Curta mechanical pocket calculator was donated to the Maine Society of Land Surveyors by the estate of John Cothern, and was auctioned off at the 2014 MSLS Scholarship Auction on January 31, 2014. John Cothern was a land surveyor (ME PLS #1006) and it is my understanding that John was a member of the Maine Board of Licensure for Professional Surveyors during the 1990s before he died in 1995.

I first learned of the Curta calculator in the late 1960s through advertisements in Scientific American magazine, but it was not until the auction that I actually saw one in real life. As soon as I took it out of the case and held it in my hand, I knew I had to have it and eventually submitted the winning bid.

In 1972 I graduated from Carnegie Mellon University in Pittsburgh with a civil engineering degree. During my college years I used a slide rule if I only needed 3 significant digits, otherwise I used
logarithmic tables and trigonometric tables. I never owned a mechanical calculator while at college. A few months before I graduated in June 1972 I saw for the first time an actual electronic calculator, the four-function Sharp EL-8. In 1974, I finally “found my way” and started working for a company that performed boundary surveys and saw the future in the HP35 electronic calculator that did trigonometric calculations.

The Curta mechanical pocket calculator dominated the market from 1949 until 1972 when electronic calculators with trigonometric functions went on the market. The Curta was the smallest four-function pocket calculator available for sale, but could still calculate to 11 positions with the Curta I model, and to 15 positions with Curta II model. Surveyors were able to carry the Curta in a pocket and use it in the field. One interesting detail is that the Curta was able to add, subtract, multiply and divide, but it did all by just adding! (This was done with a patented contraption called the “complemented step drum”)

Logarithms
Most text books had an appendix of 4 place log tables that could be used when multiplying and dividing or taking exponents. The library had books of 7 place log tables in the reference section for more exacting work.

Trigonometric values were determined most often by using the Coast and Geodetic Special Publication 231 which gave values for natural sine and cosines to eight decimal places (Coast and Geodetic 1942). I owned Jean Peters’ book that gave eight place tables for sine, cosine, tangent and cotangent for every second of arc (Peters 1965).

Monroe LN-160X
I saw my first mechanical calculator when I started working in September 1972 for the New Jersey Department of Transportation on a survey crew. Each crew was given a Monroe LN-160X mechanical calculator. My crew used it mostly for reducing topo shots. The procedure was to enter the elevation of the height of instrument into the calculator, then key in a rod reading and subtract it to get the elevation of the first topo point. Next, that same rod reading would be added back in to get the original elevation of HI and the second rod reading would be keyed in and subtracted to get the elevation of the second topo point. It was much quicker and easier than performing the calculations by pencil and paper.

The Monroe LN-160X was much like a laptop in size and use in that it could be used while sitting in the truck, but not used out in the field. It weighed 8 pounds (11 pounds with its protective suitcase) and had dimensions of 12 inches by 10 inches by 5 inches. I used it either on a desk or used the top of the protective suitcase as a table when in the truck.

The first truly portable calculator
If the Monroe could be compared to a laptop, then the Curta could be compared to a calculator. The Curta and its case weighed...
just 16 ounces and was a cylinder with
diameter of 3 inches and height of 4 inches. Users typically would hold the Curta in the
left hand, manipulate the place settings with the left fingers and turn the crank with the
right hand. The Curta could thus be used out in the field. The Monroe and the
Curta could perform the same calculations, but the Curta was definitely easier to use
outside the office and probably could do calculations quicker than the Monroe.

The “Curta Collectors and Registry Page” (www.vcalc.net/cu-peo.htm) lists comments
made by surveyors of their experiences using a Curta calculator back in the 1950s to
1970s. Some commented that they used the Curta during their licensing exams
because the full size office mechanical calculators were too noisy and slide rules
were not precise enough. Only the “old timers” used log tables and did multiplica-
tions out by pencil and paper. John Fauill from Brookfield Wisconsin stated that he
has “…never lost the memory of holding in my left hand the black cylinder that seemed
to vibrate with life as my right hand thumb and first finger turned the handle. Both
hands worked in unison as the product of complex group of figures were calculated.
There was never any need to look at the calculator, eyes focused on the numbers on
the paper in front and my mind focused on the silent count with the continuous whirr
of the mechanism a constant partner. A true blending of man and machine.”

It was not until 1972 that another revolutionary development took place with
the advent of the HP-35 calculator, the first scientific electronic pocket calculator
that was able to perform trigonometric and exponential functions. The HP-35 elimi-
nated the need for mechanical calculators and books of trig functions, and at 9 ounces
was about half the weight of the Curta. The HP-35 signaled the end of the age of
mechanical calculators.

**Typical usage**
Most mechanical calculators would add
the numbers entered on the keyboard
when the hand crank was turned clockwise
and would subtract when the hand crank
was turned counterclockwise. The Curta
mechanical calculator was different in
that the hand crank was always turned
clockwise whether adding or subtracting.
The reason is that the Curta only used
addition even when subtracting!

The Curta was able to do this by turning
a subtraction into an addition through
the use of a mathematical “trick” called the
nines-complement algorithm. (Note that all
electronic calculators and computers that
use binary numbers use this same “trick” by
turning subtraction into addition using the
similar twos-complement algorithm.)

This is best explained through an example:

| 291326 | minuend |
| - 5798 | subtrahend |
| 285528 | difference |

Since the Curta is a 15 digit machine, add
zeros to make the example 15 digits:

| 000000000291326 | minuend |
| - 000000000005798 | subtrahend |

The procedure is instead of subtracting
the subtrahend, add the nines-complement
of the subtrahend. The nines-complement
of a number is formed by replacing each
digit with nine minus that digit. Thus the
nines-complement of the subtrahend of our
example is:

| 00000000005798 | subtrahend |
| 99999999994201 | nines-complement of the subtrahend |

Now add the nines-complement of the
subtrahend to the minuend:

| 000000000291326 | subtrahend |
| + 99999999994201 | nines-complement of the subtrahend |
| 100000000285527 | sum |

A portion of a short movie showing the major parts of YACS—Yet Another Curta Simulator. YACS is a VRM (Virtual Reality Modeling Language) simulation. http://bit.ly/1wJ1Kk3
Note that the leading “1” (shown in bold red) lies outside the 15 digits, so it is omitted. Also note that the answer (or more precisely, the difference) is “1” short, so add “1” to get the correct answer of “285528”.

The Curta used a patented “complemented step drum” in which each digit also had a nines-complement on this drum. Thus when a number was keyed into one of the 11 possible digits, that number would be added when the crank was turned. However, lifting the crank up (to show the red area) and then turning the crank would add the nines-complement.

In the following figure, turning the crank with just a black area showing would add the digit, while turning the crank after first lifting the crank to show the red area would add the nines-complement.

With all mechanical calculators, 144 would be keyed in; next the crank would be turned 9 times; next the carriage would be moved one digit over so that 1440 will be added each time we turn the crank; and finally the crank would be turned 8 times. After turning the crank 17 times (9 times and then move the carriage and turn 8 times) we would have 89 shown on the “revolution counter” and 12816 on the “result counter”.

The Curta was also able to do “fast multiplication” and in a different procedure would only require 3 crank revolutions instead of 17. In this case we have

\[144^2 = 144 \times (100 - 11) = 144 \times (100 - 10 - 1)\]

\[\begin{align*}
144 \text{ would be keyed using the setting knobs} \\
\text{The crank would be pulled up and a subtractive revolution would calculate } 144^*(-1) \\
\text{The carriage would be turned to position 2 and with the pulled up crank a subtractive revolution would calculate } 144^*(-10) \\
\text{The carriage would be turned to position 3, push the crank in the down, addition position and make one additive revolution which calculates } 144^*+100.
\end{align*}\]

The Curta would have 89 shown on the “revolution counter” and 12816 on the “result counter” but only 3 crank revolutions would be needed instead of 17. All other mechanical calculators could be used in the same way, but their revolution counter would have shown “111” (the 1 in the tens column would show as red and the one in the units column would show as red) instead of “89”.

For a demonstration of square root calculation by the odd numbers subtraction method see the five minute long YouTube video entitled “Square root of 2 on the pepper grinder”: youtu.be/haaCoVrGd6k

In conclusion, the Curta Mechanical Calculator would have been the calculator of choice before the advent of the HP-35 calculator, the first scientific electronic pocket calculator that was able to perform trigonometric and exponential functions and which signaled the end of the reign of the Curta mechanical calculator.

**References**


The Curta Calculator: www.vcalc.net/cu.htm#babbage


**Note:** This article is appearing as a three-part series in the New Hampshire Land Surveyors Association newsletter TBM and is reprinted here with permission of the author.

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