VisagiSMile - Dental Software for Digital Smile Design

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Abstract:

For achieving an optimal esthetic result from a dental treatment we need to create a suitable smile design that creates a perception which fulfills the esthetic expectations of the patient. It is also important that the teeth proportions to be correctly diagnosed and designed before an irreversible restorative dental procedure to be done.

Excellent quality digital smile design software products exist on the market. However these solutions do not apply in its fullness the visagism concept which produces a smile design in relation to the facial type and personality of the patient which is perceived as more harmonious. The visagism concept has been recently applied in the dental software "VisagiSMile" which helps clinicians to personalize and improve smile designs.

VisagiSMile is a software that automates the process of creating personalized digital smile design. VisagiSMile is a multiplatform web application for aesthetic dentistry which does not require installation, but only a simple registration process to get started. All cases and data are stored on a server to allow dentists to work on different devices and platforms – computers, tablets and smartphones. The research on the visagism concept is an ongoing process which constantly changes the requirements for the software. With the ongoing development of the software as an agile web application new versions are released every few weeks. Future plans include improvement of the accuracy of algorithms and of the teeth designs. Together with the product development, VisagiSMile's user base also grows with over 1000 currently registered dentists.

Keywords: dental software, aesthetic dentistry, visagism, web application, digital smile design

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INTRODUCTION

Nowadays the availability of information and the technological development in the field of aesthetic dentistry have led to increased patients' demands which have driven dental professionals to certain questioning about customization. When planning clinical cases, ignoring the individual psychological characteristics of the patient may lead to

dissatisfaction, even when all the classical rules and established standards of aesthetics are being used.

Concepts, techniques, and materials by which dentists establish new smiles with minimally invasive approaches and maximum natural effect on the restorations are applied in aesthetic dentistry, in the same time restoring the mastication and phonetics to achieve better quality of life. Besides the aesthetic rules established throughout time, the emotional expression of the treatments, represented by the shapes and lines constituent of a smile, should also be taken into consideration when creating a customized and personalized treatment plan.

The concept of "visagism" can help dentists perform restorations that correspond not only to the esthetic, but also to the psychological features of the created image, which affects the emotions, identity, behavior and confidence of the patient. On the other side, these factors affect the way the patients react to the definite treatment [13]. The visagism concept has been recently applied in the dental software "VisagiSMile" which helps clinicians to personalize and improve smile designs [17].

DIGITAL PLANNING OF AESTHETIC DENTISTRY CASES

For achieving an optimal esthetic result from a dental treatment we need to create a suitable smile design that creates a perception which fulfills the esthetic expectations of the patient. [4] [12] It is also important that the teeth proportions to be correctly diagnosed and designed before an irreversible restorative dental procedure to be done. [3].

Excellent quality DSD (Digital Smile Design) software products exist on the market, such as DSD 2D [5], Smile Designer Pro [15], Planmeca Romexis® Smile Design [14]. However these solutions do not apply in its fullness the visagism concept which produces a smile design in relation to the facial type and personality of the patient which is perceived as more harmonious. When creating a personalized smile design it is a good practice to apply the "visagism" concept [9].

Visagism applied in aesthetic dentistry is associated with assessment of the facial type, which usually involves subjective judgment, time consuming personality test and complex calculations of the teeth configuration. The numerical results are then visualized as a teeth design crafted by hand, which served for the patient, for the dentist and for the dental laboratory.

VisagiSMile is a software that automates the process of creating creating personalized digital smile design. VisagiSMile is a multiplatform web application for aesthetic dentistry which does not require installation, but only a simple registration process to get started. All cases and data are stored on a server to allow dentists to work on different devices and platforms – computers, tablets and smartphones. The research on the visagism concept is an ongoing process which constantly changes the

requirements for the software [17].

The process of creating clinical cases with VisagiSMile requires two main photographs: one of a full-face with maximal smile and visible dentition and another of the upper jaw with retracted lips and black contrasting tool. The photograph in full-face with maximal smile and visible dentition uploaded in VisagiSMile is automatically placed behind the facial frame. By marking the landmark points on the image, the software automatically analyzes the facial structure and classifies the facial shape as strong, dynamic, delicate or calm (Fig.1).
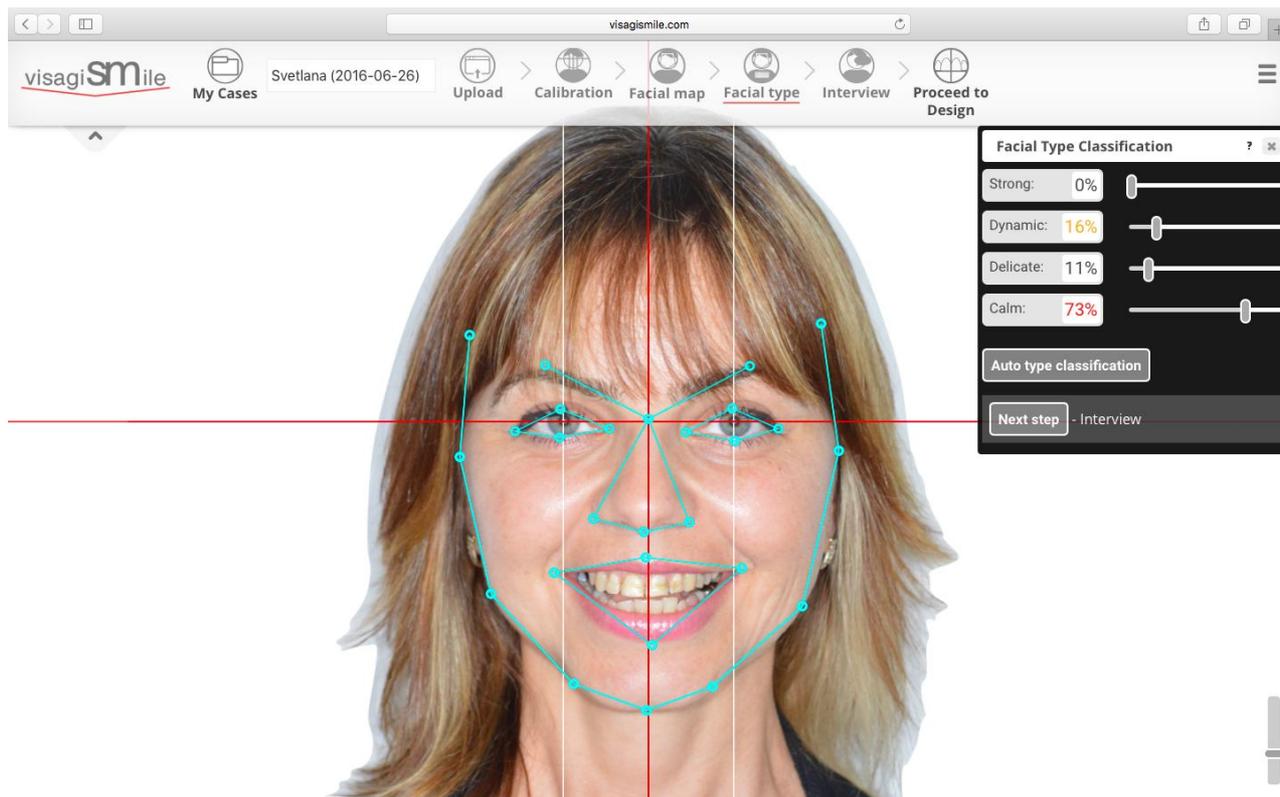

Fig. 1 Facial map with landmark points and type classification.

By analyzing the face, VisagiSMile can automatically calibrate the picture by using the pupils' positions. The software also recognizes the facial features and creates a facial map. The image recognition is performed with the help of Betaface API [1]. The facial map is then used to classify the type of face of the patient. The software currently uses two methods of classification: geometrical approximation and classification trees.

The first method to automatically classify the patient's face is by geometrical comparison of the facial map with the typical maps for different types of faces – strong, dynamic, delicate and calm. This method assumes that all points and facial features from the facial map are important for the facial type. The algorithm was first trained by analyzing 91 faces, classified by an expert dentist. The results of the training are typical facial maps for the different facial shapes which are stored in a database. When a picture of a patient

is uploaded and the facial map is selected by the dentist, the algorithm iterates trough the facial features – the facial contour, the eyes, the nose and the eyebrows, the mouth. It compares each feature to the reference maps and calculates which shape fits best. By using the results for all features, it classifies the whole face (for example 12% strong, 39% dynamic, 49% delicate, 0% calm). When validated on testing data, the geometrical approximation method classified 56% of the cases correctly. The accuracy would be further improved by training the algorithm with more cases.

A more skeptical approach is to assume that probably the points and the features from the facial map are significant for the facial type, but not all of them are important and the significant ones are not equally important. By applying the iterative data mining approach of the CRISM-DM methodology classification models that predict the type of the faces have been created [2][8]. The most effective model for classifying the facial type is a classification tree with 84,24% accuracy (Fig. 2).
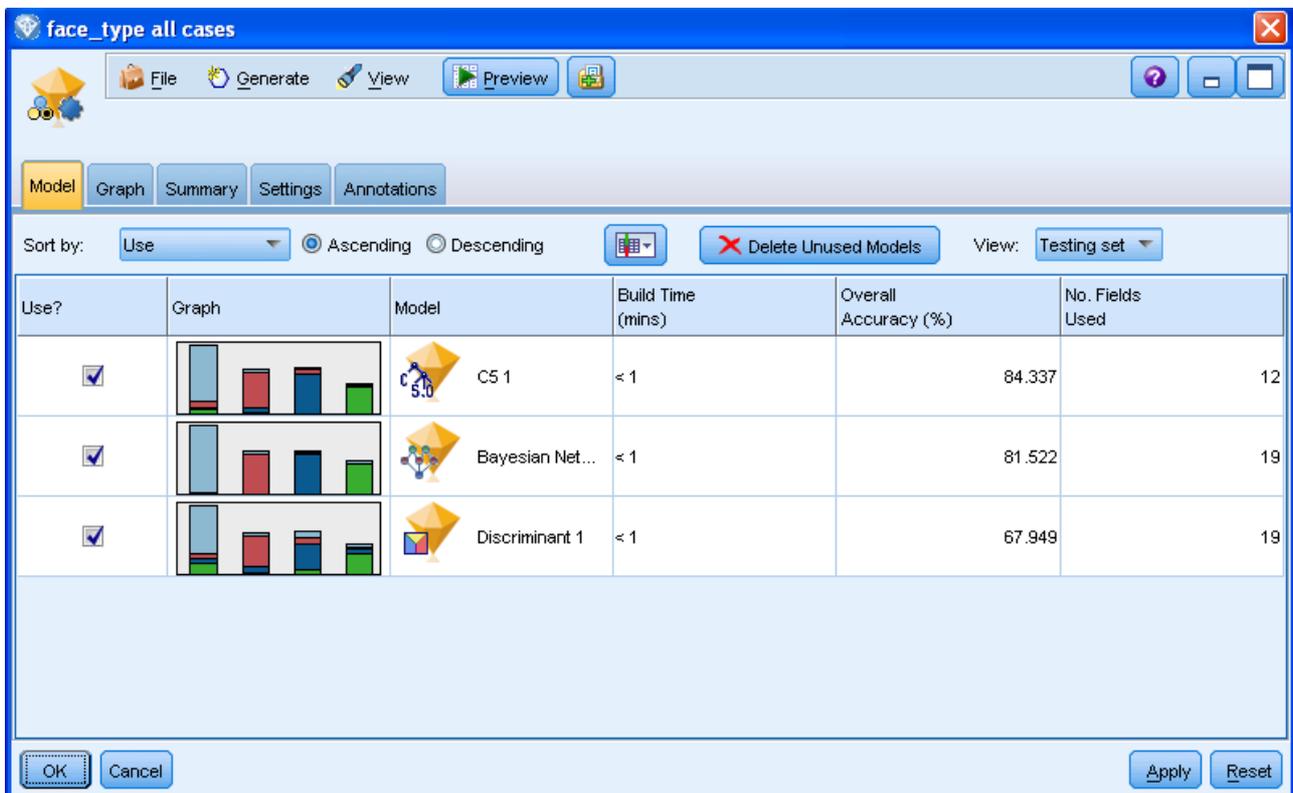

Fig. 2 Classification models created with IBM SPSS Modeler

The optimal tooth shape is determined with an online interview - a questionnaire in the software (Fig. 3). Based on the data from the interview, a software algorithm automatically calculates the temperament, as perceived by the patient – a combination of four types: strong, dynamic, delicate and calm. The tooth shapes matching the individual characteristics of the patient are respectively: strong - rectangle, dynamic - triangle, delicate - circle, calm - square [8].
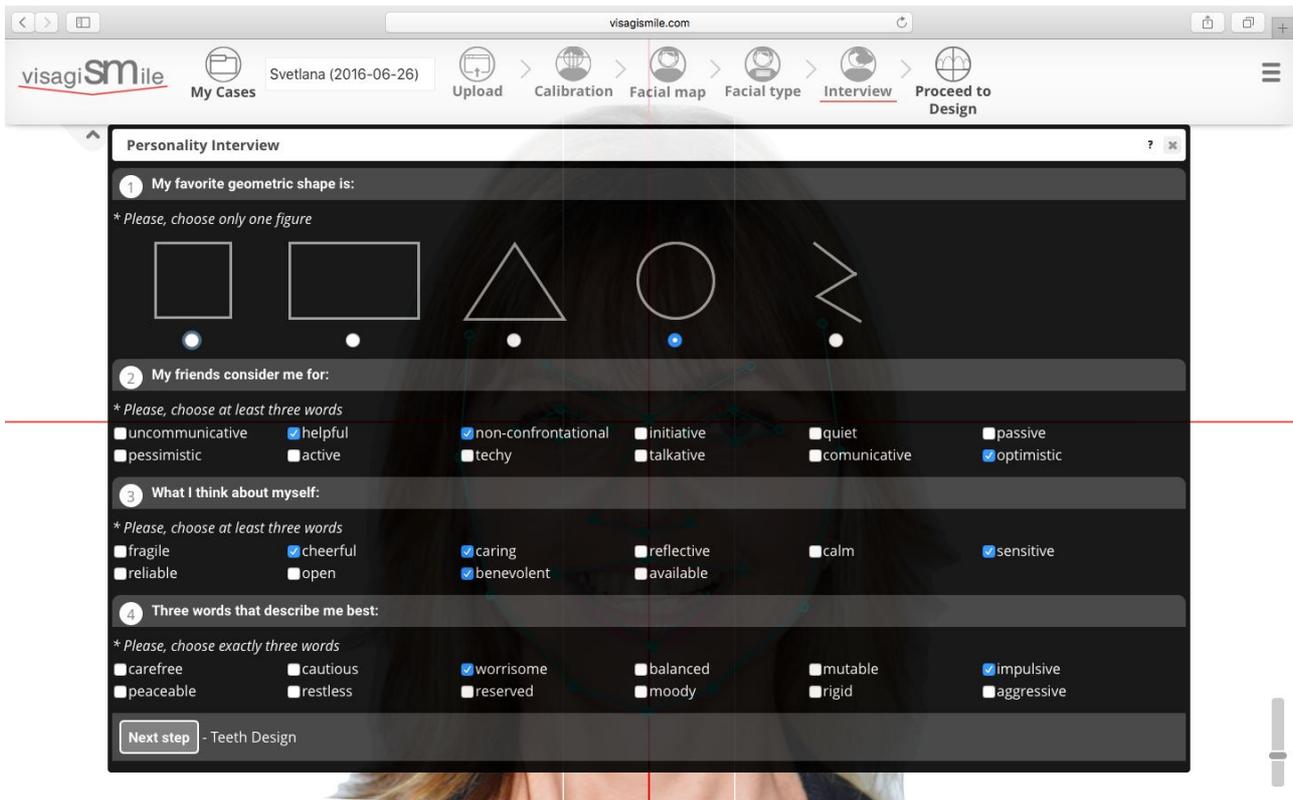
Fig.3 Personality interview.

The patient's preferences about the desired teeth design are also taken into account in the calculation of the suggested teeth configuration. The preferences include characteristics of the teeth related to their color, texture and shape.

According to the facial analysis, the software calculates the main parameters of the individual smile frame: incisal projection, tooth shapes, tooth inclination, dominance, etc. [10][11] The smile design incorporates the data from the interview along with the facial analysis and the patient's choice in accordance with the aesthetic rules (Fig. 4).
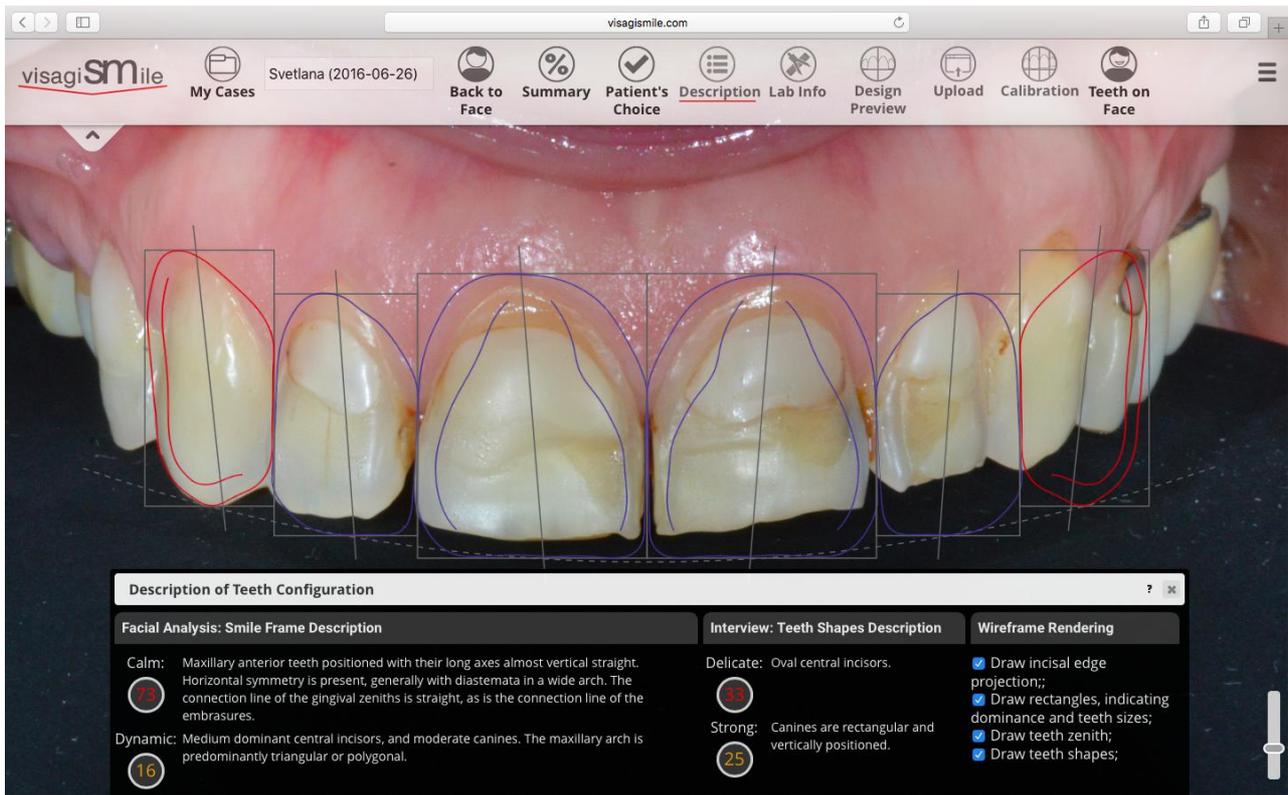
Fig. 4 Final design with detailed text description analysis summery of face reading, interview and patient choice.

The digital smile design project could easily be visualized on the patient's face to allow the clinician to analyze the teeth proportions, the incisal edge projection and other esthetic parameters in relation to the patient's face (Fig 5).
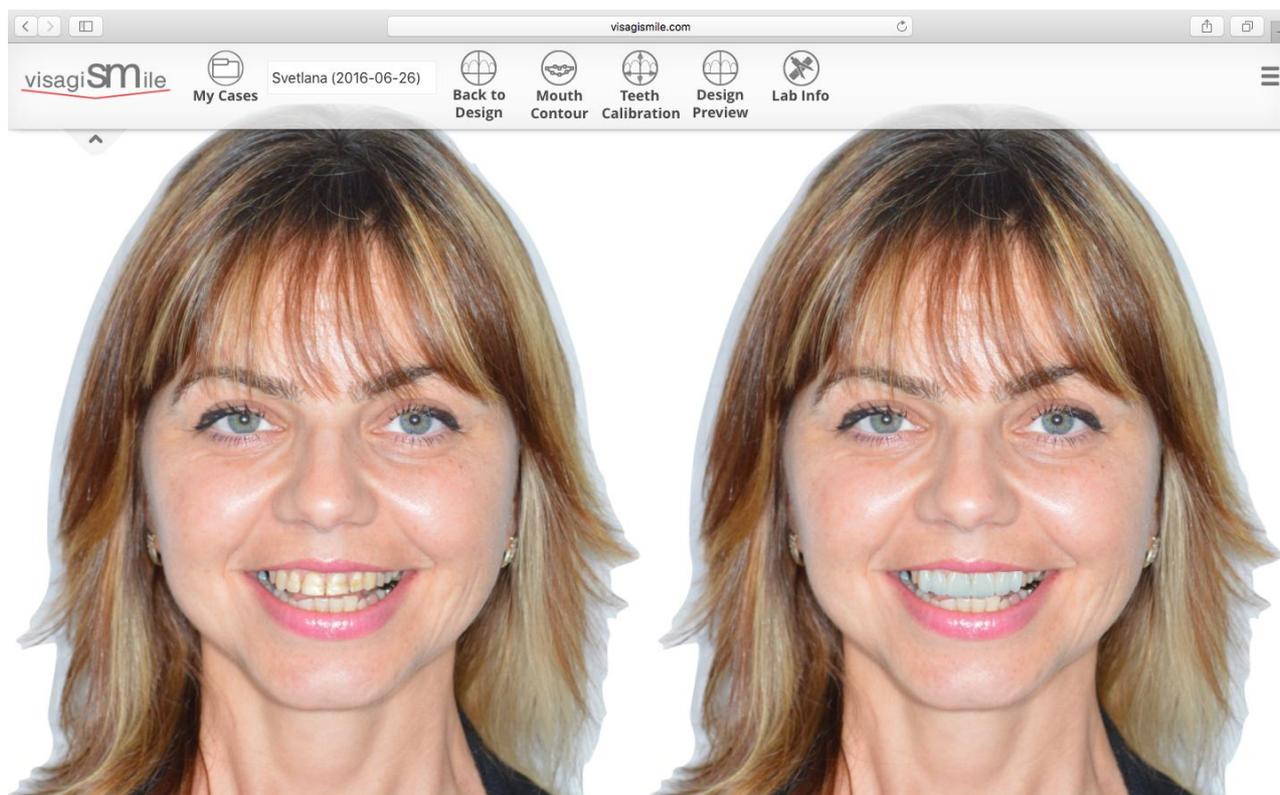
Fig. 5 Final design digitally positioned on patient's face.

The final design can be exported as a PDF or PNG file containing both the graphic of the generated design and detailed information with sizes, correlations, inclines and shapes of the teeth and the whole composition. The file can be sent to the dental technician for a diagnostic wax up according to those references.

SOFTWARE APPROBATION - DIAGNOSTIC PROTOTYPING

The main challenge in the presented clinical case was to go minimally invasive to the teeth structures. The enamel is already worn out and needs to be preserved in order to improve the durability of the treatment. By adding volume on the buccal surface of the teeth on the upper jaw, positioning them more vestibulary, we could expand the arch and became minimally invasive and totally additive in this case.

The diagnostic wax up was created based on the parameters, such as shapes, proportions and arrangement of the front teeth provided by VisagiSMile software's digital proposal (Fig. 6).

Fig. 6 Diagnostic wax up front view

The first additive composite mock up was based on the diagnostic wax up. A self curing composite material was injected into a silicon key and inserted on the non-prepared teeth (Fig. 7).

Fig. 7 First mock up made on the non-prepared teeth.

This first mock up served as a powerful motivational and communicational tool with the patient, showing and explaining all the changes that can be made as the desired final outcome [7][6][9]. New full face and intraoral pictures were made and all the changes were discussed with the patient by comparing the relevant before and after mock up pictures. After acceptance by the patient, the treatment and the following steps were planned (Fig 8).

Fig. 8 Digital workflow-before treatment, digital planning, diagnostic prototyping.

CONCLUSION

VisagiSMile is a novel aesthetic dentistry software which is:

- an important guideline for the dentist when doing the direct mock up, (or concepts like DSD, SKYN etc.);
- an important guideline for the dental technicians to re-create the design desired by the clinicians and the patients;
- a planning tool which helps clinicians to do precise, predictable and adequate smile designs;
- used in CAD/CAM technologies. The generated design can be integrated to the digital planning of dental constructions;
- used as an education tool to save and share cases worldwide.

With the ongoing development of the software as an agile web application new versions are released every few weeks. Future plans include improvement of the accuracy of algorithms and of the teeth designs. Together with the product development, VisagiSMile's user base also grows with over 1000 currently registered dentists.

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