THE DENTAL ADVISOR
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Clinical Case Report

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Model Simplicity: A New Concept for Digital Dentistry

Introduction: Digital impression systems create a virtual model of a patient's mouth. Laboratories or milling centers with dental Computer-Aided Design (CAD) software are able to create substructures, crowns and even custom implant abutments from that virtual model. The tools they use no longer involve waxing pens, carvers or casting machines, but instead include a computer monitor, mouse and milling equipment.

Traditional laboratory crown fabrication has required detailed model work, with removable dies for checking margins and building of porcelain. The first generation of models produced from digital impressions are very similar to traditional laboratory poured and trimmed models but have not been in a form that laboratories or milling centers could produce themselves. There are also several new digital impression systems close to being released, that don't have large-scale model solutions available. Even though 3D printers capable of producing models are now available for dental laboratories and milling centers, the challenge has been producing models in a cost-effective, efficient manner. Printed models require removal of support material which can be difficult, particularly with small parts such as removable dies. Matching of dies to the appropriate model, while not difficult, presents extra steps in the production process. The interface between a removable die and the sectioned model can be complex, requiring customized settings for die shapes, tapers and extraction techniques. While these challenges are not insurmountable, they introduce additional complexity into a process that isn't entirely necessary with the popularity of today's monolithic laboratory-milled restorations. The following is an example of a simple new model concept for dental laboratories that addresses these issues and was produced using an ***Eden 260V*** *(Objet Ltd.)* printer.

Clinical Presentation:

A 54-year-old patient presented with generally worn dentition, defective amalgam restorations and visible cracks in some of the molars (Figure 1). The patient was aware of her bruxism but requested conservative treatment rather than a full-mouth reconstruction to rebuild the lost vertical dimension. A plan was developed to replace place full-coverage crowns where needed and replace some of the amalgams with direct composite fillings. Full-contour zirconia was chosen as the crown material, based on its high strength and ability to provide the tooth-colored appearance that the patient desired. The minimal reduction necessary for this material was also conducive to the situation of a worn tooth with a short clinical crown.

Figure 1. Pre-op photo.

Figure 2. Crown preparation of tooth #30.

Treatment began on the lower right quadrant. Teeth #28, 29 and 31 received new composite fillings. A composite core was placed in tooth #30, and the tooth was prepared for a full-contour zirconia crown (Figure 2). Gingival retraction cord was placed in order to reveal the margin for a digital impression. ***iTero*** *(Align Technology, Inc.)* was used to scan the operative quadrant, the opposing quadrant and the patient's bite. The resulting virtual model was evaluated on the monitor to ensure complete capture of data for an accurate restoration.

Laboratory

Dental Designer *(3Shape)* program was used to enter the case identifying a crown for tooth #30, and both a sectioned model and an un-sectioned model. The open format "STL" scan file from ***iTero*** was imported into ***Dental Manager*** *(3Shape)*.

The ***Model Builder*** *(3Shape)* module was used to re-orient the scan data, set the plane of occlusion and identify prep tooth margins. After identifying margins, the ***Model Builder*** software added bases to both arches; for the un-sectioned model, a die was virtually extracted from the arch. STL files were generated for each model part: operative arch, opposing arch and the sectioned die (Figure 3). The crown was then designed with *3Shape* design software (Figure 4), milled and sintered overnight according to the material manufacturer's recommendations.

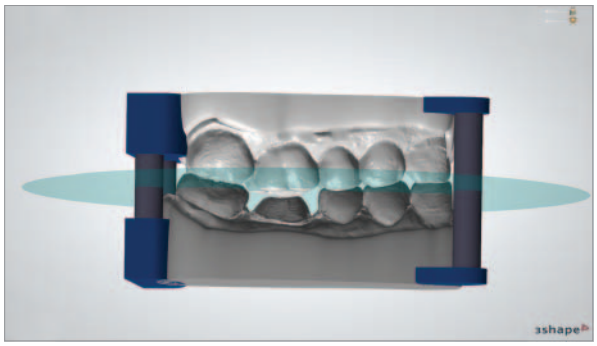

Figure 3. *3Shape* Model Builder Output.

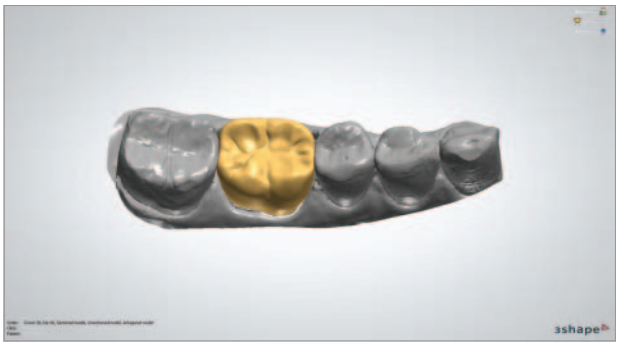

Figure 4. Designed Restoration.

For this case a solid model, a detached die and the opposing arch were generated. Current model builder software does not support this solution automatically so a workaround was developed. The solid arch and detachable die were loaded into an industrial CAD software program (Figure 5). A small rectangular shape was created to bridge the space between the un-sectioned model and the detachable die (Figure 6). The rectangular shape was repositioned so the 3 individual objects could be combined into a single 3D mesh (Figure 7). ***Objet Studio*** software was used to position this model with others in a project for ***Eden 260V*** printer (Figure 8).

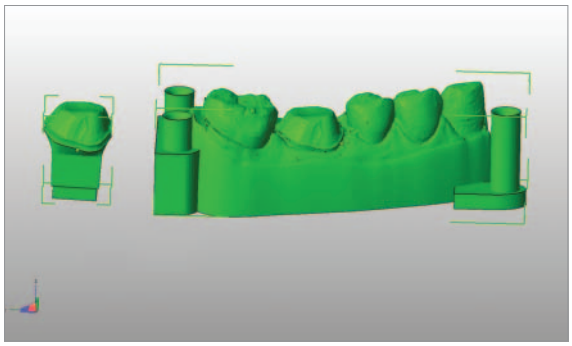

Figure 5. Un-sectioned model arch with sectioned die as separate files.

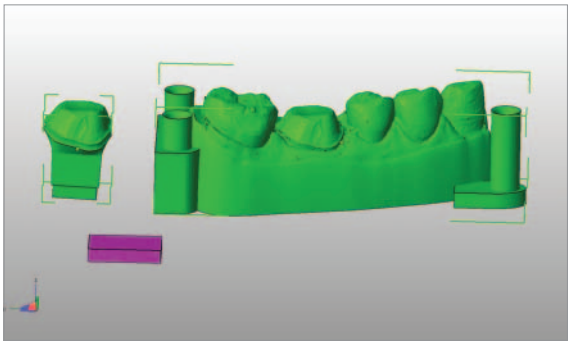

Figure 6. Connector bridge added to the un-sectioned arch and die files.

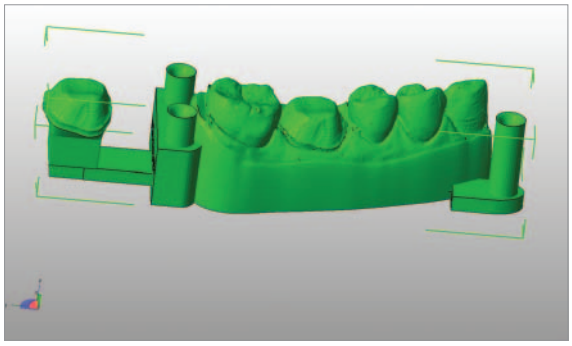

Figure 7. New solid model arch with detached die.

Figure 8. Objet Studio project for the *Eden 260V*.

The ***Eden 260V*** took slightly less than 2 hours to print the 7 complete models in this project (Figure 9). Support material was removed from the models under high-pressure water spray. The crown margins were finished to the detachable die and the contacts were adjusted to the adjacent teeth on the solid model (Figure 10). The crown was stained and glazed, contacts checked again, and then delivered to the doctor for seating.

Restoration Seating:

The ***Lava Plus*** *(3M ESPE)* zirconia crown was received from the milling center and evaluated first on the model. The fit of the crown on the die was perfect, with no rock or rotation, and the margins were undetectable. Interproximal contacts on the solid model were broad and firm, as requested. Try-in of the crown in the mouth revealed margins that were undetectable, and contacts were firm, as represented on the solid model. Minimal occlusal adjustment was needed. The crown was bonded with ***Scotchbond Universal*** with ***Rely X Ultimate Adhesive Resin Cement*** *(3M ESPE)* (Figure 11).

Figure 9. Completed print job prior to cleaning.

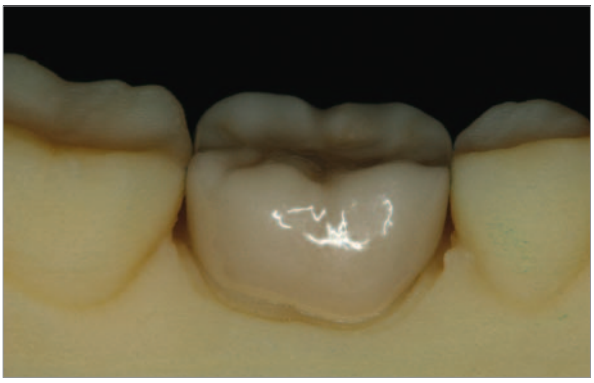

Figure 10. Crown contacts on solid model.

Figure 11. Restoration placed.

Conclusions:

Today's digital impression systems have proven accuracy and acceptance. Models generated from these impression systems are currently only manufactured by a few companies. New digital impression systems are being released, but who will manufacture those models? There really hasn't been a cost-effective, efficient manufacturing solution for large laboratories and milling centers to produce their own models from digital impressions.

The new model concept presented offers an innovative solution for printing models that addresses the production issues that have prevented laboratories and milling centers from adopting this workflow. The detached die for margin finishing with the unsectioned solid model for contacts truly simplifies the model design and construction, yet provides the details and precision that laboratories require. It is undoubtedly ideal for today's monolithic material milled restorations. In the case presented, the accuracy of the new model concept was confirmed by the fit of the crown in the patient's mouth.

3D printing of models by laboratories is entering an exciting new phase. Models can now be produced quickly, efficiently and accurately by laboratories with high-resolution 3D printers such as the ***Eden 260V*** *(Objet Ltd.)*. This model concept will be integrated directly into 2013 ***Dental Designer Model Builder*** *(3Shape)* module so that the additional 3D editing pictured in this report will not be required. Technology is changing the way dentists practice and dental laboratories operate. New business models and new production models are inevitable as the digital workflow continues to evolve.