# From Virtual Smile Design to Guided Wax-Up Using Adobe Photoshop

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## Abstract

The lack of quantifiable measurements and the subsequent unrealistic expectations that develop can limit the use of virtual smile design or augmented reality applications. Developing a standardized measurement method that guides the laboratory wax-up after virtual smile design may solve this problem and allow many clinicians to utilize it in their day-to-day practice. This technique article presents an efficient method of utilizing Adobe Photoshop software to create a facially driven smile design, to gather quantifiable measurements, and to fabricate a wax-up based on the digital design.

**Keywords:** Digital dentistry, Esthetics, Smile design, Wax-up.

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## Introduction

The current trend in esthetic dentistry is based on "facially-driven smile designs".[1] This concept was popularized in 2012 when Coachman[2,3] introduced the terminology, Digital Smile Design. Many applications offered by different manufacturers now utilize the same general idea brought forward by Coachman.[4] Some even go as far as allowing patients to use augmented reality to modify tooth shape and size until the patients are pleased with the proposed treatment.[5]

The drawback of many of the applications that offer a virtual smile design or augmented reality is that these applications can present unrealistic expectations that may be difficult to achieve, especially when factors such as arch form, skeletal relationship, and occlusion are not taken into account in a two-dimensional view. Yet, these factors remain crucial for the success of the proposed restorative dentistry. In addition, most software do not provide measurements that will allow clinicians to transfer their digital designs to the dental laboratory and eventually into the patient's mouth.

Many dentists are now using their knowledge of design principles and utilizing readily available software to create two-dimensional designs that allow both the dentist and the patient to visualize the end result before treatment is initiated. Examples of software programs that are used include Keynote, Microsoft PowerPoint, and Adobe Photoshop. However, clinicians are still unable to gather quantifiable measurements from designs made on these programs. McLaren and Goldstein[6] described the only published technique for calculating tooth size and form by using Adobe Photoshop and focused on a mathematical formula and calculations. In contrast, this technique article presents a simple, calculation-free method using Adobe Photoshop to apply the principles of facially driven smiles and to generate a wax-up based on measurements obtained from the final smile design.

## Technique

This technique requires an extraoral frontal view photograph of the patient, as well as a retracted intraoral frontal view. Adobe

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Photoshop CC 2014 was used for this demonstration, but all versions of the software will render similar results.

- Upload a photograph of the patient into the Adobe Photoshop software.
- Using the line tool found in the sidebar, create lines to mark the facial midline using the nose, upper lip, and lower lip as guidelines. Using the same tool, mark the "canine lines" using the inner canthus of the eye, the ala of the nose or the commissure of the lip in a relaxed position,[7,8] and mark the interpupillary line to determine the occlusal plane angulation (Fig. 1).
- To determine and mark the patient's lip line, a simple method is to draw an elliptical using the ellipse tool, making sure that the lower border or the elliptical follows the lower lip (Fig. 1). Determining the lip line can be critical for patients with extensive tooth wear.
- Now that the basic analysis lines are in place, import the retracted intraoral photograph. The intraoral photograph is re-scaled using the transform tool (Edit > Free Transform) to allow for superimposition of the intraoral picture over the visible teeth in the extraoral view. Reducing the opacity of the intraoral picture to approximately 70% allows the clinician to more accurately superimpose the photograph. Figure 2 shows the superimposition with the intraoral photograph set to 70%
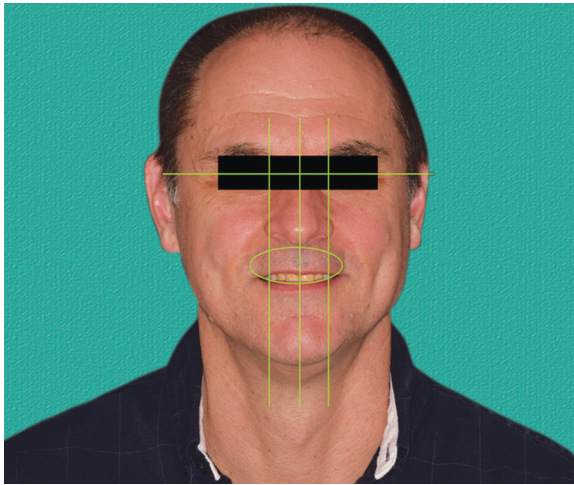
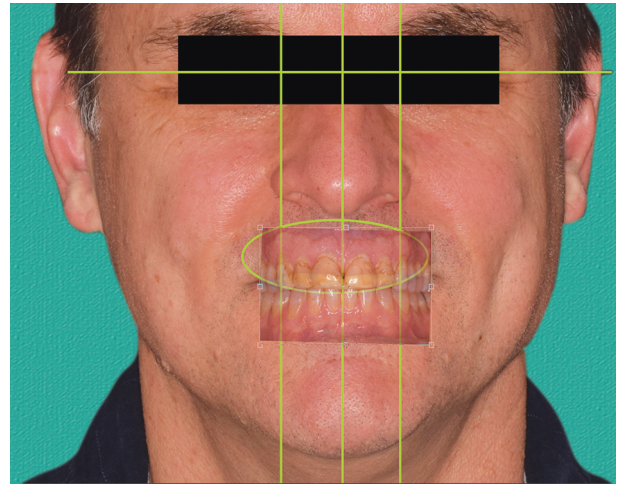**Fig. 1:** Basic analysis lines in place showing the midline, canine lines, interpupillary line and smile line



**Fig. 2:** Retracted intraoral view superimposed over the visible teeth from the extraoral view
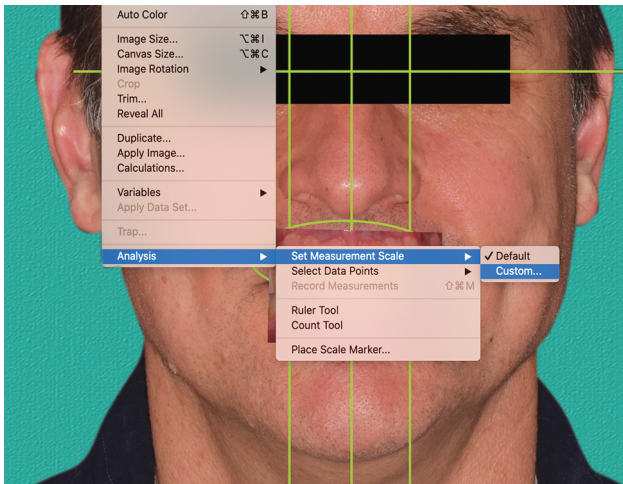


**Fig. 3:** Finding and using the custom measurement scale feature on adobe photoshop
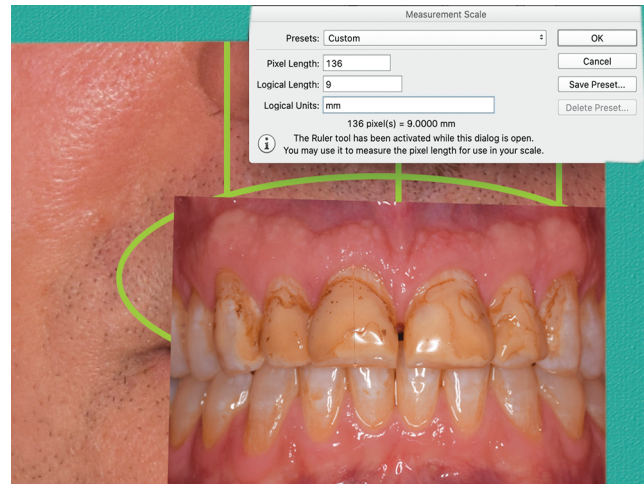


**Fig. 4:** Custom measurement scale created. Adobe photoshop measured the distance from the gingival margin to the incisal edge to be 136 pixels. The logical length was entered to be 9 and the units changed to mm

opacity—the opacity of the photograph is easily changed by adjusting the layer opacity which is seen in the layers panel on the lower right side of the software.

- Determine your known point of reference. Using a periodontal probe or measurement device, measure the central incisor intraorally or on the diagnostic cast. The central incisors are used because they are generally easier to measure and mark on photographs, but other teeth or stable structures may also be used. In this example, the clinical crown of the maxillary right central incisor measure 9 mm. This number will be used in the following step with the custom measurement scale feature.

- To input the incisor measurement into the software and to allow it to program accordingly, select the "Image" option in the Photoshop main menu while making sure that the intraoral picture layer is still selected. Select "Analysis" > "Set Measurement Scale" > "Custom" (Fig. 3). The custom measurement scale will allow us to use our known point of reference (i.e., the right central incisor) to program the software into putting everything else into perspective. In this example, we told the software that the 136 px measured on the right

central incisor are equal to 9 mm. The rest of the pixels are put into perspective. The logical units are now changed to millimeters (Fig. 4).

- In the layers panel, move the intraoral photograph layer and place it below the analysis lines to allow for the smile design process to be done within those pre-set parameters.

- Create or select a suitable tooth mold to use for the smile design. Sundar and Chelliah[9] described a technique to create a personalized tooth mold from smiles of your choice, but many preset molds are also available for use.[10] The design choice will depend on gender, age, and face shape, among other factors. Figures 5 and 6 show the selected tooth shape and size for this patient. In Figure 6, the teeth on the right side have been cut at the lip line using the lasso tool to allow for better visualization of the end result.

- Once happy with the smile, use the ruler tool to measure the length and width of the proposed smile design (Figs 7 and 8). The software is now calibrated based on the measurements that were input previously, and the output values can be used to guide the wax-up. For this case, the proposed tooth length
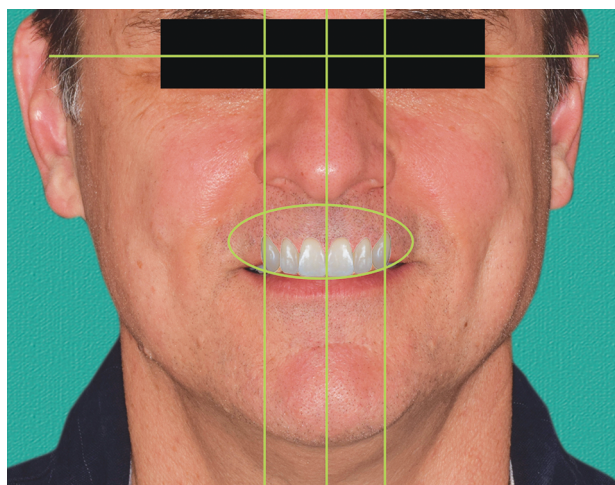
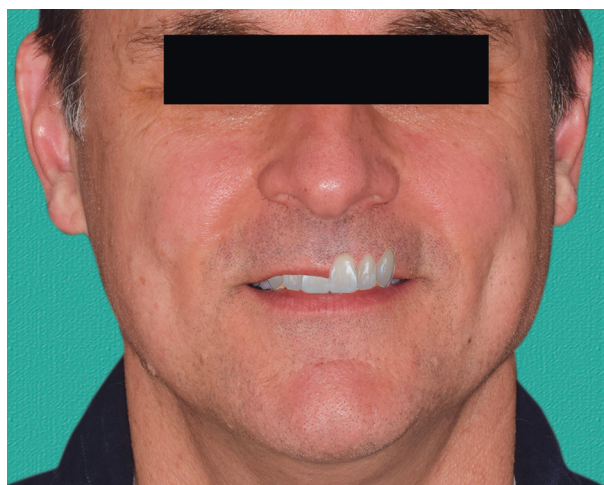**Fig. 5:** Smile was designed using the analysis lines as a guide



**Fig. 6:** Smile was designed using the analysis lines as a guide. Teeth have been cut on the right side to visualize end result
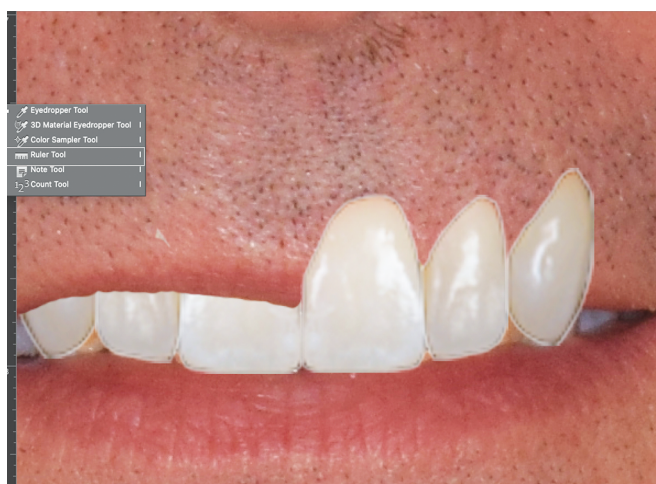


**Fig. 7:** Finding the ruler tool to measure the dimensions of the proposed smile



**Fig. 8:** Using the ruler tool to measure the proposed tooth height shows the maxillary left central incisor to measure 9.96 mm, which can be rounded up to 10 mm



**Fig. 9:** Wax-up created based on the length and width measurements obtained from the virtual smile design. The gauge shows the maxillary right central incisor to measure 10 mm in length

is 9.96 mm, or 10 mm if rounded up. Figure 9 shows the wax-up created for the patient, based on the measurements obtained from the smile design.

## Discussion

Adobe Photoshop, a readily available photograph editing software, can serve as a powerful tool with multiple advantages for dentists planning esthetically demanding cases. Although there is a learning curve with the software, the tools described in this technique article are basic. Because Adobe Photoshop is a non-dental software, tutorials are available on the Internet that introduce these basic tools and provide help to those with an interest in digital design to utilize the software for treatment planning, communicating with patients, and guided wax-ups.

One main advantage to utilizing this technique, in particular, is that it allows the dentist to present to patients only those options which are realistic and feasible, given the clinical presentation. This is because the proposed two-dimensional design will have

already been waxed-up on an articulator. Designs that may not be feasible will be identified by the laboratory early on. Thus, the risk of conveying unrealistic expectations to patients is minimized.

To understand the limitations of the use of programs like Adobe Photoshop, it is crucial to return to, and understand, the basics of digital imaging. In essence, digital images can be divided into two groups: bitmaps and vectors.[11] Most images found on the Internet are bitmap, or pixel-based, images. These images are also sometimes referred to as raster images. Pixels are a series of tiny squares, each with a different color, that make up an image. The two main drawbacks of bitmap images are the large file size and inability to appropriately scale them.[11] The term "pixelated image" describes a bitmap image that has been re-scaled beyond its pixel capacity—this largely depends on the resolution of the image. Resolution is a term that describes the number of pixels per inch in an image. The higher the pixel count per inch, the higher the resolution and, as a result, the better an image can be scaled.

The other type of digital image is known as a vector image. These images are not based on pixels, but rather use mathematical formulas to draw curves and lines. These are then combined together and manipulated to form an image. The drawbacks of bitmap images are overcome in vectors—they can be scaled without distortion and are generally much smaller in size. This is because the mathematical formula is simply used to re-draw the image at a larger size.[11]

Due to the limitations of using a pixel-based software like Photoshop, the above-mentioned technique can only be used for guided wax-ups and does not allow the restorative dentist to skip the usual steps of mockups, temporization, and adjustments before fabrication of the definitive restorations. A disadvantage of the proposed technique is the potential for operator error, as it is subject to the clinician's ability to take high-quality photographs at appropriate angles, to accurately align the photographs, and to select the most suitable pixels at both the cervical margin and the incisal edge.

## Conclusion

The article presents clinicians with a simple technique of creating a guided wax-up based on a virtual smile design by using the software, Adobe Photoshop. This technique is completed without the complexity of mathematical formulas and depends upon the utilization of the custom measurement scale feature found within the software. The use of this technique allows the restorative dentist to achieve more predictable esthetic results and provides the laboratory technician with quantifiable measurements that they can use to bring the vision of the dentist to life.

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