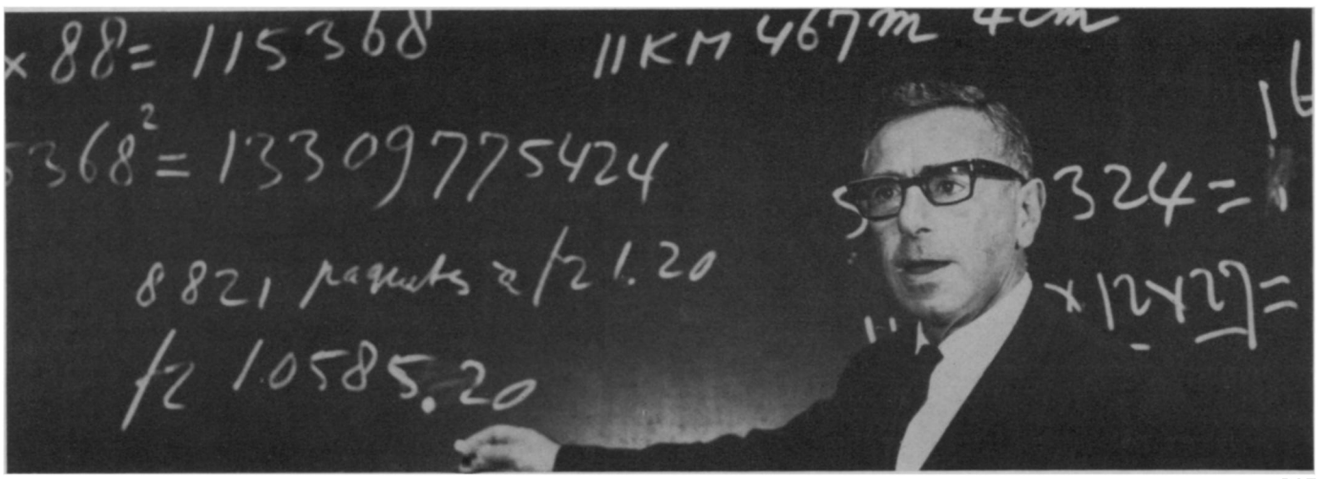

DAE

Klein on computers: "I don't trust the machine . . . It turns out great quantities . . . I can't bother to check them all."

CERN's human computer

William Klein's phenomenal arithmetic ability, once a theatrical oddity, is now a tool of science.

The European Center for Nuclear Research (CERN) vies with the United States in fundamental physics, hoping to discover new atomic secrets that might redress the balance of technologic power for the proud European fathers of it all.

While the weird banks of equipment on opposite sides of the Atlantic resemble one another, CERN enjoys one instrument the United States can hardly duplicate; its theory division's human computer, William Klein.

"No machine has yet been programmed that can display the sort of intellectual skill that William brings to computation," says colleague Edwin Shaw. "He restores man's ego in the face of electronic marvels."

Multiplication, for instance, of any five figure numbers takes him but a few seconds Even 1,388,978,361 × 5,645,418,-496 = 7,841,364,129,733,165,056 is done all in his head in 64 seconds. For Klein, this involves 25 multiplications, each of two two-digit numbers—49 operations in all.

Division, addition, subtraction, powers, roots, logarithms and factors are all handled with equal facility. Behind this unique ability lies a phenomenal memory for numbers and sheer intellectual virtuosity.

Klein rarely follows the standard sequence of calculation that a computer would follow.

His basic material, acquired by long hard effort, includes knowing by heart the multiplication tables up to 100 × 100, all squares up to 1000 × 1000, logarithms of all integers under 150, to five decimal places, and all prime numbers below 10,000—plus an enormous number of odd facts and principles, some his own, some adopted from earlier theoreticians.

One day several years ago, for example, Klein was at a British business exhibition. He visited the Friden stand and asked for a demonstration of the company's new "root" machine.

"All right, sir, let's try all the fives," offered a salesman, feeding 555555555555. Before he could press the button for the result, Klein said quietly, "745356 should be about right."

The operator was justifiably amazed when 745355.9924 appeared.

Klein had obviously not gone through the laborious process of conventional square rooting. Instead he remembered that 0.5555 is the decimal equivalent of 5/9, the square root of which is ⅓ times the square root of 5. Knowing the square root of 5 and dividing by 3 gives the answer.

There are some 2,700 people at CERN, and Klein knows most of their license numbers. "I can't help it," he says. He also knows the date of birth and death of about 100 composers. One on his favorite memory feats, especially in Geneva's professional as well as diplomatic potpourri, is to ask an audience for any number up to 24 digits. Then, after half an hour of intricate calculations, he will recite that long, long number, forward and backward.

But the CERN wizard seems a brave, sad-hearted clown, or perhaps a captain Ahab drawn to the Moby Dick of the inhuman computer. A bachelor, spare, modest and shy, Klein is a chain smoker; meeting a visitor, he puts two packs on the table, and empties them as fast as he can.

Klein studied medicine, but never higher mathematics.

He was born in Amsterdam on Dec. 4, 1912. ("That was a Wednesday of course.") He was the son of a strict medical practitioner. The father insisted that one of his two sons become a doctor and William, the elder, dutifully went to medical school for five years from 1932 to 1937; he quit before the last two clinical years.

The sons lived well enough until 1940. They hid from the occupying Nazi army, but William's brother, like Anne Frank, was discovered and sent to a death camp.

Destitute after the war, Klein turned to the stage. From the age of 9 or 10—"I was not one of those 3- to 4-year-old prodigies," he says—he had independently worked at his mental arithmetic. His first interest was factoring and prime numbers. In his spare time he worked up to almost 20,000, distinguishing the indivisible prime numbers from those

that were products of two or more other numbers. He grew more enthusiastic as the computation became easier.

His teachers never encouraged him or recognized that he could help the other pupils to learn to think. Indeed, they usually asked bitterly, "How did you get the solution so quickly?" And when told, the typical response was, "But this is not the way I taught you to do it—and expect you to do it."

"I was not good at math," recalls Klein. "Mental arithmetic does not mean mathematics. In algebra, I was all right. But geometry, spatial, stereo problems . . . och."

His father had been absolutely inhospitable to this strange interest and forbade any talk of it. But in 1945, William went on stage in Pascal's variety show, where he worked until 1951, thoroughly enjoying show business and performing in three countries.

In 1951, he obtained a job as a special calculator at the Mathematics Center affiliated with Amsterdam University. He served on many projects for government, industry and universities, such as helping scientists to diminish the vibrations of airplane wings and helping technicians to take the bugs out of popular products. "This was all numerical," Klein says, musing, "It was the precomputer age, ahh, a jolly good time."

He met a UNESCO official, so impressing him that the man organized a serious lecture course for Klein in Paris. He was a smash with the Sorbonne mathematics faculty which wanted instruction as well as answers. He was then authorized to lecture in French grammar schools—his first but lasting taste for inspiring children. Word spread among headmasters and he began full time work in France, leaving the Amsterdam math center.

But again the siren call of the midway drew him from his other duties. This time it was Pigalle, and later Marseilles and Toulon. Sometimes he performed in the open air, nailing a sign to a tree and passing around a cup. He dreaded the rain and the gendarmes.

Next he met some Monroe Calculator people in Paris, demonstrated his talent and was assigned to London. He still likes to say "blimey." The BBC had him perform, and again it was vaudeville: "Miracles of the Music Hall." Says a yellowing program, "The Dutch Miracle, William Klein, The Man With the £10,000 brain."

At Easter 1956 he came to Geneva. He met some professors at a cocktail party, and they gave him his start lecturing on mental arithmetic in Swiss grammar schools. Again with the Amsterdam math center, he worked on projects for Geneva agencies, contacted CERN and was hired in 1958 as numerical theoretician supreme and problem-solver.

What does Klein think of the New Math and children's education? He declines judgment, but says, "Fortunately there are not yet computers in grammar schools. But basically, there are two methods to do multiplication, one bad, used by almost everybody, and the other excellent but used by very few."

"Mental arithmetic would be so good for general memory training," he sighs. "The next generation could work so much faster, too. Society's the poorer for rejecting mental arithmetic."

Can many youngsters acquire Klein's prowess? "I'm sorry, but it is difficult. You need long self-training and exercise . . . and a bit more. I don't like to say 'gift'."

Here at CERN, one of the world's centers of advanced science, how does he feel? "Science is less and less interested in mental arithmetic," he says sadly. "More and more it is losing its influence, instead of gaining, because of the computer."

Still, he is gratified, for he is deep in theoretical physics, working with Europe's best, exploring the mysteries of matter. They provided him with lots of challenging integrations and differential equations, until he even had to learn "some higher math" on his own. He also works on number theory for governments including Austria and Great Britain.

The computer can do more and more, he admits. When he arrived at CERN, the organization had only a small unit and the scientists relied heavily on him for programming. "Now everyone wants to do his own programming," he says.

"I don't trust the machine," he mutters. "Of course it turns out great quantities of results, 5,000 or 6,000; I can't bother to check them all, but I do check 15 or so."

To keep mental arithmetic alive, Klein gives 37 lectures in 3 weeks each year in the schools, in French, German and Italian. Can he think in any of these languages or the three others he speaks? "No. When the problem gets tough, I think and talk Dutch!"

David Alan Ehrlich

Example

What is the 5th root of 2476099? "That is too easy; I know it by heart, 19." William Klein said.

The 5th root of 91 is tougher. The log x equals log 91 divided by 5. Knowing the logs to 150, Klein can divide 1.95904 by 5, getting 0.39180, the log of the answer, 2.46495.

Asked for an example of a difficult problem and how he would handle it, he said, "Write any 6 digit number, and I will factor it."

Here is what happened to 583721.

After about a minute and a half, Klein said, "This is a tough one (pleasing his visitor). It's not a multiple of 7, 11 or 13—or 23 or 29—or 37—or 31 or 43. Is it a prime number?"

He rejected 7, 11 and 13 because $7 \times 11 \times 13$ equals 1001. "If you subtract the biggest appropriate multiple of 1001, 583583 from 583,721 and you get 138. Which equals $2 \times 3 \times 23$. This means 138 contains no 7, 11 or 13. And if you add a multiple of 1001, 583583 plus 583721, you also won't have 7, 11, 13 possibilities.

"Next I tried 23 and 29 together, because $3 \times 23 \times 29$ equals 2001. Then 31 and 43 because $3 \times 43 \times 31$ equals 3999.

"No, by this one of my methods I'd have to divide all numbers up to 583721's square root . . . to see if it's a prime number. It would mean 120 divisions, too bloody long."

What was his method? One of his main techniques, developed long ago: always fishing with numbers that are multiples of 1000, plus or minus 1.

Then he said, "Wait just a little longer. I will use techniques of the great 18th century Basle theoretician Leonhard Euler. It can be easy."

Clocked at about 3 minutes, Klein came up with the answer.

"Euler said that if a number can be written in one way and only one way in the sum of two squares, then it's a prime number. For instance, 41 equals 5^2 plus 4^2 and 73 equals 8^2 plus 3^2. But 221 equals 14^2 plus 5^2 and also 11^2 plus 10^2. It is not a prime number. 13×17 equals 221.

"Then Euler discovered x^2 plus Dy^2. D can have only certain fixed values and one of them is 232." According to Euler, if a number in the form $x^2 + Dy^2$ can have more than one set of values for x and y, then it is not a prime.

"I used 232 for our number, trying to write it in x^2 plus $232y^2$ equals 583721. I started using 1, 2, 4, and so on as y, and saw whether the remainder was a square. I got two solutions using 50 or 40. This proved that 583721 is not a prime number.

"With another trick, I got the answer.

(232×40^2) plus 461^2

(232×50^2) plus 61^2

Criss-crossing 50×461 (no squares) equals 23050 and 40×61 is 2440 . . . adding, 25490 . . . one factor is 2549 . . . subtracting, we get 20610 and 2061 equals 9×229. . . . I picked 229, divided and, sure enough 2549×229 equals our 583721."