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THE CUTTING EDGE

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One of the fastest-growing new technologies in orthodontics is the use of three-dimensional digital dental models. There are two basic methods of producing digital models. "Destructive imaging" removes part of the cast, a little at a time, while it is being imaged. "Non-destructive imaging" uses structured light, laser light, or x-rays to image while leaving the original cast intact.

This month's article, by Martin Freshwater of GeoDigm Corporation, describes a laser-based approach called *e*models--three-dimensional digital dental models designed to improve the accuracy and efficiency of orthodontic diagnosis, treatment planning, and bracket placement. Although the initial impetus for such technology was to eliminate the time, labor, and space required to produce and store traditional plaster casts, the utility of *e*models goes far beyond efficient record-keeping. Added benefits include digital tools to view, measure, and analyze the models, as well as the ability to print out two-dimensional images.

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3D Digital Dental Models Using Laser Technology

GeoDigm's *e*models are constructed through a proprietary laser scanning process that digitally maps the geometry of a patient's dental anatomy to a high-resolution 3D digital image, with an accuracy of ±.01mm. Scanners project a laser stripe onto the surface of a plaster cast and use digital cameras to analyze distortions in the stripe (Fig. 1). The plaster cast is oriented on all axes to expose all its surfaces for scanning.

This process produces 3D vertices that are connected into thousands of triangles to form the 3D image. The software then displays the *e*model on the computer screen by assigning color shades to each triangle based on its relative orientation to a digital light source. The result is a high-resolution 3D image that can be viewed, measured, and manipulated on the computer screen as if it were a plaster cast in your hand.

Clinical Management of Digital Models

The orthodontist sends the impressions and bite registration to GeoDigm in the supplied shipping kit. GeoDigm pours and trims a full plaster cast, which is then scanned into an *e*model and articulated based on the bite registration and information provided by the doctor. The model is then loaded onto the GeoDigm server, where it is available 24 hours a day for downloading to the office computer. A copy is maintained on GeoDigm's server for secure digital file storage. The practice can request that the plaster cast be returned for a nominal fee to cover shipping costs. Turnaround time is within five days of impression receipt.

Using the *e*model software, the clinician can move, rotate, or zoom in on the model and make measurements in any plane or orientation. Point-to-point, Bolton analysis, and curve-length measurements can easily be made by pointing and clicking with the mouse (Fig. 2). Cross-sectioning tools allow *e*models to be sliced in any vertical or horizontal plane to check symmetry,

overjet, overbite, and complete measurements at any location (Fig. 3).

Color Bite Mapping features permit the analysis of occlusal relationships (Fig. 4). The 3D color-coded map demonstrates occlusal contact between the arches. In addition, the software has an articulation feature that enables the clinician to set the center of rotation (Fig. 5). Using this feature, you can animate the articulation process and visualize the occlusal contact as it happens.

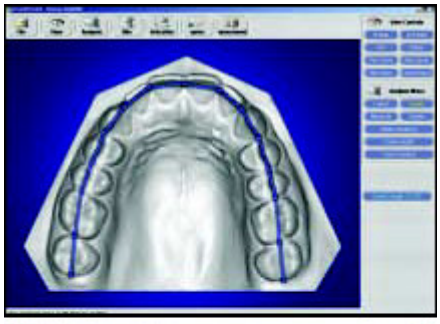
One of the latest innovations in 3D digital treatment planning is called an *e*plan, which simulates multiple treatment options to help determine the most effective treatment plan (Fig. 6). The *e*plan tools enable the clinician to accurately simulate tooth rotations, movements, and extractions with the click of a mouse. They also allow patients to watch the movement of their own teeth from a malocclusion view to a post-treatment view. Thus, they provide an effective communication tool for patients, their families, and referring dentists.

Conclusion

The opportunities for 3D digital technology in orthodontics are endless. GeoDigm is currently focused on leveraging *e*model technology as the digital platform for other applications, including eplacement (digital bracket placement) and crown-and-bridge fabrication. Many of these innovations are already deployed in selected orthodontic practices, delivering new efficiencies for doctors and enhanced care for patients. •

FIGURES

Fig. 1 Laser scanning process.



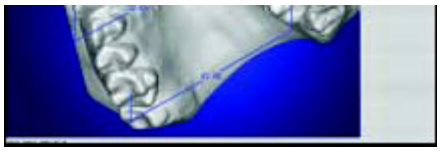


Fig. 2 Various measurements and curve-length analysis.

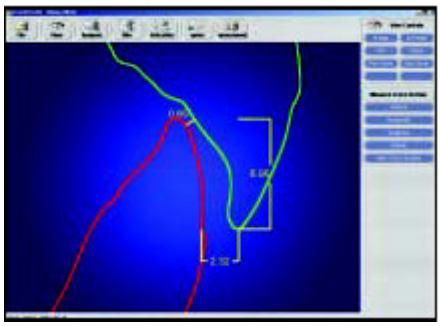


Fig. 3 Cross-sectional measurements.

Fig. 4 Color Bite Mapping.

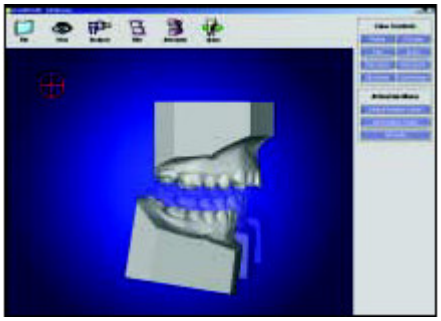


Fig. 5 Articulation feature.

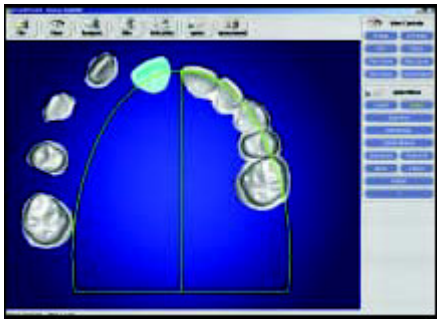


Fig. 6 Treatment-planning software.

FOOTNOTES

1 Trademark of GeoDigm Corporation, 1630 Lake Drive W., Chanhassen, MN 55317; www.geodigmcorp.com.