Unless we accept the doctrine of Preestablished Harmony, that is, action at a distance without the presence of an intervening medium, the facts both of light and electricity would seem to require the presence of a medium or ether; and, in the case of electrical phenomena, what appear to be substantial particles, which we may assume could be produced by the modifications of the ether.

In regard to the atom and its composition, the scientist is led to postulate many particles, the presence of which the facts require, but the properties or nature of which cannot be described in terms of atomic substance.

As the Writings tell us, the key to the solution of a rational understanding of the creative process lies in the application of the doctrine of discrete degrees, and it would seem that the evidence in regard to the atom, and the nature or properties of the particles that compose it, lead even the scientist himself to at least a vague perception of substance discretely above or differing from the material substance of the atom. The question that we would ask therefore, is, whether in the light of the facts of science as we understand them, and our interpretation of these facts in the light of our own philosophy, we are presuming too much in assuming that the particles that compose the atom are in reality manifestations of those discreted substances of the ether referred to in the *Divine Love and Wisdom*.

TRADITION vs. OCTONARY ARITHMETIC

KENNETH ROSE

"But we've always done it this way!"

What an immense influence this plea has had on human affairs through the centuries! It has challenged reason at every level, from affairs vital to the welfare of the human race to trivia affecting individuals, and emerged victorious in an unreasonable percentage of the conflicts. It can be used to defend any mistake that has been made more than once, and becomes stronger as the need for correction grows. It has delayed some scientific advances for centuries after their conception, and has foisted onto civilization such monstrosities as the English system of measurement, the Gregorian calendar, and men's formal wear. It cannot be said that tradition has no value, but it is often an enemy of the scientist, both in his own thinking and in the world's acceptance of his ideas.

One of Emanuel Swedberg's assets as a scientific thinker was a willingness to reexamine anything in the light of reason, regardless of how long it had been established. Thus at the age of thirty he was bold enough to suggest that a practice that had been going on for more than five thousand years was not as efficient as it could be. Many different systems of numbering had come and gone in that time, but with few if any exceptions they gave particular significance to the number ten. Even the sexagesimal system of the Babylonians used special symbols for ten and one hundred as well as for sixty. There is little doubt that this common feature of so many different systems originated from the practice of using the fingers as an aid to calculation. But after systems were perfected for calculating on paper the ten remained. How many people stopped to ask after that whether the base ten was really an asset? Their number can never be known, because virtually all of them suffered ignominious defeat at the hand of tradition.

Swedberg wrote a brief explanation of "A New System of Reckoning Which Turns at 8" to present to King Charles XII of Sweden. The king had apparently encouraged him in pursuing the matter, having himself experimented with a system based on 64. The king's death prevented delivery of the manuscript, but it was preserved and is now in the Royal Library at Stockholm. In 1941 it was translated from the Swedish by Dr. Alfred Acton and published by the Swedenborg Scientific Association. Dr. C. E. Doering reviewed it in the October, 1941, issue of the NEW PHILOSOPHY.

This little work still serves as a valuable illustration of the nature of tradition and its influence upon human thought. The reader sees that the system using eight remains unused in spite of its advantages. But, more important, he witnesses his own reactions to its novelty and gains an insight into how many of his own mental processes are little more than traditional rituals, established by practice more than by reason.

The system of octonary reckoning can be described easily to anyone who really understands the decimal system. But most people have no occasion to understand it, and cannot be expected to do so. They learned it as they learned to speak, first by mere imitation of others and later by habit. How much are seven and six? Why? It is said that a first grader once gave the answer as nine and four, and that his teacher thought he was being impertinent when he claimed that it was just as good an answer as ten and three. The story is believable, because as a general rule first grade students are more likely than first grade teachers to be aware that thirteen means ten and three. The teachers "have always done it that way."

In octonary arithmetic seven and six make eight and five, which can be represented as 15. Seven more added on makes two eights and four, or 24. But these symbols are so strongly associated with the words "fifteen" and "twenty-four" in the human mind, that most people find it quite difficult to think of them as any other numbers than three times five and two dozen, respectively. Considerable confusion can be avoided by the use of different symbols for octonary numbers. Swedberg chooses the consonants *l, s, n, m, t, f,* and *v* for the numbers one to seven, and uses *o* for zero. This changes 15 to *lt* and 24 to *sm.* It is noteworthy that the individual digits have exactly the same meanings in one system as in another. It is only the positions of digits that mean something different in octonary. The successive columns represent powers of eight, not of ten. But 15 has "always" meant fifteen, and it is easier to change the symbols than to suppress this idea.

The next problem is to give the new numbers names, preferably not so arbitrary as the "teens," "-ties," "hundreds," etc., of the decimal system. Swedberg devised a novel system for this, taking advantage of the fact that his symbols were more or less pronounceable. He calls the first seven numbers *ell, ess, enn, emm, ett, eff,* and *ev;* most of them the traditional names of the letters, but with adjustments reflecting the author's preference of consistency to tradition. The number eight might have been pronounced *lo,* just as it was written, but the succeeding numbers *ll* (nine), *ls* (ten), *ln* (eleven), etc., do not lend themselves to direct pronounciation. So six vowel sounds are used between the consonants, the choice of sound being determined by the columns in which the consonants appear. The numbers from eight to eight and seven are pronounced with *y,* thus:

Number	*Symbol*	*Pronunciation*
eight	*lo*	*ly*
nine	*ll*	*lyl*
ten	*ls*	*lys*
eleven	*ln*	*lyn*
twelve	*lm*	*lym*

The sound *u* follows consonants in the third column from the right; *lom* is pronounced *lum, loo* simply *lu*. In large numbers, each consonant is followed by an appropriate vowel sound, and zeros are ignored. To the English reader this produces a few unfortunate coincidences, such as the fact that *fv* is pronounced *fvy; svooon, "sevin"*; and *toooon, "ten."* As large a number as *soltvfl* becomes quite a mouthful—*"salitovufyl."* But this word is short considering the information it contains. It imparts all the information that would be given by such a name as "two million, fifteen thousand, seven hundred, sixty-one," and in approximately the same order:

s two
a million
l one
i ten thousand
t five
o thousand
v seven
u hundred
f six
y tens
l one

Note that this is an analogy, but *not* a translation, because the columns do not represent tens but powers of eight. There is no such short name as "million" to represent eight to the sixth.

This brings up a question: What number is it that is represented by *soltvfl?* Well, it happens to be the twelfth power of three, but perhaps this answer does not satisfy the reader. This is understandable, but it should be realized that this answer is just as bad: *"soltvfl* is the octal representation of the number 531,441." The decimal version of the number is no more deserving than any other of the dignity of being *the* name for it. Actually, *salitovufyl* is as good an answer as any. If the reader thinks it uninformative, he should reflect on the fact that 531,441 says nothing more clear. It has been uninformative for a longer time, but is that an advantage?

The fact is that only two handfuls of the numbers we use have names of their own. The numbers from thirteen up are clearly dependent on ten for their meanings, and even eleven and twelve are not independent names. Their root meanings are "one left over" and "two left over." Left over from what? Yes, there it is again! It might be said that "dozen" means twelve, but the *two* in that word is only disguised by being in French (*deux et dix font douze*).

It takes such a mild shock as the study of octonary arithmetic to give even a slight realization of how we lean on ten, and how much of our calculation is not reasoning at all. Octal multiplication makes this point forcefully. It is done in the same way as decimal, but of course uses a different multiplication table. The only difficulty it involves is in ignoring the reflex that produces decimal answers whenever multiplications are presented to the consciousness. It is not hard to see that three times seven makes two eights and five (*st,* pronounced *syt*) ; it *is* difficult to ignore the impulse to write down 21 without thinking.

The octal multiplication table is included in the book, in a form devised by John Napier and known as "Napier's Bones." Its use is not adequately described in either the text or the footnote. It is given better treatment in the *Encyclopedia Britannica* under "Calculating Machines."

In a few places Swedborg himself appears bound by decimal tradition. He gives a table for converting numbers from octonary to decimal, which is simply a catalogue of decimal equivalents. The nature of the octonary system offers a better way to carry out the conversion, using no recorded information beyond the meanings of the eight symbols. The process is to multiply the first digit by eight, add the second, multiply the sum by eight, add the next digit, and so on until the last digit has been added. The example in the book is the conversion of *mntsm,* which would be done in these steps by the above system: 32—35—280—285—2280—2282—18256—18260.

Conversion in the other direction uses the inverse processes. The number is divided by eight and the remainder recorded. Then the quotient from the first division is again divided by eight and the remainder recorded to the left of the preceding one.

This process eventually terminates itself when a quotient becomes zero. The important thing about both these algorithms is that they may be used to convert octonary numbers into *any* other system. There is nothing decimal about them.

It is natural to proceed from octonary to an investigation of other possible systems. Even within the framework of the Hindu-Arabic system (with columns representing powers of the base) there is a system using each integer from two upward. Perhaps the most interesting base is two. This system represents all numbers by means of two symbols. Because of this, it is a very natural one to use in electronic computing machinery. Here at last the exigencies of technical progress have demanded the overthrow of decimal tradition. Binary arithmetic has become a very practical reality within the last three decades (or four octades). And as a result, octonary arithmetic has at last come into its own. Octonary desk calculators are now available, using symbols quite different from Swedberg's: 000 for 0, 001 for 1, 010 for 2, 011 for 3, 100 for 4, 101 for 5, 110 for 6, and 111 for 7. Each key and wheel is actually marked with these triple symbols, so that the machinery is octonary, but the numbers can be read in binary.

Swedberg showed an inkling of this future use for octonary arithmetic. An advantage he mentions is that eight "by halving, could be reduced to its *principium* or *terminum primum,* namely, 1, without the intervention of any fraction." This is mentioned in passing, and subordinated to the consideration that octonary arithmetic was well adapted to the Swedish weights and measures of the time. Examples of this occupy half of the work. But those units have long since been changed. Swedberg is accredited with initiating the change, but not by his work on octonary arithmetic. A year after he wrote this work he anonymously published a tract proposing that the measurements be changed to conform to the decimal system. Thus the purpose for which Swedberg wrote the work very soon ceased to be. The person to whom it was addressed had died. The weights and measures to which it was adapted were changed. The facility of halving the base remained only an interesting abstraction for two centuries, but survived other considerations to become at last a reason for extensive use of octonary arithmetic.

But even the use to the computer industry is not so important as one thing that remains and will remain abstract. The practice in challenging tradition, and retaining only such parts of it as could not be improved by reason, was essential to Swedberg's development as a scientist and his preparation for the task of overthrowing the traditions that obscured the truths of the Christian Church.