The stage was set for exciting advances in dentistry in the 1950s and 1960s when prototypes of computer-aided design (CAD) and computer-aided manufacturing (CAM) were introduced into industrial settings. In those applications, the geometry of the “parts” was simpler than that generally needed for dental restorations, but the same techniques could be applied to creating dental crowns.

Early dreamers like Mörmann, Duret and colleagues and me were intrigued by the possibilities. But the road was far less smooth than any of us imagined. Computing power was limited; a gigabyte drive was unheard of, yet design of the complex geometries of crowns was computationally intensive. CAM systems were large, and the thought of having a desktop milling machine was laughable. Equipment companies perceived that dental CAD/CAM systems would be like cameras for which revenue would be driven by selling the materials like film. Simultaneously, the material companies perceived that the systems were equipment and beyond the scope of their product line. Perseverance, however, paid off. The dreamers continued to work, and CAD/CAM systems are now part of everyday dentistry.

In this supplement, you will read about the success of one of the systems that emerged as an effective in-office automated system known as the CEREC system (Sirona Dental Systems GmbH, Bensheim, Germany), though much of what you read will apply to any CAD/CAM system. The CEREC system has been available commercially for 20 years, is used by more than 17,000 dentists and in 28 dental schools in the United States, and has produced approximately 12 million restorations. In the first article of this supplement, Mörmann chronicles the evolution of his idea into a series of increasingly robust systems.

At first blush, the thought of machining a brittle material like dental ceramics was ridiculous. But as Giordano describes in the second article of this supplement, innovations in materials created esthetic materials that could withstand potential damage introduced by CAD/CAM operations. When created with an in-office CAD/CAM system, esthetic restorations provided in a single appointment are a reality.

But can an automatically produced restoration fabricated in the dental office perform as well and deliver the same esthetics as those created by skilled artist technicians? In the third article of this supplement, Fasbinder reviews the literature pertaining to performance of CEREC-generated restorations. He provides insight into the types of restorations that could be produced over time and the successful fit, esthetics and survival of ceramic restorations produced in the dental office.

While thousands of dentists have incorporated CAD/CAM systems into their offices, there still are many dentists who have not. In the fourth article of this supplement, Trost and colleagues summarize the practice management considerations, providing guidance for clinicians to make informed decisions about incorporating the technology into their own practices. While this article focuses on decisions relating to the CEREC system, the same kinds of considerations will apply to future in-office systems. In this month’s issue of JADA, Strub and colleagues have summarized how CEREC’s successes have catalyzed the development of other systems.

Without question, the dreams of automation have had an irreversible impact on dentistry. With in-office systems, esthetic,
long-lasting restorations can be produced in a single appointment. Laboratory-based systems expand the possibilities for restoration type and material selection. But clinicians must be concerned with more than just the initial product, whether it is produced by CAD/CAM systems or using traditional approaches. Ceramics, including those used in dentistry, have interesting performance characteristics. Even when highly polished, they lose strength when subjected to repeated loading, like normal occlusal contact. Over 1 million cycles (approximately five years of clinical function), both alumina- and zirconia-based veneered structures lose 50 percent of their strength.10 Damage caused by sandblasting, by chairside adjustments with a bur or even during the CAD/CAM fabrication process can reduce the restoration's strength further and compromise its life expectancy. For some materials, researchers have recorded as much as a 30 percent reduction in strength after sandblasting.11 This information is especially important for posterior restorations, which are subject to the highest stresses in the mouth.

But doesn’t sandblasting enhance adhesion? Perhaps, but it also introduces substantial damage. So my colleagues and I explored alternatives that can provide excellent bond strength without sandblasting. For alumina and zirconia cores, bond strengths equal to those on particle-abraded surfaces have been achieved by using metal primers in combination with adhesive cement formulations such as Panavia 21 (Kuraray America, New York City) and RelyX Unicem (3M ESPE, St. Paul, Minn.) on “as-received,” etched surfaces.12

The performance of ceramics can be compromised by a mismatch between coefficients of thermal expansion of core and veneer materials. While this is not an issue for in-office-produced monolithic materials, it can play an important role in crown and bridge survival.13 It also may be a major factor in porcelain chipping, which is reported commonly for zirconia-based layered crowns. While much remains to be learned and many innovations still are possible, there already has been much success with CAD/CAM systems’ producing ceramic restorations. Innovations will continue to affect and challenge dentistry. I hope you find this summary of 20 years of the success of one dream enlightening. ■

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