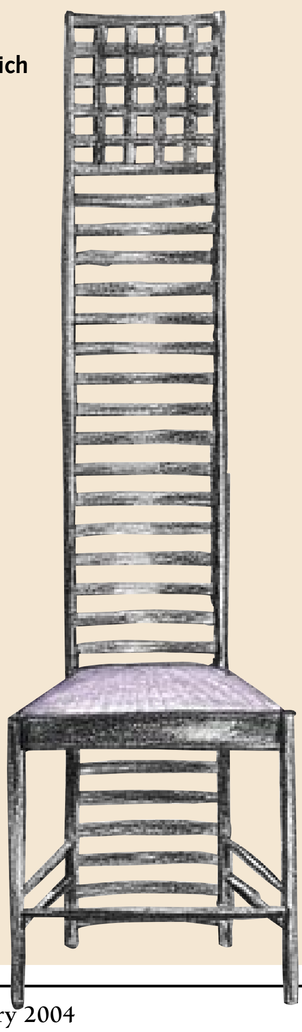
Proportion, harmony and magic feature in Andrew Skelton's *Golden Section*

A Golden Rule

above Careful proportion does not necessarily imply symmetry as this walnut chest shows. Its harmonious but individual rhythm leads your eye over the piece and keeps you (very) interested

below A Shaker and a Mackintosh ladderback – both instantly recognizable by their distinctive proportions. The Shaker chair is subtle and refined, with the back slats getting smaller towards the bottom. The back of the Mackintosh chair is based on a simple square grid, which makes no allowance for perspective

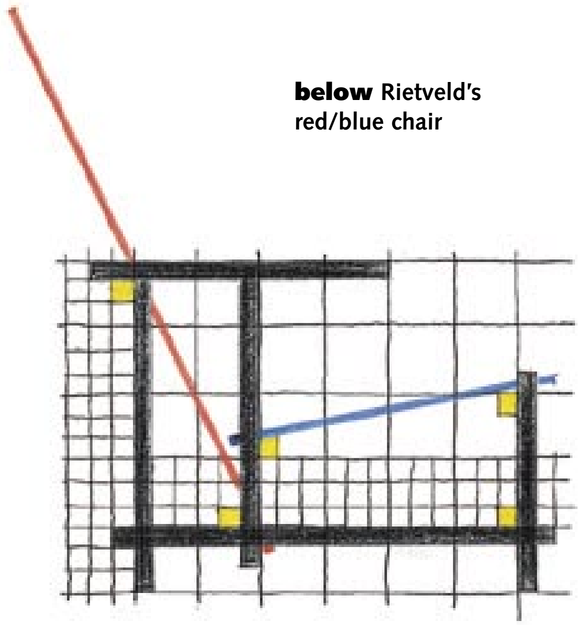


ILLUSTRATIONS BY THE AUTHOR

> *"Without waiting, passively, for repetitions to impress or impose regularities upon us, we actively try to impose regularities upon the world"*
>
> **Karl Popper — Cabinetmaker, Philosopher & Theorist**

I have always felt that proportion is one of the most important aspects of furniture design. The way the elements are put together – rather than the elements themselves – convey your intentions as a designer. Unity and harmony or disquiet and unease, whatever your aim, the parts have to fit together in a convincing way. For my own part, I have never followed or used any mathematical system of proportion, working pieces out by scale drawing or full-size experimentation. This may be vanity, believing that as the artist I can trust my eye and judgement. There is even a bit of laziness – for some of the math and geometry can get complicated. Distrust of a universal system of rules is certainly part of my make-up, as is a feeling of closer association with the vernacular than with the clinical and controlled architecture of Ancient Greece.

Having researched this article on proportion I wonder now if mine has been a somewhat shallow – lazy

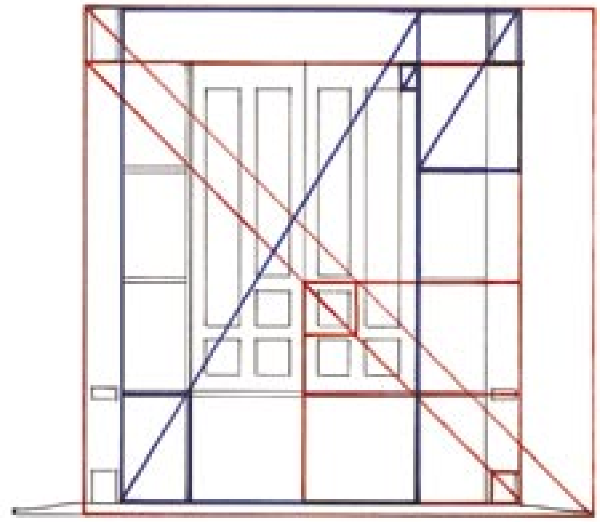


below Rietveld's red/blue chair

GRIDS

The simplest way to give geometric harmony to a design is to use grids which although common to all periods are associated more with mass-production. Standard components that inter-link both physically and aesthetically can be seen in modular furniture which allows you to mix and match within a range. These storage units by Charles and Ray Eames, 1950, show how functional and visual diversity can be achieved while staying within standard production dimensions. Grids and modules can give a rewarding sense of rightness to a design, but are demanding and difficult to work within, particularly in the case of furniture which interacts so closely with the human body. Gerrit Rietvelt used a 4" grid (the thickness of three rails) in his red/blue chair which searches for an expression of simplicity but does little to acknowledge ergonomics. This grid works perfectly for deStilj furniture, with deliberately simple and unified planes, but is inadequate for most furniture. The thickness of components as well as their spacing must be considered, thus the Eames units have a grid for the structural frame which encloses the grid for the modules.

above Storage units by Charles and Ray Eames, 1950



above For the bookcase below the designer uses regulating lines to adjust proportion and create a balanced design. The red lines represent the square and the blue lines the golden rectangle.

REGULATING LINES

Most books on the history of art have drawings that analyze paintings and buildings by applying regulating lines to show how the composition fits within a square, golden rectangle or whatever. Pleasing design is often ordered and controlled and many use these lines to tweak and tighten up an existing design rather than as a formula that generates the design. The Bauhaus artist Oskar Schlemmer had a clear opinion about the order of this process: "It is utterly fatal to invoke the laws of proportion before the picture has been visualized… one ends up with inspiration under handcuffs. If mathematical proportion and measurement are needed they should function as regulative."

above The subtle, harmonious and balanced proportions of this cabinet/bookcase in walnut were refined by the use of regulating lines.

GOLDEN SECTION

Throughout the history of Western art the most common ways of generating mathematical proportion are based on the Golden Section. Although Gothic buildings are concerned with harmony and numbers, this is really a study of classical architecture (Ancient Greek, Roman, Renaissance, Georgian, etc.) modelled on the Parthenon – considered by many to be the most majestic building of all time.

The Golden Section was certainly know to the ancient Egyptians, but it is more convincingly connected to the Greek geometricians Pythagoras and Eudoxus. The latter is said to have carried around a stick, which he invited people to divide in the proportion that most pleased them. (They mostly – of course or the story wouldn't be worth telling – divided it in the Golden Ratio) This is because the ratio a:b is the same as the ratio b:(a+b) – the smaller part is to the larger part as the larger part is to the whole. Expressed as numbers, the Golden Ratio is approximately 1:1.6 but it is really a geometric relationship, denoted by the Greek letter psi (Y). If you are at all interested get out a compass and follow these examples.

Fig 1

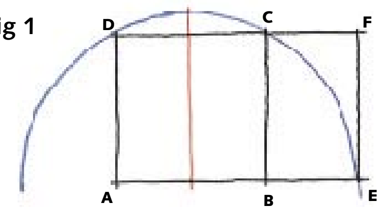


Fig 2

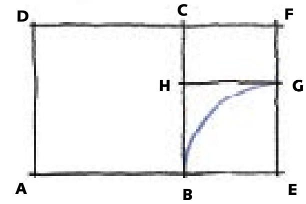


Fig 3

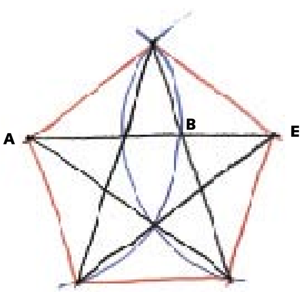


Fig 4

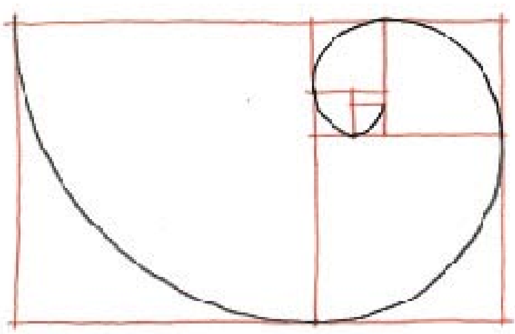


Fig 1 To draw the Golden Rectangle, draw a square ABCD. Divide AB and draw an arc so that the square is within a semi-circle. Extend AB to E and complete the rectangle at F. AEFD is a Golden Rectangle and the line AE is divided in the Golden Ratio at B.

Fig 2 The rectangle BEFC is also a Golden Rectangle and if you draw the square BEGH, HGFC is also golden and so on – you can see why people think it is so special!

Fig 3 The five-pointed star or pentagram, has been endowed with magical properties as each line cuts another in the Golden Ratio. If you use a line, AE, the same length as in fig 1 and draw arcs from A and E with radius the length of the side of the original square, AB in fig 1, then you establish the vertices of a pentagon.

Fig 4 The Golden Spiral is drawn by creating squares, as in fig 2, and drawing a quarter circle in each square. The spiral is related to natural growth and is found most clearly in the Nautilus shell whose logarithmic spiral has a perfect structural harmony of strength to weight. The idea of growth finds numerical expression in the Fibonacci Series (Fibonacci was a 13th-C Italian mathematician) where each unit is the sum of the two previous numbers. In this series – 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, and so on the ratios become dynamic and individual and suggest a kind of spring energy as opposed to the static ratios of 1:2, 2:3 etc. Moreover the higher the series goes the more closely it resembles the Golden Ratio thus 13:21 is 1:1.615384615, which is pretty close. If you want to find more of the Fibonacci Series and some of the claims about it just plug it into a www search engine and prepare to be staggered…

– position. After all, we don't need to be tied by rules – we live and work, thankfully, in a fairly pluralistic society where in matters of art, architecture and all that stuff – even furniture – pretty much anything goes! We are not duty-bound to stick within one system or another – the overall composition of a piece might be free, but the gradation of the drawers can be derived from a mathematical progression.

As woodworkers, the simple proportional problems we often want to solve are how to graduate a set of drawers and where to position a handle. We also need to consider perspective and the fact that elements appear to be smaller the lower down they are – so for a handle, keyhole, or whatever, to appear to be in the middle of a low door, it needs to be above the center. How much is often determined visually and – as these decisions can usually be left until the piece is nearly finished – they can be decided by trial and error. A similar problem is determining the size of, say, door rails, which often need (visually) a wider bottom rail – the notion that objects look better with heavier bases is expressed in nature and can be seen in the growth of leaves and trees. Again, this may be best arrived at by trial and error, full-size drawings, or you may want to adopt some system of proportion. A good way of backing up your hunch is to keep a sketch book and record the comparative dimensions of nicely proportioned furniture, doors, windows or whatever. Museums and historic buildings open to the public are normally happy for you to sketch (but not to photograph), although it is wise to ask first. I was once told to stop drawing as they thought I might be sketching the security system. Was it their paranoia or my questionable appearance?

Why Math?

I will mostly look at mathematical proportion – which I am not putting forward as in any

> “Distrust of a universal system of rules is certainly part of my make-up”

way superior to innate judgements and feelings – I’m just putting it out there in case it grabs anyone. The proportions of objects may be dependant on nature or even on the cultural importance of an element – public buildings ‘need’ grand entrances but the people that go through them are the same as those that enter a small building. Structure is also an important way of sizing elements and in our engineering-dominated world it is something we understand and feel comfortable with.

Proportion can tell the story of a structure – how the load is carried on a bridge for instance – and can reassure us as being obviously strong enough for its purpose and excite us with feelings that it is too slender to be sufficiently strong. Proportion is also governed by practicality – fitting stuff into a space is often our primary task – and the CD rather than the Golden Rectangle may be the governing ratio. We might consider it more appropriate to size elements, in furniture, according to the materials they are made from and the function they perform. This may differ from elements sized more specifically by proportion in architecture or engineering. In furniture, especially wooden furniture, what may serve the purpose is often far too small to look ‘right’ and so visual appearance – and proportion – becomes paramount.

Sacred Geometry

Common to all systems of proportion is a search for unity and a sense that they possess some aesthetic virtue

HAMBRIDGE AND DYNAMIC SYMMETRY

The 20th-C American artist and mathematician Jay Hambridge studied the Parthenon and from his measurements developed the idea of dynamic symmetry and growth.

Draw the square ABCD, fig 1, and with center A draw an arc radius AC to establish E. If the square has sides of a given length the diagonal, and thus side of the rectangle AE is √2 (Pythagoras). This rectangle had significance for the Cubists and became known as ‘La Section d’Or’ and is the basis for the common A4 European sizes of paper.

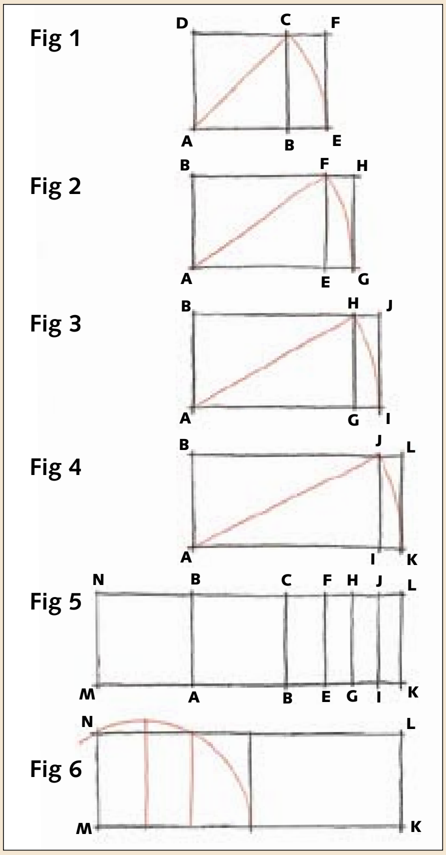
In fig 2 you take the √2 rectangle, AEFB, draw the arc from A radius AF and you get a rectangle of side √3.

The next development, fig 3, gives a √4 rectangle or a double square. Try it – it works!

Fig 4 is a rectangle of side √5.

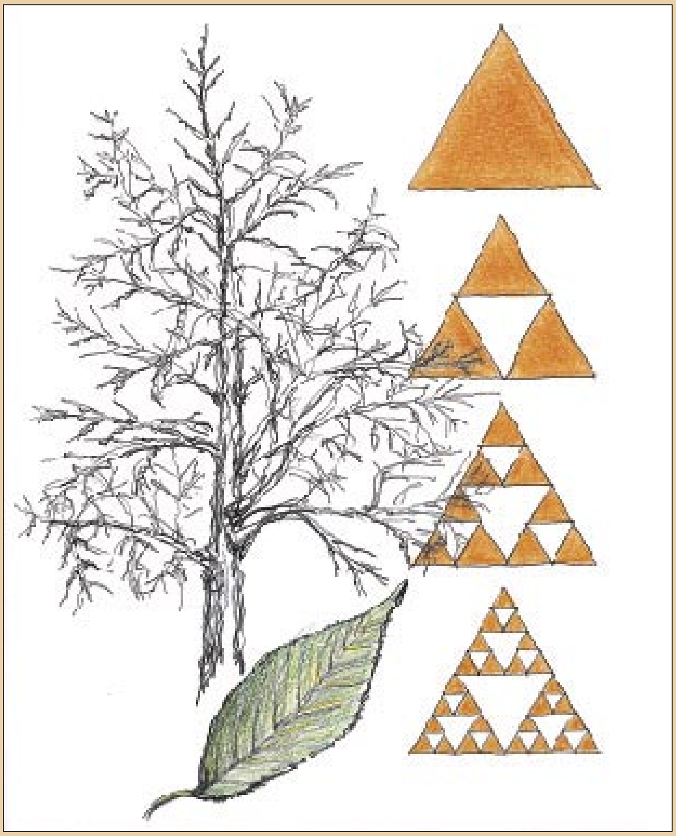
Hambridge added another square, MABN, fig 5, to produce a measurement that occurs in Greek architecture and the growing series of √2+1, √3+1 etc. You could also use the series √2-1, √3-1 etc or the rectangles BEFC, EGHF, GIJH etc for the gradations of drawers in a chest of drawers.

Magically enough, fig 6, if you divide the rectangle MKLN (√5+1) in half you get two golden rectangles!



NATURE AND SERIES

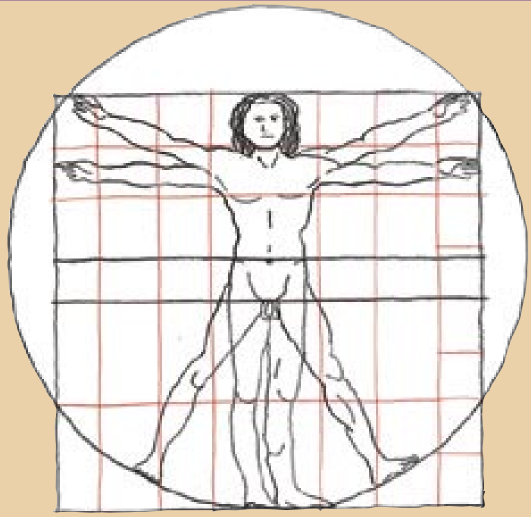
The Fibonacci series and the Hambridge rectangles reflect nature and growth. In trees (well some trees) the spacing of the branches is further apart at the base and diminishes towards the top, as does the relative size of the elements. The leaf shape is similar to the tree shape, as in fractals which can be broken into smaller, self similar shapes. The Golden Rectangle also exhibits self similar characteristics and logarithmic growth.



THE GOLDEN RATIO AND THE HUMAN BODY

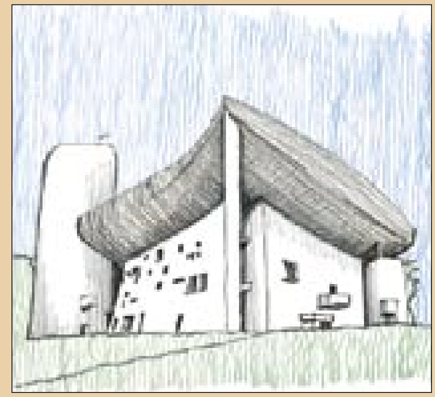
In classical art and architecture the focus is not so much nature as man and the search for significant mathematical relationships between the parts of the human body. In the drawing of Leonardo da Vinci the span of outstretched arms is made to equal the height so that the body fits a square and a circle. The proportion of man is stretched to eight heads whereas most human bodies are 7 to 7½ times as tall as the height of their head. This allows the body to be divided exactly in two at the groin and halved again at the knee. A line drawn through the navel (the center of the circle) divides the square in the Golden Ratio.

The architect Le Corbusier developed a system of measurement and proportion – Le Modulor – based on practical human measurements, which he hoped would be adopted by mass-production. There are Golden Ratio relationships between the measurements which grow in a Fibonacci-like series of dynamic additions. His system and the inspired way he used it are worth a look and his book on Le Modulor shows exciting ways of dividing squares and rectangles. Le Corbusier, famous/infamous for his expression the 'house is a machine for living in', was a unique and human-centerd architect. In my opinion, anyone who can produce a building as inspired as his Chapel at Ronchamp merits close study and cannot be associated with machines and sterility.

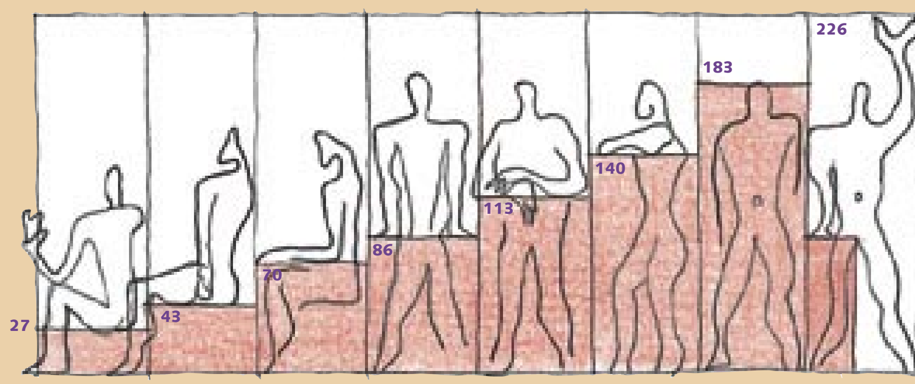


above Leonardo's idealized man

below Chapel at Ronchamp, Le Corbusier



below Le Corbusier's Modulor measurements



in themselves. What is found to be beautiful is universal if you relate it to music, the human body, natural growth and the universe. As Einstein put it, "God does not play dice with the world…without the belief in the inner harmony of our world there could be no science." Mathematics has been used to generate much of what we consider to be great art and much of what we find intuitively pleasing relates to mathematical laws, but the trouble with this type of thing is that if you want to make it fit it will. Whether you believe in and follow a geometry of universal truth is a matter of personal choice.

> ***"The Golden Section was certainly known to the ancient Egyptians, but it is more convincingly connected to the Greek geometricians Pythagoras and Eudoxus"***

FURTHER READING

Some of these books may be out of print, but should be available from libraries.

- Changing Ideas in Modern Architecture, **Peter Collins, Faber and Faber, ISBN 0 571 08158 4.**
- Proportion, Science, Philosophy, Architecture, **Richard Padovan, Spoon Press, ISBN 0 419 22780 6.**
- Sacred Geometry, **Robert Lawlor, Thames and Hudson, ISBN 0 500 81030 3.**
- Le Modulor, **Le Corbusier, Faber and Faber.**
- Towards a New Architecture, **Le Corbusier, The Architectural Press ISBN 85139 692 5.**
- The Elements of Dynamic Symmetry, **Jay Hambridge, Dover.**