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WHY 'THE PENCIL'?

Henry Petroski

This year marks the tenth anniversary of this column and also of the publication of my book *The Pencil*. For the 55 columns that have appeared to date, there are probably 55 reasons why their subjects were chosen when they were. But *The Pencil*, being a single book, has a single story of its origins. That is not to say that it is a simple story. It is, however, a story that addresses questions that many readers have asked me over the past 10 years, and so I will try to explain here how the book came to be. It is a story of impressions, images, memories, curiosity, serendipity and choice. It is also a story of failure, research and engineering science, and one for which some background is necessary for the telling.

I certainly used but took little note of pencils throughout school, college, graduate school and my first couple of jobs. Yet for all my nonchalance, I must have developed a model of the pencil as a piece of black lead encased in a hexagonal cylindrical shaft of wood painted yellow and tipped with a band of brass that held a pink rubber eraser. I say this because shortly after joining the faculty of Duke University in 1980, I was struck by the fact that its stock institutional pencils did not conform to my ideal of pencilness.

I knew immediately that the pencils I took out of my department's supply cabinet were different, but it took me a moment to understand exactly what it was that called them to my attention. Instead of being the usual lustrous yellow complemented by a distinctively painted brass ferrule, the Duke pencils were a matte blue banded with a piece of plain aluminum. They not only looked unpencil-like, but the inferior finish also gave them a cheap feel in the hand. Furthermore, where a good yellow writing pencil typically had its brand name and degree of hardness stamped sharply in gold or silver up along one face, the blue Duke pencils were carelessly branded in white paint, giving them the school colors but little other distinction. The imprinted legend "DUKE UNIVERSITY * No. 2" evoked the Avis car rental advertising slogan, "We try harder," which seemed apt since Duke was not then ranked as high as it is now.

The pencils themselves bore no identifying mark as to who manufactured them, but the cardboard bands that grouped them into dozens in the supply cabinet showed them to be made in Montana by the Blackfeet Indian Writing Company. I inquired among my colleagues about this source, and someone remembered reading that this tribe had taken up pencil making to fight unemployment on its reservation. Duke was one of the earliest and largest customers of the Blackfeet, and Duke's purchasing department was proud to be using a supplier that was so politically correct—although that terminology was still to be coined, and Duke's motives in its choice of pencil supplier should not be second-guessed. I thought the decision was admirable, but the poor quality control of the lead, casing, imprinting and erasers of the Blackfeet/Duke pencils did not seem to me to convey an image consonant with Duke's aspirations in the early 1980s.

Although I gradually became somewhat accustomed to the look and feel of the pencils, their appearance and performance continued to annoy me. There were times when, as in my schoolboy years, I could not successfully sharpen a pencil taken fresh from the supply cabinet because its point kept breaking in the sharpener. On looking at the batch from which the pencil came I saw that the leads were badly off center in their wood casings and so were being bent to breaking by the rotary action of the sharpener blades. Another problem with the pencils was a growing deterioration of their erasers, which were too hard and gritty even on the freshest of pencils.

To the company's credit, at the behest of Duke's purchasing department it did tighten its quality control, and the blue pencils became consistently better. They remained cheap looking, however, with blue paint slopped over the unsharpened business end of a brand new pencil, nonuniform white lettering up the side and a tinny-looking bare aluminum ferrule. Nevertheless, I continued to use them by the gross. The very fact that these pencils were not well made and their lead was on occasion very scratchy brought them all the more to my attention and made me look at pencils of all kinds in a comparative way. It is not regularity but anom-

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Figure 1. Pencils and pencil leads made over several centuries by J. S. Staedtler demonstrate the variety of this deceptively simple implement. (Photographs courtesy of the author.)

aly that attracts attention, and I thought increasingly of the pencil as representative of all manufactured items and a metaphor for engineering itself.

The Mechanical Pencil

I had come to Duke from Argonne National Laboratory, where I worked on problems dealing with cracks in pipes, pressure vessels and other steel structures. All of my effort at the lab had been toward understanding and describing how cracks originate, grow and lead to benign leaks or to catastrophes. At Duke, I continued to work on such problems, and in order to do so I read a wide range of literature on failure and fracture mechanics. In the course of reading a 1983 issue of the *Journal of Applied Mechanics* (JAM) I came across a brief note on broken pencil points, written by Stephen Cowin, a mechanician at Tulane University. I was fascinated by this piece of serious analysis on such a seemingly frivolous subject, and I read it with great interest.

As I related in *The Pencil*, Cowin's paper led me to the sparse literature on broken-off pencil points, and I resolved to attack the open problem of why they broke off at the angle that they did. The explanation for the slanted fracture surface did not seem to me to be substantial enough for a technical article, or even a brief note, however. So I began to analyze the pencil point from scratch, using not beam theory but the theory of elasticity, which could be expected to give a more accurate prediction of the proportions of broken-off pencil points. In writing up my results, I thought it might be a nice touch to give a brief history of the pencil, in part to fill out the manuscript on such an apparently slight subject. It seemed to me noteworthy that this object was centuries old, had no doubt frustrated many an engineer and scientist by breaking at inopportune times, and yet evidently had not been analyzed for the record until 1979. In order to make my point, I had to know when the pencil was invented and when it took its modern form. In the course of seeking this information, I came upon some fascinating aspects of the pencil's history, such as the accidental discovery of the raw material graphite in the mid-16th century in the Lake District of England and the fact that in 19th-century America Henry David Thoreau had played an important role in pencil making. I only alluded to these things in my article, which appeared in *JAM* in 1987, but I expected then that I would return to them at some later date.

The Metaphorical Pencil

In the meantime my first book, *To Engineer Is Human*, was published. The book attracted a fair amount of attention, not only for its discussion of the role of failure in the engineering design process but also because of its writing, which drew broadly from sources ranging from technical reports to poetry to make its argument. Among the things that such attention brought to me was a visit from Edwin Barber, a senior editor at W. W. Norton. He expressed an interest in my writing and in keeping in touch, and promised to send me a copy of a book recently published by Norton that he thought might interest me.

The book was Richard Feynman's *Surely You're Joking, Mr. Feynman!* and I read it with great pleasure. What struck me most vividly were Feynman's description of his bongo playing and his

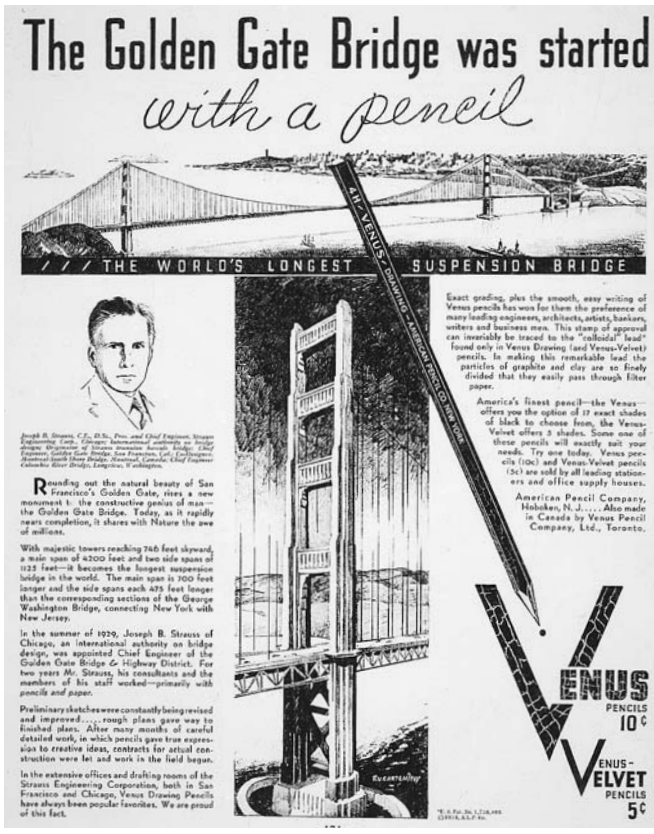

Figure 2. Ads for Venus pencils (circa 1930) often employed engineering themes.

passing reference to Thomas Huxley's essay "On a Piece of Chalk," in which a piece of common carpenter's chalk serves as a vehicle for discussing such monumental subjects as the earth's geology and evolution. When I looked up the essay in the library, I found that it reinforced my belief in the pencil as a vehicle for conveying the nature of engineering. The pencil could be a veritable symbol of engineering, with stories of its invention, manufacture and use providing promising opportunities to introduce different topics relating to engineering and its place in the larger scheme of things. I envisioned opening the various chapters of the book with unfamiliar facts and anecdotes about the familiar pencil, thus drawing the reader into the discussion.

In 1985 I was also applying for fellowships to fund a sabbatical leave, and I was preparing a variety of proposals to write a book on engineering and culture. The fellowship I most hoped to receive was one from the National Humanities Center in nearby Research Triangle Park.

The fellowship application required the customary description of the proposed project, and I laid out what I thought was a compelling argument for the book I envisioned writing. I called my project "With a Pencil: Essays on Engineering and Culture" and described what I saw as the potential of the pencil as a vehicle and metaphor for discussing aspects of engineers and engineering, ranging from creativity to quality control. I held up Huxley's use of a piece of chalk as a model. In retrospect I doubt that my initial proposal had the kind of unity that a competitive fellowship application should possess, and so I should not have been surprised that it was not successful.

What did surprise me, however, was a telephone call around the time that the fellowship decisions were made. The call was from Leon Kass, who I later learned from the dust jacket of his book, *Toward a More Natural Science: Biology and Human Affairs*, held the impressive title of Henry R. Luce Professor of the Liberal Arts of Human Biology, the College and the Committee on Social Thought, at the University of Chicago. Kass had been on the selection committee for the National Humanities Center; thus he had read my application, and he wanted to tell me that he thought that my idea for a book using the pencil as proposed was an excellent one and that he hoped I would find the support that I was seeking. He let me know, however, that the competition for fellowships from the Humanities Center would be very stiff, especially for an engineer. He suggested that I look to other possible sources of funding, and he encouraged me to look into fellowship programs at the National Endowment for the Humanities, which was more likely to be receptive to the idea.

The NEH program director with whom I spoke was Daniel Jones, who after hearing about my proposal not only encouraged me to apply for a fellowship but also called my attention to Michael Faraday's 1861 book, *Lectures on the Chemical History of a Candle*, which had been delivered "before a juvenile audience at the Royal Institution." In his lectures, Faraday used a simple burning candle to illuminate the world of chemistry. I would add a reference to Faraday's book to that of Huxley's *On a Piece of Chalk* to bolster the fellowship application that I would submit the following year.

The Diversity of Pencils

In the meantime, I had put my sabbatical plans on hold and made arrangements to go to London for the summer to teach a course on historic structures in Britain with my Duke colleague and historian of science Sy Mauskopf. Just before leaving for London I received a call from Alec Nisbett, a television producer working for the British Broadcasting Company. He had been reading the British edition of *To Engineer Is Human* and wanted to pursue the possibility of making a television documentary based on the book for the BBC's science series, *Horizon*. I told him I would be in London for six weeks that summer, and we planned to meet shortly after my arrival.

After a couple of meetings, we agreed that we would prepare a "treatment," a preliminary script that serves as a proposal for a television program. Since my family and I had only a small flat in Bloomsbury, I decided to work on the first draft of the treatment at the British Museum. On my way there after class one day, I stopped at a

stationery store in Southampton Row to buy some pencils, erasers and pads of paper. I lingered in the store examining all the pencils, noting how they differed from what I would find in America. The writing pencils that I bought were stamped HB rather than No. 2, they were eraserless, and they were presharpened. The variety of pencils and their subtle differences from American ones rekindled in me a determination to write about pencils and engineering.

The pencil was increasingly on my mind, and I noticed things to which I might not otherwise have paid attention. On finding a seat in the Reading Room, to which I had obtained a pass on the pretense of doing research on pencil manufacturing in England, I found myself sitting next to an elderly man who was taking notes from some books in German. He kept his pencils and erasers and hand sharpener in a pouch that most Americans would associate with schoolchildren. What caught my eye most, however, was the pencil he was using. It consisted of a stub inserted into a wooden *porte-crayon* whose tip was blackened with graphite and whose shaft was polished by years of use. The curiosities associated with the pencil seemed endless.

In Amsterdam later that summer I was drawn into a stationery store whose window displayed still different pencils and appurtenances. I purchased a modern pencil extender in the form of a metal tube and a variety of pencils I did not expect to find easily in America. My family began to tease me about my new obsession, but they also realized the seriousness of it and brought me many a fine example of unfamiliar pencils that they came across in their separate excursions. In fact, I came home from Europe with a collection of pencils and pencil paraphernalia that would serve me well when I began the pencil book in earnest. Almost as a diversion at first, I wanted to understand why European pencils were different from American ones. I wanted to know the origins of the differences. Were they technological or cultural? Were there in fact cultural differences in technology? The pencil conceit was appearing to be more and more fertile.

At the outset of paying attention to pencils, I could not have said exactly what I was going to do with all the ones I was collecting, but I had come to look at the pencil as an object to be studied as one might study flora or fauna. As a botanist classifies plants, so an engineer could categorize pencils; as a zoologist dissects animals, so an engineer could disassemble pencils. I came to know the pencil as an artifact with poorly understood origins and as a cultural icon with technological pretensions—or was it the other way around? Regardless, the pencil appeared to hold tremendous potential to reveal the essence of engineering itself.

On returning to Durham for the new school year, I had to put my pencils aside, however, for I had teaching and research to do, as well as a script to complete. As the year continued, I also put the finishing touches on my technical note on the fracture of pencil points and completed my fellowship applications, which had come to embrace the pencil as metaphor with more authority and conviction. In the spring of 1987, when *To Engineer Is Human* was first being seen by Britons who tuned into BBC2, I learned that I had been awarded fellowships by both the National Endowment for the Humanities and the National Humanities Center, the former paying me a stipend and the latter giving me the place to write my book.

The fellowships, and my sabbatical, would not start until September, however, and I spent the summer finishing up a research project dealing with the nature of cracking and failure in concrete. I also had to prepare a paper on the role of failure in design for presentation at an international conference on design theory and planning to be held in Boston. That meeting, which would take place in August, would be the last technical meeting I would attend for a year. During my sabbatical, I would stop by my office but once a week, and after hours at that, to pick up my mail. I would spend a year looking at, reading about and writing with a pencil, although only metaphorically, for I would compose my book on a word processor.

Thoreau's Pencils

Meanwhile, though, since Concord, Massachusetts is so close to Boston, the day after I delivered my paper on the role of failure I drove out past Route 128 to visit the Thoreau Lyceum, where I had learned from an article my daughter had found for me that there were some actual Thoreau pencils on display. I wanted to see these examples of mid-19th century pencil making, with their square leads and plain wood finish that made them more products of joinery than of mass production. Indeed, I was to learn that Thoreau & Co. was among the last of the cottage-industry pencil producers in America, being driven out of the pencil-making business around mid-century by lower-priced German-made pencils. In time the American market was dominated by pencils made in America by German subsidiaries and by the highly mechanized factories of a growing number of domestic pencil companies. Nevertheless, the story of the Thoreau family's involvement in pencil making in the second quarter of the 19th century was central to the story of the pencil in America, and I was grateful for the opportunity to hold, fondle and inspect examples of the Thoreaus' art and to

Figure 3. Pencils made by J. Thoreau & Co., the family business of Henry David, were bundled in dozens with a minimum of packaging.

discover some obscure books on Henry David's role in it all.

While in Concord I also visited Walden Pond, of course, and the Concord Museum, where I viewed a replica of the interior of the cabin Thoreau built at the pond. The focus of my attention was his desk, on which were displayed the drafting tools and pencils that he used to draw up the results of his surveys. The last place I visited was the Concord Free Public Library, which has a whole room devoted to books by and about Thoreau, as well as some relevant artifacts. What struck me most about this collection was the contrast between how the books and pencils were cared for. The books were neatly arranged on shelves behind glass, but the pencils were thrown together in a pile. They were a motley collection, clearly well used by their original owners and clearly not discarded only because of their association with Thoreau. (A nail from his cabin was on display for like reasons, but it was obviously much more treasured than the pencils, for unlike them it was catalogued among the literary holdings.) The handful of pencils was taken up by the curator as if from a jelly jar and given to me to look at. I turned them around in my fingers, inspected them for clues about how they were assembled and laid them out on the top of a file cabinet to photograph. I did not think they should be used to write with, for that would wear them out, however slightly. But to this day I regret my reverence in not trying to draw a line, just to experience the feel of the drag of the lead on the tooth of the paper.

The involvement of Henry David Thoreau with pencil making presented unusual scholarly challenges and opportunities, and they underscored the fundamental tension between technology and the rest of culture. The story of the pencil's development might have been expected to be purely internal history of technology, involving largely anonymous artisans, craftsmen and engineers, but the surprising presence of a literary personality like Thoreau in the story emphasizes the fact that making pencils or any product of industry is not done in isolation from or to the exclusion of other aspects of culture. Thoreau's literary and personal nature no doubt informed his pencil making, and his pencil making must somehow have influenced his other pursuits. Although he said of himself that he compartmentalized his life—when he made pencils he did that, and when he reflected on nature he did that—there is good evidence in *Walden* that to him at least the world of business and economics was not so removed from the world of the pond and its ecology as disciplinarians might wish us to think.

Thoreau fully understood that there are distinct ways of communication practiced by those who deal in things and those who deal in ideas. A map of the pond was not included in *Walden* as a mere joke, as some scholars have actually suggested, but rather as the surveyor and self-described civil engineer Thoreau's natural way of describing the profile of the pond's bottom as a rock-solid counterexample to the mock philosophical thesis of bottomlessness. Thoreau edited and revised the map as he might a literary manuscript, and the analogies he drew between a law of the mean in topography and in philosophy indicate his serious intention. He incorporated the methods and conventions of usually distinct disciplines to produce his unique literary artifacts.

Thoreau recognized, perhaps more explicitly than many because of his serious involvement and accomplishment in both technical and humanistic things, the inherently interdisciplinary nature of virtually everything. And because of this, he believed in the value of the microcosm as a means of making the seemingly inaccessible complexities of the world accessible. In building his own cabin and keeping his own farm he was understanding and explaining world economy—and the individual's place in it. Farming and philosophy, respectively, are not exclusively of the hand and of the head. The farmer who also philosophizes is not doomed to grow a poorer crop for his thinking, and the philosopher who knows the feel of the earth is not thereby forced to weaken his arguments about the sky.

Henry David Thoreau was "determined to know beans" not only to reap a profit in his beanfield but also to better know the whole world. He saw reflected in virtually every object and idea every other object and idea. When he was building his cabin and his "hands were very employed," by his own account he read but little. But he found that "the least scraps of paper which lay on the ground" afforded him "much entertainment, in fact answered the same purpose as the Iliad." As Thoreau could find the classics in scraps of paper, and Blake a world in a grain of sand, so it is possible to find the essence of engineering in a common artifact. Indeed, we might find it more readily than in an abstract philosophical treatise or a complex technical history. That the artifact may have had little written on it, and of that barely anything that is quoted or quotable, proves little of the artifact's significance in the history of technology or in the broader culture within which it is embedded. It was such inspiration that spurred me on to follow whatever line the pencil in my hand drew.

Within days of my visit to Concord I moved my books and files and computer into my assigned study at the National Humanities Center and immediately began writing about the pencil. I am not surprised that I opened the book with a description of Thoreau's list of supplies for an excursion into the Maine woods or that the chapter on his family's business became pivotal. I was determined to know pencils as Thoreau knew beans. And as beans led him to a better understanding of the world, so I hoped that pencils would lead to a better understanding of engineering.