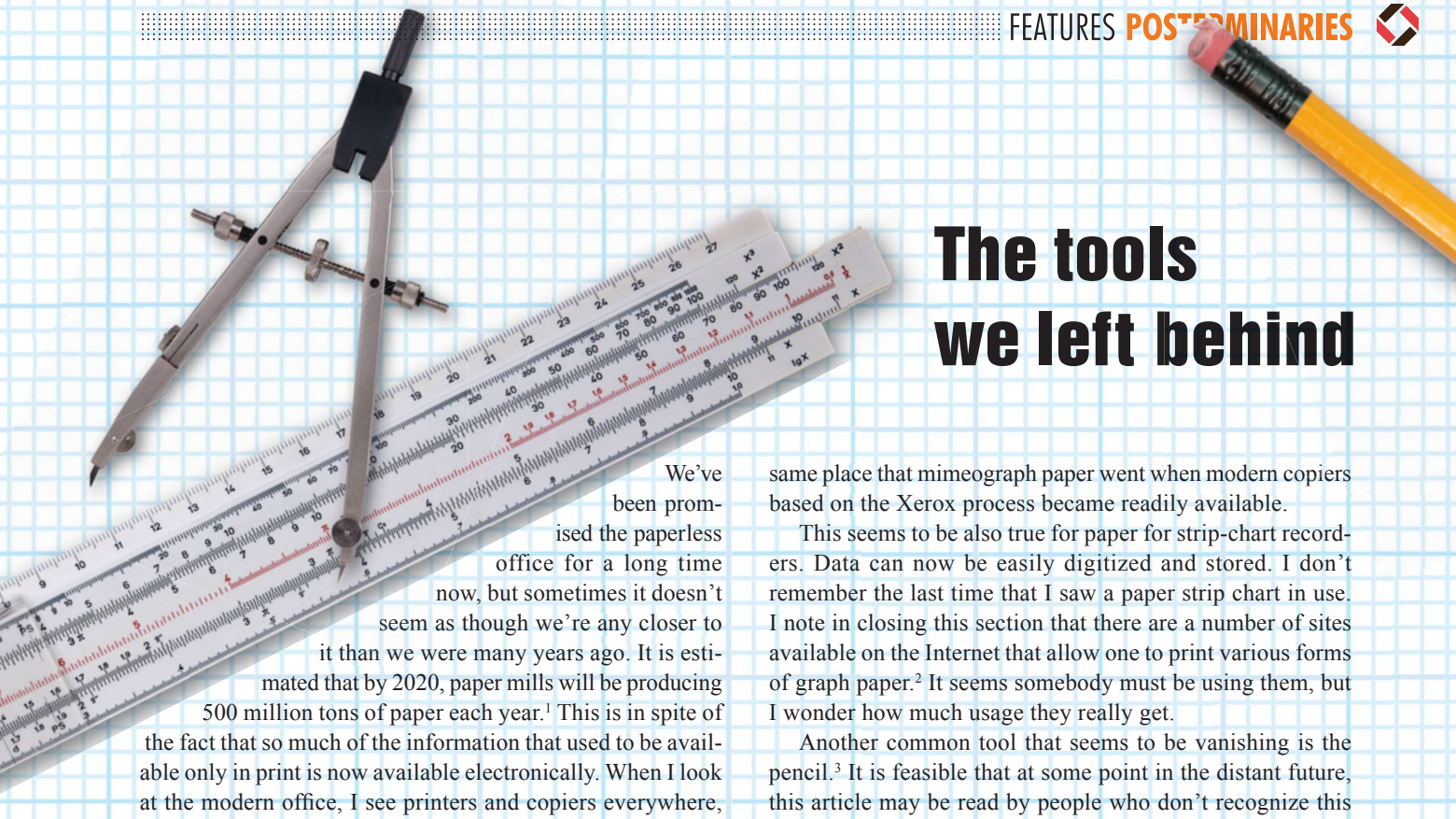


The tools we left behind

We've been promised the paperless office for a long time now, but sometimes it doesn't seem as though we're any closer to it than we were many years ago. It is estimated that by 2020, paper mills will be producing 500 million tons of paper each year.[1] This is in spite of the fact that so much of the information that used to be available only in print is now available electronically. When I look at the modern office, I see printers and copiers everywhere, all consuming vast amounts of paper.

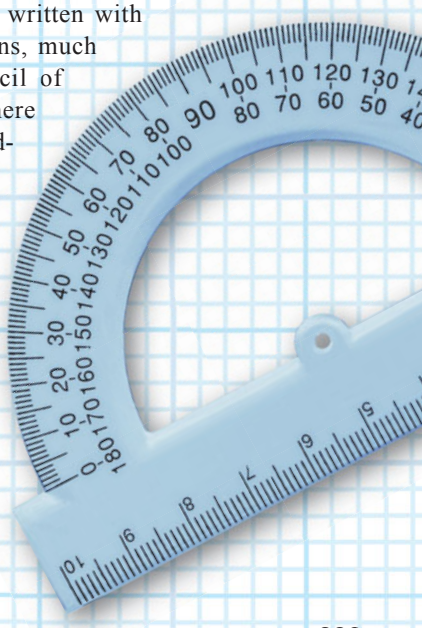
However, we have made some progress, albeit in limited steps. Most of our journals are now available electronically, so I am seeing fewer and fewer paper copies of journals. The ready availability of these articles means that we don't have to make paper copies and save them in case of curiosity or dire need, because their electronic source is almost always at hand. At one time, I used to have five, five-drawer filing cabinets filled with journal articles. Now, I'm down to two, and I'm seriously reducing the number of paper copies of new journal articles that I print. Many of the paper forms that I used to have to sign are now handled electronically, some even with electronic signatures, so the forms never have to be printed. That alone must save a vast forest of trees, because every bureaucracy loves its forms.

Another form of paper that has vanished from the modern office is the once ubiquitous graph paper. Every place that I've ever worked in a technical capacity had its vast trove of graph paper in all of its myriad forms: linear, semi-log, log-log, polar scales, Smith charts, and numerous other types. You always had to keep multiple types of semi-log and log-log graph paper, for example, with one decade on the log axis, two decades, three decades, four decades, and so on. The problem multiplied with log-log graph paper because you might only need one decade on one axis, but might need, two, three, four, or more on the other axis. The number of possible combinations is huge. I remember huge filing cabinets filled with every conceivable type of graph paper. All of that is gone now. I don't believe that I've seen an actual piece of graph paper in years, much less used one. All of that know-how is now provided by the graphing capabilities of modern spreadsheets (such as Microsoft Excel). The graph paper has gone to the same place that mimeograph paper went when modern copiers based on the Xerox process became readily available.

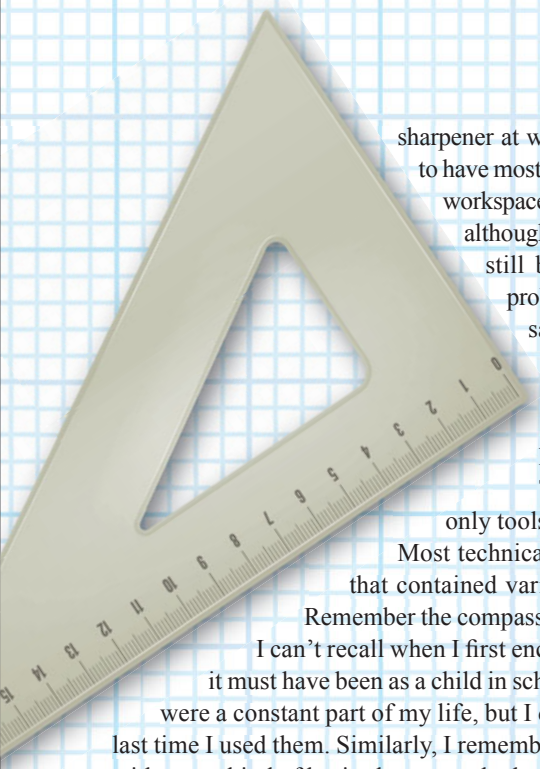
This seems to be also true for paper for strip-chart recorders. Data can now be easily digitized and stored. I don't remember the last time that I saw a paper strip chart in use. I note in closing this section that there are a number of sites available on the Internet that allow one to print various forms of graph paper.[2] It seems somebody must be using them, but I wonder how much usage they really get.

Another common tool that seems to be vanishing is the pencil.[3] It is feasible that at some point in the distant future, this article may be read by people who don't recognize this reference. A pencil is an exquisitely crafted wooden tube filled with graphite. The pencil could be sharpened to a point, exposing the graphite, and allowing one to write on paper, leaving information in the form of graphite tracks. In its most common form, one end of the pencil is banded with a metal band clasping the wooden tube and simultaneously clasping a small piece of rubber that could be used to erase the graphite. One could write and erase, write and erase, to the nth degree, until the written product was achieved. In the past, even this article that I've typed on my computer using my word processing program would have instead been written laboriously by hand using a pencil.

Pencil and eraser were preferred over ink pens because of the erasability, or non-permanence, of the text. Trying to correct something written with pen and ink was, and remains, much more problematic. The pencil of choice was a Number 2, where the number represents the hardness of the graphite. When the graphite wore down or broke, the pencil could be sharpened again, exposing more of the graphite until all of the wood in the pencil was sharpened away. Offices, in those days, had vast quantities of pencils of various kinds, as well as multiple pencil sharpeners.[4] I don't remember when I last saw a pencil



https://doi.org/10.1557/mrs.2017.112 Published online by Cambridge University Press



sharpener at work. They too seem to have mostly vanished from the workspace, along with pencils, although I note that you can still buy them. They've probably all gone to the same place that the graph paper, strip charts, and mimeograph paper have gone.

These are not the only tools we've left behind. Most technical offices had stores that contained various drawing tools. Remember the compass and the protractor? I can't recall when I first encountered them, but it must have been as a child in school. For years, they were a constant part of my life, but I don't remember the last time I used them. Similarly, I remember plastic templates with every kind of basic shape punched out so that you could easily place the template to paper and draw a square, rectangle, triangle, circle, or ellipse. You could get templates with these geometric forms in various sizes and simply select the one to draw your figure.

Templates with more complex geometric shapes were also commonly available. The forms represented commonly drawn structures, such as the representations of resistors, capacitors, inductors, and other electrical elements. In fact, there were templates commercially available and common in offices that would allow one to trace out common shapes used in science and engineering. All of that seems to have vanished as soon as electronic drafting tools became available. Somewhere, there must be a massive graveyard for all of this stuff. Can you imagine the speculations of future archaeologists and anthropologists if this treasure trove of ancient tools is ever uncovered?

And, of course, no discussion of the tools of yesterday would be complete unless we include that most elegant of all scientific and engineering tools—the slide rule.[5] At work, I am part of a diverse lunch group, some who are fresh out of college, some who are mid-career, and some who are—how shall I say this—extreme middle age. Periodically, those of us in this latter category will wax rhapsodic about our slide rules and how accurately we could solve problems with them.

Slide rules were instruments with a fixed wooden part, a wooden slide, and a glass slide that served as a cursor. The fixed wooden part and the movable wooden slide were covered with various scales. By adjusting the position of the sliding part relative to the fixed part, and by judicious use of the glass slide, one could perform various mathematical operations, including simple arithmetic (multiplication and division; addition and subtraction with some effort), as well as more complex operations, such as roots and powers, trigonometry, and logarithms and exponentials. Most slide rules were rectilinear, but circular slide rules were also available and could be used to perform other types of calculations. Because the most common type of slide rule had a rectilinear sliding rule, they were often referred to as "slipsticks." In those days, it was easy to identify science and engineering students, because they almost always carried a slide rule. The slide rules typically came in a case, which could be fitted to your belt and basically functioned as a holster. It was not uncommon to see a group of science and engineering students moving rapidly across campus with their slide rule holsters flapping wildly against their legs as they strode boldly between classes.

I currently have two slide rules. One was manufactured by *Post* and the other by *Keuffel und Esser*. One of my first required courses as a freshman in college was on the scientific and engineering use of the slide rule. Of course, as soon as inexpensive, handheld electronic calculators became available, the slide rule essentially vanished from technical life. Every now and then, in a fit of nostalgia, I locate one of my slide rules and work with it for a bit to see if I can still remember how to use the dang thing. Alas, those skills seem to have long departed. There used to be organizations that would sponsor slide rule competitions to stimulate interest in the use of these marvelous instruments. Maybe, if I ever retire, I'll find enough time to teach myself again all of those slide rule techniques that I used to know.

A final example of tools that seem to have vanished is blackboards (and chalk). These have been replaced with whiteboards and markers with erasable ink, and, more recently, "smart boards." I often wonder what is going to be the next commonplace tool to disappear or be replaced. One thing that hasn't seemed to have declined is regular mail. Even in this day and age, when I have multiple email accounts, I still seem to get as much paper mail as I ever did. We may never get to the completely paperless office, but our common work tools have changed dramatically, and for the better. Now, if I could only get rid of the junk mail!

Steve Moss

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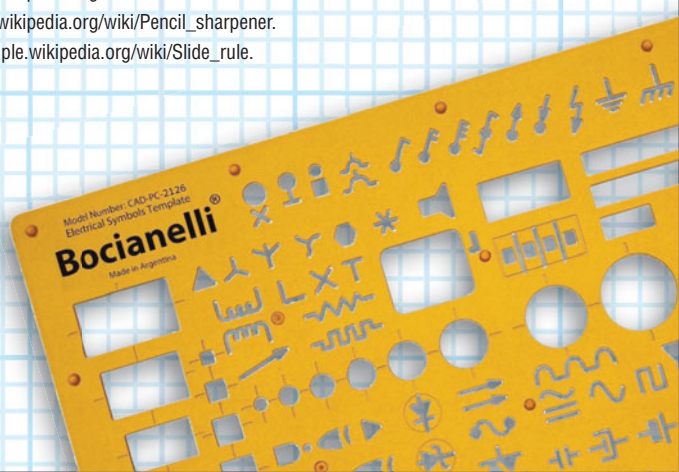

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