



Revolutionary instruments

STORY David Rooney
PHOTOGRAPHS John Short

Long before the digital age, rotating paper instruments known as volvelles allowed the user to compute myriad data, offering solutions to scientific problems of the medieval and early modern age. Only a few delicate and fascinating examples have survived

“With an almanack and a watch, one could, from three hundred leagues away, say with accuracy what he was doing.” So claimed Louis de Rouvroy, the Duke of Saint-Simon, of his godfather, King Louis XIV. For France’s so-called Sun King, calendrical order ruled his life and that of his court. Those close to him used calendars to glorify the king’s image as the ruler of time itself. It would be no surprise, therefore, to find that during his last years, the king kept an exquisitely detailed perpetual calendar close at hand in his personal cabinet.

It was no ordinary calendar. The king’s device (see opposite), which covered the years 1710 to 1736, contained a circular rotating dial showing the phases of the moon, new moons, the age of the moon, and

the dates of the month. Two smaller dials provided information about the year, solar cycles, months, zodiac signs, feast days, and the length of the day. Sadly, the king would only be able to use this prized instrument for five years before his death in 1715.

These rotating paper disks were known as volvelles, from the medieval Latin *volvella* or *volvellum* meaning “to turn,” and they were used from the fourteenth century to calculate the movement of the stars, the dates of lunar eclipses, or the patterns of the tides without recourse to extensive tables of numbers. Such devices, called “paper instruments” by the German maker Georg Hartmann in 1544, were hybrids of books and the scientific instruments of brass, wood, and ivory that have survived in greater numbers. Volvelles brought the universe to order and, it was believed, helped predict the future. Today, paper volvelles are rare, owing to their fragility, and highly prized by collectors as very early types of analog computing devices.

Perhaps the most famous and desirable example of the volvelle-maker’s art was Petrus Apianus’s sumptuous 1540 publication *Astronomicum Caesareum* (or *The Emperor’s Astronomy*), described by the historian Derek J. de Solla Price as “the most luxurious and intrinsically beautiful scientific book that has ever been produced.” In this spectacular hand-colored publication, which took approximately eight years to produce, a total of 83 volvelles impart complex information about the position and movement of celestial bodies, as well as astrological quantities and the means to find

King Louis XIV treasured his perpetual calendar with 3 movable volvelles, which was made for the years 1710-1736. Certain dignitaries at his court received copies, such as the example shown (left), owned by Louis Nicolas Le Tonnelier de Breteuil, an officer of the royal household and father of the mathematician Émilie du Châtelet. The hand-colored engravings are highlighted with gold and silver

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the dates of Easter and Passover. Without the volvelles, such calculations would need to be made by hand, which was a lengthy and difficult task. The book historian Sten G. Lindberg has commented that volvelles were “what the slide rule became and what the pocket calculator is now for our scientists.”

Apianus, a contemporary of Nicolaus Copernicus, was an astronomer and printer at the University of Ingolstadt, Bavaria, and soon gained a reputation for the quality of his work on geography and cartography. He came to the attention of the Holy Roman Emperor Charles V, who paid for the printing of the *Astronomicum* as well as granting Apianus three thousand golden guilders, appointing him court mathematician, and offering him a knighthood, such was the high status of his paper masterpiece.

The *Astronomicum* may have been the high-water mark in the age of paper instruments, yet it also came at a remarkable period of transformation in our understanding of the cosmos. It represented the

earth-centered view of the universe, which had held power since ancient times. Yet, in 1543, just three years after Apianus’s book was finished, Copernicus published *De revolutionibus orbium coelestium*, which proposed a sun-centered solar system that eventually came to displace geocentrism and pave the way for modern astronomical models.

However, the Copernican revolution did not mark the end of volvelles. These multipurpose devices combined carefully designed scientific mechanisms with often elaborate and richly detailed art to make artefacts that were both beautiful and useful, and they were applied to the most intractable problems of the age.

For centuries, navigation at sea had been a problem for maritime nations keen to expand their empire and profit from global trade. The navy that ruled the waves could rule the world, and during the late seventeenth century, astronomers mapped the stars in ever greater detail in the service of astronomy and navigation. Such work entered the public domain with volvelle star charts

Right: before the invention of the sextant, an astrolabe was used to observe and calculate the position of celestial bodies. This manuscript version, made around 1800, consists of a circular base plate, 3 paper volvelles, and a brass radius pointer. Below: *Astrolabium* (c. 1575) contained 8 large woodcut diagrams on paper, each featuring several layers of intricate rotating parts. It complemented Leonard Thurneisser’s *Archidoxa* and was said to enable the user to predict her or his fate or natural disasters



PHOTOGRAPH: HARRY RANSON CENTER, THE UNIVERSITY OF TEXAS AT AUSTIN





Left: a star chart (c. 1722) by Jan Jansz Stampioen the Younger. The disk can be moved to indicate the part of the sky visible at any date and time, and to make calculations about the Netherlands (Stampioen's home)

such as the finely detailed and colored chart and calculator by Jan Jansz Stampioen the Younger in the Netherlands. By the eighteenth century, national competitions with lavish cash prizes had yielded a raft of promising new techniques and technologies linking astronomy, instrument making, and horology to solve the so-called "longitude problem," with the British clockmaker John Harrison completing his masterpiece, known as *H4*, in 1759.

In England, in 1767, the Astronomer Royal at the Royal Observatory Greenwich began publishing the annual *Nautical Almanac*, which contained tables of calculations to aid the practice of astronomical navigation at sea. The following year, in France, the astronomer and science popularizer Jacques-François Dicquemare published his "cosmo-plane," a giant wall-mounted volvelle comprising three concentric disks, each one

lavishly engraved and mounted on board. Designed in part to solve problems in maritime navigation, the device included information on the sun, solstices, equinoxes, seasons, the zodiac, standard units of measurement, and magnetic declination, together with maps of the four continents and numerous tables. Dicquemare dedicated his instrument to Jean-Antoine Nollet, a favored lecturer to the French aristocracy.

As devices capable of astrological prediction, volvelles had long been as familiar in medical contexts as in navigational ones. Astrology was particularly important in the medical tradition that followed the death of the Swiss physician Paracelsus in 1541, in which the planets were believed to influence the body and its "humors." Yet the role of zodiacal predictions in the practice of medicine was nothing new. An English work of about 1482 included a volvelle that

Below: the "cosmo-plane" (1768) was a huge wall-mounted instrument used to aid navigation at sea. Right: a detail from 1540's *Astronomicum Caesareum* by Petrus

Apianus, which has been referred to by the astronomer Owen Gingerich as "the most spectacular contribution of the book-maker's art to sixteenth-century science"



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could be set to the sign and degree of the zodiac for any given day and used to predict the most effective time for medical treatment. By the late sixteenth century, physicians were required by law to find the position of the moon, using a volvelle, before operating on a patient.

One of the most extravagant astrological-medical treatises to employ volvelles was the second edition of the German scholar Leonard Thurneisser's major work, *Archidoxa*, published in 1575. Thurneisser was the personal doctor of the Elector of Brandenburg, and became noted for his medical treatments, astrological

calendars, horoscopes, and talismans to ward off evil. In *Archidoxa*, he claimed that the reader could not only understand the power of the planets and stars but could predict the future. Eight large woodcut diagrams on paper, each comprising several layers of vividly hand-colored volvelles, accompanied the treatise.

The success and proliferation of volvelles relied on close relationships between writers, artists, mathematicians, engravers, printers, bookbinders, and publishers, as well as access to the high-quality data that underpinned the accuracy of these paper instruments. It would be easy to dismiss them as secondary to the instruments in wood and metal that we know today, and it is true that they were often playthings for the privileged. However, they wielded great power, and, in their day, commanded the highest respect from monarchs, aristocrats, and scholars. Science conferred status, and prediction of future events was in great demand among those whose position might be at risk. Knowledge was power, and these beautiful, spectacular volvelles were instrumental in holding onto it. ♦