The Deep Roots of Some Aspects of Aesthetic Design

Alan Cannell, September 2009

Introduction

While examining the mass distribution of handaxes (as a follow-up to the work on manuports, Cannell, 2002) it quickly became obvious that mass was not the principal motive in handaxe creation, but that symmetry and shape were.

Like many others, I noted that the ratio between length and width of axes is often close to phi; however, this simple statistical approach to axe design excluded other expressions of phi that were apparently being used.

These same expressions are found in art and architecture and, as part of on-going research, a survey has been carried out to check on the preferences of shape in men and women.

The results indicate that certain of mankind's aesthetic tastes have been constant for hundreds of thousands of years.

Presentation Index

- The ‘Golden Section’ and the human body
- Elements of the Phi in Art and Architecture
- The Golden Ratio in Prehistory
- Beauty in the Eye of the (Male) Paleolithic Beholder
- Carved Rocks and Sexual Selection
- Preference in Shape: Results of a Simple Study

The Golden Section (Phi) and the Human Body

The golden ratio can be expressed as a mathematical constant, usually denoted by the Greek letter (phi). The figure of a **golden section** illustrates the geometric relationship that defines this constant. (1.618:1)
Expressed algebraically:

$$\frac{a+b}{a} = \frac{a}{b} = \varphi\,.$$

This equation has as its unique positive solution the algebraic irrational number:

$$\varphi = \frac{1+\sqrt{5}}{2} \approx 1.6180339887\ldots$$

This links the numbers 1, 2 and 5.

A rectangle with the sides of 1: 1.618 is a ‘Golden Rectangle’ – Credit Cards have this shape.

Phi, and its square also have a relationship with unity

- 2.618 = phi ^{2}; where phi^{2} - phi = 1
- 1.618 = phi; where phi – (phi-1) = 1
- 1 = phi/phi
- 0.618 = phi-1; where phi – (phi-1) = 1
- 0.382 = (phi-1)$^{2;}$; where (phi-1)^{2} + (phi-1)=1

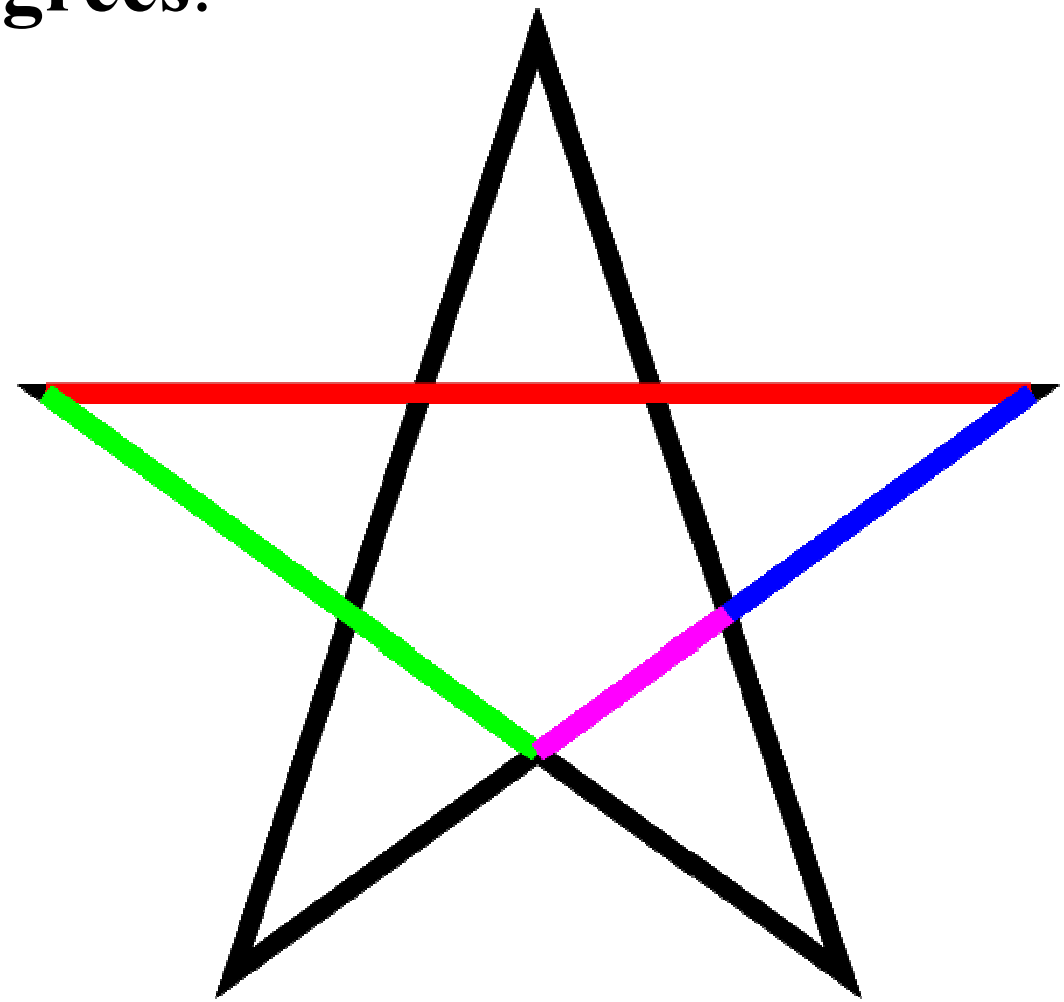
Indeed, phi can be expressed as:

$$\sqrt{\frac{5+\sqrt{5}}{5-\sqrt{5}}}$$

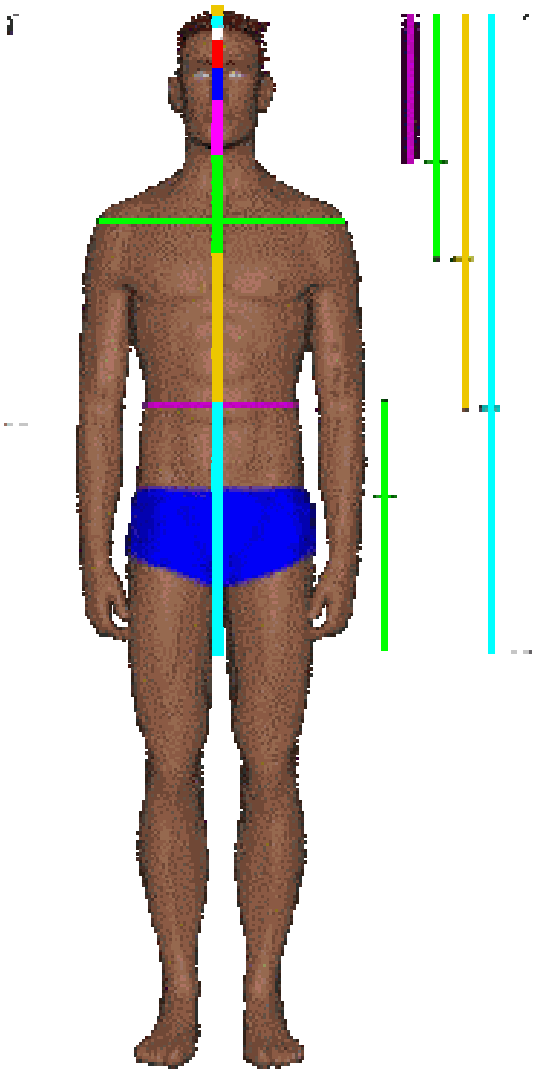
- This allows unity to be developed into 5, of which there are many examples in nature: human hands, amphibian feet…

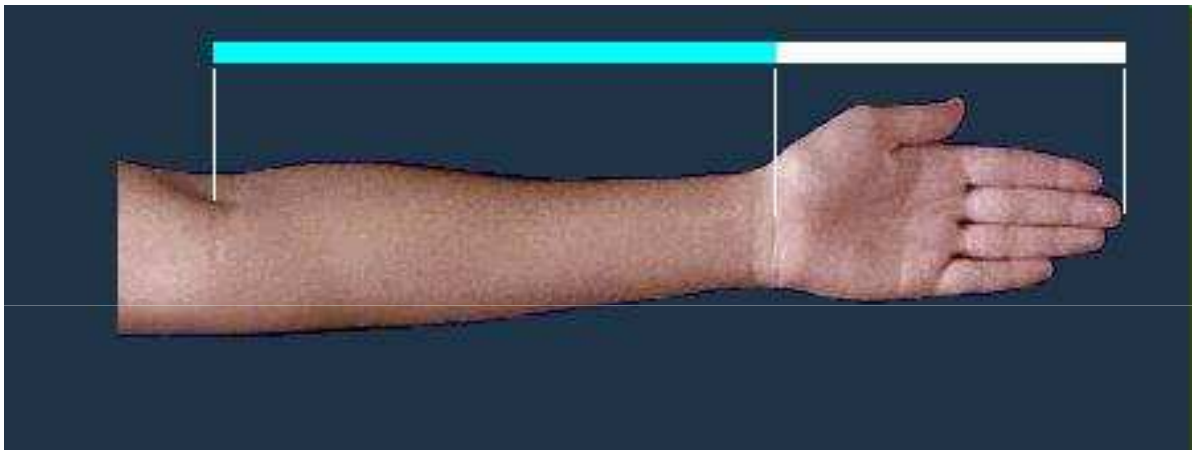
Frog foot image: wiki commons

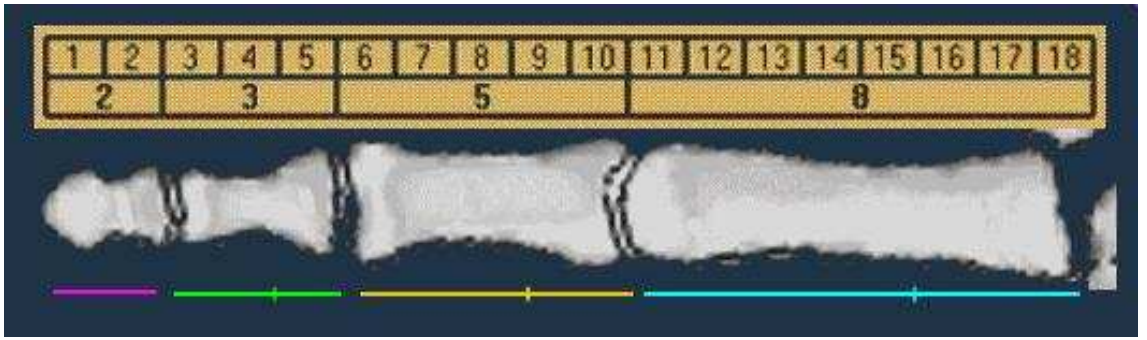
Dividing a circle into 5 equidistant points forms the Pentagram, the lengths of which all conform to the Golden Ratio. Each point forms an angle of **36 degrees**.



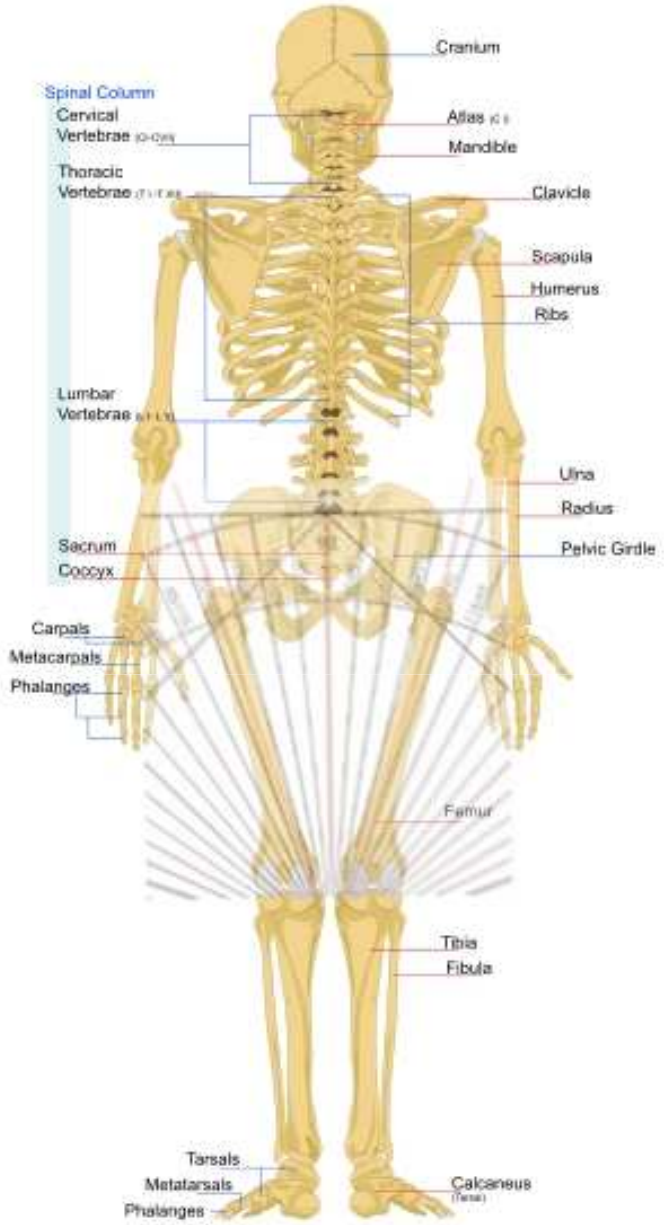
The human body conforms to the same Golden Ratio, as do many living beings:







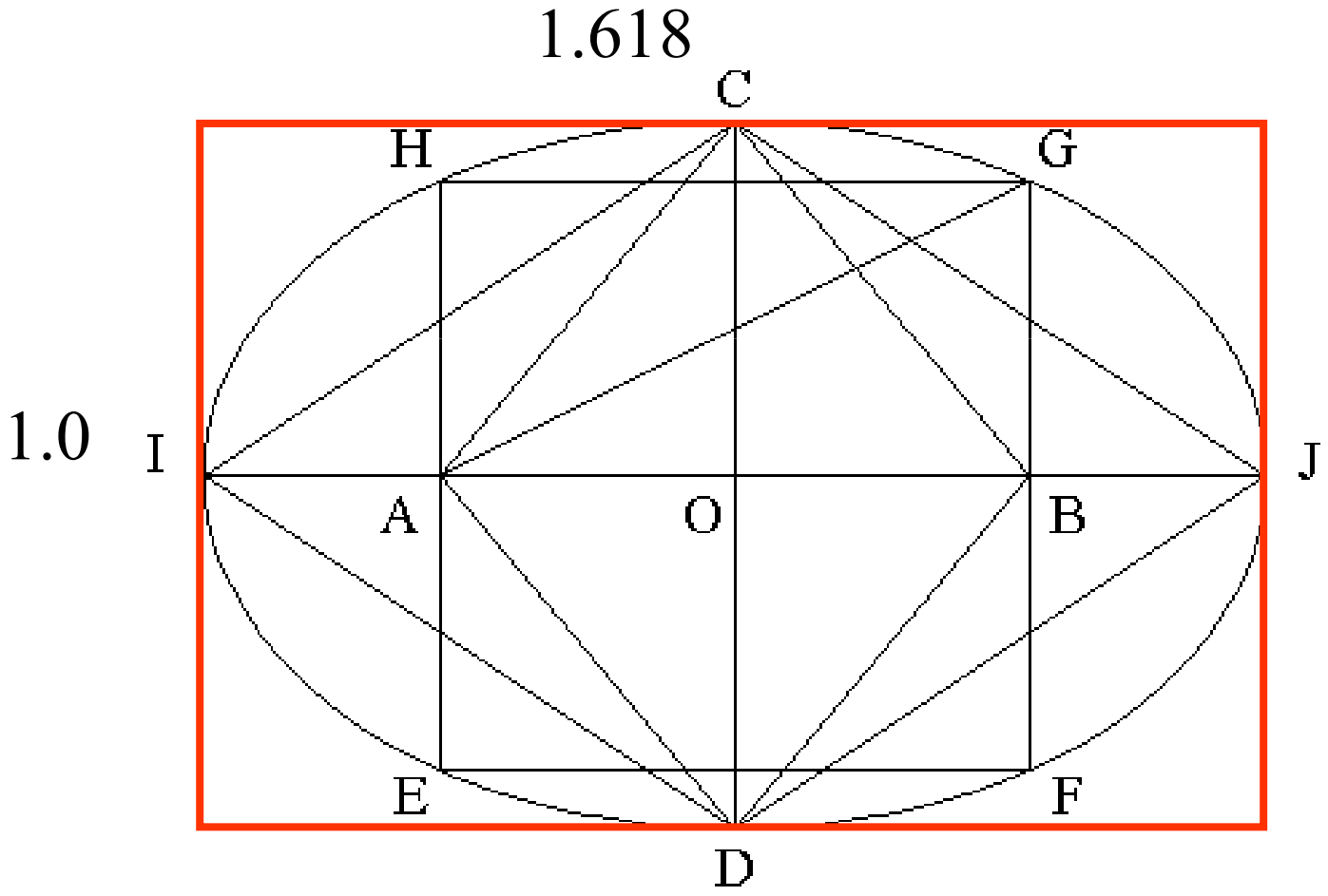
(Images: http://goldennumber.net/body.htm)



(Image Wiki)

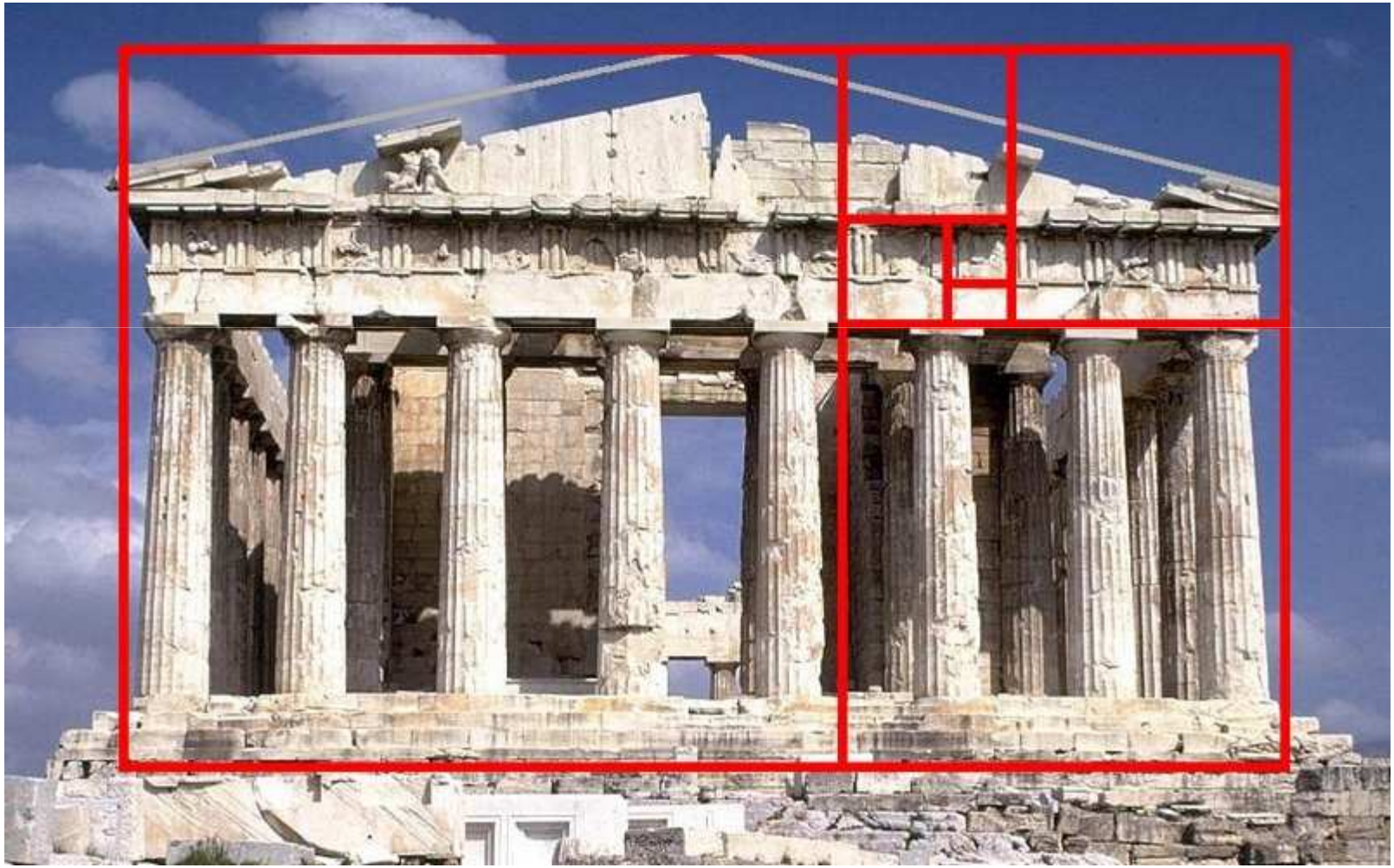
The angle formed by the inside of the femurs in the female human skeleton is also the Pentagram angle of 36 degrees.

An ellipse inscribed within a golden rectangle is a **golden ellipse.**



Elements of Phi Golden Ratio in Art and Architecture

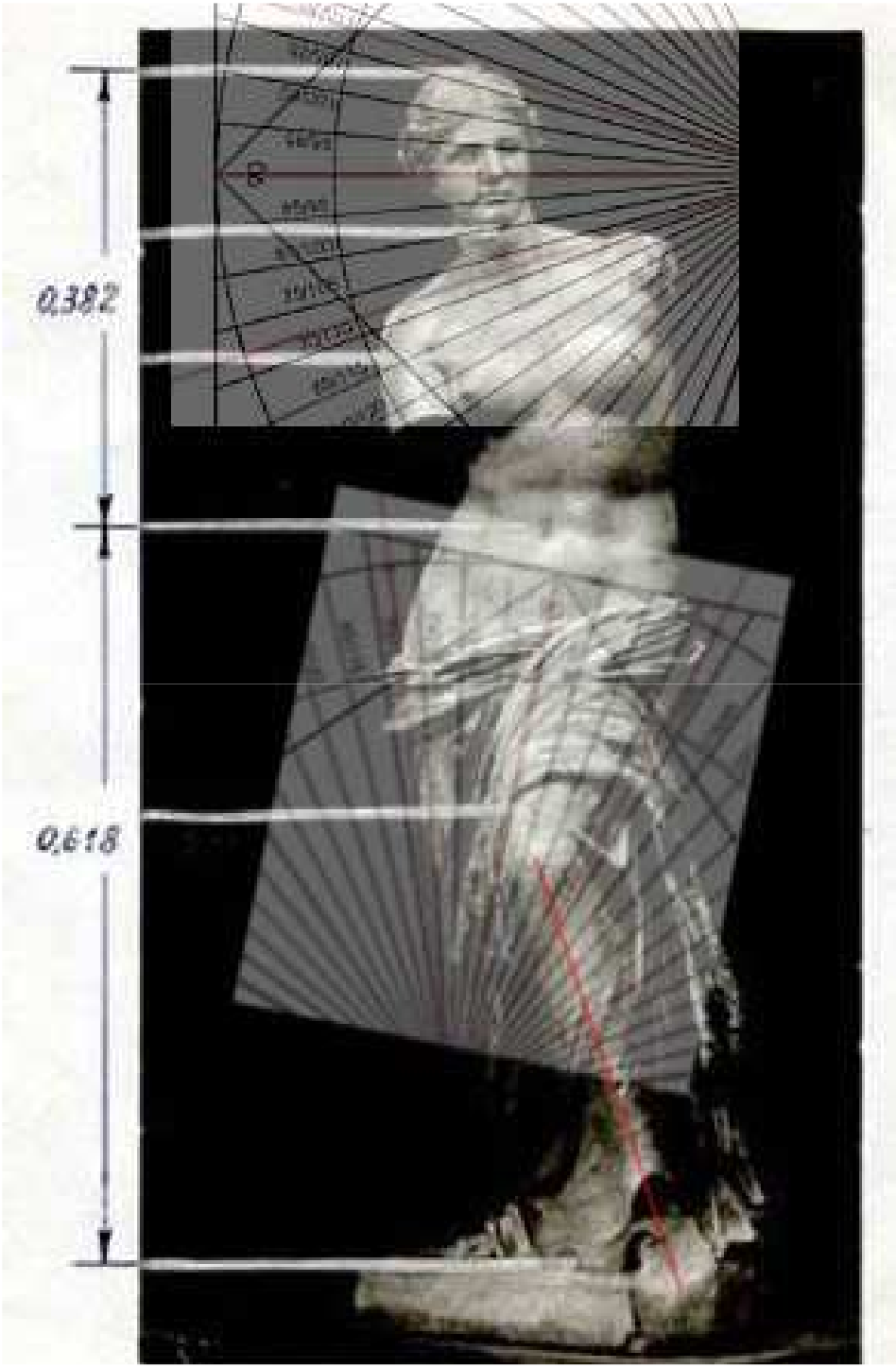
The Golden Ratio has been widely used in architecture and the arts; from the Parthenon …



http://goldennumber.net

... To the Bird´s Nest Olympic Stadium: note that the distinctive centre cross is at 36 degrees.

image: wiki commons



Aphrodite/
Venus de Milo.

In the arts, as well as the well- noted height ratios in phi, it is worth noting that the thighs are set at 36 degrees. As will be shown below, this angle divided by 2 (18 degrees) is often found in relation to vertical or horizontal planes – as in the shoulders, tilted at 18 degrees and the lower leg.

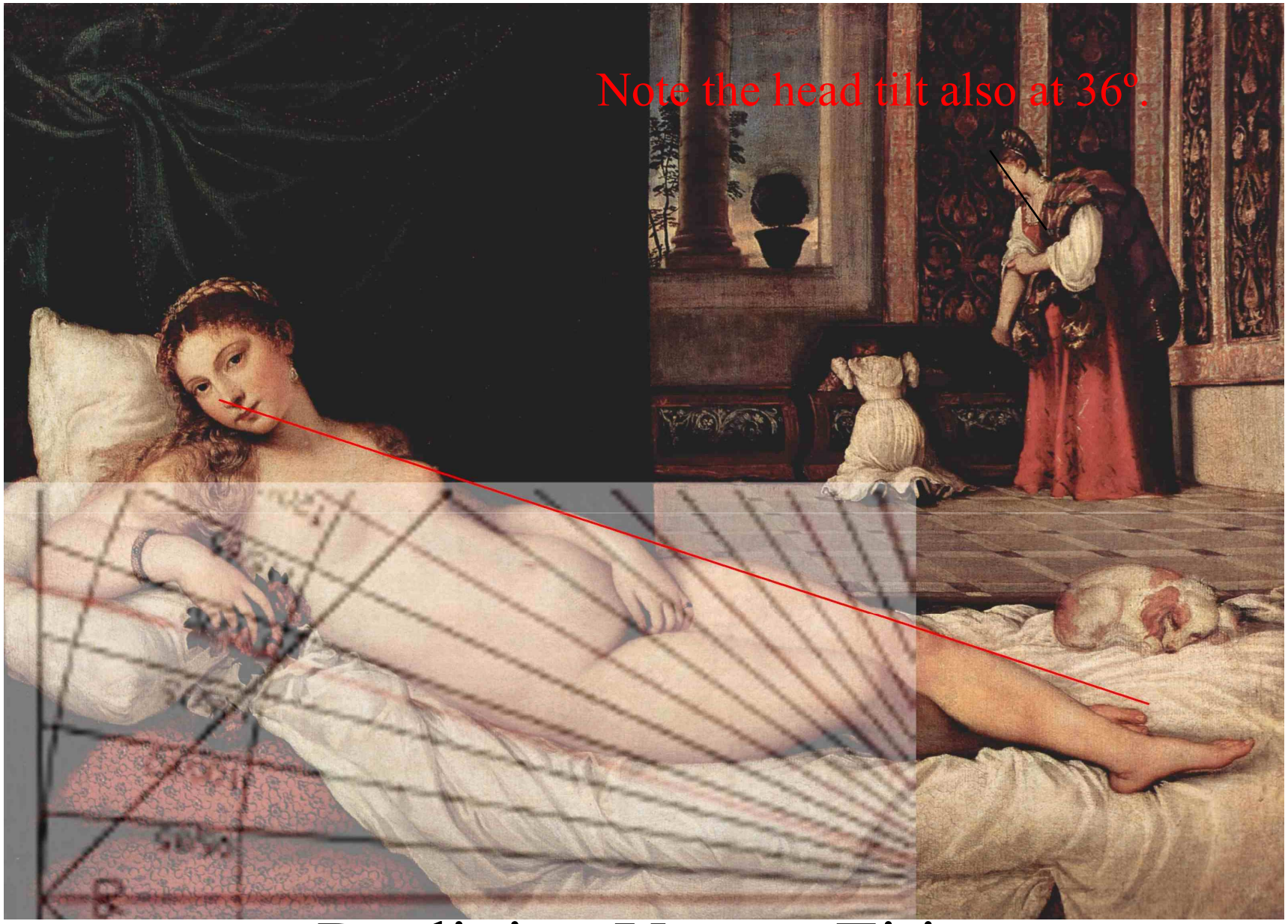
Image: wiki commons

Birth of Venus, Botticelli. Note the head tilted at 18^{o} - forming 36^{o} with the neck.

Image: wiki commons

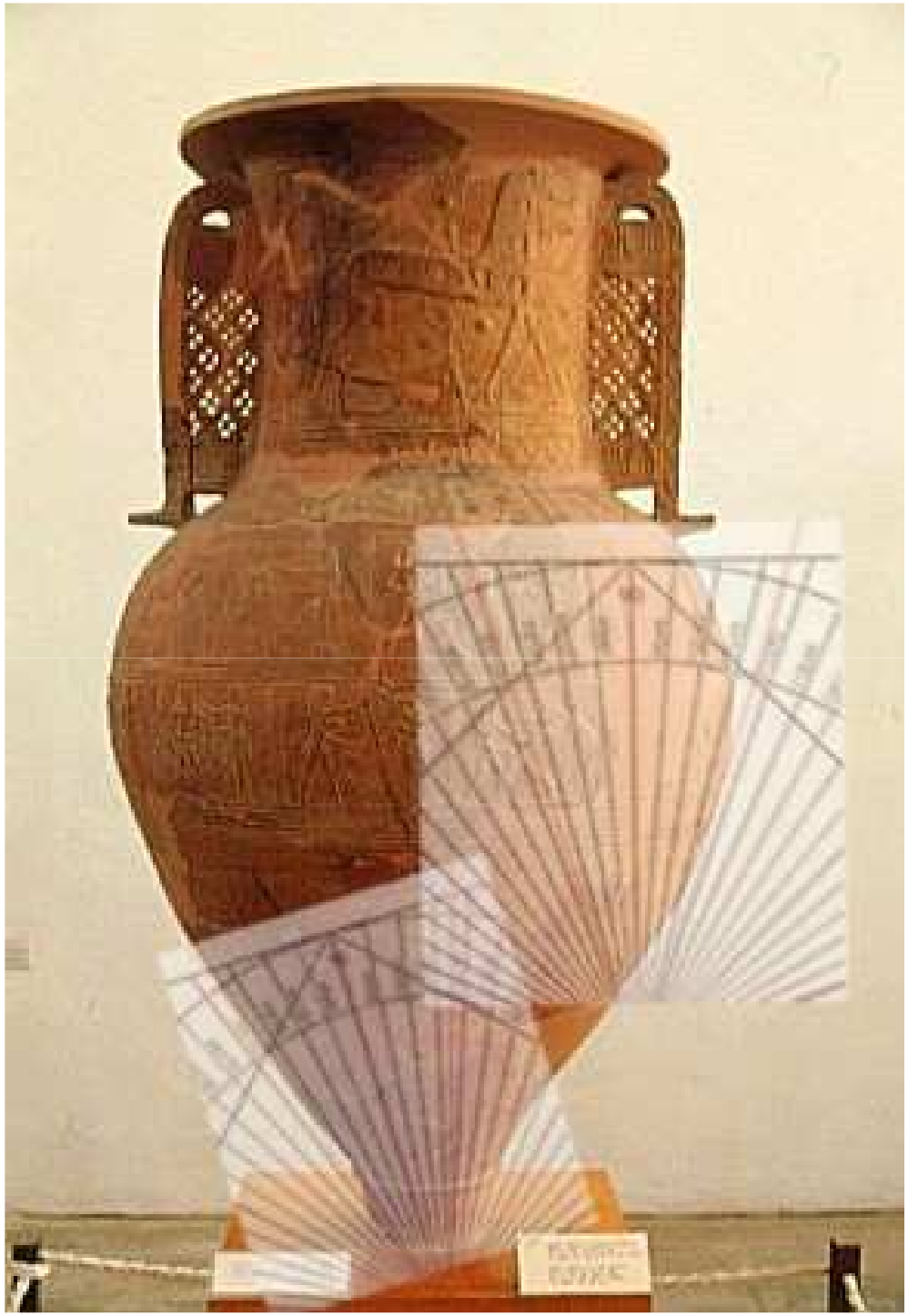
Salome, Titian.
The neckline is set at 18º, the centre of the face at 36º.

Image: wiki commons



Reclining Venus, Titian

image:http://www.titian-tizianovecellio.org/The-Venus-of-Urbino-1538.html



Amphora, Mykonos 7th C BC: both 18 and 36 degrees are used (in relation to the vertical) to determine the shape.

Image: dkimages

The Golden Ratio in Prehistory: so just how far back do our modern tastes go?

Footprint of H. Erectus from 1.5mya
Image:http://news.bbc.co.uk/2/hi/science/nature/7913375.stm

Do Achuelean Hand Axes, made for about 1.5 million years, tell us anything?

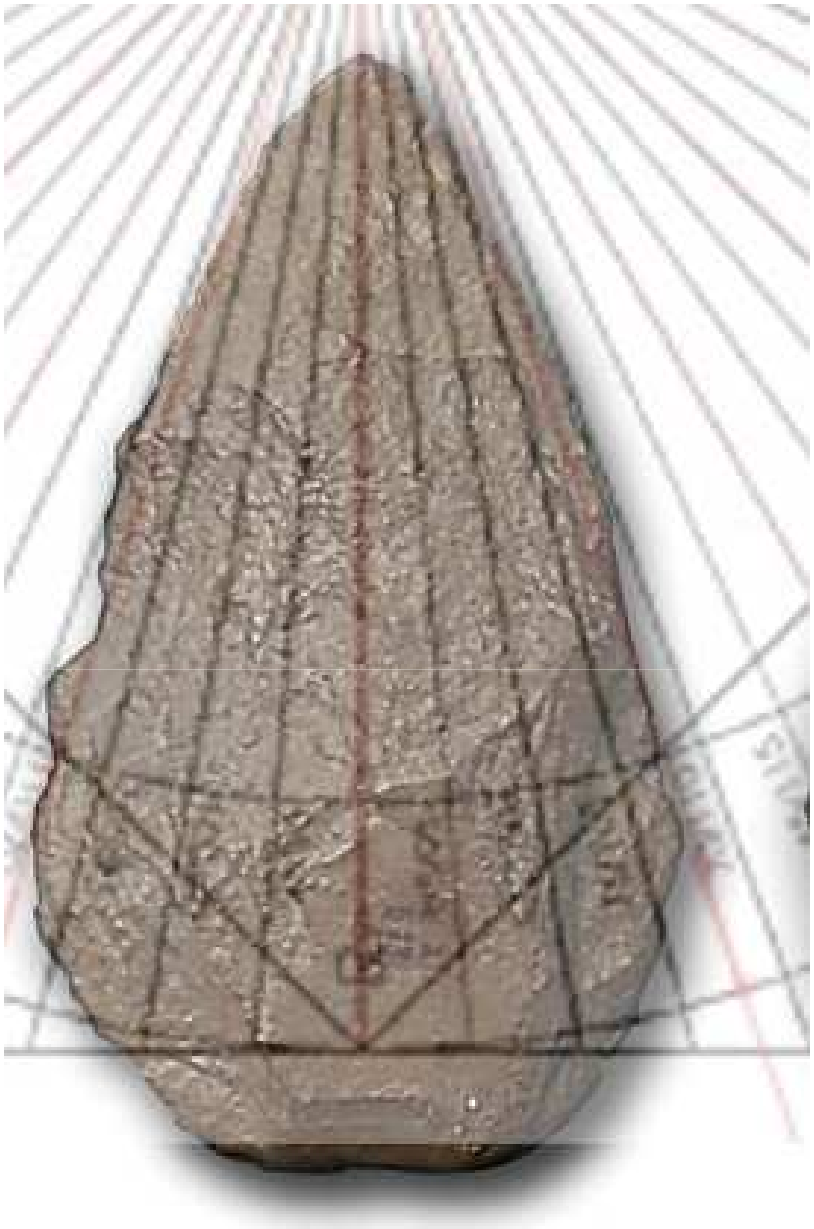
Image: http://www.ele.net/acheulean/handaxe.htm

The actual functional use of these hand axes is not understood (Bordes 1968; Debenath and Dibble 1994; Gowlett, Crompton and Yu 2001; Isaac 1977; McPherron 2001; Roe 1981; etc.).

However, for over a million plus years, its basic shape remained constant as it spread across three continents.

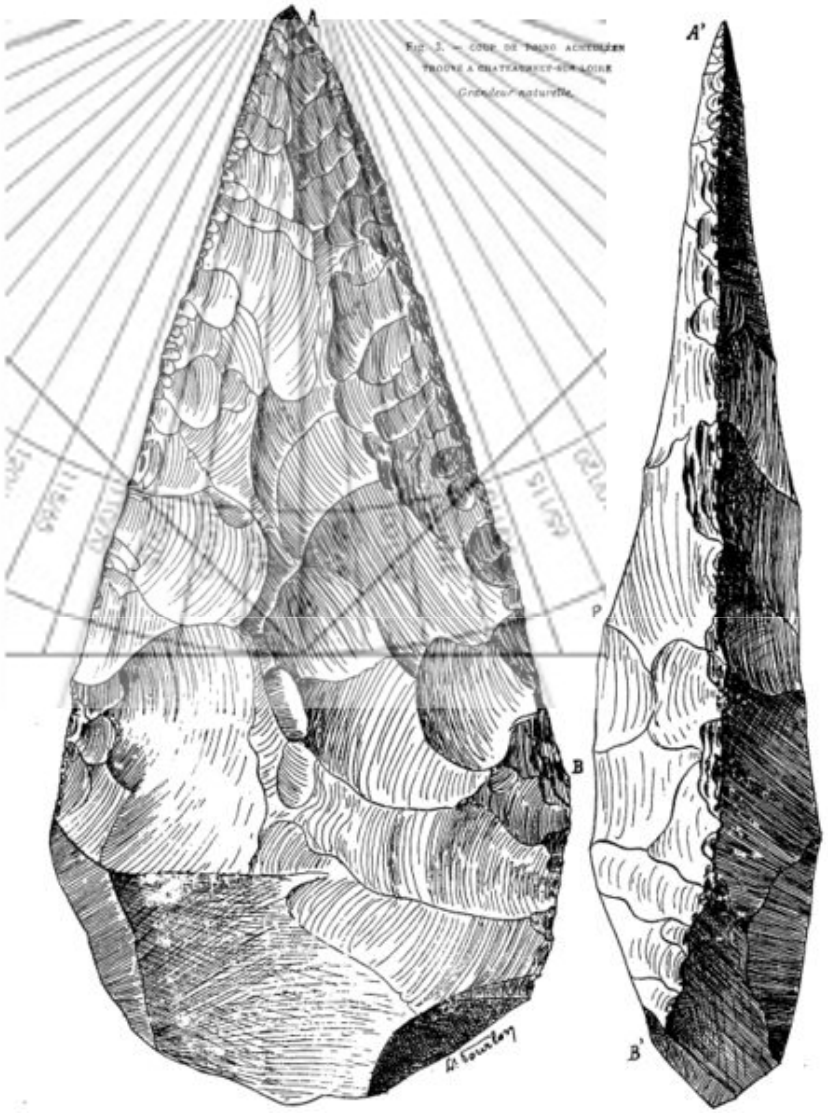
This unchanging morphology is often suggested as 'proof' that the handaxe was made to conform to unchanging, deeply engrained mental templates.

If so, then we would expect see the same templates in use today.



A common template is based on a ‘blade’ or tip and a butt; the length and width being in the Golden Ratio.
The angle of the blade often tends to 36 degrees (as shown in the red lines of the protractor superimposed on the original image by the author in this and all other slides).

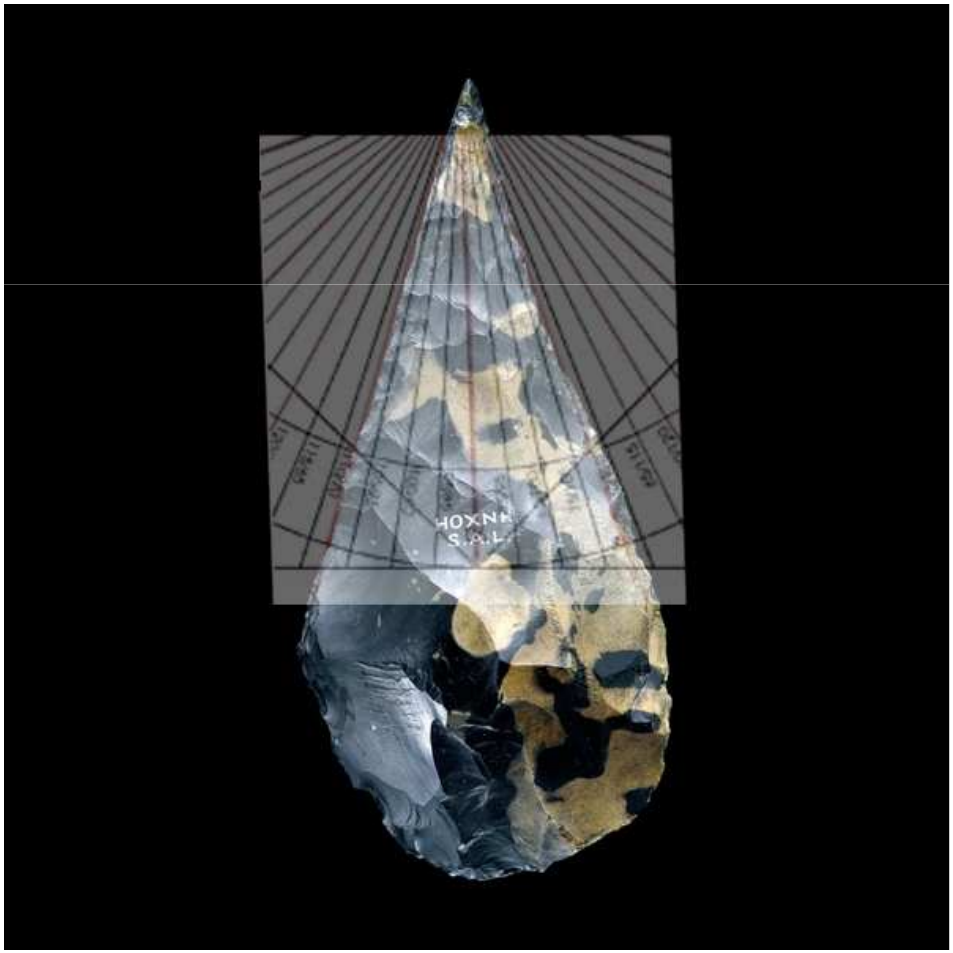
Image: http://en.wikipedia.org/wiki/File:Bifaz_de_Atapuerca_(TG10).jpg

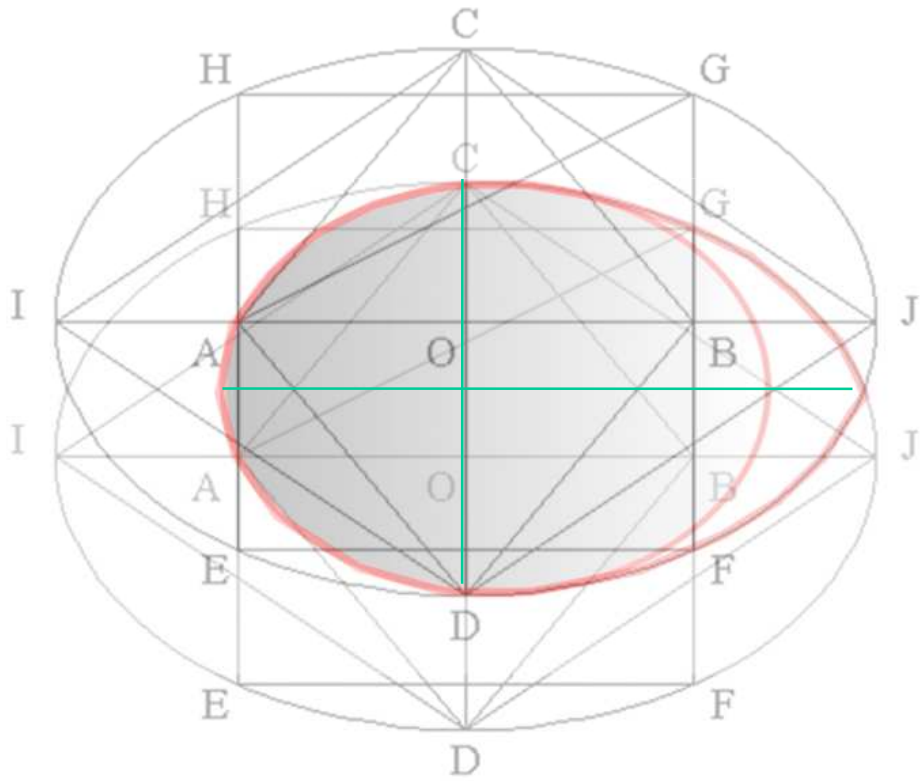


Coup de poin: Achuel, France. The original 'Achuelian' axe with perfectly formed blade angle of 36 degrees.

http://www.anth.ucsb.edu/faculty/stsmith/classes/anth3/courseware/LithicTech/images/Handaxe.gif

British Museum:The Gray's Inn and Hoxonian Axes





Another common template is the Golden **‘Composite Ellipse’,** a complex geometric shape in which the Golden Ratio appears between length and width of the axe, as well as in the elliptical curves of the ‘blade’.

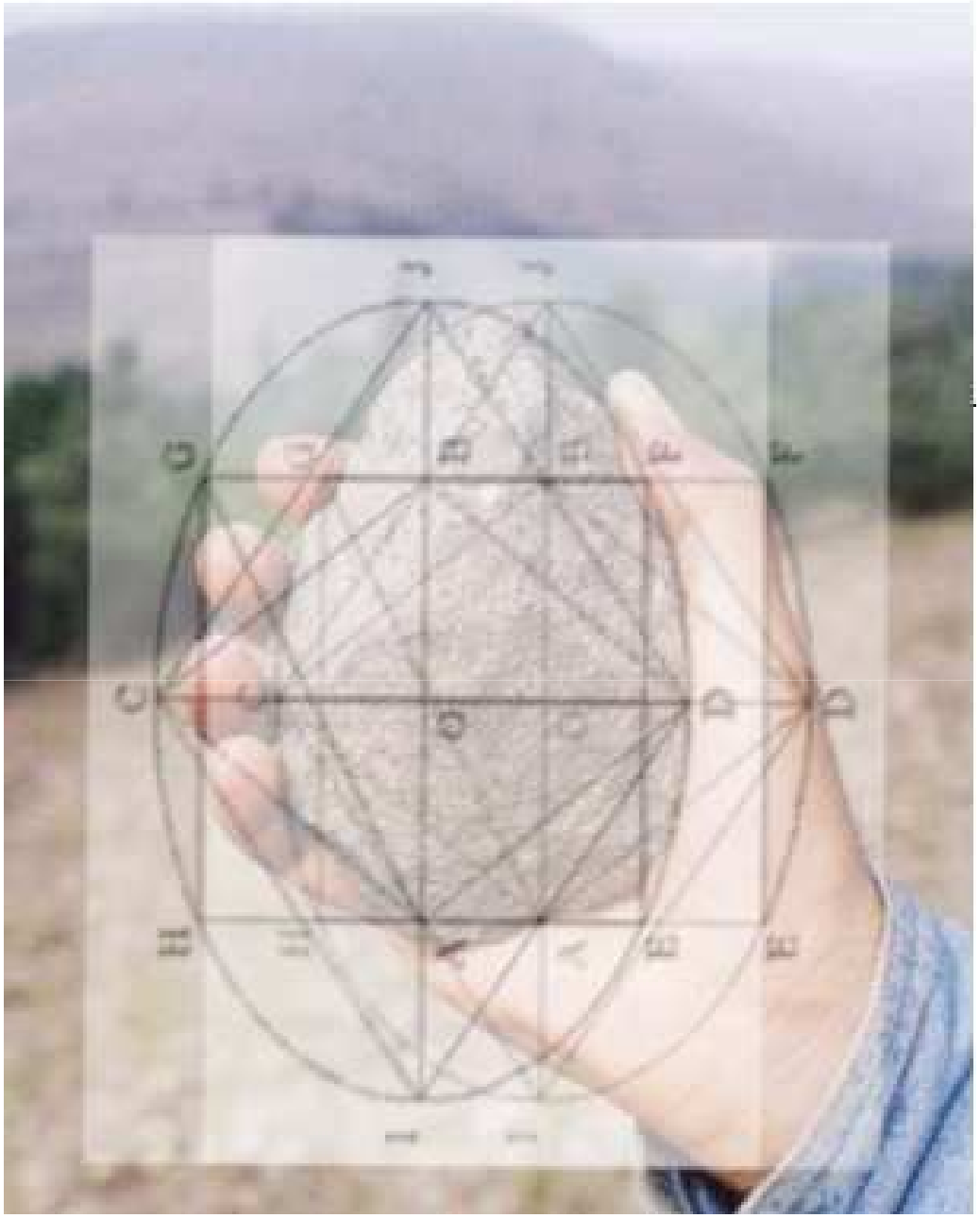


Image: http://www.ele.net/acheulean/handaxe.htm

Typical examples of the ‘Composite Ellipse’

Boxgrove, UK. 500kya:

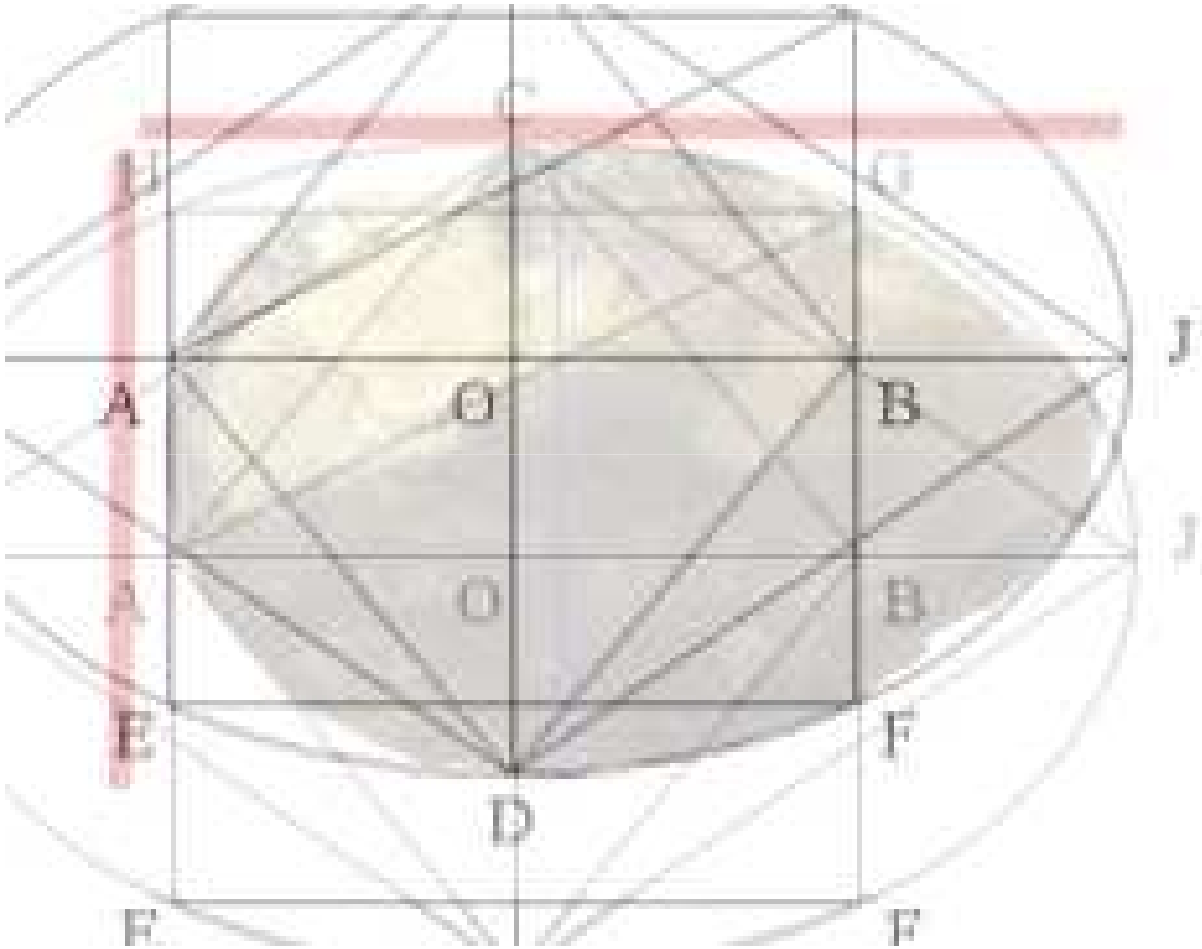


Image source: http://home.wanadoo.nl/marco.langbroek/acheul.html

A template often found, as in this large example from Olorgesailie, Kenya, (900kya), has a 36 degree ‘blade’ added to a Golden Ellipse

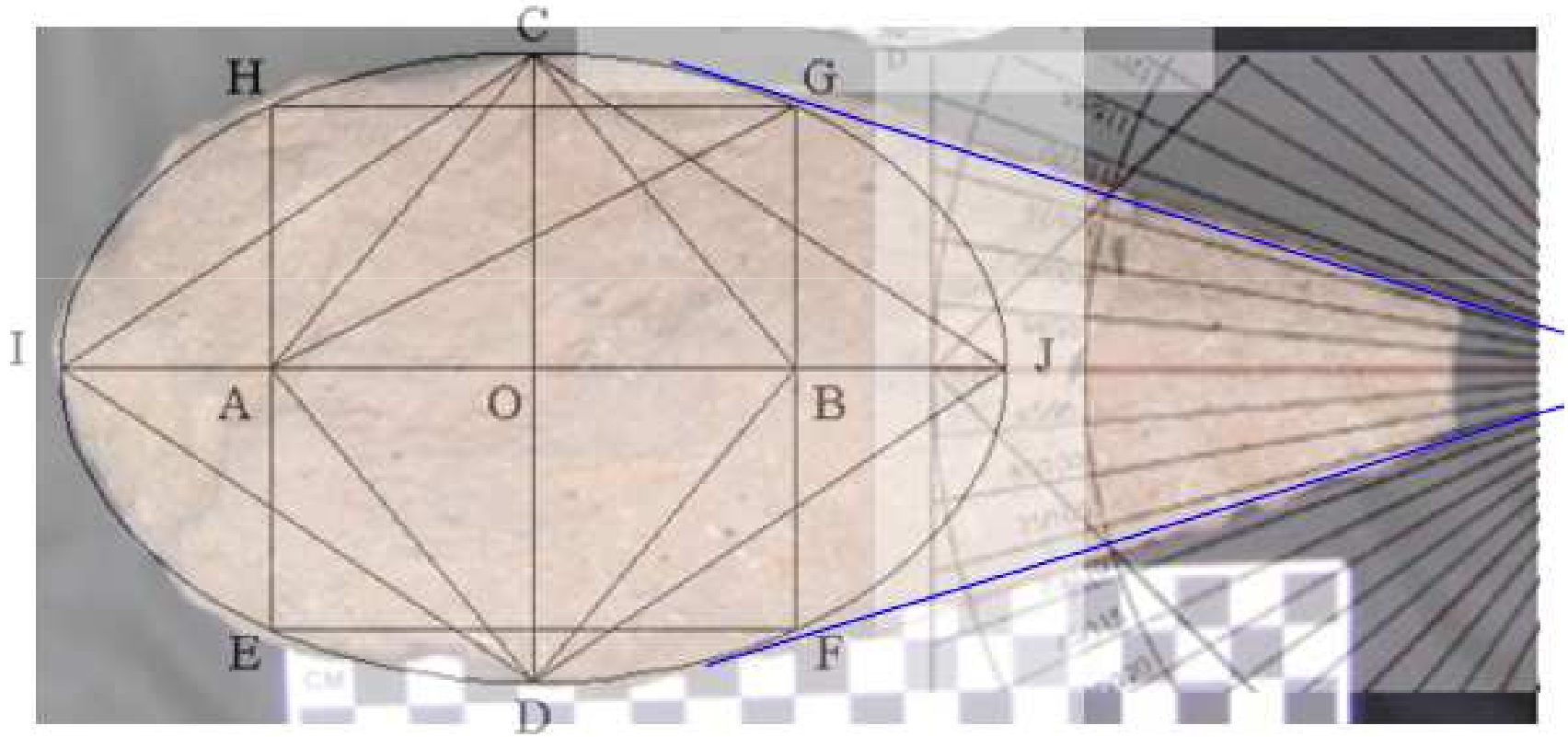
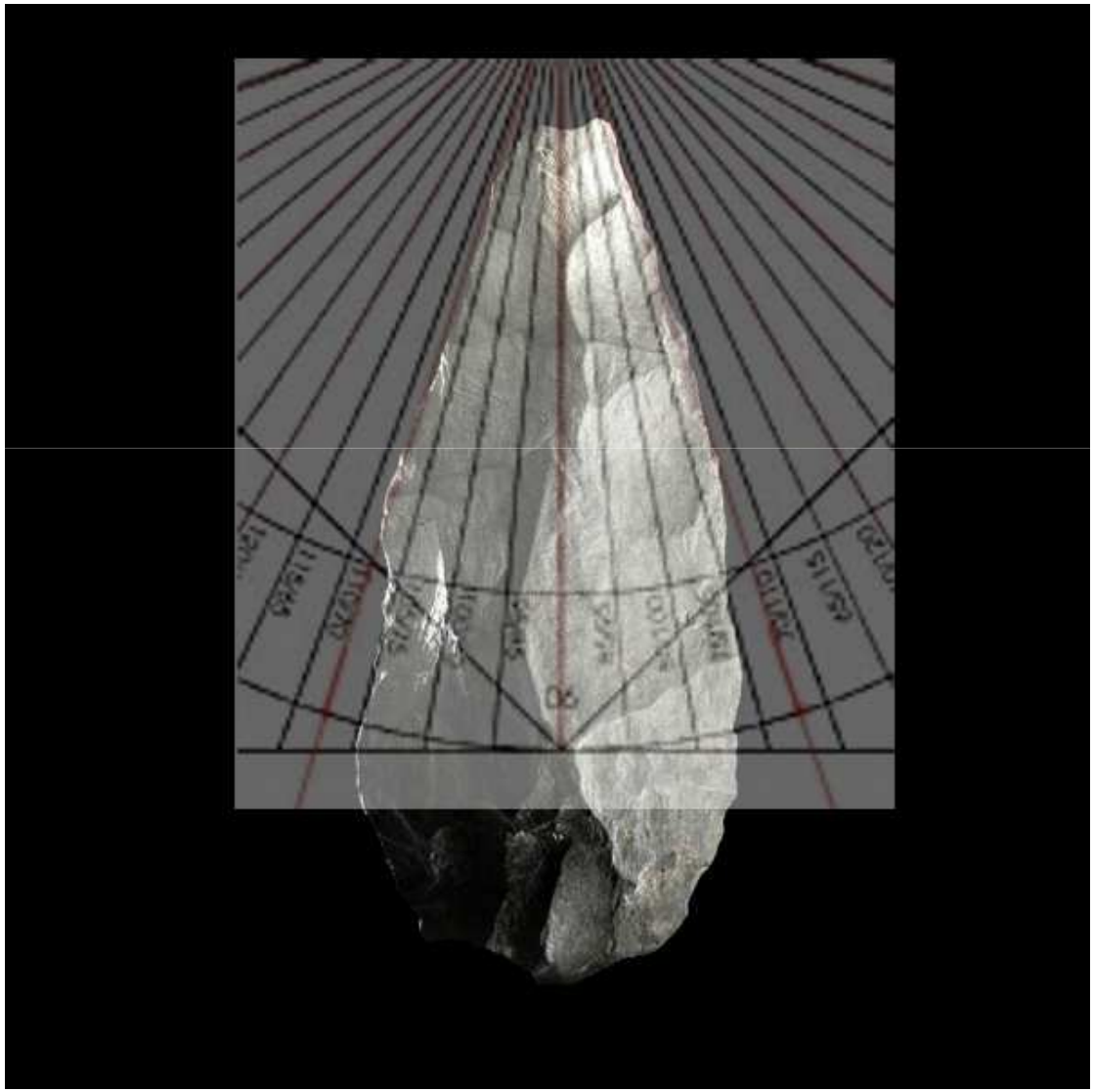
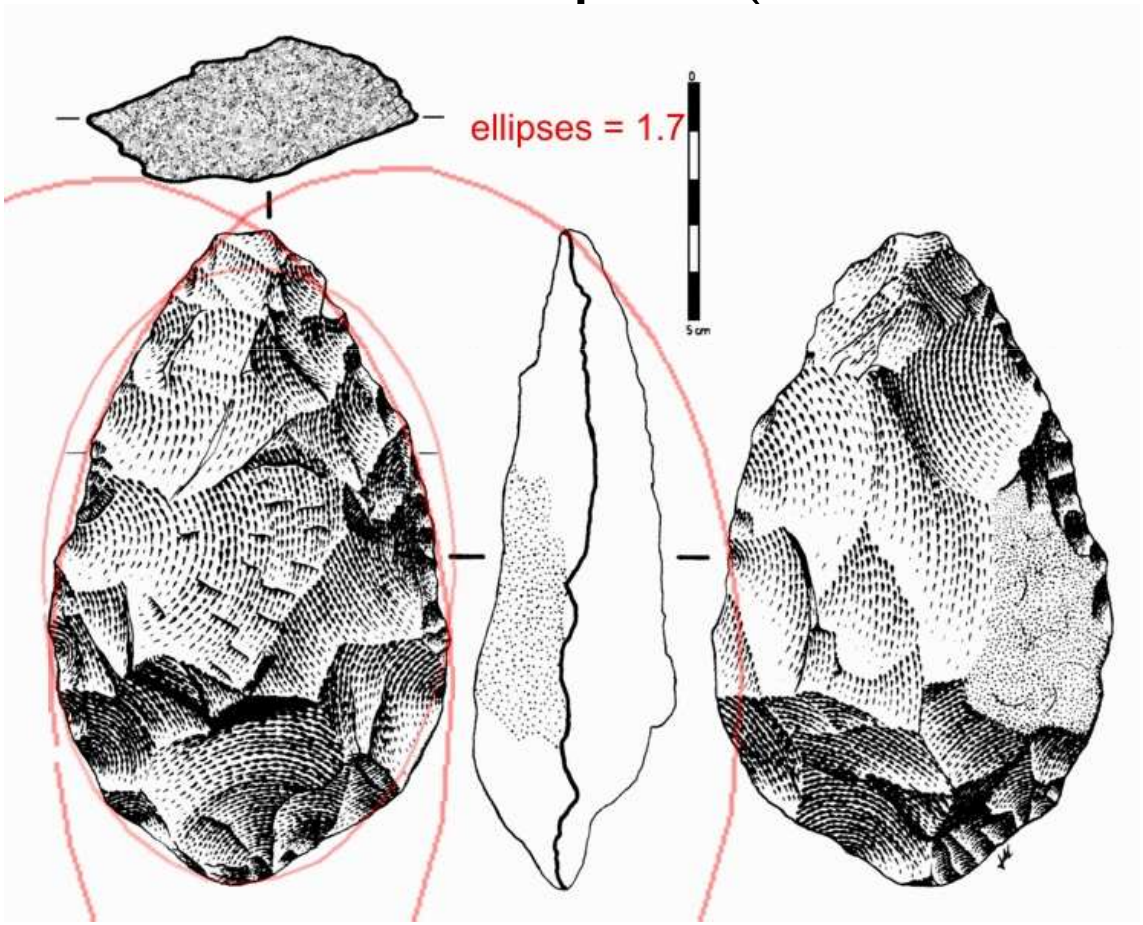


Image: http://www.ele.net/acheulean/handaxe.htm - overlay alan cannell

British Museum: Olduvian



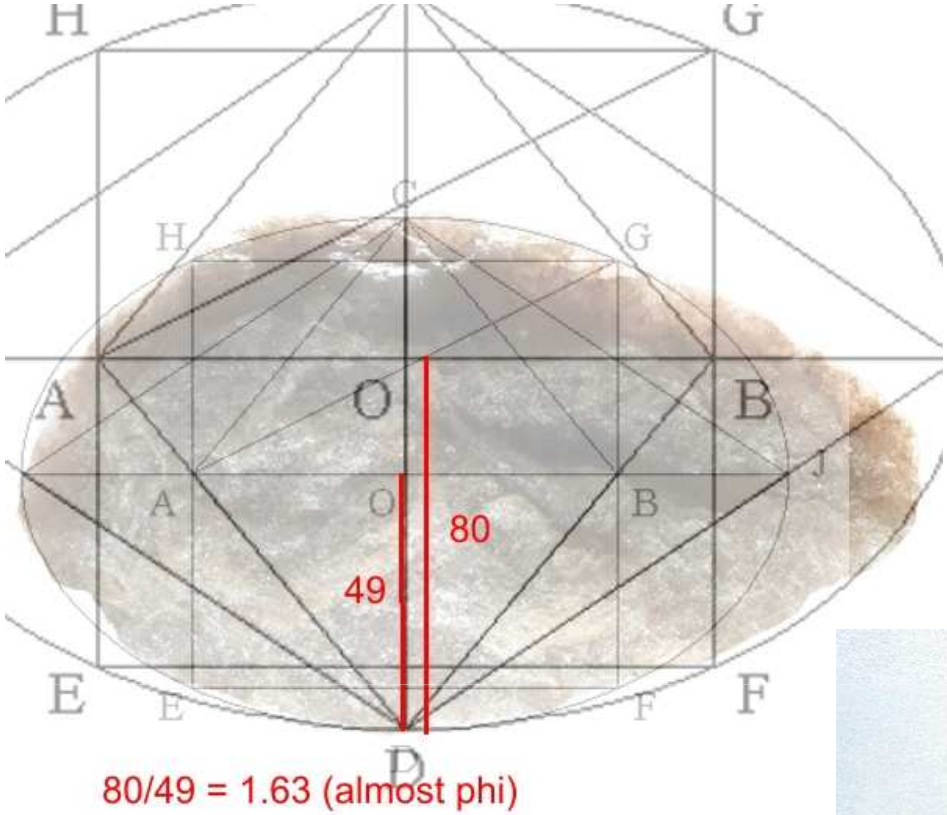
Yet another is a composite ellipse based on a golden ellipse with an elliptical blade: handaxe from Zamora Spain (date not known)

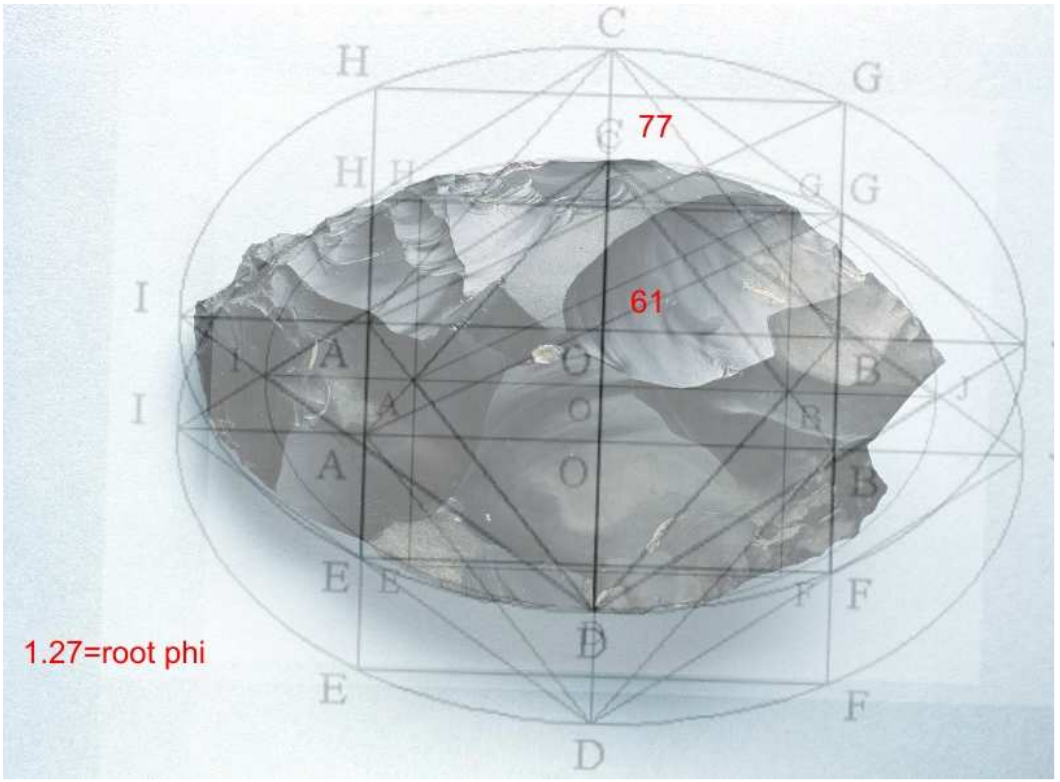


Note that the ratio of the ellipses approaches phi

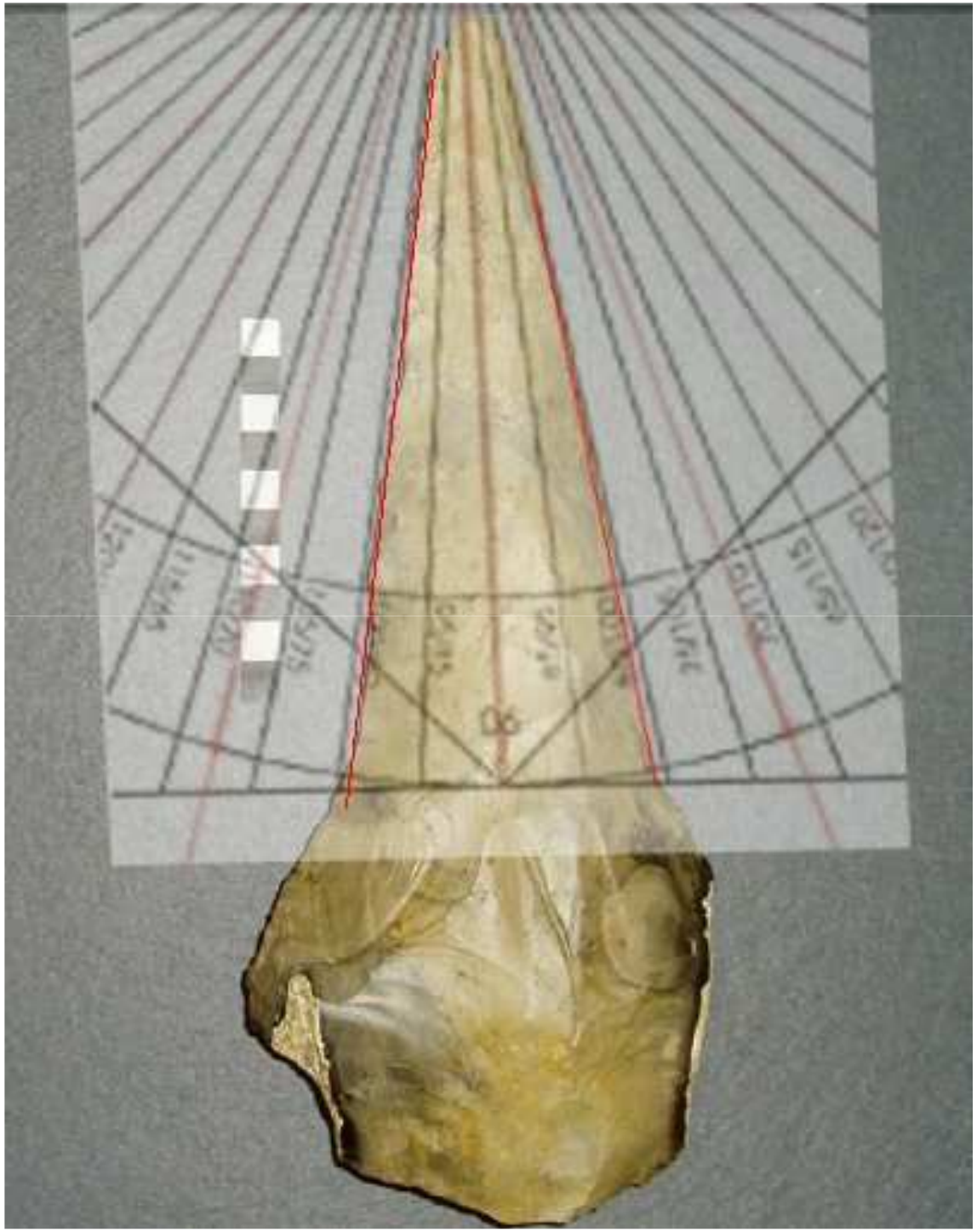
http://en.wikipedia.org/wiki/File:Hand_axe_spanish.gif

Composite Ellipse examples - British Museum: Olduvai 800kya; Norfolk 700kya

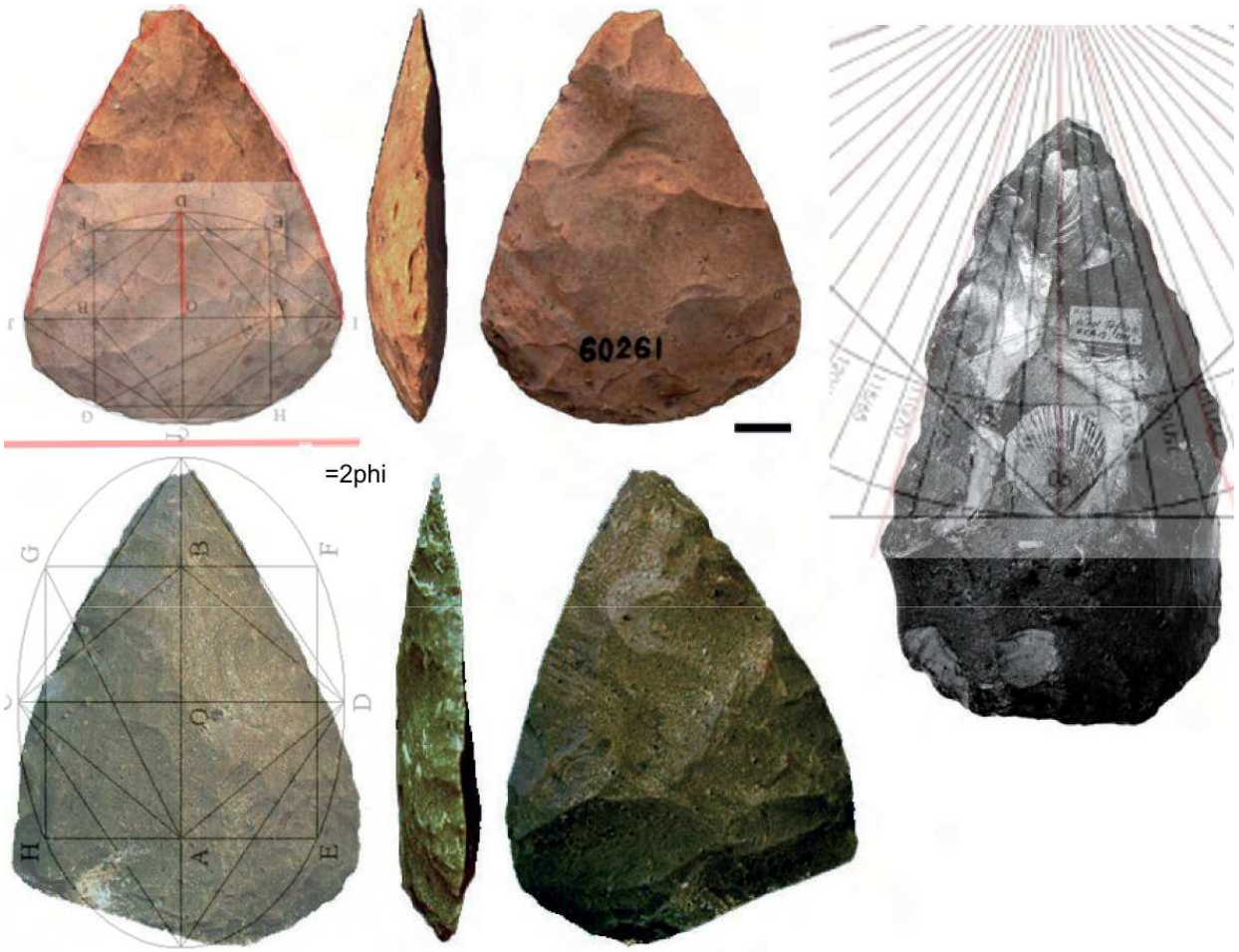




Note that the relationship between the ellipses (body and blade) also reflects phi.

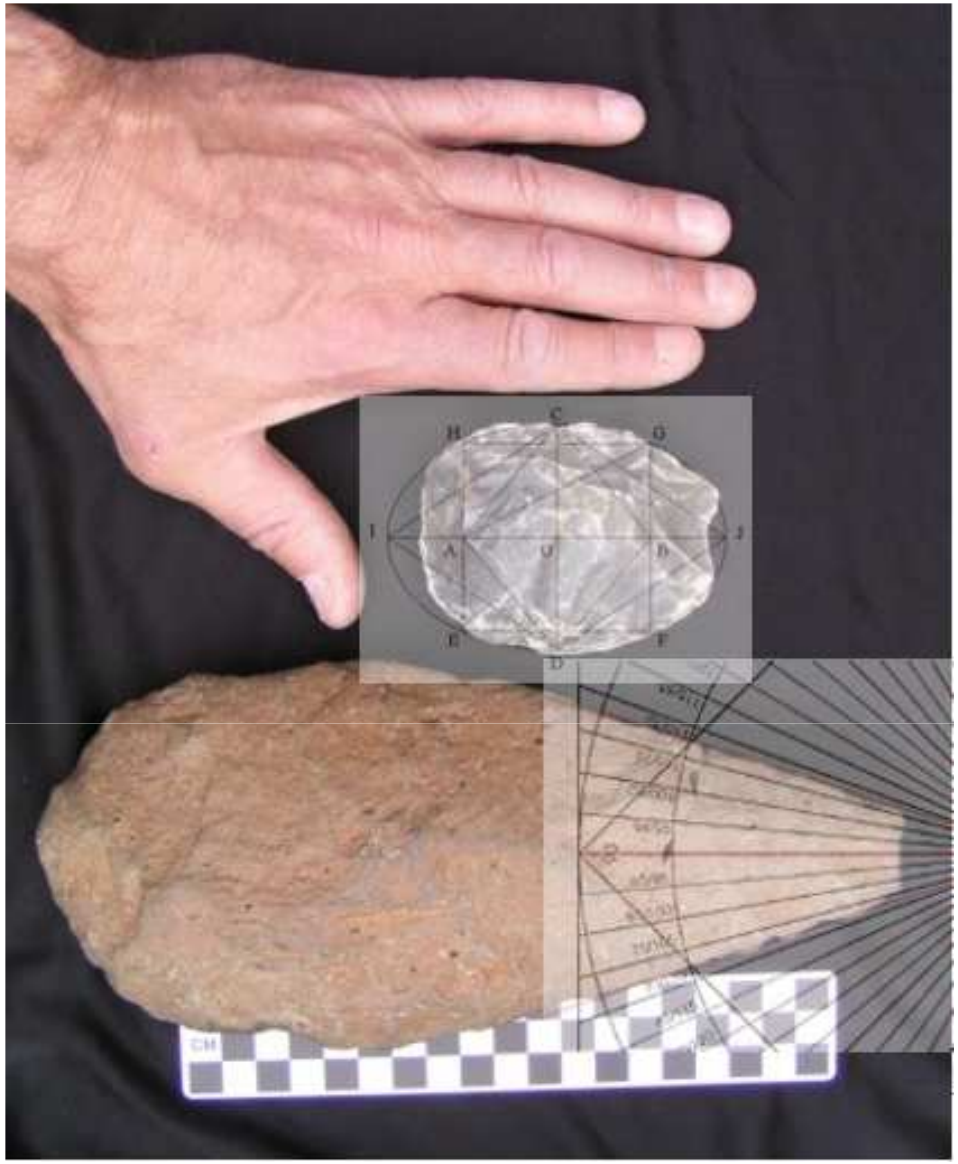


British Museum: Giant Ficron with 18^{o} ‘blade’. This angle,(36/2) is also strongly reflected in modern design – as is shown below.



http://www.donsmaps.com/neandertalsymbols.html

Mousterean *(Usually Neanderthal)* bifaced Acheulean and (right), biface from West Tofts, UK. The top left has a butt based on an ellipse with elliptical 'blade', the ratio between the ellipses being 2 phi. The bottom left has a l/w ratio of phi. The blade on the right tends to 36 degrees. (The fossil shell, neatly bisected by the vertical was only seen by the author after the protractor had been fitted. On reflection, this surely classifies as art.)



Warren Hill, England, 250kya and Olorgesailie, Kenya, 0,9mya. Expressions of phi with very different values of l/w

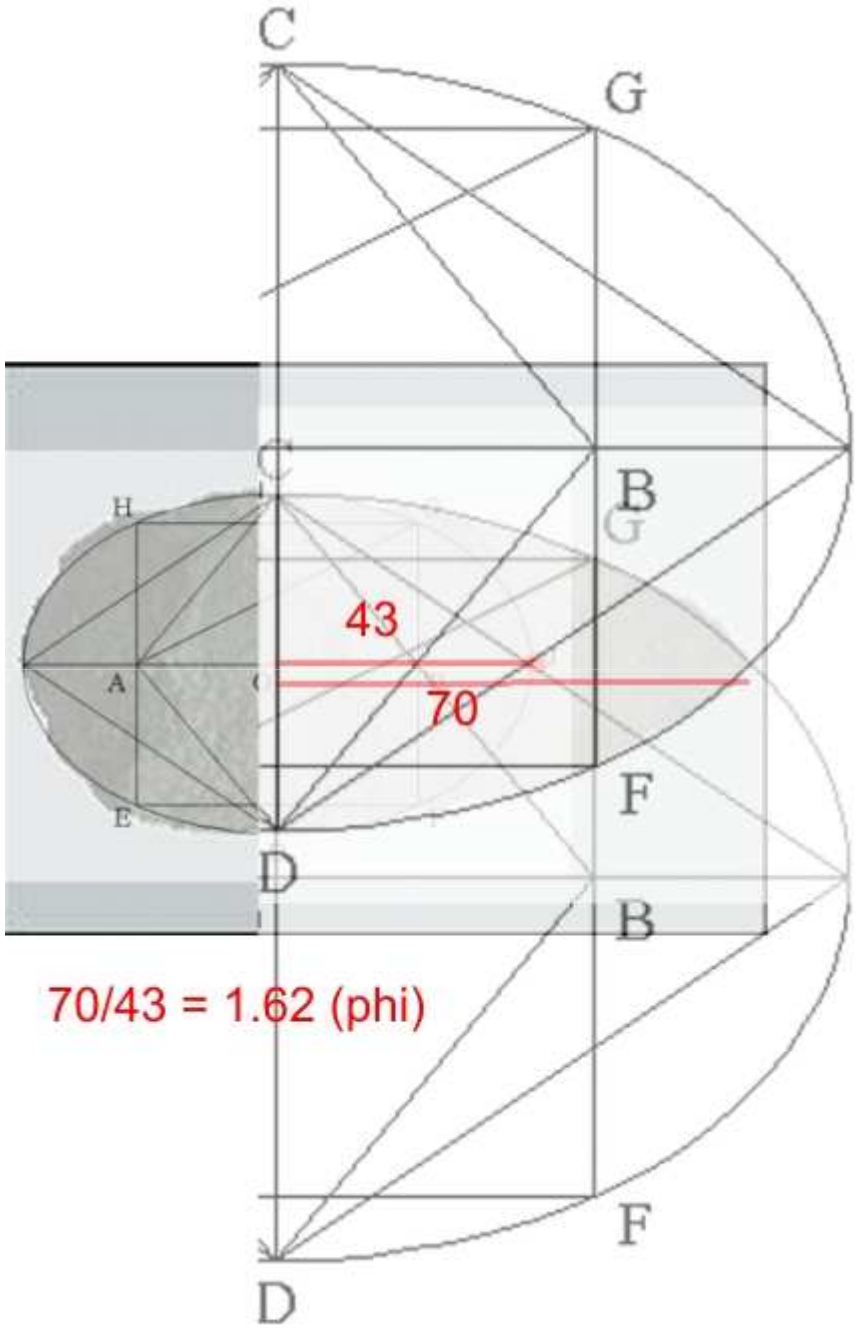
Image: http://www.ele.net/acheulean/handaxe.htm - overlay alan cannell

Nearly all available images of handaxes express some form of phi, often in the overall area dimensions, the use of ellipses or 36 degree angles. These properties may have been overlooked due to the conditioning of 19th Century classification of 'Paleolithic techniques' by shape or style, ignoring any underlying expression of phi - Micoquian, Ficron, Lancelote, etc.

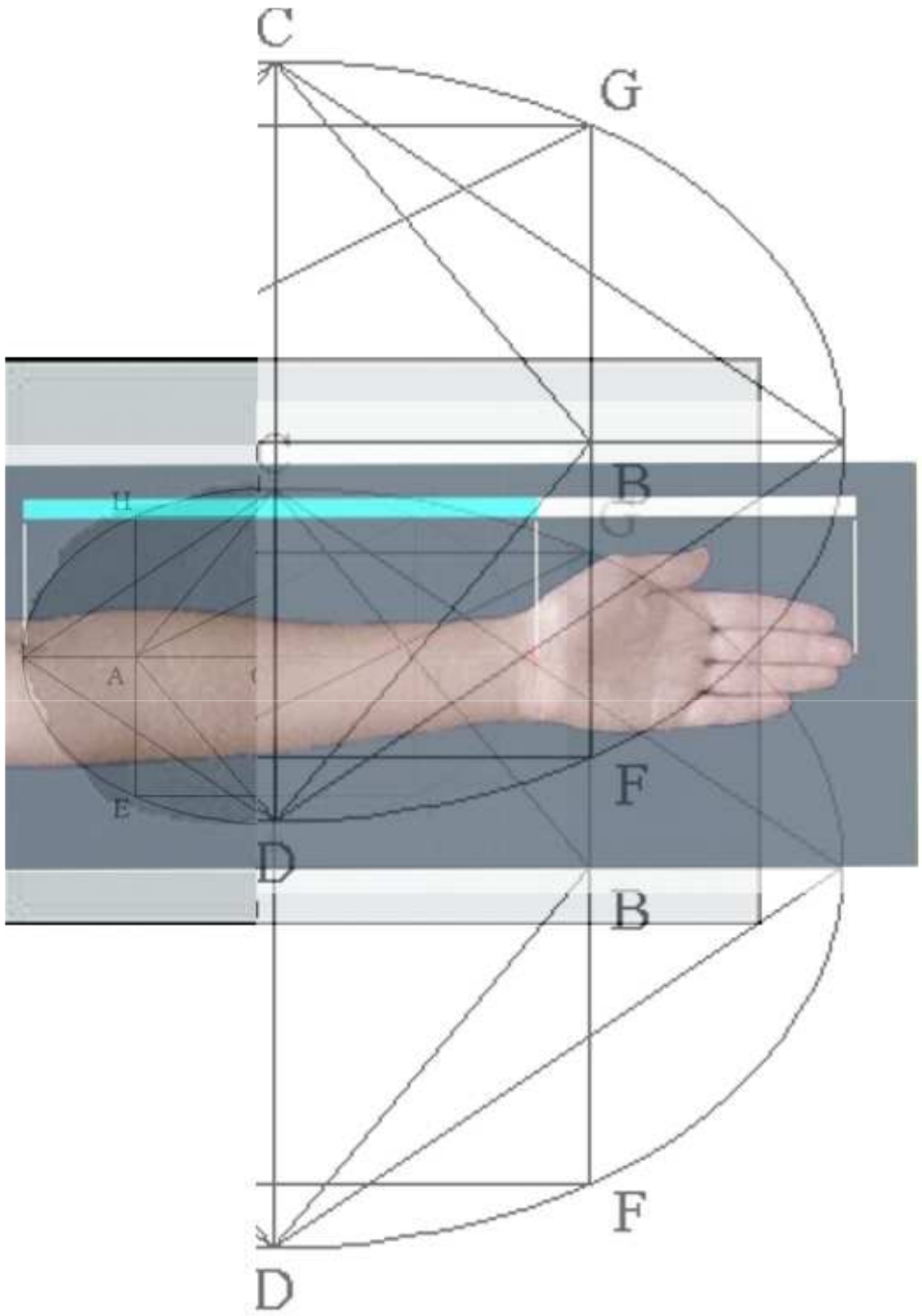
As much research has also concentrated on the l/w ratio using simple statistical regression analysis, this again masks any other expressions of form. The problem with using dimensional data to analyze axes is that templates can be based on the golden ratio, but have very different L/W ratios.

For example, this “exquisite” (sic) 500+kya axe from Warwick, UK, has a format derived from a composite ellipse…

Image:
http://news.bbc.co.uk/2/hi/uk_news/england/coventry_warwickshire/4117227.stm

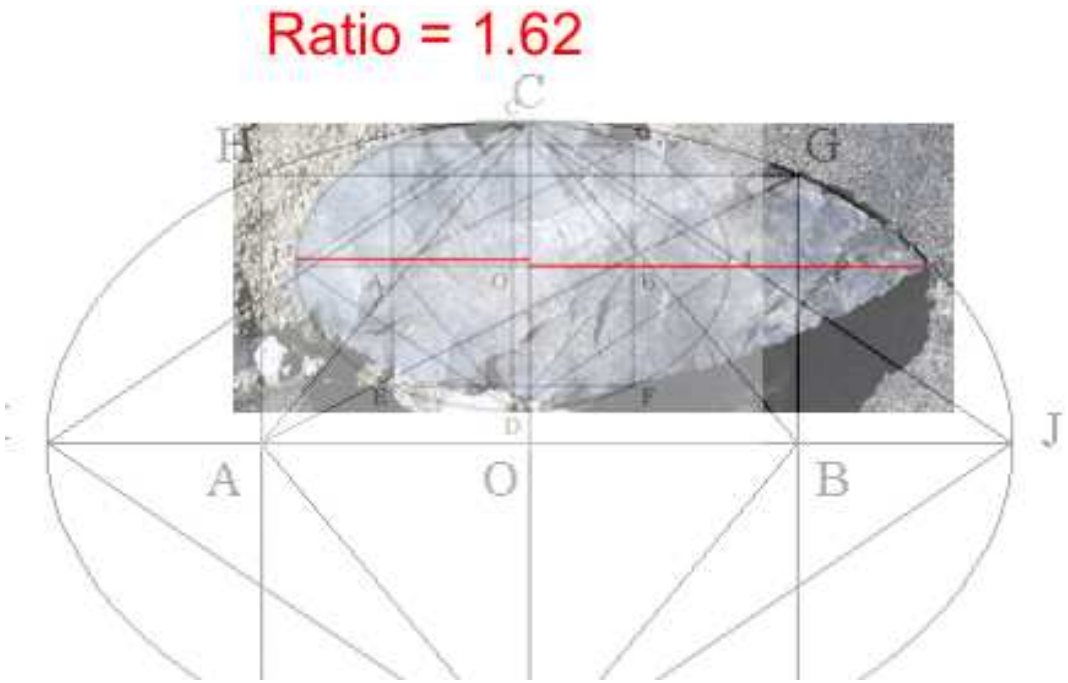


In this case phi = length of the ‘blade’/ half the base ellipse.



Again, this is also based on the geometry of the human body. The GR also being the ratio between the base ellipse and the sum of the two half ellipses.

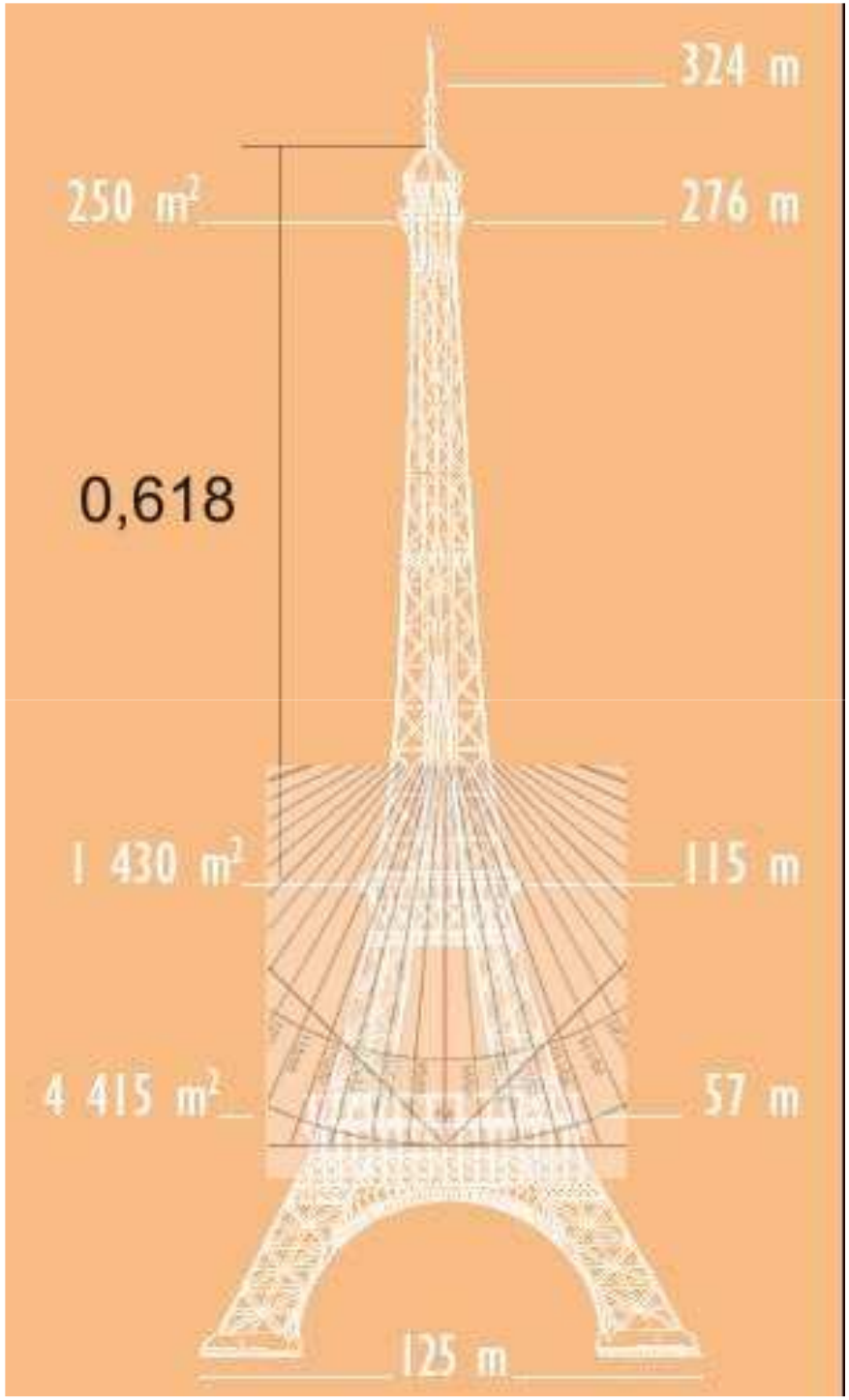
Image: Wiki Commons



The same template is seen in an axe from Kibish, Ethiopia, dating from 195kya.
The resulting design is, aesthetically, highly satisfactory…

…so much so that it now dominates the London skyline in the form of Norman Foster´s Gherkin'. (Warwick axe superimposed by the author over the image of the building).

Image: wiki commons



The Paris skyline is also graced by a tower with a central section in 36°, as in many examples of handaxes; the 2nd platform lying at 'phi'

http://www.tour-eiffel.fr/teiffel/uk/

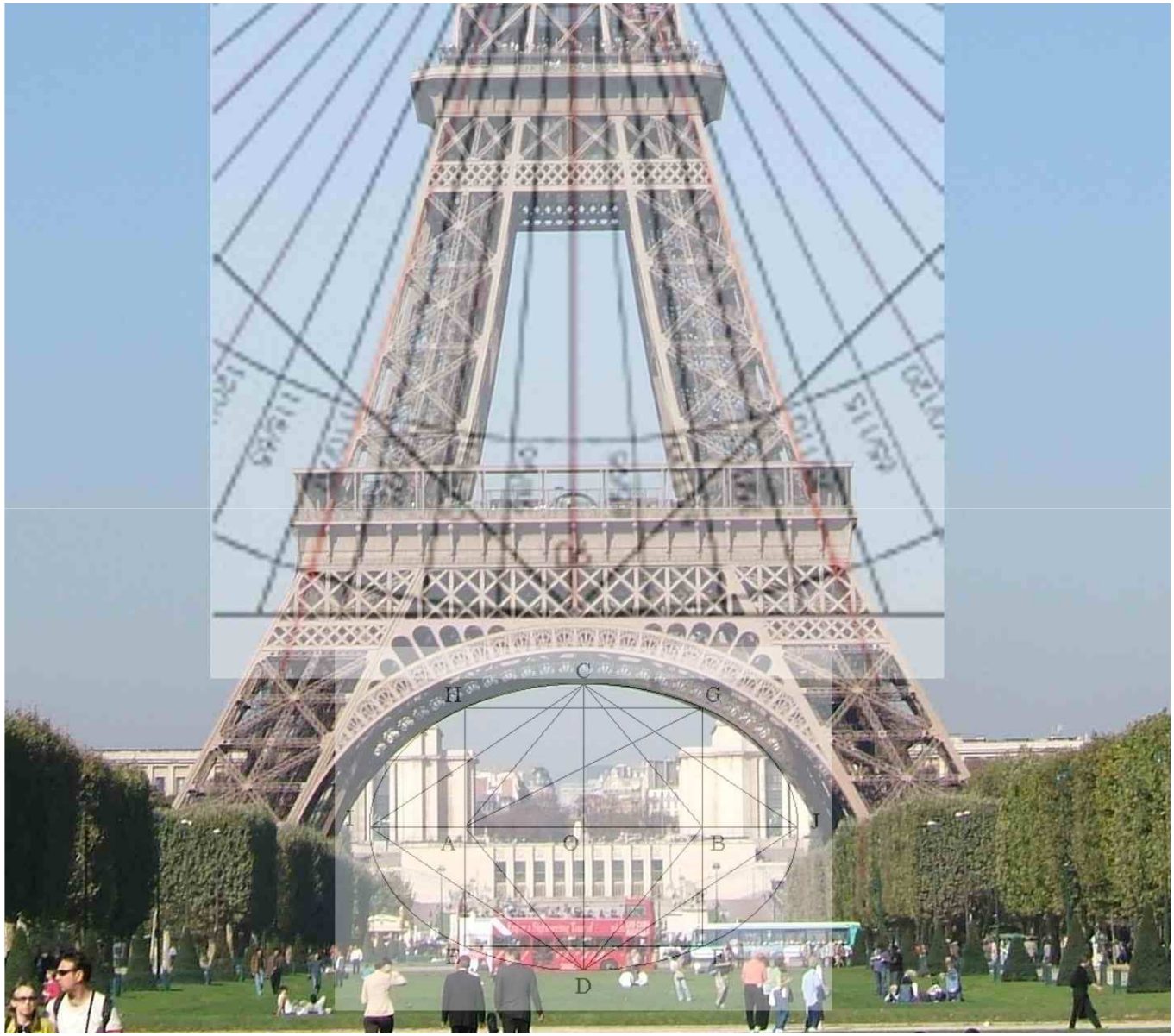


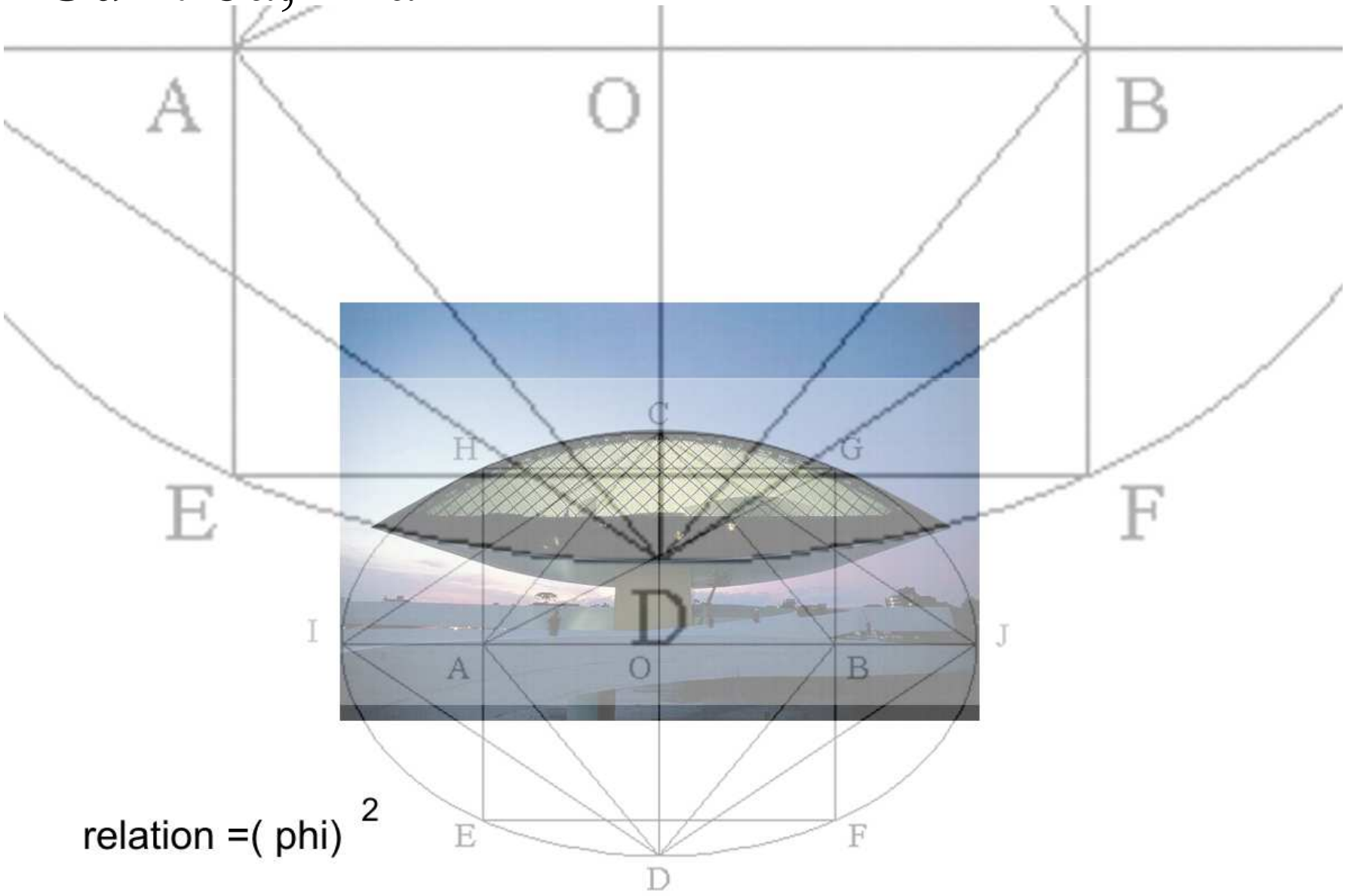
Image: wiki commons

The arch is formed by part of the Golden Ellipse that fits the height.

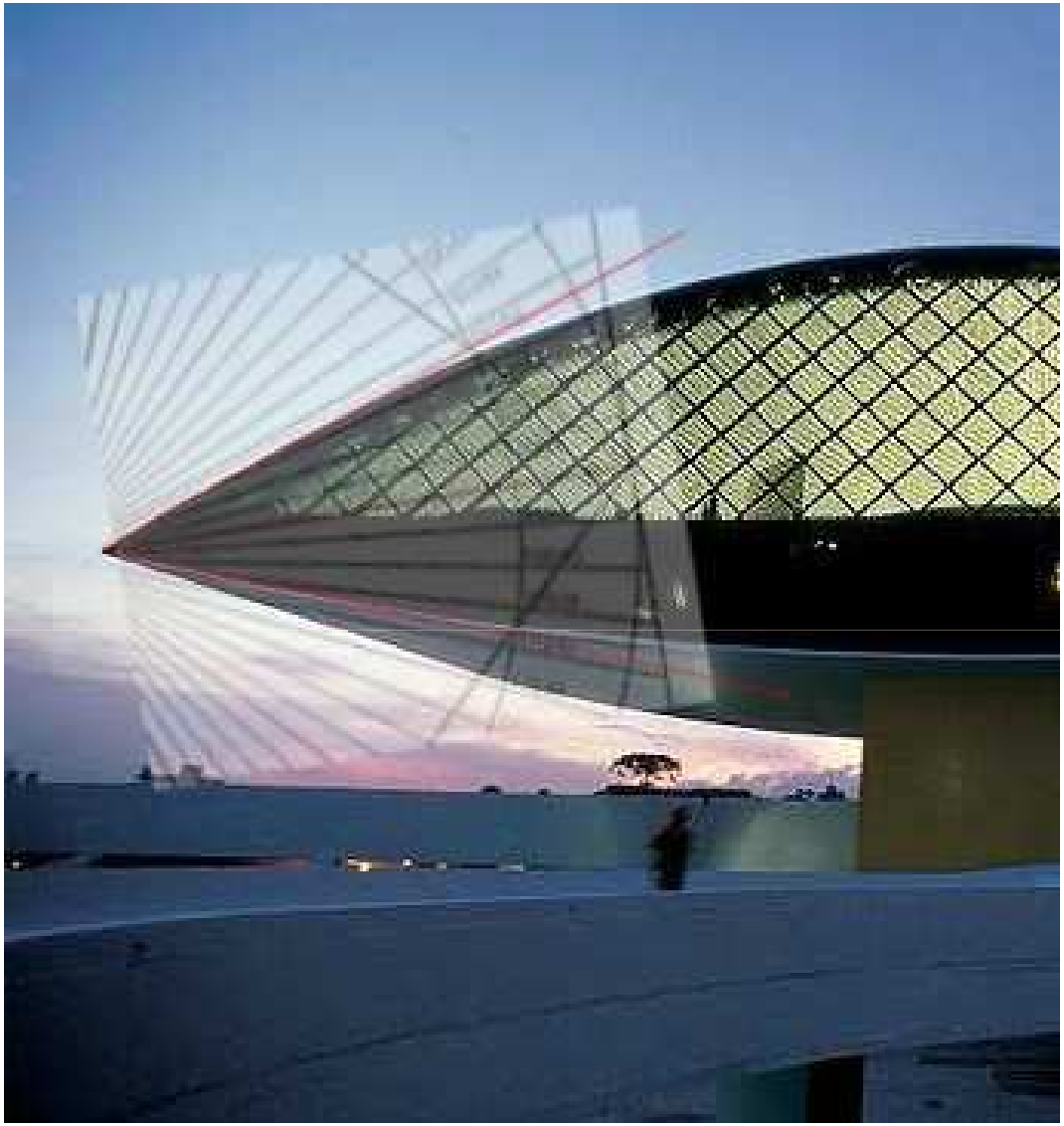
And so is the waterfront in Rio: MAM, Oscar Niemayer, Niterói, Brazil. Note the 36 degree angle in relation to the bay.

http://www.portaldascuriosidades.com/forum/index

And the ‘Eye’- Museu Oscar Niemeyer, Curitiba, Brazil



relation =(phi) ^{2}



Note that the ‘Corners’ of the ‘Eye’ form an angle of 36 degrees (shown in red).

Image:http://www.museuoscarniemeyer.org.br/fotos.htm

Beauty in the Eye of the Paleolithic (Male) Beholder: “where did our ‘modern’ taste come from and when did it evolve?”

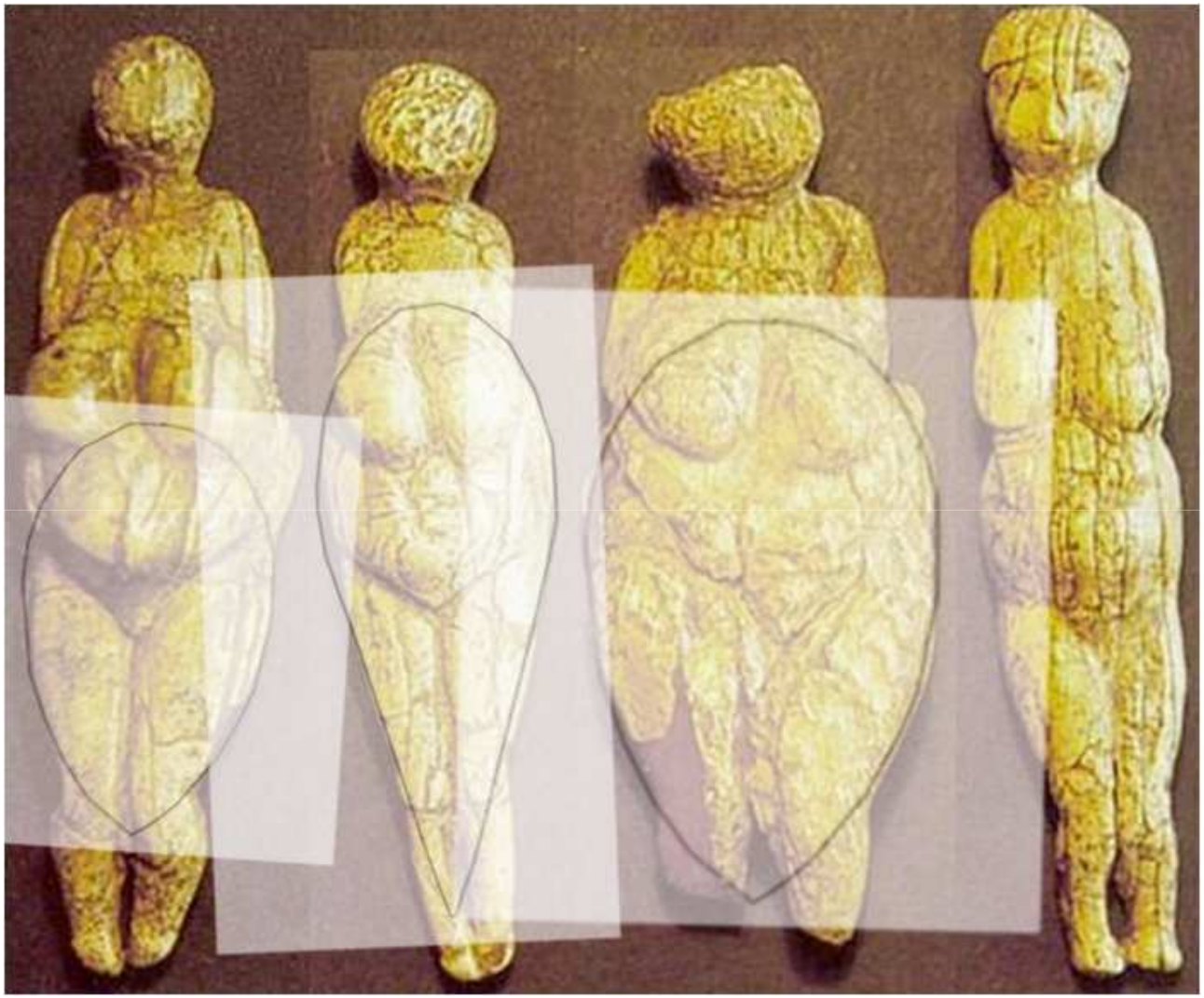
- Mass Distribution Analysis has indicated that stone tools were made principally by males (Olduvian cobble tools and manuports, Cannell, 2002).
- We have no real idea what (or if) beauty was in the eye of the male beholder 1mya or 250kya; however, certainly the feminine form was (see below) as was symmetry (sought in axe design).

Possible female figurine from Berekhat Ram, Israel. Found between two layers of volcanic ash: 230kya and 800kya. Microscopic analysis by Alexander Marshack indicates humans were responsible for the design.

Image: http://www.donsmaps.com

We can also get a glimpse of taste from Russian Venus Figurines (20kya) in mammoth ivory, Avdeevo.

Image: http://www.donsmaps.com



Figures 1 and 3 (from the left) have thighs that conform to a Composite Ellipse. Figure 2 has the thighs set at 36 degrees.

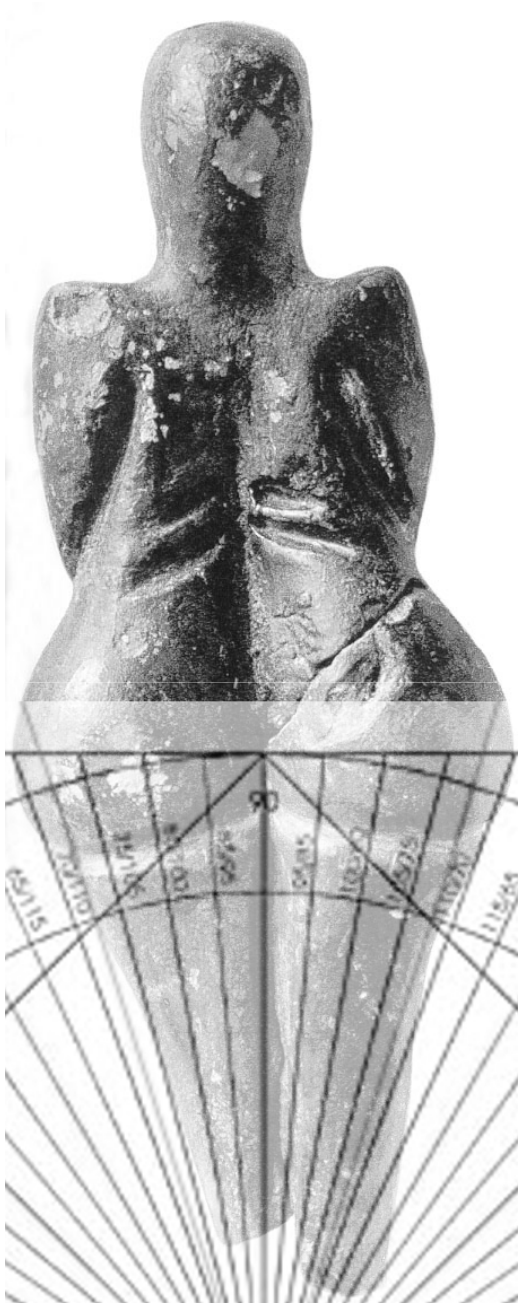


Image: http://www.donsmaps.com

Ceramic Venus of Dolni Vestonice: copy of 27kya artefact. Thighs set at about 36 degrees.

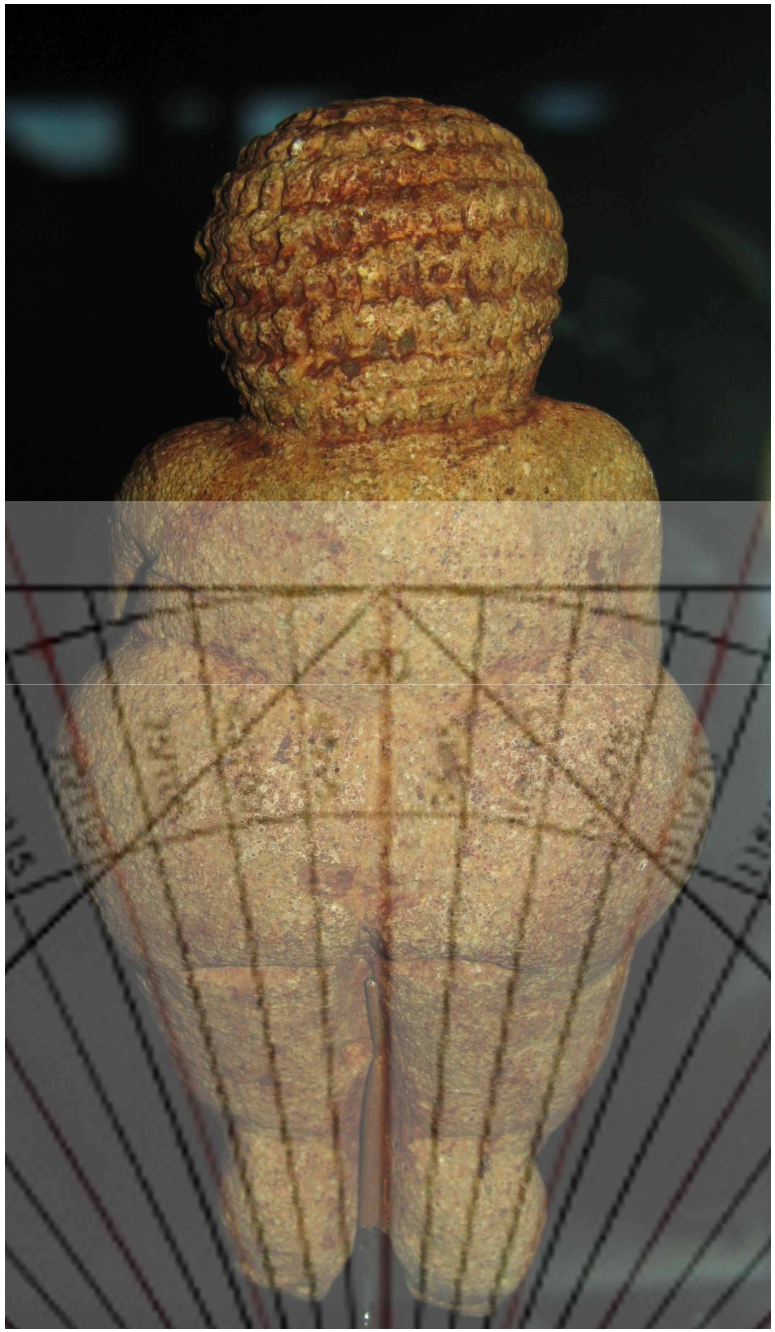
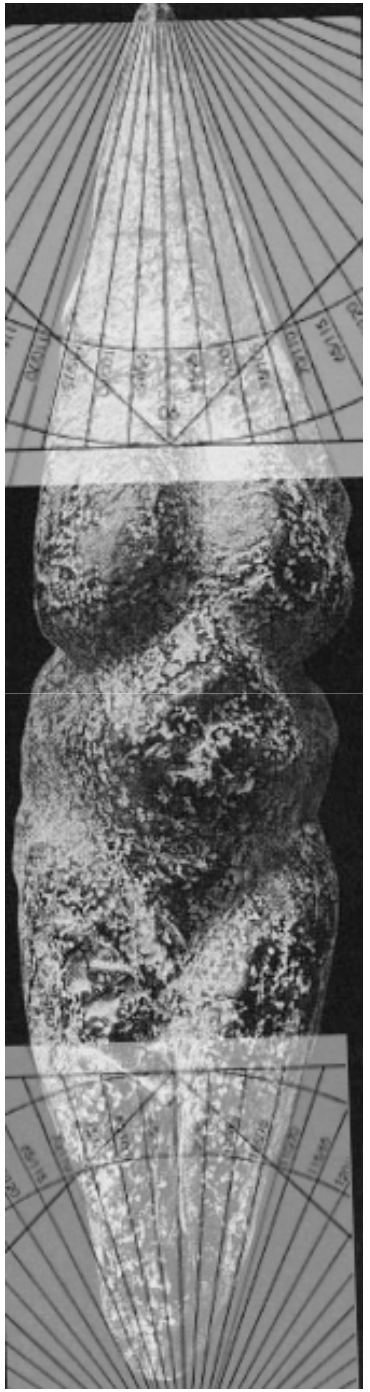


Image: http://www.donsmaps.com

Willendorf Venus: again, limits of legs and buttocks tend to fit the angle of 36 degrees.

The rock face carving (Venus and Horn) shows breasts in a ‘classic’ hand axe format with a 36 deg top. (The legs curve inwards with the rock so it is not possible to determine their angle).

The ‘Serpentine’ or Savignano Venus figurine (R) even has both ‘ends’ in 36 deg.



Images: http://www.donsmaps.com

Bilzingsleben, bone carving (350kya – Feliks, 2008, Phi in the Acheulian). Possibly the earliest known pictorial art form. Whatever the markings mean, the outer marks form an angle of 36 deg.

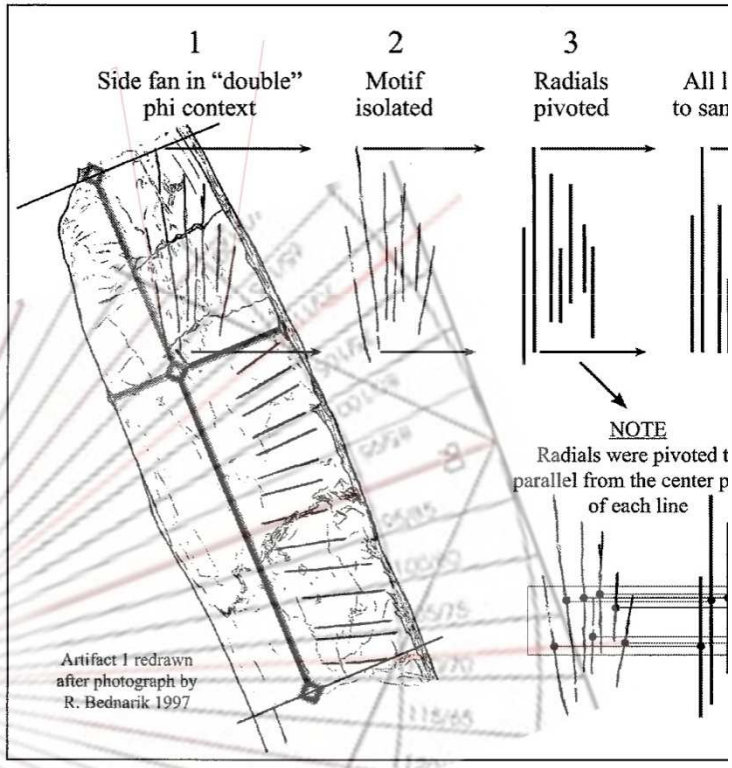
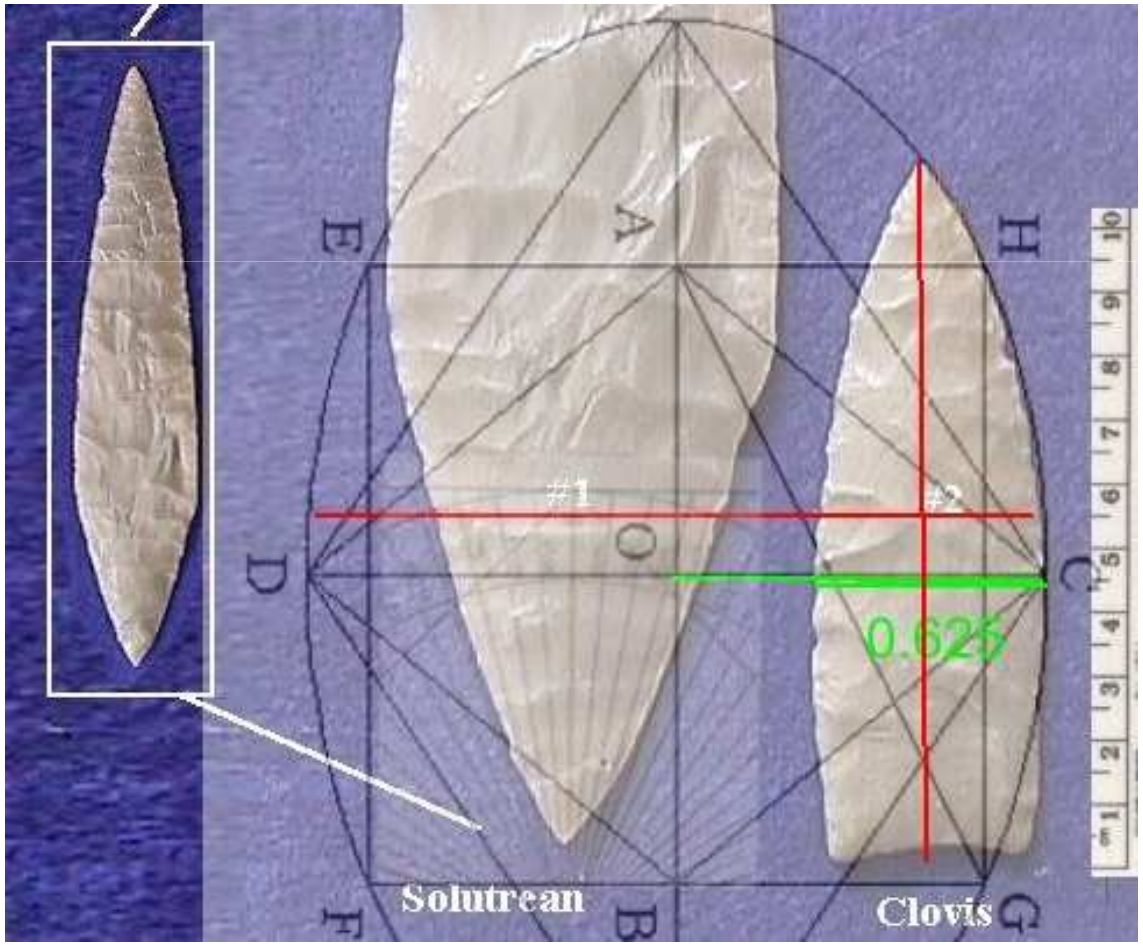


Figure 2.17. 14 instances of Phi in a 7-line motif. This study f
hominids of Acheulian tradition had a profound sense of ratio
of line, shape, angle, and positioning. As in Fig. 16 one measur
parallel. A second variable was removed in Step 4 by setting

This influence of the Golden Ellipse and 36^{o} is present in recent Paleolithic cultures. The elliptical 'Clovis' blade must have proved to be highly efficient: form and function acting together with a possible phi relation between length and diameter. The Solutrean haft terminates in 36^{o}.



Replica Image:www.geocities.com/blobrana

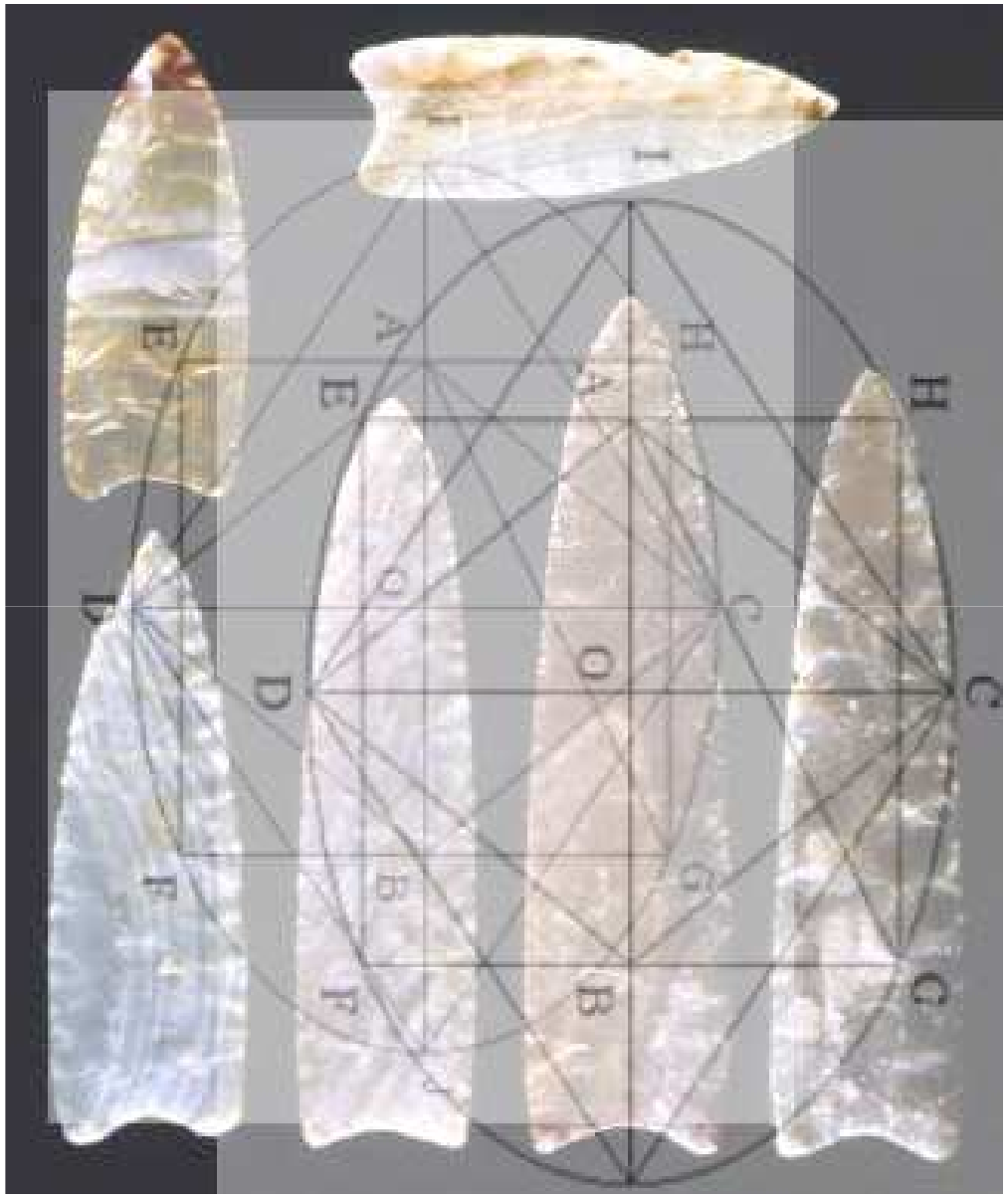


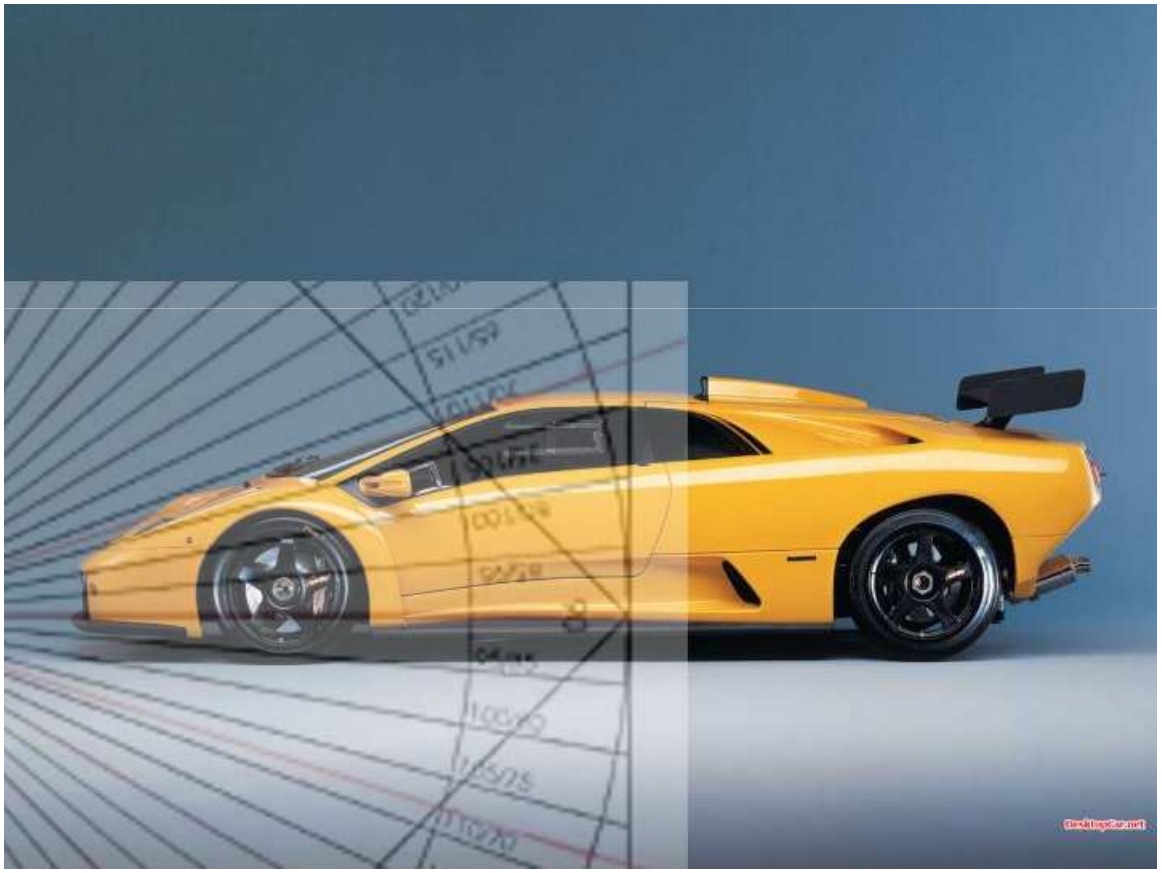
Image:lithiccastinglab

The Drake Clovis points: note that, in a nice touch someone (Smithsonian?) has instinctively laid out the samples to conform to the Golden Ellipse that defines 2 of the points, the axis being aligned with the centre of the longest blade.

Comments

- The ***one*** conclusion that can be drawn is that modern human researchers like to display examples of handaxes and stone tools that contain expressions of phi.
- In order to verify if the use of these phi based 'mental templates' was also widespread in prehistory it is necessary to examine whole assemblages of axes (on-going research). Although Lycett has shown that symmetry in axes was deliberately sought for "functional, adaptive or social reasons", strongly suggesting that specific shapes were also sought.
- Some expressions of phi – especially the 36 degree angle – appear to be associated with the female figure by the Upper Paleolithic.

As these angles of 36 and 18 degrees have appealed to male eyes for tens/hundreds of millennia, it is often used in product design – either deliberately or by ‘instinct’ - such as in cars: Lamborghini- diablo, etc.



http://www.desktopcar.net/wallpaper/28320-2/Lambo_diablo_08.jpg

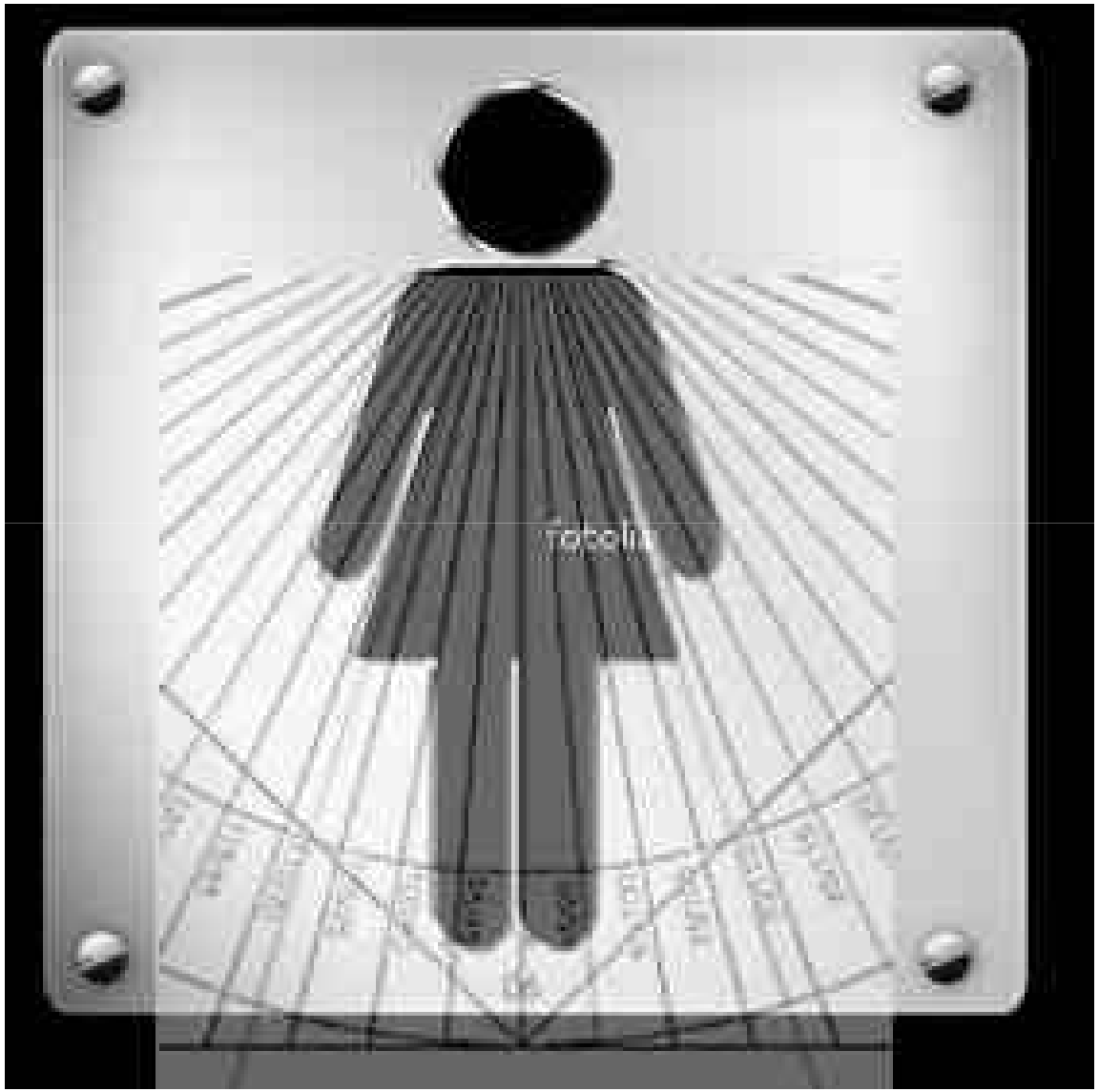
Unlike the old Mini (which had almost vertical sides), the new BMW Mini-Cooper has an 18º ‘tilt’ from the axle to the roof, (like many modern cars). This is almost purely for style.

Image:http://www.masp.art.br/exposicoes/2005

Axe formats appear even in other unusual forms of art: Picasso, The Athlete, MASP, Brazil...

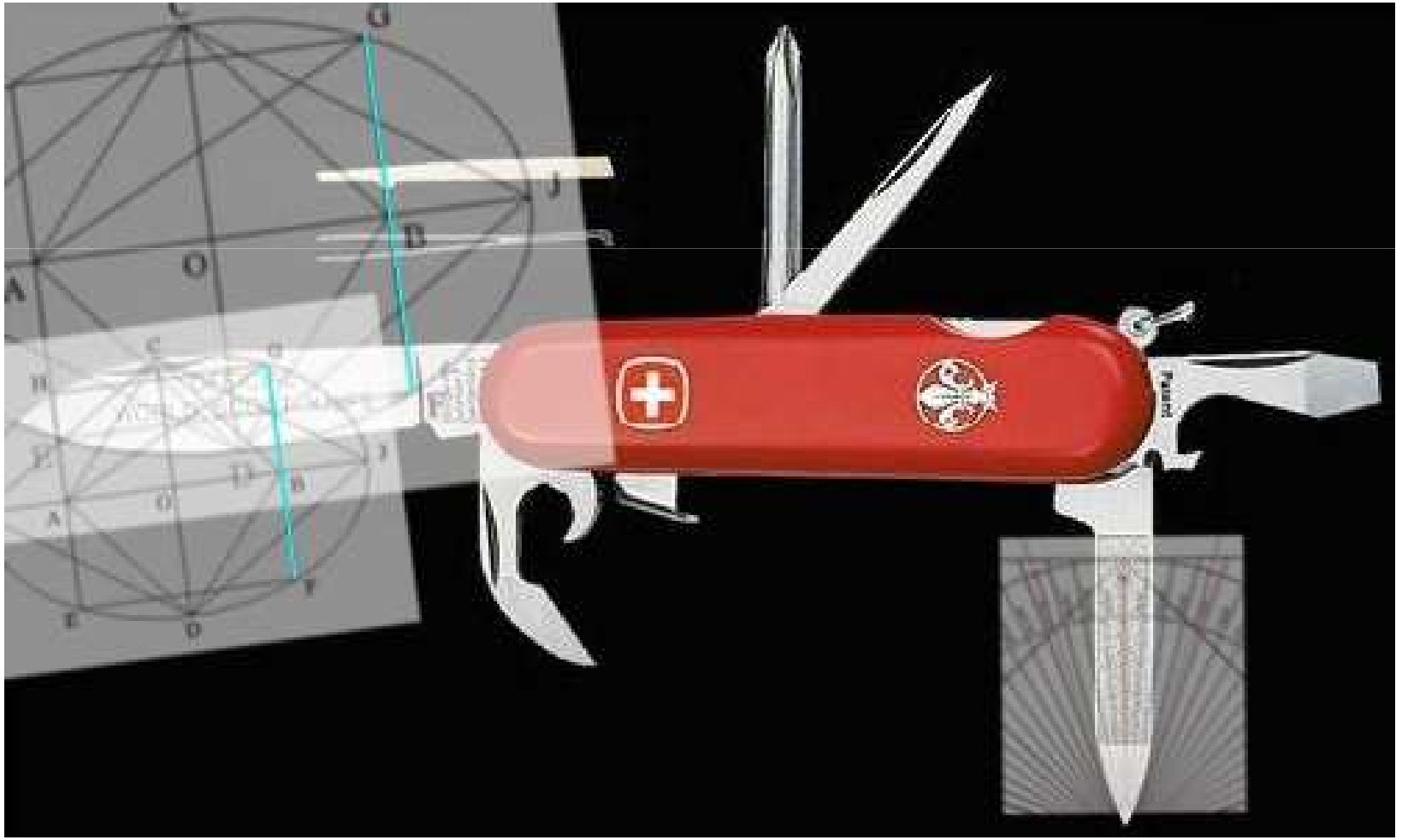
Classic Axe Formats:

1. Composite Ellipse
2. Golden Ellipse w/36º.
3. Composite Ellipse
4. 36º



And even in the mundane and symbolic.

The Hand Axe is often referred to as the Homo Erectus ‘Swiss Army Knife’ (Schik and Toth, 1993). It should be the other way round; the knife is a modern version of the axe, with a Composite Ellipse blade, (ratio between the blue lines is ‘phi’). The point on the file is 36 degrees.



Carved Rocks and Sexual Selection

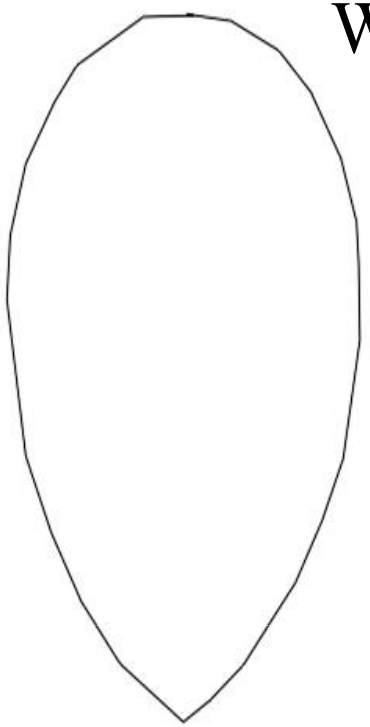
It has been suggested that the handaxe was a social artifact and skill in creating these tools may have represented an "historically accrued social significance". One theory goes further and suggests that ‘some special hand-axes were made and displayed by males in search of mate at social gatherings, using a large, well-made hand-axe to demonstrate that they possessed sufficient skill’ (*and an appreciation of nature and feminine beauty?*). This perhaps explains why so many are found together.(Kohn, M and Mithen, S, 1999, *Handaxes: Products of Sexual Selection?)*

For those who think this maybe a little far-fetched, we can always ask the question: is the gift of a well-carved rock still attractive to human females and part of sexual rituals?
Called ‘pear or tear-shaped’; this ring is actually closer to the Composite Ellipse format (image corrected for the camera angle).

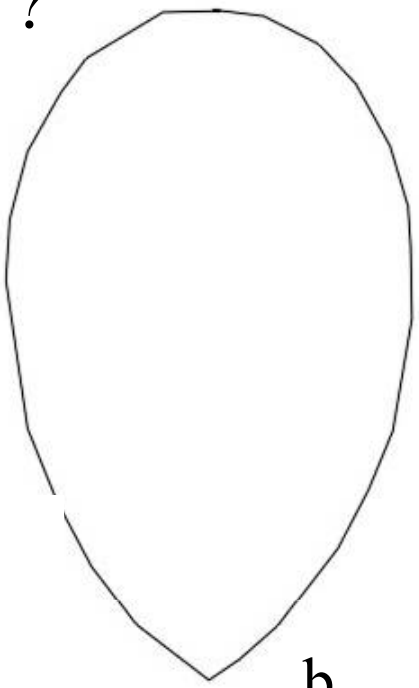
Preference in Shape:
A Test of Taste

A sample of some 70+ (mainly students of architecture who have an interest in form) were asked to choose their ‘preferred’ shape from the following 3 slides.
This was done BEFORE they saw this slide presentation on the roots of aesthetic design.

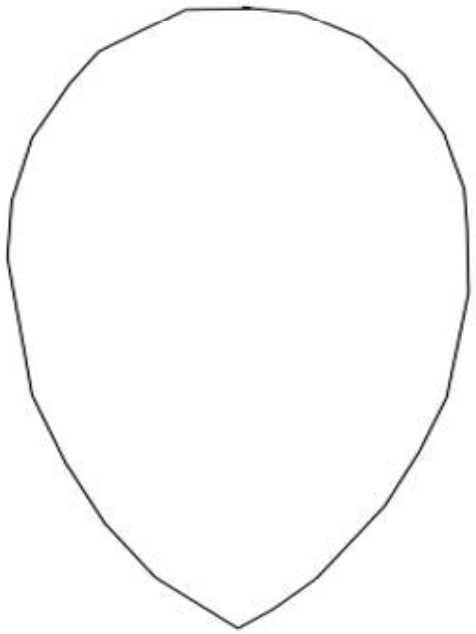
Which shape looks ‘right’?



a



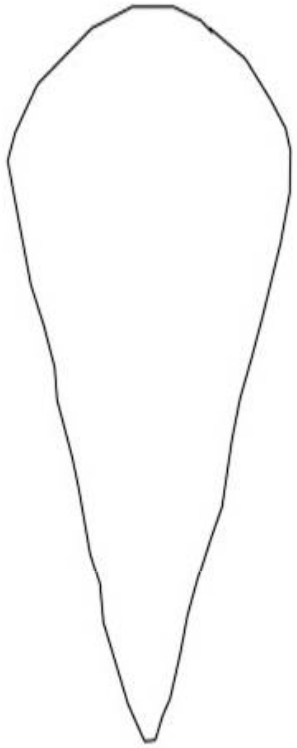
b



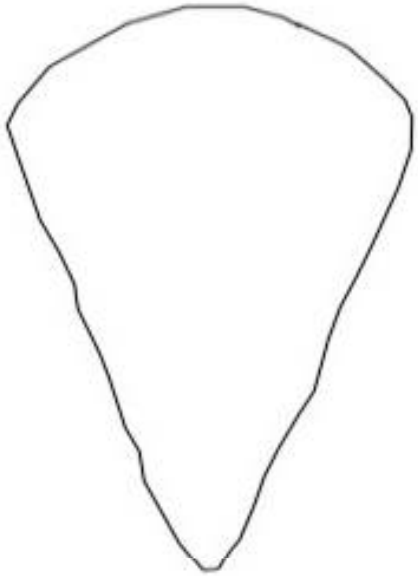
c

b) Is the composite ellipse

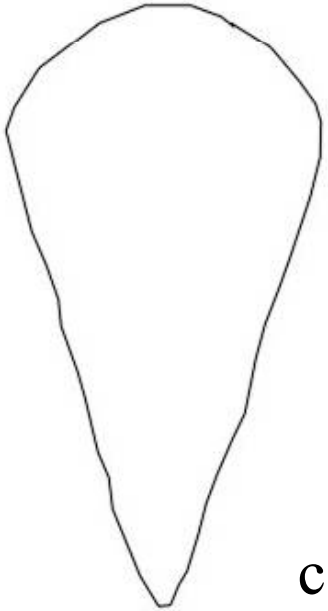
Which shape looks ‘right’?



a



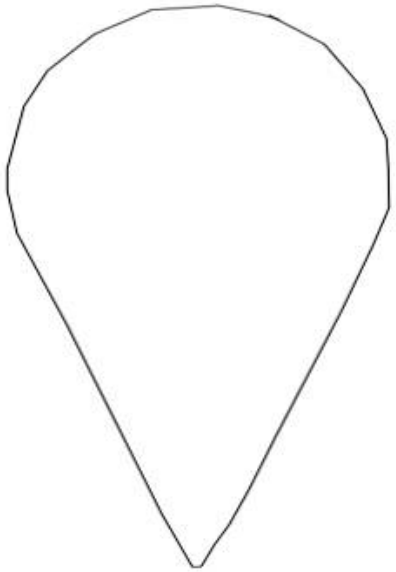
b



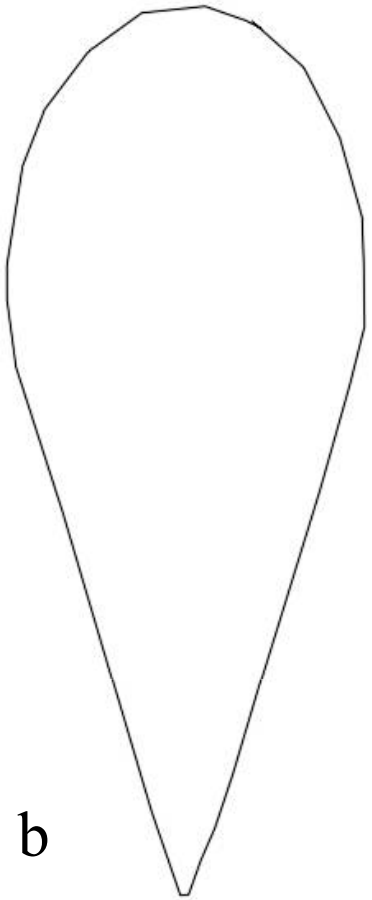
c

Only c) has a
36 deg. point

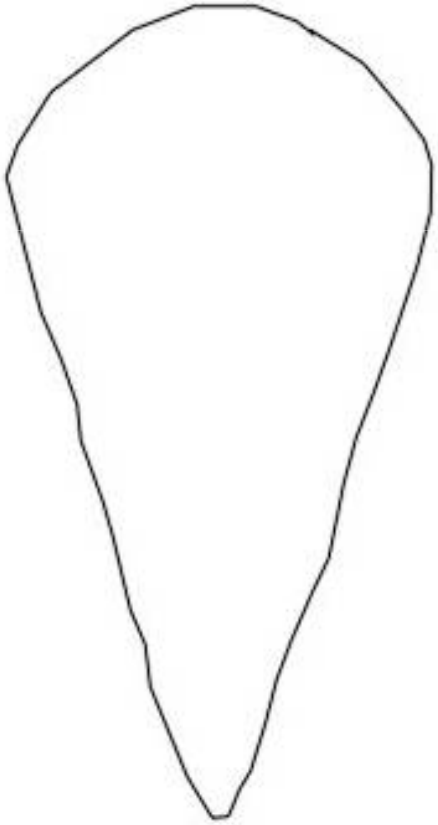
Which shape looks ‘right’?



a



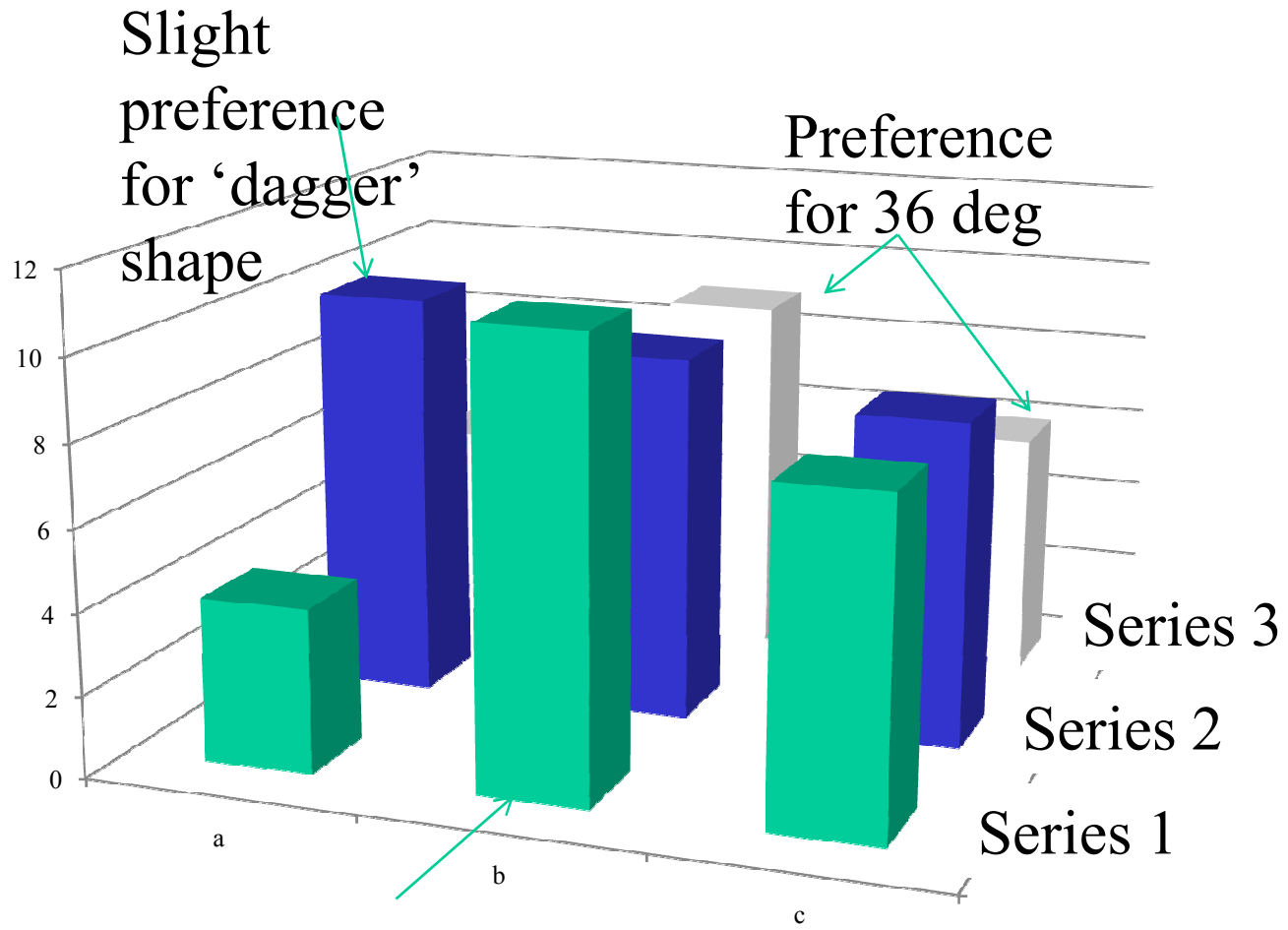
b



c

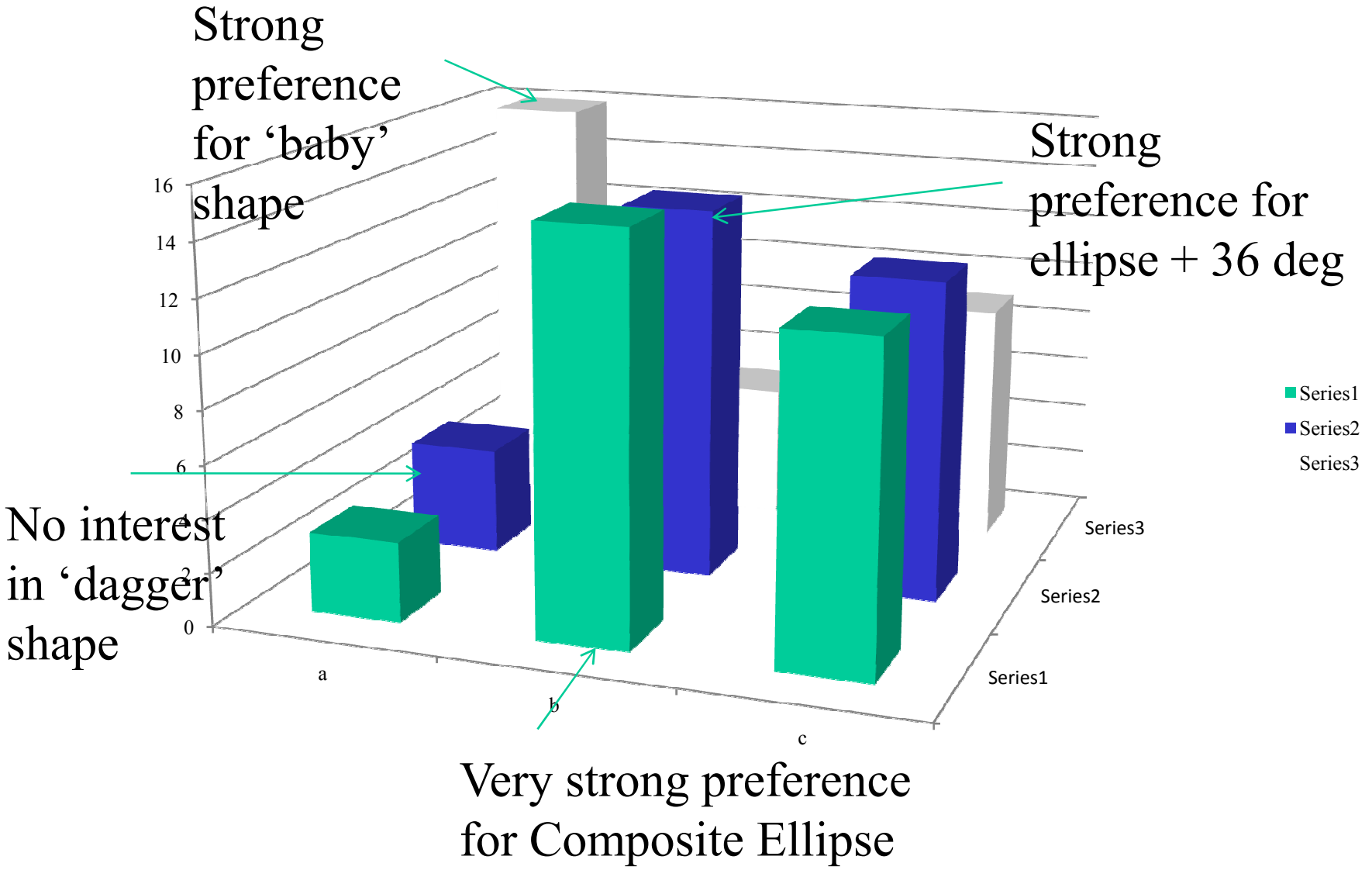
This is a ‘trick question’ as all shapes are linked to the GR:
a) by height and width,
c) by the point and
b) by the ellipse and point

Results: Male Tastes



Strong selection of golden composite ellipse

Results: Female Tastes



Tentative Conclusions

(Alan Cannell, September 2009)

- Aesthetic taste of shape is ‘hardwired’ in men and women who find expressions of the Phi satisfying, especially Golden Ellipses and the 36 or 18 degree angles.
- The format of many handaxes indicates that our modern sense of taste/beauty was inherited from our ancestors possibly some 50,000 generations back. (1.5mya).
- Probably based on the female form, the same formats are still widely used today to appeal to both male and female consumers.

Topics of On-going Study

(Alan Cannell, September 2009)

- There is evidence to show that women enhance their relation to phi through posture, specifically: forming a 36 degree angle with the thighs (the classic Beauty Queen pose) and in the coquettish feminine head tilt, which is normally set – apparently by instinct – at 18 or 36 degrees.
- Phi is known to be related to facial features and universal concepts of beauty. This may be the result of sexual selection, as there is some evidence to indicate that sexual selection has led to different expressions of phi (and different concepts of beauty) in Neanderthals.

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