

# Smile Design principles and applications

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## What Is Smile Design?

Smile design is defined as the process of creating an esthetic smile based on scientific and artistic guidelines established through studies, perception, and cultural and racial standards that have been recognized over time.<sup>4</sup> Smile design is a dynamic field with evolving trends that take into consideration: facial esthetics, lip dynamics, pink and white esthetics, and personality. Traditional smile design focused on the orodental complex. Modern smile designers must have a global understanding of the entire patient to design the perfect smile. Subjectivity is fundamental when it comes to smile design. Purely scientific smiles are generic, symmetric, and seem fake. Copying and pasting the same smile using the same tooth library and gingival esthetics for each patient results in an un-esthetic result. No 2 smiles are identical, and each smile must take on an identity of its own based on the guidelines outlined later. In the era of social media, it is popular for dentists to showcase artificial smiles. What sets a beautiful smile apart is the integration of organic guidelines to achieve “perfect” results. In essence, embracing nature and its imperfections is the next level of smile design.

### Principles of Smile design :

#### **Facial view: Macro-esthetics :**

The critical elements we look for in the facial view are balance and harmony, or a lack of tension in the composition of the face. We start by observing a frontal view with a full smile and then take two orthodontic measurements from the profile view with the patient in repose. The macro-esthetic elements are as follows:

1. The parallelism between the interpupillary line and the line corresponding to the occlusal plane (drawn between the cusp tips of the maxillary canines .

here we are looking to determine any canting of the maxilla. Clinically, a length of floss can



Fig. 1-4 The macro-esthetic elements.

be used to visualize this.

2. The location of the facial midline in relation to the maxillary dental midline .

this too can be visualized clinically with floss.

### 3. Lip anatomy.

This is viewed in terms of symmetry to the face and fullness of the upper and lower lips. We also assess how prominent or retruded the lips are, from a profile view. The degree of lip support helps determine if the case should be 'built out' facially or not.

4. Tooth exposure at rest. This is one of the most critical elements of facially directed treatment planning. As we know from Vig and Brundo's study, a woman at age 30 shows 3.4 mm of her maxillary central incisors with the lip at rest; at 60 years of age the maxillary centrals are no longer displayed and she shows approximately the same 3.4 mm of her lower incisors. A man shows 1.7 mm of the maxillary centrals at 30 years of age and that same amount on the lower arch at 60 years of age.

This decrease in maxillary central display is due to the loss of muscle tone over time, gravity and wear of the incisal edges. Lengthening the incisal edges of our patients' teeth will thus result in a more youthful appearance. To assess the amount of tooth display at rest, we ask our patients to relax their lips, say the word 'Emma' and then freeze. In the Esthetic Evaluation Form this is the first step towards determining the existing incisal edge position of the tooth to the lips and face. The next thought should be, where is this edge located ideally?

### 4. Nasolabial angle .

This is an orthodontic measurement assessed from a profile view of the patient with the lips in repose.

Typically, we strive for a nasolabial angle of 90°, and thus an angle of less than 90° (prominent maxilla) means the maxillary anterior restorations should be smaller and less dominant, while an angle of greater than 90° (retruded maxilla) means the patient can afford to have their maxillary anterior restorations 'built out'.



Fig. 1.7 Relax the lips, say 'Emma' and then freeze.

## 5. Ricketts' E-plane.

A second orthodontic measurement, also assessed from a profile view, describes the imaginary line drawn from the tip of our patient's nose to the chin. Clinically, we can utilize a length of floss held against these two facial landmarks and measure with a periodontal probe. Ideally, the upper lip is 4 mm from the E-plane and the lower lip is 2 mm away. If the upper lip is greater than 6 mm from the plane then we consider this a concave profile. If the lips are on the plane then there is more of a convex profile. In nature, a maxillary central incisor can be anywhere from 10 mm to 12.5 mm long, and it is appropriate to design maxillary centrals towards the larger end of this range for the concave patient and towards the smaller end of this range for those who are more convex. As a rule of thumb, for the convex patient with a high smile line, the length of the maxillary central should not exceed 10.5 mm.

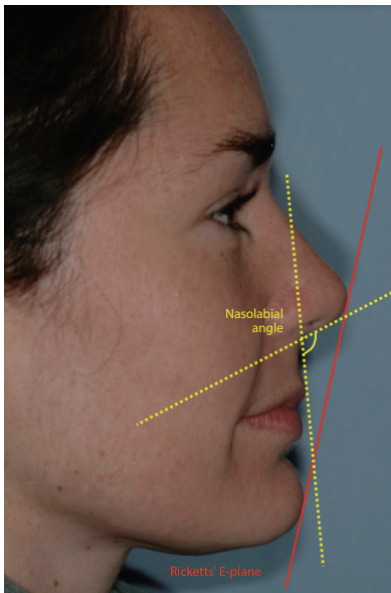


Fig. 1.8 The nasolabial angle.

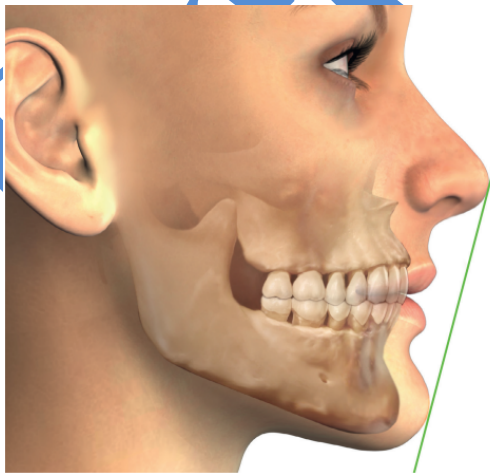


Fig. 1.9 A concave profile. This case can be 'built out' with changing tooth position and tooth size by increasing the length of the maxillary central incisors at the higher end of their range (10–12.5 mm).

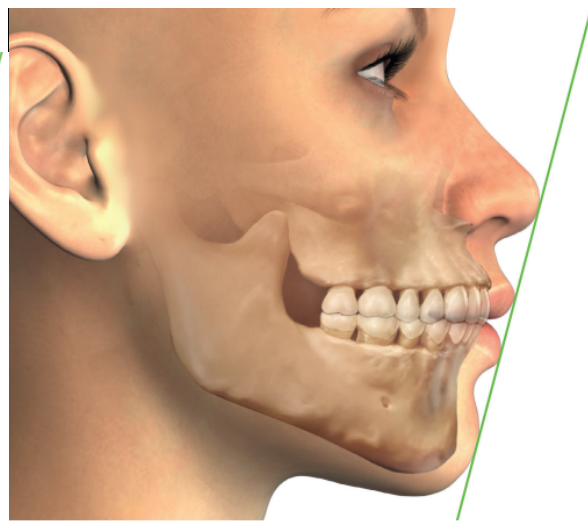


Fig. 1.10 A convex profile. In this case the shape and position of the teeth is downsized.

## Dentofacial view – Mini Esthetics :

This view , comprising of the teeth and lips, deals with the vertical and horizontal components of the smile. We ask for a full, natural smile and assess the amount of gingival display (as a 'high smile line' case will be inherently more challenging). We observe the degree to which the incisal edges of the maxillary anterior teeth echo the curve of the lower lip, count how many teeth show in the smile and check for the presence of excessive negative space bilaterally.

The position of the facial midline in relation to the maxillary dental midline is noted. We know from Kokich's study that the midline can be 'off' up to 4 mm in either direction and will still be inoffensive to the layperson's eye. According to that same study, however, a midline cant is extremely noticeable to most people and thus a higher priority to correct. Phonetics are addressed as well in this part of our diagnosis. We observe the closest speaking space and listen for any lisping as the patient pronounces 'S' sounds .

Next 'F' sounds are pronounced and we look for the incisal edge of the maxillary centrals to just brush against the wet/dry line of the lower lip . The lip should not seem to 'reach' for that incisal edge (tooth too short) nor should the tooth 'trip over' the lower lip (tooth too long).

Note that the 'F' sounds should be pronounced gently, as a forceful pronunciation will recruit the muscles of the lips and give an inaccurate read. The letter 'E' should be pronounced as well, as this mimics a wide smile and is useful to observe.



Fig. 1.11 The dentofacial view.

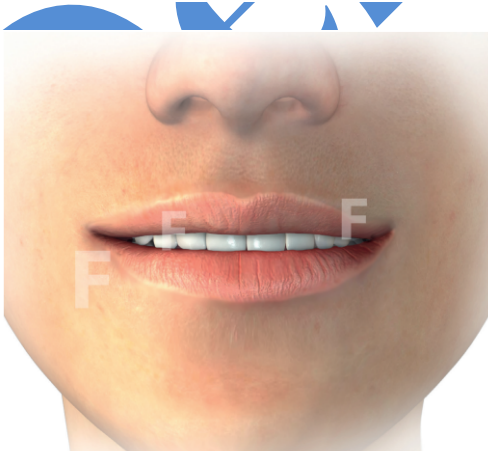


Fig. 1.13 'F' sounds are pronounced and we look for the incisal edge of the maxillary centrals to just brush against the wet/dry line of the lower lip.



Fig. 1.12 Listen for any lisping as the patient pronounces 'S' sounds.

## Dental view: Occlusal analysis and micro-elements

With the dental view we begin by evaluating the patient's occlusion. We then assess the balance between the 'white zone' (the teeth) and the 'pink zone' (the gingiva) and consider 16 specific micro-esthetic elements. The fundamentals of occlusion can be defined as a mutually protected occlusion. Simply stated, this means the front teeth separate the back teeth in all directions without interference ('anterior coupling')<sup>8</sup> and the back teeth support the front teeth in a vertical direction. This beautifully designed relationship works extremely well, as it minimizes premature contacts and interferences that would cause wear and trauma to the whole system. Any interference with complete occlusion, protrusive, and right and left working is identified with articulating paper and noted on the form. We also note which teeth provide guidance in the working positions, whether it is canine guidance, premolar guidance or a 'group function' scenario.



Fig. 1.14 The dental view.

## Micro-esthetic elements :

By analysing these elements we can clearly identify the necessary changes to be incorporated into our diagnostic wax-up:

- Incisal edge position. The position of the maxillary central's incisal edge as it relates to phonetics, function and esthetics. Remember once more that the position of the maxillary central incisor is the most critical aspect of the smile. Once we know where this tooth's gingival margin goes and where the incisal edge needs to be positioned then everything falls into place; the height of that tooth defines its ideal width (roughly 80% of the height, as we know from various studies) and simple biometric guidelines then provide the widths of the other teeth.

Ideally, the edges of the maxillary central incisors and the points of the canines lie on the same horizontal line, with the lateral incisors' edges set above this line.

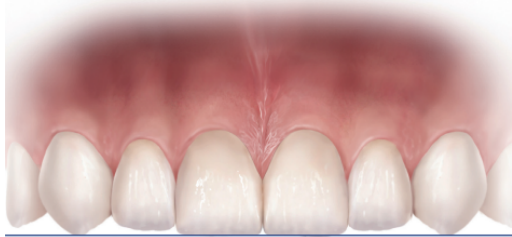


Fig. 1.16 Ideal incisal edge position.

- Soft tissue symmetry. The gingival height of the maxillary centrals and canines should ideally be at the same level, with that of the lateral incisors being 1.0–1.5 mm below this line. This is

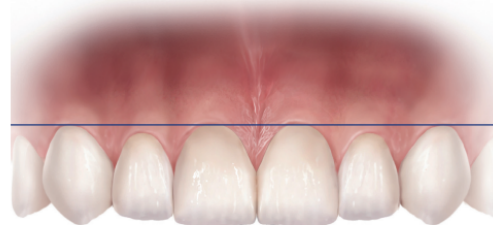


Fig. 1.17 Soft tissue symmetry.

especially critical in the high smile line patient.

- Trigonal shapes. The peak of the gingival seam is highest at the distal aspect of the maxillary central incisor, approximately 1 mm distal to the tooth's midline.

This is often described as a 'gull-wing' effect. The zenith point of the laterals and canines,

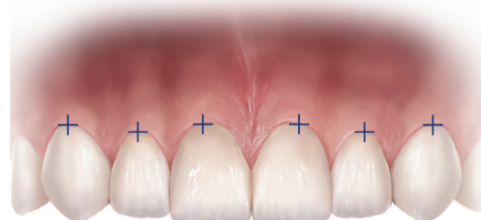
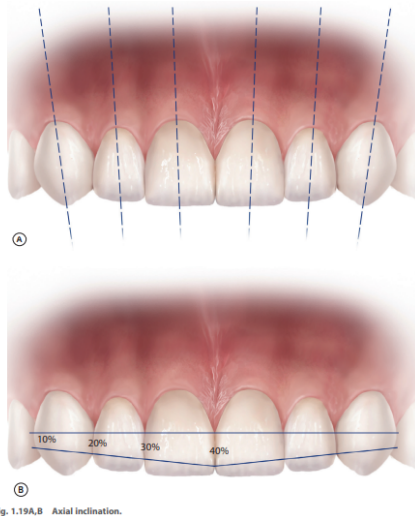


Fig. 1.18 Trigonal shapes.

however, should be centred mesiodistally.

- Axial inclination. The six anterior teeth have their roots distally inclined, with the centrals being the closest to upright and the inclination increasing as we move distally. This subtlety

reflects the position of the underlying roots, as no two structures can occupy the same space.



- Tooth proportion. The width of the maxillary central incisor should be 75–85% of its height .

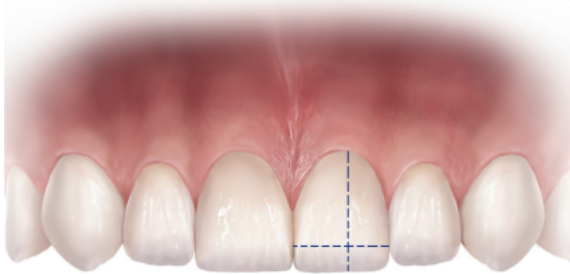
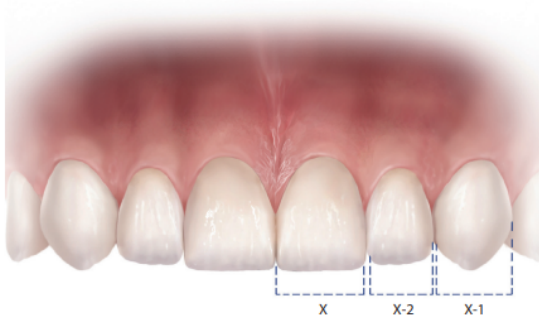


Fig. 1.20 Tooth proportion.

- Tooth-to-tooth proportion .

The latest biometric study from Dr Stephen Chu shows that if the central incisor's mesiodistal width is X mm, then the lateral should measure X-2 mm and the canine should be X-1 mm.<sup>11</sup>

Note that X-1 should account for the entire mesiodistal width of the canine, versus the traditional golden proportion approach that only accounted for the mesial half of this tooth.



- Line angles .

The contour ridges, or line angles, give the outline form to the teeth. Adjusting the line angles of a tooth

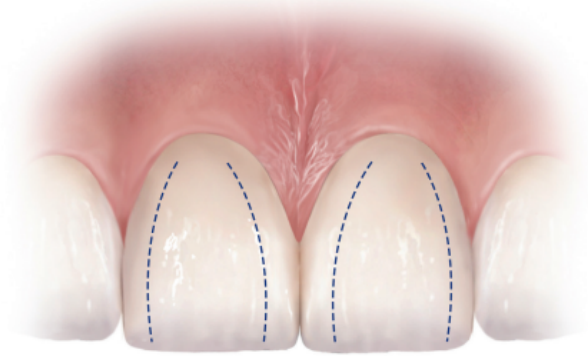


Fig. 1.22 Line angles.

can make it appear wider or narrower,

- Height of contour (labial view). The height of contour should be distal to the midline at the gingival

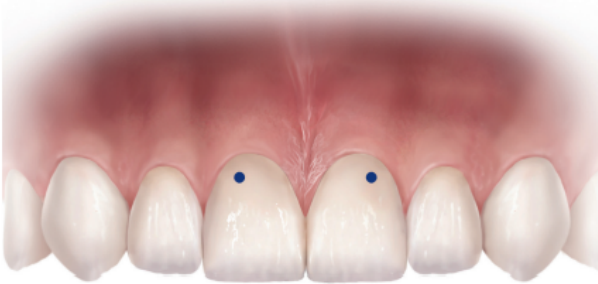


Fig. 1.23 Height of contour - labial view.

third .

- Papilla proportions . The papilla occupies 40% of the space from the contact area to the cemento-enamel junction of the central incisors and stays consistent in this volume from central to lateral to

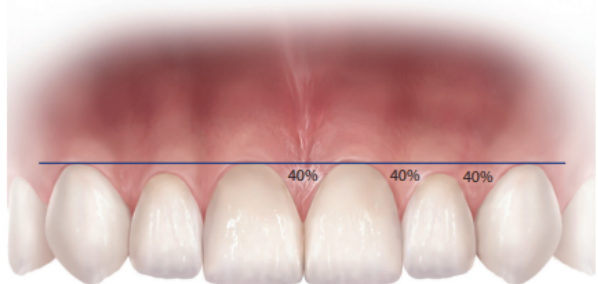


Fig. 1.24 Papilla proportion.

canine.

- Contact area . The contact area between the centrals starts at 40% of the height of the tooth and decreases to 30%, 20% and 18% as we go from the central to the lateral to the canine, and then to the

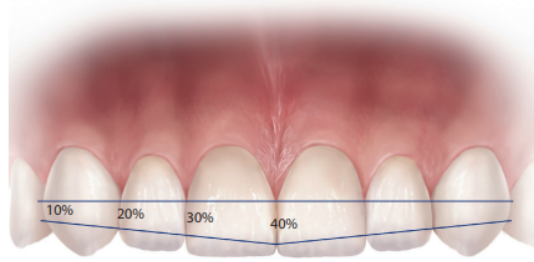


Fig. 1.25 Contact area.

distal of the canine.

- Incisal embrasures .Between the central incisors the embrasure space makes up 20% of the tooth's height. This increases to 25%, 30% and 35% as we move distally.13 Abrasion and wear cause the incisal embrasures to disappear over time, and so recreating these embrasures will give our patients a more

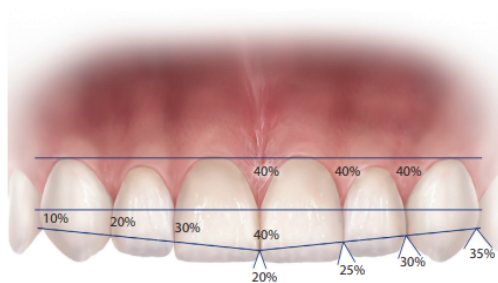


Fig. 1.26 Incisal embrasures.

rejuvenated look.

- Texture. This shows where the lobes of the tooth are formed in development and occurs in both a vertical and horizontal direction. It is an element that gives the tooth a more natural look and we must

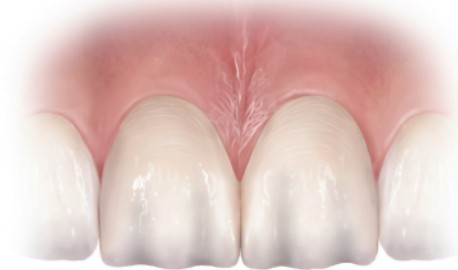


Fig. 1.27 Texture.

ask whether the patient desires this.

- Height of contour (incisal view) . This vantage point shows that the maxillary central's height of contour is distal to the tooth's midline



Fig. 1.28 Height of contour – incisal apical view.

- Profile view. This view shows that there are three planes of the tooth from the cemento-enamel

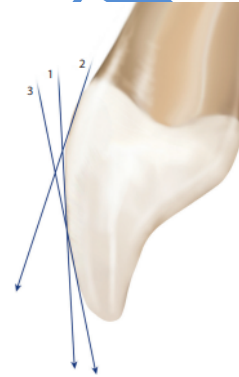


Fig. 1.29 Profile view.

junction, through the body of the tooth, to the incisal edge

- Parallel of curves . The contact points, incisal edges and lower lip should form three curves that echo

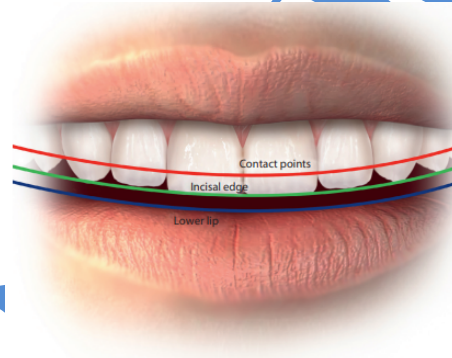


Fig. 1.30 Parallel of curves.

one another harmoniously.

- Incisal edge contour . A 3-dimensional edge on the anterior tooth creates a natural appearance. The edges of worn anterior teeth have well-defined buccal and lingual incisal line angles, and these contours

can be emphasized or minimized depending on our esthetic goals.

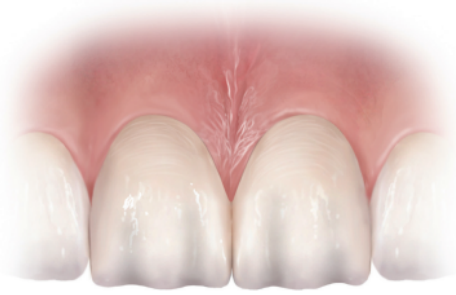


Fig. 1.31 Incisal edge contour.

We indicate, on the form, whether each of these elements is acceptable or not in the existing dentition, and if not our planned improvements are described. By becoming comfortable in this language of micro-esthetics we can communicate meaningfully with our lab technician, and little is left to the imagination.

## **GOLDEN PROPORTION**

The width of the central incisor should be in golden proportion to the width of the lateral incisor and that the width of the lateral incisor to the width of the canine should also be in golden proportion as should the width of the canine to the first premolar. The width of the central incisor should be multiplied by the value defined as the golden proportion, which is 0.618, or approximately 62%. The resultant width of the lateral incisor should be multiplied by 62% to give the width of the canine as viewed from the frontal. This concept of as viewed from the frontal is essential in applying the use of the golden proportion.

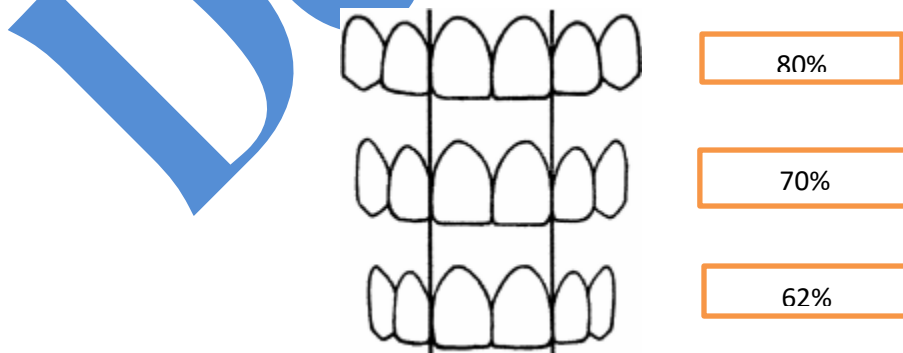
## **REPEATED RATIO**

Lombardi described the use of a "continuous proportion or repeated ratio which has been established between the width of central and lateral incisor and is continued in the ratio of the placement of the remaining teeth and spaces." The proportion of the width of the central incisor and the lateral incisor should be consistent between the width of the lateral incisor and the canine and from the canine to the first premolar moving distally. The ratio between the width of the central incisor and the lateral incisor should be applied consistently to define the desired ratio between the lateral incisor and the canine.

## **RECURRING ESTHETIC DENTAL (RED) PROPORTION**

The golden proportion as defined by Levin is limited to use of the 62% proportion. (The 62% proportion comes from the golden proportion of 0.618). The author believes that when the golden proportion is used, the lateral incisor appears too narrow, and the resulting canine is not prevalent enough. Preston reported that the golden proportion was found in the relationship between the maxillary central and lateral incisors in only 17% of the casts of patients he studied when viewed from the frontal. The concept of evaluating the frontal view is useful, however. The idea of a continuous proportion or repeated ratio as defined by Lombardi opens up the idea of using a continuous proportion not necessarily limited to the 62% proportion. This idea implies, however, that the ratio of the widths established between the central and lateral incisors then must be used as one moves distally. If the elements of both concepts are combined, one derives what the author has defined as the recurring esthetic dental (RED) proportion. The RED proportion states that the proportion of the successive widths of the teeth as viewed from the frontal should remain constant as one moves distally. Rather than being locked into using the 62% proportion, the dentist can use the proportion of his or her own choosing as long as the dentist is consistent while moving distally. Instead of having to accept the proportion already defined by the widths of the central and lateral incisors, the dentist can define his or her desired RED proportion.

The use of the RED proportion gives greater flexibility. In Figure 5, the central incisors are all the same width. Figure SA has a lateral incisor that is 80% the width of the central incisor and a canine that is 80% the width of the lateral incisor. As can be seen, the canine is especially wide and gives the appearance of denture teeth laid out flatly side by side on carding wax. In Figure SB, a 70% RED proportion is used. Several studies that evaluated the ratio of the widths of the maxillary lateral to the central incisor on sample patients reported mean proportions of 66% to 78%.<sup>2, 9</sup> In Figure SC, the 62% RED proportion is used, which corresponds to the golden proportion. Although an approximate 70% RED proportion is preferred by the author, the RED proportion should be modified to fit the face, skeletal structure, and general body type of the patient. A person who is an ectomorph would be more likely to be able to use a smaller RED proportion, and an endomorph would use a larger RED proportion.



## WIDTH-TO-HEIGHT RATIO

Another important proportion that needs to be evaluated is the width-to-height ratio of the central incisor. The preferred width-to-height ratio of the central incisor has been reported to be in the range of 66% to 80%.<sup>2</sup> Mold guides from a denture manufacturer reveal a central incisor with a mean width-to-height ratio of 78%. A width-to-height ratio of 78% has been determined to be the most pleasing to the author. Figure 6 illustrates three anterior tooth displays using different width-to-height ratios. Figure 6A shows an 85% width-to-height ratio, which gives a square appearance. Figure 6B fits into the more normal ratio cited earlier. Figure 6C shows a 65% width-to-height ratio, which makes the teeth appear taller. A tall person would be more likely to be able to use a smaller width-to-height ratio, and a short person would be more likely to be able to use a larger width-to-height ratio.

## USE OF DENTAL PHOTOGRAPHY

Dental photography is essential in evaluating a smile. Photographs provide unlimited time as well as the ability to measure the dimensions and proportions of the teeth. An image taken parallel to the facial plane and at least 8 inches away from the teeth should be used to minimize distortion. The camera lens is not parallel to the entire facial plane but only to the front two teeth and gives a perspective view. If the camera is located too close, the teeth are distorted. A 35-mm camera with a 100-mm macro-lens set at 1:2 magnifications is preferred. A digital camera with similar optical capabilities also may be used. It is important to use a high-quality camera, which gives adequate depth of field, proper lighting, and minimal optical distortion.

## FACIAL IMAGE VIEW EVALUATION (FIVE)

The term used by the author to describe the use of a photograph to evaluate and measure the relative tooth dimensions of a smile is facial image view evaluation (FIVE). A common dimension of a central incisor is measured first on the photograph and then on the cast. The cast dimension is divided by the image dimension to compute a conversion factor, which correlates the size of the image to the actual size of the teeth. The height of the central incisor is preferred, but the width of the central incisor can be used if the gingival margin is not totally visible.

Proportional smile evaluations are based from the smile view as others see the patient, not from casts as dentists see teeth. Figure 7 A shows how the widths of the teeth are determined when using a cast, and Figure 7B shows the resulting view of the anterior six teeth. Figure 7C shows how the widths of teeth are determined when using a frontal view, and Figure 7D gives the facial view of the front teeth. A single reference point in front of the smile is used to make a two-dimensional evaluation of the frontal plane of a three-dimensional smile. To determine properly the appropriate RED proportions of the widths of the teeth, a frontal view must be used.

The photographic image widths and heights of the anterior eight teeth are measured and recorded. The photographic measurements are multiplied by the conversion factor to give the FIVE dimensions. The further distal the dentist moves, the greater is the discrepancy between the FIVE and the cast dimensions.

## **USING FIVE DIMENSIONS TO EVALUATE RED PROPORTIONS AND WIDTH-TO-HEIGHT RATIOS**

Once the FIVE dimensions have been calculated, the RED proportions and width-to-height ratios can be calculated easily. When using the RED proportion, the ratio or percentage of the successive widths of the teeth is being evaluated. The FIVE width of each successive distal tooth is divided by the FIVE width of the adjacent mesial tooth. The FIVE width of #5 (maxillary right first premolar) is divided by the FIVE width of #6 (maxillary right canine) giving a decimal or percentage that is recorded. The FIVE width of #6 is divided by the FIVE width of #7 and recorded. Subsequently the FIVE widths of #7/#8, #10/#9, #11/#10, and #12/#11 are calculated and recorded. According to RED smile design principles, the percentages should be similar. As discussed previously, a value of approximately 70% for each RED proportion is desired. The FIVE width of #8 is divided by the FIVE height of #8 and recorded. The FIVE width of #9 is divided by the FIVE height of #9 and recorded. A value of 78% is desired

## **RED SMILE DESIGN**

Through the combined use of RED proportion and width-to-height ratio, a powerful tool for smile design exists. Figure 8 shows the anterior six teeth with a constant width between the distal of the canines, a constant width-to-height ratio, and different RED proportions. A tremendous difference can be observed in the appearance of the teeth when the width-to-height ratio remains constant and only the RED proportion is changed. Figure 8A shows a RED proportion of 80%. Not only are the teeth squarer, but also they become shorter. Figure 8C shows a RED proportion of 62% (golden proportion), in which the teeth become much taller to maintain the same width-to-height ratio. Figure 8B shows a RED proportion of 70%, which is preferred by the author.

When working with the anterior six teeth, mathematical formulas for calculating the ideal size of the central incisors may be used. The equation used to determine the ideal width of a central incisor from a predetermined RED proportion is:

$$(\text{FIVE width of the anterior 6 teeth}) / 2(1 + \text{RED} + \text{RED}^2) = \text{width of the central incisor}$$

(The RED should be expressed as a decimal < 1.)

Once the width of the central incisor has been established, the height can be determined by using the formula:

$$\text{Width of central incisor} / \text{width to height ratio} = \text{Height of the central incisor}$$

The anterior six teeth are the only teeth clinically in which the individual mesial and distal FIVE dimensions of the teeth can be altered significantly by making changes in the widths of the existing teeth. Because all evaluations are done; using the facial image view, the FIVE widths of the premolars and molars are modified more easily by altering the buccal widths. For this reason, dentists do not use a formula for determining the ideal width of the central incisor to include the width of more than the anterior six teeth.

## **Digital Smile Design**

We begin with the Aesthetic Evaluation Form and understanding our patient's needs and wants, followed by looking at the facial, dentofacial and dental views. A camera is used to document the facial view, analyzing the general anatomical form and symmetry of the face.

The next step is the dentofacial view, where we analyse the positioning of the lips to the teeth, and then the dental view, which helps assess color, tooth shape, translucency, value, zenith levels and the other micro-esthetic elements.

After the complete series of photographs are obtained, we start our reverse digital planning, using the digital smile design methodology.

For a photograph of the patient's full-face smiling, we first orient the head so that it is exactly straight up and down, that is, not leaning to the left or the right. This will help orient the interpupillary line exactly parallel to the horizon. If this is not done correctly, the relationship of the incisal plane to the horizon will be incorrect, which might mask a canted maxilla.

Next, we zoom in and overlay the intra-oral photograph. We can now measure the size of the tooth on a physical model, and can calibrate an image of a ruler against the tooth in the photograph to correlate to the same height.

Next we carefully draw the outline of the new tooth forms, paying attention to the gingival zeniths, embrasures and incisal and proximal lines. The dimensions of these new tooth forms, the new extents of the 'white' and 'pink' zones, are measured via the digital ruler and the information is used to guide the wax-up.

Prior to wax-up fabrication, the digital smile design can be tested virtually by simply cutting and pasting the new teeth into the patient's mouth. We observe the positioning of the lips, gingival zeniths, and shapes and sizes of the teeth. If both dentist and patient are satisfied, the wax-up can be fabricated and an intra-oral mock-up performed.

The gingival levels are corrected surgically, with the periodontist using the digital measurements as a guide.

Immediately following the gingival surgery, a new impression is obtained, a mock-up of the incisal changes is applied to the model itself, and a proper emergence profile is waxed for each tooth at the cervical region.

After 4–6 weeks of healing, a second mock-up – now with corrected gingival zeniths – is applied intra-orally. The Aesthetic Pre-Evaluative Temporary (APT) veneer preparation method is now used, with the veneers prepared directly through the mock-up. The APT technique allows us to be as non-invasive as possible, and the resulting preparations are entirely in enamel

## **The APT Preparation Technique**

This is a preparation method wherein the teeth are prepared directly through the bis-acryl mock-up, ensuring minimal removal of tooth structure. The APT technique is indicated in esthetic cases where the arch is being expanded or length and volume are being added to the teeth, although it can be used in a reductive scenario as long as pre-preparation enameloplasty is first performed.

Once the mock-up is applied intra-orally at the preparation visit, phonetics, esthetics and function are again assessed. Once all are deemed satisfactory, anesthesia is administered and tooth preparation can commence.

Depending on the restorative material and degree of shade shift, either 0.3 or 0.5 mm depth grooves are decided upon and made in a horizontal fashion along the cervical, middle and incisal aspects of the teeth. Pencil marks are made to indicate the extent of the facial depth grooves, so that the mock-up can be removed and the depth cuts blended until all pencil marks disappear. Incisal depth cuts should be made prior to mock-up removal as well. Removing the mock-up will reveal that certain surfaces of the tooth remain completely untouched (i.e. any structure that is approximately 0.6 mm away from the facial extent of the APT), and therein lies the beauty of this method. Once the mock-up is removed, the interproximal and gingival margins can be defined and the preparations are complete.