The golden section is a symmetrical relation built from asymmetrical parts. Two numbers, shapes or elements embody the golden section when the smaller is to the larger as the larger is to the sum. That is, $a : b = b : (a + b)$. In the language of algebra, this ratio is $1 : \varphi = 1 : (1 + \sqrt{5})/2$, and in the language of trigonometry, it is $1 : (2 \sin 54°)$. Its approximate value in decimal terms is 1 : 1.61803.



The second term of this ratio, φ (the Greek letter *phi*), is a number with several unusual properties. If you *add* one to φ, you get its square (φ × φ). If you *subtract* one from φ, you get its reciprocal (1/φ). And if you multiply φ endlessly by itself, you get an infinite series embodying a single proportion. That proportion is 1 : φ. If we rewrite these facts in the typographic form mathematicians like to use, they look like this:

$$\varphi + 1 = \varphi^2$$

$$\varphi - 1 = 1/\varphi$$

$$\varphi^{-1} : 1 = 1 : \varphi = \varphi : \varphi^2 = \varphi^2 : \varphi^3 = \varphi^3 : \varphi^4 = \varphi^4 : \varphi^5 \ldots$$

If we look for a numerical approximation to this ratio, 1 : φ, we will find it in something called the Fibonacci series, named for the thirteenth-century mathematician Leonardo Fibonacci. Though he died two centuries before Gutenberg, Fibonacci is important in the history of European typography as well as mathematics. He was born in Pisa but studied in North Africa. On his return, he introduced arabic numerals to the North Italian scribes.

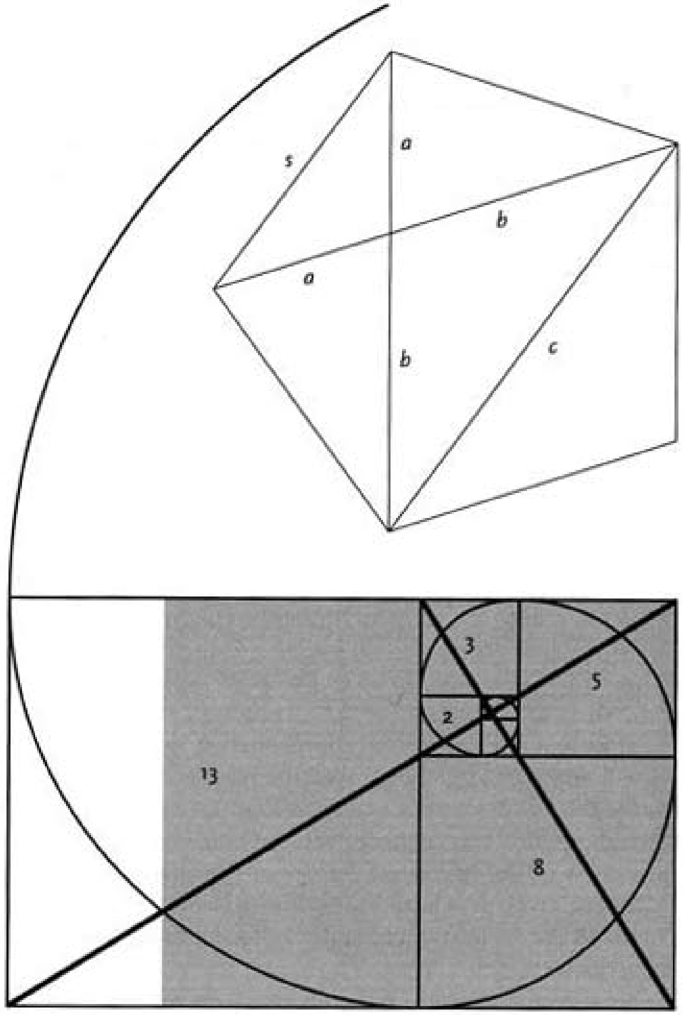
As a mathematician, Fibonacci took an interest in many problems, including the problem of unchecked propagation. What happens, he asked, if everything breeds and nothing dies? The answer is a logarithmic spiral of increase. Expressed as a series of integers, such a spiral takes the following form:

0 · 1 · 1 · 2 · 3 · 5 · 8 · 13 · 21 · 34 · 55 · 89 · 144 · 233 · 377 · 610 · 987 · 1597 · 2584 · 4181 · 6765 · 10,946 · 17,711 · 28,657 ...

Here each term after the first two is *the sum of the two preceding*. And the farther we proceed along this series, the closer

*The Golden Section*

The screened area represents a two-page spread in which each page embodies the golden section. The root of the spiral, which is the navel of the page, lies at the intersection of the diagonals. This is a Renaissance structure: precisely measured and formed, yet open-ended, unconfined. Like Thoreau's vision of the mind (page 66), it is *hypethral*. (Compare the equally elegant but closed, medieval structure on page 173 and the resolutely linear structure on page 154.)




G Golden Section, $1:\varphi = 1:1.618...$. In the pentagon, the side $s$ and the chord $c$ embody the golden section. The smaller is to the larger as the larger is to the whole, or $s:c = c:(s+c)$. When two chords intersect, they divide each other in the same proportion: $a:b = b:c$, where $c = a + b$. Moreover, $b = s$. Thus, $a:s = s:c = c:(s+c) = 1:\varphi$.

An evolving sequence of figures that embody the golden section also defines the path of a logarithmic spiral. And if the lengths of the sides of the figures are rounded off to the nearest whole numbers, the result is a Fibonacci series of integers.

we come to an accurate approximation of the number φ. Thus 5 : 8 = 1 : 1.6; 8 : 13 = 1 : 1.625; 13 : 21 = 1 : 1.615; 21 : 34 = 1 : 1.619, and so on.

In the world of pure mathematics, this spiral of increase, the Fibonacci series, proceeds without end. In the world of mortal living things, of course, the spiral soon breaks off. It is repeatedly interrupted by death and other practical considerations – but it is visible nevertheless in the short term. Abbreviated versions of the Fibonacci series, and the proportion 1 : φ, can be seen in the structure of pineapples, pinecones, sunflowers, sea urchins, snails, the chambered nautilus, and in the proportions of the human body as well.



If we convert the ratio 1 : φ or 1 : 1.61803 to percentages, the smaller part is roughly 38.2% and the larger 61.8% of the whole. But we will find the exact proportions of the golden section in several simple geometric figures. These include the pentagon, where they are relatively obvious, and the square, where they are somewhat more deeply concealed.

The golden section, 1 : φ, differs by roughly one per cent from the interval of the minor sixth in the chromatic scale. The proportion 5 : 8, which is the arithmetic value of the minor sixth in music, is often used in typography as a rough approximation to the golden section.

The golden section was much admired by classical Greek geometers and architects, and by Renaissance mathematicians, architects and scribes, who often used it in their work. It has also been much admired by artists and craftsmen, including typographers, in the modern age. Paperback books in the Penguin Classics series have been manufactured for more than half a century to the standard size of 111 × 180 mm, which embodies the golden section. The Modulor system of the Swiss architect Le Corbusier is based on the golden section as well.

If type sizes are chosen according to the golden section, the result is again a Fibonacci series:

(a) 5 · 8 · 13 · 21 · 34 · 55 · 89 …

These sizes alone are adequate for many typographic tasks. But to create a more versatile scale of sizes, a second or third interlocking series can be added. The possibilities include:

(b) 6 · 10 · 16 · 26 · 42 · 68 · 110 …
(c) 4 · 7 · 11 · 18 · 29 · 47 · 76 …

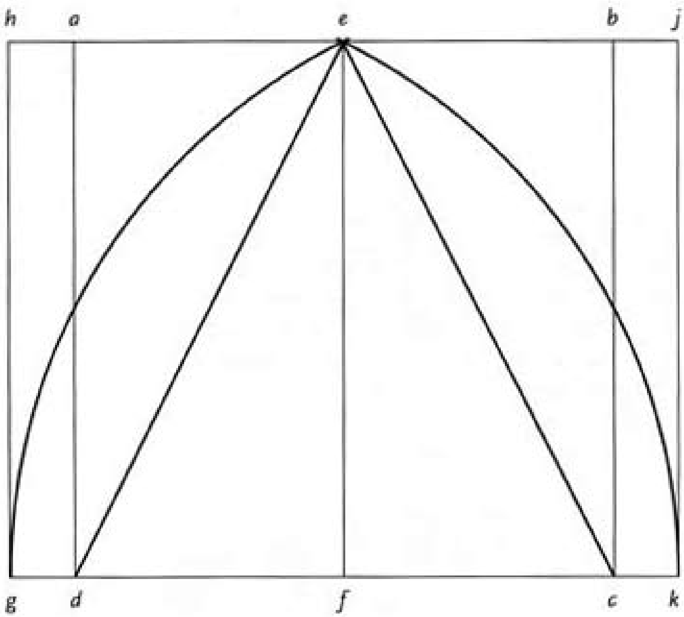
All three of these series – **a**, **b** and **c** – obey the Fibonacci rule (each term is the sum of the two terms preceding). Series **b** is also related to series **a** by simple doubling. The combination of a and b is therefore a two-stranded Fibonacci series with incremental symmetry, forming a very versatile scale of type sizes:

(d) 6 · 8 · 10 · 13 · 16 · 21 · 26 · 34 · 42 · 55 · 68 …

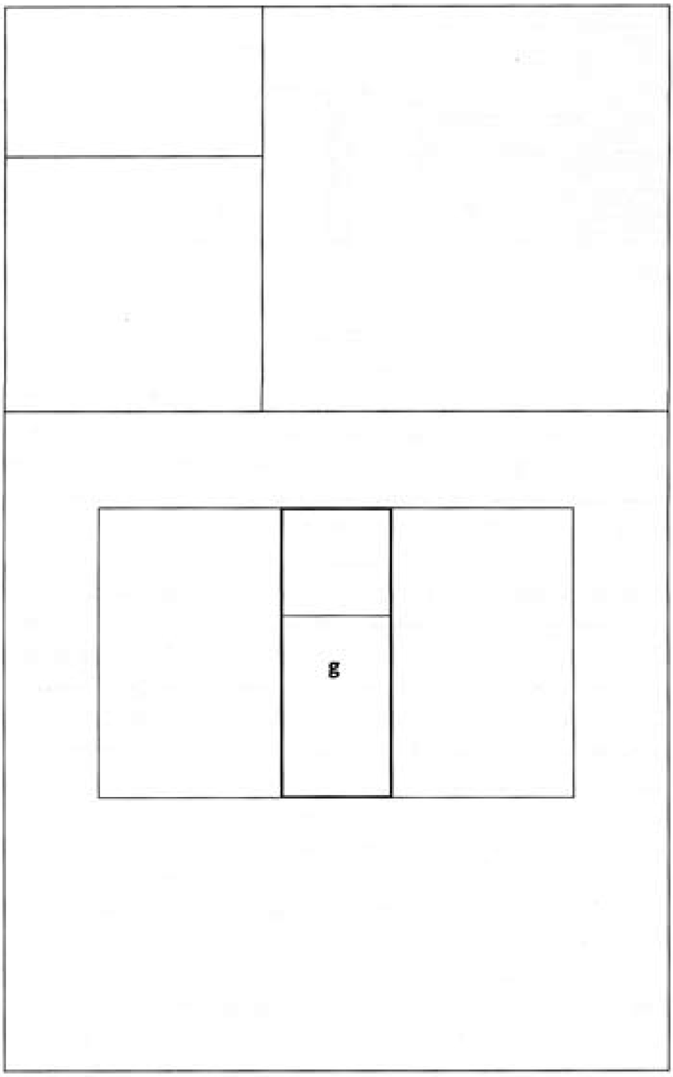
*The Golden Section*

The double-stranded Fibonacci series used by Le Corbusier (with other units of measurement) in his architectural work is similarly useful in typography:

(e) 4 6½ 10½ 17 27½ 44½ 72
5 8 13 21 34 55 89 …




Finding the golden section in the square. Begin with the square *abcd*. Bisect the square (with the line *ef*) and draw diagonals (*ec* and *ed*) in each half. An isosceles triangle, *cde*, consisting of two right triangles, is formed. Extend the base of the square (draw the line *gk*) and project each of the diagonals (the hypotenuse of each of the right triangles) onto the extended base. Now $ce = cg$, and $de = dk$. Draw the new rectangle, *efgh*. This and its mirror image, *ejkf*, each have the proportions of the golden section. That is to say, $eh : gh = gh : (gh + eh) = ej : jk = jk : (jk + ej) = 1 : \varphi$. (Contrast this with figure $Z_2$ on page 153.)




The relationship between the square and the golden section is perpetual. Each time a square is subtracted from a golden section, a new golden section remains. If two overlapping squares are formed within a golden-section rectangle, two smaller rectangles of golden-section proportions are created, along with a narrow column whose proportions are $1 : (\varphi + 1) = 1 : 2.618$. This is **g**, the Extended Section, from the table on page 149. If a square is subtracted from this, the golden section is restored.

*The Golden Section*

THIS PARAGRAPH, for example, is indented according to the golden section. The indent is to the remainder of the line as that remainder is to the full text measure. Here the measure is 21 picas, and the indent is 38.2% of that, which is 8 picas.

The amount of *sinkage* (the extra white space allowed at the top of the page) is 7 lines (here equal to 7 picas). Add the extra pica of white space created by the indent itself, and you have an imaginary 8-pica square of empty space in the upper left corner of the textblock.

The size of the elevated cap is related in turn to the size of the indent and the sinkage. Eight picas is 96 pt, and 61.8% of that is 59.3 pt. But the relationship between 59 or 60 pt type and an 8-pica indent would be difficult to perceive, because a 60 pt letter is not visibly 60 pt high. The initial used has an actual 60 pt cap height instead. Depending on the face, such a letter could be anywhere from 72 to 100 pt nominal size; here it is 84 pt Castellar.

## 8.3 PROPORTIONS OF THE EMPTY PAGE

### 8.3.1 *Choose inherently satisfying page proportions in preference to stock sizes or arbitrary shapes.*

The proportions of a page are like an interval in music. In a given context, some are consonant, others dissonant. Some are familiar; some are also inescapable, because of their presence in the structures of the natural as well as the man-made world. Some proportions also seem particularly linked to living things. It is true that wastage is often increased when an 8½ × 11 inch page is trimmed to 7¾ × 11 or 6¾ × 11, or when a 6 × 9 book page is narrowed to 5⅝ × 9. But an organic page looks and feels different from a mechanical page, and the shape of the page itself will provoke certain responses and expectations in the reader, independently of whatever text it contains.

The fourth of these choices offers Neoclassical poise but is not the best for quick navigation. Folios near the upper or lower outside corner are the easiest to find by flipping pages in a small book. In large books and magazines, the bottom outside corner is generally more convenient for joint assaults by eye and thumb. Folios placed on the inner margin are rarely worth considering. They are invisible when needed and all too visible otherwise.



It is usual to set folios in the text size and to position them near the textblock. Unless they are very black, brightly colored or large, the folios usually drown when they get very far away from the text. Strengthened enough to survive on their own, they are likely to prove a distraction.

8.5.4 *Don't restate the obvious.*

In Bibles and other large works, running heads have been standard equipment for two thousand years. Photocopying machines, which can easily separate a chapter or a page from the rest of a book or journal, have also given running heads (and running feet, or footers) new importance.

Except as insurance against photocopying pirates, running heads are nevertheless pointless in many books and documents with a strong authorial voice or a unified subject. They remain essential in most anthologies and works of reference, large or small.

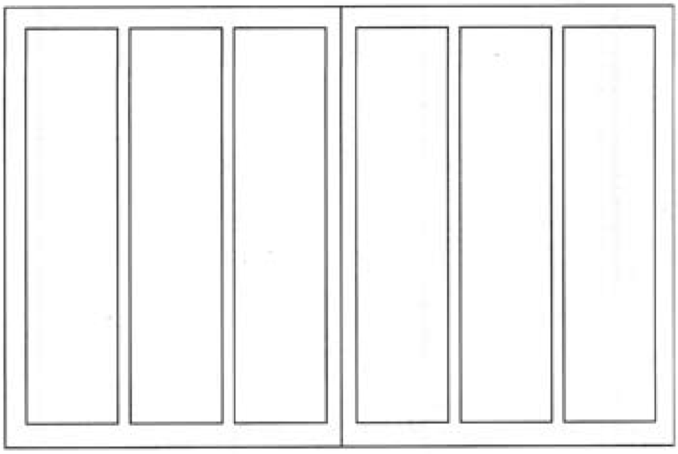
Like folios, running heads pose an interesting typographic problem. They are useless if the reader has to hunt for them, so they must somehow be distinguished from the text, yet they have no independent value and must not become a distraction. It has been a common typographic practice since 1501 to set them in spaced small caps of the text size, or if the budget permits, to print them in the text face in a second color.

## 8.6 PAGE GRIDS & MODULAR SCALES

8.6.1 *Use a modular scale if you need one to subdivide the page.*

Grids are often used in magazine design and in other situations where unpredictable graphic elements must be combined in a rapid and orderly way.

Modular scales serve much the same purpose as grids, but they are more flexible. A modular scale, like a musical scale, is a



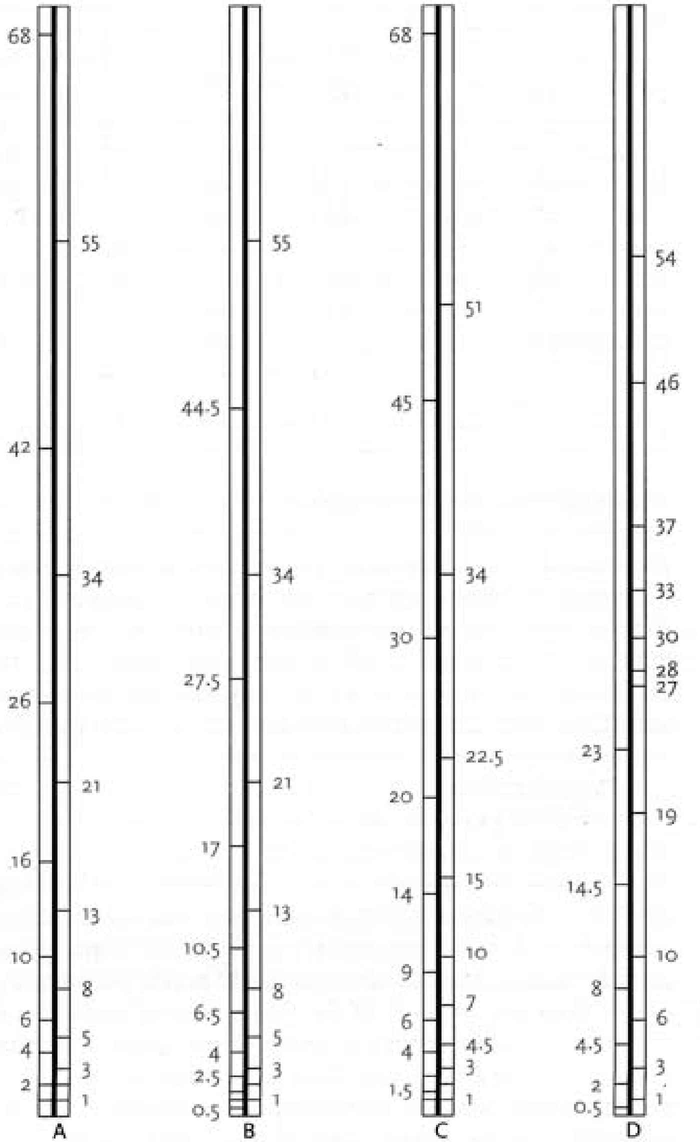
Standard grid for three-column magazine

prearranged set of harmonious proportions. In essence, it is a measuring stick whose units are indivisible and not of uniform size. The traditional sequence of type sizes shown on page 45, for example, is a modular scale. The single- and double-stranded Fibonacci series discussed on pp 157–158 are modular scales as well. These scales can, in fact, be put directly to use in page design by altering the units from points to picas.

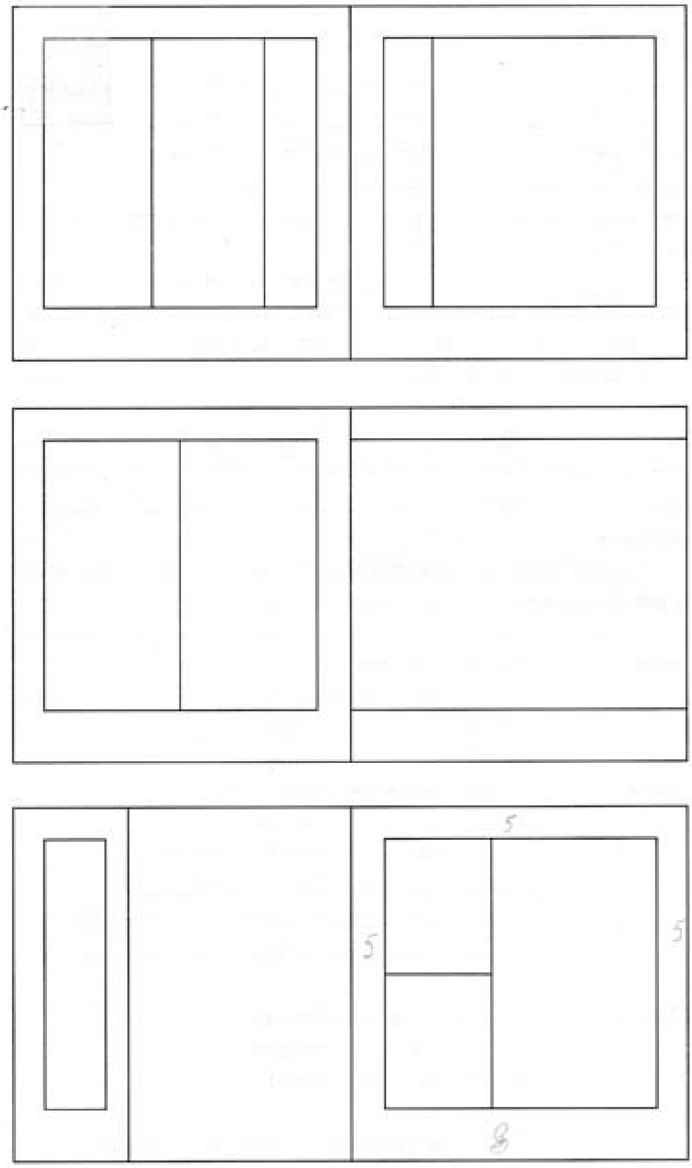
It is perfectly feasible to create a new modular scale for any project requiring one, and the scale can be founded on any convenient single or multiple proportion – a given page size, for example, or the dimensions of a set of illustrations, or something implicit in the subject matter. A work on astronomy might use a modular scale based on star charts or Bode's law of interplanetary distances. A book on Greek art might be laid out using intervals from one or more of the Greek musical scales or, of course, the golden section. A work of modernist literature might be designed using something more deliberately arcane – perhaps a scale based on the proportions of the author's hand. Generally speaking, a scale based on two ratios (1 : φ and 1 : 2, for example) will give more flexible and interesting results than a scale founded on just one.

The Half Pica Modular scale illustrated here is actually a miniaturized version of the architectural scale of Le Corbusier, which is based in turn on the proportions of the human body.

See Le Corbusier, *The Modulor* (2nd ed., Cambridge, Mass., 1954).




Four examples of modular pica sticks (shown at half actual size). **A** Whole Pica Modular scale. **B** Half Pica Modular scale. These are both two-stranded Fibonacci series, based on the ratios 1 : φ and 1 : 2. **C** Medieval Interval scale, based on the proportions 2 : 3 and 1 : 2. **D** Timaean Scale, a simplified version of the Pythagorean scale outlined in Plato's *Timaeus*.




Use of the modular scale. These pages and textblocks have been subdivided using the Half Pica Modular scale. The pages are 52 × 55 picas (8⅝" × 9⅛"), with margins of 5, 5, 5 & 8 picas. The basic textblock is 42 picas square. Thousands of different subdivisions are possible. (For more complex examples on similar principles, see Le Corbusier, *The Modulor.*)