The twelve main graphic variables employed to produce the diversity of circular visual archetypes showcased in this book.

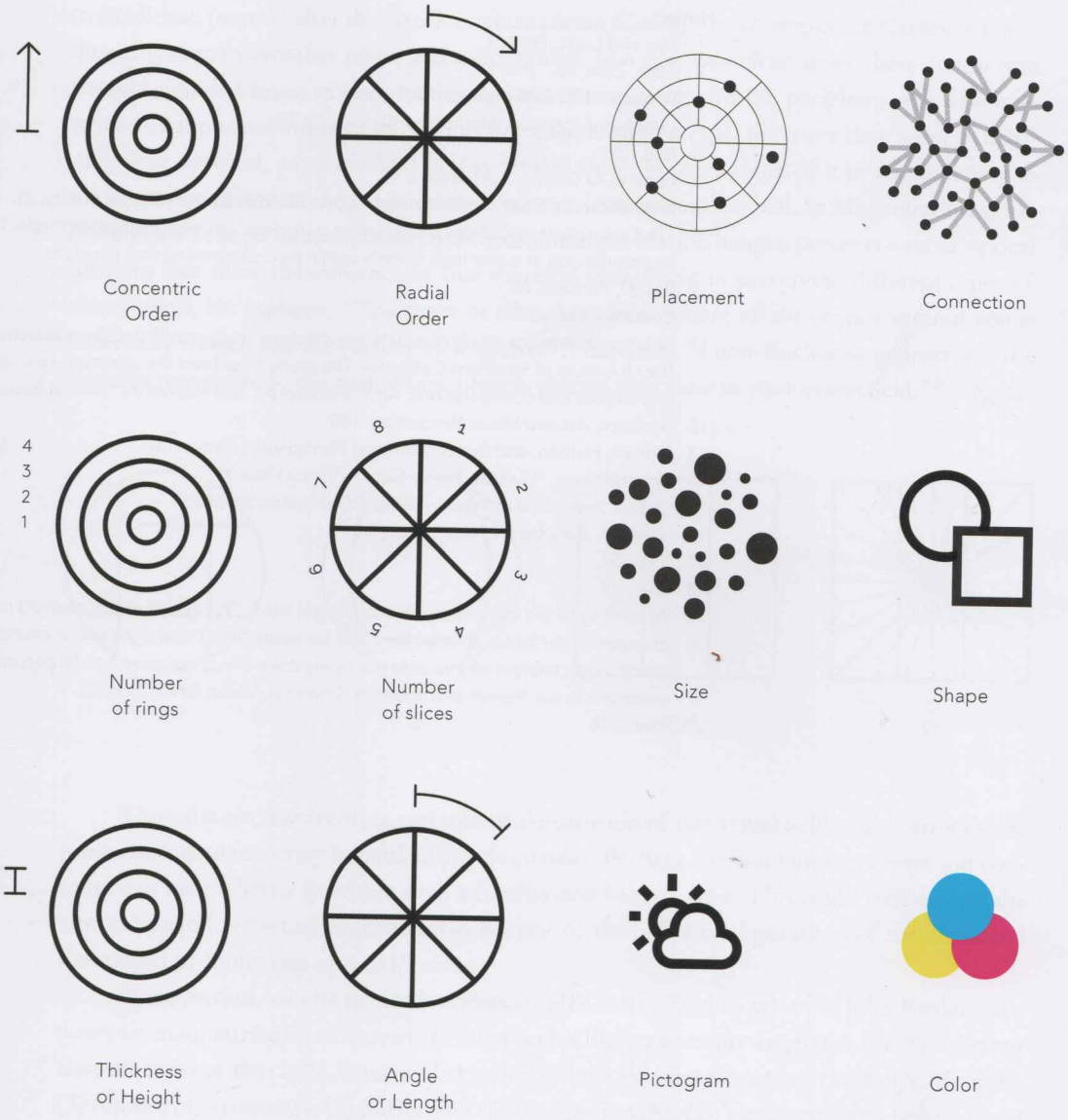


fig. 1

Concentric circle patterns. From left to right: (A) astronomical symbol for the sun used in ancient Egypt and early Chinese script; (B) roundel used by the air forces of numerous countries, including the United Kingdom and France; the band The Who; and the retailer Target; (C) petroglyph pattern found in the Jug Handle Arch, on Potash Road in Moab, Utah, from ca. 2000 BC; (D) petroglyph motif found in Argyll County of western Scotland, from ca. 4000 BC; (E) typical construct of an archery target, normally colored (from inner to outer rings): yellow, red, blue, black, and white.

fig. 2

Collection of spoke line patterns. From left to right: (A) motion streaks typical of our visual field when we are moving at a fast speed; (B) abstract pattern of the forward-motion effect, which appears as a set of converging lines with a central vanishing point; (C) typical wheel model, also known as the sun cross, an ancestral symbol used by numerous cultures across space and time; (D) typical pie chart, which assigns a numerical proportion to each slice, conveyed by its angle and area; (E) variant of the pie chart, known as a polar area diagram, where slices have the same angle but vary in length from the core.

Family 1

RINGS & SPIRALS

(pages 65 to 89)

A B C D E

As we saw in the introduction, spirals and concentric circles are among the earliest human motifs, appearing in prehistoric petroglyphs and pictographs throughout the world. The spiral is among the first shapes drawn by infants and is an elemental cipher of nature, visible in shells, the growth pattern of plants, hurricanes, and the immensely large structures of celestial galaxies. Concentric circles not only feature in a large number of natural arrangements, from the rings of a tree to ripple patterns on water, but they also hold a strong perceptual allure. Both spirals and concentric circles are commonly used as visual stimuli in hypnosis (at times enhanced with motion), which, if nothing else, attests to their ability to induce focus and concentration. It's therefore no coincidence that the bull's-eye, a pattern of concentric circles, is used as a target in sports such as darts, archery, and shooting. A similar motif has been widely used in heraldry, the military, and popular culture—from the logo of the British band The Who to the large retailer Target /*fig.* 1. The roundel is an important national emblem, displayed on military aircraft in countries such as the United Kingdom, France, El Salvador, India, Turkey, Bahrain, Gabon, and Nigeria. The remaining archetype of this first family is a subtle, more contemporary variation on the concentric-circles model in which each ring has a varying length, generally corresponding to a specific data value. Because the viewer needs to interpret often subtle differences in length among individual rings, there are some obvious readability problems with this model; nonetheless, it has become increasingly popular in the past decade, appearing in various contexts from mobile digital interfaces to printed charts.

Family 2

WHEELS & PIES

(pages 91 to 117)

A B C D E

In his book *The Vision Revolution*, Mark Changizi provides a possible explanation for our primordial fascination with wheel symbols. Changizi explains that most classic geometric illusions possess diagonal "spoke" lines, perhaps because when we observe these, our brain "interprets those lines as motion streaks due to forward motion."[4] Many of the examples included in the second family of circles explore this abstract pattern, notably the very first model, which is defined by a set of converging lines on a central vanishing point. You could certainly think of countless examples of visual phenomena that convey a similar sense of forward motion, including perspective drawings, the illusion seen while you drive down a highway as trees and road lines appear to converge in the middle, or even science fiction renditions of spacecraft traveling at warp speed, as popularized by *Star Trek*. This cognitive trigger, together with the pattern's ubiquity in nature—from scallop shells and palm leaves to the radiating sun—could explain the allure of the numerous drawings and charts, found in both art and science, that display converging diagonal lines. As the English artist Walter Crane observed, "If there can be said to be one principle more than another, the perception and expression of which gives an artist's work in design peculiar vitality, it is this principle of radiating line."[5]

The second and third models of this family enclose this primal visual motif within a circular frame, opening the door to a new set of graphical possibilities. Even though the Scottish engineer William Playfair is credited with inventing the modern pie chart in 1801—now a basic visualization model that illustrates proportions within a whole—the notion of a sectioned circle is one that dates back to Bronze Age Europe and is deeply rooted in the concept of the wheel. One of its most popular manifestations is the astronomical symbol for Earth, also known as the sun cross, solar wheel, or wheel of the year. It can represent our globe, showing the equator and a meridian, or the four seasons of a year /*fig.* 2. Variations of the sun cross divide the circle into eight equal areas instead of four, representing the midpoints of the seasons. Another important icon that uses a similar eight-spoke motif is the *dharmachakra*, also known as the wheel of the law, a symbol revered by Hindus and Buddhists and frequently used in Tibetan Buddhism. Resembling an exploded pie chart, the very last model of this family, commonly known as a rose chart or polar area diagram, was popularized by English social reformer Florence Nightingale in her famous "Diagram of the Causes of Mortality in the Army in the East" (1858).

fig. 3

Evolutionary basis for the third family of circle archetypes. The juxtaposition of concentric rings (A) and the wheel model (B) generates a large number of possible design grids, such as the static graticule (C), the volvelle (D), and the sunburst model (E). In turn, variants of these grids underpin many of the visual models described in families four through seven.

Family 3

GRIDS & GRATICULES

(pages 119 to 145)

A B C D E

The circles in the third group combine two of the primordial circle archetypes: the concentric and sectioned models. Both schemes can express a considerable number of variables on their own, dictated by the number of instances (rings or slices), the ordering of instances (generally central-peripheral or clockwise), and the size of instances (their width or angle). However, when we overlay a ring on a wheel model, the resulting grid greatly expands a chart's multidimensional capability. Early medieval designers realized the power of such a flexible grid, which continues to underpin many contemporary circular diagrams /*fig.* 3.

The first model in this family is a somewhat restricted one, allowing only for single, linear informational patterns, either via an inner-outer or revolution axis, largely due to each sliced ring being fixed in its position within the chart. By allowing each sliced ring to rotate independently along the central axis, the second model enables endless combinations among rings. A significant device that takes advantage of this flexibility is the previously described paper wheel chart known as the volvelle, a combinatorial artifact so powerful that some examples are considered prototypical computing devices.

The third group within this family depicts hierarchical structures by using the radial segmentation of each ring as a nesting mechanism. Known variously as the sunburst, radial tree map, fan chart, or nested pie chart, this model employs the logic of a radial tree, with the root at the core of the diagram and the remaining ranks (rings) expanding outward from the middle. Each individual cell usually corresponds to a given quantity or data attribute, with color indicating an additional characteristic. Ranking is emphasized in two ways: by distance from the center within the concentric circles moving toward the diagram's periphery and by position within groups of subsections that appear within the angle swept out by parent sections.

Family 4

EBBS & FLOWS

(pages 147 to 173)

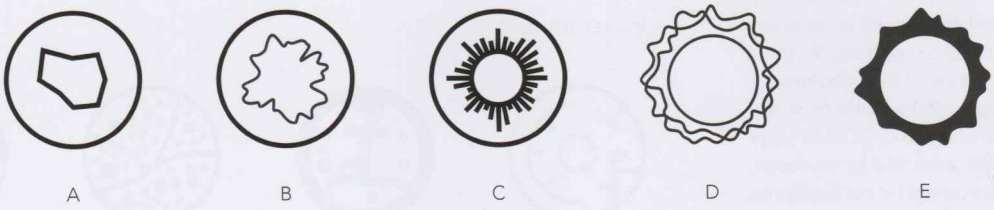


fig. 4

Common radial ebb and flow patterns. From left to right: (A) the outline of a simplified radar chart with a small number of variables; (B) a more elaborate, multivariate radar chart; (C) a circular bar chart, which can be reminiscent of a human iris; (D) a multiseries radial line chart; (E) a radial area chart.

The fourth group includes many contemporary visual models that demonstrate an increasing emphasis on quantification. Most projects in this family could be easily conveyed by means of traditional bar, area, or line charts but instead feature a circular arrangement to showcase the ebb and flow of a given measurement, typically moving in an inner (closer to the core) to outer (closer to the periphery) pattern. Such configuration makes it harder to interpret vertical dimensions when compared with their standard horizontal counterparts; however, it succeeds at emulating the allure of common circular motifs. At times reminiscent of natural patterns found in the eye's iris, in a radiating sun, or in a flower's core, some projects, such as polar, radar, or natal charts, employ conventional charting methods, while others involve more eccentric layers of meaning and association/*fig.* 4.

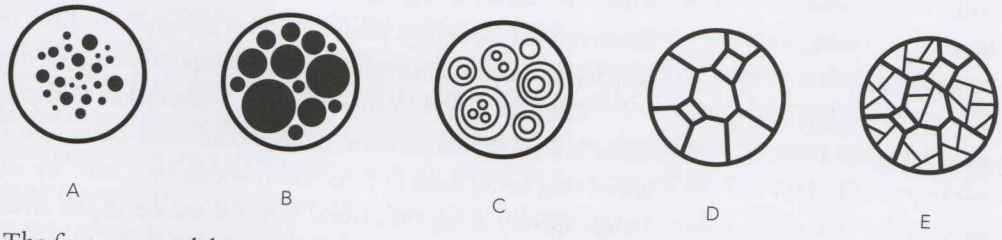
fig. 5

Popular shape and boundary models. From left to right: (A) an arrangement of multiscale circles within a circular boundary; (B) a typical circle-packing motif aiming to maximize the available space within a circular container; (C) a circular treemap exposing several hierarchical levels; (D) a simple Voronoi partitioning scheme, commonly found in nature and used to depict data quantities; (E) a Voronoi treemap exposing three hierarchical levels.

Family 5

SHAPES & BOUNDARIES

(pages 175 to 199)



A B C D E

The first two models in our fifth family explore the captivating image of circles within a circle. The first exemplifies the multivariate possibilities of the circle diagram by conveying a range of data points through the size and location of smaller internal circles, either in a static illustration or in a pattern that emulates planetary movement as a metaphor for understanding complex relationships. The second archetype employs circle packing—a two-dimensional technique that aims at arranging circle units inside a given geometric shape (in this case a circular container) so that no overlapping occurs and every inner circle is contiguous with its neighbors. Some examples go a step further by continuously subdividing inner circles into smaller ones based on a hierarchical scheme commonly known as a circular treemap. The last model in this group is the enticing Voronoi diagram, a partitioning scheme found all over nature that evolved as a graphical method for dicing and slicing a given circle into distinct geometric shapes, which at times can express the ranking of a tree structure. The size and color of these divisions can be associated with different data values/*fig.* 5.

fig. 6

Examples of blueprint and map motifs. From left to right: (A) an abstract architectural blueprint pattern; (B) the outline of the Babylonian map of the world from ca. sixth century BC (see page 38), encircled by an ocean, traversed by the Euphrates River, and featuring many regions such as Assyria and Der (inner circles); (C) the simple outline of an urban circular map; (D) a typical contour of a medieval regional or world map; (E) a small-world view of a given region, normally at the core of the sphere.

Family 6

MAPS & BLUEPRINTS

(pages 201 to 227)

A B C D E

As we saw in the introduction, the circle has been a recurrent frame for cartography for thousands of years, dating back to at least the sixth century BC. The fact that we inhabit a sphere bounded by a rounded horizon and are surrounded by other spherical celestial bodies might have dictated why the circle has always been an attractive shape for mapping geography. The sixth family of visual archetypes features a wide range of cartographic approaches, from abstract diagrams and architectural blueprints to more intricately detailed maps of a specific territory. The last type in this group is a clear manifestation of the "small world"

approach—making good use of a sphere's non-Euclidean geometry to highlight a given core entity while deemphasizing elements that fall near the periphery. It's almost impossible to browse this particular model without the image of Antoine de Saint-Exupéry's *The Little Prince* immediately coming to mind/*fig.* 6.

Family 7

NODES & LINKS

(pages 229 to 255)

fig. 7

Radial tree and network diagrams. From left to right: (A) an abstract radial tree diagram; (B) a more detailed radial tree motif, commonly used in taxonomic dendrograms; (C) a radial convergence model, where all nodes are plotted along a main guiding circle; (D) a partially connected network with visible nodes, typical of planispheres; (E) a densely connected network motif that gives more emphasis to edges (or links).

In the very last group of diagrams the circle is a vehicle for expressing connectivity among entities. Conventional graphs, composed of nodes (vertices) and links (edges), appear in many other forms beside circles. They have adopted an impressive array of visual configurations over the centuries, as one can easily attest by browsing my previous books. However, the circle has been a prevalent scaffold for mapping both trees and networks, by expressing a given hierarchy through a radial tree diagram—as seen in the first model of this family—or plotting all nodes of a given network along the edge of a guiding circle—visible in the second archetype. The last class of diagrams in this family, arguably the most intricate of the entire collection, is an expression of the network as a new cultural and scientific meme, a testimony to a contemporary movement I labeled "networkism" in my first book, *Visual Complexity: Mapping Patterns of Information* (2011)/*fig.* 7.

Notes

1 Brinton, *Graphic Methods*, 3.
2 Dondis, *Primer of Visual Literacy*, 39.
3 Staley, *Computers, Visualization, and History*, 47.
4 Changizi, *Vision Revolution*, 243.
5 Quoted in Gordon, *Esthetics*, 170.