THE ONLY MAN INFINITY FEARS

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John Candelaria of Yucaipa, California is a man who leads two lives. At work he is a mild-mannered Clark Kent, scientific illustrator and surveyor at Caltrans (occupied with traffic-flow studies and highway planning); at home, he becomes the man of steel, effortlessly vaulting past such mega-numbers as the googol (one followed by one hundred zeros), the googolplex (ten raised to the googol power), Archimedes' number (one followed by 80 quadrillion zeros), and Graham's number (a number so immense that it takes a page of specially-invented notation to define it). Since 1975, Candelaria has been preoccupied - some might say obsessed - with the task of creating a systematic nomenclature for large numbers. In three earlier **Word Ways** articles (August 1975, February 1976, May 1983) he described earlier stages of his work; this article summarizes his completed edifice, which supplies mankind with all the number-names that it could possibly want.

Make no mistake about it, these number-names are unimaginably large, far larger than is needed to describe, say, the number of electrons that could be hypothetically employed to fill the universe. Even writing such numbers out is a task best left to the imagination; in one bit of vivid imagery, Candelaria points out that a googolplex could not be typed on sheets of paper forming a cubic stack of 40 billion light-years on a side! Small wonder that Isaac Asimov, upon reading the description of the Candelaria system, moaned "your [Large Number Denomination] system makes my head swim endlessly" and the Guinness Book of World Records saluted him in its 1986 edition as "the only man infinity fears". (Of course, Norris McWhirter is engaging in hyperbole; in reality, Candelaria's largest number-name is only an infinitesimal part of aleph-null, to say nothing of the Cantorian structure of higher-order infinities.

Lest **Word Ways** readers' heads swim as well, this article does not attempt to describe Candelaria's achievement in full detail. It is enough to appreciate the pillars on which it rests: first multiplication, and next repeated exponentiation. Cardinal numbers increase by addition: one plus one is two, plus one is three, etc. Similarly, number-names increase by multiplication: one million times one thousand is one billion, times one thousand is one trillion, and so on. Candelaria calls this counting by periods, implicitly defined by (number of zeros) = 3(period) + 3. Unabridged dictionaries define number-names up to a period of 20 (vigintillion), and for good measure throw in a period of 100 (centillion).

Candelaria's first achievement was to fill in the gap, creating a nomenclature that, at least in principle, could describe every period from one through one million: viginti-million with period 21, viginti-billion with period 22, etc. Just as the cardinal numbers become unwieldy to write out in words as one proceeds toward one million, so do Candelaria's. The table below summarizes the high spots, analogous to ten, one hundred, one thousand, etc.

Period	
1	million (2 billion, 3 trillion, etc.)
10	decillion (20 vigintillion, 30 trigintillion, etc.)
100	centillion (200 ducentillion, 300 trecentillion, etc.)
1000	decingentillion (2000 bi-decingentillion, etc.)
10000	deci-decingentillion (20000 viginti-decingentillion, etc.)
100000	centi-decingentillion (200000 ducenti-decingentillion, etc.)
1000000	millillion

At millillion, Candelaria shifted gears, using the concept of repeated exponentiation of the period to gain larger steps in his nomenclature. The period of a number can be written in the exponential form period = 10^{3i+3}, where the index i is now the counter:

Index i	
1	millillion (2 billillion, 3 trillillion, etc.)
10	decillillion (20 vigintillillion, 30 trigintillillion, etc.)
100	centillillion (200 ducentillillion, etc.)
1000	decingentillillion (2000 bi-decingentillillion, etc.)
10000	deci-decingentillillion, etc.)
100000	centi-decingentillillion
1000000	millioneillion

One can now move to a second-level exponentiation in which the period becomes period = $10^{3(10^{3i+3})+3}$ with a new index i as counter:

Index i	
1	millioneillion (2 billioneillion, 3 trillioneillion, etc.)
10	decillioneillion (20 vigintillioneillion, etc.)
100	centillioneillion (200 ducentillioneillion, etc.)
1000	decingentillioneillion (2000 bi-decingentillioneillion, etc.)
10000	deci-decingentillioneillion
100000	centi-decingentillioneillion
1000000	millitwoillion

It is now time to introduce a new counter, that of the number of levels of exponents in the period. Millioneillion can be written in two ways: it is the last number-name with a period using a single exponent level, and the first number-name with a period using two exponent levels. Similarly, millitwoillion is the dividing-point between two and three exponent levels. One can at this point define a third exponent level, period = $10^{3(10^{3(10^{3i+3})+3})+3}$, carrying the nomenclature from millitwoillion to millithreeillion, but Candelaria, realizing that it was time to start taking giant steps instead of baby ones, let the exponent level provide the index:

Level	
1	millioneillion (2 millitwoillion, 3 millithreeillion, etc.)
10	millitenillion (20 millitwentyillion, etc.)
100	millihundredillion (200 millitwohundredillion, etc.)
1000	millithousandillion
10000	millitenthousandillion
100000	millihundredthousandillion
1000000	millimillionillion

Note that the period of the final number-name is described by an exponential mountain a million levels high!

But now the metamorphosis is complete; exponent level plays the role that period did previously. One can, in analogy to what was previously done with the periods, iteratively exponentiate levels a million times, calling them layers to avoid confusion. And so it goes, like DeMorgan's famous fleas that have greater fleas to feed on:

period 1:	million
level 1:	millioneillion
layer 1:	millillioneillion
height 1:	millioneillioneillion
elevation 1:	millioneillimillionillion
altitude 1:	millioneillimillillimillionillion
perigee 1:	millitwoillimillionillion

Now, if one can only figure out a way to index this sequence of number-names ...

AN ANAGRAM GENERATOR

Would you like a microcomputer program which finds all the anagrams of a short phrase such as MARGARET THATCHER (a GREAT CHARM THREAT) or RONALD WILSON REAGAN (the INSANE ANGLO WARLORD)? The Boston Computer Society's Macintosh Group (One Center Plaza, Boston MA 02108) offers such a program for $10 plus $2 postage, called Ars Magna™. As this name of the group suggests, it runs at present only on Apple's Macintosh computer, but may eventually be available for other microcomputers. If one joins the Boston Computer Society, one can buy this program, plus dozens of others, for $5 plus $2 postage apiece.