

A computer model of a theoretical tooth (the mandibular right first molar) is used to design a crown. A CAD/CAM program builds a set of contours that will allow for aesthetic modifications of the shape of the theoretical tooth.

# Tooth Tech: The New Dentistry

*The transfer of advanced technologies  
to dentistry invigorates an old market.*

BY ALEXANDRA M. BIESADA

**T**HE 1980S HAVE brought a fundamental change to dentistry. Repair and restoration have given way to elective, cosmetic procedures. The dental market has opened up, and high-tech companies are moving in. This switch from the drill-and-fill era—the good old days when dentists could earn a living filling cavities—has forced dentists to look for new ways to market their practices.

The transfer of advanced technologies such as computer-imaging systems, surgical lasers, and fiber-optics to dentistry promises to benefit manufacturers, dentists, and patients alike. For

manufacturers, it means new markets and potentially higher profits for existing technologies. For dentists, it means new life for their practices as well as the potential for greater profits. For patients, the new technology promises quicker, easier, less painful dental care.

However, dentists in the post-drill-and-fill era who fail to adopt new technologies could face economic disaster. According to C.A. Bowman, president of the Professional Services Institute (PSI), a Sacramento-based software company that markets the Nu View 1000 computer-imaging system (CIS) to dentists, "In terms of building a patient base, dentists have become their own

worst enemy in recent years, defeating the very disease—tooth decay—that kept them in business for so long." Bowman sees computer-imaging in dentistry as a "state-of-the-art marketing technique" that can help dentists thrive in the coming years when they will increasingly rely on cosmetic procedures to stay in business.

Despite the potential benefits high technology offers to dentistry, selling dentists on it is tough. "Dentists are reluctant to change," said Bowman, "and many are afraid of computers." Bowman puts the number of dentists with computer-imaging systems in their offices at about 100 (out of the more than

100,000 dentists in the United States). However, he expects that "as dentists realize these systems are not toys, but products that can help keep them in business, the market for imaging systems should grow rapidly."

A combination of factors makes dentistry "a unique marketplace," said Nelson J. Gendusa, DDS, director of research at Parkell Bio-Materials, a leading maker of commercial dental products in Farmingdale, N.Y. The relatively small number of dentists in the United States, combined with the fact that "you're dealing with an individual who makes all the purchasing decisions in the office," make the dental market an insular one.

The fact that most dentists don't have a lot of money to experiment with new technologies also makes the dental market tough. According to the American Dental Association's Bureau of Economic and Behavioral Research, solo general practitioners reported a mean net income of \$66,788 in 1987 (the last year for which complete figures are available). Dentists in nonsolo practices earned more, with general practitioners reporting mean net incomes of \$72,018. According to Biomedical Business International (BBI), a leading health-care information company in Tustin, Calif., dentists' net incomes, when adjusted for inflation, have declined since 1972. In the 10 years prior to 1983, physicians' incomes beat inflation by 10 percent while dentists' incomes lagged it by 10 percent.

Currently, there are about 53 dentists for every 100,000 Americans, according to BBI. From 1960 to 1970, the number of dentists per 100,000 people was relatively constant, but in the 15 years following 1970, the number rose dramatically as a result of government-supported programs that encouraged an increase in the number of dental graduates in anticipation of a flood of new dental patients. The number of dentists per 100,000 increased from 47 in 1970 to a peak of 59 in 1984. But the flood of new patients never came. That, and the end of the drill-and-fill era, left too many dentists to fill too few cavities. Predictably, dentists' incomes fell.

The result was a fundamental change in the practice of dentistry. Today, "More practices are relying on discretionary and cosmetic treatment as the only way to serve present patients and expand their client base," said Bowman. The emphasis on traditional treat-



A patient's view of California dentist, Dr. Richard Mungo, about to perform laser surgery.

ment has shifted to prevention and cosmetic dentistry. This shift has paved the way for the application of sophisticated technology to dentistry.

Two of the more fertile areas for technology transfer are restoration and cosmetic dentistry. "Cosmetic dentistry is growing by leaps and bounds," said Gendusa, "because everyone wants to look good." Computer-imaging systems, used routinely by plastic surgeons, have exciting cosmetic and restorative possibilities.

One imaging system that has made its way into the dentist's office is Computer-Assisted-Patient Evaluation (CAPE), which simulates cosmetic changes to give before-and-after views on a video screen. Such imaging systems let the dentist and patient look into the future—before the dentistry is even begun—and see how the patient will look after years of orthodonture or once a chipped tooth is capped.

CAPE works by taking a video "snapshot" of the patient with the data input camera. In one-thirtieth of a second the camera captures the image and feeds it into the computer, where it is digitized and displayed on the monitor. Using a magnetic digitizing tablet and a paint-type software program designed specifically for dentistry, the dentist can make computer-assisted freehand changes in the displayed image. Images can be stored for record-keeping. Dentists who neither have nor plan to have

an imaging system for their office can submit video or still photos to a professional laboratory for image-processing for about \$100 to \$150 each.

In addition to being an exciting new clinical tool, computer-imaging is an essential marketing and practice-building tool for dentists, according to Bowman of PSI. His company's \$6,300 Nu View 1000 CIS evolved from a graphics system used in the publishing industry. Working with Network Picture Systems of Santa Clara, Calif., PSI customized the system for dentists.

Like the Nu View 1000 CIS, the PreView Dental Imaging System, which is manufactured by the McGhan InstruMed Corporation, of Carpinteria, Calif., was originally designed for use in other fields and later modified for use in dentistry. McGhan was successfully marketing imaging systems to plastic surgeons when it started receiving calls from dentists inquiring about a system that they could use. The PreView dental system, which costs \$12,400, took another year and a half to develop.

Another technology adapted to computer-aided dentistry, computer-aided-design and computer-aided-manufacturing (CAD/CAM), made its debut in dental offices in France and is being developed for use in this country by Henson International of Los Angeles. CAD/CAM is used to make dental prostheses such as crowns. Rather than making a physical model, or die, of the

tooth or teeth to be replaced, an electro-optical scanning method obtains the necessary three-dimensional information, which is digitized by camera and fed into the computer. The computer stores more than 1 million values for three teeth.

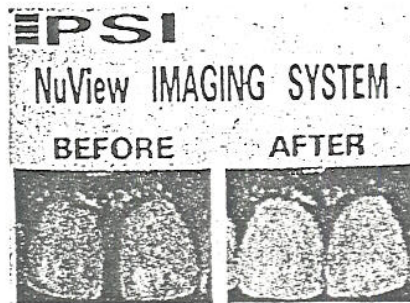
In order to make a CAD/CAM system a feasible for use in the dentist's office, the level of complexity and price had to be reduced. According to a recent review in *Journal of The American Dental Association*, since CAD/CAM's introduction to dentistry in 1971, the interaction between the dentist and the system has been simplified to make it as user-friendly as the Macintosh computer, allowing users to be trained in less than a week.

In terms of price, CAD/CAM systems are still "a long way off," said Gendusa, citing the average price to the dentist—about \$150,000—as "prohibitively expensive." However, as with other computer-imaging systems, a dentist equipped with an optical probe can gain access to a CAD/CAM system over telephone lines via modem, or by sending a floppy disk containing a "picture" to the home base of the computer and the milling machine.

Another high-tech product making its way into dentistry is laser technology. Lasers have been used in medicine for more than 20 years, but relatively little of that work has been in dentistry. In 1988, according to the Academy of General Dentistry in Chicago, fewer than a dozen dentists with general practices had laser equipment.

Some dentists, however, see lasers as the wave of the future in high-tech dentistry. Robert Pick, DDS, an assistant clinical professor of periodontics at the Northwestern University Dental School, in Chicago, and a pioneer in soft-tissue surgery with the laser, said the number of dentists using lasers is growing. "Ten years from now the laser will be commonplace in the surgical specialist's office, though somewhat less commonplace in the general practitioner's office."

Lasers are used in dentistry primarily for soft-tissue surgery—removing lesions in the mouth and periodontal work; but hard-tissue applications such as root canals and removing decay are possible. Lasers have significant advantages over traditional surgical instruments. The dental laser is, in effect, a scalpel of light contained in a handheld wand. It is more maneuverable than a



Closing the gap between present and future: Computer-imaging lets patients see results before the dentistry is even begun.

steel scalpel and can access hard-to-reach tissue that steel scalpels can't. And lasers are fast. According to Pick, "A 15-minute surgical procedure can be done in two minutes or less with the laser, with no sutures and no bleeding."

Lasers perform nearly bloodless surgery because they seal small blood vessels as they cut, providing dental surgeons with excellent visibility and protecting dentists from blood-borne infectious diseases like AIDS and hepatitis. Tony Pogrel, DDS, of the University of California at San Francisco is using a laser to treat AIDS patients with Kaposi's sarcoma in the mouth. The laser cuts out the lumps of abnormal blood vessels with less bleeding during and after surgery.

Because there is no physical contact with the tissue, the laser causes less damage to adjacent tissue and less chance of infection. From the patient's point of view, perhaps the greatest advantage of the laser is the decrease in pain during and after surgery. Researchers working in Bonn, West Germany, using an argon-fluoride laser to "drill" out cavities, said their patients reported no pain. Why? The researchers hypothesize that the absence of pain is due to the 20-nanosecond laser pulse, which falls well below the millisecond stimulus-response threshold of nerves.

Given the laser's advantages, what has kept it out of dentists' hands? Size was one problem. Initially, dental laser systems were too big to fit in most dental offices. Most laser systems used by dentists were found in hospital operating rooms. A reduction in size was essential if lasers were to make the transition from hospitals to dentists' offices.

The problem of size was recently resolved with the introduction of compact, portable laser units. A manufacturer of medical lasers, Pfizer Laser Systems of Encino, Calif., introduced a

dental laser last year. Pfizer's carbon dioxide (CO<sub>2</sub>) laser, the most common type of laser used in dentistry today, is about the size of a typewriter. Last year, a French company, Satelec, in Merignan, also introduced a compact CO<sub>2</sub> laser, which is completely contained in a handpiece and weighs about 10.5 ounces.

The cost of laser instrumentation raises questions about how prevalent this technology will become in dentistry, experts say. According to Pick, costs are coming down. "When we first started using lasers in 1983, they had six-figure prices. Today, most CO<sub>2</sub> lasers cost about \$20,000." Pfizer sells a 10-watt laser system priced at \$22,000 and a 20-watt system for \$30,000. Satelec's laser is priced at \$25,000. But even these dramatic price reductions have not put laser systems within reach of many dentists.

A more attainable new technology for dentists, and a relatively new and highly competitive market in the United States is that of dental implants—permanent, bone-anchored replacement teeth. The total implant market includes a wide range of procedures. Estimated at \$44.4 million in 1987, the implant market is forecast to reach \$100.7 million by 1992, according to a study published by BBI last year. With millions of candidates for dental implants in this country alone, the potential market is huge and is expected to grow dramatically.

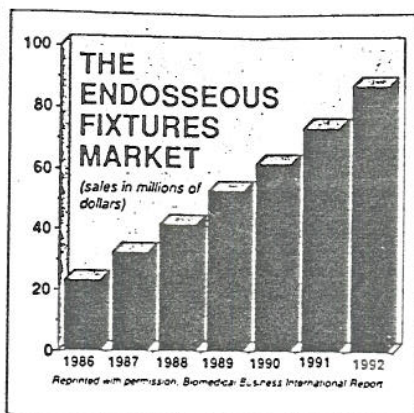
The largest implant market sector, endosseous fixtures, is currently experiencing most of the growth (see chart on opposite page). Based on a process called osseointegration—the permanent bonding of healthy bone to metal—the development of this procedure is credited to Per-Ingvar Branemark, M.D., Ph.D., a Swedish researcher and surgeon, who began studying the problem of providing patients with stable, permanent false teeth in 1952. Branemark found that titanium screws could be surgically implanted into the jawbone to anchor dentures. Titanium is accepted by the human body as a natural substance and therefore bonds with bone, forming a biological seal.

Osseointegration is completed in three stages. The first and second stages—the implantation of the titanium screws into the jaw—are performed by an oral surgeon in an operating room. The third stage—fitting and attaching the replacement teeth—is per-

formed in the dentist's office. Osseointegration is effective for patients from 16 to 80 years old and can be used to replace single teeth or entire upper or lower sets of teeth.

Marketed in the United States since 1982 by Nobelpharma USA Inc., a wholly owned subsidiary of Nobelpharma AB of Gothenburg, Sweden, the Branemark System has a 22-year record of success in Europe. By 1990, it is projected that Americans will have more than 42,000 endosseous fixtures implanted—up from 8,000 in 1985, said Gendusa of Parkell. However, he expects the implant market to begin contracting as Americans practice better preventive dentistry and, consequently, won't require implants.

Currently, there are about 20 implant systems on the market. In addition to Nobelpharma USA, the other major player is the Core-Vent Corp. of Encino, Calif. Together, Core-Vent and Nobelpharma share roughly equally between 60 percent and 70 percent of the implant market in the United States. The cost of implanting one tooth or a small group of teeth is about \$1,500 per tooth; an entire upper or lower set of teeth can range from \$5,000 to \$8,000.



The projected increase in the implant market for endosseous fixtures alone shows a \$23.2 million market in 1986 growing to \$87.2 million in 1992.

With such a lucrative market at stake, it's not surprising that Nobelpharma and Core-Vent have been engaged in a legal battle. In January, they settled a suit—in which Nobelpharma charged Core-Vent with patent infringement and unfair marketing practices—out of court. Under the terms of their agreement, Nobelpharma granted Core-Vent licensing rights on certain of its patents related to dental implants.

Despite the tight hold these two com-

panies have on the implant market, there will be opportunities for companies with new marketing strategies to succeed in this arena, reports BBI. Improvements in current surgical techniques and instrumentation represent opportunities for new companies entering the market.

Another avenue for entry, reports BBI, is to heavily market an existing implant design. Companies currently offering implants generally have small marketing budgets compared with the large dental- and medical-supply vendors. A large, well-established supplier looking to enter the implant market could quickly gain market share either by development or acquisition. Candidates for acquisition would include almost every company currently marketing implants.

Thanks to the transfer of advanced technologies to dentistry, the end of the drill-and-fill era doesn't have to limit dentists. Instead, it's an opportunity for them to apply sophisticated technologies to their practices. The technological advancements in dentistry are also good news for a growing number of suppliers to the dental market, giving everyone something to smile about. ■