Bringing Da Vinci to Dentistry

The new CAD/CAM Ceramic Center at Penn Dental Medicine boldly unites art and science.

BY JENNIFER BULDINO BONETT
Renaissance genius Leonardo da Vinci appreciated the connections between man and machine like no one before him. As an artist, inventor, and anatomist, da Vinci possessed both a deep understanding of the human body and the ability to express it brilliantly.

Today, in the Department of Preventive and Restorative Sciences at Penn Dental Medicine, there is an innovative new union between man and machine. CAD/CAM technology (computer-aided design/computer-aided manufacturing) has ushered in a Renaissance for dental restoration.

The new Penn Dental Medicine CAD/CAM Ceramic Center is dedicated to the study and application of the latest dental technologies in CAD/CAM and all-ceramic restoration materials, bringing together exceptional expertise in clinical dentistry, scientific investigation, and dental laboratory techniques. Leading the Center are Markus B. Blatz, DMD, PhD, who chairs the Department of Preventive and Restorative Sciences, and Michael Bergler, MDT, who is manager of Dental Laboratory Technology. Both are internationally recognized for their clinical and scientific contributions to esthetic and restorative dentistry.

“Dentistry is undergoing a fundamental transition from traditional clinical and laboratory procedures to CAD/CAM fabrication and all-ceramic dental restorations,” says Dr. Blatz. “In many countries around the world, CAD/CAM technology and all-ceramics have become essential parts of modern prosthetic, restorative, and implant dentistry.” Dr. Blatz — trained in prosthodontics, CAD/CAM technology, and dental material sciences in his native Germany — set out to establish a CAD/CAM center when he arrived at Penn Dental Medicine in 2006. “The Center is the culmination of the training and work we have done in the past and the strong relationships we have built with our colleagues and industry partners around the world,” says Dr. Blatz. “I have always envisioned a unique and interdisciplinary venture that has a clear focus on one of the most exciting aspects in modern dentistry, while merging excellence in research, teaching, and patient care. And Penn Dental Medicine, with its stature and exceptional infrastructure, is the ideal venue.” With his goal realized, Dr. Blatz expects the Center to position Penn Dental Medicine “as an international platform for world-class research and education in the restorative sciences.”

CAD/CAM allows clinicians to scan models and casts (and, with some systems, impressions and actual teeth) to create a 3D computer model, yielding what Dr. Blatz calls “extremely well-fitting restorations.” Beyond the traditional wax or alloy model, CAD/CAM allows dentists and dental laboratory technicians to design substructures for exacting restorations with precision down to the micrometer and customized for each patient’s individual needs.

The core of the Center, on the third floor of the Evans Building, features the most prominent CAD/CAM systems currently on the market in a state-of-the-art laboratory for the fabrication of highly esthetic tooth- and implant-supported ceramic restorations. The Center will be home to new teaching, research, and clinical efforts only possible through CAD/CAM and high-level ceramic materials. At work in the Center, with its sleek, molded countertops and powerful machines so streamlined that they look like unpretentious computer monitors and laboratory cases, is Michael Bergler, who joined Penn Dental Medicine in June 2008.

Meet the Artist. Mr. Bergler is a master dental technician, a formal title with 10 years of education and residency behind it in his native Germany. He trained at the University of Erlangen–Nuremberg and earned his Certificate for Master Dental Technician (MDT) at the Masterschool of Freiburg. In practice for 11 years, Mr. Bergler is internationally recognized for ceramic restoration fabrication and has published and lectured extensively on restorative materials, esthetic dentistry, and dental technology.

“I am honored that we were able to recruit one of the up-and-coming international stars in dental laboratory technology,” says Dr. Blatz, who has worked with Mr. Bergler in Germany and the U.S. “His arrival at Penn is a tremendous gain for the School and for the whole dental community.”
The role of master dental technician is a new area of expertise for Penn Dental Medicine. “Most computer-aided design systems only generate the substructure for a restoration,” explains Dr. Blatz. “Michael plans and designs these substructures and then does the artwork of building the individual teeth by hand and applying the layers of ceramic on top of the copings and frameworks. Despite all technical advancements, machines are not able to recreate the intricate and subtle esthetic features of a natural tooth. That’s why his artistic expertise is so important.”

Mr. Bergler will be involved in teaching and instruction at all levels, from undergraduate preclinics to continuing education courses for practicing clinicians and laboratory technicians. “We believe that close collaboration with the laboratory technician is absolutely crucial for success in restorative dentistry, yet currently, our curriculum does not reflect that sufficiently,” notes Dr. Blatz. “With input from a world-class master technician, we will be able to strengthen our curriculum in that respect to educate a well-rounded dentist who has sound knowledge in up-to-date techniques and state-of-the-art technologies.”

Leading Academic Expertise. CAD/CAM is transforming education in dental medicine. “Treatment plans for patients are different than in the past because of the availability of CAD/CAM,” explains Najeed Saleh, DMD, Clinical Associate Professor in the Department of Preventive and Restorative Sciences and Director of Restorative Undergraduate Clinics. “Every dentist and every technician needs to have an understanding of the CAD/CAM systems and all-ceramic materials that are on the market — what’s possible and what’s not possible in using them. In academic dental medicine, it’s critical to introduce the technology and to teach it properly.”

The Center is poised to benefit students and practitioners across the academic spectrum:

- The Center also offers a platform for continuing education programs through national and international symposia, didactic presentations, and hands-on courses for practicing clinicians, dental staff and students, and laboratory technicians.

Generating Innovative Research. Interdisciplinary scholarship is a hallmark of the University of Pennsylvania. With 12 schools on Penn’s unified campus, faculty at the Penn Dental Medicine CAD/CAM Ceramic Center and other leading investigators across the University can collaborate easily to enhance the study of materials, technology, and clinical applications. Within the area of materials research for example, the Center is working with the Department of Material Science and Engineering at Penn’s School of Engineering and Applied Science — an authority in the area of ceramic engineering — to study the fatigue behavior of modern high-strength and multi-layer ceramics.

“We have some of the godfathers of ceramics material research and the most advanced research facilities right on our campus,” says Dr. Blatz. “With the many open questions surrounding the biomechanical behavior and clinical application of new ceramic materials, there is an unbelievable opportunity to make our School and the University unique and to move the field forward.”

In addition to materials testing, research at the CAD/CAM Ceramic Center will include the testing of protocols and framework designs; the review and development of software; and the evaluation of outcomes as these new technologies and materials are applied in the clinic.

Attaining Clinical Excellence. CAD/CAM technology and ceramic materials are setting new standards in patient care. Through the CAD/CAM Ceramic Center, says Dr. Blatz, Penn Dental Medicine clinicians can “manage complex restorative cases from start to finish and bring together technology, clinician, and technician for optimal care and successful outcomes.”

From near-perfect accuracy in fabricating copings to crafting highly esthetic ceramic restorations, the work of the Center translates into enhanced clinical care among the School’s diverse patient population and beyond. Faculty are
exploring strategies to make new technology and materials available to all patients. And most importantly, computer-assisted procedures hold promise for virtually every specialty in clinical dental medicine: oral surgery, orthodontics, prosthodontics, periodontics, and implant dentistry.

A case in point: The typical implant surgery requires a large surgical flap opening in the gingiva. Computer-assisted surgery allows clinicians to plan implant placement virtually, based on restorative needs. With the help of CT-scans, the placement oftentimes does not require a large surgical flap and yields a precise implant placement. “The surgeon has a CAD/CAM-fabricated surgical guide that is designed according to prosthetic requirements and takes best advantage of the anatomy and morphology of the bone. Here we know exactly how much bone is available and place the best–dimensioned implant at the most accurate angle and position,” explains Dr. Blatz. “And then a restoration can be inserted immediately after the implant placement because all the information is available on the computer. CAD/CAM technology significantly increases the predictability, reliability, and esthetic outcome of even the most complex rehabilitations. Our most compromised patients who have lost all their teeth and large amounts of bone have a much better chance of receiving well-functioning and good-looking implant–supported prostheses, which have a tremendous impact on their quality of life.”

“The Center puts the School in a leadership position within restorative dentistry and will be a great resource across disciplines,” says Interim Dean Thomas Sollecito (D’89, GD’91). “In bringing together the knowledge and resources to pursue leading-edge education, research, and patient care, we are also attracting the interest of potential collaborators and other high-caliber academicians from around the nation and the world.”

Opening the CAD/CAM Ceramic Center is like opening the door to the future of dentistry. “The sky is the limit,” says Dr. Blatz. “And we’re just getting started.”

**CAD/CAM 101: THE 60-SECOND MIRACLE**

In about the time it took Olympic swimmer Michael Phelps to set a world record, dental technicians can now design superb dental restorations. With CAD/CAM technology (computer-aided design/computer aided manufacturing), designing a restorative coping no longer takes hours of intensive manual labor. It takes the push of a few buttons and about 60 seconds.

In the Penn Dental Medicine CAD/CAM Ceramic Center, Michael Bergler, MDT, needs to make a single-tooth coping. He takes a single-tooth die created from a dentist’s impression and inserts it into a specialized scanner. He moves to a computer screen and follows a handful of prompts to select his choice of material, resin, and abutment. Mr. Bergler tells the computer which tooth he wants to restore and selects the restoration type, in this case, a coping. With the push of a button, the computer renders a 3D version of the die. Instantaneously. The resolution is extraordinary and he can see every detail. He submits the form electronically to an outside milling company and the finished coping arrives in his lab in two days, precisely the way he would have hand-crafted it.

With the advent of CAD/CAM, Mr. Bergler has been able to leave behind the old tools of the trade — the casting machine, the burnout furnace, the sandblaster. All he needs now are a scanner, a computer, and workspace to craft the ceramic veneer, still done by hand to ensure the most highly esthetic outcome.

Even the impression and the dental model are about to fall out of favor. Next up at Penn Dental Medicine is an intraoral scanner, used by the dentist to make a digital impression. The accuracy? Even better than a physical impression.