each of the proton-donor and proton-acceptor species of phosphate ions. The ratio of these two species, which determines *p*H, will not undergo significant statistical variation, and the concept of *p*H is entirely valid.

Chance (*3*) demonstrated experimentally that "proton noise" was not significant in a single mitochondrion. There is probably no subcellular aqueous compartment recognizable as such, even by electron microscopy, that is so small that the chemical potential of the proton, as expressed by *p*H, would not have a stable value, and for which the concept of *p*H as it applies to large volumes has ceased to have the same validity.

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3. B. Chance, *Nature* **214**, 399 (1967).

Nuclear Energy and Growth

Alvin M. Weinberg recently cited the Club of Rome report (*1*) in defense of his proposed policy for nuclear energy development (Letters, 1 Dec. 1972, p. 933). "The simple fact is that mankind can avoid the catastrophe predicted by the Club of Rome . . . only if an essentially inexhaustible energy source is developed." I protest the use he has made of our findings. On page 131 of our report we ask rhetorically whether the assumption of infinite energy would alter the outcomes projected by our model. While energy is not explicitly included in our model relationships, the effect of unlimited energy can be partially explored through the assumption of effectively infinite resources. The assumption of infinite resources did not alter our general conclusions.

Of much more relevance to the Weinberg-Edsall exchange is that part of our report in which we describe the implications of a long delay between the generation of persistent pollutants and their appearance in the environment. Wherever the delay is long, vast amounts of pollution may be generated before there is any possibility of effective countermeasures by society.

Thus those countermeasures may come too late to avoid unacceptable pollution damage. We have cited the storage of radioactive wastes as a classic example of this problem.

Edsall points to the unrealistic assumption of social stability underlying a nuclear waste storage program. If Weinberg accepts our results, it is interesting that he does not consider the potential impact of a conceivable rapid decline in population on the stability of the social institutions that must be maintained for the protection of radioactive materials. Unsupported promises of "essentially inexhaustible energy" serve only to forestall the social and economic changes which will inevitably be required to bring demographic and material growth into balance with the finite global environment. Our research addressed issues quite removed from this country's energy policy. However, to the extent that our study provides any basis for a choice among alternative energy strategies, we would agree most emphatically with John Edsall and with Hannes Alfvén, "Fission energy does not represent an acceptable solution to the energy problem. It would place an unendurable burden on the safety and health of future generations" (*2*).

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2. H. Alfvén, *Bull. At. Sci.* **28** (No. 5), 5 (1972).

I was careful in my letter to point out that an inexhaustible energy source is a necessary—not a sufficient—condition for mankind's ultimate survival. Obviously many other things, including technologies for dealing with pollution and a degree of social stability, will also be required.

Meadows overestimates the difficulty of radioactive waste disposal in bedded salt. Radioactive wastes are now being sequestered in salt in Germany. To those of us who have been working on the matter, every problem that we have been able to think of—including such long-range questions as ultimate glaciations—seems resolvable. This includes the plugging of man-made holes (through which water might seep), although additional work is needed here.

Meadows characterizes my claim that the nuclear breeder provides an essentially inexhaustible energy source as an "unsupported promise." To the extent that any claim for the far future cannot be proved until that future has arrived, Meadows has a point. On the other hand, we do know that the amount of uranium in the granitic rocks is enormous, and that breeder technology, which is fairly well advanced, makes this all but inexhaustible resource available. I would turn Meadows' argument around and ask him, since he does not consider fission an acceptable solution to the energy problem, to propose some other solution that provides inexhaustible energy and is both technologically and economically more than an "unsupported promise."

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Multidimensioned Matrix

On reading "Switchboard versus statistical theories of learning and memory" by E. R. John (8 Sept. 1972, p. 850), I was reminded of a poem I wrote in 1967.

Old Math

I am a multidimensioned matrix
of unrepeated primes

so

my every intersection is
unique and unequatable

what I want for lunch or
whom I want for president
is indistinguishable from
reaching for a cup of tea
or (should be) touching you

any product of unduplicated primes
can be factored in only one way
no indeterminism
no subjectivity
no ambivalence
no evaluation
no opinion

however

intersections containing composites
could be factored ambiguously as
the structure of the number permits

so

sometimes spaces show
between the primes and
(touching you)
products containing composites
from time to time
get hung up and
in consequence
so do I

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