Binary-Octal

A significant development of 1950 was the Raytheon-Marchant Binary-Octal Calculator, developed jointly by our company and the Raytheon Manufacturing Company. The following article, reprinted from Math-Mechanics, *our employees' magazine, gives a non-technical description of this calculator and the part it plays in the fast-growing field of electronic computers.*

AFTER all these years, electronic computing engineers have turned their backs on decimals in favor of two-finger counting.

It's all because of the "big brains"—those dozen or so massive mechanical computers with electronic hearts and fine heads for figures.

You see, some problems—to say nothing of their answers—are reaching new heights of complexity in this atomic era. It's not that they are too tough for the human brain to master. There just isn't enough time. No mechanical brain has ever done anything human beings couldn't do, but human mathematicians just don't live long enough.

SO, MAN in his ingenuity has been able to create a tremendous superhuman machine endowed with the ability to gobble up these morsels of complex numbers, mull them over in any number of ways and then spew them out in the form of answers in a matter of seconds. Much of our modern progress can be attributed to many of the answers these electronic computers have willingly coughed up in the past few years.

The only trouble is that these huge pieces of coordinated machinery aren't happy with the Adam and Eve system of counting.

AS DESCENDANTS of this pair who counted their blessings on their fingers in the confines of the Garden of Eden, we have built our entire numbering system on decimals, i.e., 0-1-2-3-4-5-6-7-8-9—one number for each finger on our hands. Today, almost everybody counts up to the tenth finger and then starts over again with identical numbers to count up to 20, i.e., 11-12-13-14-15-16, etc. Had Adam and Eve one finger on each appendage instead of five, today we'd be counting by two's instead of ten's.

Today's electronic geniuses call their new finger counting the "binary" system. And because one digit (1) can be made to correspond to the computer's electric impulse (ON) while the other digit (0) can signify the absence of the impulse (OFF) these electronics men have adopted the "one-two" count and built it into the very brains of the "Brain" itself.

Now counting by digits—or "bigits" as users quickly nicknamed them—is not as complicated as it might seem. With the decimal system, we move over one place after the first 10, the first 100, the first 1000, etc. With binaries we move after the first 2, the first 4, the first 8, etc. That's the big difference.

Here's a chart to show how it works:

HOW TO COUNT BY "BIGITS"

Number In Decimal Digits	Equivalent In Bigits
0	0
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001
10	1010
16	10000
32	100000
64	1000000
128	10000000

Now it is comparatively easy for an engineer to memorize these equivalents up to ten or even more

—but much beyond that requires mechanical means to perform the calculations with speed and ease.

Then too, as smart as they are, big brains need men to guide them. It's the technician who must make the problems palatable to this mass of vacuum tubes and circuits they call computers. He must thoroughly analyze the problem through hundreds upon hundreds of computations before he comes near the brain. He must break it down into its simplest mathematical elements, and then set it all up again into something he calls a "program." And this is what he feeds in doses to the giant.

NOW IT'S IN this "human" stage before the big act starts where Marchant enters into the picture.

Admitted the binary system is simple enough. But have you ever tried to multiply two 30-digit binaries by hand? To say nothing of getting the decimal digits into "bigits" in the first place, or getting them back out of "bigits" into decimal digits when you are through with the entire process.

Now you know why Marchant, in cooperation with the Raytheon Manufacturing Company (now constructing several large-scale electronic digital computers), decided that a companion desk calculator would be just the thing to solve the many problems too short and too simple for the complex costly-to-operate computer even to bother with. That's how the Raytheon-Marchant Binary-Octal Calculator came into being.

Marketed early this summer, our binary calculator is now sitting beside many an electronic digital computer and is handling "bigit" conversions, pre-problem and interim-problem calculations with enormous savings in time and money.

AT FIRST glance, the Binary-Octal Calculator looks very much like any ten-bank fully-automatic Figuremaster. But there are notable differences. The keyboard, for instance. Each key has its own number, as does any Marchant, but directly over the number on the Binary-Octal key is the "bigit" equivalent. This is the way they look:

And—similarly the dial figures for the answers.

If you are wondering about the Octal part, suffice it to say that scientists never seem to make things easy for the layman to understand—although they will prove to you that they make it easier for themselves.

Assumed that you've followed the explanation up to this point, suffice it again to say that they chose the octal (8 number) scale because it can be converted from, and back into, a base binary form with ease. This scale reduces the base 2 binary form to one-third its former length—eight being the third power of two—and facilitates calculations.

So, instead of counting up to ten, Binary-Octal Calculators lop off the last two numbers and count only up to eight.

That's quite a big part for a small desk calculator to play.

Some of these big giants, such as the Navy's RADAC, the Army's ENIAC and EDVAC, the Bureau of Standards' SWAC, Remington-Rand's UNIVAC, Harvard's MARK I, II and III, and even the MANIAC and OMIBAC, fill entire rooms—some as big as 50 by 60 feet in size.

With any of these, one man can now solve in a fraction of a second a multiplication problem running into the billions and can arrive at answers to the most complicated differential equations in engineering or physics in a matter of days—problems that would take a mathematician working day and night more than three years to solve.

With these big fellows, scientists are today solving complicated and important problems in ballistics, aviation, engineering and physics and are delving into the complex mathematics of atomic engineering, light wave lengths and electron momentums. Today almost every laboratory of any size in the United States either has the use of a large scale computer, is building one, or thinking of ordering one.

And to think that these wizards, which defy even the imagination, get their "two-fingered" brain food straight from the brains of our own Marchant Calculator!