

When Slide Rules Ruled the Rockies

By Frederick V. Malmstrom, '64

It's no joke. Today's cadets fortunate enough to have seen a slide rule even bother to ask, "Whazzat?" If anyone asks you this unlikely question, then you might reply it was the gizmo which allowed us to build the Empire State Building, the Hoover Dam, the R100 rigid airship, the V-2 rocket, the Boeing 707 (mostly), the atomic bomb, and, of course, the U.S. Air Force Academy. From 1955 until 1974 all incoming cadets were issued either a Post or a K+E slide rule along with a rifle and a haircut. Anyone who dealt with complex calculations quickly found the slide rule a survival necessity.

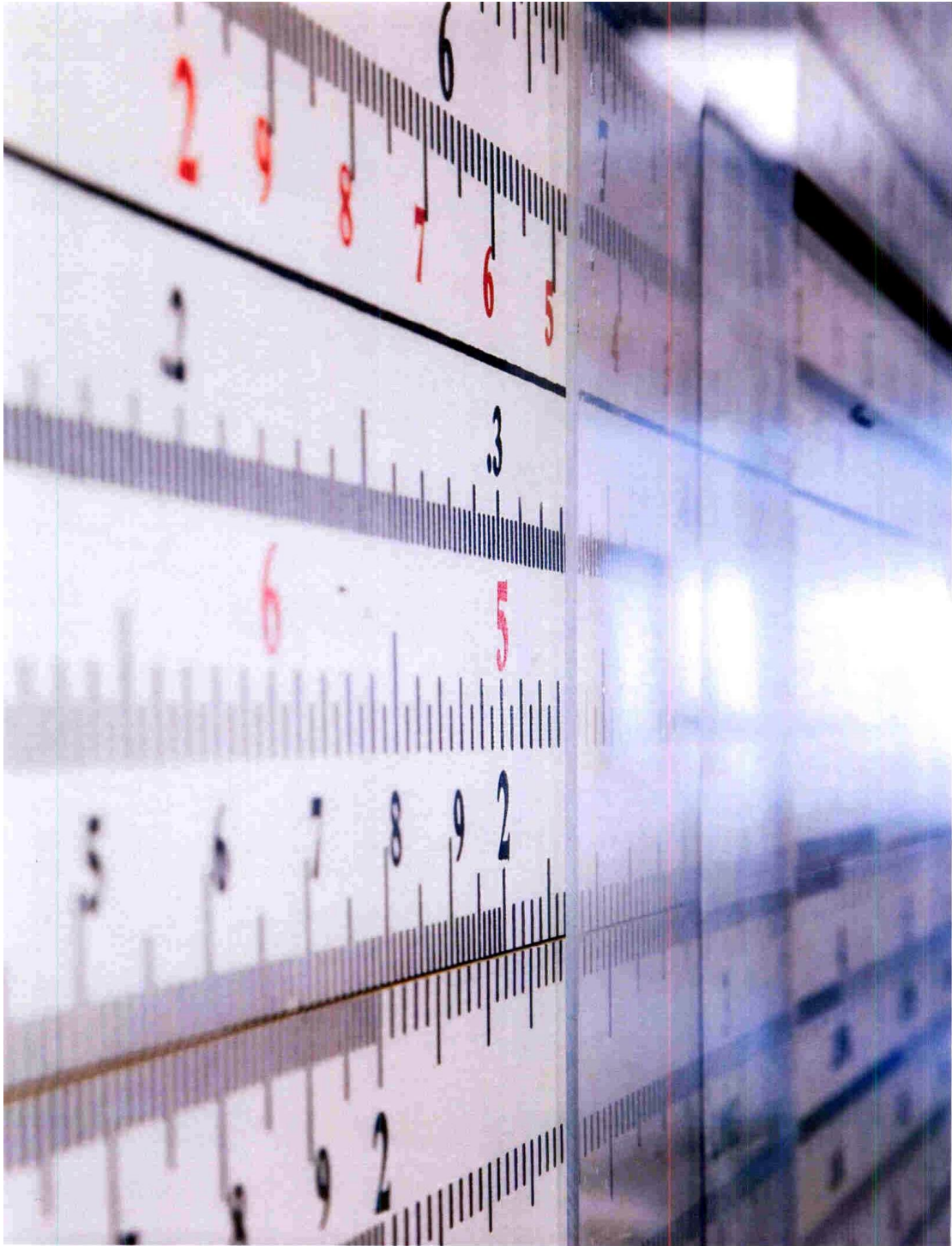
Here was an amazing gadget immune to electrical power failures which could not only multiply and divide, but call up and calculate sines, tangents (hyperbolic ones, too), square roots, cube roots, n^{th} roots, fractional powers, logarithms (common or natural) and phasors (the pre-Star Trek variety). I even knew of a practically-minded colleague who found a shortcut to compute compound interest tables. And, for those who liked to do it the hard way, there was an algorithm which allowed the user to perform simple addition and subtraction. Believe it or not, here is a Mech 361 quiz which Curt Andrus, '69, aced without the assistance of an electronic calculator!

Some Slide Rule Fun Facts

About 1614, the Scottish polymath John Napier invented both the logarithm and, most, notably, the decimal point. Napier had likewise invented a calculator now referred to as *Napier's Bones*, a rather clumsy calculating device reminiscent of a nonperforated Scrabble kit. It was an inspiration to other practical mathematicians who disliked (and who doesn't?) doing long division. It's generally agreed that shortly thereafter around 1621, the Anglican cleric William Oughtred improved upon Napier's Bones when he hit upon the idea of plotting out Napier's logarithmic tables onto two pieces of sliding wood, thus allowing him to add and subtract these tedious quantities. Presto, he had invented the "slide ruler," and he quickly improved his invention into the circular slide rule.

Over the next two centuries, the slide rule was adapted and specialized hundreds of times. Its wartime applications allowed artillery officers to compute trajectories. Astronomers used it to

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LESSON 20-H

CADET ANDRUS, R. P.
SECTION M7A

GRADED RECITATION

Block A weighs 50 lb and block B weighs 150 lb. The coefficient of friction between blocks A and B is 0.5, and between block B and the plane 0.1.

FIND: The force P which will cause impending motion.

Assume Sliding to Impending Between A & B

Ans

To II Sliding of whole system

$$\sum F_x = F - P = 0$$

$$\sum F_y = -50 + N = 0$$

$$\sum F_x = -200 + N = 0$$

$$F = N = 200$$

$$F = \mu N = (0.5)(200) = 100$$

$$P = 100$$

When $P = 200$ Sliding will be impending on whole system

Smallest Value $\therefore P = 100$

$\sum F_x = F - P = 0$
 $\sum F_y = -50 + N = 0$
 $\sum F_x = -200 + N = 0$
 $F = N = 200$
 $F = \mu N = (0.5)(200) = 100$
 $\sum M_A = P(1) - N(0) = 0$
 $P = 100$



Left: Curt Andrus, '69, solved this one with just a slide rule!
Above: One version of the venerable E-6B circular slide rule.

compute celestial movements and navigators to plot winds and drift. It was frequently decorated with specialized magnifiers and cursors. In 1921, the English engineer Otis King devised a one-foot long cylindrical rule which wrapped its scales like a caduceus around a rolling pin, thereby increasing its virtual length to a whopping 83 feet. This presented the user with an unprecedented mathematical precision of up to seven digits.

And a Few USAFA Fun Facts

Regrettably, we USAFA cadets were restricted to the traditional 12-inch double-sided (duplex) linear slide rule in the stitched leather case. Backpacks were *forbidden*, so we doolies were left to doubletime it with an armload of loose textbooks and no practical way to anchor down that slippery slide rule. Traditional engineer decor was to hang the slide rule case from the belt. I actually carried mine this way for several months, as I found I could conceal it easily beneath the flap of my blouse. Our usual classroom attire was the Class A blouse. However, when my element leader finally caught me dressed in this manner, he got his shorts into a wad (as though I were packing a concealed weapon). And so, alas, in those prehistoric days, we cadets were always publicly recognizable as those fashionable nerds who sported external celluloid pocket protectors and slide rule cases, our belts cinched just below our ribcages.

Although the slide rule had been around Europe for over 150 years, in the 1880s it wasn't much in use in America, even at West Point. Then, around 1880, two German immigrants, William J. D. Keuffel and Herman Esser (K&E) began manufacturing their own slide rules in New York. Precision and quality were of primary importance to K&E, so the men experimented with

the finest bamboo, pearwood, and mahogany. Their rules were marked off with ingenious Ramsden-type dividing machines, etched by various lithographic and photochemical processes. Their improved devices took off like the Kentucky Derby, and by 1900 practically every engineer and scientist in the United States owned at least one.

And so did cadets. Both the Post and K+E slide rules issued to USAFA cadets in the 1960s and 70s were mostly the quality bamboo-celluloid laminates good for just about anything (except of course drawing a straight line). In fact, USAFA once had perhaps 30 or more wall-sized K+E instructional duplex slide rules which hung in classrooms. Today, just two of these monsters remain at USAFA as historical nostalgia. Col. Gregory A. Seely, '76, still displays one of them in his office.

A Dazzling Variety of Slide Rules

My limited research into the universal usefulness of this device gives one an appreciation of the ingenuity of our ancestor-scientists. Slide rules were transmogrified into mind-numbing shapes such as the pocket-watch calculator, the four-sided block calculator, the tubular calculator, and the rotating grid-iron calculator. As many as 30 dazzling scales were inscribed on some of these monstrosities. The scales were modified again and again for an almost infinite number of practical specialties. From distillers who measured alcohol strength to cattle breeders who measured fat on animals, the slide rule was there. Our very own USAF doomsday specialists who wished to calculate the strength and survivability probabilities from nuclear blasts were armed with slide rules. Those of us who went on to flight training were well-familiar with our faithful loadmaster's slipstick and the navigator's E-6B circular calculator. I show one of many variations of the venerable E-6B which made its first appearance in the 1930s. It too has been largely replaced by the hand-held electronic version, although the name "E6B" seems to have stuck to this day.



Left: Cadet Douglas Jenkins, '64, well on his way to maxing another graded review.

Above: The actor Peter Sellers can be seen sardonically twirling his circular slide rule in the 1964 black comedy film *Dr. Strangelove*. Image courtesy of Columbia Pictures.

And The Speedy Death of the Slide Rule

Since around 1995 the USAFA Mathematics Department has maintained a fascinating but oft-overlooked wall display of the progression of calculating instruments issued to incoming cadets.

As noted in this photo, the classes of '59-66 and '70-78 were issued the Post, whereas '67-69 were issued the K+E. However, it was evident that by 1972 K+E's manufacturing quality standards were sliding (no pun intended) away. The reliable stitched leather case was substituted with an el cheapo composite which cracked and tore. Quality standards notwithstanding, the winds were shifting noticeably from analog to digital.

Slide rules may have been mandatory issue to cadets prior to 1975, but in 1972 it was understood the *de rigueur* USAFA engineering major would purchase his own electronic calculator (HP with Reverse Polish Notation, of course!) for the then-princely sum of \$375. By 1973, the price declined to \$275, and so on. (In 1975, I too gave in and bought my first statistics-friendly TI for a still painful \$99.) So, in 1975 the shift became official, and the Dean took the Academy from analog to digital in an irreversibly big way. A USAFA faculty colleague related to me the Texas Instruments representative groused about the USAFA calculator purchase order for the then-revolutionary TI SR-51 for the incoming cadets tying up an entire two-weeks' production run at their Dallas plant. In only four years, the venerable slide rule became obsolete at USAFA. It was that quick.

But Amidst the Agony, A Few Fond Memories

And so too did the paradigm shift become worldwide. Within five short years the slide rule succumbed to the economic rule of the Better Mouse Trap. Cadets had no more reason to fret about significant figures or the physical representation of the logarithm. From that point on, no engineers were interested in calculating

with a slide rule any more than they were interested in telling time with an astrolabe. In 1970, the Post Company was bought by Teledyne, and in 1973 the company sold its last Post Versalog. K+E hung on a while longer and desperately tried a few slide rule innovations, but they eventually filed for bankruptcy in 1982.

Yet there are still a few reminders around. In 2005, the original 1892 eight-story Keuffel and Esser Co. building at 127 Fulton Street, downtown Manhattan was registered as a historical landmark and was promptly scheduled for conversion into luxury condominiums. And for those still interested in the more cerebral side of calculating, slide rule historians and enthusiasts in 1991 formed The Oughtred Society (www.Oughtred.org). This internationally recognized society maintains an online museum of calculating instruments and publishes a semiannual journal. If you're a lover of the history of science as I am, it's well worth looking into. ▣

Fred Malmstrom is a Visiting Scholar at USAFA. He can be reached at fred.malmstrom@usafa.edu.

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