

The art of a personalized smile design



Dr. Galip Gürel

Private practice in Istanbul, Turkey; visiting professor in the Department of Prosthodontics, College of Dentistry, New York University, New York, U.S.



Dr. Braulio Paolucci

Private practice in Barbacena, Brazil



Dr. Georgi Iliev

Assistant professor in the Department of Prosthetic Dental Medicine, Faculty of Dental Medicine, Medical University of Sofia, Bulgaria



Dr. Dimitar Filtchev

Associate professor in the Department of Prosthetic Dental Medicine, Faculty of Dental Medicine, Medical University of Sofia, Bulgaria



Adriano Schayder

Certified dental technician at WELL LAB, São Paulo, Brazil

Esthetics has become one of the most important outcomes of dental treatments. Regardless of the complexity of the case, patients are seeking better-looking smiles. For many years, we, as dentists or laboratory technicians, have been using all the basic esthetic rules in order to properly create a smile design. These rules should be fundamental to the design. At the end of the treatment, the patients should feel happy. If one can evoke this feeling with a smile design, both the dentist and the patient will be satisfied giving and receiving more than standard, well-aligned teeth. However, the final esthetic results may often fail to meet the patient's expectations, owing to a dis-

harmony between the smile design and the patient's identity. Patients' demands and the level of information needed have driven the profession to question itself regarding the customization of smile designs, which if ignored may lead to dissatisfaction with the esthetic outcome, even though all the esthetic principles and rules which tend to establish standards have been taken into account.

The mock-up

Visualization of the smile design will have a great impact on the patient's understanding of the rest of the treatment. It is much more powerful than only verbally explaining what will be done. Prior

to initiating any treatment, it is necessary to visualize the desired outcome. It then becomes possible to formulate the steps required to achieve this result.

Mock-ups facilitate significant improvement in communicating with the patient by showing him or her the potential final outcome of the treatment and allowing an easy comparison of the pre- and postoperative situations, and mock-ups allow the clinician to be able to check the functional aspects. Whether it is a case of worn dentition that requires altering the vertical dimension or just a straightforward veneer case, the esthetic plane of occlusion and function will be based on

the length—incisal edge position—and position of the anterior teeth. It is very difficult to convey the envisioned final length of the central incisors to the patient just by adding composite to the incisal edges of the central incisors; thus, the patient needs to see the whole smile, including the length and position of the posterior teeth. There are different ways to make the mock-up. It can be created directly in the patient's mouth or indirectly either through a wax-up or by using digital tools.

The personalized smile design

Every human being is unique and special and the design of his or her smile should reflect his or her personality. Shape, texture, color and combination of teeth convey direct messages, and when it comes to creating smile designs, dentists must consider the unity of the whole, which means bringing the biology, structure, function and esthetics together with a fifth element, personality. Personality is the quintessential part here, because the other four elements are traditionally laid to balance it like a keystone. Through the large number of smile design elements, such as incisal edge, dominance of central incisors, tooth axis and shape, as well as subelements such as morphological details of each tooth, it is possible to establish, based on the dental scientific literature, which should be determined by the facial typology and which could visually represent the unique personality of each patient, beyond his or her personal preferences and expression of his or her will.

Visual language

Each type of line or shape has a specific emotional meaning.¹ Lines represent the most basic elements of visual language. Horizontal lines, because they conform to gravity, express stability, passivity and calmness, while vertical lines represent the movement of the point against gravity, expressing strength and power, just as inclined lines arouse the sensation of instability, tendency to movement and dynamism. Curved lines are associated with delicacy, sensuality and the feminine gender.²

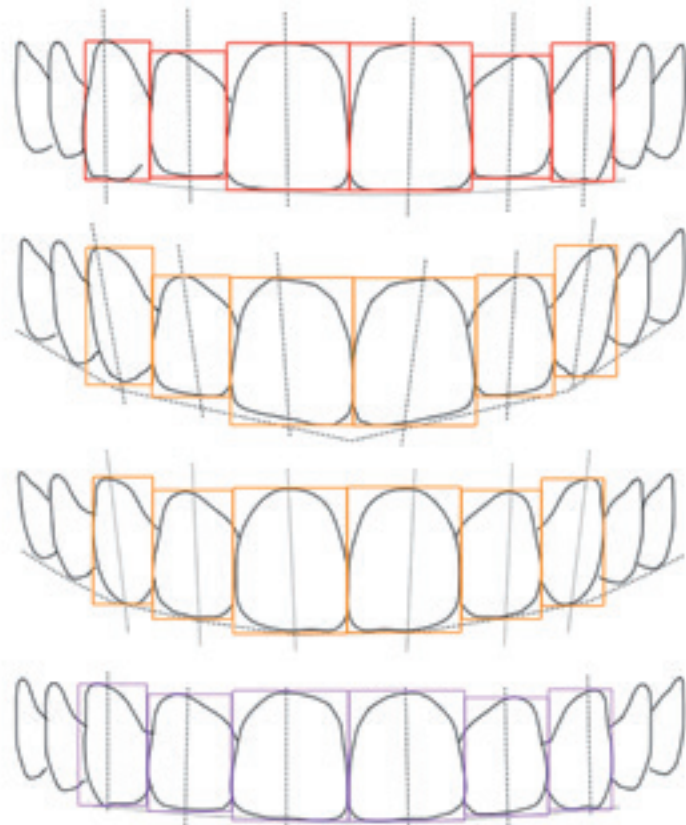


Fig. 1: When the dentist first evaluates a new patient with esthetic concerns, many critical factors may be overlooked. The verbal information exchange should be translated into a visual representation in order to aid in understanding what the final expectations should be at the end of the treatment, for the patient and the dentist. The basic means of this communication starts with a 3D preview of the design in the patient's mouth (APT: Aesthetic Pre-evaluative Temporaries) even before the rest of the treatment is planned. No matter what clinical difficulties a dentist will face and how problems will technically be solved, if the patient does not like the final esthetic outcome, the treatment will be considered a failure.

The combination of lines generates the most basic forms, transferring to them their own expressions. Thus, the vertical rectangle expresses strength by the predominance of the vertical element on the horizontal, the triangle dynamism, the oval delicacy, the square stability and immobility with the balance between its vertical element and horizontal one. These basic shapes can be observed in the facial contour as well as in the incisors' shapes and 3D configuration of the dental arrangement, thus the incisal silhouette.

The visual language knowledge applied to the main expressive elements of smile

design, such as dental shape, incisal edge, interdental ratio or dominance of central incisors, and 3D positioning of the teeth in the arch, determines four smile design types with primary expression (**Fig. 1**):

- Strong: composed mainly of rectangular dental shapes, strong dominance of the central incisors and canines over the lateral incisors (radial symmetry), as well as plane incisal edge and rectilinear 3D dental positioning on the arch from an occlusal view.
- Dynamic: triangular or trapezoidal dental shapes, standard dominance, inclined incisal edge and angled 3D dental positioning on the arch.



Figs. 2a–c: The aim of this esthetic treatment was to enhance the patient's smile. However, additional to all the esthetic smile design basics, the facial analysis and the personality of the patient should be reflected in this design, in order to create the most natural, minimally invasive, personalized smile design.

- Delicate: oval dental shapes, medium dominance, curved incisal edge and standard 3D dental positioning.
- Calm or stable: smoothly rounded square dental shapes, weak dominance (current symmetry), horizontal incisal edge and 3D rectilinear or standard dental positioning on the arch.

The case presentation

The patient had short teeth and was not happy with the narrow buccal corridors and the yellowish color of her teeth (**Figs. 2a–c**).

Esthetic analysis and Rebel Simplicity

Esthetic design can be challenging for

dentists. Rebel (Visagismile) is a recent digital previsualization technique that allows the clinician to:

- efficiently design the new smile;
- improve the communication between the dental team members involved in the treatment;
- obtain better communication and achieve better patient motivation; and
- visualize the final esthetic result even before the treatment is started.

3D Rebel smile design plays an important role in the entire treatment planning and will guide the actual clinical treatment. This approach makes it possible to share the treatment plan among team mem-

bers and to create a 3D visualization of the case in the patient's mouth. The digital project will be tested and approved even before starting the actual treatment. Accordingly, it will allow the dentist to present the treatment solution.

The Rebel workflow

Rebel offers probably the simplest steps for transferring all the necessary information to the Rebel digital laboratory. These are the three mandatory steps:

1. a single mock-up on a central incisor to be digitally scanned;
2. a full-face photographic protocol; and
3. a simple questionnaire.

Single central incisor mock-up and intra-oral digital scanning

A composite mock-up is performed on one (or two) of the central incisors in order to identify the incisal edge position vertically and the position of the facial surface buccolingually (Fig. 3). This is no different from creating any direct mock-up; however, the greatest advantage of creating this mock-up for Rebel is that the dentist does not need to concern himself or herself with the perfect design of this mock-up, meaning that he or she does not need to choose the shape of the tooth (square, triangular, rounded, etc.), the angulations of the axes of the teeth, surface texture, etc. These details of the smile design will be provided by the Rebel artificial intelligence-based software, according to the facial analysis and the personality of the patient. Therefore, this will allow any dentist at any level to start working with mock-ups and end up with high-level wax-ups.

If the dentist does not wish to make a mock-up, then he or she can alternatively write down the additional length that would be needed to be added to the cen-



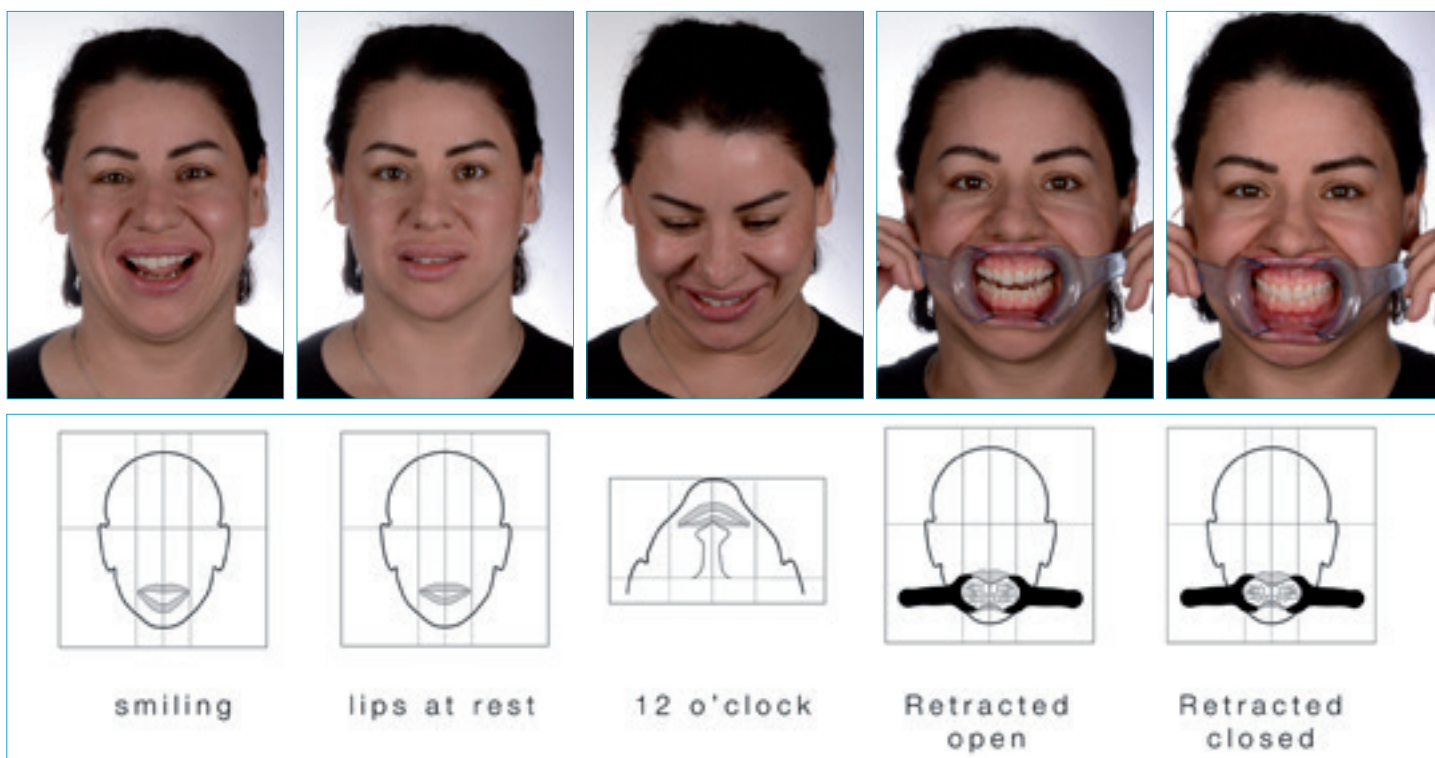
Fig. 3: Once the mock-up on the central incisor has been completed, it should be digitally scanned. It can be scanned with any intraoral scanner that can produce an STL file. Most intraoral scanners convert the 3D scan into an STL file automatically. However, if the dentist does not have an intraoral scanner in the dental practice, an analog impression of the upper jaw (preferably with the direct mock-up done on the central incisors) is taken and sent to the nearest dental laboratory that owns a scanner (laboratories that work with a CAD/CAM machine will have a digital scanner). The dental technician can digitalize this impression for the dentist and upload the STL file to Rebel, in order to complete the order via a provided link.

tral incisors vertically, and the volume on the facial aspect (e.g., 0.3 mm thicker facially). In that case, the dentist can easily relate the existing length of the teeth to the upper lip position with the help of a periodontal probe. This information should be noted (the additional length that is needed to be added to the central incisors vertically and the volume on the facial aspect e.g., 0.3 mm thicker facially)

and included in the file that will be sent to Rebel.

Full-face photographic protocol

The software requires five full-face photographs for facial analysis and classification of the patient and for relation of the 3D intraoral digital scan to the facial features. The following are the five full-face photograph types needed (Figs. 4a–f):



Figs. 4a–f: The forehead and the ears of the patient should be visible. It is crucial to keep the head upright (not tilted to the right or left, or up or down). The eyes should preferably be positioned parallel to the horizon.

Fig. 5: The optimal tooth shape is determined with the help of the interview. The questionnaire is based on popular psychological tests of personal self-assessment. The first question is an adapted test by Dellinger¹⁰ and the other three questions concern personality traits based on the theory and questionnaire by Eysenck and Eysenck.¹¹ The questionnaire is checked by a computer algorithm to classify the patient's personality. Based on the data from the interview, a software algorithm automatically calculates the temperament as perceived by the patient. The temperament is a combination of strong, dynamic, delicate and calm. After this procedure is done, the dentist and/or the technician will have a full idea of the facial analysis and the personality of the patient.

Full-face photograph in rest position

This photograph is for the automatic facial recognition process of the software, and part of the new Rebel smile design will be based on this facial analysis of the patient. Technically, it is very important that the forehead and the ears of the patient are visible. If the patient has long hair, it should be held away from the face. It is crucial to keep the head upright (not tilted to the right or left, or up or down), preferably positioning the eyes parallel to the horizon and keeping the lips apart. The software automatically checks the required full-face photograph and sends a message immediately to the dentist if the necessary technical requirements have not been met so that he or she can retake the photograph.

Full-face photograph of patient smiling

Keep the patient in the same position with the eyes open and parallel to the horizon and the head upright (not tilted to the

right or left, or up or down). This time, ask the patient to keep his or her lips apart in a soft smile (if possible, ensure the incisal edges of the maxillary incisors are displayed).

Photograph of face in 12 o'clock position

There are two simple ways of taking this specific photograph. An easy way is to keep the patient in the same position and ask him or her to incline his or her face 45° forward while giving a full smile, taking the photograph so that it shows the relationship to the maxillary central incisors and the displayed arch position to the lower lip line. The dentist can also move the patient to a supine position on the dental chair and to the 12 o'clock position, ask him or her to smile fully, and take the photograph from a 45° angle.

Full-face photograph with mouth closed and lips retracted

The patient should be asked to hold the

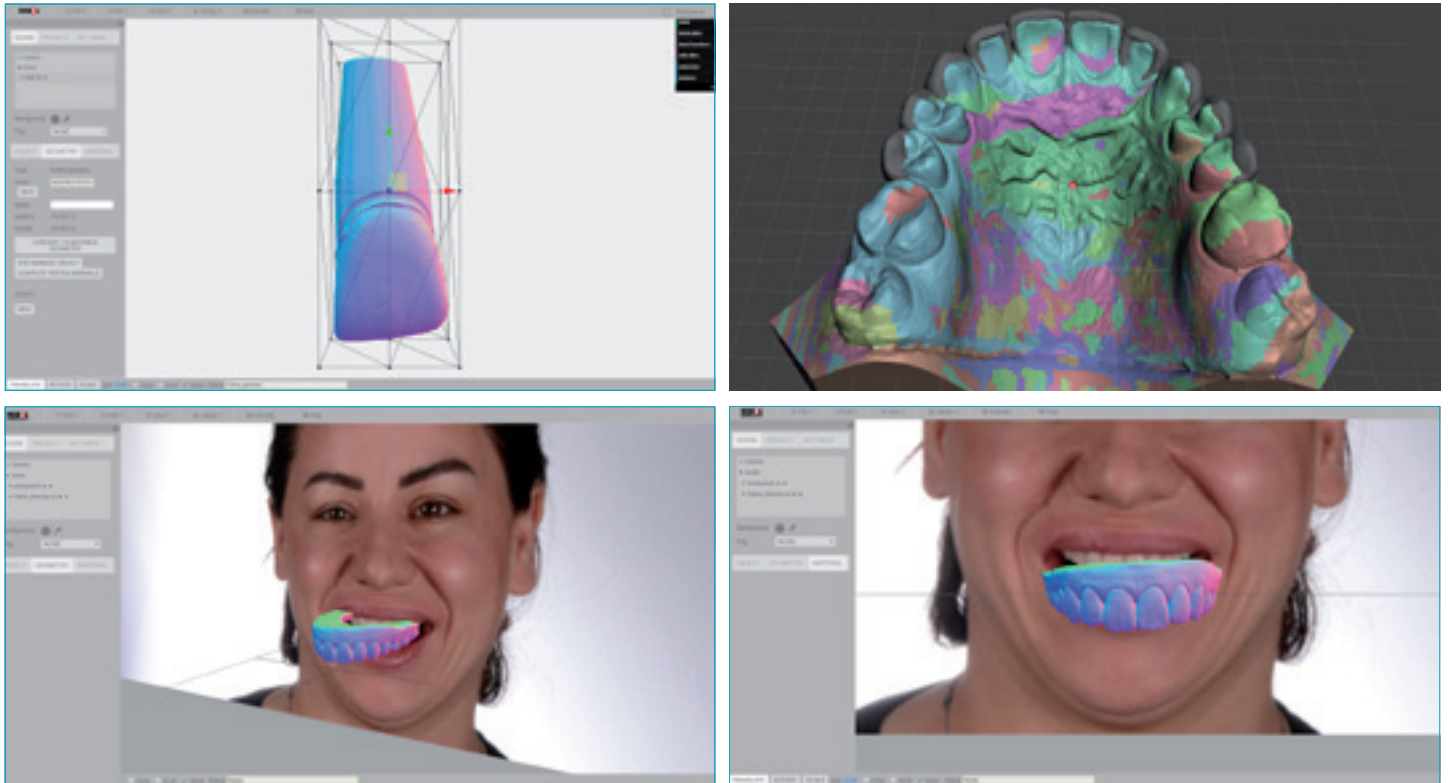
full-mouth retractors, again keeping the position of the eyes parallel to the horizon and his or her head upright (not tilted to the right or left, or up or down), and keeping his or her teeth closed and the occlusal plane parallel to the horizon.

Full-face photograph with mouth open and lips retracted

The same protocol as for the mouth closed should be repeated, but this time with the teeth (upper and lower jaws) separated.

Questionnaire

An interview to reveal the character and the personality of the patient is completed through a questionnaire available in the software and gives the dentist the primary and complementary characters of the patient (**Fig. 5**). The temperamental type of each individual is defined by a unique combination of diverse characteristics of the four main temperaments,



Figs. 6a–d: Rebel is a recent digital previsualization technique that allows the clinician to efficiently design the new smile, improve the communication between the dental team members involved in the treatment, obtain better communication, and achieve better patient motivation thanks to the visualization of the final aesthetic result even before the case has started. By the same token Rebel will enhance the predictability of the entire treatment and guide the actual clinical treatment. This approach allows the sharing of the treatment plan with team members and creates a 3D visual perception of the case in the patient’s mouth. The digital project will be tested and approved before the actual treatment starts and allows the dentist to present the treatment solutions.

and therefore, for a precise and practical evaluation, it is necessary to apply a specific questionnaire.

As the dentist is about to send the three mandatory files, he or she will also be asked to include for the Rebel digital laboratory, a description of the clinical case regarding any specific designs, such as the buccal corridors and perfect imperfections, and the intensity of the surface texture, or choose some of the optional features provided if needed. When the entire Rebel workflow has been completed, the software will guide the dentist to exit, and at a click of a button, the file will immediately be sent to the Rebel digital laboratory via email.

Rebel digital laboratory

It has a very sophisticated simplicity, owing to a very complex software behind it which enables the dentist to do the most simplistic, yet most predictable and personalized, 3D wax-up. For

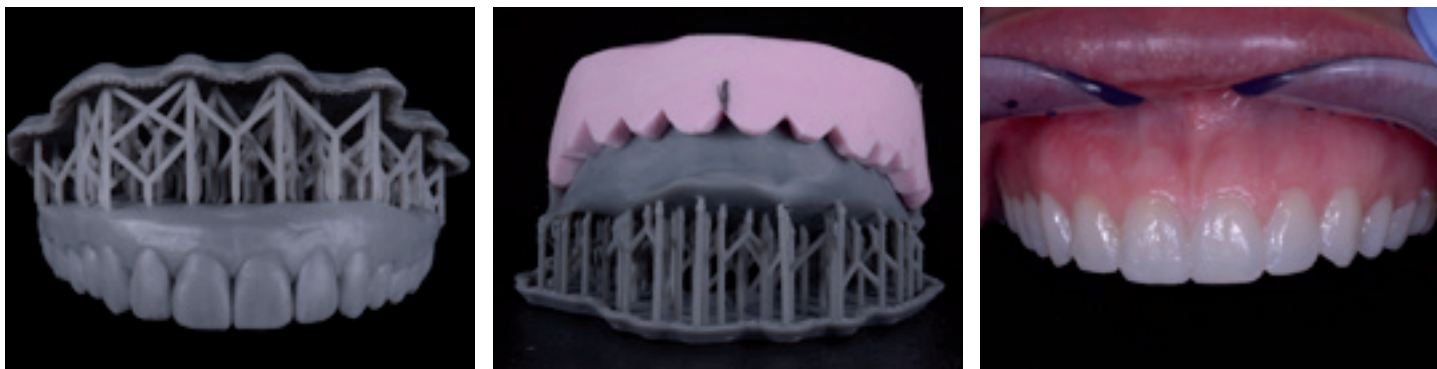
every level of dental practice, reproducible and accessible to all professionals, a concept for smile design customization was developed by Paolucci³ and Paolucci et al.⁴ The concept, called “Visual Identity of the Smile,” arose from the association of different knowledge such as esthetic and functional dental fundamentals, artistic visual language, facial recognition and personality typology. For the objective application of this concept, the Rebel software was developed.

Rebel software is able to perform facial reading, personality assessment and personal preference evaluation of each patient and convert that information into mathematical language. Through preprogrammed algorithms, an initial 2D smile design is created. The software is capable of transforming this 2D smile design into a 3D customized model automatically. The model generation is performed by a custom 3D library,

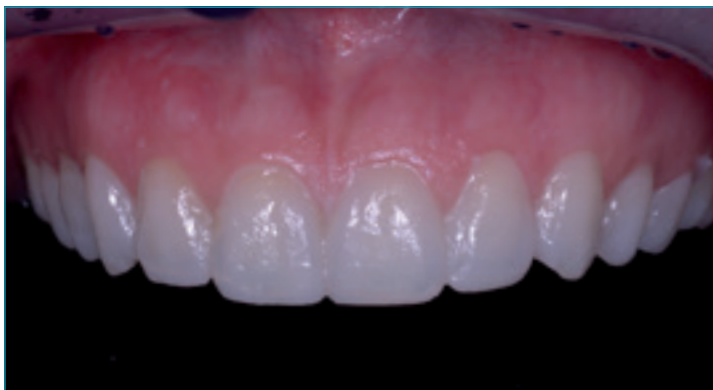
developed specifically for Rebel Simplicity. Every model is personalized according to the proposed tooth configuration.

The Rebel system is actually a virtual laboratory that converts the 2D design into 3D and creates a digital wax-up immediately. The 2D design is created by relating the facial perception and the personality of the patient to the smile design, by applying algorithms for computing the optimal combination of the incisal silhouette, tooth axis, dominance of the central incisors and the combination of individual tooth shapes out of thousands of possibilities. It may sound complicated; however, it is the simplest way of creating one of the best 3D digital wax-ups possible.

Rebel employs very sophisticated artificial intelligence-based software with algorithms; however, it provides great simplicity to the end users, the dentists and dental technicians (**Figs. 6a–d**).



Figs. 7a-d: After the STL file has been 3D-printed (a), the dentist can easily transfer this design to the patient's mouth by making a silicone impression of the digital wax-up (b). The harder this silicone transfer impression, the more precise this transfer will be, in order to duplicate all the details, such as the line angles that give the ideal shape of the teeth, as well as surface texture. This transfer should be done prior to everything. The dentist should evaluate the new design well before starting the tooth preparation with the APT (Aesthetic Pre-evaluative Temporaries) or as the final mock-up. This way, not only the ideal 3D smile design, but also a great 3D communication opportunity, will be given to the dentist and the patient. The final esthetic design should be approved at this time.



Figs. 8a-d: Once the final design has been approved by the dentist and the patient, the dentist can anesthetize the patient and start preparing the teeth through the APT (Aesthetic Pre-evaluative Temporaries). As soon as the teeth have been prepared, it is then the choice of the dentist to continue the case digitally, by taking an intraoral digital scan, or to continue with the conventional analog way. The patient leaves with the provisionals.

Back to chairside/3D printing

This STL file is then sent to the dentist via email, ready to be 3D-printed (Figs. 7a-d).

Tooth preparation through the Aesthetic Pre-evaluative Temporaries

The design of the APT (Aesthetic Pre-evaluative Temporaries). creates a

very solid reference for the tooth preparation. With the use of a depth cutter, the dentist can start preparing the teeth through the APT. His or her work will lead to the most minimally invasive tooth preparation (Figs. 8a-d).^{5,6}

Porcelain laminate veneers are tried-in and after the esthetic acceptance of the

patient and the dentist, they are bonded to the teeth under rubber-dam isolation. (Figs. 9a-c).

Conclusion

The combination of the basic rules of esthetics together with the reflection of the facial analysis and the personality of the patient in the smile design creates a



Figs. 9a–c: In the same way, the laboratory can produce these veneers digitally by milling or using pressable ceramics or utilizing feldspathic veneers. In this case, the material chosen was the IPS e.max Press pressable ceramic (Ivoclar Vivadent), after one-third incisal cut-back and feldspathic porcelain applied on top with the micro-layering technique and bonded to the teeth.

more natural and personalized smile.⁷⁻⁹ This principle presumes harmony between the smile design and the patient's personality. However, in the dental practice, its application has been limited owing to the lack of an objective method for assessing the patient personality and incorporating its results into the smile design.

Currently, Rebel can help the clinician to provide smile designs that consider patients' emotions, sense of identity, behavior and self-esteem. Combining modern digital technologies with the classic treatment rules can be used to achieve predictable esthetic results.

The Rebel concept, which can be applied very easily and rapidly, can help the dentist or ceramist to achieve this goal in the most simplistic, practical and personalized way. The authors' clinical experience

shows a minimum of 80% success in the acceptance of the final smile design treatment. Finally, before any further investigation and research is done, if the result by applying this technique does not satisfy the patient owing to the subjectivity of the matter, the dentist can always make minor alterations in order to adopt this design according to the patient's desires.

References

1. Jung CG, von Franz ML, Henderson JL, Jacobi J, Jaffé A. *Man and his symbols*. Garden City, NY: Anchor Press Doubleday; 1968. 320 p.
2. Arnheim R. *Visual Thinking*. University of California Press, 1969.
3. Paolucci B. Visagismo e odontologia. In: Hallawell P. *Visagismo Integrado: Identidade, Estilo, Beleza*. São Paulo: Senac, 2009:243-250.
4. Paolucci B, Gürel G, Coachman C, et al. *Visagismo: A Arte de Personalizar o Desenho do Sorriso*. São Paulo: Vm Cultural, 2011.

5. Gürel G, Morimoto S, Calamita MA, Coachman C, Sesma N. Clinical performance of porcelain laminate veneers: outcomes of the aesthetic pre-evaluative temporary (APT) technique. *Int J Periodontics Restorative Dent* 2012;32:625-635.
6. Mitrani R, Phillips K, Escudero F. Provisional restoration of teeth prepared for porcelain laminate veneers: an alternative technique. *Pract Proced Aesthetic Dent* 2003;15:441-445.
7. Pashley DH, Tay FR, Breschi L, et al. State of the art etch-and-rinse adhesives. *Dent Mater* 2011;27:1-16.
8. Van Meerbeek B, Yosihara K, Yoshida Y, Mine A, De Munck J, Van Landuyt KL. State of the art of self-etch adhesives. *Dent Mater* 2011;27:17-28.
9. Spreafico RC. Composite resin rehabilitation of eroded dentition in a bulimic patient: a case report. *Eur J Esthet Dent* 2010;5:28-48.
10. Dellinger, S. *Communicating Beyond Our Differences: Introducing the Psycho-Geometrics® System*. Prentice-Hall/Jade Ink, 1989/1996.
11. Eysenck, H. Eysenck, S., *Manual of the Eysenck Personality Questionnaire*. London, 1975; 47p.