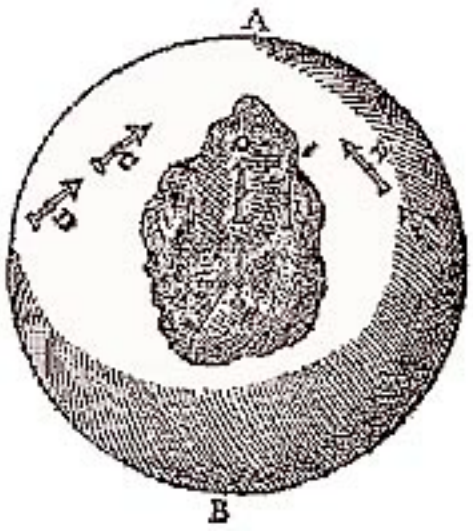
The New York Times June 13, 2000

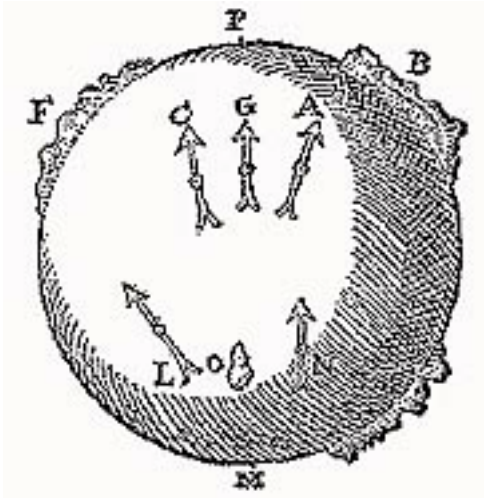
Celebrating the Book That Ushered In the Age of Science

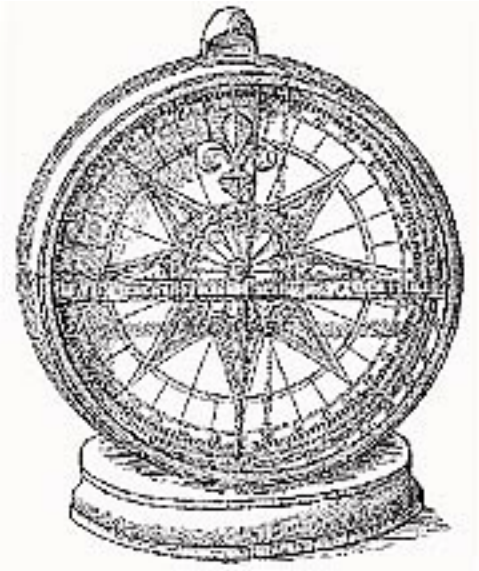
By WARREN E. LEARY

Courtesy of Dr. David P. Stern

In "De Magnete," Gilbert described his experiments with lodestones, natural magnets he whittled into round shapes he called "terrellas" or little earths. In working with them, he demonstrated that the planet itself is a giant magnet and showed how features like mountains divert the compass from true north. The the page at right is from an edition of 1628.







Courtesy of Dr. David P. Stern

Gilbert designed the "dip circle," above, to measure Earth's magnetic field. The bar in the center would be horizontal at the Equator, and dip nearer the poles. It did not live up to his hopes as an instrument to measure latitude, but it showed, in his view, "how far from unproductive magnetick philosophy is."

William Gilbert was the consummate observer, seeing wonder in nature and pondering its secrets. His curiosity, about compasses and lodestones, led this 16th century physician beyond his chosen field and into physics, where his careful explanation of his observations and reasoning laid the groundwork for modern experimental science.

Dr. Gilbert was drawn to magnetism and in it found what he thought was the soul of the earth. In 1600, Dr. Gilbert published a monumental study of magnetism that changed the way scientific theory was presented, discussed and proven. The volume, "De Magnete," Latin for "On the Magnet," provided support and direction for the 17th century renaissance in science inspired by Johannes Kepler, Galileo and Isaac Newton.

"Gilbert was the dividing point between medieval thinking and modern science," said Dr. David P. Stern, a physicist at NASA's Goddard Space Flight Center in Greenbelt, Md., who is working to rekindle interest in Dr. Gilbert and "De Magnete" on the 400th anniversary of its publication.

"He was often wrong in his conclusions," Dr. Stern said, "but he began a new age."

Dr. Stern, an expert on the magnetosphere, the huge area of charged particles trapped by the earth's magnetic field that envelop the planet, said that Dr. Gilbert was the first to explain correctly why a compass always points north and the first to propose that the earth itself was a giant magnet.

"He also introduced experimental observations into science in a systematic way," Dr. Stern said. While the ancient Greeks and others conducted experiments, he said, Dr. Gilbert was the first person to methodically tie these observations to theories he proposed and to detail the experiments so that others could reproduce them.

Because of his interest in why some objects attract others, Dr. Gilbert conducted pioneering experiments with static electricity, then called the amber effect because rubbing a dry cloth on pieces of amber causes them to attract feathers and other light objects.

He found that the attractions of magnetism and static electricity were not related, but in his book he classified numerous substances that were, or were not, drawn toward amber, the Greek word for which is "elektron."

Dr. Gilbert called the attracted materials "electricks" and what drew them the "electrick force." In doing so, experts say, he created the vocabulary now used to describe electricity, including terms like electron.

As part of the commemoration of "De Magnete," the American Geophysical Union held a seminar at its spring meeting in Washington early this month on the impact of the work on the study of magnetism. The scientific group also published a new "book review" of the work in its journal Eos, in which Stuart Malin and David Barraclough, members of the British Geological Survey, noted that the book pre-dated many better-known volumes remembered for ushering in the renaissance of science.

"De Magnete" outlined a method and philosophy of experimental science that preceded by 20 years Sir Francis Bacon's now famous call for a deductive system of empirical research and observation to uncover the secrets of nature, the authors said.

At a time when it was considered heresy to conduct experiments that might conflict with church teachings, or to present ideas that conflicted with past philosophy, they said, Dr. Gilbert's book stood alone.

"Recall that it was not until 1687 that Newton's 'Principia' was published," Dr. Malin said. And Dr. Barraclough pointed out, "De Magnete" also predates Kepler's "Astronomia Nova" (1609), in which he enunciated the first two of his three laws of planetary motion, and Galileo's "Sidereus Nuncius" (1610), in which the earliest telescopic observations of astronomical objects were reported. Dr. Gilbert supported the Copernican theory that the earth was not the immovable center of the universe. He believed that the planet turned on its axis, but erroneously thought that this motion was associated with, and perhaps caused by, magnetism.

The notion of a revolving earth was considered so unacceptable at the time that many European copies of his book had these pages removed or defaced. Galileo, who praised the book, said his copy was a gift from someone who wanted "to free his library of its contagion."

William Gilbert was born in 1544 to a middle-class family in Colchester, England, and died of bubonic plague in London in 1603. Little is known of his childhood, but he was educated at St. John's College, Cambridge, until 1569. During his 11 years there, he received bachelor's and master's degrees, and training as a medical doctor. He settled in London in 1573 to practice medicine and was so successful that by 1599 he became president of the Royal College of Physicians. In 1601, he was appointed a personal physician to Queen Elizabeth I.

But Dr. Gilbert also had another life wrapped around a consuming hobby of magnetism. From about 1581 to 1600, he conducted experiments into magnetism and electricity, often meeting and working with others who shared the same interests, biographers say.

The ancient Greeks and early Chinese knew about lodestones that attracted iron, and around the year 1,000, the Chinese discovered that an iron magnet floated in water always pointed in the north-south direction. The magnetic compass spread from Asia to the Middle East to Europe.

Yet the nature of magnetism and the directional properties of the compass remained mysteries, surrounded by myths, that attracted the curiosity of Dr. Gilbert and his associates. His years of experimentation culminated in the publication of "De Magnete," an unusual 246-page volume printed in Latin, then the universal language of science.

Dr. Gilbert divided the work into 115 chapters arranged in six books, in which he surveyed previous work, disclosed experimental results and how he derived them, discussed the findings in broad context and ended with speculation and unsolved problems -- a form that is common today for scientific papers and Ph.D. theses.

Among the devices he used for his experiments was a spherical lodestone he called a terrella, or "little earth," which had a magnetic field he likened to that of the planet and on which he tested small compass needles.

Examining the fact that there are slight variations in where compasses point, depending on their locations, Dr. Gilbert showed that this occurs because the earth is not a perfect sphere.
The terrella also helped with other geomagnetism experiments, like showing that compass orientation varied near land masses and mountains.
For these experiments, Dr. Gilbert carved out gashes in the orb to symbolize oceans and demonstrated that small needles pointed differently according to the proximity or remoteness of raised masses.

Dr. Stern said "De Magnete" gave the modern reader a glimpse into the mind of someone trying to understand nature from a point of complete ignorance. It is easy to see the confusion, naïvete and error, he said, but this should not distract from seeing the creativity and genius in what Dr. Gilbert did in his day. "He made magnetism a part of science," Dr. Stern said.
Dr. Stern has created an extensive Web site on "De Magnete" at

Museum of Science and Industry, Manchester. The scientists behind The Baby has worked with the company Ferranti to develop the Manchester Mark 1, which in turn led to the Ferranti Mark 1, the worldâ€™s first commercially available general purpose computer. The merger of academic excellence and marketing skills helped transform a dream into reality. â€œIt is one thing to have an idea and another thing to put it on the market and so on,â€ explains Dr. Thomas. â€œFortunately, it was pure coincidence that Manchester has both of the components â€“ they had the ideas to the university, and they had the engin Environment. Science. Cities. Global development.Â â€œLooking back, he was the beginning of a cultural revolution which we are still in the midst of right now,â€ says David Horowitz, a conservative writer who helped to bail out Drudge shortly before the Lewinsky affair broke. At the time Drudge was fighting a $30m lawsuit against the Clinton aide Sidney Blumenthal, whom he had falsely accused of abusing his wife â€“ one of the earliest examples in the internet age of rightwing fake news. The second revolution Drudge sparked was within the media. By exposing not just the presidentâ€™s tryst with an intern, but the decision by Newsweek to hold off on t