

The updated application of the golden proportion to dental aesthetics

Edwin I Levin explains the concept of beauty and how the Golden Proportion is not just restricted to teeth

The Golden Proportion is a partial answer to the vexed question, 'what is beauty?' The ancient Greeks believed they had an answer when they discovered that there was a constant proportion between a large and a small in the beauty of nature. This proportion is called the Golden Proportion. Golden, because it seems so noble and perfect with many amazing properties. Abbreviated to the Greek Letter Phi, it was first described by Euclid as one of the 13 elements. Thomas (1956). The Golden Proportion is extensively documented in the general literature: Huntley (1970), Livio Maria (2002) Dunlap (1997) and in specialised subjects Le Corbusier (1954) in Architecture, Lendavi Erno (1971) Music, D'Arcy Thompson (1952) in Biology, to mention but a few. Immortalised by Brown (2003) in the Da Vinci Codes,

Da Vinci (1896) was so fascinated with the Golden Proportion that he wrote and illustrated a book called the Divine Proportion together with his mentor Luca Pacioli in 1509.

An easy method was required to test whether this 'large to small, Golden Proportion, relationship' really exists in the beauty of nature, thus a gauge as in Figure 1 was constructed and then tested on the dominant landmarks in the beauty of nature and art. The answer is profoundly 'yes' in both cases. At any opening it



Figure 1: Golden Mean Gauge

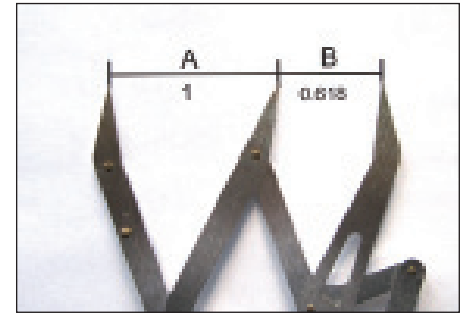


Figure 2: Golden Mean Gauge on Golden Proportion on a straight line

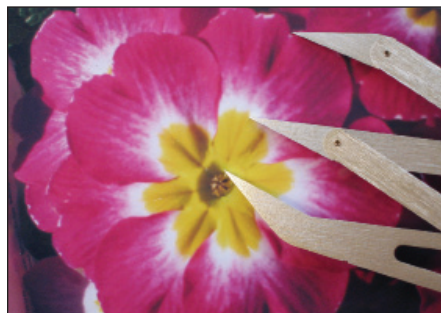


Figure 3: Photograph of flower with Golden Mean Gauge superimposed on the dominant landmarks

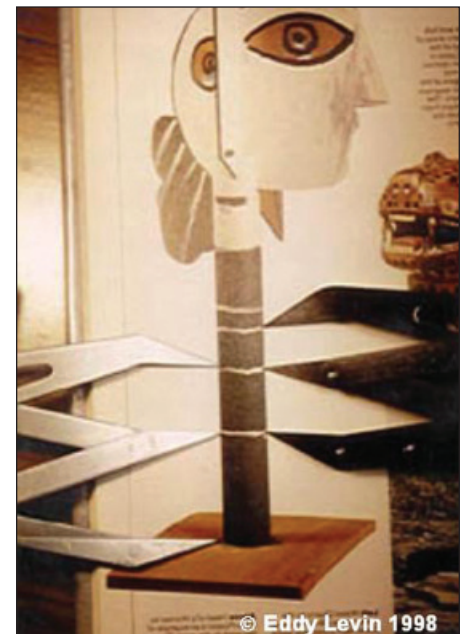


Figure 4: PICASSO showing the dominant landmarks in the Golden Proportion with 2 Golden Mean Gauges. Notice that this vertical pattern is IDENTICAL to the horizontal relationship between the teeth in Figure 15



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Golden Proportion technique for 50 years and retired in 2003. He has written for many publications and has been writing, giving lectures and courses on the Golden Proportion to dentists and laypeople all over the world including the keynote opening talk at the Israel Dental Aesthetics Seminar 2005. Since his discovery of the application of The Golden Proportion to teeth, he has expanded his interest in this concept beyond teeth and has developed a website www.goldenmeangauge.co.uk

will always show the same proportion between the large and the small opening, which is the Golden Proportion, as shown Figure 2.

The images of beauty (Figure 3) in nature, illustrate the three points of the gauge superimposed on the dominant landmarks, of a beautiful flower and (Figure 4) a painting by Picasso. These dominant landmarks are separated by a large and a small space. Amazingly these spaces are nearly always in a fixed proportion to each other, which is none other than the famous Golden Proportion as illustrated by the distance between the points of the gauge in Figure 3. The points of the gauge remain in a fixed Golden Proportion at any opening. The use of the gauge thus makes it easy to assess the Golden Proportion. Picasso in Figure 4 is easily recognisable and it is interesting to see this vertical pattern again when we look at the

horizontal relationship of teeth (see Figure 15) La Corbusier (1954) also used the identical pattern as an architectural module.

These notes illustrate just a few facets of the mystery and magic of this amazing proportion. The understanding of this concept will enable the reader to take a first step on a journey of discovery into an unexpected dimension of



Figure 5: Gold and acrylic crown. Why is the canine so wide?



Figure 6: 'NO'. You cannot use the Golden Mean Gauge at this angle. It can only be used straight from the front and not at any other arbitrary angle

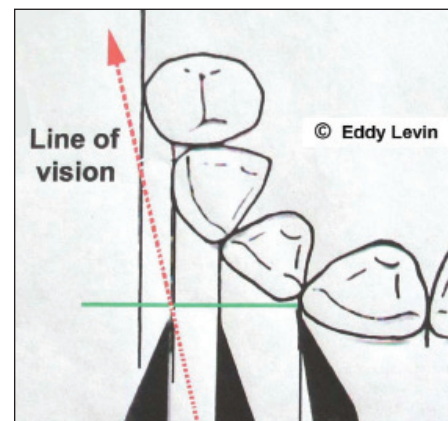


Figure 7: Golden Mean Gauge cannot be used to assess width of canine or bicuspid. Parallax risk much too great

beauty that affects our lives at every turn. It is one of the building blocks of beauty that we can easily apply to our own art and design work, confident of success.

Since my first article in the *Journal of Prosthetic Dentistry*, Levin (1978), there has been an interesting discussion going on in the literature in support of the Golden Proportion. This has been followed by further publications and lectures. Chiche (1994) published a Prosthodontic book with numerous references to the Golden Proportion. Shoemaker, (1987) wrote a series of articles promoting the Golden Proportion as an adjunct to determine good Aesthetics. Nikhat Parveen (2009) illustrated a good summary with the University of Georgia and Baratiari (1995) wrote a book *Esthetics*, with some excellent diagrams illustrating the Dental Golden Proportion.

Most colleagues are getting good results using these principles, which are being taught worldwide and many colleagues incorporate examples of the Golden Proportion in their practice booklets Phillips Edward (2008) with interesting before and after smiles and Rabanus (2003). There are others who prefer using bizarre proportions according to their own taste, not realising the vast extent of the Golden Proportion.

Regrettably however, errors are being made. By using the wrong Golden Proportion tool in the wrong place, it is thereby giving the Golden Proportion a bad name and a good aesthetic result is not achieved.

Figure 5 shows a Golden Mean Gauge superimposed on a drawing of Golden Proportion lines between the central and the lateral incisor, emphasising the Golden Proportion relationship. But, a mistake to be avoided, at all costs, is to try to determine the Golden Proportions of the teeth with the gauge at the chair side.

Figure 6 illustrates the most common, serious error, which is trying to assess the teeth with the gauge by looking at them from the side. They are just not anywhere near the Golden Proportion from this view. Another common error is due to parallax. The arch is curved and the line of sight can cause a very large parallax error as can be seen in Figure 7. This diagram shows that although the gauge, when looked at straight from the front is accurately superimposed on the Golden Proportion lines between the teeth, a slight variation in the line of sight will cause the line of vision to give a huge parallax error, getting worse over the canine and bicuspid.

These risks are easily eliminated by using the accurate paper grids in the mouth. These grids are a template for spaces in the Golden Proportion, between the teeth, from central incisor to first bicuspid, based on the widths of the central incisor, with four grids, varying from 7.5 to 9.0mm. Additionally the grid shows that the width of teeth showing in the smile (bicuspid to bicuspid of the Anterior Aesthetic segment) is in the Golden Proportion to the width of the smile (from lips at one corner of the mouth, to the other corner) as in Figure 8. It is easier to see this in practice than to describe it.

The photograph in Figure 8 shows the Golden Proportion grid being used with natural teeth and demonstrates how well they fit the grid spaces; irrespective of curvature and irrespective of whether the arch is broad or narrow. The spaces of these grids are in the Golden Proportion and the grids will help to solve most proportional problems by giving precise, reliable, aesthetic diagnostic information easily and quickly. Since using these grids the author and colleagues have rarely had complaints about tooth size or proportion. Colleagues are free to

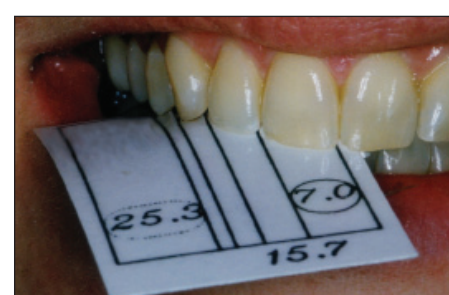


Figure 8: Golden Proportion grid illustrating how well the teeth fit the Golden Proportion spaces. Note that the neutral buccal space is in the Golden Proportion to the teeth showing in the smile

copy these grids from the original article Levin (1978) or obtain more information from the website www.goldenmeangauge.co.uk

The Golden Mean Gauge can be used, with great accuracy on photographs giving remarkable aesthetic diagnostic information, because here the curve of the arch is reduced to the flat plane on the photograph. Similarly you can use a new software system The Phi Dental Matrix (PHI) from Dr. Levin's Phi Dental Grid by PhiMatrix™ at www.phidental.com. PHI is the Greek letter symbolising The Golden Proportion.

The easiest and most reliable way for both patient and Dental surgeon to assess the aesthetics in terms of the Golden Proportion, at the chair side, is to use the inexpensive, hygienic, disposable, paper grids straight in the mouth as in Figure 8 where the spaces representing the teeth are all in the Golden Proportion to each other. An additional benefit is that the patient can also easily follow and observe in a mirror.

Another difficult problem is the question of symmetry, which although very rare in nature, patients do demand symmetry. Indeed, when the teeth are constructed totally symmetrically,



Figure 9: Gold and acrylic crown. Why is the canine so wide?

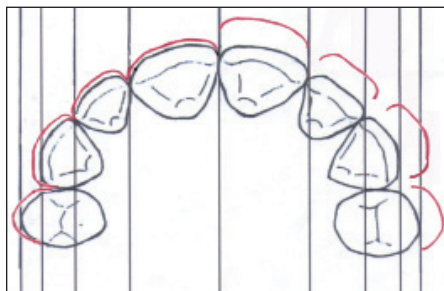


Figure 10: Facings represented by the purple line. The thicker the facing the more it disturbs the Golden Proportion lines

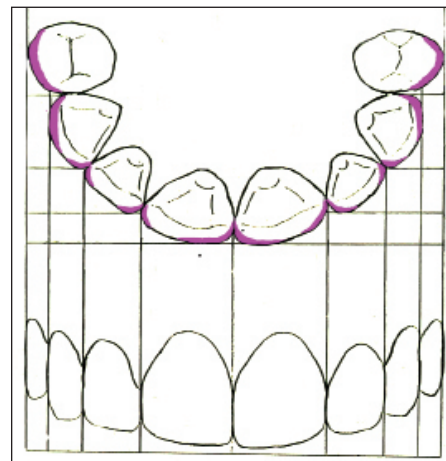


Figure 11: For Facings reduce incisors mainly mesially and distally, but canine and bicuspid mainly buccally.



Figure 12: Different widths of lateral incisor in each of the six pictures. Which one do you like best?

especially in an unsymmetrical face, there is a distinct loss of naturalness and charm. The degree of symmetry must reflect the extent of symmetry in the face.

One cannot talk about the Golden Proportion without referring to its counterpoint, which is the Fibonacci series, as immortalised in Dan Brown's book (2003) *The Da Vinci Code*. Further information on the enchanting Fibonacci Series can be seen on www.goldenmeangauge.co.uk/fibonacciage.htm

Facings

Facings are usually very successful but occasionally they look peculiar. The Golden Proportion helps us to analyse the error. Teeth need to be reduced in special places for the

thickness of the facing and where this is not allowed for, you will find a much wider tooth as in Figure 9 which spoils the Golden Proportion and looks peculiar.

This grossly enlarged width of the canine gives us a clue as to how things go wrong. The photograph is of a gold crown faced with acrylic, popular before the advent of ceramics. For those of us old enough to remember, it was a struggle to remove enough tooth substance to make space for a thickness of gold and then acrylic on top of that. Not surprisingly the teeth were grossly over contoured. Figure 10 shows the outline of the eight front teeth of the anterior aesthetic segment with super imposed Facings drawn in red and no tooth preparation. You'll notice that on the left-hand side the red

lines representing the Facings have infringed the Golden Proportion lines especially around the canine and premolar. Notice also that on the right side of the diagram, there is an exaggerated thickness of the facings. This diagram illustrates the huge embrasure spaces that need to be closed by widening the facings and explains why the gold/acrylic canine is so wide. The canine takes up all the excess space. It also gives a guide as to the best way to prepare the teeth properly as shown in Figure 11. This diagram shows that to maintain the Golden Proportions between the teeth, it is necessary to remove tooth substance mesially and distally on the central and lateral and buccally on the canine and premolar.

An interesting study on the Golden Proportion in the British Dental Journal by Bukhary et al (2007) showed six photographs with different widths of the lateral incisor (Figure 12). People were asked to choose which looked best. Not surprisingly the lateral incisor closest to the Golden Proportion came out best. Figure 13 shows the favourite of these pictures with an enlargement to the left. The lines are drawn by a very useful new piece of dental software made to determine the Dental Golden Proportions digitally (PhiDental). Note in Figure 13, the vertical line goes through the tip of cuspid, thereby establishing that the mesial incisal edge establishes the Golden Proportion. Now in addition to the clinical grids used in the mouth and the Golden Mean Gauge we can now do a Golden Proportion analyses and manipulation with a digital camera.

There have been many attempts in literature to find a relationship between the height and width of the central incisors. Marquardt (1988) showed that the width of the two incisors are

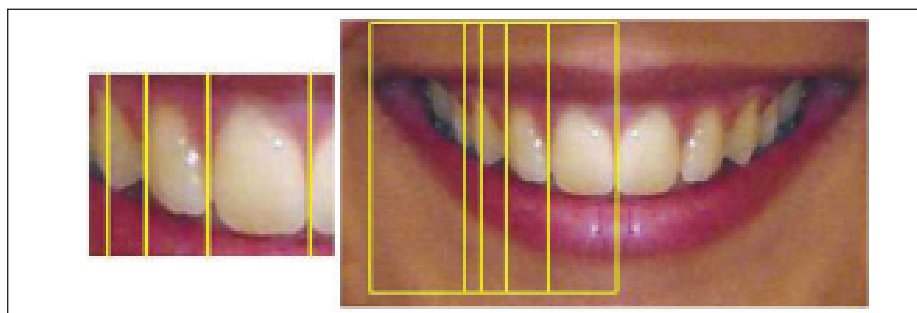


Figure 13: Enlarged view of preferred Figure D which is closest to the golden proportion. Also illustrating the dental Phi matrix software

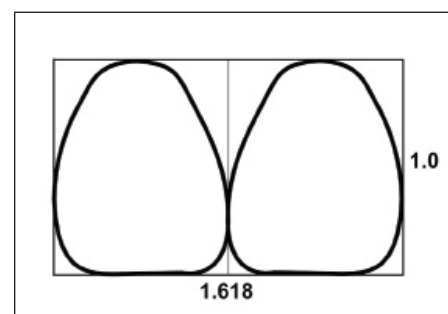


Figure 14: The width of both centrals is in the golden proportion to their height. The golden rectangle



Figure 15: The incisal height divides the lower face into the golden proportion as shown by the gauge

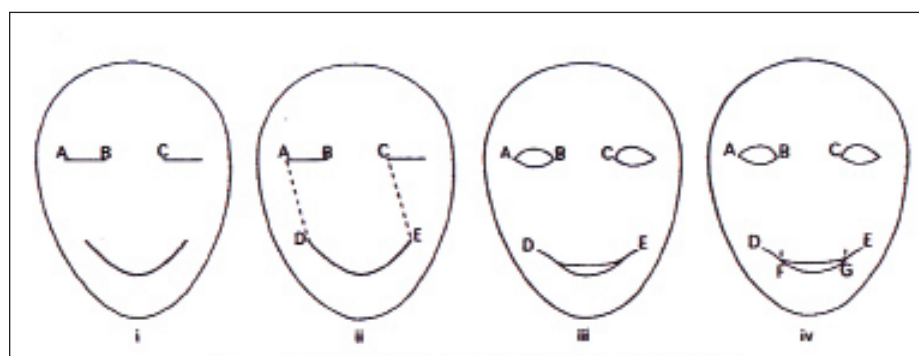


Figure 16: Showing diagrammatic representation of the golden proportion relationship between eyes and teeth.

in the Golden Proportion the height of the incisors (Figure 14). Senior (1958) also made an identical observation.

What is the difference between a smile and a grin? One difference is that the teeth are together in the grin whereas they are slightly apart in the relaxed face with a little free way space in the smile. In this relaxed smile, the incisal edge of the incisors, divides the lower third of the face, from the bottom of the nose to the bottom of the chin into the Golden Proportion as seen on the photograph Figure 15.

Full dentures

One of the major difficulties in establishing aesthetics in full denture work is to establish how far forward the upper incisors should be. The Golden Proportion is able to give us a lot of help in this context. In Figure 16(i) the dash AB representing the eye is in the Golden Proportion to the distance between the eyes BC and furthermore, the distance AC is equal to the width of the smile DE. The reader is advised to look at photographs of faces of people

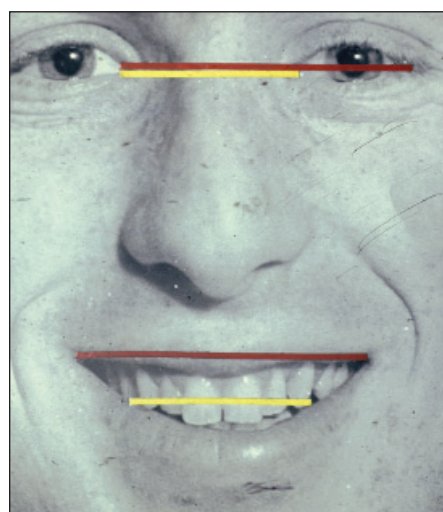


Figure 17: The photograph with coloured strips showing identical golden proportion relationships between eyes and smile



Figure 18: Bilateral Golden proportion relationship of the motor car headlights similar to buccal corridors of the mouth

and confirm these measurements before proceeding any further. Figure 17 illustrates the dimensions to establish.

The width of the eyes refers to the 'white of the eye' only, between the inner and outer red canthus of the eye. FG in Figure 16(iv) represents the anterior aesthetic segment, from first bicuspid on one side, to first bicuspid on the

other side, and this is in the golden proportion to the total width of the smile DE. DF and GE represent the neutral buccal corridors which provide a back cloth to the anterior aesthetic segment of teeth which show in the smile. The buccal corridors can be clearly seen on the paper grids in Figure 8. In the aesthetically pleasing smile, the spaces between the corner of the

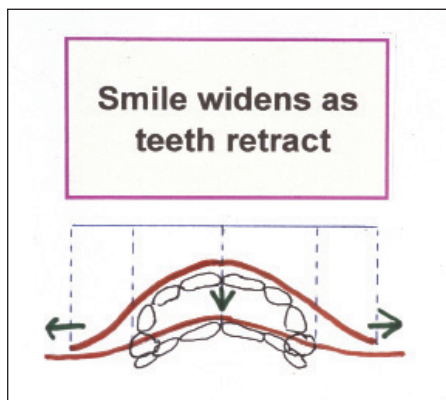


Figure 19: As resorption increases so the smile becomes wider

mouth and the dental arch form the 'back-drop' in which the anterior aesthetic segment is featured and is in the golden proportion to the width of the smile.

Figure 18 shows a common example of this bilateral manifestation of the Golden Proportion in car design. The headlights are in the same golden proportion to the grill work between, as the buccal corridors are to the anterior aesthetic segment.

How much resorption to replace?

Unfortunately the longer a person has had their front teeth extracted, the more resorption takes place and the more the upper lip falls backward, widening the smile as illustrated in Figure 19. (In contrast to immediate dentures where the front teeth are replaced in their exact positions. They are not only usually very successful but also successful for a long time.)

We know from the eye measurement what the width of the smile should be, and we can build it up again close to that level, compensating for all the shrinkage by bringing the upper incisors forward. To find out how much resorption has taken place and how far we can bring the upper incisors forward, you need to measure the distance from A to C on the patient as shown in Figure 16 (i and ii).

From the Canthus of the eye to the contralateral one, this width is equal to the width of the smile. This can be confirmed from the photographs. With elderly patients who have lost their teeth some time ago you will often find that the smile width is much greater than the eye distance. It is unlikely that you will be able to bring the teeth as far forward as you

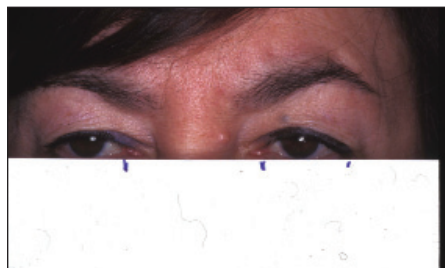


Figure 20: Noting the golden proportion landmarks of the eyes



Figure 22: Comparing the smile width, with the eye widths

would like, because the patient may object to the feeling of their teeth so far forward.

In practice record the measurements A B and C on a piece of card as shown in Figure 20 and then test how close it is to the Golden Proportion and then offer that up to the mouth as in Figure 22 to see how close it is to the corners of the mouth. You can now adjust the width of the smile by thickening the wax flange in the upper incisor area, on the bite blocks, which have been returned to you mounted on an articulator. The more the thickened flange pushes out the upper lip the narrower will the width of the smile become.

Figure 23 illustrates this point. This photograph of a rather nice smile falls down on closer inspection, where one sees a big difference between the attractive full lips on the right side and the lean, long, lips on the left. The prosthesis on the left side has not been built out sufficiently. Notice how the corner of the mouth is extended and the upper left lip is very thin.

Phonetics is another equally important factor in the correct positioning of the upper front teeth. Pound (1973), who had the reputation as the Hollywood denture expert, illustrated the importance of phonetics. He postulated that you need a minimum of one millimetre between the incisors when patients say the sibilants or by counting 60 to 69.

A final interesting fact about the Golden Proportion is that The Golden Proportion is the only number equal to its reciprocal.



Figure 21: Checking that the eye landmarks are in the Golden Proportion



Figure 23: Photograph showing deficiency of lip support on the left

Summary

The summary includes a brief description of the Golden Proportion and is followed by photographs of the beauty of nature and art with the Golden Mean Gauge, superimposed on the dominant landmarks of the picture. Teeth are of course included in the beauty of nature. Errors in the use of the Golden Proportion are illustrated with special reference to Facings. A new, Golden Proportion software program for Dental Surgeons is introduced. Solutions to Full Denture problems are considered.

The five main features of the Golden Proportion applicable to dentistry are summarised as follows:

1. The eight teeth of the anterior aesthetic segment are all in the Golden Proportion to each other Figures 8 and 11.
2. The eight teeth of the anterior aesthetic segment from premolar to premolar, are all in the Golden Proportion, to the width of the smile (as seen from the front) Figure 8
3. The incisal edge of the incisors divides the distance from the bottom of the nose to the bottom of the chin into the Golden Proportion Figure 15
4. The width of the two central incisors is in the Golden Proportion to their height Figure 14
5. The connection of the Fibonacci series with dental aesthetics is referred to. The Golden Proportion is the flipside of the Fibonacci series.

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