Alex Groce (agroce@gmail.com), Northern Arizona University

Henry Petroski's *The Pencil* is one of Henry Petroski's many, always both scholarly and literary, and, most importantly, always engaging, books on engineering theory, practice, and history. For the software engineer, the pencil has a special place; while software engineers are not, particularly more than anyone else, pencil-users these days, we do have a special emphasis on sketching and the development of *engineering tools*, and one major thread of Petroski's history of the art of pencil-making is the use of pencils as an essential tool for engineers.

I do not have a pencil to hand, here in my office. At home, I have a number of mechanical pencils with 0.7mm leads, but no traditional wood-cased "No. 2"s. Up until I entered graduate school, I believe I would have likely at most times been near, or carried on my person, a wood-cased "No. 2" and would have often been near not the cheap plastic mechanical pencils now lying on my dining-room table near scratch paper, but high-quality mechanical pencils of the type used by architects and in "mechanical drawing." My father designed houses and taught architectural and mechanical drafting to high school students (and taught vocational education to college and graduate students in the summers). He possessed a great number of mechanical pencils, and a smaller number of wood-cased pencils, more handy for sketching.

There is, here on my desk, an "Apple Pencil" which is not a pencil at all, of course, but charmingly exploits the familiarity and even affection we have for the "true" pencil. The Apple pencil imitates, approximately, the rounded stylus with some flat surfaces to prevent rolling off a desk that, over time, came to be the most common form for the bulk of a true pencil.

Petroski's *The Pencil* is not exhaustive, but it is extensive, ranging over 22 chapters and over 350 pages, not counting notes and appendices, that include not only the engineering advances that make a modern pencil almost infinitely more resilient, reliable, useful, and economical to produce than the lead stylus a Roman might have used, but the history of the *business* of pencil making. This is a second thread connecting pencils to software: *The Pencil* celebrates the

achievements of engineers and scientists in pencil design and manufacture, of course, but more than most of Petroski's books, it is concerned with the *economics* of engineering. It is usually not sensible or even sane to produce the best conceivable software product imaginable; rather, it is best to produce a good-enough product that can be achieved at a reasonable cost. Similarly, pencil design has never been focused simply on the optimal, perfected pencil; even the *summas* of the pencil art have always included some compromises in the name of economic sense. In the final chapter of the book, Petroski quotes *Passages* patron saint Charles Babbage, but not in the context of his work on the idea of the computer. Instead, Babbage is relevant due to his remarkable book *On the Economy of Machinery and Manufactures*, and is placed in the company of Adam Smith and Milton Friedman as a prophet and poet of the nature of industrial production.

As usual with Petroski, *The Pencil* is constructed from a vast series of well-chosen and elegantly presented details and anecdotes, some of obvious relevance, and others unexpected -- it is *not* obvious from the subject of the book, for example, that the Crystal Palace of the Great Exhibition of 1851 will be generously discussed, or that Marcus Tullius Cicero, to take another example from the letter "C," will make numerous appearances across two separated chapters.

Anyone with a serious interest in engineering design and history should enjoy this book, and software engineers in particular will appreciate the importance of good tools to engineering work itself. The advancement of engineering art & science also serves to advance the development of better tools for engineering, a virtuous circle indeed. We can also particularly enjoy the discussion of parodies of software engineering's old friend, technical writing, in the form of the pastiche of word-processing manuals for that wonderful "new product" the pencil, the "essentials of a word processor in a sublimely simple form."

One aspect of the story of the pencil that at first glance seems irrelevant to software engineering, but which I propose is actually quite central, is the problem of the need for good raw materials, and efforts to find new and better ones, or make better use of existing ones by better process or mixture. What are our raw materials, you may ask? Ones and zeroes are neither in short supply nor much improved by the years. These are not our raw materials. The software engineer, at least the modern software engineer, takes rather APIs and libraries, system tools and OS functionalities, and saws them right to fit together, binds them with glue and press, and makes of them a program. Serious software, beyond what an undergraduate makes in the course of an upper-level course, is not "from scratch" but is mostly composed of pre-existing substances, cleverly and carefully aligned. Poor inputs make poor outputs, and over time to improve the state of our raw base is what some of us spend our lives about.

The greatest interest the literarily-inclined software engineer may take in this book, however, lies in its exploration of a little-known aspect of the life of Henry David Thoreau: Thoreau, who nowadays is perhaps too often thought of as a proto-hippie, nature crank, or at best as a notable abolitionist and political thinker due to his "Civil Disobedience"—Thoreau, who is perhaps not so widely read as he used to be, and ought to be—spent part of his life as a pencil engineer. Chapter 9 of *The Pencil* discusses "An American Pencil-Making Family," that family being the Thoreau family. In response to a letter from his class secretary, Thoreau wrote that during the ten years after Harvard, he had been—"Schoolmaster—a Private Tutor, a Surveyor—a Gardener, a Farmer—a Painter, I mean a House Painter, a Carpenter, a Mason, a Day Laborer, a Pencil-Maker…"

I have stood in Sleepy Hollow Cemetery, where Thoreau now lies, not far from Hawthorne, Emerson, and Louisa May Alcott, and I have seen his grave. I have walked by Walden Pond (not so isolate and unvisited now, of course). While not a stickler for perfect accuracy, I confirmed these autobiographical facts with my high school English teacher before informing you of them, because I wanted to note (and know I noted truly) that when I visited these shrines to the writer, I wish I had known his connection to engineering, for it was on a school trip to Boston that I made this pilgrimage. Had I known Thoreau's claim to a place in the history of American engineering, I might have better appreciated him then, for my excitement at the time was to see the MIT campus, which to me seemed the Parthenon, and Chartres, and Hagia Sophia of American engineering. Petroski makes the case that to appreciate Thoreau, one must add "engineer and inventor" to his list of appellations.

The story in full (as far as I can tell, actually, the exact content of Chapter 9 of *The Pencil*) is available as an article in Invention & Technology magazine, here: https://www.inventionandtech.com/content/h-d-thoreau-engineer-1. That Thoreau, of all major American writers, is likely the one for which the best case can be made that he was a serious engineer, is appropriate. *Walden* is a book full of the exact observation of things, description worthy of a surveyor or engineer, as if to make it possible for the reader to reproduce the things described. Thoreau's first chapter is called "Economy" and in it, not for the last time, he offers us a lengthy list of materials and their costs, to explain and justify his famous sojourn in the woods. To live *where* he did was not his only experiment, and the methods of his living, including experiments in what one might call labor-unintensive farming (sans machines), are those of a creative engineer, not a hapless poet. While the context gives the words their scope of the whole of society, Samuel Florman (or Henry Petroski) has written no better exaltation of

the engineer's work than "Drive a nail home and clinch it so faithfully that you can wake up in the night and think of your work with satisfaction—a work at which you would not be ashamed to invoke the Muse. So help you God, and so only.   Every nail driven should be as another rivet in the machine of the universe, you carrying on the work."