAM System of restoration fabrication. This revolutionary technology will allow preparation and installation of a finished crown or bridge in a single visit. All this with no impressions, no temporary crowns, no waxing and casting and no further adjustments needed. Dentists and patients will also benefit from the development of new dental materials unavailable with traditional methods.

The way the new system works is simple. The dentist uses a laser probe to take pictures of the area to be restored. These pictures are then used by a computer to design a crown perfectly adapted to the patient's mouth. After reviewing and if necessary, modifying the design on a computer screen, the dentist starts the manufacturing process, using a mico-milling machine which automatically shapes a crown out of a solid block of material. The finished crown can be immediately cemented in place.

Combining three of the most modern developments in science, the laser, the computer, and the micro-milling machine, dentistry of the future is certainly going to be different, easier and will be here apparently soon.

Commentator: Patrick J. Pierre



Chicago Dental Society
Television/Video

INSTRUCTIONS

FIRST:	Review the objectives and summary of the purpose of the presentation.
SECOND:	Read the presentation outline which summarizes the videocassette presentation.
THIRD:	View the videocassette.
FOURTH:	Review the suggested readings.
FIFTH:	Complete the post-test and transfer your responses to the answer sheet. Include your continuing education reporting card for the ADA and/or Academy of General Dentistry. We will send it directly to the appropriate registry. If there is a specific form which we must file with your state's licensing board or state association, include it with appropriate instructions to us.
SIXTH:	Complete the evaluation form.
SEVENTH:	Return the post-test and evaluation form.
PROBLEMS?	Call or write: **CHICAGO DENTAL SOCIETY TELEVISION/VIDEO** **P.O. Box 80669** **Lincoln, Nebraska 68501** **Phone 800-228-4630 or (in Nebraska) 402-472-2007**

CAD-CAM LIVE!

OBJECTIVES

This program shows the clinical application of computer-aided design (CAD) and computer-aided manufacturing (CAM) in the fabrication of a molar crown. The major objective of the program is to demonstrate how robotics and computers are used in dentistry.

Upon completion of this module, the practitioner-participant should be able to:

1. recall the background of development for computer-aided dentistry
2. list the equipment used in the dental office for CAD-CAM systems
3. understand how the impression is made using the electro-optical method
4. know the difference between an optical and traditional impression
5. understand that the stone model or die is analogous to a memory system in which information is stored, as on a computer disk
6. list the three parts corresponding to the three basic steps of the process in the CAD-CAM system
7. describe three configurations for using the CAD-CAM system in dental offices
8. list the seven steps involved with the clinical production of a fixed prosthesis

9. state two phases performed in milling the prosthesis.
10. describe in general the computation of tool paths in the machine tool process
11. describe in general the execution of the milling process used to produce prosthesis
12. describe coloration of the prosthesis

CAD-CAM LIVE!

PRESENTATION OUTLINE

I. Introduction

II. Electro-Optical Impression.

III. Work on the Video Model.

IV. CAM - Demonstration and Explanation.

V. Coloration of Prosthesis - Dr. Bernard Duret.

VI. Closing Remarks - The Finished Crown.

CAD-CAM LIVE!

Francois Duret, D.D.S.
Director of Research and Education
University of Marseilles, France

I. INTRODUCTION

This program provides the viewer a demonstration of the CAD-CAM system in the production of a molar crown on a typodont. The system was introduced to the dental profession in 1971 and is presently being used in dental offices in France. The Duret System, developed by Hennson International, is described by Dr. Francois Duret and Dr. Gerald McLaughlin.

The crown preparation demonstrated had been prepared prior to the start of the program. A chamfer preparation is preferred by both Dr. Duret and Dr. McLaughlin for full crowns.

The traditional method of crown fabrication, after tooth preparation has been completed, includes taking impressions of both the prepared tooth, adjacent teeth and opposing dentition. A stone model is then made and the prepared tooth becomes a die to which a wax pattern is carved. The actual cast restoration is made using the "lost wax method." The entire process includes different materials and various steps in handling which can lead to

errors being introduced into the final product. The CAD-CAM system eliminates use of the stone die and other steps necessary to complete the crown.

The accompanying article (from the JADA, Vol 117, November 1988), "CAD/CAM in Dentistry," should be read by the viewer before completing the test. The two footnote references in the following paragraph refer to the footnotes for the article.

II. ELECTRO-OPTICAL IMPRESSION

After the tooth preparation has been completed, a three-dimensional probe system, which utilizes two small cameras, takes a series of views which follow the path of insertion for the crown. The electro-optical method of impression-taking combines holography [19] and Moire [20] which carries volumetric information which is digitized and is fed into the computer's memory.

A rubber dam clamp was modified to include three small spheres, which serve as reference points in correlating the various views which are taken.

Several views are taken including the buccal, lingual and proximal. During the demonstration, Dr. Duret took eleven views which included the opposing dentition, check bite, path of insertion, proximals, mesial, distal,

occlusal and vestibular views. The pictures were in three dimensions and were stored in the computer's memory for later use. The "munion" view referred to by Dr. Duret is actually the path of insertion.

The teeth must be dry before taking the electro-optical impression and a thin coating of white, non-toxic material is sprayed on the teeth to enhance the quality of the picture.

A silicon check-bite allows a picture of the opposing occlusion, with the three spheres in place, making correlation of occlusion near perfect. The length of time required to take the optical impression is from five to ten minutes.

The optical impression corresponds to the traditional steps taken to produce a stone model. The only difference is in the use of numerical values in the optical system which are stored in the memory of the computer, and take the place of steps used to make the stone model.

III. WORK ON THE VIDEO MODEL

After the views have been taken and stored in the computer's memory, the complete set of pictures is first displayed on the video screen. Each view is recalled and

identified from the memory and characteristic zones, such as contact areas, cusps and alignment of grooves and cusps of the upper and lower arch.

The margins are established by using a view of the preparation on the video screen and defining a series of points along the desired position of the margin. The tracing of the margin is analagous to drawing the margin on the stone die with a fine lead pencil. When these steps have been completed the computer automatically calculates the three-dimensional shapes of the impressions and transfers them into the CAD system to design and build the computer model of the crown.

Cement space of ten microns is entered into the program and the interior of the crown will be automatically created. The space will begin with the margin line and no space enlargement is made to the margin itself. The occlusal surface is established by the operator's preference of the school of occlusion. The "build-up" term is used in the CAD design, similar to the "wax-up" technique used in the traditional laboratory procedure.

Functional occlusion is achieved by use of a specially designed articulator which includes a camera connected to the CAD, and a small light which is attached to the labial surface of a mandibular incisor. Mandibular movements are

read by the camera and are entered into the computer's memory. A special prototype of an articulator with three lights and two cameras was shown. It will provide an even more precise record of movements than the one presently being used.

IV. CAM - DEMONSTRATION AND EXPLANATION

The operation of the CAM is described by Dr. Duret and Dr. McLaughlin. The robot is a micro-milling machine with five electric motors and with four axis machining. The prosthesis is milled by eight tools which are placed on a rotating disk. Each tool is automatically checked prior to its use. A stream of coolant plays over the cutting tool and the block of material from which the prosthesis is made, to prevent over-heating. The milling is automatic and is controlled by the software program in the computer. The computer program controls tool movements and technical factors such as coolant, tool changes and wear on the tools. All of the tool paths are calculated in three-dimensional space and the pre-formed block of material is sequentially milled into a crown that is ready for polishing and coloring.

The material used in the demonstration is a specially designed ceramic composite with fibers aligned to withstand

the forces which are placed upon it. The material is not a homogenous mass as seen in other available materials. A number of finished Dicor (Dentsply) crowns were also shown.

The completely milled crown, ready for coloring, took approximately two hours time from start to finish. It was removed from the CAM and given to Dr. Bernard Duret for coloration.

V. COLORATION OF PROSTHESIS - DR. BERNARD DURET

The crown was examined by Dr. Bernard Duret and slight modifications were made to the final shape prior to start of the coloration process. Several factors were considered in determining the correct color for the crown. They included:

* optical properties of the material being used,
* the hue which was proper for the material,
* a decision as to color and tint of the cement to be used, and
* surface tinting and final coating which would also influence the final color and shade of the unit.

Dr. Duret would normally work under a microscope to aid in controlling the thickness of the material being applied. A microscope also helps in detecting any dust

particles or bubbles of air which might be present in the varnish. In designing the crown, 10 microns of space was made to accomodate the different coats of stain and varnish which were applied. This would prevent an incorrect occlusion which had been established so accurately in the milling process.

The crown was placed on a special holder which has the same color as the cement which would be used for comentation.

The stains selected were from the Vita Shade Guide. The stain layers were polymerized in an electric oven for ninety seconds. The crown was degreased after polymerization using ethynol alcohol -- and allowed to air-dry thoroughly.

The occlusal surface was stained with shade modifiers which contained strong pigments. The darkest stain was placed carefully in the bottom of the central grooves. Care was taken to prevent stain layers from becoming too thick, particularly on the cusps.

A final coating of polyurethane varnish was placed on the entire surface of the crown and was polymerized for ninety seconds.

The polyurethane varnish is between 20 to 40 microns thick. It is charged with silicone and becomes part of the

100 micron thickness built up on the crown. Hardness compares closely to that of enamel after it has been polymerized. The whole staining process should take about 20 minutes.

VI. CLOSING REMARKS - THE FINISHED CROWN

Dr. Francois Duret and Dr. McLaughlin showed the completed crown placed in the mannequin with its relationships to the adjacent teeth and occlusion. The crown and die was shown to have excellent marginal adaptation.

A point was made that the amount of time spent was longer than normal due to showing steps that are not necessary in changes made to the crown, and taking time to explain them. Without the explanation, the time for completion would be under 1 1/2 hours.

Another important point was that the completed crown was made from the work which was done during the program presentation and was not pre-selected from a bank of successful crowns after rejecting the unsuccessful ones.

END OF PROGRAM

SUGGESTED READING

CAD-CAM LIVE!

1. Refer to references found on page 720 of the attached article from JADA, Vol. 117, Nov. 1988.

2. Leinfelder, Karl F. (D.D.S., M.S.), Isenberg, Barry P. (D.M.D., M.A.), and Essig, Milton E. (D.M.D.). A New Method for Generating Ceramic Restorations: A CAD-CAM System. JADA. 118 (60) 703-7 June 1989.