The Step to Man

Our recent era of change may be converging to a unique historical transformation to a new kind of life.

John R. Platt

Change, change, change, continual change. This is the watchword of modern life. We have not only adjusted to it, many of us have begun to revel in it. Conservative scientists have predicted the end of change at various times, but they have always been proved wrong. It seems it must go on forever. In the last two decades, the changes have been coming faster than ever before. Planes have passed the speed of sound, bombs have become incredible and then incredible squared, men are in orbit; and here below, new countries have proliferated, television has become universal, and every corner of the world is in a state of ferment.

Yet it seems to me that the excitement of our changes and emergencies has led us to look at them on too short a time scale. Let us not view them through the eyes of the newsman with this month's crisis or the advertiser selling this year's cars or even through the eyes of the planner announcing development programs for 15 years ahead. Let us look at our changes under the aspect of history. Grandparents are still alive who saw the coming of the motorcar and the airplane. Let us look at least as far ahead, to the time when our children will be grandparents in the 21st century; or 100 or 500 years ahead of that—to a time, say, as far away as the Renaissance is today.

I think anyone who does this will soon realize that most of the dramatic changes that have characterized the 20th century, like those in travel and communications and weapons, cannot possibly continue at the present rates for anything like these lengths of time. It becomes obvious that many of them must converge rather soon to various kinds of limits, so that these aspects of society must begin to take on much more stable forms.

Should it surprise anyone that there might be an end to structural change in society? A boy does not go on growing forever. He finally reaches manhood and stops—though his mature accomplishments are just beginning. Likewise if a world once becomes unified, by communication and travel and mutual danger, into one world, the situation must level off. What more is there to do in that direction?

Many of our important indices of technical achievement have been shooting up exponentially for many years, very much like the numbers in the biologists' colonies of bacteria, that double in every generation as each cell divides into two again. But such a curve of growth obviously cannot continue indefinitely in any field. The growth of the bacterial colony slows up as it begins to exhaust its nutrient. The exponential curve bends over and flattens out into the more general "S-curve" or "logistic curve" of growth. Stevan Dedijer, of the University of Lund, and Derek DeSolla Price of Yale University, in his book *Little Science, Big Science* [Columbia Univ. Press, New York, 1963], have recently emphasized that research-and-development expenditures in the United States are now slowing up their rate of growth in just this way and are already beginning to be "past the middle of the S-curve." The reason is clear. Big research-and-development depends on big money, and these expenditures are beginning to exhaust their nutrient.

But I think this phenomenon of slowing up is now becoming much more general. Many scientists seem to suppose that we are just at the beginning of a curve of indefinitely accelerating change. They point out that Laplace and then Michelson long ago predicted the end of change in physics and that they were wrong. But it is one thing to see a slowing up of intellectual returns in certain areas, and another thing to see that life is short and the world is small and that there are physical and natural and economic limits to everything. I think it can be shown that many of our present changes are already rushing rapidly toward such limits. And many of our social adjustments to change are well on their way to what might be called "steady-state forms" that could accommodate orders of magnitude of further technical development without much additional restructuring.

I suggest that it is time to consider a different view, that we are not at the beginning of continually accelerating change, but that we are in the middle of a unique transitional crisis, like adolescence, as we make the jump from an undeveloped scientific and technological society to a fully developed one. Who knows?—we may be even beginning to be past the worst of the crisis, at least in countries like the United States. The slowing down of growth and the beginnings of our adjustment to it may become one of the major social phenomena of the next 30 years. Do you doubt this? Take a brisk excursion with me through some of our important areas of change and see if it is not so.

Plateaus in Sciences and Technology

Consider for example what is happening at present in certain technical fields, as typified, say, by the high-energy accelerators of modern physics. DeSolla Price shows in his book that for 35 years now, we have been increasing the energies of our largest accelerators almost exponentially, as Fermi pointed out some years ago. It is worth quoting some of the numbers, although very approximate figures will suffice for the points I want to make. In the late 1920's, atomic particles could be accelerated to roughly 500,000 electron volts of energy. Successive inventions raised the limit to

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about 20 million electron volts in the 1930's; to 500 million by about 1950; and to 30 billion by the 1960's. Today, one machine under construction is designed for 50 billion electron volts. This is an increase by a factor of 10^5 in energy in these 35 years, or a multiplication of the energy by another factor of 10 in every 7 years.

Can new inventions raise the energies by still another factor of 10^5 in the next 35 years? Perhaps, but many doubt it. The reason is money. At present there is talk of a 200-billion-electron-volt accelerator which will cost far over 100 million dollars; and after that, of a 1000-billion-electron-volt machine. But this would be so large that it might require international cooperation to finance, and the work of thousands of physicists and engineers for 10 years to construct—that is, a major fraction of all the money and effort likely to be spent on physics in the whole world in that period. There are protests from other scientists whose projects are equally in need of money. Loud objections are being heard not only in scientific societies but in the halls of Congress.

Of course this probable leveling-off of one expensive field does not mean that the era of change is over, even in physics. Other areas of exponential progress may appear again and again. But this example shows us what forms and limits, from now on, will shape them all. Research-and-development is now a major social business, to be planned for, to be encouraged more richly than ever, to be put to immediate use when possible—and to be consciously limited to a fraction of the national resources and the national budget that is probably not far above the 20 billion dollars, or 3 percent, that is presently being spent on it in the United States. There is a plateau here, an organizational steady state, that we have nearly reached already.

Let us go on to consider another rapidly changing technical field and one with more social impact, the field of computing machines. In the last 20 years or so, the 10-place desk calculator has been surpassed first by John von Neumann's ENIAC computer at the end of the war and now by much faster and more sophisticated devices. It is hard to give exact figures for the improvement in speed and capacity of the machines in this period because the principles of operation have changed drastically, but it might be estimated as a factor of roughly 10^5. In one instance that I know of, a brilliant student in the early 1950's took 2 years on a desk computer to do a quantum-mechanical calculation that was done 5 years later on an electronic computer in 14 minutes. By now, the time required to do this calculation, once a machine has been programmed for it, is probably less than 1 minute.

Today the designers of solid-state and other advanced computers say that a further increase in speed and capacity by a factor of 10 or 100 is in sight, but they do not seem to expect another factor of 10^5 in the next 20 years. When the information travels between the parts of a computer with the velocity of light, the natural limit to the speed of operation has been reached, and this is a limit which is no longer very far off.

It is true that we are probably on the verge of great developments in applying computers to pattern perception and learning and to complex manipulating systems. But computers are already an integral part of advanced science and business and government. Machining and accounting and management and strategy problems are increasingly being turned over to them. It is therefore a little hard to see how even a dramatic extension of their powers could make as much further difference to our attitudes and ways of life as their development up to the present level has already made.

This may possibly be true even of the application of computers to automation, which is threatening to give us leisure in the decade ahead. This is sure to produce in the long run a great social restructuring; yet it is a restructuring which is already well under way. The problems produced by the elimination of labor are not the problems of the 30 hours a week, or 10 hours, or none, that a man works. They are problems of coupling this to economic distribution and to self-respect, and problems of idleness and boredom in the 138 or 158 or 168 hours when he does not work. They are not nearly as different from the present situation as it is different from that of the last century; and the time when we will be forced to find some sort of solution to these problems is almost certainly within the next decade or two. On the scale of history, are we not almost there already?

Plateaus in Communication and Travel

Suppose we turn instead to the fields of communication and travel. In communication, the coming of the telephone and radio and of television in the last 20 years—now with satellite relays across the oceans—has taken us onto a plateau that is obvious to anyone who thinks about it. Once we can transmit sight and sound around the world within 2 seconds whenever we want to, there is little further to be done but to extend the networks.

It is not generally realized, however, that we are also approaching an effective plateau in our speeds of travel. I once had the idea that we ought to organize a Centenary Celebration in honor of the occasion when man first traveled faster than the top speed of any animal or bird. This important breakthrough in evolution must have occurred just about 100 years ago when the steam locomotive first got up to 60 or 70 miles an hour.

Today millions of people fly at 600 miles an hour in commercial jets. Commercial supersonic transports for 2000 miles an hour are on the drawing boards; and experimental rocket planes have passed 4000 miles an hour.

How long can this acceleration of speed go on? This is an easy question to answer, because it is finished. At around 100 miles an hour, we give up land transport and take to the air. At around 17,000 miles an hour, we give up air travel because we are in orbit. And this step is already behind us.

As a matter of fact, I think the full sociological consequences of high-speed transport are already implicit in the jet-plane speeds we have today. Scarcely a hundred years ago, going around the world meant months of sailing around the Horn. Now civilians as well as armies can reach almost any point on the globe in less than a day. Can any further reduction in this time, say to 6 hours by supersonic transport, or to 1 hour by rocket, ever make as great a difference again? I think not. In most worldwide plans and operations, travel time is no longer the most significant variable.

Once horses had been tamed, men built their lives and societies around them for thousands of years. Today the United States is built around high-speed powered transportation. We have the automobile, the airplane, and the

Go-Kart. It is transport that shapes the layout of roads and cities and airports and the structure and mobility of youth and workers and families and business and government. Might not our accommodations to fast easy transportation, and our attitude of taking it for granted, go on again almost unchanged for hundreds or thousands of years? I must confess that I fail to see how any new vehicle, no matter how marvelous, could again have the revolutionary effect that the railroad, the automobile, and the airplane had when they displaced the horse and carriage. Once more, regardless of future developments, in some important sense we are there already.

It is more surprising to realize that this is also almost true of space travel today, even though at the time I am writing this, it has been just 7 years since the first orbiting satellite, Sputnik, was sent up. Dramatic order-of-magnitude improvements, and manned missions to the moon and planets, and wonderful decades or centuries of exploration, are still ahead. But the moon has already been photographed from close range and the Mariner flights are under way, sending back detailed data from Venus and Mars. Rockets already have the speed needed for exploring the solar system, and the times required would not be appreciably reduced by new plasma or nuclear rockets. The unexpected result is that the level of accessibility of the solar system that we can develop in the next 10 or 20 years may quite possibly represent its level of accessibility for hundreds of years to come.

Or to come back to terrestrial matters, consider the exploration of our own globe. Just since 1953, men have climbed the highest mountain and reached the bottom of the deepest sea. They have lived on a floating island in the Arctic and at the South Pole all year around—with running water and hot showers. Much more remains to be done, especially in exploring the oceans and penetrating the solid crust, but it is clear that the whole surface of the earth has become ours to study and use as we wish. When there is no farther to go, there is no farther to go. We have stepped up onto that plateau as well.

What about our technical achievements having to do with life and death?

I think the same imminent leveling-off can be seen here also. As everyone knows, bombs have increased in power from the 20-ton chemical "blockbuster" of the early 1940's to the 20,000-ton atomic bomb at Hiroshima and then the 20-million-ton hydrogen weapons after 1953—an increase by 6 orders of magnitude within a single decade. Today the largest hydrogen bombs are equivalent to about 100 million tons of TNT, and there are so many of them—so much "overkill"—that they could wipe out all life on the planet. But the largest ones are already too large to have maximum efficiency for surface destruction, and the use of a number of smaller ones is computed to be more "effective" for military purposes. Will we make larger bombs in the future? We can if we want to, but even for the most overwhelming military purposes, we do not need to.

Even in the matter of the *control* of nuclear weapons, I think we may be approaching some sort of limit. This takes a little explanation. How dangerous can the situation get? At the present time we are near the edge of a precipice. Every year or two there is some major international crisis where there is a serious probability of an "accident" that could trigger a nuclear war and escalate into nuclear catastrophe for the world. Korea, Suez, Berlin, Quemoy, Cuba, Vietnam. Last week's crisis, whatever it was. It is nuclear roulette, so to speak, where the probability of a fatal shot may be small each time you pull the trigger, but where, if you play the game long enough, it finally, certainly, kills you. Dedicated men have worked very hard in each of these confrontations to avoid a nuclear incident, but we may not continue to be so lucky. Next time it may be a nuclear terrorist or a suicidal maniac or just a junior officer beyond control.

As a result, some have estimated that our "half-life" under these circumstances—that is, the probable number of years before these repeated confrontations add up to a 50-50 chance of destroying the human race forever—may be only about 10 to 20 years. Obviously this is not an objectively testable number. Nevertheless the idea is clear. We see that our boasted decreases in death rates and increases in the length of individual human lives in this century are spurious, as long as this nuclear danger is so uncontrolled. This is the first time in the history of the human race that babies—all babies everywhere forever—have had such a slim chance of survival.

Then why do I say that we are near a limit in these dangers? Just because this cannot continue. No one lives very long walking on loose rocks at the edge of a precipice. Either very soon, in 10 or 20 years, or in 30 or 40, we fall over the nuclear precipice; or else very soon, before that time runs out, we argue some sense into our collective heads and move back from the danger.

Some talk of another possibility, that we might have a nuclear war with some people still surviving—at least *this* time—by going underground, in shelters and mines. But this, even if it could work, is only a temporary and horrible postponement of the problem—like falling partway down the precipice and then getting up, battered, to fall again. Do we come out of the shelters at last, to bury and clean up and rebuild, only to have the survivors going underground again with a resurgence of nuclear powers in another 20 years or so? And then again 20 years after that? Or do we stay underground for a thousand years and hope we will mysteriously have learned how to solve the problem of our competing nuclear threats after that time?

This is obviously not an alternative at all. It is nothing but a refusal to face the necessity for agreeing eventually on a method of international nuclear control, a refusal to see that no postponement in the shelters offers anything but greater danger and difficulty.

I have gone into these alternatives here, simply to explain the basis of my conclusion that within a few years the situation will be over. Either we will be finished—or half-finished, trying to drag ourselves up again with none of the problems solved—or we will have drawn back from the precipice by actually bargaining or paying for nuclear restraints, with even the most difficult nations, so as to give us all a longer half-life.

But if in this short time ahead we can find a way to reduce these crises and probabilities by, say, a factor of 10, then we might begin to have 100 or 200 years to think how to reduce them further. And then we might begin to have a chance of lasting 2000 years—or 20,000!—hopefully,

say, as long as agriculture has lasted! I can only conclude that if we live, and if we work to live, we are even now within sight of a plateau and even a falling-off in the dimension of terror. But time is running out, and it is the wisdom and effort of men today, in this present generation, within the very next few years, that will make this permanent decision for us as to whether we live or die.

Limits of Disease and Population

Finally, let us consider that other problem of life and death, the population problem.

Julian Huxley once pointed out that the two major biological inventions in historic times have been the control of germ diseases, and artificial contraceptives. They date from the work of Pasteur and of Goodyear just a hundred years ago. It is these inventions and their successors that are mainly responsible for our present population explosion—and for the hope of controlling it. They are the positive and the negative feedbacks determining human numbers.

Today bacterial diseases are approaching extinction, and virus diseases are coming under control. In the last 20 years, four of the last great killers, malaria, syphilis, tuberculosis, and polio, have been essentially wiped out, thanks to penicillin and sulfa drugs and vaccines and DDT. Cancer and circulatory diseases remain—and let no one belittle them! But most of mankind has already acquired toward disease the Pasteurian attitude, one that we might keep for a thousand years or forever, the attitude that we can do something about disease and need not remain its helpless victims.

The trouble is that this has led to an exponential growth of population that looks overwhelming unless something is done about it. And once more we discover that this present age is the time of the transitional crisis. It is said that Paleolithic man doubled his numbers every 30,000 years. Today the world population doubles every 30 or 40 years—roughly 1000 times as fast.

This exponential growth is so steep that it cannot go on for very long, on the scale of history. Today our population is over 3 billion. By the year 2000, with a 40-year doubling time, it will be 6 billion; by 2040, 12 billion; by 2080, 25 billion; by 2120, 50 billion. This is almost 20 times our present numbers—a horrible prospect—and close to the estimated limit of the earth's food supply, even at the starvation level. But if the food supply is twice or four times as great, it is only a matter of another 40 or 80 years. The problem is in the exponential character of the growth, not in any particular numbers we put in. We see that within an uncertainty of 50 years or so, the time before the population growth slows up or levels off from starvation is only a couple of long lifetimes, a time no greater than the age of the United States. In fact, the famine is beginning already, with the population going up and the amount of food per capita now dropping steadily year after year in several countries.

If the world wanted to level off its population at some less extreme density before reaching universal starvation, say at a density of no more than twice our present numbers, we see that it would have to get agreements and apply effective methods of control almost immediately, for it would have to produce a leveling-off in less than 40 years. The surprising thing is that this may now be technically possible, because of the rapid development of cheaper and simpler methods of birth control, such as oral contraceptives and intrauterine coils, in the last decade. The problem is orders of magnitude easier than was believed even 5 years ago. The setting of birth rates and growth rates for a country is ceasing to be a matter of individual expense and resistance and is becoming a question rather of public policy and persuasion and effort. It is becoming a matter for conscious decision rather than collective drift. The widespread acceptance of this attitude in all countries and all religions is another plateau-step that may be taken in the very near future.

A Cultural Shock-Front

I have taken pains to enumerate these many areas where our civilization is beginning to be "past the middle of the S-curve," just because it is not generally appreciated how numerous and how central they are, or how convincing the evidence is that there are limits in sight. I realize that prediction is uncertain and that my conclusions are novel, but I think they are at least as plausible as the uncritical assumption that changes like those of the 20th century will go on forever. Marvelous developments lie ahead, particularly in biology, but I do not think they will make as radical a change in world society, as it is now being restructured, as the changes of the last hundred years made in 19th-century social systems.

If this is true, the present generation is the hinge of history. It may be no accident that the approach to maturation in different fields shows a concurrent pattern. Our new developments in power and communication and control all support each other. And they are supporting and being supported by the simultaneous changes in economic and social and international structure. It is those aspects of technological change that have been pressing humanity so rapidly toward becoming a closely interconnected species, a species in full possession of the world and its abundance and with an adequate capacity for control and survival, that are reaching toward mature and stable forms in this generation. They are forms totally different from those of our tribal warring past, but they might conceivably go on as long as the old forms did, for hundreds or thousands of years into the future. What is happening is that we are in the midst of being compelled to reorganize the internal structure and powers of the race into a mature human integration that could be called manhood.

As a result, I think we may be now in the time of most rapid change in the whole evolution of the human race, either past or to come. It is a kind of cultural "shock-front," like the shock-fronts that occur in aerodynamics when the leading edge of an airplane wing moves faster than the speed of sound and generates the sharp pressure wave that causes the well-known sonic boom. The front edge of this pressure wave is the shock-front. It is a thin region where the low temperatures and pressures of the air ahead of the plane change suddenly to the high temperatures and pressures of the air immediately behind.

I think our present transitional crisis is a similar shock-front for the human race, buffeting us about as sudden changes in every direction come thick and fast. It is a multiple shock-front,

with each type of exponential change reinforcing all the others. The Western world has encountered this cultural shock-front first—it is closer to the airplane of history, so to speak—but it would seem from the speed of industrialization of Japan and Russia that the rest of the world can be no more than 30 or 40 years behind. Throughout the world, the farm and city ways of historic man are being transformed rapidly to the ways of a high-technology world society.

Life Ahead

But the shock-front analogy is also an instructive way of thinking about the times ahead. It suggests that after the shock-front has passed, we will have reached larger powers and interactions —higher temperatures and pressures! —but that the buffeting of change will be reduced, and the times will perhaps become psychologically and socially calmer than anything this generation or this century has known.

Life will go on being different, partly for the familiar reason that we will go on having more population and power, more communication and science, in every decade. But it will also be different in a different way, because the approach to a steady state is something rare in the history of the world. We see that humanity is on the verge of a new kind of life. I think an examination of the question of what it will be like could be one of our most constructive intellectual exercises today. It would show us how different our present problems and solutions appear, when seen in the perspective of the great changes and the different structures just ahead. It would help us see what we must do to make the changes less traumatic and to shape the structures more intelligently.

The problem of arms control, for example, becomes a different problem if it is seen as a temporary substitute for other ways of keeping the peace in a disarmed world. Innovations in education take on a different character when seen as part of the total improvement in education that will be needed for every child in the world in 50 years. The need for philosophical integration of our new knowledge about the biological and intellectual and social nature of man takes on great urgency when it is realized that this is the substructure on which the social and political philosophy of our grandchildren's world must be built. Where are our Montesquieu and Rousseau today? What have Freud and the behaviorists taught us about irrationality and educability that would help us design a good society and a free and flexible society without the danger of recurrent instability? Are many different good societies possible, and can we choose among them or move at various times from one to another?

These are problems for extensive debate, but even without answering them it is easy to show that life in any steady-state world must differ in many respects from ours.

One of the unexpected differences, for example, will be the difference in age distributions and probably a related difference in family patterns. Throughout history, children have been a majority in most societies. The proportion of children to total population was high because so many were born who did not live to adulthood. It is estimated that at most times and places, half the population has been under age 15. Today in America, because of our postwar baby boom, half the population is still under 20. This makes a large "teen-age market" that many manufacturers are now trying to reach.

But in a steady-state world—no matter whether it has a smaller population than ours or one many times larger—the same number of people would be born in every decade and the same number would die in every decade. If our death rate in early life continues to go down, there will then be just as many people at age 40 or at age 60 as at age 10. And if they all live to about 80, as it now seems they might, then half of them will be over 40 and only one-fifth of them will be children under 15. It will be very different from the Indian village or the slum neighborhood with children everywhere underfoot. The curiosity and laughter of children will be scarce, and the world will begin to be run, even more than it has been, by the old.

A strange world, for us. But it could be a good world, if the old remain young in heart and vigor. They could use their great excess of adult-power, prosperous and leisured, to make the richest education for children that the world has ever known. Perhaps childless adults will move in with family groups, so they can share in the love and laughter of the children and spend endless hours in teaching them, in something like the old Hawaiian tradition. We may move away from our small-family separateness and back toward more tribal groupings as children become scarcer, and as the reduction of the speed of change makes it easier for the different generations to talk to each other again.

The Quality of Life

What will we do with our time in that leisured world? Undoubtedly there will be still more travel and more vigorous and daring outdoor recreation. Life will be dull otherwise. Perhaps thousands will climb Everest and millions will ride dolphins. But I think the activities that will really begin to bloom are the creative arts and education and science. Not just Sunday painting, but Wednesday-Thursday-Friday-Saturday-Sunday painting. Continual rebuilding of your own home to your own taste, filling it with personal ingenuities and bold designs, might become the fashionable thing to do.

And education and science may become activities for everyone. Who kept up with the philosophers of the French Enlightenment? The leisured classes of the drawing rooms. Who did science, at first? Rich amateurs and leisured clerics with an easy routine and the time to do experiments. Already education and scientific research are our fastest-growing industries. With preschool enrichment raising the level of intelligence, as some evidence now indicates, perhaps increasing numbers will profit from education all the way to the graduate level, and continuing education for much of the population may become a lifelong activity.

Likewise in science, many adults may fix up a laboratory room in their houses, where they can work every day at some scientific project, some study in crystallization or in embryology or in teaching animals that could offer a lifetime of unfolding discovery.

One other characteristic of a steady-state world that deserves special mention is its requirement for a high standard of social justice. If we survive at all, after this great disturbing shock-front has faded into a phenomenon of history, it can only be by

working out a new attitude of tolerance and mutual support for each other, between colored and white, between rich and poor, between advanced nations and retarded ones. The unemployed, the underprivileged, the underdeveloped, all the groups neglected or exploited by our present arrangements or condemned to exclusion from our prosperity by the accident of parentage or place of birth, form a perpetual seedbed for spokesmen and would-be dictators whose juntas may take over nuclear administration in the name of correcting these wrongs. Our failure to eradicate these evils depresses the standard of living and shortens the probable "half-life" of everyone. We are now realizing this, in Congress as well as in the councils of the world. What is fortunate for us today is that our new understanding of the educational and developmental basis of prosperity has made it possible and profitable to cure these evils just at the instant when our new weapons technology has made it absolutely necessary to do so.

We can no longer afford poverty in the world—if we ever could. We can no longer afford ignorance or prejudice or neglect. It is not so much that they are a sign of moral wickedness as that they are a sign of incompetence in design and administration. It is time to apply at least the same standards of competence and satisfaction in running the world that we apply in running a family or a business. Any member of the world now not only deserves to be shown, but must be shown, as surely as a member of a rich man's family, how he can share in its abundance. Any child in the world now not only deserves to have education, but must have education, like a privileged child, for the full development of his potentialities from the age of one year on up. It is necessary not only because we can afford it but because we must afford it.

The world has now become too dangerous for anything less than Utopia.

New Knowledge and New Biology

Will it all be static in this strange new world of the steady state? The answer is no, nothing will be static. What will begin to be steady is our acceptance of these new ways of creative leisure and interaction as being the most interesting and most satisfying ways of life. But all our indices of flow, production, commerce, communication, will be up from what they are now. The marvelous accomplishments of a mature and integrated society will be just beginning. And two fields, scientific knowledge and biological technology, will surely go on changing and developing indefinitely.

I see no end to the increase of knowledge. When scientific research has as many men and as much money every year as society can afford, it will be adding even more rapidly than now to our knowledge of nature and to the ease with which we can control nature. And this world of nature is infinite to us, for it includes the human brain itself. After all the myriad galaxies of the astronomers are charted as well as we want to chart them, we will still go on studying the multimyriad complexities of the brain that has measured them.

Our knowledge of nature will surely be used increasingly for the improvement and variation of our biological apparatus for living. If we can actually set up a social structure that will enable us to live together without killing ourselves, for a thousand years or a million years—a time as long as the time since man began—it will begin to give us the time we need to understand and develop our full biological potentialities. Things we now cut out of the human body by surgery—the appendix, the tonsils—can they be eliminated from the hereditary genes instead? Our eyes and ears that give out when we are old, our hearts and arteries—why not make them better biologically from the beginning rather than by doctoring after they begin to fail? We begin to see the possibility of reshaping the human organism, as we have been reshaping plant and animal organisms now for many years, into a new form or into many new forms that will begin to show the full potentialities of protoplasm and the creative brain. In such a time, man will cease to be at the mercy of the evolutionary accidents that made his frame and his society—just as he has ceased to be at the mercy of the biological accidents that made his diseases. It will be a time when man can begin to plan what he wants man to be, as each individual makes his personal plans today—a time when accident and drift will finally begin to be replaced by conscious human values and decisions.

Metamorphosis

The accelerating powers and dangers and hammer-blow stresses of these days make us anxious and afraid. But I think it is clear that if we survive this shock-front, this roaring waterfall of change, we could be within sight of what Churchill once called the "sunlit uplands."

Various metaphors could be used to describe the situation. In many ways, it is like a child learning to ride a bicycle. There you were, up until that day, riding on the three-wheeler where you couldn't hurt yourself very much. But then you get the two-wheeler, and it seems terribly scary, and perhaps you fall and skin a knee or an elbow. But you get up again, and your father holds the handlebars, running along beside you, and suddenly you are riding alone. At one instant you are incompetent, falling to one side or the other and steering wrong, and the next instant it comes right and you are in control, safe and balanced not because you are fearful and slow but because you are going faster than ever. Wobbling and weaving but nevertheless choosing your *own* path and balancing safely at every turn. So, I think, in 30 or 40 years, if we survive, the human race will come through this time of wobbling conflict and uncertainty and falling, and will suddenly be riding in its own chosen direction, free, as only a coordinated and confident organism can be.

To say it another way, it is like the time of adolescence, when the teenager suddenly changes, with some thrashing about, from the dependent child to the independent man. Or it is like the moment of birth, full of pain and danger as the baby in the womb is suddenly pushed through into a new life where he must breathe alone and learn to walk and talk and think. Or it is like the moment of metamorphosis of the insect, when there is an incomprehensible swelling and dizzy changes of shape and desire in the tight cocoon, until suddenly it bursts open at the end of its own sharp S-curve, its own era of change, to reveal an unimagined transformation to a new free winged life.

This is the meaning of the leveling off of our S-curves. We are now nearing the end of the era of change. We have been isolated human beings, selfish, combative, ignorant, helpless. But now for several hundred years the great evolutionary hormones of

knowledge and technology have been pressing us, almost without our understanding it, into power and prosperity and communication and interaction, and into increasing tolerance and vision and choice and planning—pressing us, whether we like it or not, into a single coordinated humankind. The scattered and competing parts are being bound together. Everywhere now we begin to see men and nations beginning the deliberate design of development with a growing confidence in the choice and creation of their own future. The exponential changes have burst apart our ancient attitudes and structures, and our failure to adjust to this may yet kill us, but if we are wise and energetic and understand our own nature and purposes well enough to restructure and control these dangers, mankind may emerge very quickly into coordinated forms such as it has never known before. Our drastic changes will not go on forever. They are converging to a limit. It was implicit in the biological material all along, as surely as the butterfly is implicit in the caterpillar. We have been men. We are emerging into Man.

Yet no analogy, not even that of metamorphosis, quite captures the suddenness and radicalness, the really complete restructuring, of the transformation ahead. If the 2 billion years of life are represented by the 200-foot height of, say, the Rockefeller Chapel at Chicago, the million years of man make a 1-inch block on top of the chapel. The 20,000 years of agriculture make a thick postage stamp on top of that, and the 400 years of science make the ink on top of the postage stamp. Now, suddenly, we see what all this has been building up to; and it is about to come within a single generation or two—that is, in the thickness of the film of moisture on top of the ink on the postage stamp. In that short time we will move, if we survive the strain, to a wealthy and powerful and coordinated world society reaching across the solar system, a society that might find out how to keep itself alive and evolving for thousands or millions or billions of years, a time as long as all of evolution past. It is a tremendous prospect. Hardly anyone has seen the enormous sweep and restructuring and unity and future of it except perhaps dreamers like H. G. Wells or Teilhard de Chardin. It is a quantum jump. It is a new state of matter. The act of saving ourselves, if it succeeds, will make us participants in the most incredible event in evolution. It is the step to Man.

News and Comment

HEW: As Secretary of Department of Health, Education and Welfare Gardner Faces Formidable Tasks

President Johnson's appointment of Carnegie Corporation president John W. Gardner as Secretary of the Department of Health, Education and Welfare (HEW) caused less surprise in Washington than the naming of Arthur Goldberg as U.S. ambassador to the United Nations, but the Gardner appointment seems to have drawn similar approbation.

Gardner, whom a New York *Times* profile said "is widely regarded as the most powerful behind-the-scenes figure in American education," is stepping into what, in the next few years, could be one of the more exposed positions in American public life.

As HEW Secretary—Senate confirmation is regarded as a formality—Gardner will preside over a sprawling, expanding federation of agencies in which, until very recently, health and welfare activities have dominated—rather than the education programs with which Gardner has been chiefly identified.

The major bureaucratic components of the department are, in addition to the Office of Education, the Social Security Administration, the Food and Drug Administration, the Welfare Administration, and the Public Health Service—the parent agency of the National Institutes of Health. The Department has over 80,000 employees.

The Department of Health, Education and Welfare was created in 1953 after years of debate and out of administrative desperation. The Eisenhower Administration was able to allay the apprehensions of conservatives in Congress about the potential rise of a powerful "ministry of welfare." For some years, HEW grew slowly and was facetiously known as the Department of not much Health, Education and Welfare.

This has changed and is about to change even more markedly. Medicare legislation just signed into law will mean heavy and complex new administrative duties for the Social Security Administration. A bill to establish a national network of regional medical centers for the prevention, diagnosis, and treatment of heart disease, cancer, and stroke has passed the Senate. If it achieves final passage, the program will fall to the Public Health Service to administer. The Food and Drug Administration is given substantially increased responsibilities in a recently passed set of amendments tightening controls on psychotoxic drugs. And the agency is currently under sharp attack by Representative L. H. Fountain (D–N.C.) who has roundly criticized aspects of FDA operations and some of its personnel. The Office of Education (OED) has been transformed into a major agency in terms of both budget and scope of activities during the past 2 years by a spate of legislation. These bills provide major assistance to schools and institutions of higher education, amendments to the National Defense Education Act, and the vocational-education legislation and poverty-program legislation which deeply involves OED. Particularly in these new education measures, the HEW Secretary is given discretionary powers which are very extensive and are likely to make Congress unusually watchful of the Secretary's actions.

HEW has had five secretaries in its