Rods of crystalline carbon, each encased in a hexagonal-section sheathing of two glued bands of wood.

THE PENCIL

It has made its mark in the history of technology

BY CURT WOHLEBER

THE EARLIEST-KNOWN description of a pencil appears in a 1565 book on fossils by the Swiss naturalist Konrad Gesner, who noted a new type of writing instrument that employed "a sort of lead (which I have heard some call English antimony) shaved to a point and inserted in a wooden handle." "English antimony" had been discovered earlier in the sixteenth century in or around the valley of Borrowdale in Cumberland, England. Tradition has it that a fierce storm uprooted an oak tree, exposing a rich vein of a soft, dark mineral with properties similar to lead. Cumbrian shepherds were said to use chunks of the stuff to mark their flocks. The mineral came to be known under a variety of names, including *black lead*, *wad*, and *plumbago* (meaning "acts like lead"). It was actually a form of carbon that today we call graphite—one of carbon's two basic crystalline forms, the other being diamond.

In his 1990 book *The Pencil: A History of Design and Circumstance*, Henry Petroski wrote, "Well into modern times, the act of writing was occasioned by much preparation and inconvenience." Sharpened sticks of actual lead had been used as writing instruments since ancient times, but a stylus made of lead metal left a rather faint mark unless used on a specially prepared surface. Quill pens made a bold mark but required a messy supply of ink. Graphite offered the self-contained portability of the lead stylus while leaving a bold mark on ordinary paper.

A disadvantage of graphite was that it had to be extremely pure to be suitable for writing. For centuries the Borrowdale mine was the only source of significant quantities of pure graphite. The device Gesner described used it efficiently by enclosing a thin stalk of it in a wooden case. The illustration in Gesner's book depicts what appears to be an antecedent of the mechanical pencil, with a removable lead and a case that was not sharpened along with the point. By the 1700s, however, most pencils were made by gluing a stick of graphite into a grooved strip of pine or cedar, then gluing a wooden slat on top. Both the lead and the case had a square cross section, though sometimes additional work was done on the case to give it a hexagonal, octagonal, or round shape.

Pencil makers outside England had to either rely on limited exports of Borrowdale graphite or learn to fashion serviceable pencils out of inferior graphite from other sources. German

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craftsmen pulverized and sifted graphite to remove impurities—primarily iron oxides and clay—and mixed it with sulfur; the mixture was heated to form a paste that was brushed into pencil cases. These leads were distinctly inferior, but even a substandard pencil had sufficient advantages over other writing and drawing tools to find a ready market.

In the 1790s pencils were important enough that France's war minister commissioned an engineer named Nicolas Jacques Conte to develop a substitute for English graphite. After mere days of experimentation, Conte succeeded with a kiln-fired mixture of graphite and clay. The leads that resulted were still not a match for English graphite, but the Conte process did offer one critical advantage: By adjusting the amount of clay in the mixture, manufacturers could make leads with different degrees of hardness—a selling point for artists and draftsmen, who could use a harder pencil for thin, light lines and a softer one for thick, dark strokes.

In the first decades of the 1800s American-made pencils had a well-deserved reputation for poor quality. One early success story was John Thoreau & Company of Concord, Massachusetts, which enjoyed exclusive rights to a deposit of high-quality graphite in New Hampshire. Thoreau made some of the best homegrown pencils, but they did not rival the more expensive pencils from European manufacturers such as A.W. Faber. American pencil leads were made with a mixture of graphite, wax, glue, and other materials. The resulting pencils, according to Edward Emerson (a son of Ralph Waldo), were "greasy, gritty, brittle, inefficient."

In the 1830s John Thoreau's son, Henry David Thoreau, scoured libraries in search of insights into the manufacture of European pencil leads. He apparently did not find any useful descriptions of the Conte process. One way or another, however, Thoreau learned the proper way to mix graphite and clay and how to make leads of different hardnesses. His first leads were still too gritty, so he built a device that milled graphite and used gravity to separate fine graphite dust from heavier particles.

Henry David Thoreau left the business to pursue the interests for which he is better known, and not long after, the company abandoned pencils, finding it more profitable to sell graphite to printers, who used it in a newly developed technique for duplicating printing plates called electrotyping.

The Thoreaus had learned some of the techniques of the pencil trade from Joseph Dixon, a printer and lithographer who started working with graphite in order to make crucibles for casting lead type. Success in the pencil business came later for Dixon but lasted far longer. He gave up the trade after he was told in Boston that he would have to put foreign labels on his pencils if he expected them to sell. Dixon eventually returned to making pencils and patented a high-speed wood-planing machine for shaping pencil cases, but pencils remained a marginal adjunct to his crucible-manufacturing business until after his death in 1869. In the 1870s the Dixon Company opened a heavily mechanized pencil factory that, running at peak capacity, could turn out 80,000 pencils per day.

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Mechanization and mass production, along with healthy competition, drove pencil prices down. At the start of the twentieth century the availability of unpainted "penny pencils" made them affordable for widespread classroom use, though some educators disapproved of the recent addition of the rubber eraser at one end of the pencil, believing it an incentive to carelessness.

Tradition-bound European manufacturers were slower to adopt mass-production techniques but still dominated the market for more expensive, premium-quality pencils. In 1890 the Austrian manufacturer L. & C. Hardtmuth inaugurated a tradition when it gave its pricey new pencil, the Koh-I-Noor, a coat of bright yellow paint. The company chose yellow either to match the Austro-Hungarian flag or to evoke a connection with the Far East, source of the world's richest graphite ever since the recent depletion of the Borrowdale mine. The Koh-I-Noor received a glowing reception at the 1893 Columbian Exposition in Chicago, but it did not stand out for long. Within a few years competitors began painting their own pencils yellow and giving them names such as Mongol and Mikado (which has been known as Mirado since World War II). Today about 75 percent of all pencils are painted yellow, the color now evoking not Austria-Hungary or Asia but simply pencils.

There have been some innovations in pencil design in the last century, including sophisticated mechanical pencils and regular pencils with cases of plastic instead of wood, but most of the 14 billion pencils sold throughout the world each year would have been familiar to users of the Koh-I-Noor or its imitators 100 years ago. Computer technology has not yet seriously blunted the market for pencils, though even now some engineer is probably sketching plans for a high-tech electronic successor on the back of an envelope—with his or her trusty No. 2 pencil, of course. ★

A seventeenth-century pencil thought to be the world's oldest.