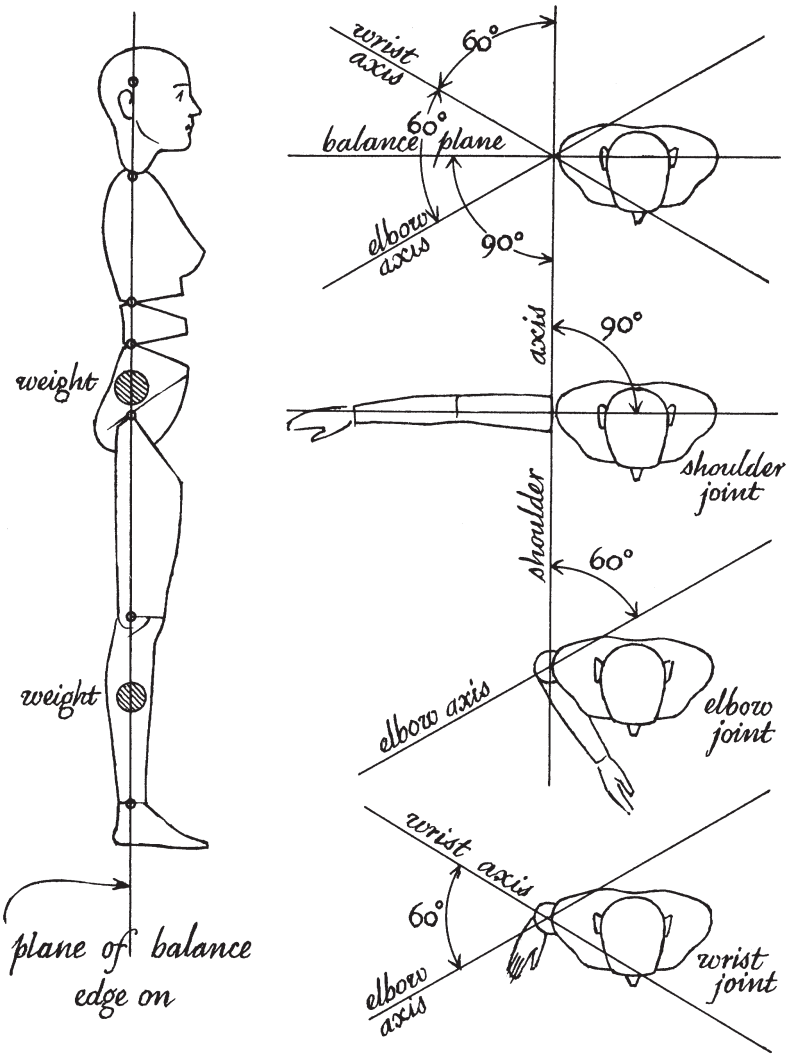
Design Envisions



Envisioning Design

An exhibition inspired by the books of Edward R. Tufte
held in the Chapin Library at Williams College
from September 22 to November 3, 2000

Diagram by W.A. Dwiggins, from his *Marionette in Motion* (1939)

Design Envisions · Envisioning Design

Charts, graphs, maps, tables, diagrams, illustrations, and other kinds of visual matter, intended to explain, instruct, impress, and persuade, surround us in a bewildering variety and ever-increasing quantity. How well these images inform us, how successful they are in their purposes, depends upon their design – and in turn, upon the skills and vision of their designers. In the field of Information Design, Edward R. Tufte's remarkable books – *The Visual Display of Quantitative Information* (1983), *Envisioning Information* (1990), and *Visual Explanations* (1997) – have been embraced as essential reading. The first of these, in Tufte's words, is about *pictures of numbers*, how to depict data and enforce statistical honesty. The second is about *pictures of nouns*, and deals with visual strategies for design: color, layering, and interaction effects. The third is about *pictures of verbs*, the representation of mechanism and motion, of process and dynamics, of causes and effects, of explanation and narrative. However, to a degree the three works necessarily overlap in coverage. They are also themselves models of good design.

Design Envisions / Envisioning Design, inspired by Edward Tufte's books, explores the results of designers' visions from the 15th to the 20th centuries – often striking visions, at the intersection (as Tufte says) of image, word, number, and art – but also looks back from the information graphics on display, to methods and larger issues of the creative process.

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Edwin A. Abbott, 1838–1926

Flatland: A Romance of Many Dimensions
New and revised edition
London: Seeley & Co., 1884
Purchased on the W. Edward Archer Fund

Flatland: A Romance of Many Dimensions
San Francisco: Arion Press, 1980
One of 275 copies
Purchased on the H. Richard Archer Fund

In the "Escaping Flatland" chapter of his *Envisioning Information*, Edward R. Tufte illustrates various techniques, such as statistical graphics, by which multiple dimensions can be described within the restrictions of two-dimensional displays such as paper and the video screen. The word "Flatland" comes from the classic book of that title first published in 1884, in which "A. Square", living in a world with only two physical dimensions, discovers the existence of three-dimensional space and is branded a heretic when he tries to explain it to his fellow geometrical shapes.

The Arion Press edition of *Flatland* cleverly presents the work both in two dimensions, on sheets of paper with explanatory graphics in line, die-cut shapes, and color, and in three dimensions, with the sheets folded accordion-style. The design of the book is impractical for reading or display, yet is utterly appropriate to its contents, reflecting the mood of the text while helping to convey its meaning.

Ars Memorandi cum Versus
Pforzheim: Thomas Anshelm, 1502
Gift of Alfred C. Chapin, Class of 1869

The fifteen woodcuts of the *Ars Memorandi* are examples of writing transformed and compressed into pictures, which in turn, because they are themselves memorable, were meant to spark the recall of the original words, or at least of their content. Each picture refers graphically to important incidents in one of the Gospels. At the center is the traditional symbol of the evangelist, here the eagle of St. John (Johannis, as noted at the head of the page). To this are added symbolic figures and objects: the flag, flute, and cup represent the feast of Tabernacles (John 7); the amorous couple, the adulteress (John 8); the candle, the light of the world (John 8); and so forth. On the facing page, explanatory text is keyed numerically to the picture. Below the text are verses by Petrus von Rosenheim (*ca.* 1380–1433) which add another, perhaps superfluous, dimension to the work, not present in the 15th-century German blockbook upon which this edition was based.

Marcus Vitruvius Pollio

De Architectura Libri X
Rome: Eucharius Silber, 1483-90
Gift of Alfred C. Chapin, Class of 1869

It would be unthinkable today to publish a basic book on architecture with only one crude illustration, but that was the case with the first printed edition of the *De Architectura* by Vitruvius. However, spaces were left blank within the text so that the reader could insert his own drawings – do-it-yourself information graphics. Shown here are an early owner's diagrams to accompany a description of a method for doubling a given area of land. Vitruvius cites, and the user illustrates, the familiar Pythagorean theorem: the square of the hypotenuse of a right triangle is equal to the sum of the squares of the sides. Thus the area of the square of a line drawn diagonally between the corners of a square is double the area of the original square.

The first illustrated edition of Vitruvius, also in the Chapin Library, was published in 1511.

Euclid

Elementa Geometria
Venice: Erhard Ratdolt, 25 May 1482
Gift of Alfred C. Chapin, Class of 1869

Oliver Byrne

The First Six Books of the Elements of Euclid
London: William Pickering, 1847
Gift of Lois K. Levy, from the books of her father,
Donald S. Klopfer, Class of 1922

The first printed edition of Euclid's *Elements of Geometry* includes numerous woodcut diagrams. Although more than five hundred years old, their design will be familiar to anyone who has used a high school geometry textbook. They are, in fact, more sophisticated than those in the textbook used by the author of this note, which were drawn much more simply, though with the letter-coding printed in red.

Oliver Byrne, school mathematics teacher and surveyor of Her Majesty's settlements in the Falkland Islands, in 1847 took a different approach to clarify the first part of the *Elements*, discarding letter-coding in favor of colored lines and shapes. As Edward R. Tufte writes in *Envisioning Information*, "Byrne's colors keep in mind the knowledge to be communicated, color *for* information. Use of the primary colors and black provides maximum differentiation (no four colors differ more)."

John Lodge Cowley, 1719–1797

An Appendix to the Elements *of Euclid*
London: Sold by T. Cadell, ca. 1775?
Purchased on the Leonard B. Schlosser, Class of 1946 Fund

Euclid

The Elements of Geometrie
Translated purportedly by Sir Henry Billingsley,
but more likely (in whole or in part) by John Dee
London: John Daye, 1570
Gift of Alfred C. Chapin, Class of 1869

Two-dimensional illustrations of Euclid's *Elements* are satisfactory when discussing lines and figures in a single plane. Solid geometry, however, is best illustrated in three dimensions, as in these two books.

Cowley's *Appendix* to Euclid provides forty-two paper models of geometric solids, each elegantly presented with preceding text in letterpress. The first edition of Euclid in English includes a few inserted paper models together with traditional diagrams printed from woodcuts.

Regiomontanus, 1436–1476

Calendarium
Venice: Bernhard Maler (Pictor), Erhard Ratdolt,
Peter Löslein, 1476
Gift of Alfred C. Chapin, Class of 1869

Joannes de Sacro Bosco, *fl.* 1230

Sphaera Mundi
Venice: Erhard Ratdolt, before 4 Nov. 1485
Gift of Alfred C. Chapin, Class of 1869

The *Calendar* (or *Ephemerides*) of Regiomontanus (Johann Müller of Königsberg) includes tables giving the daily positions of the sun and moon, and a guide to solar and lunar eclipses between 1475 and 1530. Christopher Columbus is said to have had a copy with him on his fourth voyage, and (rather improbably) to have used it to predict the lunar eclipse of 29 February 1504, with which he frightened hostile natives of Jamaica into submission. Printed from woodcuts with color added by hand, these pictures simply but effectively indicate the totality of each eclipse. Taken as a series of successive images, they illustrate the variety of eclipses that occur over time.

Several of the woodcuts in Sacrobosco's (John of Holywood) popular astronomical discourse *The Sphere of the World* also are colored, not by hand but in the press. Erhard Ratdolt, who also printed the book by Regiomontanus (and the first edition of Euclid), was a pioneer of color printing and a specialist in the production of science books. Shown are diagrams of the presumed orbit of the sun (*sol*) around the Earth (*mundi*) in the Ptolemaic solar system – its course more clearly depicted with added color – and of the Earth's poles. The text in this section is by Georg von Peurbach (1423–1461).

Galileo Galilei, 1564–1642

Istoria e dimostrazioni intorno alle macchie solari
e loro accidenti
Rome: Giacomo Mascardi, 1613
On deposit from Prof. Jay M. Pasachoff

In the summer of 1612 Galileo observed sunspots by projecting the sun's image through a telescope onto a piece of paper, adjusted so that the diameter of the sun was equal to that of an inscribed circle. For each observation he used a fresh sheet of paper, and within the circle marked the projected sunspots in ink. Thus he recorded a series of images, thirty-eight of

which were made into etchings and reproduced in his *History and Demonstrations Concerning Sunspots and Their Phenomena*. Major spots are labeled with letters for easier tracking from observation to observation. The successive images clearly show the movement of particular spots across the sun's surface, and include complexities of data that arise because a rotating sun was observed from a rotating and orbiting earth.

Because the circle remains constant from image to image, full attention can be directed to changes in the data.

Johann Gabriel Doppelmayr, 1671–1750

Atlas Novus Coelestis
Nuremberg: Heredum Homanniorum, 1742
On deposit from Prof. Jay M. Pasachoff

Doppelmayr's *New Celestial Atlas* contains a wealth of charts, star maps, and other guides to the heavens and their study, presented with style and packed with detail. Shown is a series of graphics illustrating the motion of the moons of Jupiter and Saturn compared with the Earth–Moon system, based on the observations of Giovanni Domenico Cassini in 1661. The designer has taken advantage of the large size of the sheet to include twelve related diagrams, to any of which the viewer can instantly turn. Letter-coding is keyed to the text at top and bottom. Finally, hand-coloring further aids in understanding these complicated three-dimensional mechanisms as depicted on a two-dimensional surface.

John Clerk, 1728–1812

An Essay on Naval Tactics, Systematical and Historical
Third edition
Edinburgh: Printed for Adam Black, 1827
Gift of James Phinney Baxter 3rd

John Clerk, although not himself a seaman, studied the naval engagements of the Seven Years' War and the American Revolution, and then told the British admirals what they should do to win battles. Although on a much smaller scale than the celestial mechanisms shown by Doppelmayr, the naval tactics illustrated in Clerk's *Essay* (first published in 1790–7) are just as difficult to depict in two dimensions. The reality of manuevering fighting ships in three-dimensional space, with variables of wind, current, and the firing of guns, is very different from tiny open or shaded symbols and dotted lines printed on paper. Nevertheless, Clerk's book seems to have had a major impact in the British navy, and Nelson is said to have followed his principles to victory in the Battle of Trafalgar.

Johannes Bayer

Uranometria
Augsburg: Christophorus Magnus, 1603
On deposit from Prof. Jay M. Pasachoff

Bayer's *Uranometria* is the most illustrious and historically important of all star atlases. It includes fifty-one engraved charts, each with perimeter grids so that star positions can be read to fractions of a degree. Moreover, it was in this book that Greek letters were first used to indicate the stars in a constellation, generally in order of magnitude. Brightness is also suggested graphically, by the size of the stars as engraved.

Although the *Uranometria* is not nearly as elaborate in its drawings of constellations as Bode's star atlas of 1801 (also on deposit in the Chapin Library), it leads one to ask: if a picture is meant to inform, such as this depiction of Capricorn, how closely can it approach art before art gets in the way of information?

Robert Burton, 1577–1640

The Anatomy of Melancholy
Oxford: Printed for Henry Cripps, 1638
Gift of Alfred C. Chapin, Class of 1869

Thomas Hobbes, 1588–1679

Leviathan, or, The Matter, Forme, & Power of a Common-wealth Ecclesiasticall and Civill
London: Printed for Andrew Crooke, 1651
Gift of Alfred C. Chapin, Class of 1869

In *Visual Explanations* Edward R. Tufte calls title-pages like these, and the one in the adjoining case, "visual confections," assemblies "of many visual events, selected . . . from various Streams of Story [a term from a story by Salman Rushdie], then brought together and juxtaposed on the still flatland of paper. By means of a multiplicity of image-events, confections illustrate an argument, present and enforce visual comparisons, combine the real and the imagined, and tell us yet another story."

The title-page compartments of the 1638 *Anatomy of Melancholy*, together with the prefatory poem opposite, reflect the argument, organization, and intellectual method of the book – a graphic and poetic summary before the text proper begins. In the first edition of Hobbes' *Leviathan*, the title-page combines an imagined scene at top, representing a commonwealth as a body literally composed of its citizens, and a set of compartments at bottom, filled with symbols of the commonwealth's ecclesiastical and civil aspects.

Richard Brathwait, 1588?–1673

The English Gentleman and the English Gentlewoman
Third edition revised, corrected, and enlarged
London: Printed by John Dawson, 1641
Gift of Alfred C. Chapin, Class of 1869

As in Burton's *Anatomy of Melancholy*, the compartmentalized title-page in the 1641 *English Gentleman and the English Gentlewoman* graphically summarizes the argument of the book, in concert with an explanatory text (shown here in facsimile). It is significant that the desirable aspects of a gentle*man* have largely to do with action and accomplishments, while those of a gentle*woman* are relatively passive virtues.

George F. Becker, 1847–1919

Atlas to Accompany the Monograph on the Geology of the Comstock Lode and the Washoe District
Washington, D.C.: U.S. Geological Survey, 1882
Purchased on the W. Edward Archer Fund

The Comstock Lode in Nevada produced millions of dollars in gold and silver after its discovery in 1859. Its mines were the deepest in America, reaching to over 3,000 feet from the surface, with about 185 miles of galleries. Although it was already in decline by 1878, its importance led to a detailed study of the Lode and the Washoe Valley district by the U.S. Geological Survey in 1880–1. The atlas volume shown uses a wide variety of line-, color-, and texture-coding, as well as captions, to indicate geological features, tunnels and shafts, and divisions of claims. The Sutro Tunnel, built in 1878, ran for five miles from the floor of the Carson River to the Comstock mines and was used to drain hot water from underground reservoirs.

Statistical Atlas of the United States,
Based upon Results of the Eleventh Census
Washington, D.C.: Government Printing Office, 1898
Purchased on the W. Edward Archer Fund

This dramatic volume, the most comprehensive and imaginative of its kind until the 1930s, was compiled under the direction of Henry Gannett (1846–1914), geographer for the U.S. Census Office and the U.S. Geological Survey. Colored and black and white graphs, charts, and analytical maps depict population, vital statistics, agricultural, medical, economic, and physiographic data from the Census of 1890. Here the growth of the population of the United States during the century then past is graphically divided by category. "Native stock" is meant to indicate white men, not Native Americans. Immigration is shown only from 1830, before which (in the proverbial "nation of immigrants"!) it had not been recorded as such. The subsidiary chart at the bottom subdivides the "foreign stock". In the charts and the accompanying map, color supports captions to distinguish the various divisions.

Asa P. Robinson

Report upon the Contemplated Metropolitan Railroad, of the City of New York
New York: Clayton & Medole, 1865
Library purchase

Alfred C. Chapin, 1848–1946

The Water Supply: Its Proposed Increase: Message of the Honorable Alfred C. Chapin, Mayor, July, 1889
Brooklyn, N.Y., 1889
Gift of Alfred C. Chapin, Class of 1869

The civil engineer Asa P. Robinson designed for the Metropolitan Railroad Co. a subway from the Battery to 59th St. in Manhattan. His report promotes the advantages of such a service as well as the profit to be made from it. The final fold-out plate shows the route of the proposed tunnel, water mains to be moved, and new sewers to be installed. However, Robinson's railway was never built, in an era when no civil projects could be built in New York without paying bribes to Boss Tweed.

Later in the century, the founder of the Chapin Library, Alfred C. Chapin, as Mayor of Brooklyn, New York delivered an address to the Common Council, who had approved an increased water supply for the city. An accompanying chart indicates with thin blue lines the location of existing waterworks and land supplying water, with thin red lines the territory of the proposed addition and land acquisition, and with broad red lines existing conduit. The yellow line marks conduit to be added.

J. Morgan Clements, *b*. 1869

Atlas to Accompany Monograph XLV on the Vermillion Iron-Bearing District of Minnesota
Washington, D.C.: U.S. Geological Survey, 1903
Purchased on the W. Edward Archer Fund

Here, as in the great atlas volume on the Comstock Lode, color lithography is used to full effect to show geological and geographical features. The aerial view of the Ensign and Snowbank lakes area is both closely and clearly detailed and aesthetically pleasing. The book is a good illustration of the fundamental use of color described by Edward R. Tufte in *Envisioning Information*: to *label* (distinguish different elements from one another), to *measure* (indicate altitude with

contours), to *imitate reality* (concentric blue lines for water, for example), and to *enliven* beyond what could be done in black and white alone.

Isaac D. Smead, *b.* 1849

Ventilation and Warming of Buildings
Elmira, N.Y.: Smead & Northcott, 1889
Purchased on the Thomas A. Frank, Class of 1963
Americana Fund

Benjamin Franklin, 1706–1790

An Account of the New Invented Pennsylvanian Fire-Places
Philadelphia: Printed and Sold by B. Franklin, 1744
Gift of Alfred C. Chapin, Class of 1869

Isaac D. Smead was an early inventor of heating and ventilating systems who theorized that all such apparatus should provide a constant flow of warm air for uniformity of temperature. He set up several firms for the manufacturing of heating and ventilating equipment, particularly for school buildings, and enjoyed considerable success. *Ventilation and Warming of Buildings* is an "interview" with Smead as he promotes his firms' products, aided by dozens of isometric and cutaway drawings of furnaces, dry closets (toilets without plumbing), and associated ductwork.

Franklin's pamphlet was meant to promote sales of his "new invented Pennsylvanian fire-place," an iron fire-box attached to an existing fireplace – the original Franklin stove. The fold-out plate "explodes" the unit into numbered and lettered component parts. Unfortunately, it was a technical failure until improved later in the century by Rittenhouse.

Robert Fulton, 1765–1815

Torpedo War, and Submarine Explosions
New York: Printed by William Elliot, 1810
Gift of Alfred C. Chapin, Class of 1869

Fulton, the American inventor best known for his steamboats and advances in canal navigation, was also passionately concerned with freedom of the seas, and to that end experimented with submarines and torpedoes, hoping to make ships of war obsolete. For years he worked with the support of the French government, against the British, and then with the British against the French – not caring where the end of naval warfare began. Finally he offered his inventions to his own country, and produced *Torpedo War* to promote them.

Fulton's diagram of a "clockwork torpedo," like many pictures in technical manuals today, is a welcome addition to a text which would be less comprehensible, perhaps incomprehensible, without an illustration. Conversely, the purpose of the device in the diagram would not be clear without the text. The conveyance of information often depends on a close partnership of word and image.

Victor Louis, 1731?–1802?

Salle de spectacle de Bordeaux
Paris: Chez Esprit, 1782
Gift of Jean F. Rosse in memory of J. Martin Rosse,
from the books of Helena and Herman Rosse

Victor Louis' theater at Bordeaux is one of the great architectural achievements of the 18th century. The lavish *Salle de spectacle de Bordeaux* was published to celebrate its construction and trumpet its superiority. Large engraved plans and views document its siting, layout, and decoration, progressing from the foundations to the roof. In a particularly interesting plate, one sees the ceiling of the perimeter areas of the building and of the lobby, various stairways, the main stage, and miscellaneous rooms and corridors. A smaller stage is above the lobby, on the next higher level.

One of the final plates compares the basic plan of the theater with those of fourteen other major theaters in Europe. The position of the Bordeaux theater at the center clearly gives it pride of place even before one puts ruler to paper and compares it against the scales supplied.

A.-J. Dézailler d'Angenville, 1680–1765

The Theory and Practice of Gardening
Translated by John James, of Greenwich
London: Printed by Geo. James and Sold by
Maurice Atkins, 1712
Transfer from the Williams College Library

Humphry Repton, 1752–1818

Observations on the Theory and Practice of
Landscape Gardening
London: Printed by T. Bensley for J. Taylor, 1803
Gift of Alfred C. Chapin, Class of 1869

In his *Observations*, the renowned landscape architect Humphry Repton illustrates (for example) how he will improve the view from the house at Shardeloes, in Buckinghamshire, England. Trees are planted at C to remove a dell or scar, and removed at D to make the landscape more intricate and interesting, and to eliminate the idea of a false boundary line to the park; and at F, some of the wood is cleared away to better show the lawn, and a pavilion is added to draw the eye and to accentuate the natural setting by having a man-made object for contrast. Repton often used such *before/after*

images in his books and in proposals to clients. But as Tufte notes in *Visual Explanations*, "despite the enchantment of flaps, comparisons are usually more effective when the information is adjacent in space rather than stacked in time."

An example of adjacent progressive images may be seen in a translation of the popular *Traité sur la théorie et la pratique du jardinage*. Despite intervening diagrams of the terracing process, however, it seems much more labor-intensive a leap from a rude hill at top to a formal amphitheater at bottom, than from Repton's *before* landscape to his *after*.

Juan Valverde de Amusco, *ca.* 1525–*ca.* 1588

Anatomia del Corpo Humano
Rome: Ant. Salamanca et Antonio Lafreri, 1560
Library purchase

William Harvey, 1578–1657

Exercitatio Anatomica de Motu Cordis et Sanguinis in Animalibus
Frankfurt: Gulielmi Fitzeri, 1628
Gift of Alfred C. Chapin, Class of 1869

The use of graphics to instruct readers about human anatomy began in the manuscript tradition and became increasingly refined – even artistic. Valverde's remarkable illustration of the various muscles of the body, keyed to the facing text, was derived from *De Humani Corporis Fabrica* (1543) by Vesalius, but the concept of a "skinned man" was not wholly original even to the latter.

In contrast, the frontispiece to Harvey's *Anatomical Exercise on the Motion of the Heart and Blood in Animals*, showing the venous valves, is relatively simple but perhaps more effective for concentrating attention on a living specimen. The engraving was adapted from a picture in the *De Venarum Ostiolis* (1603) by Fabrici, who observed the venous valves but, unlike Harvey, did not fully appreciate their function in the circulation of the blood.

Albrecht Dürer, 1471–1528

Alberti Dureri Clarissimi Pictoris et Geometraede Symmetria Partium in Rectis Formis Humanorum Corporum
Nuremberg: Hier. Formschneyder, Impensis Viduae Durerianae, 1534
Gift of Alfred C. Chapin, Class of 1869

W.A. Dwiggins, 1880–1956

Marionette in Motion
Detroit: Puppetry Imprints, 1939
Gift of C. Anthony Wimpfheimer, Class of 1949

Dürer, like other Renaissance artists such as Leonardo, was concerned with the relationship of geometry with art and with the natural world. His several books explain his ideas in words, but especially in pictures which have been often reproduced. In two of the woodcuts in the *Symmetria*, only two of the many that Dürer drew, the proportions of the human body and the movement of the human arm are expressed in mathematical detail. The treatment is purely philosophical, unlike the volumes by Valverde and Harvey.

The examination of anatomy in geometric terms is not without application, however, as shown in William Addison Dwiggins' diagrams of the arm movement of a marionette.

*

Text and design by Wayne G. Hammond, Assistant Chapin Librarian, typeset in Minion Pro and Gill Sans