3D Printing: At the Beginning of the Journey, Endless Possibilities

By Lee Culp, CDT

Throughout the years, restorative trends and techniques have come and gone. Some developments have transformed the face of restorative dentistry, while other concepts have faded away. Digital dentistry and 3D printing is one concept that started out small and has increased in momentum until its potential now appears to be endless.

The early generations of full contour lithium disilicate and zirconia restorations were often received negatively due to the lack of esthetics at the time but, as raw material and ceramic technology companies worked together, the materials evolved in strength and esthetics to become the dominant restorative materials in dentistry today. Likewise, this first evolution of 3D-printed ceramic restorations should be regarded in a similar way: they will continue to evolve and expand in indications and offer dentistry many additional options in patient care.

The ADA's amendment of the definition of Porcelain/Ceramic for 2023 is an exciting development in the 3D printing arena. The amendment deletes "pressed, fired, polished or milled" from the definition, allowing for potential insurance coverage of 3D-printed nano-ceramic restorations.*

Another advancement in the 3D printing market are nano-ceramic-reinforced hybrid materials such as Rodin™ Sculpture from Pac-Dent, Inc. Indicated for single crowns, inlays, onlay and veneers, it has been FDA 510(k)-cleared as a Class II medical device and fulfills all regulatory requirements for use in both permanent and temporary restorations.

Our laboratory specializes in implant surgical and restorative design and we have been using Rodin Sculpture for 14 months for all of our temporary restorations, both tooth- and implant-supported; we've had no failures on long-term tooth-supported temporary restorations and minimal complications with implant-supported temporary restorations. The material offers excellent mechanical characteristics and esthetic properties, allowing us to produce lifelike permanent restorations on par with those made with traditional material, while streamlining the production process and reducing manufacturing costs. Its high concentration of ceramic fillers ensures maximal fracture resistance and minimizes repair visits.

We now 3D print 100% of our temporary restorations and have begun clinical trials on definitive restorations. See photos at right for a few examples of restorations printed with the material.

Definitive nano-ceramic bridge.

Implant-supported restoration.

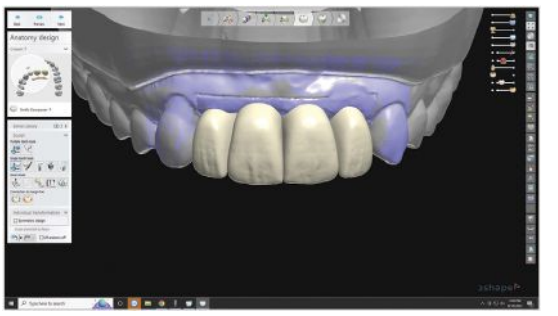
Implant bridge after seating.

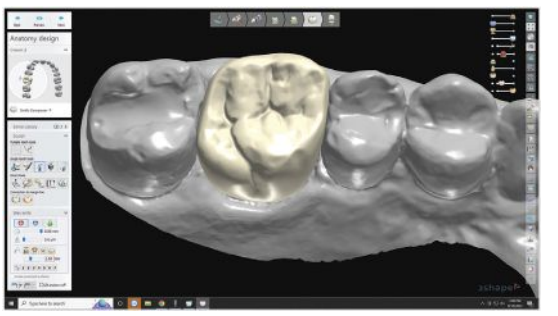
Jaw in a Day (JIAD): maxio-facial jaw replacement.

Fabrication Process

Here's a look at the design, printing process and final finishing using Rodin Sculpture system from Pac-Dent, Inc.:

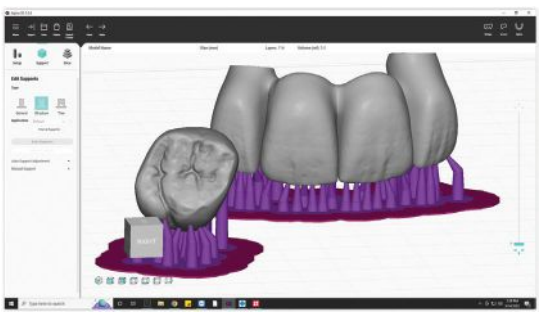
Step 1





These screenshots show the final design for an implant bridge and single molar restoration. The success of any digitally created restoration begins with an excellent CAD design, taking into consideration the strength of the restoration, esthetics and contours for function and cleanability for implant restorations.

Step 2



The design is uploaded to printer software for print support creation.

** Specifically, the 2023 definition of Porcelain/Ceramic is "Refers to materials containing predominantly inorganic refractory compounds including porcelains, glasses, ceramics, and glass-ceramics." The 2022 definition reads, "Refers to pressed, fired, polished, or milled materials containing predominantly inorganic refractory compounds including porcelains, glasses, ceramics, and glass-ceramics."*

Step 3

The completed data file is sent to the Ackuretta SOL 3D Printer and Rodin Sculpture resin is selected.

Step 4

The printed restorations are cleaned with a mild "scrubbing" with 96% alcohol and a soft toothbrush, dried and air abraded with low-pressure aluminum oxide.

Step 5

Restorations are then verified for fit and function and contoured for final esthetics with diamond burs.

Step 6

The Rodin Sculpture system includes specially designed stains and glazes with a chemistry that matches the print resin. The stain is applied and quickly light cured. The glaze is then applied and cured in an OtoFlash unit, a high-intensity light chamber with a nitrogen atmosphere, resulting in the glaze and restoration being fully cured together to ensure long-term adhesion of the two layers. Rodin Sculpture can also be easily polished to a high luster with conventional polishing techniques and polishing compound as in the fabrication of a denture.

For more information, call 909-839-0888 or visit pac-dent.com.

Lee Culp, CDT, is the CEO of Sculpture Studios, a dental laboratory, research and product development center for new and innovative digital diagnostic, restorative and digital applied applications to surgical and restorative dentistry. He is an avid writer and has contributed to eight dental textbooks, including a chapter in Dr. Peter Dawson's book, *Functional Occlusion: From TMJ to Smile Design*. He is a leading resource/inventor for many of the materials, products and techniques used in dentistry today and holds numerous patents. His writing, photography and teaching style have brought him international recognition in the specialties of digital dentistry, dental ceramics and functional esthetics. He is the recipient of numerous awards from the American Society of Prosthodontics, American Academy of Cosmetic Dentistry, Dawson Academy and the NADL.

Author's Note: Although long-term data is not yet available, additive manufacturing appears to have great potential in fabricating permanent indirect restorations. The approach I describe represents a workflow and materials to manufacture individual high-end 3D-printed nano-ceramic hybrid restorations. It must be considered that the findings are based on my subjective experiences, as evidence-based literature on this material is limited at this time. At this time, my laboratory is involved in several University-based studies to validate this new material's wear, strength, and other factors important to long-term restorative success.