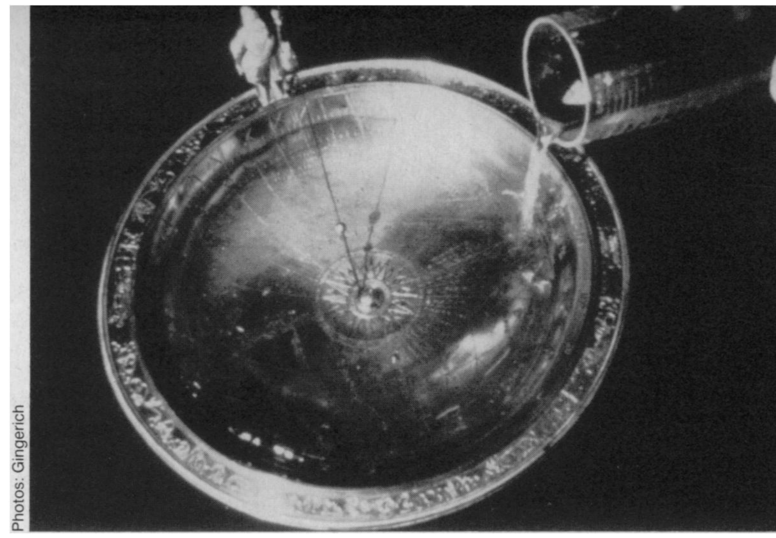
Turning Back Time

An antique sundial simulates a biblical miracle

By IVARS PETERSON



Photos: Gingerich

Schissler's 16th-century sundial. A bead on a string stretching from the bowl's center to a figure on its rim casts a shadow on the calibrated inner surface. Pouring water into the bowl shifts the bead's shadow by 10° to 20°, in effect turning back time.

"Look, I shall make the shadow cast by the declining sun go back ten steps on the steps of Ahaz." And the sun went back the ten steps by which it had declined.
— Isaiah 38, *The Jerusalem Bible*

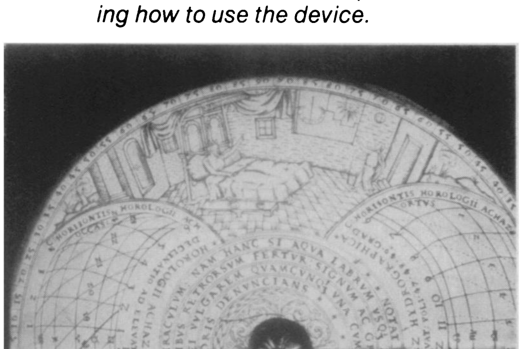
Few demonstrations of power can match the awesome effect of reversing time. By making shadows move backward, the prophet Isaiah dramatically reassured the ailing King Hezekiah that he would recover from his illness, thus gaining more time to put his house in order.

Renaissance craftsman Christopher Schissler could not, of course, duplicate Isaiah's feat. But the notion of making shadows move backward inspired the master instrument-maker to fashion an ingenious sundial to simulate the miracle. Schissler's bowl-shaped timekeeper, completed in 1578 in Augsburg, Germany, relies on the way water bends light to achieve its remarkable effect. Pouring water into its shallow, gold-plated basin makes the sun's afternoon shadow appear to retreat, yielding an earlier time reading.

The unique sundial "was not in any sense an attempt to explain the miracle in Isaiah," says historian Owen J. Gingerich of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass. "It was just a way of simulating it."

Until curiosity led Gingerich and colleague Philip Sadler to study the sundial in detail, no one in modern times understood precisely how the instrument worked. Gingerich described their painstaking analysis and reconstruction at last month's American Astronomical Society meeting in Arlington, Va.

The sundial's base features biblical scenes and a Latin inscription describing how to use the device.



Schissler's sundial, known as the Bowl of Ahaz, is both a clever device and a masterpiece of 16th-century design. It stands about a foot tall, topped by a bowl measuring about 10 inches across and 1½ inch deep at the center. The sundial's base displays pictures of King Hezekiah and is inscribed with a reference in Latin to the miracle recounted in the book of Isaiah. Another Latin inscription describes what happens when the bowl is filled to the rim with water.

Moreover, Schissler designed the sundial to work in two different sets of latitudes and to adjust for seasonal changes in the angle of sunlight. One side of the bowl keeps time for latitudes between 47° and 53°, the other for 36° to 41°. Lines crisscrossing the inner surface allow an observer to determine the time during different months of the year: A line far from the center marks clock times in December when shadows are long, while lines nearer the center correspond to times in each of the remaining months. Calibrating the sundial so precisely for such a wide range of conditions was a major feat at a time when computers weren't around to help with the intricate calculations involved.

"This instrument is quite different from anything else Schissler is known to have made," Gingerich says. And it's the only known Renaissance sundial that takes advantage of the way water refracts light.

The sundial now belongs to the American Philosophical Society in Philadelphia, which received it as a gift in 1755 during Benjamin Franklin's tenure as society president. The sundial remained in pieces until the 19th century, when a society member attempted to reassemble the instrument. Unfortunately, that reconstruction proved erroneous, Gingerich says. The string that casts a time-telling shadow across the bowl's inner surface was in the wrong place.

To correct the mistake, Gingerich and Sadler used the markings on the sundial and the sun's position at various times during the year to calculate where the indicator string ought to run to get shadows in the right places. Those calculations showed that the string required an unconventional placement, going from the bowl's center to the pike held by a Moorish figure perched on its rim. Such a placement makes it easy to swing the movable figure from one set of latitude markings to the other set on the opposite side of the bowl.

Gingerich and Sadler found that water poured into the bowl bends the shadow closer to the bowl's center by as much as 20°. For instance, a shadow originally pointing to 3 o'clock would move back to 2 o'clock. Detailed calculations show that this works for any season and for most afternoon hours, Gingerich says.

Once the string indicator was set in its proper position, the sundial functioned just as Schissler had intended. When Gingerich and Sadler poured water into the bowl, they actually saw the shifting shadow and verified their calculations.

"Our findings make the bowl even more impressive," Gingerich says. "The whole idea is very ingenious." It's clear now that Schissler's achievement — making a shadow move backward while ensuring that it could be observed year-round during many hours of the afternoon and in two sets of latitudes — was no simple matter. And, says Gingerich, "we still wonder how he succeeded in calibrating the ellipsoidal surface of the bowl." □