THE YEAR 2000

Brownlee Haydon

March 1967

THE YEAR 2000

Brownlee Haydon *

The RAND Corporation, Santa Monica, California

If I live to be as old as my father, I will live to see the year 2000.

As I look around me, I see that most of you, with reasonable luck and a certain amount of good behavior, will also live that long.

At the beginning of this century, life expectancy for the average American male was about 46 years. By 1950, this had risen to 65 years. At the rate life expectancy is rising, and considering how much above average you are in income and standard of living, if you are now between 40 and 50 you can probably expect to peer, with dwindling interest, into the next century.

* * *

Never before in history has man been able to look as far into the future as he can today, and with as much confidence that he will have something to say about what his future will be like.

No longer does he scan the heavens for signs.

The author, who is Assistant to the President, Communications, presented this paper to the Chevrolet Academy at Wayne State University, Detroit, March 2, and March 23, 1967.

The future is in his hands, in his work, here on Earth.

You may recall from Shakespeare, the conversation between Brutus and Cassius who were trying to explain Caesar's greatness and power:

> Men at some time are masters of their fates:
> The fault, dear Brutus, is not in our stars,
> But in ourselves, that we are underlings.*

Earliest man looked to the stars for portents of things to come, and read ominous warnings in eclipses, earthquakes, and droughts.

The art of foretelling the future lay primarily in the hands of the priests and soothsayers.

In Ancient Greece, as early as the 7th Century B.C., the gods spoke to men about their fate through the priests at Delphi.

Although much has been written to show that the benign guidance of these priests helped establish the Greek Empire, and even led to ethical and moral reforms, the Delphic Oracle was really an elaborate con game.

We now know that during the month-long waiting period imposed upon those who came to Delphi for advice, an elaborate intelligence game was conducted to assist the priests in giving good answers. And when this trick was found out, and applicants began to give false information

* Julius Caesar (I.ii.136)

to mislead the priests, messengers were dispatched to their home towns to gather information that would help the priests make more plausible predictions.

So much for the past.

Today you can open the newspaper almost any day and read some startling prediction about the future.

A few samples:

"Sea Living for Humans Envisioned"

(In the years to come, [the story reads,] many young Americans may go to school for weeks on end in watertight, pressurized 'campuses' built on the bottom of the sea.--UPI 1-23-67 Petroleum Today article reported in L.A. Times.)

"Driverless Auto Seen Available in 15 Years"

(Ohio State, Dr. Robert Cosgriff. 12-11-66 LA Times)

"Good Soil in the Arctic"

(Cover barren ground with black cracked asphalt, raise temperature, lengthen growing season. Toronto Globe & Mail, 2-7-67.)

"Food from Crude (Petroleum) May Feed the World."

(Standard of N.J. & Nestlé Alimentana S.A., pilot plant and animal tests of proteins from petroleum. Toronto Globe & Mail, 1-30-67.)

The future has become so much a part of our present that it has become respectable to speculate on almost any trend or tendency.

Scholars of great eminence, supported both by the foundations and by the Government, are seriously engaged in attempts to foresee the future.

Did you know that there is a World Future Society in this country, and that it publishes a "Newsletter for Tomorrow's World" called The Futurist.

The American Academy of Arts and Sciences has appointed a 31-man Commission on the Year 2000. It began its work in 1965, and has already held several seminars; its speculations will soon be made public in a book.

An Institute for 21st Century Studies has been formed at Ball State Teachers College, Muncie, Indiana.

Mankind 2000 has offices in Vienna, London, and The Hague. Bertrand de Jouvenel, the distinguished French scholar, has formed an organization

called "Futuribles"--which may be translated "possible futures"--that is supported in part by Ford Foundation money.

I have a list of two dozen more organizations and institutes that have come into being during the last decade to conduct studies of the future.

Lest you think that this is the work of crackpots, let me make a general statement, and illustrate it with some examples:

There is probably no major industrial or business organization that does not have a long-range planning group at the very highest level of management.

For example, the General Electric Company created a long-range planning group 10 years ago in Santa Barbara. It is called TEMPO. Westinghouse has a long-range planning group. Every major automobile manufacturer has long-range planners reporting to top management. A few months ago a major publisher of magazines visited RAND to talk to our professional staff about whether there will even be printed magazines by the end of the century.

Otis Chandler, publisher of the Los Angeles Times, was recently quoted as saying:

"...a quarter of a century hence the daily newspaper as we know it may have ceased to exist, possibly being replaced by some kind of teleprinter device in the home."

Even the New York Times, a fairly conservative paper, has created a Committee on the Future, staffed by senior editors. Says the Times: "It sits as a kind of Delphic Oracle, peering through the tightly woven fabric of the future."

* * *

There are two good reasons why it is important for man to look into the future.

First, he may identify things he is now doing that he must stop doing if he is to survive at all, or have a world worth living in. I will cite some examples later.

Second, he must project as far into the future as he can some of the things he may be considering doing, or may do accidentally, to see whether these will have serious and perhaps irreversible consequences for the welfare of mankind. I will give some illustrations in a few moments.

Before I try to select a few characteristics of the world of 2000, and explain how they are derived, and how they may affect you, it may be useful to say something about the art of conjecture.

At the one extreme, probably the most unreliable, is the crystal ball. You can buy one in any magic shop and do about as well as the local gypsy.

At the other extreme is the computer-equipped scientist who tells you with self-claimed infallibility how some trend is likely to go, complete to several decimal places.

We would be well-advised to ignore both of these extremists.

In between are the scholarly specialists who write wisely about alternative states of the world as they project interacting trends forward in time, taking into account the uncertainties inherent in basic assumptions that must underly all predictions. If you read their conjectures, including the footnotes and the qualifying phrases, you can accept most of what they say. And having examined their premises, formed some estimate of their sensibleness, you can decide for yourself whether the ideas are overcautious or far-fetched.

Still another way of looking at the future has been developed by colleagues of mine at The RAND Corporation, Drs. Olaf Helmer and Norman Dalkey.

Twenty years ago, they suggested that it might be possible to get a better notion of what lies ahead if you ask a panel of experts to give their opinions. The idea is inherently logical, but it attracted little attention at the time. They made a few pilot tests that satisfied them that the idea had promise. Helmer and Dalkey call this the "Delphi technique."

A few years ago, a study of long-range forecasting was undertaken at RAND, under the guidance of Dr. Helmer and Ted Gordon of Douglas Aircraft.

Despite anything you may have read in the newspapers about the future depicted by this study, it was undertaken to test a refinement in the Delphi technique and not as an attempt to predict a future world. Their predictions were merely an interesting by-product of the study.

This study involved more than 80 experts--engineers, mathematicians, economists, physical scientists, social scientists, writers, and so on. They were placed in panels to examine the future in six areas: scientific breakthroughs, population growth, automation, space progress, the probability and prevention of war, and future weapon systems.

The participants were given questionnaires and their anonymous predictions were reported to their fellow panelists. Each was then given an opportunity to alter his own predictions. Along the way, each was asked to justify his ideas. This was done several times. Through this feedback, an attempt was made to obtain consensus. Through the exchange of information there was an appeal to logic and reason, but because the panelists remained anonymous there was no appeal to authority.

Let's begin our survey of the Year 2000 by noting what these panels of experts thought about the world of 1984. (If we were to jump to the year 2000 we would leave out some interesting things we can expect to encounter during the next 30 years.)

By 1984--

o transplantation of natural organs and implantation of artificial (plastic and electronic) organs will be common practice. Personality-changing drugs will be widely used.

o Sophisticated teaching machines will be in general use.

o Automated libraries, which look up and reproduce relevant materials, will greatly aid research. We will have automatic translating machines, coupled with universal satellite relay systems for world-wide communication.

o In space, a permanent lunar base will have been established. Manned Mars and Venus fly-bys will have been undertaken. Deep-space laboratories will be in operation. New sources of power will be available using solid-core nuclear reactors and ion engines.

o In the military arena, we can expect advances in non-lethal biological and chemical agents, lightweight rocket-type personnel armament, small tactical nuclear weapons, and direct-energy weapons of various sorts. Anti-submarine warfare techniques will have been devised, but improved, deep-diving and hard-to-detect submarines will present new problems.

All that is <u>on the road</u> to the Year 2000.

For that year, the Delphi panels arrived at a consensus on the following:

- The world's population will have risen from 3.3 to 5.1 billion.

- New food sources will have been opened up through large-scale ocean farming and the fabrication of synthetic protein.

- Controlled thermonuclear power will be a new source of energy. New mineral raw materials will be derived from the oceans. Regional weather control will be past the experimental stage.

- General immunization against bacterial and viral diseases will be available. Primitive forms of artificial life will have been generated in the laboratory. The correction of hereditary defects through molecular engineering will be possible.

- Automation will have advanced farther, from doing many menial chores to performing some rather sophisticated high-IQ functions. A universal language will have evolved through automated communication.

- On the Moon, mining and manufacture of propellant materials will be in progress. Men will have landed on Mars, and permanent unmanned research stations will have been established there, while on Earth, commercial global ballistic missile transport will have been instituted.

o Weather manipulation for military purposes will be possible. Effective anti-ballistic missile defense in the form of air-launched missiles and directed energy beams will have been developed.

Since you may have found one or more of these predictions a little hard to accept, let me remark that I would probably agree with you. Remember, we are dealing with a consensus of experts, and the experts have often been wrong.

At the turn of the present century, even the most distinguished of scientists felt that anyone who tried to build an airplane was a fool. The great American astronomer, Simon Newcomb, wrote:

> "The demonstration that no possible combination of known substances, known forms of machinery, and known forms of force, can be united in a practical machine by which man shall fly long distances through the air, seems to the writer as complete as it is possible for the demonstration of any physical fact to be."

Even after the first airplanes were flying, William H. Pickering, another astronomer, wrote:

> "The popular mind often pictures gigantic flying machines speeding across the Atlantic and carrying innumerable passengers in a way analogous to our modern steamships....It seems safe

to say that such ideas must be wholly visionary, and even if a machine could get across with one or two passengers the expense would be prohibitive..."

Twenty years ago, Dr. Vannevar Bush, civilian chief of the U.S. scientific war effort, was not impressed with the performance of the German V-2 rockets. He told Congress:

"There has been a great deal said about a 3,000 mile high-angle rocket. In my opinion such a thing is impossible for many years. The people who have been writing about these things that annoy me, have been talking about a ... rocket shot from one continent to another, carrying an atomic bomb.... I say, technically, I don't think anyone in the world knows how to do such a thing...."

I think this is a lesson that applies both to those who are certain that something is <u>impossible</u>, as well as to those who are sure that something <u>will</u> happen.

I could entertain you for quite a while with just an enumeration of things that <u>may</u> be possible by the Year 2000. I would prefer, however, to discuss a few of the problems that advancing technology--as well as the blind processes of Nature--pose for civilized man.

Probably the most serious problem of all is over-population. This is a problem that in my view will either be solved by the use of common sense, aided by science, or by famine, plague and war, or by a combination of all three.

Dr. Lloyd Berkner, distinguished physicist and mathematician, writing in the Bulletin of the Population Reference Bureau, makes a simple projection of available food supply (measured in calories), and world population, and calculates how much each of us will have to eat. Like all such projections, it makes some simplifying assumptions. On balance, I think it makes sense, however.

World food supply has been rising at an average rate of 1 per cent per year, while world population has been rising at about 1.8 per cent per year.

In 1965, Dr. Berkner says, the 7 trillion calories divided among 3.3 billion persons allows an average of 2,121 calories per person per day. (You and I had more than that, but several million persons die each year of starvation, too. We are talking about averages.)

By 1980, some 8.1 trillion calories divided among 4.5 billion persons would give each an average of 1,800 calories daily.

By 1990, food production would have increased to nearly 9 billion calories, but each of the 5.7 billion persons would get only 1,575 calories a day.

By the Year 2000, with food production up to 9.9 trillion calories, and a world population of 7.4 billion, the average amount per person would be only 1,340 calories a day--not enough to sustain life. Since we know that this calorie output would not be properly balanced among starches, proteins, and fats, and certainly unevenly distributed, we can be sure that long before the Year 2000 there would be widespread starvation, disease, and revolution--unless population growth is slowed.

Fortunately, there are signs that such projections are more alarming than real. Man is not stupid, and there are ways to increase the world's food production and to slow population growth. Faced with the hard realities of famine, we may be sure that drastic actions can and will be taken.

But you will hear arguments on both sides, for years to come. Those who believe it is easy to produce enough food to feed twice or ten times the number of persons alive today will argue, as the director of the Stanford Food Research Institute does, against birth control and against making other nations into "sex clinics." Some people would rather control population than eat a diet that includes proteins made from oil.

A government researcher in the Bureau of Commercial Fisheries has estimated that the oceans can feed 10 times the present world population.

He believes that the ocean harvest can be increased from the 54 million metric tons of 1964 to a steady annual rate between 500 million to 2 billion metric tons--without depleting the ocean's stocks.*

Straight-line extrapolation into the future is dangerous and misleading. For example, take this line of reasoning:

In 1900, the United States could count only one scientist-engineer for every 1800 persons in the population.

By 1950, the ratio had fallen to one scientist for every 300 persons.

It is predicted that the ratio will be one-to-ninety in 1980, and one-to-forty in the Year 2000.

At that rate, it seems clear, everyone will be a scientist sometime in the next century. But that is plain nonsense.

The President of the National Academy of Science predicted in 1963 that by the end of the century--by 2000--our nation might be devoting from one-fourth to one-half of its gross national product to research and development. This simple-minded--and obviously wrong conjecture--was obtained by making a straightline projection based on the recent rate of growth in R & D expenditures.**

---

* Science News--2-18-67

** F. Seitz, Physics Today 16, No. 12, 29 (1963).

In the 1967 report of the President's Council of Economic Advisors there is this breathtaking sentence:

"If the American economy continues to grow at 4 per cent a year, output will double in 18 years, triple in 28, quadruple in 35."

Translated into dollars, that would mean that gross national product, which was 740 billion in 1966, would be 1 trillion dollars in 1972, and by the year 2000 would be nearly 3 trillion dollars!

You can make equally wild conjectures by drawing most trend lines far enough into the future, whether it is crime statistics or the divorce rate. The truth is, circumstances change and we must use judgment in projecting trends. Furthermore, we must look for interactions between competing futures, and make decisions with respect to actions we may take to affect the outcomes.

I mentioned earlier two compelling reasons for looking into the future as far as we can see:

- To detect danger signals, so that we can begin to take actions to forestall unpleasant events or conditions, and,
- To avoid making some foolish mistakes.

Let me give some examples.

In the first category, let us consider the use of pesticides. Most of us were brought to an awareness of this potential hazard to mankind by Rachel Carson's Silent Spring. I do not intend to take sides on this matter, but merely cite the issue it involves as one that must be seriously examined to guarantee that we do not do things today we will forever regret.

We are as yet profoundly ignorant of the effects of our use of pesticides, in the broadest sense. We know that they make their way into the rivers and are carried to the oceans. Here they are concentrated by the tiny single-celled algae known as diatoms, which are eaten by fish. We already know that some fish are loaded with pesticides--we don't know whether this is bad for them or us. But we also know that our supply of atmospheric oxygen comes largely from diatoms; in fact, they replenish all of the atmospheric oxygen every 2000 years as it is used up. So we must worry a little, at least, about whether the use of pesticides is reducing our supply of diatoms or forcing the evolution of less productive mutants, because we might be starting to run out of atmospheric oxygen.

That's one way our atmosphere could become lethal. Another way is for us to contaminate it. One meteorologist has gone so far as to predict that by the year 2025 the air will be so polluted that we will all die of asphyxiation. I don't take that kind of prediction seriously and neither should you.

What it does is sound an alarm. It tells us that we must act now if we are to avert a serious crisis later.

You are aware that more than one forecast has been made that the days of the internal combustion motor are numbered--that it will be replaced by the electric car, and sooner than most persons think.

We know that the automobile and the refineries are prime contributors to smog, but not the only ones. We also know that the primitive control devices now in use are inadequate. It is a local joke that researchers at General Motors who are studying smog must first filter the air they use in their experiments before mixing it with automobile exhaust and irradiating it with solar ultraviolet.

We know that polluted air is bad for people, plants, and materials. We know that it has changed the weather over urban areas, but we do not yet understand completely how or how much it is affecting our climate, or the balance of nature.

o A European moth, found in the industrial city of Birmingham, England, has changed from light to dark in color in the last century, to better match its smokey environment and escape preying birds.

o Many precious statues, of limestone and marble, are being slowly destroyed by the sulfur dioxide in urban air--the SO_2 is oxidized

and hydrated into sulfuric acid which attacks the stone. Somewhat similar processes are at work on the priceless frescoes in the churches of Italy and France.

o Last but not least, we know that urban air carries hazards to health. We do not yet know whether or in what way it may be related to cancer, asthma, emphysema, and bronchitis, but we suspect a connection.

We are told that air pollution affects 6000 communities now. We are told that by the end of the century pure air may be one of our scarcest resources.

What this means, of course, is that we must do something, and do it soon, if we are to have an atmosphere that is fresh and healthful in the year 2000.

Let me read a few passages from a column by a science editor in the Los Angeles Times :*

> "If man wants to go on living on the Earth he is going to have to stop burning fossil fuels (coal, oil, gasoline, etc.) and do so almost completely and almost at once."

He said nuclear reactors must be substituted for the coal, oil, and gas furnaces that operate factories and power plants today.

* March 2, 1967

Most important, the internal combustion engine--the basis of the automotive civilization of present day North America & Europe, must be abolished.

Trying to control the emissions--by adding devices to engines or improving the efficiency of burning--will not work.

* * *

Driving an automobile 25 miles--uses up more breathable air than 7,000,000 people will use in the same period of time--

Carbon dioxide in the atmosphere will be 25% greater in the year 2000 than now.

We are told that we must substitute nuclear reactors for fossil fuel energy sources--well--

The prospect of new and more efficient nuclear power sources carries with it both a promise and a threat.

On the one hand, advancing technology promises unlimited power from plutonium-fueled fast-breeder reactors that produce more plutonium than they consume in the generation of energy. In addition to cheap, virtually inexhaustible supplies of energy, there will be an enormous and rapidly increasing amount of plutonium wherever electrical power is generated. This poses the threat of more and more countries, large and small, with the capability of producing nuclear weapons.

Note that our use of fuels and pesticides, and their ultimate effect on our supply of atmospheric oxygen, are just two major contributors to the problem of air pollution. Any study of the future of our mantle of air, its interactions with the oceans and plant life, and of future climate, must consider these interrelationships as a dynamic system.

In the days of river transport, when waterwheels gave power, and even the railroads followed the rivers, where else would one put mills and factories and build cities but in valleys. But now we realize that these valleys are the worst possible places from which to disperse the aerial wastes of our homes and factories. We should have put them on the tops of mountains.

As man increases his ability to control his environment it becomes more and more necessary to take care not to do something foolish.

As an extreme example, Dr. Fritz Zwicky of Caltech, has remarked that if we try to harness the tides as a source of power we may eventually slow down the rotation of the Earth and change the length of the day.

Consider weather control. The cloud systems and oceanic currents in the atmosphere, which we are only beginning to understand through study of satellite photographs, are the final determinants of weather on the Earth. A satellite in polar orbit can examine every point on the Earth twice a day. Any attempts to increase rainfall in one part of the country may have negative effects in another part of the country, or of the world.

Consider the legal implications of diverting a hurricane from Miami, for example, and having it hit Bermuda. Even when you give one Iowa farmer some rain you may very well ruin the gate at the County Fair.

From time to time it has been suggested that the Arctic ice-cap might be melted--either by diverting warm ocean currents or by depositing a heat-absorbing dust on the surface of the ice. This is a feat that is within our power to do today. But what might the consequences be?

In addition to making the Arctic a navigable sea, which might please the Russians and Canadians, something worse could happen. A study made at RAND has shown in some detail how the ice-cap contributes to the heat budget of the Northern hemisphere, and indicates that if the cap is removed the climate of Northern Canada would be affected in such a way that we might see the start of a new Ice Age, with the formation of glaciers near Hudson's Bay.

How do we reach such conclusions? With the aid of the computer it has been possible to calculate the implied changes in the Arctic weather and to run the clock ahead hundreds of years to see what will happen. And unless there is an error in the starting assumptions, it seems likely that we would not want to fool around with the ice-cap.

To illustrate how delicate a mechanism we are dealing with, it turns

out that the ice-cap is generally about 10 feet thick, although it sometimes is only about 5 feet thick in mid-summer. Observe that this normal variation represents a 50 per cent change in thickness of the ice. It might not take much to go the rest of the way.

You will find that most meteorologists and climatologists take a very conservative view of weather modification. They are only too aware that some act of man may begin a process that could not be reversed and that might have unpredictable consequences for life on the Earth.

And just to make life interesting, there are those who believe that our continuously rising use of hydrocarbon fuels is gradually overpowering the ability of the oceans to recapture the chemicals, and predict a slowly rising temperature and eventual loss of both polar ice-caps--and the flooding of low lying coastal plains and cities.

So, air pollution--if it doesn't kill us directly, may gradually turn the Earth into a swamp.

The future role of the computer is a familiar topic of speculation. Although this instrument is a relative newcomer to the field of technology, its growth has been spectacular. Comparing today's computer with a 1953 machine, we find it is a ten times smaller, a hundred times lighter, and makes calculations 1000 times as fast. And the amount of computer power in the United States has been doubling every year in recent years.

With this universal tool becoming so easily available and cheap, many persons predict a drastic change in family life. The man of the house may be able to do much of his work at home, with a computer console in his study. The housewife may be ordering groceries and other amenities from central stores linked to the home electronically. The children may receive much of their schooling at home, either by television or with personal teaching machines and programmed instruction.

While the picture of the family sitting at a computer or TV or message center may be carrying togetherness too far for some persons' taste, it will undoubtedly have some beneficial effects.

We are already concerned about the declining integrity of the family, and its social consequences.

We are already concerned about the loss of status of parents who are no longer the traditional source of wisdom for the next generation. The truth is that most parents today do not have the knowledge their children need.

In fact, the educators tell us that if we are not to waste a critical period in the life of our children, when they learn fastest, we shall probably have to begin their education at about 1 year -- at a time when they are usually closest to their parents, especially the mother.

We can expect enormous changes in education--not only in techniques, but in its impact on our whole society.

Projecting population trends forward, we can expect college enrollment to rise from 3-1/2 million in 1960 to between 13 and 16 million in the Year 2000.

If the size of our present colleges only double, we will need 1,000 new 4-year colleges, and 2,100 new junior colleges by the Year 2000.

Capital expenditures implied by this amount to about $100 billion, and annual expenditures would rise from $10 to $40 billion.

Education will not be something one gets like the measles, or passes through, like childhood: it will be an on-going thing. Our universities already have what they call "centers for continuing education" and so-called "extension" courses reach out into the adult community. In Los Angeles, one in every four adults enrolls in an extension course sometime each year--and there are more extension students than there are regular students.

The proportion of the population that will have had a college education will pass the two-thirds mark in 1980, and continue to rise. Colleges will become a place for retraining, as adults, trying to keep pace with advancing technology, are forced to learn to do 2 or 3 or more kinds of jobs during their working career.

One member of General Electric's TEMPO group has predicted that man will devote a third of his life to study, a second third to traveling, and the last third to profit from the fruits of his labor.

It is now technically feasible to put satellites in orbits (stationary with respect to the Earth's motion) and to

- store thousands of videotaped programs aboard each satellite, so that

- anyone on the Earth dialing the proper number could receive on his personal TV set any high-school or college course, or engineering training course, or entertainment movie.

All that means is that the Earth-Satellite communication system will not be just one program selected by a TV network, but one that anyone on Earth can use to obtain any of thousands of possible programs at any time.

Dennis Gabor, the British scientist and author of Inventing the Future, says that civilization faces three grave dangers: nuclear war, over-population, and leisure. He remarks that while the majority now works for the minority, the opposite will soon apply: a small number will create for the majority of consumers. Humanity will be divided into two parts: one-fifth engaged in the continuous process of creation, and

four-fifths working a minimum amount of time and confronted with leisure they will not know how to use.

Some people argue that a very small percentage of the labor force will soon be able to produce all the goods and services our society needs. This is probably nonsense.

The argument would be that the average family income in 2000, depending upon the rate of growth assumed, would be somewhere between $15,000 and $27,000. Now, even at that higher figure, you will probably agree that people won't be sitting around trying to think of ways to spend their money. And only when that is the case will workers increase their leisure time substantially.

We all know people with twice our annual income, and you might expect them to work half the time and enjoy our living standard--plus a lot of leisure. But no one seems to be making that choice.

So, by the year 2000, the average work week may have declined somewhat, but probably not much below 35 hours. All this <u>really</u> says is that people will accept and work for a very much higher income before they will start loafing.

Conflicting arguments center upon the various likely modes of transportation in the Year 2000. Some predict more trains--high speed, air-cushioned, medium haul lines. Others predict the demise of the railroad before 2000.

Some persons, recalling that in 47 B.C. Caesar barred wheeled vehicles from Rome during daylight because of traffic congestion, expect the automobile to be banned from the city of the future. Others envision a doubling of our automobile population by the end of the century, with most of the vehicles electric powered.

Short-range electric cars are already in use--mostly in plants where noise and noxious fumes must be avoided. The Federal Power Commission reports about 100,000 units now in use in American plants. In Britain, there are 40,000 electrically powered delivery vehicles on the street.*

Still another version would have personal transport vehicles publicly owned, coin-operated, much like inter-city trailer rentals. The analogy is drawn to the World War II British air base, where bicycles were parked at convenient locations, freely available, and redistributed optimally every day. Why not do something like this with cars?

The Russians predict a wider use of remote powered vehicles. They envision a "sleeping" network of semi-conductors to provide power to vehicles, that comes to life when activated by a vehicle and then conserves power by becoming dormant again.

---

* L.A. Times--2-26-67

The city of the future will probably not be quite as fantastic as some of the wilder planners tell us. But that they will be different from what we know today is certain.

The vice-president of the Canadian Refrigeration and Air Conditioning Association has suggested that Toronto be given a Caribbean climate by tethering plastic domes a thousand feet above the city, held up by warm air currents, capturing sunlight, etc. He sees orange trees in back gardens, roses in December.

We will very likely do something about the fact that one-third of most cities consist of roads and streets--and rising land-values may make underground freeways and parking economical.

The present flight to the suburbs is consuming the open spaces around cities at the rate of a million acres a year. At the same time, the central city is becoming more and more a ghetto peopled by poor minorities, unable to escape and unable to support urban progress with taxes. We are going to have to tear down and rebuild many of our cities, and not by slum-displacement urban renewal as in the past.

By the Year 2000 we may see a proliferation of satellite cities of moderate size and a decline of giant urban concentrations. Even under the pressure of population growth, the city of the future is more likely to feature self-sufficient high-rise structures and open spaces than the urban sprawl that characterized city growth in the last half-century.

Some of my colleagues at RAND are very much concerned about privacy in the world of 2000, when our information processing, storing, and retrieval systems will have become extraordinarily cheap and widespread.

A few months ago, the Government was considering centralizing its computer facilities, and Paul Baran of RAND testified against such a move.

As we go through life we leave behind a trail of records. Starting with our birth certificate, we accumulate medical records, educational data, I-Q test scores, personality profiles, military records, a social security file of employment, a driver's license with traffic citations, and possibly police records. As adults we have charge accounts, bank credits, tax records, and so on. The list is almost endless.

Today these records are widely dispersed and generally inaccessible without a great deal of effort. In the future it is possible that the information will be centralized and cheaply available. Unless appropriate precautions are planned now, an unscrupulous person would be able to turn up scandal or defamatory information (where it exists) with comparative ease.

Until now, a person could escape his past. In the future, that may be impossible. How much will we value privacy in 2000?

The other day a professor of law, and law librarian at New York University,

predicted that an "author" might soon sell his work to an information system run by the government, industry, or libraries--rather than to publishers. He would be paid, not for the number of copies printed, but for the number of times his computer-stored material was used. The professor expects future generations to be less interested in traditionally bound books.*

But books on microfilm are already fairly popular, and to bring information to even more millions of persons in the developing countries may call for even more imaginative schemes.

David Hays, a linguist at RAND, has been quietly proposing that someone give him $200 million so that he could set up a thousand new libraries around the world, each with a million "books." The idea for providing the underdeveloped world with a billion books rests on technology that is already here.

The National Cash Register company has devised a way to put as many as 2500 pages of printing on a 4 x 6 card--it is called ultramicrocard. A 200-power magnifying reader, costing $200, is needed.

But imagine having a million-book library in a filing case four feet high and six feet long. If its catalog consisted of bound volumes--say 80 volumes of 1000 pages each--it would take up more wall space than the card file.

* N.Y. Times--2-11-67

But the need is great. Central Africa has 1200 higher educational institutions for 150 million persons, and only 2 million books. Most of the world has fewer than one book per five persons in its libraries; we have about 3 per person.

It is safe to say that libraries of this sort will be commonplace in the Year 2000--in this country, as well as abroad. Earlier this year, the director of the New York Public Library revealed that nearly 2 million of its books--almost all those published after 1870--are in an advanced state of deterioration.

The Wall Street Journal recently described the library of the future--of the year 2000--as a "computer-run warehouse." The patron would go into a cubicle where at the push of a button he could call forth tapes, recordings, films, and print-outs of books.

At the library-of-the-future meeting earlier this month, I heard Ray Bradbury, the well-known science fiction writer react to this suggestion. He is a man who, if he hasn't seen the future, has invented it. And this sort of library is not for him. He threatens to short-circuit the machines. He wants a library to be a place where you can smell and handle the books.

What can we look forward to on the international scene in the Year 2000?

Most analysts--including the Delphi group, the Commission for the Year 2000, Herman Kahn, and a number of European futurists--believe (first of all) that the likelihood of a major war between now and 2000 is small, and (second) that we may be entering an era of stability--a "Hundred Years' Peace."

It is difficult to classify and rank the futures of the many political elements that make up the world, but let me try to say just a word about some of the more important.

Many persons believe that the United States will withdraw from its position of "policeman of the world" and may become once more an isolationist, Western Hemisphere centered nation.

There are two schools of thought on China. One, exemplified by Herman Kahn, feels that too many persons have confused size and power, and that China's enormous population will remain a handicap to its industrial progress and political influence. Others argue that by the end of this century, China, Indonesia, and Brazil will all have risen to positions of power. A subset of this school believes that China will withdraw from international competition and, like the 19th Century U.S., consolidate its internal gains--economic, political, and scientific: in essence, they predict a rebirth of historic Chinese self-interest and disdain for the rest of the world.

Japan is expected to move from a fifth or sixth-rate power in population and national product, to third rank in gross national product and second in per capita income.

What of the two Germanys? East Germany by the Year 2000 may have become a stable, self-sufficient nation with a future. West Germany, still regarded as a threat by most of Western Europe, will rank fourth in the value of its national output, but will be close behind Japan in income per capita.

Both Africa and Latin America will be wracked by political unrest in the coming decades, postponing until beyond the Year 2000 the achievement of the social revolutions and national autonomy that will permit steady economic advance.

Such generalizations are probably meaningless, unless supported by detailed analyses of individual countries. Because that is impractical to do here, suffice it to say that there is a higher probability of peace than of war, and an even chance that some kind of world government will be evolving toward the end of this century.

* * *

In the past, and not too far in the past at that, man regarded Nature and his environment as more often than not an adversary. It was the sometimes benign sea, from which he made a living, that could smash his vessel and batter his harbor. For the farmer, it was the warm sun,

the gentle rain, and easy breeze, that might scorch his crops, flood his rivers, uproot his orchards, and carry the topsoil into the next county.

All these events occur today, here and in distant lands. But there is a difference. Not only do we have swift means of rescuing the stricken--not always all, or soon enough--but we can gradually learn to prevent or alleviate many of the "natural" disasters of the past.

The panorama of future possibilities that I have laid before you does not represent a world that you will have whether you want it or not. Most of the developments I have described, and the circumstances they imply, are man made. How much open space, park, and wildland; how much clean air and water; what kinds of schools and cities and means of transport; even the kind and amount of personal freedom and privacy you will have will depend upon decisions you may be called upon to make in the years to come. Decisions being made today directly affect the future. Some of today's decisions have a statistical probability of affecting someone we have never seen in distant lands, and may never see--in future generations.

Rational man must view the future as subject to his control. And each of you bears some responsibility for the kind of world you and your children will have in the Year 2000.