THE END

Among other things, I am a prophet by profession. That is, I predict the future and get paid for doing so.

There is a catch, of course. I don't cheat, so there is a sharp limit to my usefulness. Since I make no passes over a crystal ball, lack the services of a henchman in the spirit world, have no talent for receiving revelation, and am utterly free of mystic intuition, I can't tell anyone which horse will win the Derby, or whether his wife is cheating on him, or how long he will live.

All I can do is look at the world as steadily as possible (a difficult enough task these days), try to estimate what is happening, and then make the basic assumption that whatever is happening will continue to happen. Once that is done, I can make very limited predictions. I can tell you, for instance, about when the Derby will no longer be run at all, about when it will cease to matter whether anyone's wife is cheating on him, and, most of all, how long all of us (with perhaps inconsiderable exceptions) are going to live.

For instance, I look at the world today and I see people, lots of them. Concerning these people, there are two things to say: (1) there are more people now than there have ever before existed at any one time, and (2) these people are increasing in numbers at a faster rate now than ever before in history.

Just as an example—

In the time of Julius Caesar, the total number of people on Earth was probably something like 150,000,000 and the world

SOURCE: "The End" appeared in *Penthouse*, January 1971.

population was increasing at the rate of perhaps 0.07 per cent per year; or 100,000 per year.

Nowadays, the population is (at latest estimates) 3,650,000,000, or twenty-four times what it was in old Julius' time, and is increasing at a rate of nearly 2 per cent per year, thirty times the ancient percentage rate. The Earth is now gaining people at a rate of 70,000,000 a year, so that it takes us only two years to add to the population a number equal to all those who lived on the planet in the palmy days of Rome.

The question is: What does this mean for the future?

The doom-criers, of whom I am one, cry, "Doom!". The optimists, on the other hand, talk about modern science and the utilization of hybrid grain and fertilizers. They talk of distilling the ocean for fresh water, of fusion energy, and of the colonization of other planets.

Well, why not? Let's grant everything the optimists want and take a look at some figures.

If we accept 3,650,000,000 as the population of the Earth today and allow an average of 100 pounds per person (some are small, some are children), then the total mass of human flesh and blood is equal, at present, to about 180,000,000 tons.

It is also estimated that the number of people on Earth (and therefore the mass of human flesh and blood) is presently increasing at a rate that will cause it to double in thirty-five years.

(Actually, the time it has taken for the population of Earth to double has been decreasing rather steadily through history. In Roman times, the rate of natural increase was doubling the Earth's population only after 900 years. Presumably, we ought to suppose that as time goes on the Earth will continue to double its population in shorter and shorter intervals. However, I will be conservative and suppose that thirty-five years will remain the period of doubling throughout the future.)

Let me then introduce a mathematical equation not because any of you absolutely need it but because, without it, I will be accused of pulling figures out of a hat. The equation is:

$$(180{,}000{,}000)\ 2^{x/35} = y \qquad \text{(Equation 1)}$$

This equation will tell us the number of years, x, it will take to reach a mass of human flesh and blood equal to y, if we start with Earth's present population and double it every thirty-five years. To make the equation easier to handle we can solve for x and we get:

$$x = 115\ (\log y - 8.25) \qquad \text{(Equation 2)}$$

Using this equation, we might ask ourselves the following question, for instance: How many years will it take to increase our numbers to the point where the total mass of humanity equals the total mass of the Universe?

I introduce this question because I assume that no optimist will ever dream of arguing that man can possibly reach this point, so that it will represent an ultimate limit beyond cavil. It may be, of course, that the time it will take to achieve this fantastic end is so long (trillions of years, do you suppose?) that there is no point in discussing it. Well, let's see—

The Universe consists (as a rough estimate) of a hundred billion galaxies, each one containing a hundred billion stars about the size of our own Sun, on the average. The mass of the Sun is about 2.2 billion billion billion tons, so the mass of the known Universe in tons (throwing in some extra mass to allow for planets, interstellar dust and so on) is perhaps the figure 3 followed by fifty zeros (or 3×10^{50} in mathematical lingo.) If we set this equal to y in Equation 2, then log y is equal to 50.48. Subtract 8.25 from this and multiply the difference by 115 and we find that x is equal to 4,856.

What this means, in turn, is that at the present rate of increase in human population, the mass of humanity will equal the mass of the known Universe in 4,856 years, so that by A.D. 6826 we reach absolute dead end.

A period of 4,856 years is long, certainly, in comparison to an individual life, but if it takes only that much time to run out of Universe (rather than the trillions of years that might have been suspected), then there has to be the queasy feeling that the actual limit will come much sooner. After all, even the most starry-eyed idealist wouldn't think we could colonize all the planets of all the stars of all the galaxies—let alone convert the stars themselves into food—all in the next few thousand years.

Actually, during that period of time, we are almost certain

to be confined to the planet Earth. Even if we colonize the rest of the solar system, it is beyond hope that we can actually transfer sizable portions of the human population to such forbidding worlds as the Moon and Mars.

So suppose we ask ourselves how long it will take (at the present rate of human increase) for mankind to attain a mass equal to no more than that of the single planet Earth. The Earth's mass is 6,600 billion billion tons, and if that is taken as y, then log y is 21.82. Throwing that into the equation, we find that x equals 1,560.

In 1,560 years, at the present rate of increase; that is, by A.D. 3530, the mass of humanity will be equal to the mass of the Earth. Will any optimist in the audience raise his hand if he thinks that mankind can possibly achieve this under any circumstances?

Let's search for a more realistic limit, then. The total mass of living tissue on Earth today is estimated to be something like twenty million million tons, and this cannot really increase as long as the basic energy source for life is sunlight. Only so much sunlight reaches Earth; only so much of that sunlight can be used in photosynthesis; and therefore only so much new living plant tissue can be built up each year. This amount built up is balanced by the amount that is destroyed each year, either through spontaneous death or through consumption by animal life.

Animal life may be roughly estimated as one tenth the mass of plant life or about two million million tons the world over. This cannot increase either, for if, for any reason, the total mass of animal life were to increase significantly, the mass of plants would be consumed faster than it could be replaced, as long as sunlight is only what it is. The food supply would decrease drastically and animals would die of starvation in sufficient numbers to reduce them to their proper level.

To be sure, the total mass of *human* life has been increasing throughout history, but only at the expense of other forms of animal life. Every additional ton of humanity has meant, as a matter of absolute necessity, one less ton of non-human animal life.

Not only that, but the greater the number of human beings,

the greater the mass of plants that must be grown for human consumption as food (either directly, or indirectly by feeding animals destined for the butcher) or for other reasons. The greater the mass of grains, fruits, vegetables, and fibers grown, the smaller the mass of other plants on the face of the Earth.

Suppose we ask, then, how many years it will take for mankind to increase in numbers to the point where the mass of humanity is equal to the present mass of all animal life? Remember that when that happens there will be no other animals left—no elephants or lions, no cattle or horses, no cats or dogs, no rats or mice, no trout or crabs, no flies or fleas.

Furthermore, to feed that mass of humanity, all the present mass of plant life must be in a form edible to man; which means no shade trees, no grass, no roses. We couldn't afford fruits or nuts because the rest of the tree would be inedible. Even grain would be uneconomic, for what would we do with the stalks? We would most likely be forced to feed on the only plants that are totally nutritious and that require only sunlight and inorganic matter for rapid growth—the one-celled plants called algae.

Well then, if the total mass of animal life is two million million tons, log y equals 12.30 and x works out to 466. This means that by A.D. 2436 the last animal (other than man) will have died, and the last plant (other than algae) will also have died.

By A.D. 2436 the number of human beings on Earth will be forty trillion or over eight thousand times the present number. The total surface of the Earth is equal to about 200,000,000 square miles, which means that by A.D. 2436 the average density of the human population will be 200,000 per square mile.

Compare this with the present density of Manhattan at noon—which is 100,000 per square mile. By A.D. 2436, even if mankind is spread out evenly over every part of the Earth—Greenland, the Himalayas, the Sahara, the Antarctic—the density of population will be twice as high *everywhere* as it is in Manhattan now.

We might imagine a huge, world-girdling complex of high-rise apartments (over both land *and* sea) for housing, for offices, for industry. The roof of this complex will be given over entirely to algae tanks containing an ocean of water, literally,

and twenty million million tons of algae. At periodic intervals there will be conduits down which water and algae will pour, to be separated, with the algae dried, treated, and prepared for food, while the water is returned to the tanks above. Other conduits, leading upward, will bring up the raw minerals needed for algae growth, consisting of (what else?) human wastes and finely chopped up human corpses.

Even this limit, quite modest compared to the earlier suggestions of allowing the human race to multiply till its mass equaled that of the Universe or merely that of the Earth, is quite unbearable. Where would we find any optimist so dead to reality as actually to believe that in a space of four and a half centuries, we can build a planetary city twice as densely populated as Manhattan.

To be sure, all this is based on the assumption that the increase in human population will continue at its present rate indefinitely. Clearly, it won't. Something will happen to slow that growth, bring it to an utter halt, even reverse it and allow the human race to decrease in numbers once more. The only question is what that "something" will be.

To any sane person it would surely seem that the safest way of bringing this about is a worldwide program for the voluntary limitation of births; with the enthusiastic participation of humanity as a whole . . .

Failing this, the same result will inevitably be brought about by an increase in the death rate—through famine, for instance.

The question is: How much time do we have to persuade the people of Earth to limit their births?

Anyone, however optimistic, can see that global birth control will not be achieved easily. There are stumbling blocks. There are important religious bodies who object strongly to the utilization of sex for pleasure rather than for progeny. There are long-standing sociological traditions that equate many children with strong national defense, with help around the farm and home, with security in parental old age. There are long-standing psychological factors which equate many children with a demonstration of masculine virility and wifely duty. There are new nationalist factors which cause minority groups

to view birth control as a device to limit *their* numbers in particular, and to view unlimited births as a method for outbreeding the establishment and "taking over."

So how much time do we have to counter all this?

If it were a matter of population alone, we might argue that even if things went on exactly as they are, science would keep us going for 466 years anyway, till man was the only form of animal life left on Earth.

Unfortunately, it isn't a matter of population alone. There are factors in our technological society which are multiplying at a more rapid rate than population is and which introduce further complications.

There is the matter of energy, for instance. Mankind has been using energy at a greater and greater rate throughout his existence. Partly this reflects the steady increase in his numbers; but partly this also reflects the advance in the level of human technology. The discovery of fire, the development of metallurgy, the invention of the steam engine, of the internal-combustion engine, the electric generator, all meant sharp increases in the rate of energy utilization beyond what could be accounted for by the increase in man's numbers alone.

At the present moment, the total rate of energy utilization by mankind is doubling every fifteen years, and we might reasonably ask how long that can continue.

Mankind is currently using energy, it is estimated, at the rate of 20,000,000,000,000,000,000 (20 billion billion) calories per year. To avoid dealing with too many zeros, we can define this quantity as one "annual energy unit" and abbreviate that as AEU. In other words, we will say that mankind is using energy, now, at the rate of 1 AEU a year. Allowing a doubling every fifteen years and using an equation similar to that of Equation 2 (which I will not plague you with, for by now you have the idea), you can calculate the rate of energy utilization in any given year and the total utilization up to that year.

Right now, the major portion of our energy comes from the burning of fossil fuels (coal, oil, and gas), which have been gradually formed over hundreds of millions of years. There is a fixed quantity of these and they cannot be re-formed in any reasonable time.

The total quantity of fossil fuels thought to be stored in the Earth's crust will liberate about 7500 AEU when burned. Not all that quantity of fuel can be dug or drilled out of the Earth. Some of it is so deep or so widely dispersed that more energy must be expended to get it than would be obtained from it. We might estimate the energy of the recoverable fossil fuels to be about 1000 AEU.

If that 1000 AEU of fossil fuels is all we will have as an energy source, then, at the present increase of energy utilization, we will have used it up completely in 135 years; that is, by A.D. 2105. If we suppose that those reserves of fossil fuel which seem unrecoverable now will become recoverable in the next century or so, then that will give us about forty-five years more at the ever increasing rate and we will have till A.D. 2150.

Of course, it is not fossil fuels only that we can work with. There is energy to be derived from nuclear fission of uranium and thorium. The total energy from recoverable fission fuel is uncertain, but it may be a hundred times as great as that from fossil fuels, and that will give us 135 years more and carry us to A.D. 2285.

In other words, in 315 years, or a century and a half *before* we have reached the ridiculous population limit of having mankind the only form of animal life, we will have utterly run out of the major energy sources we use today—assuming things continue as they are going.

Are there other sources? There is sunlight, which brings Earth 60,000 AEU per year, but we'll need that for the algae tanks.

There is fusion power, the energy derived from the conversion of the heavy hydrogen atoms (deuterium) of the oceans to helium. If all the deuterium of the ocean were fused, the energy released would be equal to 500,000,000,000 AEU, enough to keep us going comfortably, even at an endlessly accelerating rate, to a time well past the population limit of the planetary double-Manhattan. (It will bring about a problem as to what to do with all the heat that will be developed—thermal pollution—but there are earlier worries.)

Energy will not be the real limit of mankind, *if* we can harness controlled fusion in massive quantities. We haven't done

it yet, but we're on the trail and presumably will do it eventually. The question now is: How much time do we have to make fusion possible, practical, and massive?

We ought to do it before our supply of fossil and fission fuels gives out, obviously, and that means we will have 315 years at most (unless we manage to limit population and energy utilization before then).

That sounds like time enough, but wait. The utilization of energy is inevitably accompanied by pollution, and the deterioration of the environment through a rate of pollution that will double every fifteen years may bring a limit much sooner than that imposed by the disappearance of energy sources.

But we want to deal only with the inevitable. Suppose we bring pollution under control. Suppose we block the effluent of chemical industries, control smoke, eliminate the sulfur in smoke and the lead in gasoline, make use of degradable plastics, convert garbage into fertilizer and mines for raw materials. What then? Is there any pollution that cannot possibly be controlled?

Well, as long as we burn fossil fuels (and only so can we get energy out of them) we must produce carbon dioxide. At the moment, we are adding about 8 billion tons of carbon dioxide to the atmosphere each year by burning fossil fuels. This doesn't seem like much when you consider that the total amount of carbon dioxide in the atmosphere is about 2,280 billion tons or nearly 300 times the quantity we are adding per year.

However, by the time all our fossil fuel is gone, in A.D. 2150, we will have added a total of 60,000 billion tons of carbon dioxide to the atmosphere or better than twenty-five times the total quantity now present in the air. A little of this added supply might be dissolved in the oceans, absorbed by chemicals in the soil, taken up by a faster-growing plant life. Most, however, would remain in the atmosphere.

By A.D. 2150, then, the percentage of carbon dioxide in the air would rise from the present 0.04 per cent to somewhere in the neighborhood of 1 per cent. (The oxygen content, five hundred times the carbon dioxide, would be scarcely affected by this change alone.)

This higher percentage of carbon dioxide would not be enough to asphyxiate us, but it wouldn't have to.

Carbon dioxide is responsible for what is called the "greenhouse effect." It is transparent to the short waves of sunlight, but is relatively opaque to the longer waves of infrared. Sunlight passes through the atmosphere, reaches the surface of the Earth and heats it. At night, the Earth re-radiates heat as infrared and this has trouble getting past the carbon dioxide. The Earth therefore remains warmer than it would be if there were no carbon dioxide at all in the atmosphere.

If the present carbon dioxide content of the atmosphere were merely to double, the average temperature of the Earth would increase by 3.6° C. We might be able to stand the warmer summers and the milder winters but what of the ice caps on Greenland and Antarctica?

At the higher temperatures, the ice caps would lose more ice in the summer than they would regain in the winter. They would begin to melt year by year at an accelerating pace and the sea level would inexorably rise. By the time all the ice caps were melted, the sea level would be at least 200 feet higher than it is and the ocean, at low tide, would lap about the twentieth floor of the Empire State Building. All the lowlands of Earth, containing its most desirable farmland and its densest load of population, would be covered by the rolling waters.

At the rate at which fossil fuels are being increasingly used now, the ice caps will be melting rapidly about a century from now. To prevent this, we might make every effort to switch from fossil fuel to fission fuel, but in doing that, we would be producing radioactive ash in enormous quantities and that would present an even greater and more dangerous problem than carbon dioxide would.

The outside limit of safety, thanks to pollution, no matter *what* we do (short of limiting population and energy consumption) is only a hundred years from now. Unless we develop massive fusion power by 2070, the face of the Earth will be irremediably changed, with enormous damage to mankind.

But do we even have that century in which to maneuver if we don't limit population?

It is not just that population is increasing, but that it is growing ever more unbalanced. It is the cities, the metropolitan agglomerates, that are increasing their loads of humanity, while the rural areas are, if anything, actually decreasing in population. This is most marked in the industrialized and "advanced" areas of the world, but it is making itself felt everywhere, with increasing force, as the decades slip by.

It is estimated that the urban population of the Earth is doubling not every thirty-five years, but every *eleven* years. By A.D. 2005, when the Earth's total population will have doubled, the metropolitan population will have increased over ninefold.

This is serious. We are already witnessing a breakdown in the social structure; a breakdown that is concentrated most strongly in just those advanced nations where urbanization is most apparent. Within those nations, it is concentrated most in the cities, and, in particular, in the most crowded portions of those cities.

There is no question but that when living beings are crowded beyond a certain point, many forms of pathological behavior become manifest. This has been found to be true in laboratory experiments on rats, and the newspaper and our own experience should convince us that this is true for human beings, also.

Population has been increasing as long as the human race has existed, but never at the present rate, and never under conditions of such fullness-of-Earth. In past generations, when a man could not stand the crowds, he could run away to sea, emigrate to America or Australia, move toward the frontier. But now the Earth is filled up and one can only remain festering in the crowds, which grow ever worse.

And does social disintegration increase merely as the population increases, or as the level of urbanization increases? Will its level double only every thirty-five years or even only every eleven years? Somehow, I think not.

I suspect that what counts in creating the kind of troubles we see about us—the hostilities, angers, rebellions, withdrawals—is not just the number of people swarming about each individual, but the number of interactions possible between an individual and the people swarming about him.

For instance: if A and B are in close proximity, they may possibly quarrel; but an A–B quarrel is all that is possible. If A, B, and C are all in close proximity, then A may quarrel with B or with C; or B may quarrel with C. Where two individuals may have only one two-way quarrel, three individuals may have three different quarrels of this sort, and four individuals, six different quarrels.

In short, the number of possible interactions increases much more rapidly than the mere number of people crowded together does. If the metropolitan areas increase ninefold in population by the year 2000 then I suspect that the level of social disorder and disintegration will increase (at a guess) fiftyfold, and I feel pretty sure that society will not be able to bear the load.

I conclude, then, that we have only the space of the next generation to stop the population increase and reorganize our cities to prevent the pathological crowding that now occurs. We have thirty years—till A.D. 2000—to do it in and that estimate is rather on the optimistic side, if anything.

Unfortunately, I don't think that mankind can fundamentally alter its ways of thinking and acting within thirty years, even under the most favorable conditions; and the conditions are far from favorable. As it happens, those who dominate human society are, generally, old men in comfortable circumstances, who are frozen in the thought patterns of a past generation, and who cling suicidally to the way of life to which they are accustomed.

It seems to me, then, that by A.D. 2000 or possibly earlier, man's social structure will have utterly collapsed, and that in the chaos that will result as many as three billion people will die.

Nor is there likely to be a chance of recovery thereafter, for in the chaos, the nuclear buttons are only too apt to be pushed and those who survive will then face an Earth which will probably be poisoned by radiation for an indefinite period into the future.

And as far as human civilization is concerned, that will be

THE END

AFTERWORD

Articles like the foregoing qualify me for the title of "doom-crier." That word is usually used in a derogatory sense, but I accept it cheerfully. When I foresee doom, I intend to cry it. The doom won't be averted by looking the other way, I assure you; it will, rather, be hastened.

Sometimes people ask why doom-criers don't make constructive suggestions. Well, they do; or at least, I do. All you have to do is look at the next article, which, by the chances of the game, hit the newsstands at the same time as the foregoing (although in a different magazine).