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TIPS FROM OUR READERS

Virtual smile design tip: From 2D to 3D design with free software

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Starting with the use of photographs and more recently with the use of straightforward and accessible software programs, virtual or digital smile design has been used to analyze patient's smiles and design 2D images to provide a guide for planning and communication.[1] A problem with the superimposition of 2D photographs is it relies on transferring the proposed design to a physical or digital dental cast.[2-4] The most widely described method is the use of calipers.[1] This leads to a loss of information between the 2D project and the wax pattern.[5] The method described represents an accessible and straightforward method of transferring 2D data to 3D digital casts using a free 3D computer graphics software program.[6] The purpose was to transform a joint photographic expert group (JPEG) 2D image into a 3D standard tessellation language (STL) file (Fig. 1).

TECHNIQUE

1. Make a frontal smile portrait of the patient, frontal intraoral image, and occlusal images for virtual smile design.
2. Analyze the smile (identify midline, plane of occlusion, interpupillary line, lower lip line, front teeth proportions) and shape a 2D smile using the tracing tool lines in presentation software (Keynote [Apple, Inc] or Power Point [Microsoft Corp]) and export the project in JPEG format with masks and grids.
3. Convert the JPEG file into a scalable vector graphics file with an open-source vector graphics software program (Inkscape).
4. Convert the vector graphic image into an STL file with an open-source 3D computer graphics software program (Blender).
5. Load the STL cast and 2D digital smile project files into a 3D meshing software program (MeshMixer; Autodesk, Inc) and align them in the frontal view using the transformation tool.
6. Import the teeth from the Brenes Tooth Library (available free) and align them to the frontal 2D design imported as STL.
7. Once the digital waxing has been designed, export the STL binary file to be printed or milled.

The same operations can be performed for an occlusal view (Fig. 2). A free tooth library can be used to create the 3D virtual smile design, which can be printed using a 3D printer for the evaluation of trial restorations.

This video presents the various stages of transformation of the JPEG file from the 2D analysis into an STL file to be integrated into the computer-aided design (CAD) software for the realization of the virtual wax pattern. Supplemental Video 1 (available online).

DISCUSSION

A smile design consists of creating tooth shapes and arranging them harmoniously with respect to the face. Davis[7] proposed several key points to analyze and, if necessary, to harmonize for a smile design. Among them, 3 parameters are essential: horizontal plane, facial midline, and tooth proportions.

Although a discrepancy between the interincisal midline and the facial midline might be esthetically acceptable, a canted midline is quickly perceived and is typically unacceptable. However, the transfer of the horizontal and vertical planes to the laboratory technician remains problematic despite the use of different transfer systems. A 2D virtual smile design allows a

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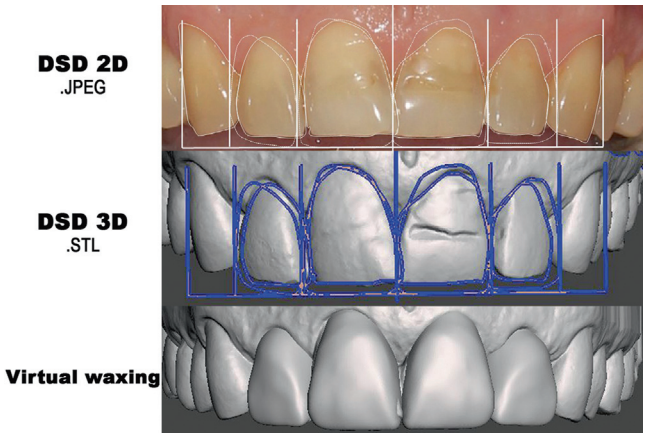

Figure 1. Conversion of 2D digital analysis to 3D digital wax pattern. Oriented photography and digital smile analysis saved as JPEG file. Then, 2D analysis is transformed into 3D STL file and aligned to 3D digital cast. Finally, wax pattern is edited virtually in 2D STL analysis (Christian Brenes tooth library). DSD, digital smile design; JPEG, joint photographic expert group; STL, standard tessellation language.

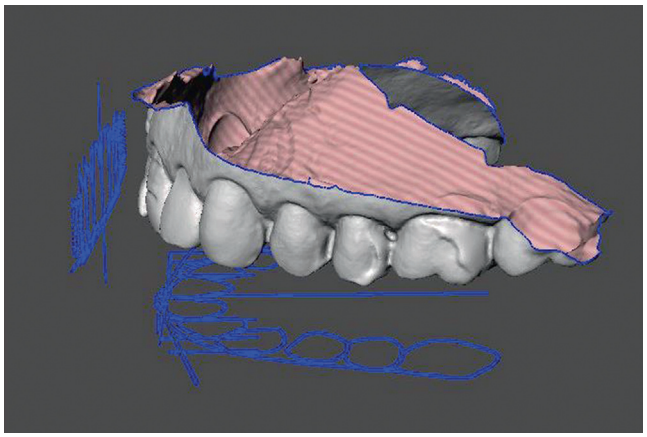

Figure 2. Registration of 2D analysis transformed to STL file with 3D STL cast. Analysis performed in front view and occlusal view. STL, standard tessellation language.

preview and better communicates esthetics to the patient and dental technician. The tooth shapes are easily modifiable, making it possible to test several solutions.[1] The reference plans are identified and ensure the esthetic result.

The technique described allows the transfer of these data on a virtual cast so that the digital waxing can be designed inside this grid. It allows the reference lines and shape guides essential for an esthetic result to be transferred reliably. Limitations of this technique are related to distortions created by the arch curvature. The larger the curvature of the anterior segment, the more the distortions as one moves away from the plane of the central incisors. This limit can be improved by duplicating the virtual smile design 2D guide in STL format. One will be placed just before the central incisors and will serve as a guide for the central and lateral incisors. The second will be placed just in front of the canines and will serve as a guide for them. Disadvantages of the technique include the use of different software programs for the transformation of JPEG files into STL files, even if the manipulation takes only a few minutes. Clinicians would need to learn to use these software programs to achieve the 3D digital wax pattern within the 3D digital smile grid dimension and tooth boundaries.

The technique presented here allows the creation of a smile design using a free software program in a digital workflow. This is an advantage for the use of smile design by dental students.

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