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Golden Ratio in Architecture and the Human Heart

BY

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Introduction

Natural and artificial design always contains certain elements that provide the aesthetic attributes of the individual structure or item. These design elements might be unique to the individual items under study but in most cases, exhibit a pattern in the things that are aesthetically pleasing. The most famous of these patterns is the Golden Ratio that is also known as the Divine Section, Divine Proportion, and Golden Mean (Rydén, 3). It was first used in architecture in 2650 BC in the building of the Great Pyramids of Giza (King, 68). The Golden Ratio has also been observed in human anatomy, especially in the bone structure. The pattern of the human body provides a consistency that is harmonious and thought to indicate the perfect nature of human anatomy (Henein, 242). What is the importance of the golden ratio in architecture and the human body?

The Golden ratio is an irrational number (1.618) that emanates from the Fibonacci sequence. Aesthetically pleasing structures and human faces have the Golden Ratio of 1:1.1618 (Tanackov, Jovan, and Milan, 644). In nature, the Golden Ratio is a distinct relationship represented by phi, Φ (Henein, 243). Two numbers are said to be in golden ratio if the ratio of the sum of the numbers (say a+b) divided by the larger number (b) is equal to the result of the large number divided by the smaller number (b/a) (Benjafield and Christine, 423).

Golden Ratio in Architecture

The Ancient Greeks hypothesized on a triangle that had sides related to each other in the golden proportion (King, 67; Tanackov, Jovan, and Milan, 643). It was thought to create a harmony and balance and in some cultures, special magical or mythical properties. While it is impossible to find any unambiguous synthetic application of the Golden Mean, it is presented in architecture as a way of ensuring that the building has a natural and balanced design (Henein, 244). The design hierarchical scaling is not unique to the Golden Mean and can vary depending on which experimentally verified scaling method is being applied.

In natural growth, hierarchical scaling is present in many of the plans and processes that use distinct scales. Natural structures tend to be skewed towards the smaller number hence develop in an ordered hierarchy up to the maximum point (Brinkworth and Paul, 3). The aesthetic elements of the Golden Ratio in modern buildings are thought to provide users with a general feeling of harmony and peace in the design (King, 69). However, it also appears in some standard elements, at least in part. For example, the basic ratio for designing stairs is expected to provide elevation while spreading the individual stairs and their individual elevation in a perfect harmony (Obara, 10). While this does not automatically imply that the Golden Ratio is the base standard, it indicates the need for harmony in design and architecture.

The most important examples of architecture found to have the Golden Ratio in the Notre Dame cathedral's western face and the length to width ratio of the columns of the Parthenon in Greece. The Eden Project in St. Austell in South Western England is one of the most famous buildings designed using the Fibonacci series (Rydén, 6). It is in essence a series of greenhouses that are based on geodesic domes. The Core is an education center built at about $15 million that is designed using plant spirals and the Fibonacci series (Rydén, 4). The building was designed

using the plant spirals and the Fibonacci numbers (Akhtaruzzaman and Shafie, 1). The logo of the building is actually the pattern of the golden spiral on the façade. The logo is known as 'The Seed' and is three hundred million years old (Henein, 239).

The application of the Golden Ratio in architecture is now considered controversial. The Parthanenon, for example, does not bear the ratio as has been claimed in numerous literatures. The length to width ratio is 1:2.25, the height to length ratio is 1:3.56, and the height to width ratio is 1:5.58 (King, 68). Only the height to width ratio is close to the Golden Ratio (Benjafield and Christine, 424). In modernist research, the golden ratio has also been found in areas that were not part of the Great Mosque of Kairouan's original design (Brinkworth and Paul, 2). The Renaissance period, driven in part by the work of Leonardo da Vinci and other artists and architects of the time incorporated the aesthetic elements of individual features and overall design within buildings (Scott and Shikhman, 43). In most of them such as the Parthanenon, the design is not readily visible (Obara, 13). Replicas of it in New Jersey, completed with the parts of the original building that no longer exist indicate the Golden triangle proportions within its structures (Obara, Para. 15).

Another core structure, the Great Wall of China, also has some key Golden Ratio attributes in the columns that are placed intermittently across its length (Vongsheng and Chan, 1). The basis of this is not known, and might be as controversial as the presence of the ratio in the Pyramids of Giza. In the latter, it is known that ancient Egyptians viewed the pyramids as more than tombs and placed a lot of significance in their design and architecture (Obara, Para. 12). Benjafield and Christine (1870) states that " Le Corbusier, the famous Swiss architect, based his entire design philosophy on such systems as the Golden ratio and its core Fibonacci series." The architect saw this mathematical rhythms whose relation is apparent and in harmony. Le

Corbusier's most famous work to utilize the Modulor system of gold ratio proportions, the Villa Stein, has approximate golden rectangles in its inner structure, elevation and ground plan" (Benjafield and Christine, 420).

In modern buildings, the United Nations building also contains the golden ratio in its rectangular proportions. The current UN headquarters in New York was designed by Wallace K. Harrison. The UN was established as a global organization after the Second World War to maintain world peace (Vongsheng and Chan, 3). The lead architect, Harrison, was not known to use the Golden Ratio in his designs but one of the architects in his team, Charles E Jeanneret, frequently used the ratio in his designs (Rebekahm, 290). The most obvious application in the building's design is in the width of the entire building compared to the height of each batch of 10 floors. The Toronto CN Tower, the tallest freestanding tower in the world, also has elements of the golden ratio in its architectural design (Benjafield and Christine, 422). The ratio is present in the ratio of the total height of the building and the elevation of the observation deck.

According to Akhataruzzaman and Shafie (10), the use of the Golden Ratio in architecture must be seen in the context of some of the inconveniences presented by applying some designs. In credit cards, for example, the standard card sizes that are used in determining the length and the width would provide an inconvenient proportion. The subsequent 55 and 89 Fibonacci numbers would also produce an inconvenient design for a credit card, hence the use of the 86mm and the width, 54mm, is a rounding off the 53.75mm that ould provide the Golden Ratio (Tanackov, Jovan, and Milan, 642).

Using the element of inconvenience as a central element, one can see why it is hard for perfect applications of the Golden Ratio to exist in fabricated structures. Spink (Para. 13) notes

that even in most of the examples given of the application of the ratio in nature, the spiral is either too tight or too close to provides the perfect Golden proportions. Mies Van der Rohe, a legendary architect best known for his monumental glass skyscrapers designed the Illinois Institute of Technology's Chapel (Henein, 239). The entire building façade has the golden proportions; it is divided into five subsequent columns by golden rectangles (Bejenaru and Vladlen, 613). The rectangles are then repeated to form a pattern. The façade of the Parthenon and certain elements within it can be circumscribed using golden rectangles (Benjafield and Christine, 425). While it is possible it was not deliberate, the proportions that result from the calculations indicate that whichever proportions were in use were close to the golden ratio.

The application of the Golden Ratio in architecture and by extension the arts is based on the idea that it is more pleasing to the human eye and creates a harmony that is almost perfect. Although the scientific basis of this claim has been disputed, the golden ratio is unarguably important in important works of art and architecture (Ajluni, Martin and Yalamarthy, 30). Leonardo da Vinci used it extensively in his most famous works: *The Last Supper, the Mona Lisa,* and the *Vitruvius Man* (Kalajdzievski, 15).

In the Notre Dame in Paris, the architecture indicates a deliberate use of the Golden ratio in the design of the first three floors, the two towers, and the space between them. In the Taj Mahal that was built in 1653, the Golden Ratio is clear in the ratio of the height to the width of the Arches (Kalajdzievski, 14). The main controversy even within scholars who attest to the validity of use of the Golden Ratio in art and architecture is why the human eye finds the proportions appealing.

Golden Ratio in the Human Heart

The use of the Golden Ratio in art and architecture emanates from its observation in nature. Pythagoras first hypothesizes that the human body is designed on a certain proportion. Subsequent studies and hypothesis showed the presence of the human ratio in certain anatomies, including general anatomy. Leonardo da Vinci's work, the Vitruvius Man, best illustrates the concept of the proportionality of man (Storeygard, 228). While the rhythmic pulse of the heart has always been thought to follow a harmonic and perhaps divine pattern, it is only in recent research that this claim has been seriously considered (Brinkworth and Paul, 3; King, 12).

Among the key findings in recent years is the correlation between the temperature variation in human beings and the Golden Ratio (Spinak, 20; Tanackov, Jovan, and Milan, 643). This led to extensive claims of the presence of the ratio in the proportionality of the heartbeat over time; this element of research remains uncorroborated. A study by the British Medical Journal established that individuals with a ratio of 1.6180 between their diastolic and systolic counts were less prone to fatal cardiac arrests than those with higher (Spinak, Para 19). Using a sample of 160, 000, the researchers established that having a harmonious golden ratio is the sign of good health (Spinak, Para. 20).

Henein (240) found that "…the transverse and vertical dimensions of the heart accord the golden ratio without any variations based on ethnicity. The ratio of 1:1.618 is also maintained in mild heart failure but is significantly reduced in end-stage cardiac failure." In healthy ventricles,

the mitral annulus dimensions have the golden ratio that is significantly reduced in cases of mitral regurgitation and dilated cardiomyopathy (Scott and Shikhman, 44).

According to Storeygard, (229), another correlation is in the angles between the ascending aorta continuation and the mid-luminal axes of the trunk, and the continuation of the tract axis of the ventricle and the outflow tract axis. The presence of the Golden ratio in temperatures has been extensive researched and corroborated (Benjafield and Christine, 425). The basic measure is a scale showing the critical temperatures in human beings as a variable similar to the heartbeat over time. Henein (242) posits that this key finding in temperature correlates to the fact that human beings are made up of water whose phi properties are clear in human temperature.

According to Henein (239), the overall ventricular and cardiac dimensions are consistent with both the golden angle and ratio in a healthy heart. This represents function efficiency and optimum pump structure while a significant deviation is representative of a disease state. Function efficiency of the heart is a factor of the individual components and the effectiveness of the whole heart design. In cases of heart failure, either the pump action of the heart is critically below optimum or individual core components have failed (Ajluni, Martin and Yalamarthy, 31). The Golden Ratio represents this correlation between the natural design of the heart and its functionality. In modern attempts to build an artificial heart for use in future transplants, the Golden Ratio has been used extensively to design and build the first models (Benjafield and Christine, 424; Henein, 67).

Another possible although controversial relationship on the claim that the Electrocardiogram (ECG) beats in a Phi rhythm. The background of this is the harmony and

consistency seen in a Phi rhythm in music and compositions (Brinkworth and Paul, 2). The perfect melody of consistency and a pattern provides a basis for the golden ratio in the heart. When applied to the pulse, the P wave, the deflection caused by current, and the QRS complex are the core parts. Tanackov, Jovan, and Milan (642) note that the T wave is significant because it is the point at which the ventricles reset.

The harmonics of the human heart also indicate that when an individual is receptive and relaxed, the mean distance between the heartbeats is 1.618. While the presence of the Golden Ratio in this case might be coincidence, it has been inferred to imply that a harmonic pulse in wellbeing follows the Golden ratio (Henein, 240). In some divinity circles, the relation of the electrical waves of the heart at the ratio implies a form of infinity in such good feelings as love and happiness. Benjafield and Christine (424) posit that the basis of this claim is the fact that the Golden Ratio is irrational and hence infinite and might then imply that if two people are feeling receptive to each other than their heart rhythms are in harmony and infinitely connected.

In the wellbeing concept, individuals who are not receptive, those who are in a logical-state of mind, tend to show a static distance between the frequency peaks of around 1.0 (Tanackov, Jovan, and Milan, 642). The inference in this latter claim is that when human beings are in a mental state of mind, they contain energy and do not access their full potential. This harmony of the heart rhythm basis now forms the core of most wellbeing systems such as Yoga and therapy. The presence of the Golden Ratio and its derivatives of the Golden Spiral in nature further drive the idea that its presence in the heart pulse is indicative of the harmony of happiness and wellbeing (Benjafield and Christine, 424; King, 20).

The electrocardiograms, used in modern medicine to diagnose heart conditions, vary considerably depending on the many factors that affect the heart. This includes the emotion of the patient at the time of measurement, physical activity, age, health, wellbeing and other such factors (Henein, 13; Benjafield and Christine, 424). This variance explains why ECG's are not single measurements but recorded over a period and then represented on a graph. Heartbeat2000, an organization that seeks to study the connection between the human pulse and Phi, suggests that any ECG T point that indicates a Phi relationship represents a state of harmony, peace, wellbeing, and receptiveness (Henein, 12). This area of research requires scientific corroboration and extensive research because it presents an intriguing perspective on another occurrence of the Golden ratio in nature. The Golden Ratio can also be seen in other body parts such as the human lungs and facial proportions. In the human lungs, the structure of the windpipe and the constituent bronchi. The ratio of the short to the long bronchus is 1:1.618 (Ajluni, Martin and Yalamarthy, 29).

Conclusion

The Golden ratio is a mathematical representation of proportionality that occurs in nature and in the arts and science. This representation has been the subject of study since Euclid first use the number *e* to describe natural logarithms and Fibonacci described the Fibonacci series. The latter provides the basis for the ratio in the result of the ratio of each subsequent number with the preceding one. Represented by the letter Phi, the Golden Mean features prominent in art, architecture, and medicine. In art and architecture, the core design elements of functionality and aesthetics in addition to structural soundness within the unitary concept of the Golden Ratio. Many structures in history and even in postmodern architecture adopt the Golden ratio because

of its aesthetic elements. Although the same aesthetic advantages have been found in human beauty, the reasons for their appeal are still not known (Tanackov, Jovan, and Milan, 642).

In human health, the Golden Ratio is an indication of health in the variation of human temperature (Henein, 40). As an extension to this research, scholars now think that there is a connection between the measure of the heartbeat over time, the electrocardiogram (ECG) and good health and wellbeing. Although this research lacks corroboration, the rhythm of the heartbeat is a significant indicator of the health of the individual. The presence of the Golden ratio in individual cardiac elements such as the ventricular and aortal structures and pump actions might be the basis for the significance of the heartbeat. Essentially, the Golden Ratio is a mathematical concept that is significant in human health and aesthetics. It indicates a harmony in design and consistency within that harmony, and structures in patterns or how the individual aesthetic elements fit into the core design.

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