The Role of Golden Ratio on Web Design

Husnulzaki Wibisono Haryadi (13515005)[1]
Program Studi Teknik Informatika
Sekolah Teknik Elektro dan Informatika
Institut Teknologi Bandung, Jl. Ganesha 10 Bandung 40132, Indonesia
[1]*husnulzaki.wh@std.itb.ac.id*

***Abstract*—Web pages hold an important role to visualize and summarize the content of a website for the sake of visitors. This role demands the pages of website to maintain the right composition of aesthethic and functionality and still accomodate a proportional portion of content on its layout in order to provide positive user experience to website visitors. An effective method in effort to improve the visual layout of a website is through the implementation of golden ratio. This paper covers the distinct feature of golden ratio and basic ideas of its exploitation in order to create a harmonious website.**

***Keywords*—Fibonacci spiral, golden ratio, web design, web page.**

I. Introduction

Web pages are the "face" of the internet that will be the first thing web visitors see when they visit a website. The concept of "website" and "web pages" arises mainly to overcome the complicated method the information in World Wide Web (WWW) were originally maintained. When World Wide Web was published to the world for the first time in 1972, it can only be written in straight *Hyper Text Markup Language* (HTML) without any formatting method and in order to edit a web page, the web owner has to use *FTP* to upload text file into the browser[1].

This method, while regarded as efficient and secure for military (where it is originally serve for serveral years prior to the publication), were proven very inconvenient for public use. Therefore, new protocol named Hyper Text Transfer Protocol (HTTP) were built to gave way to web page formatting through mark-up tags, image maps, and CGI scripting. These features were the foundation of the dynamic and interactive web pages as we know today[4].

These development by itself reflects what is needed and thus provided by web page on modern day Web. Web pages visualize the content of a website and summarize the information that contained within it so it can easily digested by visitors of the website. This goal, while seems trivial, demands the pages of website to maintain the right composition of aesthethic and functionality and still accomodate a proportional portion of content, all in the effort to create a positive user experience for the visitors.

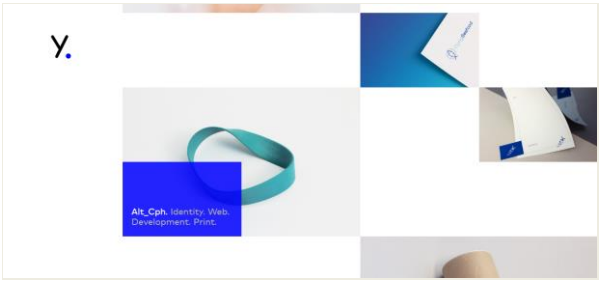


Fig. 1.1 An example of web design to create a progressive look on the website (yourlocalstudio.dk)

For this reason, a good web design is needed in running a website. Design of a website relies on several points, such as navigation concept, structure of the site, layout, text organization, etc. This paper will covers the graphical layout of a web design, more specifically on how to improve the layout and appearance of a web pages by utilizing golden ratio in order to set a reference point to element positioning.

II. Anatomy of Web Page

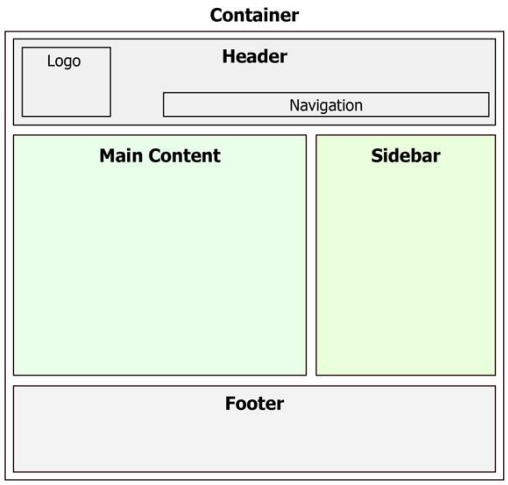


Fig. 2.1 The illustration of web page's anatomy (code.tutsplus.com)

A. Container

All web pages use a container to contain page elements. The way used to build a container may vary for every web site. The most commonly used method is by *body* tag or

div tag.

B. Header

The term *header* is not really specify an element but is more generally used in referring to the top section of the web page where the logo, navigation, etc. are located. However, when a header is referred as an element, it is usually in the form of container.

C. Navigation

Page navigation is one of the most important element in the web page, as it is what the visitors used to navigate through the website. That is why it is almost always located within the header or somewhere near the top of the page.

In general, there are two types of navigation :

1. Horizontal : A series of links displayed inline, usually referred to as "navigation".
2. Vertical : A series of links displayed as a vertical stack, usually referred to as "menu".

D. Main Content

Main content is the element that are primarily sought by the visitor when they open a web page. Main content should be the main focal point of a web page.

E. Sidebar

The sidebar is the element with secondary content, such as advertising, site search, subscription links, etc.It is most often right aligned but can be left aligned or both (two sidebars) as long as it does not disrupt main content viewing. For websites that use horizontal AND vertical navigation, the sidebar is often replaced with the vertical navigation element.

F. Footer

Like the header, the footer is not really a specific element but more of a containing section. Footer located in the end of a web page and serve the purpose to notify the visitor that they have reached the completion of a web page. Within the footer will be copyright, legal and contact information primarily.

G. "Whitespace"

This is any area of the web page that is not covered by typography or other content.

III. General Understanding of Golden Ratio

A. The Origin of Golden Ratio

The golden ratio, also known as the divine proportion, golden mean, or golden section, is a number often encountered when taking the ratios of distances in simple geometric figures such as the pentagon, pentagram, decagon and dodecahedron. It is denoted ϕ, or sometimes τ[5].

The term "golden section" were first used by Martin Ohm in 1835 on the second edition of his book *Die Reine Elementar-Mathematik*[5], while the first known use of the word "golden ratio" in English is in James Sulley's article in 9th edition of *Encyclopedia Britannica* in 1875[5]. The symbol ϕ ("phi") was originally used by Mark Barr at the beginning of the 20th century to honor the Greek sculptor Phidias who was claimed to made extensive use of golden ratio throughout his works[5]. Similary, the notation τ ("tau") is an abbreviation of Greek word *tome* which means "to cut"[5].

B. The Definition of Golden Ratio

The ratio of two quantities are referred to as ϕ or "golden ratio" if this ratio equals to the ratio of the sum of two quantity to the largest if the two quantities[2].

To understand this definition deeper, consider the following circumstance :

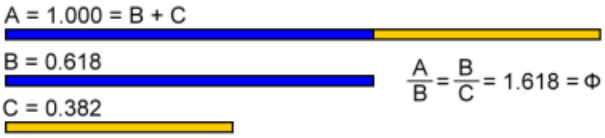


Fig. 3.1 Illustration to the definition of golden ratio (goldennumber.net)

Given a string A with total length of 1000. The string then must be divide into two shorter string, namely B and C, such that B > C and A:B equal to B:C. It will be discovered that the only number that could satisfy this condition is 1.618 which is the value of ϕ.

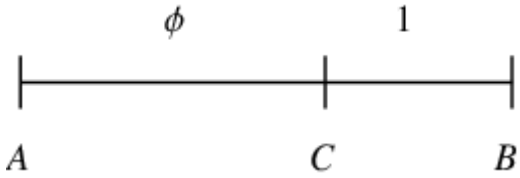


Fig. 3.2 Illustration to Euclid's definition of ϕ (mathworld.wolfram.com)

Euclid ca. 300 BC define the value of ϕ in term of "extreme and mean ratios" on a line segment, i.e., (following Fig. 3.2) such that

$$\phi = \frac{AC}{CB} = \frac{AB}{AC}$$

which gives

$$\frac{\phi + 1}{\phi} = \phi$$

and clearing the denominators gives

$$\phi^2 - \phi - 1 = 0$$

which is in the form of quadratic equation. Because it has been defined that $\phi > 1$, by using quadratic formula the value of ϕ can be discovered, namely

$$\phi = \frac{1}{2}(1+\sqrt{5}) \\ = 1.6190339 \ ...$$

Note that ϕ is an irrational number, meaning that it's decimal sequence will never end.

IV. The Feature of Golden Ratio

A. The Relation between Golden Ratio and Fibonacci Sequence

Fibonacci sequence is a sequence in which each number equals to the sum of it's two consecutive predecessor, i.e.

0, 1, 1, 2, 3, 5, 8, 13, 21, 34, ...

Fibonacci sequence provides a way to derive ϕ mathematically, since the ratio of each consecutive number will have closer value to ϕ as the series progress, for example :

1/1 = 1
2/1 = 2
3/2 = 1.5
5/3 = 1.666
8/5 = 1.6
13/8 = 1.625
21/13 = 1.615

and so on.

The closed-form expression for the Fibonacci sequence involved in ϕ is

$$F(n) = \frac{\phi^n - (-\phi)^{-n}}{\sqrt{5}}$$

B. The Fibonacci Spiral

There are many ways to implement ϕ into geometric form, one of the renowed geometric application of ϕ is in the form of golden spiral and Fibonacci spiral.

Basically, golden spiral is a logarithmic spiral with ϕ as the growth factor. In other word, golden spiral is a spiral whose radius increased by ϕ every quarter of a turn.

A simplified version of golden spiral is Fibonacci Spiral. A Fibonacci Spiral can be drawn by arranging two square with the same size side-by-side, then add a third square such that the side of the third square consist of the side of the two square that preceed it, therefore the side's length of each succeeding square simulate the number in Fibonacci sequence. A spiral then is made by draw a quarter of circle inside every square, with the radius of circle equal to the side of the square. Given the relation between Fibonacci sequence and the golden ratio, this spiral will hold identical shape to the actual golden spiral, as shown in Fig. 4.1. The point of recreating golden spiral through this method is merely to ease the process of determining reference point while using

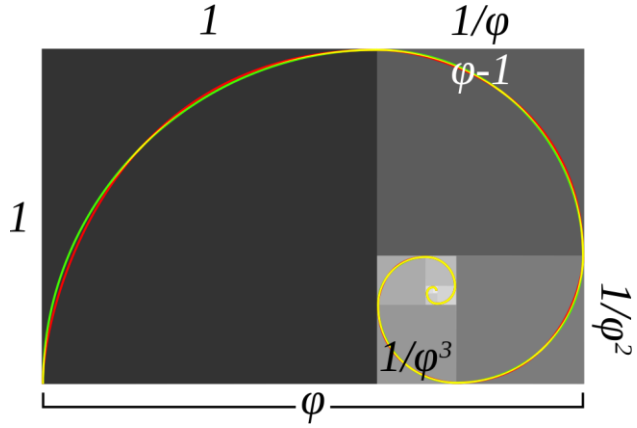


Fig. 4.1 The comparison between Fibonacci Spiral (shown by green line) and the actual logarithmic golden spiral (shown by red line). The overlapping portions appear in yellow
(en.wikipedia.org)

C. The Beauty of Golden Ratio

One of the most distinct feature of golden ratio is it's recurring appearance in almost every aspect of human life. Many proportion in human and animal anatomy, including the spiral of human DNA, are based on ϕ. There is also many evidence of golden ratio's embodiment on artworks and architecture throughout the millenia.

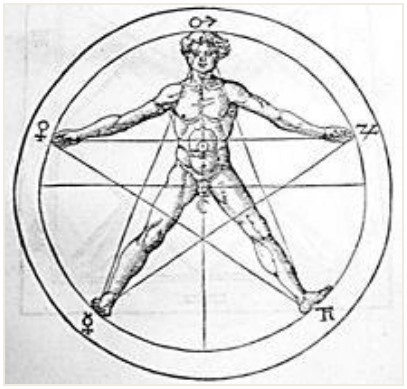


Fig. 4.2 The drawing of a man's body on pentagram by philosopher Heinrich Agrippa (1486-1535)
(en.wikipedia.org)

In year 1498, Italian mathematicians Luca Pacioli and Leonardo Da Vinci in their book *De Divina Proportione* ("On The Divine Proportion") advocate that the golden ratio's application yields pleasing, harmonious proportion[3]. This statement were supported by many notable works of arts that explicitly applied golden ratio on it's body. Some of the most notable example are *The*

Sacrament of the Last Supper by Salvador Dali (1904-1989) and The Parthenon in Greece.

(a)

(b)

Fig. 4.3 (a) *The Sacrament of the Last Supper* and (b) Parthenon, both are the example of the implementation of golden ratio
(en.wikipedia.org)

V. Utilizing Golden Ratio in Web Design

A. Set the Layout Dimension

Golden ratio can be used as a guideline to determine the dimensions of page's layout. One of the simplest way to do this is by set the dimension of the web page into 1:1.618.

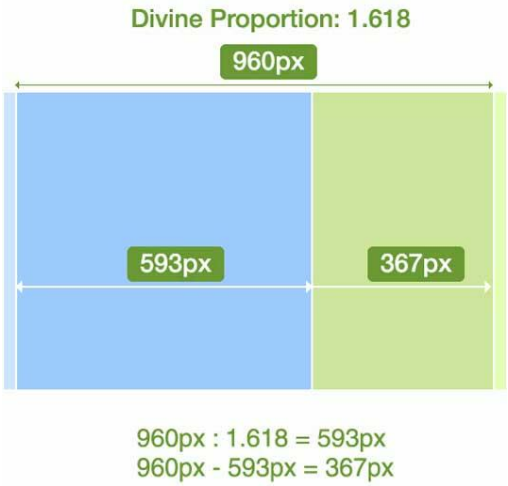
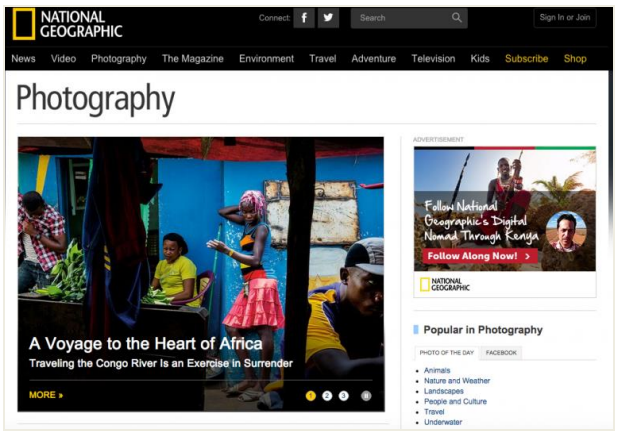


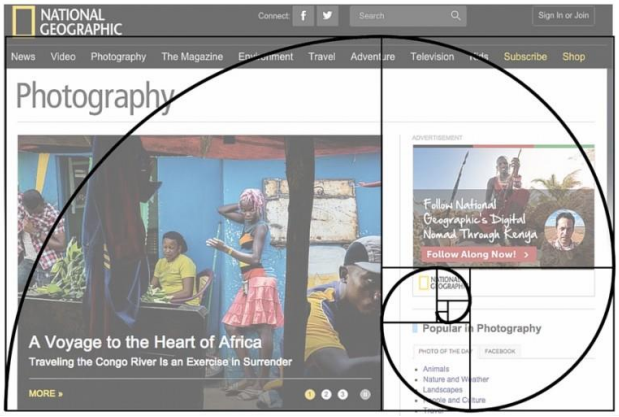
Fig. 5.1 The illustration of dividing the layout of web page based on divine proportion
(smashingmagazine.com)

For example, the typical layout width of a web page is 960 pixels. If the layout width is divided by 1.618, the result will be 593px, which is the height of the layout.

Breaking the layout into two columns by using this number will result in a layout that is well suited to web design. National Geographic has adopted this layout to create a clean, easy-to-read, well organized website. It provides the readers with a website that has a natural sense of order, balance, and hierarchy.



(a)



(b)

Fig. 5.2 (a) The general layout of NatGeo site (b) The comparison of site's layout proportion with Fibonacci spiral
(nationalgeographic.com)

B. Conserve Layout Spacing

Spacing is an all-important element of any design, be it the use of negative or positive space, and it can often make or break the final result. Determining the spacing of elements can be a rather time-consuming affair; instead, start with the Fibonacci Spiral and let the squares guide where the next element must be placed. This will ensure the proportion and spacing that applied are calculated, rather than 'instinctual'.

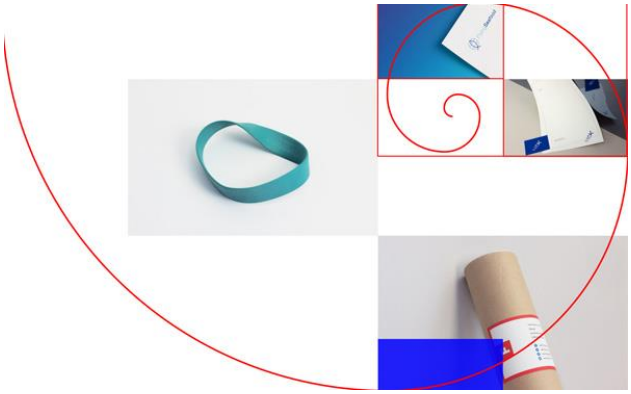


Fig 5.3 "Your Local Studio" implements a layout-spacing using golden ratio throughout its website
(yourlocalstudio.dk)

In addition, several Fibonacci Spiral can be layered in order to continue constant proportions throughout the design when working with several elements.

C. Determine Content Placement

The Fibonacci Spiral can be used as a guide to determine the placement of content. Human eye is naturally drawn to the center of the spiral, which is where it will look for details, so the design should be focused on the center of the spiral and areas of visual interest should be placed within the spiral.

Take a look in Fig. 5.2b. Notice that a smaller logo is placed in the center of the spiral. Although seems subliminial, it is actually a good placement to double-up on brand images because visitor's eyes are naturally drawn there.

Another example of content-placement shows the relation of content density and it's distance from the center of spiral. The website of graphic designer Tim Roussilhe in Fig. 5.4 are organized according to the golden ratio and golden spiral, which focuses on the text in the upper left section of the website. The eye begins in the top-center with "Bonjour My Name is Tim." It then travels past the description of what Tim does, on to the menu buttons, hits the logo in the top-left corner, before coming to rest in negative space, having absorbed all the details it needs.

Fig 5.4 The comparison of web page that apply Fibonacci spiral on its content distribution
(timothee-roussilhe.com)

D. Rule of the Third[1]

While not specifically made for designing web, the Rule of the Third can be quiet useful to provide guidance in content arrangement of a web page. Rule of the Third states that every composition can be divided into nine equal parts by two equally-spaced horizontal lines and two equally-spaced vertical lines[6]. The four points formed by the intersections of these lines can be used to place the most important elements. Aligning a composition according to Rule of thirds creates more tension, energy and interest in the composition than simply centering the feature would.

[1] Rule of the Third is actually a simplification of golden ratio composition that divide the image into nine equal parts for the same purpose.

Fig. 5.5 The comparison of web page which apply Rule of Third on its content placement (demandware.com)

Consider the design of demandware.com presented in Fig. 5.5. Although the design uses a number of vibrant colors, it is not noisy and seems to be both simple and clear. The navigation options are clearly visible and the structure of the site seems to be easy to scan.

It almost perfectly uses the Rule of Thirds as two out of four intersections of the lines (pink blocks in the picture) contain exactly the information which the company wants its users to see — namely what the site is all about and an example of their work. Note also how perfectly the main sections are placed on the second horizontal axis.

VI. Conclusion

Visual aspect in holds an important point in web page. How a website presents it's content to visitors will determine the value of the website in the eyes of visitor, apart from the value of the content itself. This is why web design is considered as a crucial aspect among web owner.

Among various method to improve the value of a web design, golden ratio have proven useful in providing reference and guideline in designing the layouts of a web pages. In some cases, applying divine proportion and Rule of Third may significantly improve the communication of web's design to the visitors. However, the methods that are provided here only covers general ideas of the power of golden ratio, while how much does a golden ratio truly capable of is entirely depends on the creativity of the designer to exploit them.

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PERNYATAAN

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Bandung, 8 Desember 2016

Husnulzaki Wibisono Haryadi- 13515005