ROTSAERT Dental Laboratory Limited

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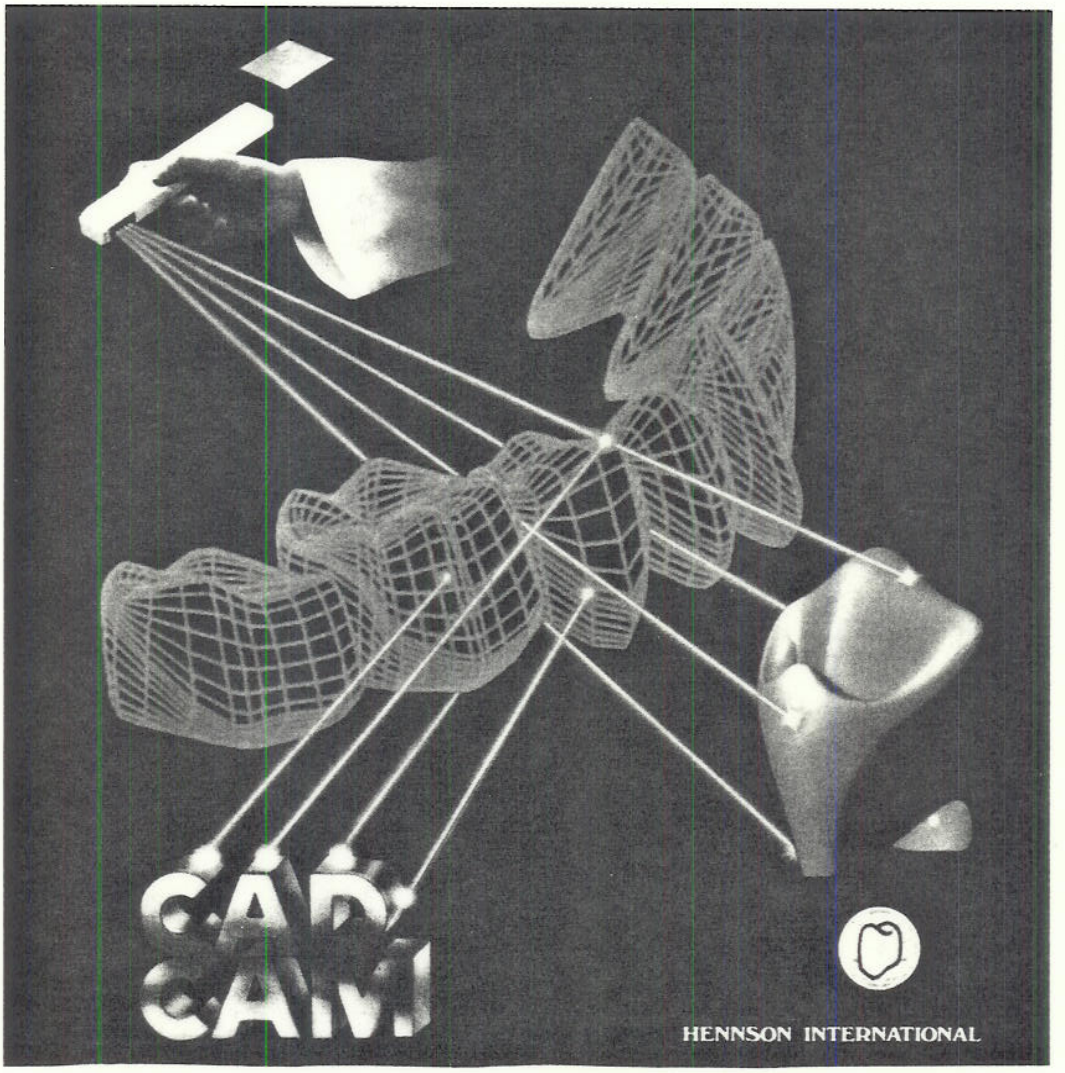
INTRODUCTION

NEW SYSTEM REVOLUTIONIZES DENTAL TECHNOLOGY



METHODOLOGY OF COMPUTER AID DESIGN AND COMPUTER AID MANUFACTURE (CAD/CAM) OF FIXED DENTAL PROSTHESIS.

NEW SYSTEM REVOLUTIONIZES DENTAL TECHNOLOGY

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Come see the slide presentation of a Crown & Bridge by computer-aided design, and computer-aided manufacturing. Presented by Dr. Francois Duret, inventor and producer of this dramatic new system; in the East Meeting Room of the Toronto Convention Centre at 1 p.m. on Wednesday November 19, 1986.

There will also be a hands-on presentation of a new photometric shade process.

GENTLEMEN: I wish to attend your DURET SYSTEM seminar at the Toronto Convention Centre on Wednesday, November 19, 1986 (the day before the Winter Clinic).

Dr._____

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METHODOLOGY OF COMPUTER AID DESIGN AND COMPUTER AID MANUFACTURE (CAD/CAM) OF FIXED DENTAL PROSTHESIS.

(From Dr. Francois Duret's original Methodology, translated by Henri Rotsaert))

Computer Aid Design and Computer Aid Manufacture (CAD/CAM) of fixed dental prosthesis represents an innovation of such dimensions that its development can only be described as a revolution in a technology that has remained virtually unchanged in 300 years - until now.

A brief description of the traditional method of designing and producing crowns and bridges, and a comparison between this process and the capabilities of the CAD/CAM system, illustrates the extent of this technological advance.

Current procedures involve some variation, but all depend on several fundamental steps: 1) taking impressions of the teeth to be restored, using various impression materials: 2) sending this cast to the dental laboratory, which, through various stages - models, mounts, wax-up, casts, porcelain and finish - makes the dental prosthesis; and 3) making modifications - which are sometimes necessary due to inaccuracies caused both by the materials being used, and by human error - upon insertion.

By comparison, the CAD/CAM system eliminates the need for time-consuming and generally unpleasant impression-taking; reduces the patient's involvement in the process to a single visit, and decreases overall production time for the dental prosthesis to a fraction of the span required by traditional methods. A completed crown can be on its way to the dentist within a half-hour; furthermore, this prosthesis is of excellent quality.

Fifteen years in the making, the CAD/CAM system was conceived in the imagination of Dr. Francois Duret, a brilliant French dental surgeon. Dr. Duret's conceptualization began with the premise that a computer could assist prosthodontists to design and automatically produce high-quality prosthesis. He hypothesized that in one appointment, a dentist could create, produce, and fit a prosthesis that exactly met the patient's needs.

For twelve years, Dr. Duret and his colleagues developed a method of using a dental probe to take three-dimensional measurements of teeth; generating a computer image of these measurements; creating the dimensions of the needed prosthesis through data pertaining to this digitized image; and finally, manufacturing the prosthesis by means of a digitally-controlled micro-milling machine.

In 1983, at the Granciere Dental Surgery congress in Paris, Dr. Duret promised a feasibility model of the dental CAD/CAM system by 1985. A prototype working system was developed, and demonstrated at the Paris meeting in 1985.

A production system is currently on line in Europe, and in North America, it will be introduced in 1987.

As in any technological innovation, descriptions of completely current methodology are impractical since new techniques and systemic modifications overtake even the most promptly complied updates. However, an extensive body of information concerning the dental CAD/CAM system is available:

COMPOSITION OF THE SYSTEM

1. The Optical Probe

The optical probe, which measures the teeth in three dimensions, functions according to such an innovative method that we are obliged to limit any descriptions of the technology.

Briefly, however, the probe - which operates by a process similar to that of the MOIRE optical pattern outlined by the Ancients - locates a point in the position of a particular tooth with an accuracy that permits less than a 20um margin of error.

2. The Image Processing System

The image processing system, which is linked to the probe, makes a digital record of the probe's measurements, which have been transmitted by a Charge Coupled Device (C.C.D.) - and sorts the information obtained from this record in order to avoid a computer overload.

The C.C.D., a matrix micro-captor of considerable accuracy and speed (it scans at three to six megahertz), provides images on a flat surface several times per second. The information generated by the C.C.D. is applied to the software in producing the prosthesis.

The image processor enumerates, simplifies and transmits relevant data to calculate the dimensions of the prepared tooth.

Software for the creation of dental prosthesis is used with a powerful, quick, 32 bits light microprocessor. The CAD software, conceived according to the concept of MATRA DATAVISION EUCLID, generates an interior and exterior shape that adheres to the imperatives of the mouth: a design created by dentists for dentists.

The intrados (interior design) reflects not only form but also the dynamics of space, fluid flow, reduction, and retention of the prosthesis; the extrados (exterior design) gains its shape and volume from the privileged (contact) areas of interproximal, labial, lingual and occlusion: what results is a theoretical, original and ideal tooth, ready either for immediate use or modification, created by the dentist through the CAD system, depending on the needs of the patient.

3. The Digital Controller

The digital controller operates a program which combines direct, linked, and written material; which guides the micro-milling machine in a path that is determined by the requirements of the prosthesis and by the geometric characteristics of the cutting tool; and which controls the machining of the internal and external components of the prosthesis in three axis.

4. The Micro-Milling Machine

The micro-milling machine, which operates under instructions from the computer, has several burs and mould supports, thus fulfilling the requirements of high-quality automatics machining executed by lathes with sliding step or linear displacements. The final product can allow for manual shading, or can contain a semi-automatic finish, using previously selected shapes and colours. The final polishing is done by hand; the methods used depend on the material. For example,full metal crowns only require final polishing; for porcelain material, glaze and bake.

The innovative materials used in this technology resemble the mechanical and biological characteristics of the tooth; and because these substances are processed directly - no structural changes are made before the prosthesis is fitted in the patient's mouth - the risk of distortion is eliminated.

CONFIGURATION OF THE SYSTEM

The basic components of the CAD/CAM system comprise a modular configuration that facilitates its use in a wide variety of dental offices.

For offices with only one operating theatre, a complete system can be used, or simply a system composed of a probe and a modem; both systems entail privileged transmission of information to dental laboratories through coding of access to data; and both permit modifications of software as it evolves.

As well, the modular structure of the system facilitates its function in multiple-use dental offices; the CAD, the microcompressor, and the digital controller can be linked to several optical probes - without losing transmission capabilities - through a modem to suitable equipped dental laboratories.

If the dentist is equipped with a data capture system, the information will be processed by the CAD software in the dental laboratory, and machining will be done either in the laboratory or by a machining tool in the dental office, to which instructions from the laboratory's digital controller are transmitted.

METHODS OF USE

The procedure for producing a crown follows a number of stages, which are outlined according to the configuration of the system set up in a particular dental office.

In an office equipped with a complete CAD/CAM system, the procedure begins as it does in any office - with preparation of the tooth for a crown or bridge. Initially, the area is prepared as for impression-taking; in addition, a liquid can be applied to enhance the quality of the digital coding. Next, the dentist uses the optical probe - an endoscopic micro-camera - to record a series of video-monitored images, each of which can be examined to ensure that is is accurately rendered; this process makes it possible to achieve precise representations of even the most inaccessible areas of the mouth.

For a dentist accustomed to using the probe, it takes less than three minutes to create images of the particular tooth, the adjacent teeth, and the opposing surfaces; these relatively brief procedures are the only ones in the entire CAD/CAM process that involve working in the patient's mouth.

To process the image and integrate the different perspectives requires only another two to three minutes.

The next stage, which requires special training similar to other data-system education programs, uses the CAD software to verify that the form of the tooth is acceptable. This process is carried out either in the dental office or in the dental laboratory, and takes two to ten minutes. If the preparation needs adjustment, the software will show where modifications have to be made on the prepared tooth, and a new endoscopic imprint is made on the area that was corrected. The software will show the correction on the screen.

In creating the extrados, a model is displayed on the screen to the dentist, who accepts or modifies the tooth form - for example, the emergence profile, the occlusal, or the harmony - by using various interactive functions. A magnification (or zoom) effect incorporated into the software can highlight the margins, the occlusal angle, the areas of contact, the fissures, the cervical curvature, the centric stops, and the cuspid guidance. All these instructions are conveyed in comprehensible language based on dental terms.

Occlusal movements are monitored according to a number of theoretical trajectories, of which the chosen pattern will determine the modification of the particular occlusal formation.

The last stage of the operation - the machining - involves a material which has the characteristics of dental enamel, which makes it possible to achieve a completed product of excellent quality. To this end, it is essential for the technician to check the monitor at every stage of the machining process, even though this process is entirely automated.

After designing the shape and colour of the tooth (as previously discussed), the part to be machined is placed and automatically held in place. Then, a single on-off switch engages the machining cycle, which lasts 15 to 20 minutes per element in order to produce an excellent finish. However, the working time is reduced to 10 minutes by improvements to the cutting machine, and by machining the intrados while the extrados is being created in CAD.

Following the completion of the machining cycle, it is desirable to buff or glaze, depending on the material being used for the prosthesis. Then, the accuracy of the prosthesis is verified by a second optical probe reading, which compares the results to the original reading used for the digitally-controlled machining process in order to indicate the degree of accuracy to which you work.

To complete an aesthetically desirable crown using this system requires only one visit, and takes a maximum of 25 minutes.

In a dental office using a modem, the work done in the office consists only of the measurement, its verification, and a portion of the image interpretation: these stages take a total of five to seven minutes. The ensuing work is completed within 20 minutes in the dental laboratory, then delivered to the dental office.

FUTURE DEVELOPMENT

The current methodology describes only the creation and production of single-element prosthesis or those of limited size. However, by july, 1987, it is expected that the CAD/CAM system will be adapted for large-scale bridges, inlays, pin crowns and their attachments. And by 1987, the system will also accomodate diagnosis in orthodontics and paradontology, as well as production of the brackets and splints.

Managements software is already being planned for the current version of the system, and future software will reflect the same evolutionary process employed in today's personal data microprocessing systems: programs that contribute to the development of the dental CAD/CAM concept will be made widely accessible and will form the foundation of future development of software.

Training programs will be supervised by an exclusively dental team, and will emphasize the theoretical and practical requirements for familiarization with the CAD/CAM system.